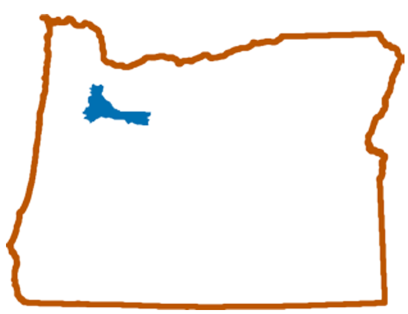
Marion County

MULTI-JURISDICTIONAL ALL- HAZARDS MITIGATION

PLAN VOLUME IV: DOGAMI REPORTS

- Marion County
- City of Aumsville
- City of Aurora
- City of Detroit
- City of Gervais
- City of Hubbard
- City of Idanha
- City of Jefferson
- City of Keizer
- Keizer Fire District



- City of Mill City
- City of Mt Angel
- Mt Angel Fire District
- City of Scotts Mills
- City of Stayton
- City of Sublimity
- City of Turner
- City of Woodburn/ Woodburn Fire District

FEMA

Effective April 10, 2023 through April 10, 2028

The 2022 Marion County Multi-Jurisdictional Hazards Mitigation Plan is a living document that will be reviewed and updated periodically to address the requirements contained in 44 CFR 201. It will be integrated with existing plans, policies, and programs. The Disaster Mitigation Act of 2000 (DMA2K) and the regulations contained in 44 CFR 201 require that jurisdictions maintain an approved mitigation plan in order to receive federal funds for hazard mitigation grants. This plan meets those requirements as evidenced by FEMA approval which is effective per the cover date range of this plan.

Cover photos: (clockwise from top left): Marion County post-fire scene (2020); City of Detroit post-fire scene 10/20/2020; Tanker tipped on Hwy 22. Photos courtesy of Marion County.

Mission:

Create a more resilient Marion County by partnering with the whole community.

Comments, suggestions, corrections, and additions are encouraged to be submitted from all interested parties.

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Acknowledgements

The 2022 Marion County Hazard Mitigation Plan (HMP) update was conducted via a multi-jurisdictional partnership of Marion County and the Cities of Aumsville, Aurora, Detroit, Gates, Gervais, Hubbard, Idanha, Jefferson, Keizer, Mill City, Silverton, Stayton, Turner, and Woodburn, and the special districts of Keizer Fire District, Mt. Angel Fire District, and Woodburn Fire District.

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In 2019, the Department of Land Conservation and Development (DLCD) applied for and received a Pre-Disaster Mitigation grant PDMC-PL-10-OR-2019-005 from FEMA through the Oregon Department of Emergency Management (OEM) to assist Marion County.

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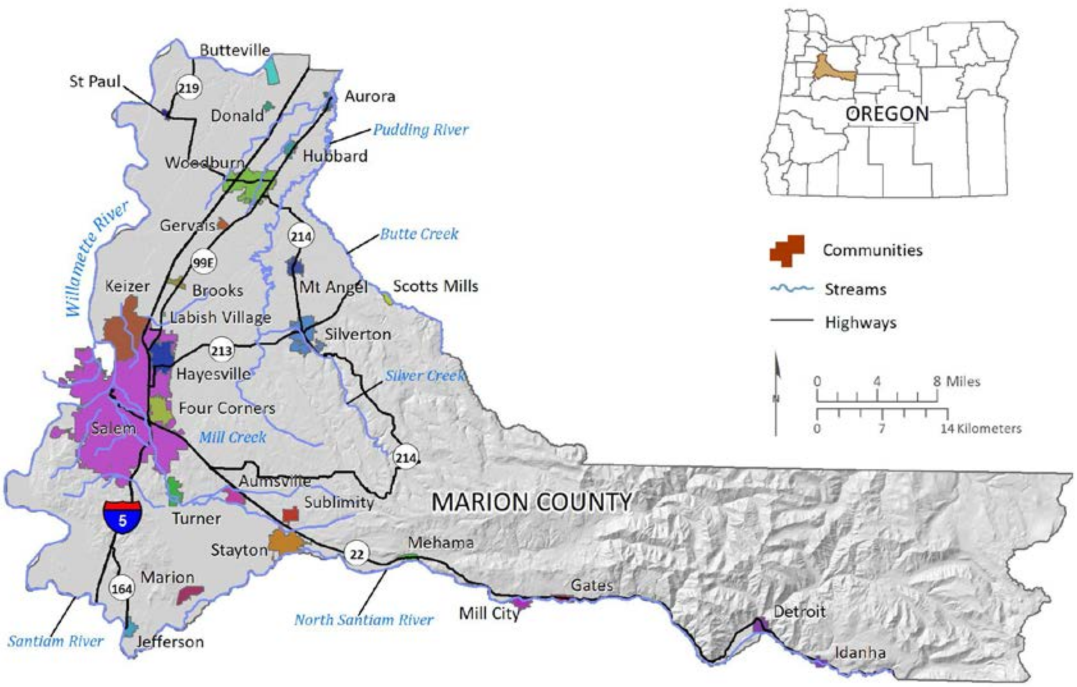
State of Oregon
Oregon Department of Geology and Mineral Industries
Ruarri Day-Stirrat, State Geologist

OPEN-FILE REPORT O-22-05

MULTI-HAZARD RISK REPORT FOR MARION COUNTY, OREGON

INCLUDING THE CITIES OF AUMSVILLE, AURORA, DETROIT, DONALD, GATES, GERVAIS, HUBBARD, IDANHA, JEFFERSON, KEIZER, MILL CITY, MT. ANGEL, SALEM, SCOTTS MILLS, SILVERTON, ST. PAUL, STAYTON, SUBLIMITY, TURNER, AND WOODBURN AND THE UNINCORPORATED COMMUNITIES OF BROOKS, BUTTEVILLE, FOUR CORNERS, HAYESVILLE, LABISH VILLAGE, MARION, MEHAMA, AND WEST SALEM



by Matt C. Williams and Ian P. Madin

2022

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Cover image: Study area of the Marion County Risk Report. Map depicts Marion County, Oregon and communities included in this report.

WHAT'S IN THIS REPORT?

This report describes the methods and results of natural hazard risk assessments for Marion County communities. The risk assessments can help communities better plan for disaster.

Expires: 6/30/23

Oregon Department of Geology and Mineral Industries Open-File Report O-22-05
Published in conformance with ORS 516.030

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GEOGRAPHIC INFORMATION SYSTEM (GIS) DATA

See the digital publication folder for files.
Geodatabase is Esri® version 10.7 format. Metadata are embedded in the geodatabase and are also provided as separate .xml format files.

Marion_County_Risk_Report_Data.gdb

Feature dataset: Asset_Data
feature classes:
Building_footprints (polygons)
Communities (polygons)
UDF_points (points)

Metadata in .xml file format:
Each dataset listed above has an associated, standalone .xml file containing metadata in the Federal Geographic Data Committee Content Standard for Digital Geospatial Metadata format

EXECUTIVE SUMMARY

This report was prepared for the communities of Marion County, Oregon, with funding provided by the Federal Emergency Management Agency (FEMA). It describes the methods and results of the natural hazard risk assessments performed in 2021 and 2022 by the Oregon Department of Geology and Mineral Industries (DOGAMI) within the study area. The purpose of this project is to provide communities with detailed risk assessment information to enable them to compare hazards and act to reduce their risk. The risk assessments contained in this project quantify the impacts of natural hazards to these communities and enhances the decision-making process in planning for disasters.

We arrived at our findings and conclusions by completing three main tasks for each community: compiling an asset database, identifying and using the best available hazard data, and performing natural hazard risk assessments.

- In the first task, we created a comprehensive asset database for the entire study area by synthesizing assessor data, U.S. Census information, FEMA Hazus®-MH general building stock information, and building footprint data. This work resulted in a single dataset of building points and their associated building characteristics. With these data we were able to represent accurate spatial locations and vulnerabilities on a building-by-building basis.
- The second task was to identify and use the most current and appropriate hazard datasets for the study area. Most of the hazard datasets used in this report were created by DOGAMI and were produced using high-resolution, lidar topographic data. Although not all the data sources used in the report provide complete, countywide information, each hazard dataset used was the best available at the time of the analysis.
- In the third task, we performed risk assessments using Esri® ArcGIS Desktop® software. We took two risk assessment approaches: (1) estimated loss (in dollars) to buildings from flood (recurrence intervals) and earthquake scenarios using the Hazus-MH methodology, and (2) calculated the number of buildings, their value, and associated populations exposed to earthquake, and flood scenarios, or susceptible to varying levels of hazard from landslides, channel migration, wildfire, and volcanic lahar.

The findings and conclusions of this report show the potential impacts of hazards in communities within Marion County. Earthquakes: Although earthquake damage will occur throughout the entire county, extensive damage and losses are more probable in the northeastern portion of the county near the Mt. Angel Fault and areas with liquefaction-prone soils. Our findings indicate that most of the critical facilities in the study area are at High risk from an earthquake. We used multiple Hazus-MH earthquake simulations to illustrate the potential reduction in earthquake damage through seismic retrofits. Flooding: Some communities in the study area have moderate risk from flooding and we found only a small percentage (<1%) of flood exposed buildings were elevated above the 100-year flood elevation. Landslides: Our analysis shows that areas with moderate to steep slopes or at the base of steep hillsides are at greatest risk from landslide hazards, such as along the North Santiam River, the communities of Mt. Angel and Scotts Mills, and southwestern portions of Salem. Channel migration zone hazards: Nearly 826 buildings along the Pudding River and Santiam and North Santiam Rivers were exposed to channel migration hazard. Wildfires: The wildfire hazard data used in this study were created prior to the unprecedented 2020 Labor Day Wildfires, however the results corresponded to the actual impacts of the 2020 Labor Day Wildfires in the county. Volcanic-lahar hazards: Lahar hazard is a potential risk and could have significant impact for areas and the communities along the North Santiam River.

The information presented in this report is designed to increase awareness of natural hazard risk, to support public outreach efforts, and to aid local decision-makers in developing comprehensive plans and natural hazard mitigation plans. This study can help emergency managers identify vulnerable critical facilities and develop contingencies in their response plans. The results of this study are designed to be used to help communities identify and prioritize mitigation actions that will improve community resilience.

Results were broken out for the following geographic areas:

- Unincorporated Marion County (rural)
- Community of Hayesville
- Community of Brooks
- Community of Marion
- City of Aumsville
- City of Detroit*
- City of Gates*
- City of Hubbard
- City of Jefferson
- City of Mill City*
- City of St. Paul
- City of Salem (West Salem)*
- City of Scotts Mills
- City of Sublimity
- City of Woodburn
- Community of Four Corners
- Community of Butteville
- Community of Labish Village
- Community of Mehama
- City of Aurora
- City of Donald
- City of Gervais
- City of Idanha
- City of Keizer
- City of Mt. Angel
- City of Salem
- City of Silverton
- City of Stayton
- City of Turner

*Portions of the cities of Detroit, Gates, and Mill City that were within Linn County are included in this report. The City of Salem that was within Polk County was examined individually and designated as City of Salem (West Salem).

Selected countywide results

Total buildings: 170,562

Total estimated building value: $62 billion

Mt. Angel Deterministic Magnitude 6.8 Earthquake Scenario
Red-tagged buildings[a]: 7,479
Yellow-tagged buildings[b]: 17,028
Loss estimate: $6.7 billion

100-year Flood Scenario
Number of buildings damaged: 2,552
Loss estimate: $126 million

Landslide Exposure (High and Very High-Susceptibility)
Number of buildings exposed: 7,470
Exposed building value: $2.7 billion

Channel Migration Zone (Erosion Hazard Area – 30-year):
Number of buildings exposed: 826
Exposed building value: $300 million

Wildfire Exposure (High and Moderate Risk):
Number of buildings exposed: 2,819
Exposed building value: $814 million

Lahar Exposure (1,000 to 15,000-year):
Number of buildings exposed: 1,789
Exposed building value: $415 million

[a]Red-tagged buildings are considered uninhabitable due to complete damage
[b]Yellow-tagged buildings are considered limited habitability due to extensive damage

1.1 INTRODUCTION

A natural hazard is an environmental phenomenon that can negatively impact humans, and risk is the likelihood that a hazard will result in harm. A natural hazard risk assessment analyzes and quantifies how different types of hazards could affect the built environment, population, and the cost of recovery, and identifies potential risk. Risk assessments are one basis for developing mitigation plans, strategies, and actions, so that steps can be taken to prepare for a potential hazard event.

Key Terms:

- *Vulnerability:* Characteristics that make people or assets more susceptible to a natural hazard.
- *Risk:* Probability multiplied by consequence; the degree of probability that a loss or injury may occur as a result of a natural hazard.

Although previous multi-hazard risk studies have been completed (Burns and others, 2008), this is the first multi-hazard risk assessment analyzing individual buildings and the resident population in Marion County. It is therefore the most detailed and comprehensive analysis to date of natural hazard risk and provides a comparative perspective never before available. In this report, we describe our assessment results, which quantify the various levels of risk that each hazard presents to Marion County communities.

Marion County is situated in the northwestern part of Oregon in the Willamette Valley and is subject to natural hazards, including: earthquake, riverine flooding, landslides, channel migration, wildfire, and lahar. This region of the state is moderately to heavily developed, composed of dense urban areas transitioning to suburban development in unincorporated parts of the study. There are also large uninhabited areas where the county jurisdiction extents into the Cascade Mountains within national forestland. Where natural hazards have the potential to damage assets or harm people, the result is natural hazard risk. The primary goal of the risk assessment is to inform communities of the risk posed by various natural hazards and to be a resource for risk reduction actions.

1.2 Purpose

The purpose of this project is to help communities in the study area better understand their risk and increase resilience to earthquakes (including liquefaction and site amplification), riverine flooding, landslides, channel migration, and wildfire natural hazards that are present in their communities. This is accomplished by the best available, most accurate and, detailed information about these hazards to assess the number of people and buildings at risk.

The main objectives of this study are to:

- compile and/or create a database of critical facilities, tax assessor data, buildings, and population distribution data,
- incorporate and use existing data from previous geologic, hydrologic, and wildfire hazard studies,
- perform exposure and Hazus–based risk analysis, and
- share this report widely so that all interested parties have access to its information and data.

The body of this report describes our methods and results. Two primary methods (Hazus-MH and exposure), depending on the type of hazard, were used to assess risk. Results for each hazard type are reported on a countywide basis within each hazard section, and community based results are reported in detail in **Appendix A: Community Risk Profiles**. **Appendix B** contains detailed risk assessment tables. **Appendix C** is a more detailed explanation of the Hazus-MH methodology. **Appendix D** lists acronyms and definitions of terms used in this report. **Appendix E** contains tabloid-size maps showing countywide hazard maps.

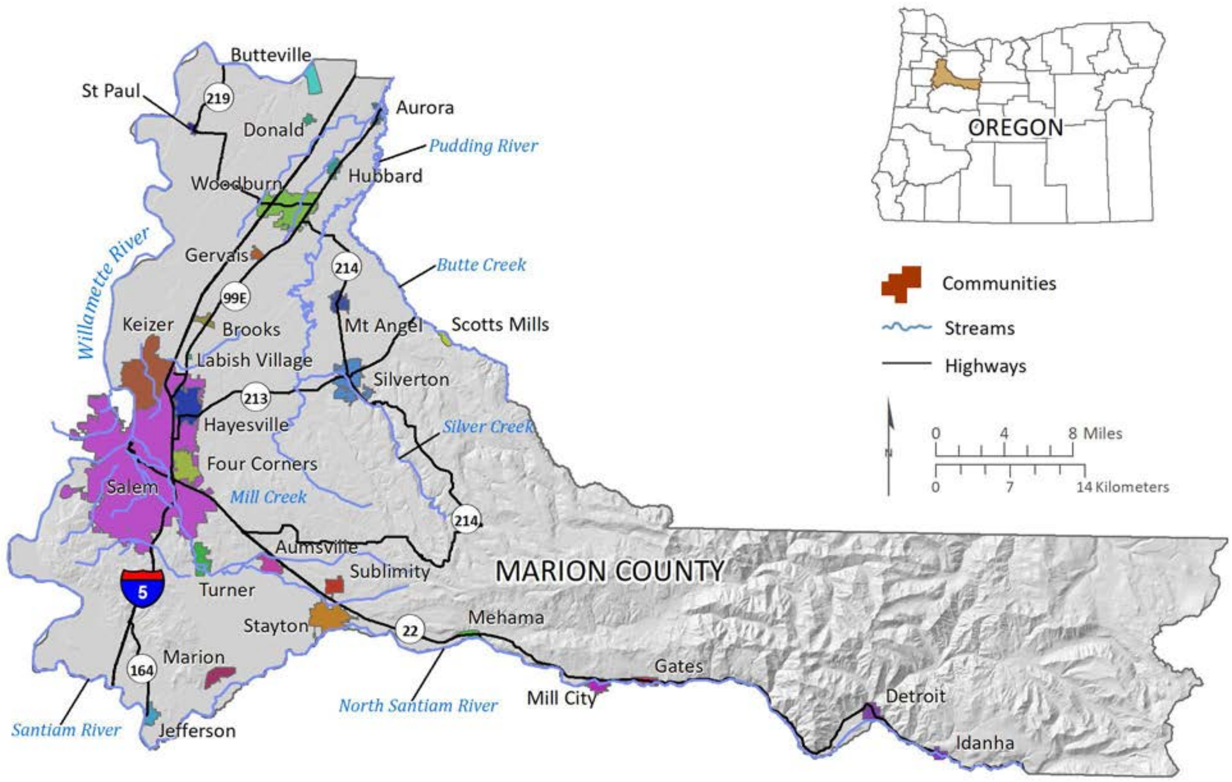
1.3 Study Area

The study area for this project includes the entirety of Marion County, Oregon. To make the report more functional, the study extent was expanded to include portions of the cities of Salem, Mill City, Gates, and Idanha that extend into neighboring counties (**Figure 1-1**). The study area is located in the northwestern portion of the state; the county is bordered by Clackamas County to the north, Wasco County and Jefferson County to the east, Linn County to the south, and Yamhill County and Polk County to the west. The entire western boundary of Marion County with Polk County and Yamhill County is defined by the Willamette River. The total area of Marion County is 3,070 square kilometers (1,184 square miles). Starting in the east, the study area transitions from timberland, to farmland, to suburbs, and then to urban development in the west.

The geography of the county's eastern half consists of the heavily forested Cascade Range. Mount Jefferson, a stratovolcano in the Cascade Range, is located at the southeastern corner of Marion County. The Willamette National Forest makes up a significant portion of the county's eastern half. The western half of the county transitions from the heavily forested mountains to gently rolling farmland and then onto the broad flat bottom of the Willamette Valley.

The population of the study area is approximately 349,000 based on an estimated population for each community in 2020 from the Portland State University (PSU) Population Research Center https://www.pdx.edu/population-research/population-estimate-reports. The study area includes the city of Salem, which is the state capital and the second-largest city in Oregon with a population of approximately 175,000. Most of the residents in the study area live in the western half of the county. The incorporated communities of the study area are Aumsville, Aurora, Detroit, Donald, Gates, Gervais, Hubbard, Idanha, Jefferson, Keizer, Mill City, Mt. Angel, St. Paul, Salem, Scotts Mills, Silverton, Stayton, Sublimity, Turner, and Woodburn (**Figure 1-1**). The portion of Salem that is within Polk County is included in this study and is designated as Salem (West Salem). Portions of the incorporated communities of Detroit, Gates, and Mill City that are within Linn County are included in this study. The unincorporated communities that were individually examined in this study were Brooks, Butteville, Four Corners, Hayesville, Labish Village, Marion, and Mehama.

Figure 1-1. Study area: Marion County with communities in this study identified.



1.4 Project Scope

For this risk assessment, we limited the project scope to buildings and population because of data availability, the strengths and limitations of the risk assessment methodology, and funding availability. We did not analyze impacts to the local economy, land values, infrastructure (transportation, power, water, gas, communication, and sewage), or the environment. Depending on the natural hazard, we used one of two methodologies: loss estimation or exposure. Loss estimation was modeled using methodology from Hazus®-MH (FEMA, 2012a, 2012b, 2012c), a tool developed by FEMA for calculating damage to buildings from flood and earthquake. Exposure is a simpler methodology, in which buildings are categorized based on their location relative to various hazard zones. To account for impacts on population (permanent residents only), 2010 U.S. Census data (U.S. Census Bureau, 2010a) was used to distribute people into residential structures on a census block basis. Permanent resident counts were then adjusted to current estimates from the PSU Population Research Center.

A critical component of this risk assessment is a countywide building inventory developed from building footprint data and the Marion County tax assessor database (acquired 2021). The other key component is a suite of datasets that represent the currently best available science for a variety of natural hazards. The geologic hazard scenarios were selected by DOGAMI staff based on their expert knowledge of the datasets; most datasets are DOGAMI publications. In addition to geologic hazards, we included wildfire hazard in this risk assessment. The following is a list of the risk assessment methodologies that were applied. See **Table 1-1** for data sources.

Earthquake Risk Assessment

- Hazus-MH loss estimation from a Mount Angel Fault magnitude (Mw) 6.8 scenario. Includes earthquake-induced or "coseismic" liquefaction, soil amplification class, and landslides.

Flood Risk Assessment

- Hazus-MH loss estimation to four recurrence intervals (10%, 2%, 1%, and 0.2% annual chance)
- Exposure to 1% annual chance recurrence interval

Landslide Risk Assessment

- Exposure based on Landslide Susceptibility Index and landslide deposit mapping (Low to Very High)

Wildfire Risk Assessment

- Exposure based on Overall Wildfire Risk (Low to High)

Channel Migration Risk Assessment

- Exposure based on the erosion hazard area—30-year (exposed, not exposed)

Volcanic Lahar Risk Assessment

- Exposure to three potential lahar scenarios (Small to Large)

Table 1-1. Hazard data sources for Marion County.

Hazard	Scenario or Classes	Scale/Level of Detail	Data Source
Earthquake	Mount Angel deterministic Mw-6.8	Countywide	FEMA (Hazus-MH 5.0 fault database)
- Coseismic landslide	Susceptibility – wet (3-10 hazard classes)	Statewide	DOGAMI (Madin and others, 2021)
- Coseismic liquefaction	Susceptibility (1-5 classes)	"	"
- Coseismic Soil amplification	NEHRP (A-F classes)	"	"
Flood	Depth Grids: 10% (10-yr) 2% (50-yr) 1% (100-yr) 0.2% (500-yr)	Countywide	DOGAMI (Appleby and others, 2021) – derived from FEMA (2019) data
Landslide	Susceptibility (Low, Moderate, High, Very High)	Statewide, Countywide	DOGAMI (Burns and others, 2016), DOGAMI (Calhoun and others, 2020)
Channel Migration	Susceptibility (Not Exposed, Exposed)	Pudding and North Santiam Rivers and tributaries	DOGAMI (Appleby and others, 2021)
Wildfire	Overall Wildfire Risk (Low, Moderate, High)	Regional (Pacific Northwest, US)	ODF (Gilbertson-Day and others, 2018)
Lahar	Size and frequency: Small (100 to 1,000-year) Medium (1,000 to 15,000-year) Large (>15,000-year)	Mount Jefferson and surrounding areas	USGS (Walder and others, 1999)

1.5 Previous Studies

Wang (1998) used Hazus-MH to estimate the impact from a Mw-8.5 Cascadia Subduction Zone (CSZ) earthquake scenario on the state of Oregon. The results of that study were arranged into individual counties. Marion County was estimated to experience a 3.5% loss ratio in the Mw-8.5 CSZ scenario (Wang, 1998).

Burns and others (2008) developed earthquake and landslide hazard maps and used Hazus-MH to estimate future earthquake damage for the Mid/Southern Willamette Valley which included Marion County. The earthquake scenarios used in the Hazus-MH analysis were the Mt. Angel Fault, magnitude (Mw) 6.9 and the CSZ, Mw-9.0. Both scenarios aggregated results at the census tract level using the default Hazus-MH general building stock database. Estimated loss ratios for Marion County were 43% for the Mt. Angel Fault and 25% for the CSZ scenarios.

We did not compare the results of this projects with the results of these previous studies because the level of detail and accuracy of the building information and site-specific earthquake inputs were not comparable. Comparative analysis was not part of the scope of this project.

2.1 METHODS

Where there is interaction between people and natural hazards there is risk. We used a quantitative approach through two modes of analysis, Hazus-MH loss estimation and exposure, to assess the level of risk to buildings and people from natural hazards.

2.2 Hazus-MH Loss Estimation

According to FEMA (FEMA, 2012a, p. 1-1), "Hazus provides nationally applicable, standardized methodologies for estimating potential wind, flood, and earthquake losses on a regional basis. Hazus can be used to conduct loss estimation for floods and earthquakes [...]. The multi-hazard Hazus is intended for use by local, state, and regional officials and consultants to assist mitigation planning and emergency response and recovery preparedness. For some hazards, Hazus can also be used to prepare real-time estimates of damages during or following a disaster."

Key Terms:

- *Loss estimation:* Damage in terms of value that occurs to a building in an earthquake or flood scenario, as modeled with Hazus-MH methodology. This is measured as the cost to repair or replace the damaged building in US dollars.
- *Loss ratio:* Percentage of estimated loss relative to the total value.

Hazus-MH can be used in different modes depending on the level of detail required. Given the high spatial precision of the building inventory data and quality of the natural hazard data available for this study, we chose the user-defined facility (UDF) mode. This mode makes loss estimations for individual buildings relative to their "cost," which we then aggregate to the community level to report loss ratios. Cost used in this mode are associated with rebuilding using new materials, also known as replacement cost. Replacement cost is determined using a method called RSMeans valuation (Charest, 2017) and is calculated by multiplying the building area (in square feet) by a standard cost per square foot. These standard rates per square foot are in tables within the default Hazus-MH database.

Damage functions are at the core of Hazus-MH. The damage functions stored within the Hazus-MH data model were developed and calibrated from the observed results of past disasters. We estimated damage and loss by intersecting building locations with natural hazard layers and applying damage functions based on the hazard severity (e.g., depth of flooding) and building characteristics (e.g., first floor height). **Figure 2-1** illustrates the range of building loss estimates from Hazus-MH flood analysis by showing the percentage of building loss from flood and in some cases (in yellow) where a building's first floor height is above the level of flooding.

We used Hazus-MH version 5.0 (FEMA, 2021), which was the latest version available when we began this risk assessment.

Figure 2-1. 100-year flood zone and building loss estimates example in city of Salem, Oregon.

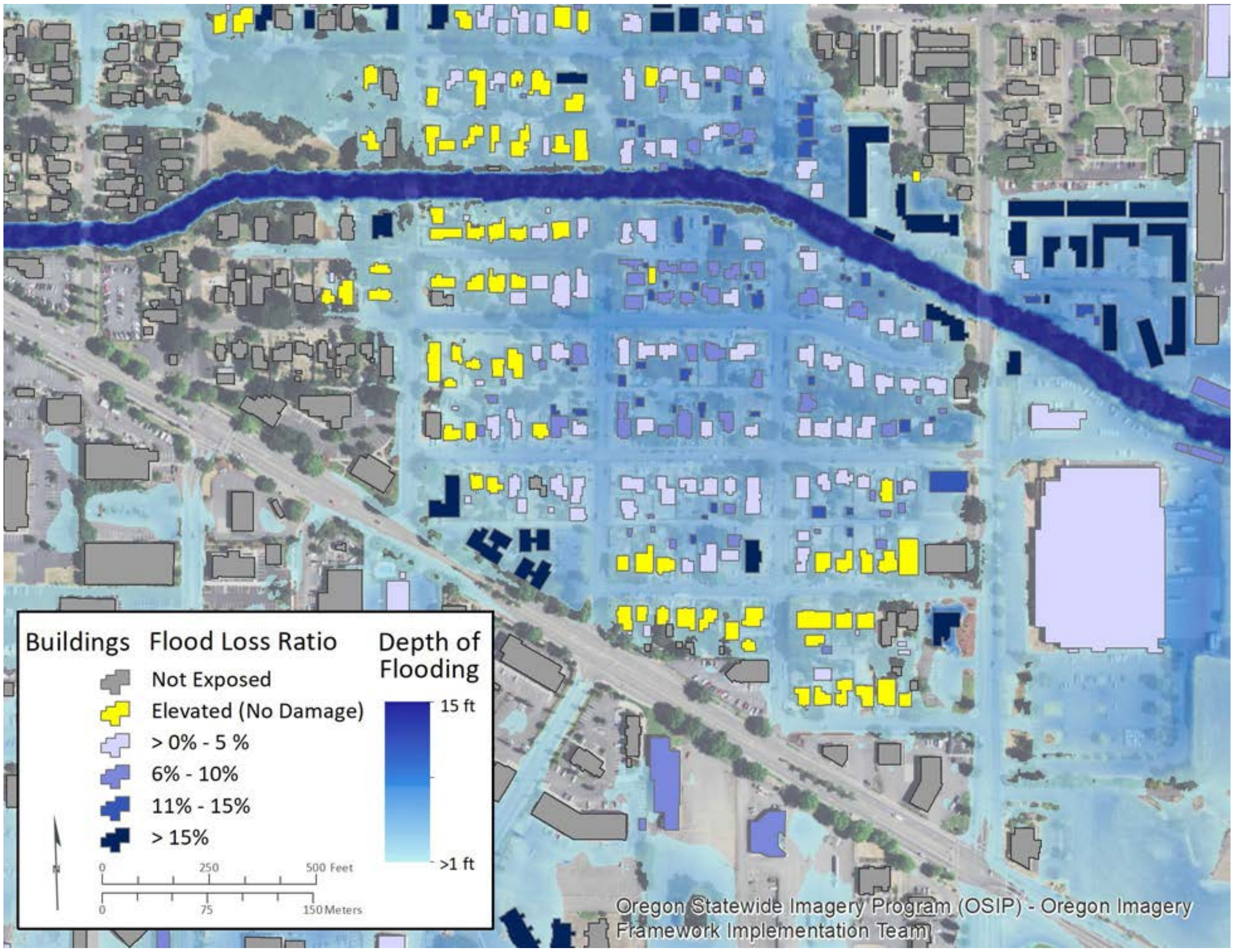


Image source: Oregon Statewide Imagery Program, 2018

Depth grid: Derived from the effective FEMA Flood Insurance Rate Map data for Marion County, 2019

2.3 Exposure

Since loss estimation using Hazus-MH is not available for all types of hazards, we used exposure analysis to assess the level risk for Marion County for landslide, channel migration, wildfire, and lahar hazards. Exposure methodology identifies the buildings and population that are within a particular natural hazard zone. This is an alternative for natural hazards that do not have available damage models like those in Hazus. It provides a way to easily quantify what is and what is not threatened. Exposure results are communicated in terms of total building value exposed, rather than a loss estimate. For example, **Figure 2-2** shows buildings that are exposed to different areas of landslide susceptibility where building footprints are colored based on what susceptibility zone the center of the building is within.

> ***Key Terms:***
>
> - *Exposure:* Determination of whether a building is within or outside of a hazard zone. No loss estimation is modeled.
> - *Building value:* Total monetary value of a building. This term is used in the context of exposure.

Exposure is used for landslide, wildfire, channel migration, and volcanic lahar. For comparison with loss estimates, exposure is also used for the 1% annual chance flood.

Figure 2-2. **Landslide susceptibility areas and building exposure example in the city of Mill City, Oregon.**

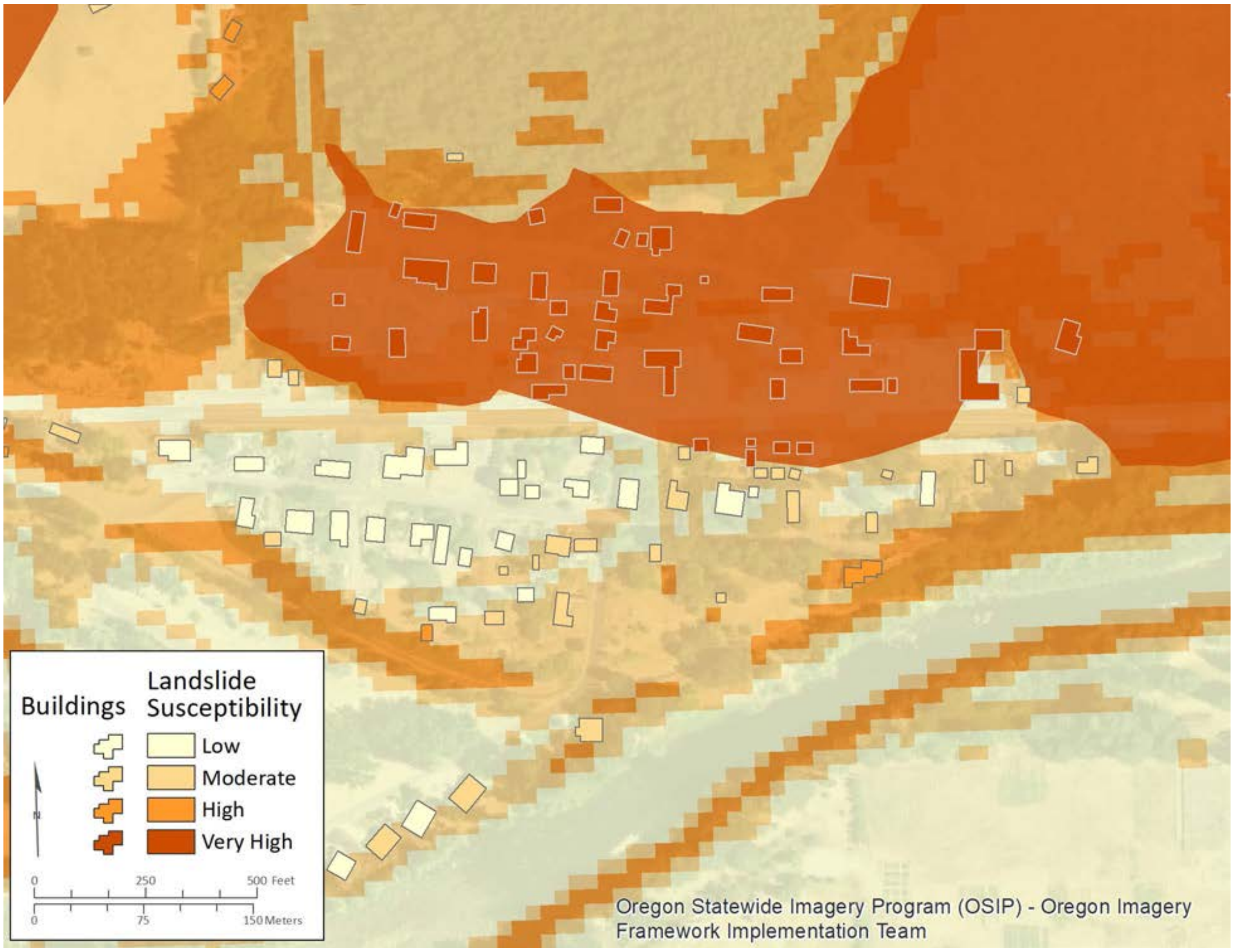


Image source: Oregon Statewide Imagery Program, 2018

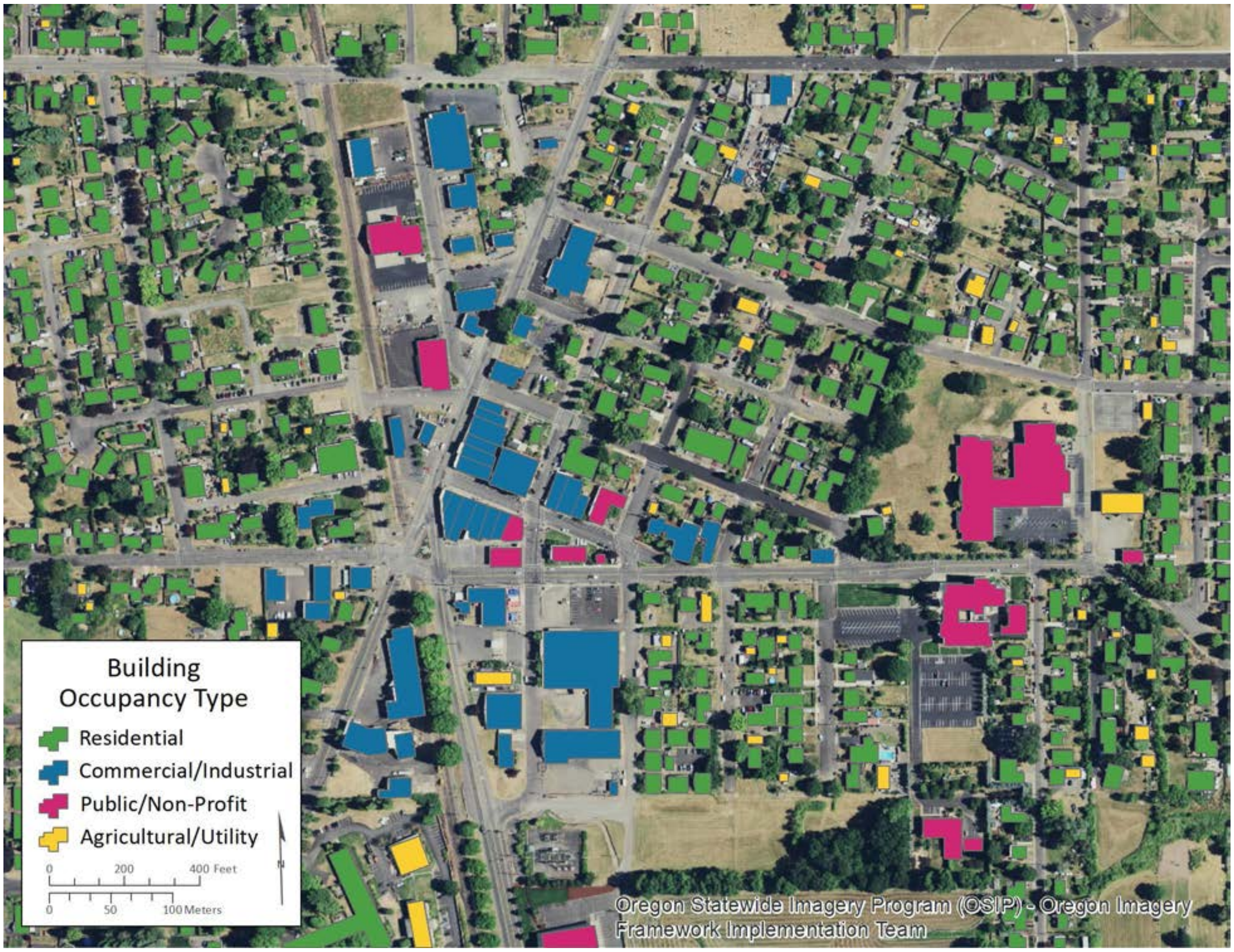
Landslide data source: Landslide susceptibility overview map of Oregon, (Burns and others, 2016)

2.4 Building Inventory

A key piece of the risk assessment is the countywide building inventory. This inventory consists of all buildings larger than 9.3 square meters (100 square feet), as determined from existing building footprints (Williams, 2021). **Figure 2-3** shows an example of building inventory occupancy types used in the Hazus-MH and exposure analyses in Marion County. See also **Appendix B: Table B-1** and **Appendix E**: **Plate 1** and **Plate 2.**

To use the building inventory within the Hazus-MH methodology, we converted the building footprints to points and migrated them into a UDF database with standardized field names and attribute domains. The UDF database formatting allows for the correct damage function to be applied to each building. Hazus-MH version 2.1 technical manuals (FEMA, 2012a, 2012b, 2012c) provide references for acceptable field names, field types, and attributes. The fields and attributes used in the UDF database (including building seismic codes) are discussed in more detail in **Appendix C.2.2**.

Figure 2-3. Example of building occupancy types, city of Mt. Angel, Oregon.



The distribution of building count and value per community in Marion County ranges from 159 buildings and $35 million for Idanha to 58,163 buildings and $22.5 billion for Salem (**Table 2-1**). A table detailing the occupancy class distribution by community is included in **Appendix B: Detailed Risk Assessment Tables**.

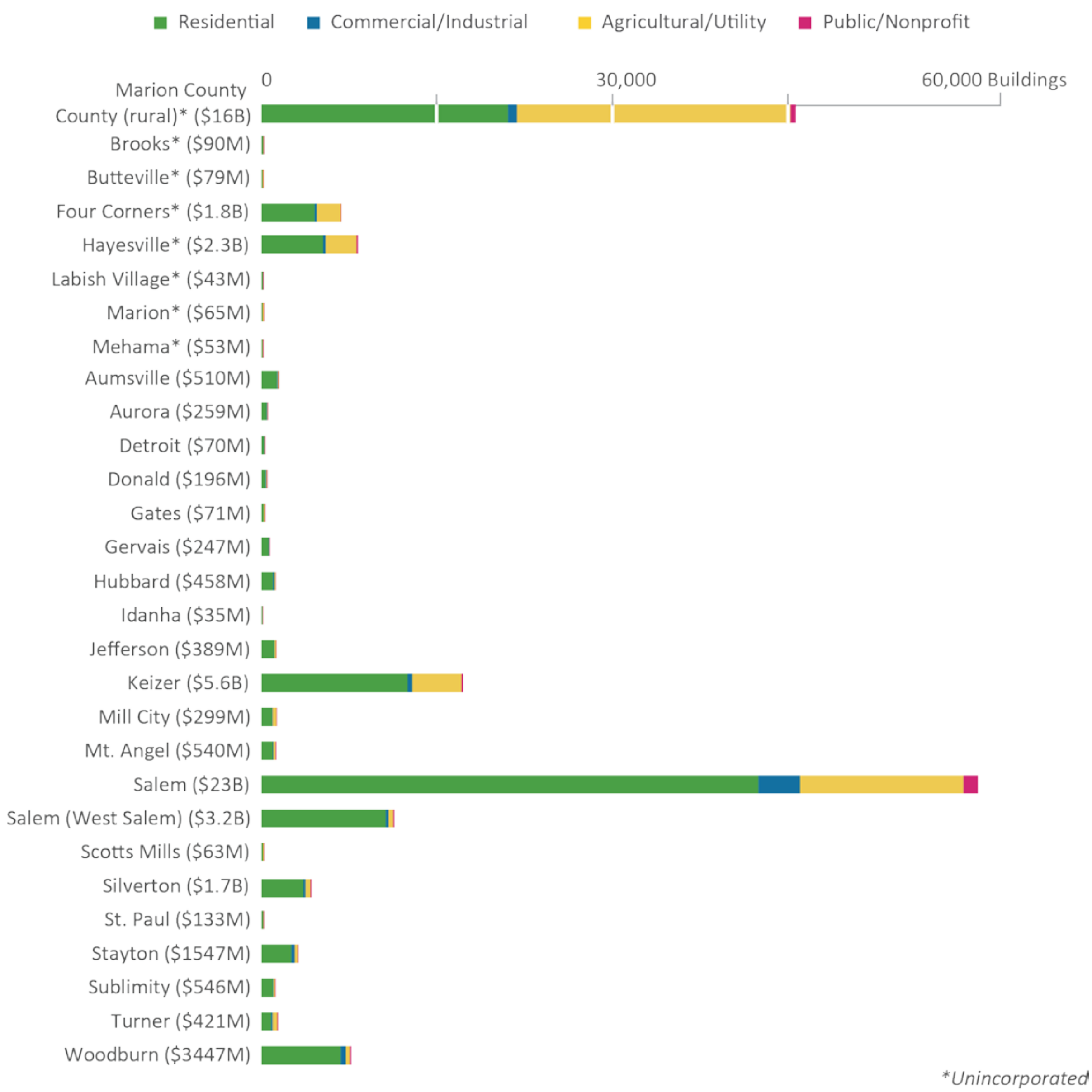
Table 2-1. Marion County building inventory.

Community	Total Number of Buildings	Percentage of Total Buildings	Estimated Total Building Value ($)	Percentage of Total Building Value
Unincorp. Marion Co (rural)	43,387	25.4%	16,042,238,000	26%
Brooks	249	0.1%	89,505,000	0.1%
Butteville	193	0.1%	78,691,000	0.1%
Four Corners	6,508	3.8%	1,801,596,000	2.9%
Hayesville	7,876	4.6%	2,382,452,000	3.8%
Labish Village	167	0.1%	43,407,000	0.1%
Marion	244	0.1%	64,728,000	0.1%
Mehama	189	0.1%	53,460,000	0.1%
Total Unincorporated County	58,813	34.5%	20,556,077,000	33%
Aumsville	1,459	0.9%	509,635,000	0.8%
Aurora	560	0.3%	258,763,000	0.4%
Detroit	315	0.2%	69,925,000	0.1%
Donald	490	0.3%	195,528,000	0.3%
Gates	326	0.2%	71,352,000	0.1%
Gervais	719	0.4%	247,297,000	0.4%
Hubbard	1,187	0.7%	458,199,000	0.7%
Idanha	159	0.1%	35,338,000	0.1%
Jefferson	1,243	0.7%	389,441,000	0.6%
Keizer	16,380	9.6%	5,592,798,000	8.9%
Mill City	1,269	0.7%	299,237,000	0.5%
Mt. Angel	1,219	0.7%	539,815,000	0.9%
Salem	58,163	34.1%	22,532,083,000	36%
Salem (West Salem)	10,797	6.3%	3,194,904,000	5.1%
Scotts Mills	242	0.1%	63,043,000	0.1%
Silverton	4,077	2.4%	1,740,060,000	2.8%
St. Paul	247	0.1%	132,631,000	0.2%
Stayton	3,043	1.8%	1,546,547,000	2.5%
Sublimity	1,157	0.7%	546,449,000	0.9%
Turner	1,365	0.8%	421,185,000	0.7%
Woodburn	7,332	4.3%	3,446,910,000	5.5%
Total Study Area	170,562	100%	62,847,216,000	100%

The building inventory was developed from a building footprints dataset developed in 2021 called the Statewide Building Footprints for Oregon, release 1 (SBFO-1) (Williams, 2021). The SBFO-1 data of Marion County was modified from a building footprints dataset maintained by the city of Salem (obtained June 2020). The building footprints provide a spatial location and 2D representation of a structure. The total number of buildings within the study area was 170,562.

Marion County supplied assessor data and we formatted them for use in the risk assessment. The assessor data contains an array of information about each improvement (i.e., building). Tax lot data, which contains property boundaries and other information regarding the property, were obtained from the county assessor and were used to link the buildings with assessor data. The linkage between the two datasets resulted in a database of UDF points that contain attributes for each building. These points are used in the risk assessments for both loss estimation and exposure analysis. The majority of buildings are within the jurisdictions of the unincorporated county, Salem, and Keizer, and the most common building usage in the study area is residential (**Figure 2-4**).

Figure 2-4. Community building value in Marion County by occupancy class.



Critical facilities are important to note because these facilities play a crucial role in emergency response efforts. We embedded identifying characteristics into the critical facilities in the UDF database so they could be highlighted in the results. Critical facilities data came from the DOGAMI Statewide Seismic Needs Assessment (SSNA; Lewis, 2007). We updated the SSNA data by reviewing Google Maps™ data. The critical facilities we identified include hospitals, schools, fire stations, police stations, emergency operations, and military facilities. In addition, we included other buildings based on specific community input and structures that would be essential during a natural hazard event, such as public works and water treatment facilities. Communities that have critical facilities that can function during and immediately after a natural disaster are more resilient than those with critical facilities that are inoperable after a disaster. Critical facilities are present throughout the county with most in unincorporated county and Salem (**Table 2-2**). Critical facilities are listed for each community in **Appendix A**.

Table 2-2. Marion County critical facilities inventory.

Community	Hospital & Clinic		School		Police/Fire		Emergency Services		Military		Other*		Total	
	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)
(all dollar amounts in thousands)														
Uninc Marion Co (rural)	0	0	32	222,199	17	26,342	1	3,645	0	0	8	110,070	58	362,256
Brooks	0	0	2	10,380	0	0	0	0	0	0	0	0	2	10,380
Butteville	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Four Corners	0	0	3	37,353	0	0	0	0	0	0	0	0	3	37,353
Hayesville	0	0	6	60,750	1	2,994	0	0	0	0	0	0	7	63,744
Labish Village	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marion	0	0	0	0	1	306	0	0	0	0	0	0	1	306
Mehama	0	0	0	0	1	791	0	0	0	0	0	0	1	791
Total Uninc. County	0	0	43	330,682	20	30,433	1	3,645	0	0	8	110,070	72	474,830
Aumsville	0	0	2	38,868	2	4,462	0	0	0	0	1	1,071	5	44,401
Aurora	0	0	0	0	2	2,918	0	0	0	0	0	0	2	2,918
Detroit	0	0	0	0	1	473	0	0	0	0	0	0	1	473
Donald	0	0	0	0	1	1,430	0	0	0	0	0	0	1	1,430
Gates	0	0	0	0	1	1,227	0	0	0	0	0	0	1	1,227
Gervais	0	0	2	43,279	0	0	0	0	0	0	1	1,697	3	44,976
Hubbard	0	0	0	0	2	3,754	0	0	0	0	1	336	3	4,090
Idanha	0	0	0	0	1	760	0	0	0	0	0	0	1	760
Jefferson	0	0	1	11,888	1	1,657	0	0	0	0	0	0	2	13,545
Keizer	1	4,557	12	163,943	3	25,017	0	0	0	0	0	0	16	193,517
Mill City	0	0	2	24,319	1	2,319	0	0	0	0	0	0	3	26,638
Mt. Angel	1	891	3	37,489	2	3,671	0	0	0	0	1	837	7	42,888
Salem	7	148,614	53	750,052	10	47,524	1	19,038	4	33,228	5	236,483	80	1,234,939
Salem (West Salem)	1	2,578	9	145,936	2	2,694	0	0	0	0	0	0	12	151,208
Scotts Mills	0	0	1	5,687	1	1,742	0	0	0	0	0	0	2	7,429
Silverton	5	32,651	5	100,286	2	6,532	0	0	0	0	1	1,654	13	141,123
St. Paul	0	0	3	23,762	1	3,095	0	0	0	0	0	0	4	26,857
Stayton	1	16,142	6	93,544	2	9,115	1	2,238	0	0	2	4,840	12	125,879
Sublimity	0	0	2	9,733	1	2,557	0	0	0	0	1	717	4	13,007
Turner	0	0	1	7,729	2	4,980	0	0	0	0	0	0	3	12,709
Woodburn	5	32,796	10	153,206	3	16,683	0	0	0	0	1	1,452	19	204,137
Total Study Area	21	238,229	155	1,940,403	61	173,043	3	24,921	4	33,228	22	359,157	266	2,768,981

Note: Facilities with multiple buildings were consolidated into one building.

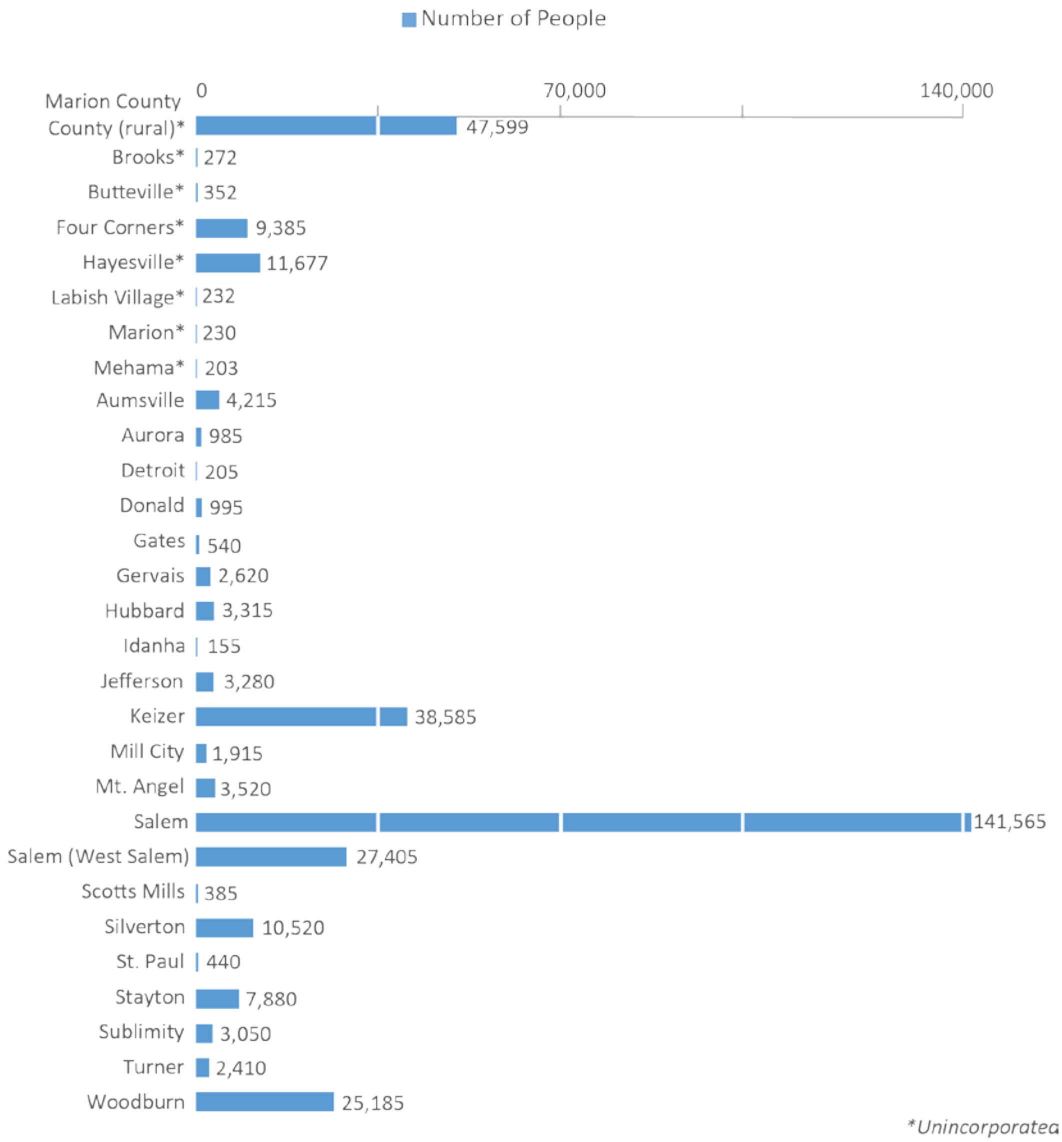
* Category includes buildings that are not traditional (emergency response) critical facilities but considered critical during an emergency based on input from local stakeholders (e.g., water treatment facilities or airports).

2.5 Population

One purpose of the UDF database design was so that we could estimate the number of people at risk from natural hazards. Within the UDF database, the population of permanent residents reported per census block was distributed among residential buildings and pro-rated based on building area derived from 2010 U.S. Census data. This census block-based distribution was further adjusted with the PSU Population Research Center estimates for 2021 (**Figure 2-5**). We did not examine the impacts of natural hazards on nonpermanent populations (e.g., tourists), whose total numbers fluctuate seasonally. Due to lack of information within the assessor and census databases, the distribution includes vacation homes, which in many communities make up a small portion of the residential building stock. From information reported in the 2010 U.S. Census regarding vacation rentals within the county, it is estimated that approximately 4% of residential buildings are vacation rentals in Marion County (U.S. Census Bureau, 2010b).

From the Census and PSU Population Research Center data, we assessed the risk of the 349,120 residents within the study area that could be affected by a natural hazard scenario. For each natural hazard, with the exception of the earthquake scenario, a simple exposure analysis was used to find the number of potentially displaced residents within a hazard zone. For the earthquake scenario the number of potentially displaced residents was based on residents in buildings estimated to be significantly damaged by the earthquake.

Figure 2-5. Population by Marion County community.



3.1 ASSESSMENT OVERVIEW AND RESULTS

In these risk assessments, we considered six natural hazards (earthquake, flood, landslide, wildfire, channel migration, and volcanic lahar) that pose a risk to Marion County. The assessment describes both localized vulnerabilities and the widespread challenges that impact all communities. While results of this risk assessment do not typically represent singular hazard events, they do quantify the potential overall level of risk present for assets and residents. The loss estimation and exposure results, as well as the rich dataset included with this report, can lead to greater understanding of the potential impact of disasters. Communities can become more resilient to future disasters by utilizing the results in plan updates and developing future action items for risk reduction.

In this section, results are presented for the entire study area. The study area includes all unincorporated areas and cities within Marion County. Individual community results are in **Appendix A: Community Risk Profiles.**

3.2 Earthquake

An earthquake is a sudden movement of rock on each side of a fault in the earth's crust, which abruptly releases strain that has accumulated. The movement along the fault produces waves of shaking that spread in all directions. If an earthquake occurs near populated areas, it may cause causalities, economic disruption, and extensive property damage (Madin and Burns, 2013).

Two earthquake-induced hazards, also called coseismic hazards, are liquefaction and landslides. Liquefaction occurs when saturated soils substantially lose bearing capacity due to ground shaking, causing the soil to behave like a liquid; this action can be a source of tremendous damage. Coseismic landslides are mass movement of rock, debris, or soil induced by ground shaking. All earthquake damages in this report include damages derived from shaking and from liquefaction and landslide factors.

3.2.1 Data sources

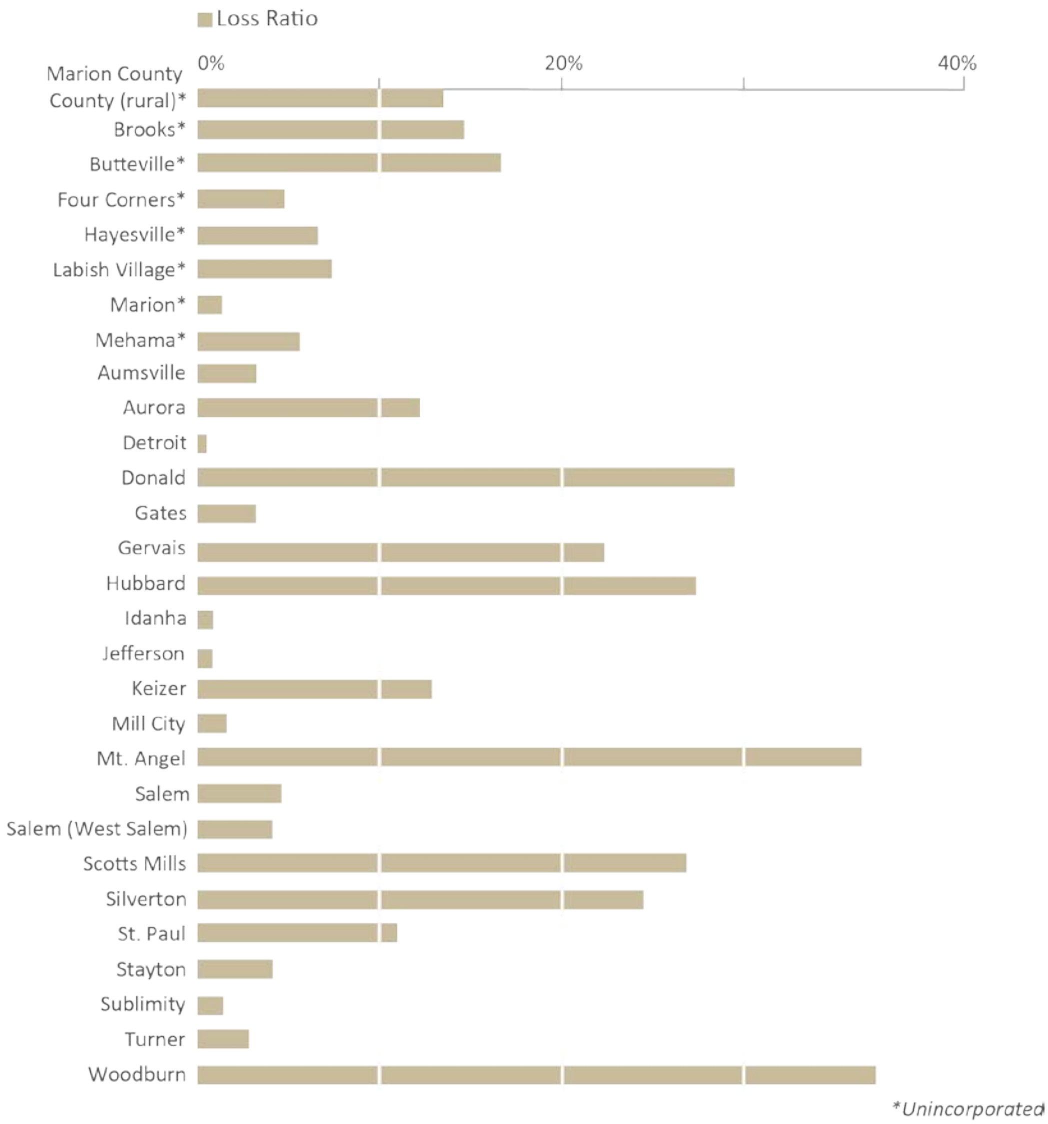
Hazus-MH offers two scenario methods for estimating loss from earthquake: probabilistic and deterministic (FEMA Hazus-MH, 2012b). A probabilistic scenario uses U.S. Geological Survey (USGS) National Seismic Hazard Maps, which are derived from seismic hazard curves calculated on a grid of sites across the United States that describe the annual frequency of exceeding a set of ground motions as a result of all possible earthquake sources (USGS, 2017). A deterministic scenario is based on a specific seismic event, such as a CSZ Mw-9.0 event. We used the deterministic scenario method for this study along with the UDF database so that loss estimates could be calculated on a building-by-building basis.

The Mt. Angel Fault is an active fault located near the cities of Mt. Angel, Woodburn, and Silverton. On March 25, 1993, a Mw-5.7 earthquake occurred with an epicenter approximately 5 kilometers (about 3 miles) east of the city of Scotts Mills, Oregon. Many buildings were damaged from the event, including the Capitol building in Salem. Many unreinforced masonry buildings in the area were significantly damaged due to intense shaking. The preliminary damage estimate was $28.4 million ($50 million in 2022) (Black, 1996).

The Mt. Angel Fault deterministic scenario was selected as the most appropriate for communicating earthquake risk for Marion County. We based this decision on several factors, such as previous Hazus-MH earthquake analyses in the region, location of the active fault relative to nearby structures, local familiarity from the 1993 event, and available seismic data. The default Hazus-MH database contained the location and orientation of the fault and provided a recommended magnitude for use in a simulated earthquake event.

The following hazard layers used for our loss estimation are derived from work conducted by Madin and others (2021): National Earthquake Hazard Reduction Program (NEHRP) soil classification, landslide susceptibility (wet), and liquefaction susceptibility. The liquefaction and landslide susceptibility layers were used by the Hazus-MH tool to calculate the probability and magnitude of permanent ground deformation caused by these factors. Hazus-MH uses a characteristic magnitude value to calculate the impacts of liquefaction and landslides. For this study, we followed the details provided in the default Hazus-MH database and used Mw-6.8 as the characteristic event.

Figure 3-1. Mt. Angel Fault Mw-6.8 earthquake loss ratio by Marion County community.



3.2.2 Countywide results

Because an earthquake can affect a wide area, it is unlike other hazards in this report—every building in Marion County, to some degree, will be shaken by a Mt. Angel Fault Mw-6.8 earthquake. Hazus-MH loss estimates (**Table B-2)** for each building are based on a formula where coefficients are multiplied by each of the five damage state percentages (none, low, moderate, extensive, and complete). These damage states are correlated to loss ratios that are then multiplied by the building dollar value to obtain a loss estimate (FEMA, 2012b). Loss estimates from the earthquake scenario described in this report vary widely by community in Marion County (**Figure 3-1**).

In keeping with earthquake damage reporting conventions, we used the ATC-20 post-earthquake building safety evaluation color-tagging system to represent damage states (Applied Technology Council, 2015). Red-tagged buildings correspond to a Hazus-MH damage state of "complete," which means the building is uninhabitable. Yellow-tagged buildings are in the "extensive" damage state, indicating limited habitability. The number of red or yellow-tagged buildings we report for each community is based on an aggregation of the probabilities for individual buildings (FEMA, 2012b).

We considered critical facilities nonfunctioning if the Hazus-MH earthquake analysis showed that a building or complex of buildings had a greater than 50% chance of being at least moderately damaged (FEMA, 2012b). Because building specific information is more readily available for critical facilities and due to their importance after a disaster, we chose to report the results of these buildings individually.

The probability of damage state was determined by Hazus-MH earthquake analysis, and we reviewed the damage states in the results. The number of potentially displaced residents from an earthquake scenario described in this report was based on the formula: ([Number of Occupants] * [Probability of Complete Damage]) + (0.9 * [Number of Occupants] * [Probability of Extensive Damage]) (FEMA, 2012b). The probability of damage state was determined in the Hazus-MH earthquake analysis results.

Marion countywide Mt. Angel Fault Mw-6.8 earthquake results:

- Number of red-tagged buildings: 7,479
- Number of yellow-tagged buildings: 17,028
- Loss estimate: $6,671,977,000
- Loss ratio: 11%
- Non-functioning critical facilities: 85
- Potentially displaced population: 15,064

The results indicate that Marion County could incur moderate to significant losses (11%) due to a Mt. Angel Fault Mw-6.8 earthquake. These results are strongly influenced by proximity to the Mt. Angel Fault and ground deformation from liquefaction. The communities in the northeast part of the county (Gervais, Hubbard, Mt. Angel, Scotts Mills, Silverton, and Woodburn), close to the Mount Angel Fault, all have higher levels of estimated losses compared with the rest of the county. This is consistent with the damage that occurred from the 1993 Scotts Mills earthquake. In addition, high liquefaction susceptibility exists within most of the floodplains throughout the county which increases the risk from earthquakes. A large portion of Keizer and developed areas along the North Santiam River are built on highly liquefiable soils have higher estimates of damage from this earthquake scenario than other communities in the study area.

Although the impacts of coseismic landslides were included in the Hazus earthquake results, we did not perform an analysis that specifically isolated damage caused by coseismic landslides. It is worth noting that coseismic landslides likely contribute a small percentage of the overall estimated damage from the earthquake hazard in Marion County. Landslide exposure results show that 4.3% of buildings in Marion County are within a Very High or High susceptibility zone. This indicates that a similar percentage of the loss estimated in this study may be due to coseismic landslide.

Building vulnerabilities such as the age of the building stock and building type are also contributing factors in damage estimates. The first seismic buildings codes were implemented in Oregon in the 1970s (Judson, 2012) and by the 1990s modern seismic building codes were being enforced. Nearly 66% of Marion County's buildings were built before the 1990s. Certain building types are known to be more vulnerable than others in earthquakes, such as manufactured homes. In Hazus-MH, manufactured homes are one occupancy type that performs poorly in earthquake damage modeling. Communities that are composed of an older building stock and more vulnerable occupancy types are expected to experience more damage from earthquake than communities with fewer of these vulnerabilities.

If buildings could be seismically retrofitted to Moderate or High code standards, earthquake risk would be greatly reduced. In this study, a simulation in Hazus-MH earthquake analysis shows that loss ratios drop from 11% to 7%, when all buildings are upgraded to at least Moderate code level. While retrofits can decrease earthquake vulnerability, for areas of High landslide or liquefaction hazard, additional geotechnical mitigation may be necessary to have an effect on losses. Two simulations of a deterministic Mw-6.8 earthquake where all buildings are upgraded to Moderate code standards or to High code standards show a reduction in loss estimates (**Figure 3-2**).

Key Terms:

- *Seismic retrofit:* Structural modification to a building that improves its resilience to earthquake.
- *Design level:* Hazus-MH terminology referring to the quality of a building's seismic building code (i. e. Pre, Low, Moderate, and High). Refer to **Appendix C.2.3** for more information.

As a means of comparison, we also ran a CSZ Mw-9.0 scenario in Hazus for the same building dataset. While the overall damages and number of potentially displaced population are fewer than the Mt. Angel scenario, the damage is more widespread throughout the county. Emergency response could be more difficult in this scenario because emergency services would not be concentrated in a specific area of the county. In addition to a thinned-out response within the county itself, the regional impact may further exacerbate the level of demand for these services.

Marion countywide CSZ Mw-9.0 earthquake results:

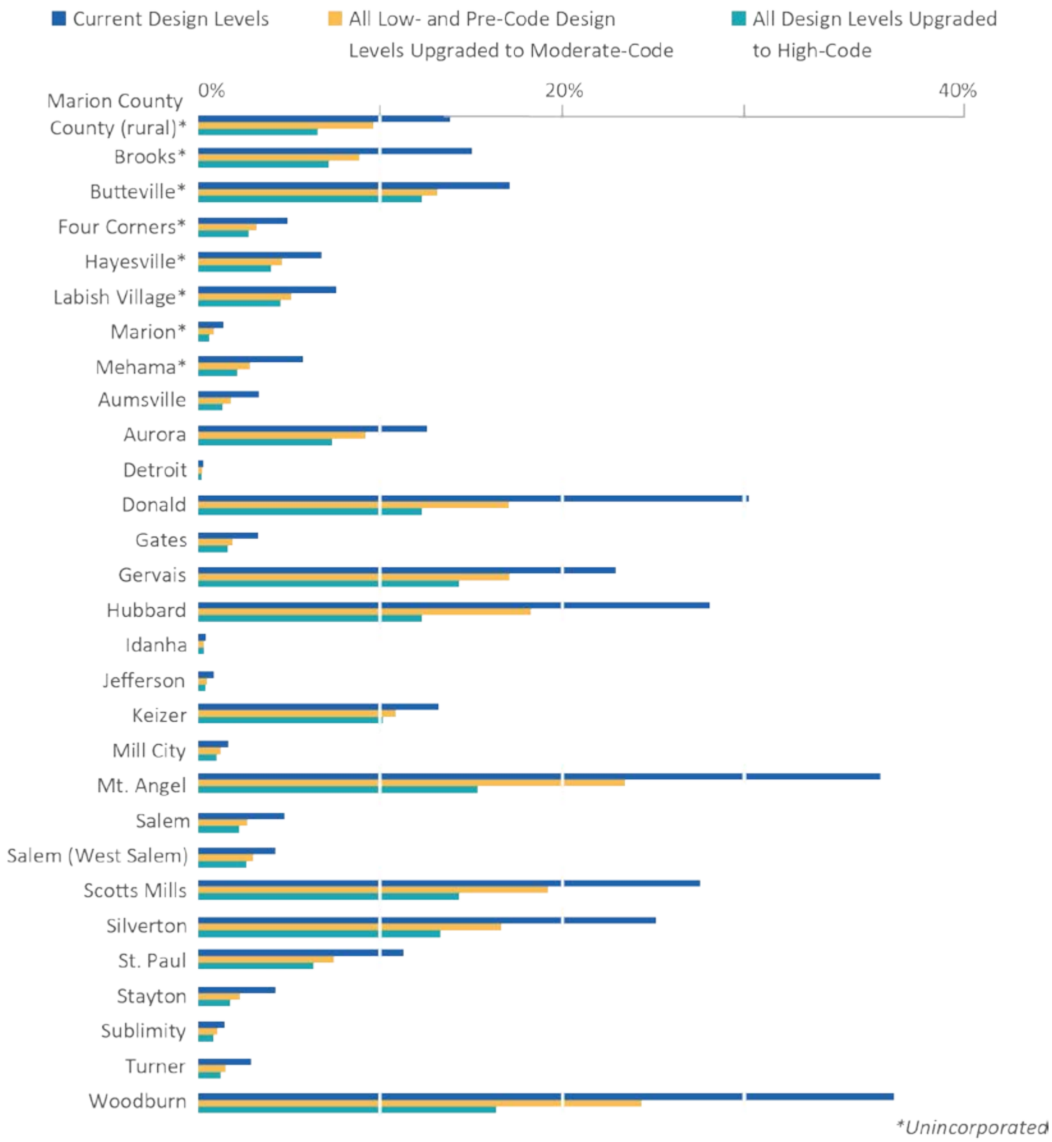
- Number of red-tagged buildings: 4,040
- Number of yellow-tagged buildings: 9,294
- Loss estimate: $2,820,655,000
- Loss ratio: 4.5%
- Non-functioning critical facilities: 44
- Potentially displaced population: 8,086

3.2.3 Areas of significant risk

We identified locations within the study area that are comparatively at greater risk to earthquake hazard:

- Areas near the epicenter of the simulated earthquake scenario are likely to incur a significant amount of damage. The communities of Mt. Angel, Scotts Mills, Silverton, and Woodburn have higher estimated loss ratios compared to other communities in the study due to the level of shaking likely to occur.
- Buildings along the Willamette, the Santiam, and North Santiam Rivers are at higher risk from earthquake damage due to significant exposure to liquefaction.
- Unreinforced masonry buildings in the older downtown portions of Salem, Silverton, and Stayton are more vulnerable to substantial damage during an earthquake compared to other nearby structures built to modern standards. The Molalla Union High School, an unreinforced masonry building, was significantly damaged during the 1993 Scotts Mills earthquake (Dewey and others, 1994).
- 82 of the 236 critical facilities in the study area are estimated to be nonfunctioning due to an earthquake similar to the one simulated in this study.

Figure 3-2. Mt. Angel deterministic Mw-6.8 earthquake loss ratio in Marion County, with simulated seismic building code upgrades.



3.3 Flooding

The frequency and severity of flooding may change over time due to changes in climate and precipitation patterns, land use, and how we manage our waterways. This study represents our current understanding of flood hazards and flood risk, but we recognize that flood models and risk assessments will need to be updated with time and changing conditions.

In its most basic form, a flood is an accumulation of water over normally dry areas. Floods become hazardous to people and property when they inundate an area where development has occurred, causing losses. Floods are a commonly occurring natural hazard in Marion County and have the potential to create public health hazards and public safety concerns, close and damage major highways, destroy railways, damage structures, and cause major economic disruption. Flood issues such as flash flooding, ice jams, post-wildfire floods, and dam safety were not examined in this report.

A typical method for determining flood risk is to identify the probability and impact of flooding. The annual probabilities calculated for flood hazard used in this report are 10%, 2%, 1%, and 0.2%, henceforth referred to as 10-year, 50-year, 100-year, and 500-year scenarios, respectively. The ability to assess the probability of a flood, and the level of accuracy of that assessment is influenced by modeling methodology advancements, better knowledge, and longer periods of record for the stream or water body in question.

The major rivers and creeks within the county are the Mill Creek (near Salem), the Mill Creek (near Woodburn), Butte Creek and Silver Creek, and the Pudding, North Santiam, Santiam, and Willamette Rivers. In addition, there are several tributaries to these major streams that have mapped flood zones. All the mapped streams are subject to flooding and damaging buildings within the floodplain.

The impacts of flooding are determined by adverse effects to human activities within the natural and built environment. Through strategies such as flood hazard mitigation these adverse impacts can be reduced. Examples of common mitigating activities are elevating structures above the expected level of flooding or removing the structure through FEMA's property acquisition ("buyout") program.

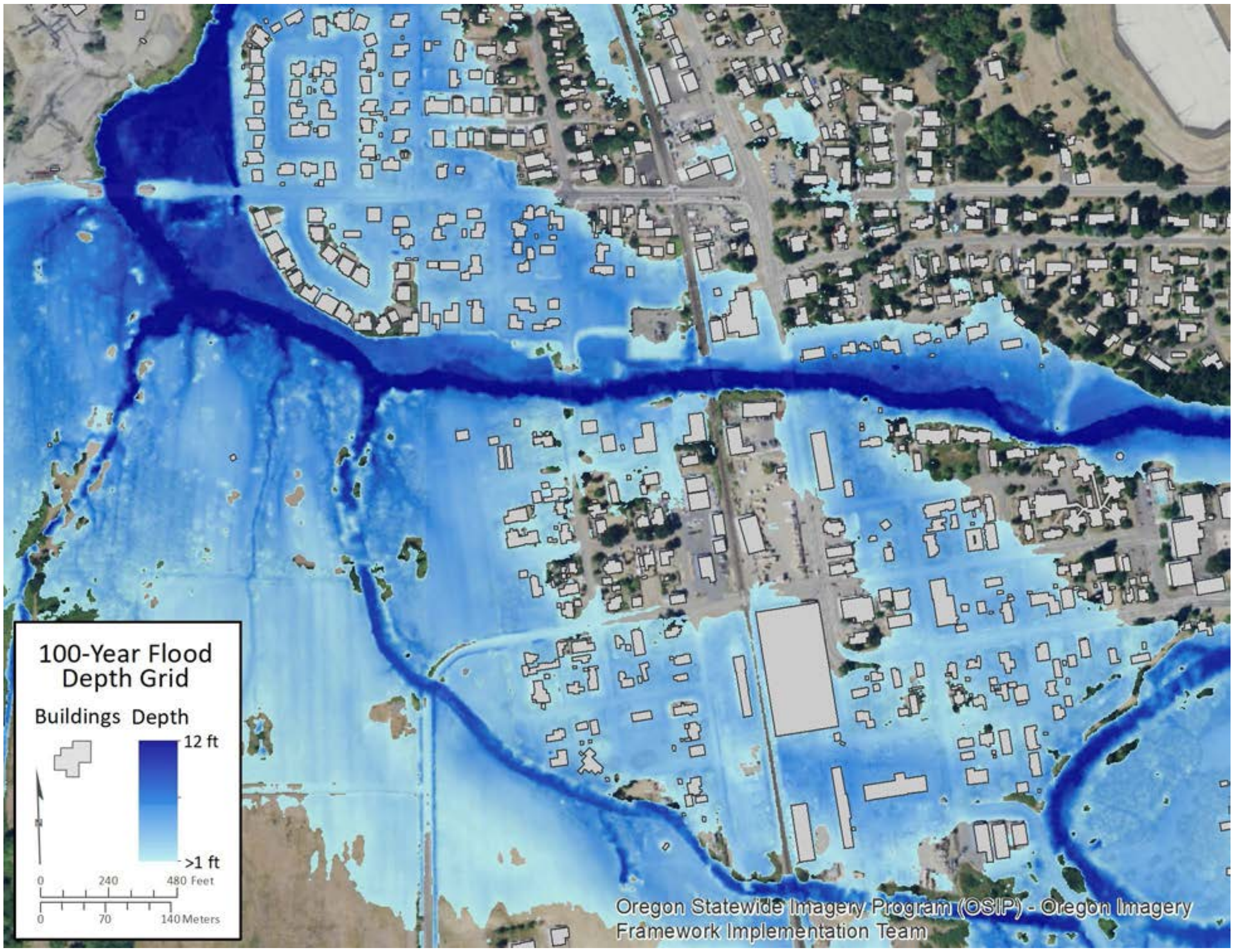
3.3.1 Data sources

The Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) for the study area were updated and made effective in 2019 (FEMA, 2019); these were the primary data sources for the flood risk assessment. Further information regarding NFIP related statistics can be found at FEMA's website: https://www.fema.gov/policy-claim-statistics-flood-insurance. These were the only flood data sources that we used in the analysis, but flooding does occur in areas outside of the detailed mapped areas.

DOGAMI developed the 10-, 50-, 100-, and 500-year depth grids from detailed stream model information within the study area (Appleby and Williams, 2021). DOGAMI used high-resolution lidar collected in 2009, 2013, and 2018 to create the depth grids (Willamette Valley 2009 project, Clackamol 2013 project, and Santiam 2018 project - Oregon Lidar Consortium; see http://www.oregongeology.org/lidar/collectinglidar.htm). The set of depth grids were used in this risk assessment to determine the level to which buildings are impacted by flooding.

Depth grids are raster GIS datasets in which each digital pixel value represents the depth of flooding at that location within the flood zone **(Figure 3-3)**. Depth grids for four riverine flooding scenarios (10-, 50-, 100-, and 500-year) were used for loss estimations and, for comparative purposes, exposure analysis.

Figure 3-3. Flood depth grid example in the city of Turner, Oregon.



Building loss estimates are determined in Hazus-MH by overlaying building data on a depth grid. Hazus-MH uses individual building information, specifically the first-floor height above ground and the presence of a basement, to calculate the loss ratio from a particular depth of flood.

For Marion County, occupancy type and basement presence attributes were available from the assessor database for most buildings. Where individual building information was not available from assessor data, we used oblique imagery and street-level imagery to estimate these important building attributes. Only buildings in a flood zone or within 152 meters (500 feet) of a flood zone were examined closely to attribute buildings with more accurate information for first-floor height and basement presence. Because our analysis accounted for building first-floor height, buildings that have been elevated above the flood level were not given a loss estimate—but we did count residents in those structures as displaced. We did not look at the duration that residents would be displaced from their homes due to flooding. For information about structures exposed to flooding but not damaged, see the **Exposure analysis** section.

3.3.2 Countywide results

For this risk assessment, we imported the countywide UDF data and depth grids into Hazus-MH and ran a flood analysis for four flood scenarios (10-, 50-, 100-, and 500-year). We used the 100-year flood scenario as the primary scenario for reporting flood results (also see **Appendix E, Plate 4**). The 100-year flood has traditionally been used as a reference level for flooding and is the standard probability that FEMA uses for regulatory purposes. See **Table B-4** for multi-scenario cumulative results.

Marion countywide 100-year flood loss:

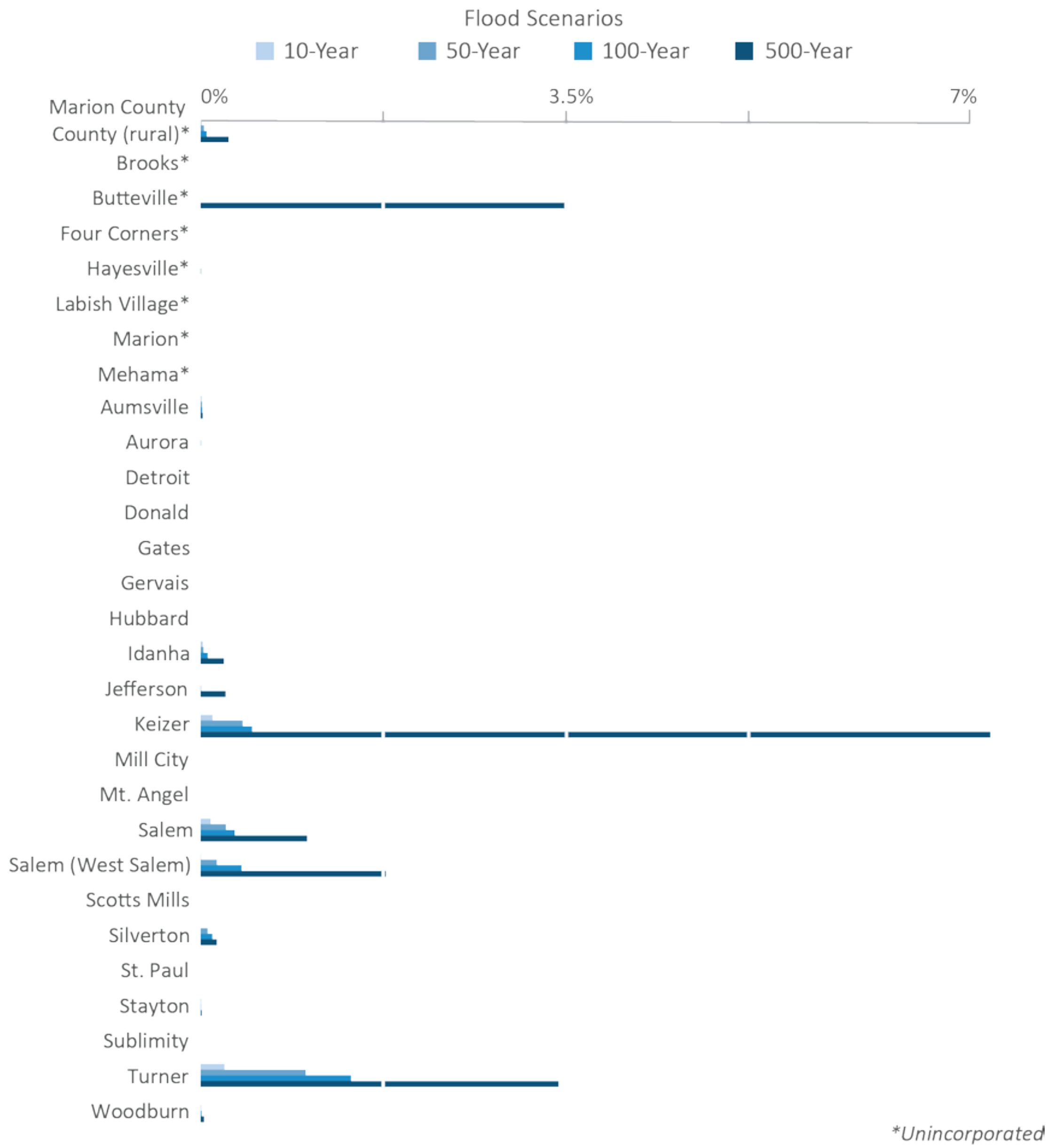
- Number of buildings damaged: 2,552
- Loss estimate: $126,324,000
- Loss ratio: 0.2%
- Damaged critical facilities: 10
- Potentially displaced population: 4,568

3.3.3 Hazus-MH analysis

The Hazus-MH loss estimate for the 100-year flood scenario for the entire county is more than $126 million. While the loss ratio of flood damage for the entirety of Marion County is 0.2%, the impact to areas of development near flood-prone streams is significant (**Figure 3-4**). In situations with communities where most residents are not within flood designated zones, the loss ratio may not be as helpful as the actual replacement cost and number of residents displaced to assess the level of risk and impact from flooding. The Hazus-MH analysis also provides useful flood data on individual communities so that planners can identify problems and consider which mitigating activities will provide the greatest resilience to flooding.

The main flooding problems within Marion County are primarily in the areas of Turner and Salem near the Mill Creek floodplain. The community of Keizer also has a high level of estimated damage from the Willamette River and its tributaries that flow through the community. (**Figure 3-4**). There are few areas of concentrated flood damage in the study area. The small amount of damage that is estimated is scattered across the county at various places along the mapped streams.

Figure 3-4. Ratio of flood loss estimates by Marion County community.



3.3.4 Exposure analysis

Separate from the Hazus-MH flood analysis, we did an exposure analysis by overlaying building locations on the 100-year flood extent. We did this to estimate the number of buildings that are elevated above the level of flooding and the number of displaced residents. This was done by comparing the number of non-damaged buildings from Hazus-MH with the number of exposed buildings in the flood zone. A small proportion (2%) of Marion County's buildings were found to be within designated flood zones. Of the 3,053 buildings that are exposed to flooding, we estimate that 501 are above the height of the 100-year flood. This evaluation also estimates that 4,568 residents might have mobility or access issues due to surrounding water. See **Appendix B: Table B-5** for community-based results of flood exposure.

3.3.5 Areas of significant risk

We identified locations within the study area that are comparatively at greater risk from flood hazard:

- The very large floodplain of Mill Creek (near Salem) and its tributaries from the city of Turner to Salem correspond to high levels of urban development. This area is at high risk from flood hazard.
- Many buildings in the city of Keizer along Labish Ditch are at risk of the estimated 500-year flood.
- Buildings within the Willamette River floodplain, particularly in the city of Salem, including West Salem, are at risk from flood hazard.

3.3 Landslide Susceptibility

This study represents our current understanding of landslide susceptibility within this study area. However, changing climate, precipitation patterns, land use, wildfire events, and land and forest management strategies may increase or decrease the susceptibility to landslides.

Landslides are mass movements of rock, debris, or soil most commonly downhill. There are many different types of landslides in Oregon. In Marion County, the most common are debris flows and shallow- and deep-seated landslides. Landslides can occur in many sizes, at different depths, and with varying rates of movement. Generally, they are large, deep, and slow moving or small, shallow, and rapid. Factors that influence landslide type include slope steepness, water content, and geology. Many triggers can cause a landslide: intense rainfall, earthquakes, or human-induced factors like water concentration, excavation along a landslide toe or loading at the top. Landslides can cause severe damage to buildings and infrastructure. Fast-moving landslides may pose life safety risks and can occur throughout Oregon (Burns and others, 2016).

3.3.1 Data sources

The Statewide Landslide Information Layer for Oregon (SLIDO), release 3.2 (Burns and Watzig, 2014) is an inventory of mapped landslides in the state of Oregon. SLIDO is a compilation of past studies; some studies were completed very recently using new technologies, like lidar-derived topography, and some studies were performed more than 50 years ago. Consequently, SLIDO data vary greatly in scale, scope, and focus and thus in accuracy and resolution across the state.

Burns and others (2016) used SLIDO 3.2 inventory data along with maps of generalized geology and slope to create a landslide susceptibility overview map of Oregon that shows zones of relative susceptibility: Very High, High, Moderate, and Low. Landslide inventory data directly define the Very High landslide susceptibility zone, whereas the landslide inventory data coupled with statistical results from generalized geology and slope maps define the other relative susceptibility zones (Burns and others, 2016). Statewide landslide susceptibility map data have the inherent limitations of SLIDO and of the generalized geology and slope maps used to create the map. Therefore, the Statewide Landslide Susceptibility Map varies significantly in quality across the state, depending on the quality of the input datasets. Another limitation is that susceptibility mapping does not include some aspects of landslide hazard, such as runout, where the momentum of the landslide can carry debris beyond the zone deemed to be a high hazard area.

Burns and Mickelson (2012) published detailed landslide inventory and susceptibility maps for the city of Silverton. DOGAMI (Harvey and Peterson, 1998; 2000; Hofmeister and others, 2000; Hofmeister and Wang, 2000) produced several landslide hazard maps in the city of Salem region approximately 20 years ago (IMS-6, IMS-5, IMS-17, IMS-18). These maps are currently part of the city of Salem's development building code. This report did not use either of these datasets and thus results in this report are different than one would obtain if these datasets were used.

Recent landslide inventory mapping in Marion County (Calhoun and others, 2020) based on lidar using methods outlined in DOGAMI Special Paper Special Paper 42 (SP-42: Burns and Madin, 2009) was published in 2020 and was not incorporated into the 2016 Statewide Landslide Susceptibility Map. For this risk assessment, we took a conservative approach and overlaid this new landslide inventory (Calhoun and others, 2020), which is equivalent to Very High susceptibility, and replaced the susceptibility zones in the Statewide Landslide Susceptibility Map (Burns and others, 2016). Areas that were previously mapped as Very High but were outside of the new landslide mapping were changed to High zones.

We used the data from the combined Statewide Landslide Susceptibility Map (Burns and others, 2016) and new landslide mapping (Calhoun and others, 2020) in this report to identify the general level of susceptibility of a given area to landslide hazards, primarily shallow and deep landslides. We overlaid building and critical facilities data on landslide susceptibility zones to assess the exposure for each community (**Table B-6**). The total dollar value of exposed buildings was summed for the study area and is reported below. We also estimated the number of people threatened by landslides. Land value losses due to landslides and potentially hazardous unmapped areas that may pose real risk to communities were not examined for this report.

3.3.2 Countywide results

Communities that developed in terrain with moderate to steep slopes or at the base of steep hillsides may be exposed to landslides. We found that communities along the North Santiam and Santiam Rivers and Scotts Mills have a high level of exposure to landslide hazard. The percentage of building value exposed to very high and high landslide susceptibility is approximately 4.3% for the entire study area.

We combined High and Very High susceptibility zones as the primary scenarios to provide a general sense of community risk for planning purposes (**Appendix E: Plate 6**). It was useful to combine exposure for both susceptibility zones to best communicate the level of landslide risk to communities. These susceptibility zones represent areas most susceptible to landslides with the highest impact to the community.

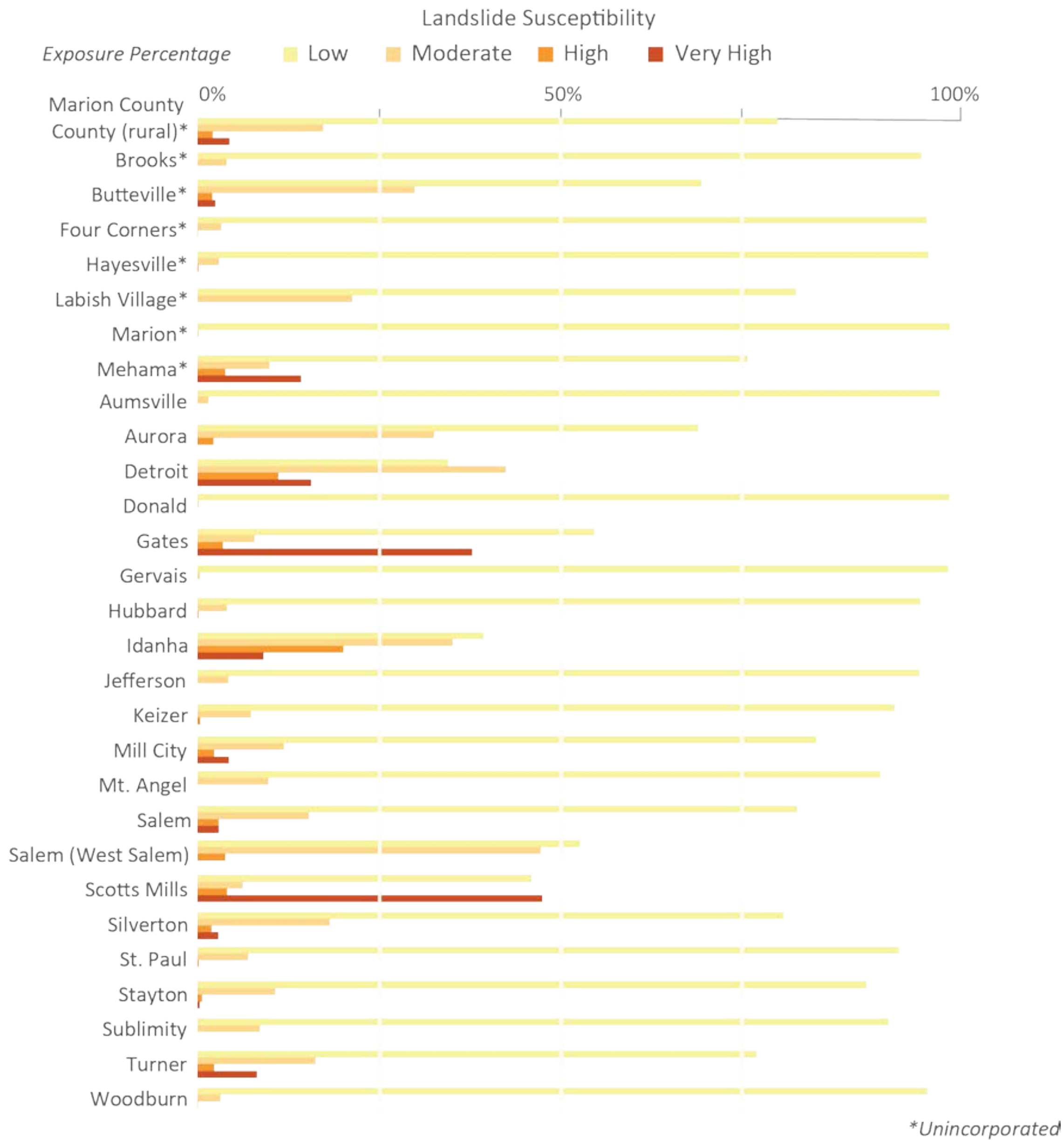
For this risk assessment we compared building locations to geographic extents of the landslide susceptibility zones (**Figure 3-5**). The exposure results shown below are for the High and Very High susceptibility zones. See **Appendix B: Detailed Risk Assessment Tables** for exposure analysis results of all susceptibility categories.

Marion countywide landslide exposure (High and Very High susceptibility):

- Number of buildings: 7,470
- Value of exposed buildings: $2,663,045,000
- Percentage of total county value exposed: 4.3%
- Critical facilities exposed: 3
- Potentially displaced population: 18,538

Most of the developed land in Marion County is located on the gentle terrain found in the Willamette River Valley, which is typically Low susceptibility landslide zones. However, there are developed areas in the southwest part of Salem, large portion of Scotts Mills, and communities along the North Santiam River that are highly susceptible to landslide hazard. Landslide hazard is ubiquitous in the eastern panhandle portion of Marion County, which may present challenges for planning and mitigation efforts. Awareness of nearby areas of landslide hazard is beneficial to reducing risk for every community and rural area of Marion County.

Figure 3-5. Landslide susceptibility exposure by Marion County community.



3.3.3 Areas of significant risk

We identified locations within the study area that are comparatively at greater risk to landslide hazard:

- Buildings in the unincorporated county along the North Santiam River are exposed to High and Very High landslide hazard.
- Many buildings in the cities of Scotts Mills and Silverton have significant exposure to High and Very High landslide hazard.
- The residential neighborhoods in the southwestern portions of Salem and just outside of Salem are built on existing landslides (mapped as Very High susceptibility).

3.4 Channel Migration

The frequency and severity of channel migration may change over time due to changes in climate and precipitation patterns, land use, and how we manage our waterways. This study represents our current understanding of channel migration hazards and risk, but we recognize that channel migration mapping and risk assessments will need to be updated with time and changing conditions.

Channel migration is a dynamic process by which a stream's location changes over time. This process includes channel bed and bank erosion, sediment deposition, and channel avulsion, a process in which the stream abruptly moves to a new location on the floodplain. Many factors influence channel movement, including the local geology, size, and quantity of sediment within the river, discharge of water, vegetation, channel shape, and slope. Human changes to the channel, such as the construction of dams and levees, also has a major impact on how a channel changes its course. In combination, these factors affect how a river's energy and erosive power is dispersed. Straight, steep streams have highly concentrated erosive power; by contrast, curving channels that flow across wide and flat floodplains allow the river to dissipate its energy over a wider area and for sediment to be deposited (Rapp and Abbe, 2003).

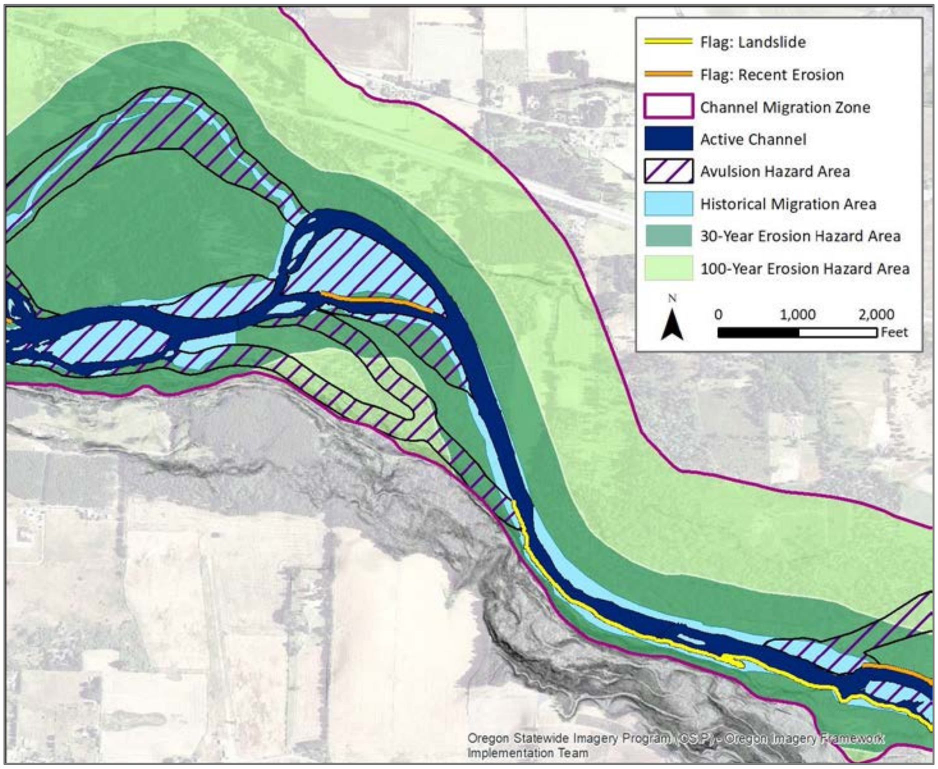
The area in which a stream channel moves laterally over a given time is known as a channel migration zone (CMZ). In places where development has occurred within the CMZ, structures are at risk for severe damage to foundations and infrastructure. The CMZ typically extends beyond the limits of the regulatory floodplain, but little consideration is given to this potential hazard. This factor contributes greatly to the level of risk that exists for many developed areas along streams (Rapp and Abbe, 2003).

3.4.1 Data sources

The channel migration zones used for this report were developed by Appleby and others (2021) for the Pudding River and the Santiam and North Santiam Rivers. The CMZ includes the areas of historical channel migration, potential erosion, and channel avulsion; these areas are mapped based on geology, historical aerial imagery, lidar topography, limited field work, and measured rates of historical channel migration. The methodology for developing the related zones and how they are combined are described in Appleby and others (2021). The CMZ is subdivided into seven subcomponents: the active channel, historical migration area, 30-year and 100-year erosion hazard areas, the avulsion hazard area, and flagged streambanks that are actively eroding or adjacent to landslides (**Figure 3-6**).

To assess the exposure within each community, we overlaid buildings and critical facilities on the 30-year erosion hazard area within the CMZ. While there is risk throughout the CMZ, we chose to examine the structures within the 30-year erosion hazard area, because it represents the area of greatest probability of being at risk from channel migration during the next 30 years. We estimated the total dollar value of exposed buildings and the number of people potentially displaced from the 30-year CMZ and reported these values in the following section. Land value losses due to CMZ were not examined for this report.

Figure 3-6. Example diagram of the components of a channel migration zone (CMZ) map in Marion County, including the active channel (AC) in dark blue, historical migration area (HMA) in light blue, avulsion hazard area (AHA) with hatched lines, 30-year and 100-year erosion hazard areas (EHA) in dark and light green, flagged streambanks with yellow and orange lines, and CMZ boundary outlined in magenta (from Appleby and others, 2021).



3.4.2 Countywide results

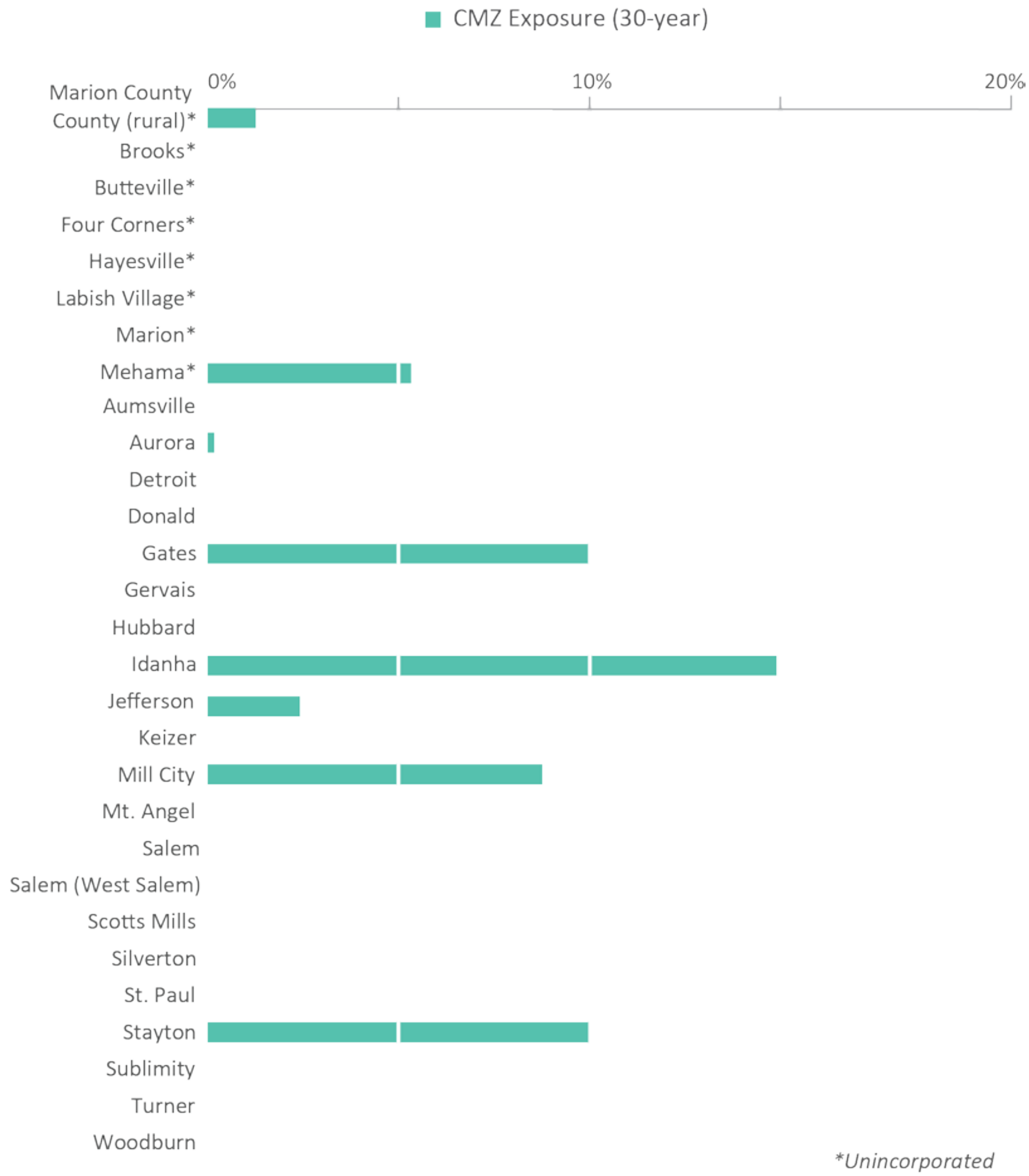
Mapped channel migration areas along the North Santiam, Santiam, and Pudding Rivers show a very high level of risk from this hazard for many communities along these watercourses. To quantify risk, the exposure analysis was conducted by determining which buildings were within or outside of the CMZ (see **Appendix E: Plate 8**). Due to the frequency of shifting channel patterns in these streams, channel migration hazard presents a significant risk compared to other hazards in the county.

Marion countywide channel migration exposure (30-year Erosion Hazard Area):

- Number of buildings: 826
- Value of exposed buildings: $295,868,000
- Percentage of total county value exposed: 0.5%
- Critical facilities exposed: 2
- Potentially displaced population: 1,475

A significant number of buildings in the unincorporated county and cities along the Santiam and North Santiam Rivers are within areas where channel migration is likely to occur. Nearly half of the buildings in the city of Stayton are mapped within the potential channel migration zone. **Figure 3-7** illustrates the distribution of exposed building value due to channel migration with the different communities of Marion County. See **Appendix B: Detailed Risk Assessment Tables** for complete analysis results.

Figure 3-7. Channel migration zone exposure by Marion County community.



3.4.3 Areas of significant risk

We identified locations within the study area that are comparatively at greater risk to channel migration hazard:

- The portions of the communities of Marion, Gates, Idanha, Jefferson, Mill City, and Mehama located along the Santiam and North Santiam Rivers have areas of potential risk from channel migration hazard.

- Many residential and commercial buildings are exposed to channel migration hazard in the southern portion of Stayton along the Santiam River.

3.5 Wildfire

The frequency, intensity, and severity of wildfires may change over time due to changes in climate, drought conditions, urbanization, and how we manage our forested lands. This study represents our current understanding of wildfire hazards and wildfire risk, but we recognize that wildfire models and risk assessments will need to be updated with time and changing conditions.

Wildfires are a natural part of the ecosystem in Oregon. However, wildfires can present a substantial hazard to life and property in growing communities. The most common wildfire conditions include hot, dry, and windy weather; the inability of fire protection forces to contain or suppress the fire; the occurrence of multiple fires that overwhelm committed resources; and a large fuel load (dense vegetation). Once a fire has started, its behavior is influenced by numerous conditions, including fuel, topography, weather, drought, and development (Gilbertson-Day and others, 2018). Post-wildfire geologic hazards can also present risk. These usually include flood, debris flows, and landslides. Post-wildfire geologic hazards were not evaluated in this project.

The Marion County Community Wildfire Protection Plan (WCCWPP), from 2017, recommended that the county develop policies that address fire restriction enforcement, wildland urban interface standards, and building code enforcement related to emergency access. Forests cover large portions of the study area and play an important role in the local economy, but also surround homes and businesses (MCCWPP, 2017). Contact the Marion County Planning Division for specific requirements related to the county's comprehensive plan.

As previously mentioned, Marion County was impacted by the 2020 Labor Day Fires, specifically the Beachie Creek and Lionshead Wildfires. These fires are termed "megafires" because they were greater than 100,000 acres in size. The Beachie Creek wildfire burned nearly 194,000 acres and the Lionshead wildfire burned 205,000 acres (Northwest Interagency Coordination Center website, accessed 2/25/2022). The fires resulted in severe impacts to the built and natural environment in Marion County and directly demonstrate the level of wildfire risk in the county. The Oregon Department of Emergency Management estimates that more than 1,500 structures, including 700 homes were destroyed within the study area from these wildfires.

3.5.1 Data sources

The Pacific Northwest Quantitative Wildfire Risk Assessment (PNRA): Methods and Results (Gilbertson-Day and others, 2018) is a comprehensive report that includes a database of spatial information related to wildfire hazard developed by the United States Forest Service (USFS) for the states of Oregon and Washington. The steward of this database in Oregon is the Oregon Department of Forestry (ODF). The database was created to assess the level of risk residents and structures have to wildfire. For this project, the burn probability dataset, a dataset included in the PNRA database, was used to measure the risk to communities in Marion County.

Using guidance from ODF, we categorized the Overall Wildfire Risk dataset into low, moderate, and high-hazard zones for the wildfire exposure analysis. Overall Wildfire Risk was developed as a combination of burn probability and the presence of infrastructure and assets. The range of values in the risk dataset describe the level of potential impact and are characterized by very high negative values that indicate very high risk down to zero which indicates low risk. The risk dataset also includes positive values that represents uninhabited areas that benefit from wildfire, but these were combined into the low-risk category (Gilbertson-Day and others, 2018).

Overall Wildfire Risk values were grouped into three hazard categories:

- Low wildfire hazard (-0.000011 to 0.005)
- Moderate wildfire hazard (-0.000119 to -0.000011)
- High wildfire hazard (-0.203 to -0.000119)

We overlaid the buildings layer and critical facilities on each of the wildfire hazard zones to determine exposure. In certain areas no wildfire data are present which indicates areas that have minimal risk to wildfire hazard (see **Appendix B: Table B-8**). The total dollar value of exposed buildings in the study area is reported in the following section. We also estimated the number of people threatened by wildfire. Land value losses, infrastructure, and environmental impacts due to wildfire were not examined for this project.

3.5.2 Countywide results

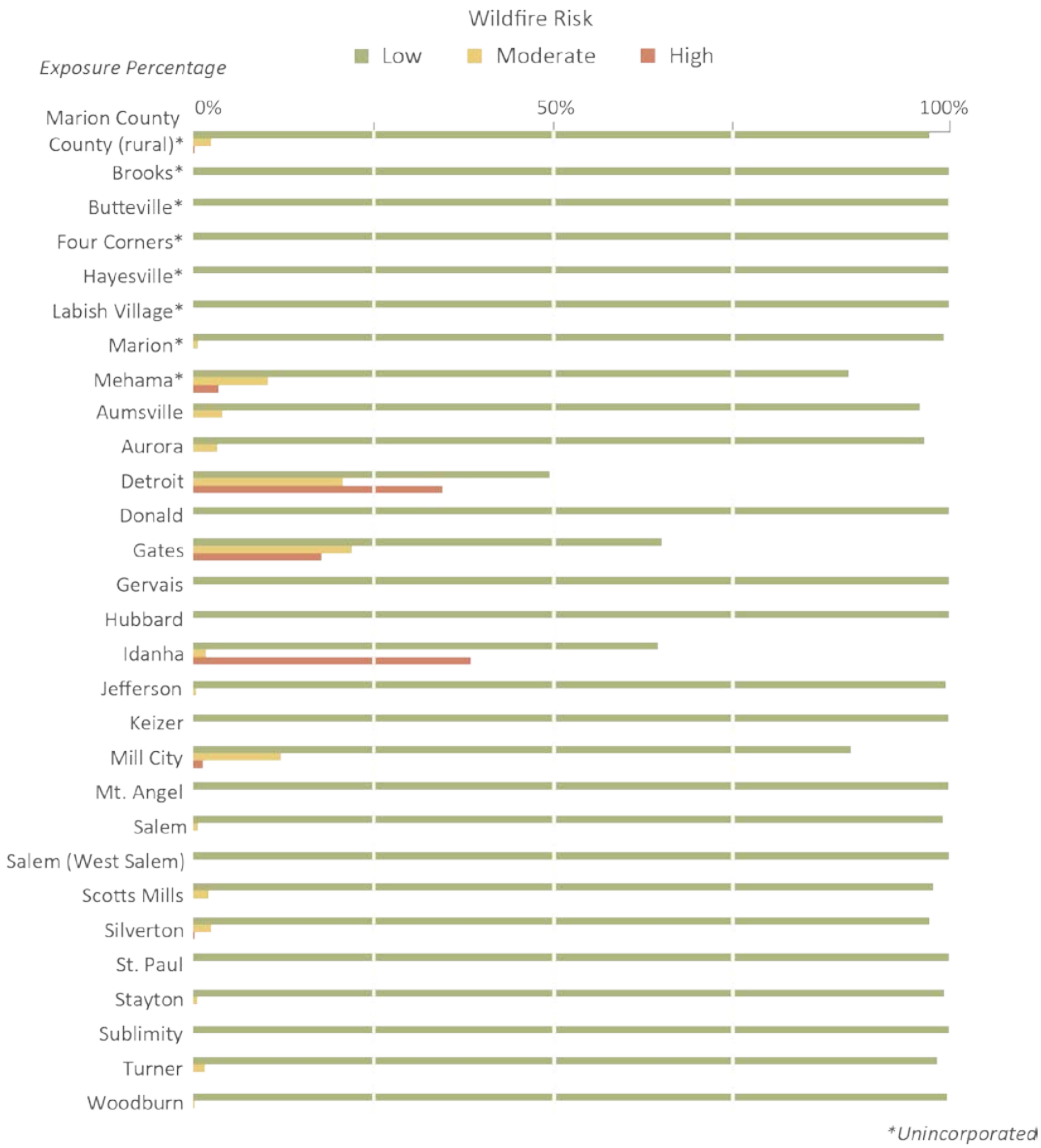
The High hazard category was chosen as the primary scenario for this report because that category represents areas that have the highest potential for losses. However, Low hazard is not the same as no hazard. Moderate wildfire risk is included with high risk in the assessment of exposure to wildfire, because under certain conditions moderate risk zones can be very susceptible to burn. In combining the High and Moderate risk categories within Marion County, we can emphasize areas where lives and property are most at risk.

Marion countywide wildfire exposure (High or Moderate risk):

- Number of buildings: 2,819
- Value of exposed buildings: $813,993,000
- Percentage of total county value exposed: 1.3%
- Critical facilities exposed: 7
- Potentially displaced population: 4,754

For this risk assessment, the building locations were compared to the geographic extent of the wildfire risk categories. More than 1,000 buildings in along the North Santiam River are exposed to High or Moderate wildfire hazard. These are the primary areas of greatest risk to this hazard, especially in heavily forested areas along state Highway 22 (**Appendix E: Plate 7**). The communities of Detroit, Idanha, Gates, and Mill City have the highest percentage of exposure to high and moderate wildfire hazard within the study area. **Figure 3-8** illustrates the level of risk from wildfire for the different communities of Marion County. See **Appendix B: Detailed Risk Assessment Tables** for multiscenario analysis results.

Figure 3-8. Wildfire risk exposure by Marion County community.



3.5.3 Areas of significant risk

We identified locations within the study area that are comparatively at greater risk from wildfire hazard:

- While the Beachie Creek, Lionshead, and P-515 wildfires that occurred in the fall of 2020 caused widespread and devastating damage to areas along the North Santiam River, those wildfires were not specifically examined in this report. However, the areas that burned will be at risk to indirect hazards such as post-wildfire debris flows, rock falls, and flash flooding. The data used in this risk assessment, both asset and hazard information, originated prior to the date of these fires. The areas most at risk based on the data used in this study correspond to areas impacted by the 2020 wildfires.
- Exposure to wildfire risk is highest for communities in the forested areas along state Highway 22 that follows along the North Santiam River.

3.6 Volcano Hazard – Lahar

A lahar is a water-saturated mixture of muddy debris and rock fragments that originates from a volcano and flows down channels at a rapid speed. Lahars are typically generated from a volcanic eruption but can be initiated during heavy rains or by a sudden outburst of glacial melt. They are most common when a volcano that is covered with heavy loads of snow and ice erupts. When water mixes with materials from eruptions, a lahar or volcanic debris flow can occur (Driedger and Scott, 2008).

Distal volcanic hazards, as opposed to proximal volcanic hazards affect areas away from the center of geologic activity. A lahar is considered a distal volcanic hazard because a lahar can travel long distances and cause damage (Burns and others, 2011). Because a lahar moves like flowing concrete, it has the capacity to destroy most things in its path. Lahar deposits tend to exacerbate flooding and channel migration risk in the river valleys they affect (Driedger and Scott, 2008). For additional detailed information on the volcanic hazards and potential impacts, Walder and others (1999) Volcano Hazards in the Mount Jefferson Region, Oregon, USGS Open-File Report 99-24 should be reviewed. This report discusses the risk from lahars to the Detroit Dam and Detroit Lake. If lahars entered this lake, they could cause large waves that could overtop the dam and possibly cause dam failure, with catastrophic effects downstream. Such events have very low probabilities but great potential consequences (Walder and others, 1999).

3.6.1 Data sources

The lahar zones used in this report were created by Walder and others (1999) and were based on previous volcanic eruptions to estimate the extent of potential lahars on Mount Jefferson. Three nested lahar zones were computed based on an estimated volume of debris that could suddenly flow from Mount Jefferson. The largest and least likely scenario (>15,000-year annual recurrence) is designed at a volume of 500 million cubic meters (650 million cubic yards) and would correspond to volcanic activity or a low-probability landslide event involving large flank failures not caused by magmatic intrusion (Walder and others, 1999). The intermediate and small lahar scenarios are based on more likely events ranging from small eruptions, stream explosion, or rain-on-snow events. Such events are estimated to produce volumes of debris smaller than the largest scenario. The intermediate scenario, categorized in this report as "Medium," has an estimated volume of 100 million cubic meters (130 million cubic yards) with an annual recurrence of 1,000 to 15,000 years. The smallest scenario, categorized as "Small," has an estimated volume of 20 million cubic meters (25 million cubic yards) with an annual recurrence of 100 to 1,000 years.

For this risk assessment, we compared the locations of buildings and critical facilities to the geographic extent of the lahar inundation zones to assess the exposure for each community (**Appendix B: Table-B**, and **Appendix E: Plate 8**). The exposure results shown below are for only the Medium scenario. We also estimated the number of people at risk from lahar hazard.

3.6.2 Countywide results

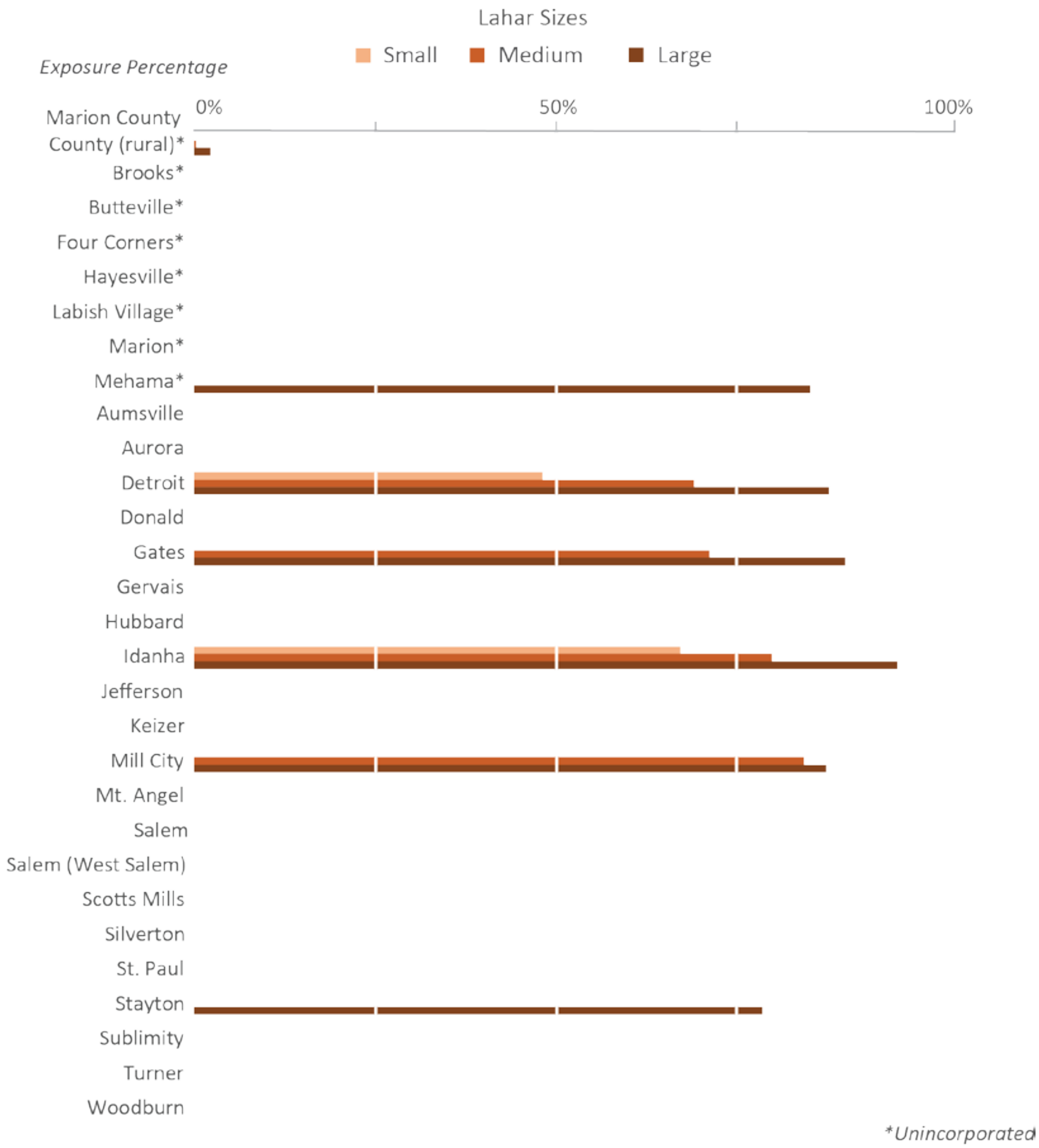
Most of the 350,000 residents in the study area are not exposed to lahar hazard, but the hazard poses significant concerns for those closer to Mount Jefferson and those within the distal riverine valley.

The total dollar value of exposed buildings was summed for the study area and is shown in **Figure 3-9**. The communities most threatened from a volcanic eruption and lahar event are Gates, Detroit, Idanha, and Mill City. See **Appendix B: Detailed Risk Assessment Tables** for cumulative multiscenario analysis results.

Marion countywide lahar exposure (Medium scenario):

- Number of buildings: 1,789
- Exposure value: $414,766,000
- Percentage of exposure value: 0.7%
- Critical facilities exposed: 3
- Potentially displaced population: 2,401

Figure 3-9. Lahar exposure by study area community.



Note that "Salem (West Salem)" is the portion of the city of Salem within Polk County. Values for "Salem" and "Salem (West Salem)" can be summed to calculate the total value for the city of Salem.

3.6.3 Areas of vulnerability or risk

We identified locations within the study area that are comparatively more vulnerable or at greater risk to lahar hazard:

- Lahar risk is present for all buildings near the North Santiam River along state Highway 22.
- The 100–1,000-year return interval is a significant threat for residents closer to Mt. Jefferson. Detroit has 47% exposure and Idanha has 66% exposure to this hazard.

4.0 CONCLUSIONS

The purpose of this study is to provide a better understanding of potential impacts from multiple natural hazards at the community scale. We accomplished this by using the latest natural hazard mapping and loss estimation tools or exposure analysis to quantify risk to buildings and potential displacement of permanent residents. This detailed approach provides new context for the county's risk reduction efforts. We note several important findings based on the results of this study:

- **Extensive damage and losses for some areas in Marion County can occur from an earthquake—**Based on the results of a Mt. Angel Fault Mw-6.8 earthquake, some communities in Marion County will experience at least some impact and disruption. Results show that this earthquake could cause building value losses of 30% to 35% to all communities in the northeastern portion of Marion County. The damages in this part of the county are primarily from earthquake shaking, while damage to other buildings along the Willamette, Santiam, and North Santiam Rivers could also be due to ground deformation related to liquefaction. High vulnerability within the building inventory (unreinforced masonry) also contributed to losses expected in the county.
- **Retrofitting buildings to modern seismic building codes can reduce damages and losses from earthquake shaking—**Seismic building codes have a major influence on earthquake shaking damage estimated in this study. We found that retrofitting to at least Moderate code was a very effective mitigation strategy because the additional benefit from retrofitting to High code was minimal. In our simulation of upgrading buildings to at least Moderate code, the estimated loss for the entire study area was reduced from 11% to 7%. We found further reduction in estimated loss in our simulation to 5.2% by upgrading all buildings to High code. Communities with older buildings, that were constructed below the Moderate seismic code standards, are both the most vulnerable and have the greatest potential for risk reduction. For example, the city of Mt. Angel could reduce losses from 37% to 13% by retrofitting all buildings to at least moderate code. This stands in contrast to areas with newer building stock, such as the city of Keizer, which would see small reductions in damage estimates. Although seismic retrofits are an effective strategy for reducing earthquake shaking damage, it should be noted that earthquake-induced landslide and liquefaction hazards will also be present in some areas, and these hazards require different geotechnical mitigation strategies.
- **Some communities in the study area are at moderate risk from flooding—**Many buildings within the floodplain are vulnerable to significant damage from flooding. At first glance, Hazus-MH flood loss estimates may give a false impression of lower risk because they show lower damages within individual communities relative to other hazards we examined. This is likely due to the difference between the type of results from loss estimation and exposure analysis, as well as the limited area impacted by flooding. Flooding is one of the most frequently occurring natural hazards and thus commonly has repetitive losses that occur with recurrence intervals of 10s to 100s of years versus volcanic hazards with recurrence intervals of 100s to thousands of years. We estimate that an average of 13% building value loss occurs for buildings within the 100-year flood zone. The areas that are most vulnerable from flood hazard within the study are buildings along the Mill Creek (near Salem) between Turner and Salem and along Labish Ditch in Keizer.
- **Elevating structures in the flood zone reduces vulnerability—**We used flood exposure analysis in addition to Hazus-MH loss estimation to identify buildings that were not damaged but were within the area expected to experience a 100-year flood. By using both analyses in this way,

we quantified the number of elevated structures within the flood zone. This showed possible mitigation needs in flood loss prevention and the effectiveness of past activities. For example, in the city of Turner nearly a third of the buildings exposed to flooding are elevated above the base flood elevation. Based on the number of buildings exposed to flooding throughout the county, many would benefit from elevating above the level of flooding.

- **Landslide risk is significant for steeper areas in the county**—The recent landslide mapping used in this study was created using lidar and modern mapping methods to develop very accurate landslide hazard maps. We used exposure analysis to assess the threat from landslide hazards. The developed areas in the southwest part of Salem, a large portion of Scotts Mills, and communities along the North Santiam River are highly susceptible to landslide hazards. Nearly 50% of the buildings in Scotts Mills are exposed to Very High or High landslide hazard.
- **Exposure analysis show that buildings in the riverine valleys of the study area are at risk from channel migration hazard**—Exposure analysis shows that channel migration hazard is a threat to communities and buildings along the Pudding, Santiam, and North Santiam Rivers. The city of Stayton has very high risk from channel migration hazard, with nearly 400 buildings exposed to the hazard.
- **Results from the wildfire risk assessment correspond to the 2020 Labor Day Wildfires along the North Santiam River**—Exposure analysis based on data prior to the 2020 wildfires show that buildings along state Highway 22 are significantly more vulnerable to wildfire hazard than the rest of the county. Hazards that are related to post-wildfire conditions, such as post-wildfire debris flow, rockfalls, and flash flooding, are likely to be present in burned areas. Post-wildfire damage assessments were not within the scope of this study, but such activities could offer a better understanding to limit future risk.
- **Exposure analysis shows that communities along the North Santiam River are at risk to lahar hazard**—Exposure analysis shows that volcanic lahar hazard is a minor threat to some communities in the study area. Structures near the North Santiam River along state Highway 22 are most at risk to lahar compared to other parts of the study area. In the community of Detroit and Idanha there are 47% and 66%, respectively, of buildings exposed to the 100- to 1,000-year return interval of lahar hazard.
- **Many of the study area's critical facilities are at significant risk to earthquake and channel migration**—Critical facilities were identified and were specifically examined within this report. We have estimated that 35% (85 of 236) of Marion County's critical facilities will be non-functioning after a Mt. Angel Fault Mw-6.8 earthquake. Additionally, 8% (20 of 236) of critical facilities are exposed to channel migration hazard and 4% (11 of 236) to flood hazard. We found little exposure of critical facilities to landslide, wildfire, and lahar hazards.
- **The biggest causes of displacement to population are earthquake and landslide hazards**—Potential displacement of permanent residents from natural hazards was estimated within this report. We estimated that there is risk to 5.3% of the population in the county from landslide hazard (not a single hazard event) and 4.3% from an earthquake. Channel migration hazard is a potential threat to 1.8% of permanent residents. A small percentage of residents are vulnerable to displacement from flood, wildfire, and lahar hazards.
- **The results allow communities the ability to compare across hazards and prioritize their needs**—Each community within the study area was assessed for natural hazard exposure and loss. This allowed for comparison of risk for a specific hazard between communities. It also allows for a comparison between different hazards, though care must be taken to distinguish loss

estimates and exposure results. The loss estimates and exposure analyses can assist in developing plans that address the concerns for those individual communities.

5.0 LIMITATIONS

There are several limitations to keep in mind when interpreting the results of this risk assessment.

- **Spatial and temporal variability of natural hazard occurrence** – With the exception of earthquakes, other hazards like flood, landslide, channel migration, and wildfire are extremely unlikely to occur across the fully mapped extent of the hazard zones. For example, areas mapped in the 100-year flood zone will be prone to flooding on occasion in certain watersheds during specific events, but not all at once throughout the entire county or even the entire community. While we report the overall impacts of a given hazard scenario, the losses from a single hazard event probably will not be as severe and widespread.
- **Loss estimation for individual buildings** – Hazus-MH is a model, not reality, which is an important factor when considering the loss ratio of an individual building. On-the-ground mitigation, such as elevation of buildings to avoid flood loss, has been only minimally captured. Also, due to a lack of building material information, assumptions were made about the distribution of wood, steel, and unreinforced masonry buildings. Loss estimation is most insightful when individual building results are aggregated to the community level because it reduces the impact of data outliers.
- **Loss estimation versus exposure** – We recommend careful interpretation of exposure results. This is due to the spatial and temporal variability of natural hazards (described above) and the inability to perform loss estimations due to the lack of Hazus-MH damage functions. Exposure is reported in terms of total building value, which could imply a total loss of the buildings in a particular hazard zone, but this is not the case. Exposure is simply a calculation of the number of buildings and their value and does not make estimates about the level to which an individual building could be damaged.
- **Population variability** – Some of the communities in Marion County have a number of vacation homes and rentals, which are typically occupied during the summer. Our estimates of potentially displaced people rely on permanent populations published in the 2010 U.S. Census (United States Census Bureau, 2010b) and adjusted for population growth based on PSU Population Research Center data. As a result, we are slightly underestimating the number of people that may be in harm's way on a summer weekend.
- **Data accuracy and completeness** – Some datasets in our risk assessments had incomplete coverage or lacked high-resolution data within the study area. We used lower-resolution data where there was incomplete coverage or where high-resolution data were not available. We made assumptions to amend areas of incomplete data coverage based on reasonable methods described within this report. Data layers in which assumptions were made to fill gaps are building footprints, population, some building specific attributes, and landslide susceptibility. Many of the datasets included known or suspected artifacts, omissions and errors, however repairing these problems was beyond the scope of the project and are areas needing additional research. We are aware that some uncertainty has been introduced from these data amendments at an individual building scale, but at community-wide scales the effects of the uncertainties are slight.

6.1 RECOMMENDATIONS

The following areas of implementation are needed to better understand hazards and reduce risk to natural hazard through mitigation planning. These implementation areas, while not comprehensive, touch on all phases of risk management and focus on awareness and preparation, planning, emergency response, mitigation funding opportunities, and hazard-specific risk reduction activities.

6.2 Awareness and Preparation

Awareness is crucial to lowering risk and lessening the impacts of natural hazards. When community members understand their risk and know the role that they play in preparedness, the community becomes a safer place to live. Awareness and preparation not only reduce the initial impact from natural hazards, but they also reduce the amount of recovery time for a after a disaster—this ability is commonly referred to as "resilience."

This report is intended to provide local officials with a comprehensive and authoritative profile of natural hazard risk to underpin their public outreach efforts.

Messaging can be tailored to stakeholder groups. For example, outreach to homeowners could focus on actions they can take to reduce risk to their property. The DOGAMI Homeowners Guide to Landslides (https://www.oregongeology.org/Landslide/ger_homeowners_guide_landslides.pdf) provides a variety of risk reduction options for homeowners who live in high landslide susceptibility areas. This guide is one of many existing resources. Agencies and local community organizations that partner with local officials in the development of additional effective resources could help this information reach a wider audience.

6.3 Planning

Local decision-makers can make plans based on the geohazard and risk information presented in this report. The primary framework for accomplishing this is through the comprehensive planning process. A comprehensive plan sets the long-term trajectory of capital improvements, zoning, and urban growth boundary expansion, all of which are planning tools that can be used to reduce natural hazard risk.

Another framework is the natural hazard mitigation plan (NHMP) process. NHMP plans focus on characterizing natural hazard risk and identifying actions to reduce risk. The information presented in this report is a key resource because it directly informs the vulnerability assessment section of the NHMP plan.

While there are many similarities between this report and an NHMP, the hazards or critical facilities in the two reports can vary. Differences between the reports may be due to data availability or limited methodologies for specific hazards. The critical facilities considered in this report may not be identical to those listed in a typical NHMP due to the lack of damage functions in Hazus-MH for non-building structures and to different considerations about emergency response during and after a disaster.

6.4 Emergency Response

Critical facilities play a major role during and immediately after a natural disaster. This study can help emergency managers identify vulnerable critical facilities and develop contingencies in their response plans. Additionally, detailed mapping of potentially displaced residents can be used to reevaluate evacuation routes and identify vulnerable populations to assist with early warning.

The building database that accompanies this report can guide predisaster mitigation, emergency response, and community resilience improvements. Vulnerable areas can be identified and supported through awareness campaigns. These campaigns can be aimed at predisaster mitigation actions, such as seismic retrofitting. Emergency response entities can benefit from the use of the building dataset through identification of potential hazards and populated buildings before and during a disaster. Reduction of the magnitude of the disaster, emergency planning, and improved response time contribute to a community's natural hazard resilience.

6.5 Mitigation Funding Opportunities

Several funding sources are available to communities that are susceptible to natural hazards and have specific mitigation projects they wish to accomplish. State and federal funds are available for projects that demonstrate cost effective natural hazard risk reduction. The Oregon Department of Emergency Management (OEM) State Hazard Mitigation Officer (SHMO) can provide communities assistance in determining eligibility, finding mitigation grants, and navigating the mitigation grant application process.

At the time of writing this report, FEMA has three programs that assist states, local communities, tribes, and territories with natural hazard mitigation funding: Hazard Mitigation Grant Program (HMGP) Building Resilient Infrastructure and Communities (BRIC), and Pre-Disaster Mitigation (PDM) Grant Program. FEMA also has a grant program specifically for flooding called Flood Mitigation Assistance (FMA). The SHMO can help with finding further opportunities for earthquake and tsunami assistance and funding.

6.6 Hazard-Specific Risk Reduction Actions

6.6.1 Earthquake

- Evaluate critical facilities for seismic preparedness by identifying structural deficiencies and vulnerabilities to dependent systems (e.g., water, fuel, power).
- Evaluate vulnerabilities of critical facilities. We estimate that 35% of critical facilities (**Appendix A: Community Risk Profiles**) will be damaged by an earthquake scenario described in this report, which will have many direct and indirect negative effects on first-response and recovery efforts.
- Identify communities and buildings that would benefit from seismic upgrades.

6.6.2 Flood

- Map areas of potential floodwater storage areas.
- Identify structures that have repeatedly flooded in the past and would be eligible for FEMA's "buyout" program.
- Additional risk reduction strategies may be found on FEMA's website at https://www.ready.gov/floods.

6.6.3 Landslide

- Create modern landslide inventory and susceptibility maps.
- Monitor ground movement in high susceptibility areas.

- Evaluate risks to transportation networks and land value losses due to landslide in future risk assessments.
- Study the risk from landslides that are experience channel erosion at the toe of the landslide.
- Additional risk reduction strategies may be found on FEMA's website at https://www.ready.gov/landslides-debris-flow.

6.6.4 Channel migration

- Future development in areas with the largest CMZs, particularly Pudding River, the Santiam, and North Santiam Rivers, should include CMZ mitigation strategies into plans and designs.
- Evaluate the losses in land value or productivity due to channel migration.
- Evaluate risks to transportation networks and bridges due to channel migration.
- Identify areas suitable for conservation corridors along rivers that are at risk from channel migration. These can be multipurpose including areas that provide or improve floodwater storage, riparian and aquatic habitat restoration, and climate change resilience, and water quality.

6.6.5 Wildfire-related geologic hazards

- Evaluate post-wildfire geologic hazards including flood, debris flows, and landslides.
- Additional risk reduction strategies may be found on FEMA's website at https://www.ready.gov/wildfires.

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9.0 APPENDICES

APPENDIX A. COMMUNITY RISK PROFILES

A risk analysis summary for each community is provided in this section to encourage ideas for natural hazard risk reduction. Increasing disaster preparedness, public hazards communication, and education, ensuring functionality of emergency services, and ensuring access to evacuation routes are actions that every community can take to reduce their risk. This appendix contains community specific data to provide an overview of the community and the level of risk from each natural hazard analyzed. In addition, for each community a list of critical facilities and assumed impact from individual hazards is provided.

A.1 Unincorporated Marion County (Rural)

Table A-1. Unincorporated Marion County (rural) hazard profile.

Community Overview				
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Unincorporated Marion County (rural)	47,599	43,387	54	16,042,238,000

Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	205	0.4%	247	1	9,060,000	0.1%
Earthquake	Mt. Angel Mw-6.8 Deterministic	1,794	3.8%	7,868	25	2,169,985,170	14%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	4,282	9.0%	3,132	2	1,000,718,000	6.2%
Channel Migration	Channel Migration Zone	263	0.6%	288	0	90,300,000	0.6%
Wildfire	High and Moderate Risk	1,671	3.5%	1,550	3	416,940,000	2.6%
Lahar	Medium Zone (1,000 to 15,000-year)	152	0.3%	175	0	43,913,000	0.3%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-2. Unincorporated Marion County (rural) critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Abiqua School						
Ames Municipal Airport						
Aurora Sewage Treatment Plant						
Aurora State Airport		X				
Bethany Charter School		X				
Bethel Elementary School		X				
Brooks Sewage Treatment Plant		X				
Cascade JR/SR High School						
Central Howell Elementary School		X				
Cloverdale Elementary School						
Crosshill Christian School						
Detroit Ranger Station			X		X	
Drakes Crossing RFPD		X				
Drift Creek Station						
Elkhorn Station			X		X	
Evergreen Elementary School		X				
Fruitland Elementary School		X				
Harchenko Industrial Airport						
Holy Family Academy		X				
Jefferson Christian School						
Jefferson High School						
Jefferson Middle School						
Jefferson Sewage Water Treatment	X					
Lake Labish Elementary School						
Livingstone Adventist Academy						
Marion County Emergency Operations Center						
Marion County Fire District 1 - Brooklake Station 5						
Marion County Fire District 1 - Four Corners Station 1		X				
Marion County Fire District 1 - Labish Station 7		X				
Marion County Fire District 1 - Macleay Station 4						
Marion County Fire District 1 - Pratum Station 3						
Marion County Public Works						
Monitor Elementary School						
Monitor RFPD 58						
Mt Angel Sewage Treatment Plant						
North Marion Intermediate School						
North Marion Middle School						

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Landslide High and Very High Susceptibility Exposed	Channel Migration Zone Exposed	Wildfire High or Moderate Risk Exposed	Lahar Medium Hazard Zone Exposed
North Marion Primary School						
North Marion SR High School						
Pioneer Elementary School						
Pratum Elementary School						
St. John Bosco High School		X				
St. Paul Substation		X				
Sacred Heart Catholic School						
Silver Crest Elementary School						
Silverton RFPD - Abiqua Station						
Silverton RFPD - Crooked Finger Station					X	
Silverton RFPD - Victor Point Station						
Talbot Station						
Valley Inquiry Charter School						
Victor Point Elementary						
William P Lord High School		X				
Woodburn RFPD 6 - Station 24 Waconda						
Woodburn RFPD 6 - Station 25 Broadacres						

A.2 Unincorporated Community of Brooks

Table A-3. Unincorporated community of Brooks hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]		Total Building Value ($)
Brooks		272	249		2		89,505,000
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0.0%	0	0	0	0.0%
Earthquake	Mt. Angel Mw-6.8 Deterministic	14	5.1%	61	0	13,149,525	14.7%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First floor height” above the level of flooding (base flood elevation).

Table A-4. Unincorporated community of Brooks critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Brooks School						
Willamette Valley Christian School						

A.3 Unincorporated Community of Butteville

Table A-5. Unincorporated community of Butteville hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Butteville		352	193		0	78,691,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	Mt. Angel Mw-6.8 Deterministic	18	5.2%	56	0	13,144,000	17%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	15	4.2%	10	0	3,393,000	4.3%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First floor height” above the level of flooding (base flood elevation).

A.4 Unincorporated Community of Four Corners

Table A-6. Unincorporated community of Four Corners hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Four Corners		9,385	6,508		3	1,801,596,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	Mt. Angel Mw-6.8 Deterministic	199	2.1%	558	1	86,297,683	4.8%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-7. Unincorporated community of Four Corners critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Landslide High and Very High Susceptibility Exposed	Channel Migration Zone Exposed	Wildfire High or Moderate Risk Exposed	Lahar Medium Hazard Zone Exposed
Auburn Elementary School						
Four Corners Elementary School		X				
Mary Eyre Elementary School						

A.5 Unincorporated Community of Hayesville

Table A-8. Unincorporated community of Hayesville hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Hayesville		11,677	7,876		7	2,382,452,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	Mt. Angel Mw-6.8 Deterministic	333	2.8%	954	2	158,024,983	6.6%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	14	0.1%	6	0	2,218,000	0.1%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	7	0%	7	0	1,209,000	0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-9. Unincorporated community of Hayesville critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Early College High School						
Grace Academy		X				
Hayesville Elementary School		X				
Lamb Elementary School						
Marion County Fire District 1 - Chemeketa Station 8						
Middle Grove Elementary School						
Scott Elementary School						

A.6 Unincorporated Community of Labish Village

Table A-10. Unincorporated community of Labish Village hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Labish Village		232	167		0	43,407,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	Mt. Angel Mw-6.8 Deterministic	4	1.9%	18	0	3,210,885	7.4%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

A.7 Unincorporated Community of Marion

Table A-11. Unincorporated community of Marion hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Marion		230	244		0	64,728,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	Mt. Angel Mw-6.8 Deterministic	0	0.1%	4	0	875,700	1.4%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	3	1.3%	1	0	408,000	0.6%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-12. Unincorporated community of Marion critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Marion Fire Station						

A.8 Unincorporated Community of Mehama

Table A-13. Unincorporated community of Mehama hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Mehama		203	189		1	53,460,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	Mt. Angel Mw-6.8 Deterministic	3	1.3%	17	0	3,014,033	5.6%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	42	21%	29	0	9,312,000	17%
Channel Migration	Channel Migration Zone	8	3.9%	12	0	3,051,000	5.7%
Wildfire	High and Moderate Risk	36	18%	28	0	7,074,000	13%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0%	0	1	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-14. Unincorporated community of Mehama critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Mehama Fire Station						X

A.9 City of Aumsville

Table A-15. City of Aumsville hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]		Total Building Value ($)
Aumsville		4,215	1,459		5		509,635,000
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	6	0	76,000	0%
Earthquake	Mt. Angel Mw-6.8 Deterministic	36	0.9%	93	2	16,580,652	3.3%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0.0%	0	0	0	0.0%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-16. City of Aumsville critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Aumsville Elementary School						
Aumsville Police Department						
Aumsville RFPO		X				
Aumsville Sewage Treatment Plant		X				
Willamette Valley Baptist School						

A.10 City of Aurora

Table A-17. City of Aurora hazard profile.

Community Overview				
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Aurora	985	560	2	258,763,000

Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	2	0	7,000	0%
Earthquake	Mt. Angel Mw-6.8 Deterministic	32	3.3%	100	2	31,708,988	12%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	27	2.7%	15	0	5,511,000	2.1%
Channel Migration	Channel Migration Zone	0	0%	1	0	118,000	0.05%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First floor height” above the level of flooding (base flood elevation).

Table A-18. City of Aurora critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Aurora Police Department		X				
Aurora RFPD - Aurora Station		X				

A.11 City of Detroit

Table A-19. City of Detroit hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facili	uilding Value ($)
Detroit	205	315	1	69,925,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	0	0%	2	0	186,986	0.3%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	52	26%	78	0	18,032,000	26%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	120	59%	185	0	36,915,258	53%
Lahar	Medium Zone (1,000 to 15,000-year)	128	62%	198	0	47,132,000	67%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First floor height” above the level of flooding (base flood elevation).

Table A-20. City of Detroit critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
	Exposed	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Detroit Fire Station						

A.12 City of Donald

Table A-21. City of Donald hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facili	uilding Value ($)
Donald	995	490	1	195,528,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	181	18%	221	1	57,784,232	30%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First floor height” above the level of flooding (base flood elevation).

Table A-22. City of Donald critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Aurora RFPD - Donald Station		X				

A.13 City of Gates

Table A-23. City of Gates hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facili	uilding Value ($)
Gates	540	326	1	71,352,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	6	1.1%	20	0	2,291,112	3.2%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	231	43%	151	0	28,397,000	40%
Channel Migration	Channel Migration Zone	53	10%	27	0	7,145,000	10%
Wildfire	High and Moderate Risk	212	39%	124	1	27124398	38%
Lahar	Medium Zone (1,000 to 15,000-year)	369	68%	216	1	49,569	70%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-24. City of Gates critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Gates Main Station					X	X

A.14 City of Gervais

Table A-25. City of Gervais hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facili	uilding Value ($)
Gervais	2,620	719	3	247,297,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	397	15%	266	4	55,400,740	22%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First floor height” above the level of flooding (base flood elevation).

Table A-26. City of Gervais critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
City Hall		X				
Gervais High School		X				
Gervais Middle School		X				

A.15 City of Hubbard

Table A-27. City of Hubbard hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facili	uilding Value ($)
Hubbard	3,315	1,187	3	458,199,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	379	11%	466	3	125,813,507	28%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	6	0.2%	2	0	594,000	0.1%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-28. City of Hubbard critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Hubbard Police Department		X				
Hubbard RFPD		X				
Hubbard Sewage Treatment Plant		X				

A.16 City of Idanha

Table A-29. City of Idanha hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facili	uilding Value ($)
Idanha	155	159	1	35,338,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	3	1.7%	2	0	23,000	0.1%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	0	0.1%	1	0	149,000	0.4%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	28	18%	39	0	9,935,000	28%
Channel Migration	Channel Migration Zone	23	15%	21	0	4,094,000	15%
Wildfire	High and Moderate Risk	79	51%	66	0	13610108	39%
Lahar	Medium Zone (1,000 to 15,000-year)	141	91%	127	0	27,525,000	78%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-30. City of Idanha critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Idanha-Detroit RFPD						

A.17 City of Jefferson

Table A-31. City of Jefferson hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facili	uilding Value ($)
Jefferson	3,280	1,243	2	389,441,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	5	0.1%	2	0	8,000	0.0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	2	0.1%	12	0	3,211,000	0.8%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0.0%	0	0	0	0.0%
Channel Migration	Channel Migration Zone	62	1.9%	25	0	8,146,000	2.1%
Wildfire	High and Moderate Risk	15	0.5%	4	0	1,626,000	0.4%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-32. City of Jefferson critical facilities.

	Flood 1% Annual Chance	**Earthquake Moderate to Complete Damage**	**Landslide High and Very High Susceptibility**	**Channel Migration Zone**	**Wildfire High or Moderate Risk**	**Lahar Medium Hazard Zone**
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Jefferson Elementary School						
Jefferson Main Station				X		

A.18 City of Keizer

Table A-33. City of Keizer hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facili		uilding Value ($)
Keizer		38,585	16,380		15		5,592,798,000
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	704	1.8%	336	0	26,571,000	0.5%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	2,479	6.4%	3,994	5	722,048,109	13%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	142	0.4%	62	0	18,852,000	0.3%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	17	0.0%	6	0	2190893	0.0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First floor height” above the level of flooding (base flood elevation).

Table A-34. City of Keizer critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Centennial School		X				
Claggett Creek Middle School						
Clear Lake Elementary						
Cummings Elementary School		X				
Forest Ridge Elementary School						
Gubser Elementary						
Keizer Elementary		X				
Keizer Fire District		X				
Keizer Police Department		X				
Kennedy Elementary School						
Clearlake Station 6						
McNary High School						
Urgent Care Inland Shores						
Weddle Elementary School						
Whiteaker Middle School						

A.19 City of Mill City

Table A-35. City of Mill City hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facili	uilding Value ($)
Mill City	1,915	1,269	3	299,237,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	5	0.3%	17	0	4,876,531	1.6%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	126	6.6%	78	0	19,040,000	6.4%
Channel Migration	Channel Migration Zone	196	10%	72	0	25,451,000	8.5%
Wildfire	High and Moderate Risk	260	14%	171	2	38745652	13%
Lahar	Medium Zone (1,000 to 15,000-year)	1,604	84%	1,069	3	245,855	82%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-36. City of Mill City critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Mill City Main Station					X	X
Santiam Elementary					X	X
Santiam JR SR High School						X

A.20 City of Mt. Angel

Table A-37. City of Mt. Angel hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facili		uilding Value ($)
Mt. Angel		3,520	1,219		7		539,815,000
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	613	17%	553	1	197,469,572	37%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	2	0	87,000	0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-38. City of Mt. Angel critical facilities.

	Flood 1% Annual Chance	**Earthquake Moderate to Complete Damage**	**Landslide High and Very High Susceptibility**	**Channel Migration Zone**	**Wildfire High or Moderate Risk**	**Lahar Medium Hazard Zone**
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
John F Kennedy SR High School		X				
Mount Angel Fire Department						
Mount Angel Police Department						
Mount Angel Public Works						
Mt Angel Middle School						
Silverton - Mt Angel Family Medicine						
St Mary's Public School						

A.21 City of Salem

Table A-39. City of Salem hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)	
Salem	141,565	58,163	80	22,532,083,000	

Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	2,571	1.8%	1,431	8	70,473,000	0.3%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	1,924	1.4%	3,591	5	1,044,527,904	4.6%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	11,252	7.9%	2,927	1	1,261,015,000	5.6%
Channel Migration	Channel Migration Zone	0	0.0%	0	0	0	0.0%
Wildfire	High and Moderate Risk	1,555	1.1%	432	0	170035265	0.8%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0.0%	0	0	0	0.0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-40. City of Salem critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Armed Forces Reserve Center						
Baker Elementary School						
Battle Creek Elementary	X					
Blanchet Catholic School						
Bush Elementary School		X				
Candalara Elementary School						
Chavez Elementary						
Chemawa Indian School		X				
Crossler Middle School						
Eagle Charter School						
Englewood Elementary School		X				
Grant Community School						
Hallman Elementary School						
Hammond Elementary School		X				
Heritage School						
Highland Elementary School						
Hoover Elementary School						
Houck Middle School						
Immanuel Evangelical Lutheran School						
Judson Middle School						
Lee Elementary School						
Leslie Middle School						
Liberty Elementary School						
Marion County Community Corrections		X				
McKay High School						
McKinley Elementary School						
McNary Army Aviation Hangars	X					
McNary Field	X					
MG George A White Building						
Military Department						
Miller Elementary School						
Montessori Discovery Center						
Morningside Elementary School						
North Salem High School	X					
Oregon Dept of Transportation	X					
Oregon Emergency Management						
Oregon State Hospital						
Oregon State Police	X					
Oregon State Police – Capitol Office						

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Landslide High and Very High Susceptibility Exposed	Channel Migration Zone Exposed	Wildfire High or Moderate Risk Exposed	Lahar Medium Hazard Zone Exposed
Oregon Youth Authority - Hillcrest Youth Corrections						
Parrish Middle School						
Pringle Elementary School						
Queen of Peace School						
Richmond Elementary School						
Roberts High School						
St John Lutheran School						
St Joseph School						
Salem Academy Christian School						
Salem Child Development Center						
Salem Clinic Main						
Salem Clinic South						
Salem Emergency Services						
Salem Fire Dept - Station 01						
Salem Fire Dept - Station 02						
Salem Fire Dept - Station 03						
Salem Fire Dept - Station 04						
Salem Fire Dept - Station 07						
Salem Fire Dept - Station 09						
Salem Fire Dept - Station 10						
Salem Heights Elementary School						
Salem Hospital	X					
SALEM KINDERCARE						
Salem Montessori School						
Salem Police Department						
Salem Public Works	X					
Schirle Elementary School						
SONSHINE CHRISTIAN SCHOOL						
South Salem High School			X			
Sprague High School						
St Vincent Depaul School						
Stephens Middle School						
Sumpter Elementary School						
Swegle Elementary School						
Urgent Care Clinic South						
Waldo Middle School						
WASHINGTON ELEMENTARY SCHOOL						
Wright Elementary School						
Yakima Valley Farm Workers Clinic						
Yoshikai Elementary School						
Zoom Care Salem						

A.22 City of Salem (West Salem)

Table A-41. City of Salem (West Salem) hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Salem (West Salem)		27,405	10,797		12	3,194,904,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	361	1.3%	157	0	12,098,000	0.4%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	758	2.8%	580	1	132,316,114	4.1%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	1,104	4.0%	424	0	117,055,000	3.7%
Channel Migration	Channel Migration Zone	4	0.0%	1	0	428,000	0.0%
Wildfire	High and Moderate Risk	0	0.0%	0	0	0	0.0%
Lahar	Medium Zone (1,000 to 15,000-year)	7	0.0%	4	0	772	0.0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First floor height” above the level of flooding (base flood elevation).

Table A-42. City of Salem (West Salem) critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Landslide High and Very High Susceptibility Exposed	Channel Migration Zone Exposed	Wildfire High or Moderate Risk Exposed	Lahar Medium Hazard Zone Exposed
Brush College Elementary School		X				
Chapman Hill Elementary School						
Harrit Elementary School						
Kalapuya Elementary School						
Myers Elementary School						
Riviera Christian School						
Salem Fire Dept - Station 05						
Salem Fire Dept - Station 11						
Straub Middle School						
Walker Middle School						
West Salem Clinic						
West Salem High School						

A.23 City of Scotts Mills

Table A-43. City of Scotts Mills hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facili	uilding Value ($)
Scotts Mills	385	242	2	63,043,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0.0%	0	0	0	0.0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	96	24.9%	118	0	16,983,461	26.9%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	234	61%	140	0	31,315,000	50%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	15	3.9%	7	0	1280323	2.0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0.0%	0	0	0	0.0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First floor height” above the level of flooding (base flood elevation).

Table A-44. City of Scotts Mills critical facilities.

	Flood 1% Annual Chance	**Earthquake Moderate to Complete Damage**	**Landslide High and Very High Susceptibility**	**Channel Migration Zone**	**Wildfire High or Moderate Risk**	**Lahar Medium Hazard Zone**
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Scotts Mills Elementary School						
Silverton RFPD - Scotts Mills Station						

A.24 City of Silverton

Table A-45. City of Silverton hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facili	uilding Value ($)
Silverton	10,520	4,077	13	1,740,060,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	81	0.8%	12	0	1,861,000	0.1%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	1,107	10.5%	1,406	1	427,198,866	24.6%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	568	5.4%	188	0	80,361,000	4.6%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	336	3.2%	106	0	44651351	2.6%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0.0%	0	0	0	0.0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First floor height” above the level of flooding (base flood elevation).

Table A-46. City of Silverton critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Evergreen Surgeons - Walter Harris						
Family Medical Group Silverton		X				
Mark Twain JR High School						
Northwest Family Medicine						
Robert Frost Elementary School						
Silverton - McClaine Street Clinic						
Silverton Christian School						
Silverton High School						
Silverton Hospital						
Silverton Middle School						
Silverton Police Department						
Silverton Public Works						
Silverton RFPD - Headquarters						

A.25 City of St. Paul

Table A-47. City of St. Paul hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facili		uilding Value ($)
St. Paul		440	247		4		132,631,000
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0.0%	0	0	0	0.0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	10	2.2%	40	0	14,607,033	11.0%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	1	0.3%	1	0	220,000	0.2%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0.0%	0	0	0	0.0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0.0%	0	0	0	0.0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-48. City of St. Paul critical facilities.

	Flood 1% Annual Chance	**Earthquake Moderate to Complete Damage**	**Landslide High and Very High Susceptibility**	**Channel Migration Zone**	**Wildfire High or Moderate Risk**	**Lahar Medium Hazard Zone**
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
St Paul Elementary School						
St Paul High School						
St Paul Parochial School						
St Paul RFPD						

A.26 City of Stayton

Table A-49. City of Stayton hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facili	uilding Value ($)
Stayton	7,880	3,043	12	1,546,547,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	1	0.0%	2	0	33,000	0.0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	62	0.8%	150	0	64,342,531	4.2%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	97	1.2%	32	0	13,290,000	0.9%
Channel Migration	Channel Migration Zone	866	11%	379	2	157,134,000	10%
Wildfire	High and Moderate Risk	50	0.6%	22	2	9113578	0.6%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0.0%	0	0	0	0.0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First floor height” above the level of flooding (base flood elevation).

Table A-50. City of Stayton critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Regis High School					X	
Santiam Memorial Hospital - Stayton						
St Mary's Catholic School						
Stayton Christian School						
Stayton City Shops						
Stayton Elementary School						
Stayton Emergency Services						
Stayton High School					X	
Stayton Middle School						
Stayton Police Department				X		
Stayton RFPD						
Stayton Water Treatment Plant				X		

A.27 City of Sublimity

Table A-51. City of Sublimity hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facili	uilding Value ($)
Sublimity	3,050	1,157	4	546,449,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0.0%	0	0	0	0.0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	6	0.2%	19	0	7,850,753	1.4%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0.0%	0	0	0	0.0%
Channel Migration	Channel Migration Zone	0	0.0%	0	0	0	0.0%
Wildfire	High and Moderate Risk	0	0.0%	0	0	0	0.0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0.0%	0	0	0	0.0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-52. City of Sublimity critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Sublimity Elementary School						
Sublimity Middle School						
Sublimity Public Works						
Sublimity RFPD						

A.28 City of Turner

Table A-53. City of Turner hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facili	uilding Value ($)
Turner	2,410	1,365	3	421,185,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	596	24.7%	347	1	5,849,000	1.4%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	9	0.4%	55	0	11,885,560	2.8%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	300	13%	149	0	42,486,000	10%
Channel Migration	Channel Migration Zone	0	0.0%	0	0	0	0.0%
Wildfire	High and Moderate Risk	50	2.1%	28	0	6515452	1.5%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0.0%	0	0	0	0.0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-54. City of Turner critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Turner Elementary School						
Turner Fire Department	X					
Turner Police Department						

A.29 City of Woodburn

Table A-55. City of Woodburn hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facili	uilding Value ($)
Woodburn	25,185	7,332	17	3,446,910,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	41	0.2%	8	0	266,000	0.0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	4,595	18.2%	3,270	4	1,287,042,534	37.3%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	15	0.1%	5	0	1,224,000	0.0%
Channel Migration	Channel Migration Zone	0	0.0%	0	0	0	0.0%
Wildfire	High and Moderate Risk	87	0.3%	20	0	8217418	0.2%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0.0%	0	0	0	0.0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First floor height” above the level of flooding (base flood elevation).

Table A-56. City of Woodburn critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Landslide High and Very High Susceptibility Exposed	Channel Migration Zone Exposed	Wildfire High or Moderate Risk Exposed	Lahar Medium Hazard Zone Exposed
French Prairie Middle School		X				
Gethsemane Christian Academy		X				
Heritage Elementary School		X				
Legacy Medical Group - Woodburn		X				
Lincoln Elementary School		X				
Nellie Muir Elementary School						
Salud Medical Center						
Silverton - Woodburn Immediate Care and Family Medicine						
Silverton - Woodburn Internal Medicine						
St Luke's School						
Valor Middle School						
Woodburn Arthur Academy						
Woodburn Family Medicine						
Woodburn High School						
Woodburn Police Department						
Woodburn Public Works						
Woodburn RFPD 6 - Station 21 HQ						
Woodburn RFPD 6 - Station 22 James Street						
Woodburn Success High School						

APPENDIX B. DETAILED RISK ASSESSMENT TABLES

Table B-1. Marion County building inventory.

(all dollar amounts in thousands)

	Residential			Commercial and Industrial			Agricultural			Public and Nonprofit			All Buildings			
Community	Number of Buildings	Building Value ($)	Building Value per Community Total	Number of Buildings	Building Value ($)	Building Value per Community Total	Number of Buildings	Building Value ($)	Building Value per Community Total	Number of Buildings	Building Value ($)	Building Value per Community Total	Number of Buildings	Number of Buildings per Watershed Total	Building Value ($)	Value of Buildings per Watershed Total
Unincorp. Marion Co (rural)	20,033	7,206,367	45%	719	858,042	5.3%	22,199	7,441,292	46%	436	536,537	3.3%	43,387	25%	16,042,238	26%
Brooks	156	37,487	42%	27	17,240	19.3%	58	14,603	16%	8	20,175	22.5%	249	0.1%	89,505	0.1%
Butteville	116	55,557	71%	1	474	0.6%	74	21,203	26.9%	2	1,456	1.9%	193	0.1%	78,691	0.1%
Four Corners	4,336	1,449,611	80%	177	200,238	11.1%	1,967	96,170	5.3%	28	55,578	3.1%	6,508	3.8%	1,801,596	2.9%
Hayesville	5,038	1,848,581	78%	207	197,850	8%	2,502	121,144	5.1%	129	214,877	9.0%	7,876	4.6%	2,382,452	3.8%
Labish Village	138	36,978	85%	9	3,475	8.0%	19	2,158	5.0%	1	796	1.8%	167	0%	43,407	0%
Marion	125	35,697	55%	2	597	0.9%	114	24,616	38.0%	3	3,817	6%	244	0.1%	64,728	0.1%
Mehama	114	30,536	57%	18	10,838	20%	55	10,609	20%	2	1,476	3%	189	0.1%	53,460	0.1%
Total Unincorp County	30,056	10,700,813	52%	1,160	1,288,755	6%	26,988	7,731,795	37.6%	609	834,713	4%	58,813	34.5%	20,556,076	32.7%
Aumsville	1,283	384,099	75%	50	43,934	9%	104	28,682	6%	22	52,919	10%	1,459	0.9%	509,635	0.8%
Aurora	428	169,434	65%	60	37,293	14%	65	45,575	18%	7	6,460	2.5%	560	0.3%	258,763	0.4%
Detroit	242	54,049	77%	11	4,215	6%	55	7,943	11.4%	7	3,718	5%	315	0%	69,925	0%
Donald	359	82,831	42%	32	80,527	41%	94	29,610	15%	5	2,560	1.3%	490	0%	195,528	0%
Gates	206	48,934	69%	6	3,639	5%	112	18,036	25%	2	743	1%	326	0%	71,352	0%
Gervais	637	182,425	74%	13	13,617	6%	46	4,930	2%	23	46,325	19%	719	0%	247,297	0%
Hubbard	962	293,470	64%	141	150,652	4%	75	7,476	2%	9	6,602	1%	1,187	1%	458,199	1%
Idanha	94	19,141	54%	14	9,160	26%	46	6,000	17%	5	1,037	3%	159	0%	35,338	0%
Jefferson	1,060	321,719	83%	35	19,728	5%	130	26,216	7%	18	21,778	6%	1,243	1%	389,441	1%
Keizer	11,877	4,758,762	85%	393	360,465	6%	3,993	210,603	4%	117	262,968	5%	16,380	10%	5,592,798	9%
Mill City	884	233,300	78%	27	11,726	4%	339	21,704	7%	19	32,507	11%	1,269	1%	299,237	0%
Mt. Angel	941	345,131	64%	69	87,703	16%	153	22,087	4%	56	84,893	16%	1,219	1%	539,815	1%
Salem	40,365	14,640,969	65%	3,364	5,133,496	23%	13,261	733,938	3%	1,173	2,023,679	9%	58,163	34%	22,532,083	36%

(all dollar amounts in thousands)

	Residential			Commercial and Industrial			Agricultural			Public and Nonprofit			All Buildings			
Community	Number of Buildings	Building Value ($)	Building Value per Community Total	Number of Buildings	Building Value ($)	Building Value per Community Total	Number of Buildings	Building Value ($)	Building Value per Community Total	Number of Buildings	Building Value ($)	Building Value per Community Total	Number of Buildings	Number of Buildings per Watershed Total	Building Value ($)	Value of Buildings per Watershed Total
Salem (West Salem)	10,106	2,784,458	87%	220	174,429	5%	407	21,552	1%	64	214,465	7%	10,797	6%	3,194,904	5%
Scotts Mills	149	39,987	63%	5	1,226	2%	78	12,337	20%	10	9,494	15%	242	0%	63,043	0%
Silverton	3,426	1,285,699	74%	186	235,685	14%	385	53,125	3%	80	165,551	10%	4,077	2%	1,740,060	3%
St. Paul	155	65,091	49%	14	13,122	10%	63	25,634	19%	15	28,784	22%	247	0%	132,631	0%
Stayton	2,463	963,861	62%	243	401,864	26%	256	48,559	3%	81	132,263	9%	3,043	2%	1,546,547	2%
Sublimity	979	486,698	89%	35	25,793	5%	128	16,869	3%	15	17,089	3%	1,157	1%	546,449	1%
Turner	822	287,771	68%	99	66,333	16%	383	27,530	7%	61	39,552	9%	1,365	1%	421,185	1%
Woodburn	6,469	2,223,170	64%	388	887,455	26%	352	77,309	2%	123	258,975	8%	7,332	4%	3,446,910	5%
Total Study Area	113,963	40,371,813	64%	6,565	9,050,817	14%	47,513	9,177,510	15%	2,521	4,247,075	7%	170,562	100%	62,847,215	100%

Table B-2. Earthquake loss estimates.

(all dollar amounts in thousands)

			Total Earthquake Damage							
			Buildings Damaged				All Buildings Changed to At Least Moderate Code			
	Total Number of Buildings	Total Estimated Building Value ($)	Yellow-Tagged Buildings	Red-Tagged Buildings	Sum of Economic Loss	Loss Ratio	Yellow-Tagged Buildings	Red-Tagged Buildings	Sum of Economic Loss	Loss Ratio
Unincorp. Marion Co (rural)	43,387	16,042,238	5,262	2,605	2,169,985	13.5%	4,114	1,252	1,508,735	9.0%
Brooks	249	89,505	46	15	13,150	14.7%	33	6	7,740	9.0%
Butteville	193	78,691	40	15	13,144	16.7%	33	8	10,102	13.0%
Four Corners	6,508	1,801,596	466	92	86,298	4.8%	250	49	56,715	3.0%
Hayesville	7,876	2,382,452	777	176	158,025	6.6%	447	90	107,487	5.0%
Labish Village	167	43,407	15	3	3,211	7.4%	10	2	2,169	5.0%
Marion	244	64,728	3	0	876	1.4%	1	0	533	1.0%
Mehama	189	53,460	14	3	3,014	5.6%	6	1	1,485	3.0%
Total Unincorporated County	58,813	20,556,076	6,625	2,911	2,447,702	11.9%	4,893	1,408	1,694,966	8.0%
Aumsville	1,459	509,635	78	15	16,581	3.3%	25	2	8,869	2.0%
Aurora	560	258,763	76	24	31,709	12.3%	57	13	23,240	9.0%
Detroit	315	69,925	1	0	187	0.3%	1	0	134	0.0%
Donald	490	195,528	130	91	57,784	30.0%	118	33	32,604	17.0%
Gates	326	71,352	17	3	2,291	3.0%	7	1	1,305	2.0%
Gervais	719	247,297	151	115	55,401	22.0%	155	58	41,279	17.0%
Hubbard	1,187	458,199	279	186	125,814	27.0%	253	77	81,760	18.0%
Idanha	159	35,338	1	0	149	0.0%	1	0	104	0.0%
Jefferson	1,243	389,441	11	1	3,211	1.0%	4	0	1,869	0.0%
Keizer	16,380	5,592,798	3,017	977	722,048	13.0%	2,546	613	591,976	11.0%
Mill City	1,269	299,237	14	2	4,877	2.0%	7	1	3,577	1.0%
Mt. Angel	1,219	539,815	300	253	197,470	37.0%	273	135	123,614	23.0%
Salem	58,163	22,532,083	2,965	626	1,044,528	5.0%	1,600	309	595,384	3.0%

(all dollar amounts in thousands)										
			Total Earthquake Damage							
			Buildings Damaged				**All Buildings Changed to At Least Moderate Code**			
	Total Number of Buildings	**Total Estimated Building Value ($)**	**Yellow-Tagged Buildings**	**Red-Tagged Buildings**	**Sum of Economic Loss**	**Loss Ratio**	**Yellow-Tagged Buildings**	**Red-Tagged Buildings**	**Sum of Economic Loss**	**Loss Ratio**
Salem (West Salem)	10,797	3,194,904	456	124	132,316	4.0%	328	76	94,315	3.0%
Scotts Mills	242	63,043	53	65	16,983	27.0%	52	38	11,827	19.0%
Silverton	4,077	1,740,060	867	539	427,199	25.0%	754	303	282,972	16.0%
St. Paul	247	132,631	31	8	14,607	11.0%	22	5	9,671	7.0%
Stayton	3,043	1,546,547	126	23	64,343	4.0%	63	12	34,658	2.0%
Sublimity	1,157	546,449	18	2	7,851	1.0%	8	1	5,678	1.0%
Turner	1,365	421,185	47	8	11,886	3.0%	18	3	6,218	1.0%
Woodburn	7332	3,446,910	1764	1506	1,287,043	37.0%	1610	772	820,194	24.0%
Total Study Area	170,562	62,847,215	17,028	7,479	6,671,977	11.0%	12,796	3,860	4,466,215	7.0%

Table B-3. Flood loss estimates.

			(all dollar amounts in thousands)											
			10% (10-yr)			**2% (50-yr)**			**1% (100-yr)**			**0.2% (500-yr)**		
Community	**Total Number of Buildings**	**Total Estimated Building Value ($)**	**Number of Buildings**	**Loss Estimate**	**Loss Ratio**	**Number of Buildings**	**Loss Estimate**	**Loss Ratio**	**Number of Buildings**	**Loss Estimate**	**Loss Ratio**	**Number of Buildings**	**Loss Estimate**	**Loss Ratio**
Unincorp. Marion Co (rural)	43,387	16,042,238	97	1,650	0.0%	180	4,923	0.0%	247	9,060	0.1%	559	41,213	0.3%
Brooks	249	89,505	0	0	0.00%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Butteville	193	78,691	0	0	0.00%	0	0	0.00%	0	0	0.00%	31	2,646	3.36%
Four Corners	6,508	1,801,596	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Hayesville	7,876	2,382,452	0	0	0.0%	0	0	0.0%	0	0	0.0%	1	2	0.0%
Labish Village	167	43,407	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Marion	244	64,728	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Mehama	189	53,460	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Total Unincorp County	58,813	20,556,076	97	1,650	0.0%	180	4,923	0.0%	247	9,060	0.0%	591	43,861	0.2%
Aumsville	1,459	509,635	4	43	0.0%	6	63	0.0%	6	76	0.0%	6	94	0.0%
Aurora	560	258,763	0	0	0.0%	0	0	0.0%	2	7	0.00%	0	0	0.00%
Detroit	315	69,925	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Donald	490	195,528	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Gates	326	71,352	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Gervais	719	247,297	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Hubbard	1,187	458,199	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Idanha	159	35,338	1	7	0.0%	1	9	0.0%	2	23	0.1%	3	76	0.2%
Jefferson	1,243	389,441	0	0	0.0%	0	0	0.0%	2	8	0.0%	50	892	0.2%
Keizer	16,380	5,592,798	230	6,150	0.1%	320	21,726	0.4%	336	26,571	0.5%	4,908	408,198	7.3%
Mill City	1,269	299,237	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Mt. Angel	1,219	539,815	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Salem	58,163	22,532,083	489	20,961	0.1%	1,065	52,786	0.2%	1,431	70,473	0.3%	3,924	221,657	1.0%
Salem (West Salem)	10,797	3,194,904	3	6	0.0%	64	4,790	0.1%	157	12,098	0.4%	635	54,672	1.7%
Scotts Mills	242	63,043	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Silverton	4,077	1,740,060	0	0	0.0%	6	1,099	0.1%	12	1,861	0.1%	27	2,615	0.2%

			(all dollar amounts in thousands)											
			10% (10-yr)			**2% (50-yr)**			**1% (100-yr)**			**0.2% (500-yr)**		
Community	**Total Number of Buildings**	**Total Estimated Building Value ($)**	**Number of Buildings**	**Loss Estimate**	**Loss Ratio**	**Number of Buildings**	**Loss Estimate**	**Loss Ratio**	**Number of Buildings**	**Loss Estimate**	**Loss Ratio**	**Number of Buildings**	**Loss Estimate**	**Loss Ratio**
St. Paul	247	132,631	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Stayton	3,043	1,546,547	0	0	0.0%	2	10	0.0%	2	33	0.0%	5	153	0.0%
Sublimity	1,157	546,449	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Turner	1,365	421,185	93	928	0.2%	282	4,084	1.0%	347	5,849	1.4%	534	13,929	3.3%
Woodburn	7,332	3,446,910	0	0	0.0%	1	10	0.0%	8	266	0.0%	17	1,074	0.0%
Total Study Area	170,562	62,847,215	917	29,744	0.0%	1,927	89,501	0.1%	2,552	126,324	0.2%	10,700	747,221	1.2%

Table B-4. Flood exposure.

Community	Total Number of Buildings	Total Population	1% (100-yr) Potentially Displaced Residents From Flood Exposure	% Potentially Displaced Residents From Flood Exposure	Number of Flood Exposed Buildings	% of Flood Exposed Buildings	Number of Flood Exposed Buildings Without Damage
Unincorp. Marion Co (rural)	43,387	47,599	205	0.4%	313	0.7%	66
Brooks	249	272	0	0.0%	0	0.0%	0
Butteville	193	352	0	0.0%	0	0.0%	0
Four Corners	6,508	9,385	0	0.0%	0	0.0%	0
Hayesville	7,876	11,677	0	0.0%	0	0.0%	0
Labish Village	167	232	0	0.0%	0	0.0%	0
Marion	244	230	0	0.0%	0	0.0%	0
Mehama	189	203	0	0.0%	0	0.0%	0
Total Unincorporated County	58,813	69,950	205	0.0%	313	1.0%	66
Aumsville	1,459	4,215	0	0.0%	6	0.0%	0
Aurora	560	985	0	0.0%	2	0.0%	0
Detroit	315	205	0	0.0%	0	0.0%	0
Donald	490	995	0	0.0%	0	0.0%	0
Gates	326	540	0	0.0%	0	0.0%	0
Gervais	719	2,620	0	0.0%	0	0.0%	0
Hubbard	1,187	3,315	0	0.0%	0	0.0%	0
Idanha	159	155	3	2.0%	3	2.0%	1
Jefferson	1,243	3,280	5	0.0%	3	0.0%	1
Keizer	16,380	38,585	704	2.0%	347	2.0%	11
Mill City	1,269	1,915	0	0.0%	0	0.0%	0
Mt. Angel	1,219	3,520	0	0.0%	0	0.0%	0
Salem	58,163	141,565	2,571	2.0%	1,726	3.0%	295

Community	Total Number of Buildings	Total Population	1% (100-yr) Potentially Displaced Residents From Flood Exposure	% Potentially Displaced Residents From Flood Exposure	Number of Flood Exposed Buildings	% of Flood Exposed Buildings	Number of Flood Exposed Buildings Without Damage
Salem (West Salem)	10,797	27,405	361	1.0%	174	2.0%	17
Scotts Mills	242	385	0	0.0%	0	0.0%	0
Silverton	4,077	10,520	81	1.0%	19	0.0%	7
St. Paul	247	440	0	0.0%	0	0.0%	0
Stayton	3,043	7,880	1	0.0%	2	0.0%	0
Sublimity	1,157	3,050	0	0.0%	0	0.0%	0
Turner	1,365	2,410	596	25.0%	448	33.0%	101
Woodburn	7332	25185	41	0.0%	10	0.0%	2
Total Study Area	170,562	349,120	4568	1.0%	3053	2.0%	501

Table B-5. Landslide exposure.

			(all dollar amounts in thousands)								
			Very High Susceptibility			**High Susceptibility**			**Moderate Susceptibility**		
Community	**Total Number of Buildings**	**Total Estimated Building Value ($)**	**Number of Buildings**	**Building Value ($)**	**Percent of Building Value Exposed**	**Number of Buildings**	**Building Value ($)**	**Percent of Building Value Exposed**	**Number of Buildings**	**Building Value ($)**	**Percent of Building Value Exposed**
Unincorp. Marion Co (rural)	43,387	16,042,238	2,019	676,155	4.2%	1,113	324,563	2.0%	8,651	2,680,246	17%
Brooks	249	89,505	0	0	0%	0	0	0%	17	3,460	4%
Butteville	193	78,691	6	1,851	2%	4	1,542	2.0%	58	22,666	29%
Four Corners	6,508	1,801,596	0	0	0%	2	78	0%	176	56,831	3%
Hayesville	7,876	2,382,452	0	0	0%	6	2,218	0.1%	235	68,187	3%
Labish Village	167	43,407	0	0	0%	0	0	0%	33	8,921	21%
Marion	244	64,728	0	0	0.0%	0	0	0%	1	89	0%
Mehama	189	53,460	19	7,351	14%	10	1,962	3.7%	21	5,100	10%
Total Unincorp. County	58,813	20,556,076	2,044	685,357	3.3%	1,135	330,362	1.6%	9,192	2,845,499	14%
Aumsville	1,459	509,635	0	0	0%	0	0	0%	26	7,372	1%
Aurora	560	258,763	0	0	0%	15	5,511	2.1%	192	81,235	31%
Detroit	315	69,925	54	10,546	15%	24	7,485	10.7%	134	28,616	41%
Donald	490	195,528	0	0	0%	0	0	0%	1	314	0%
Gates	326	71,352	141	26,006	36%	10	2,391	3.4%	20	5,402	7.6%
Gervais	719	247,297	0	0	0%	0	0	0%	2	748	0.3%
Hubbard	1,187	458,199	0	0	0%	2	594	0.1%	53	17,912	3.9%
Idanha	159	35,338	20	3,092	8.8%	19	6,843	19%	60	11,972	34%
Jefferson	1,243	389,441	0	0	0%	0	0	0%	56	15,970	4.1%
Keizer	16,380	5,592,798	0	0	0%	62	18,852	0.3%	1,107	396,935	7.1%
Mill City	1,269	299,237	45	12,464	4.2%	33	6,576	2.2%	155	34,342	12%
Mt. Angel	1,219	539,815	0	0	0%	0	0	0%	108	50,742	9.4%
Salem	58,163	22,532,083	1,531	633,172	2.8%	1,396	627,843	2.8%	8,647	3,333,449	15%

			(all dollar amounts in thousands)								
			Very High Susceptibility			**High Susceptibility**			**Moderate Susceptibility**		
Community	**Total Number of Buildings**	**Total Estimated Building Value ($)**	**Number of Buildings**	**Building Value ($)**	**Percent of Building Value Exposed**	**Number of Buildings**	**Building Value ($)**	**Percent of Building Value Exposed**	**Number of Buildings**	**Building Value ($)**	**Percent of Building Value Exposed**
Salem (West Salem)	10,797	3,194,904	0	0	0%	424	117,055	3.7%	4,759	1,455,158	46%
Scotts Mills	242	63,043	132	28,843	46%	8	2,471	3.9%	12	3,784	6.0%
Silverton	4,077	1,740,060	115	47,778	2.7%	73	32,583	1.9%	737	305,763	18%
St. Paul	247	132,631	0	0	0%	1	220	0.2%	27	8,898	6.7%
Stayton	3,043	1,546,547	9	4,227	0.3%	23	9,063	0.6%	338	159,959	10%
Sublimity	1,157	546,449	0	0	0%	0	0	0%	92	45,157	8.3%
Turner	1,365	421,185	113	33,157	7.9%	36	9,329	2.2%	199	66,040	16%
Woodburn	7,332	3,446,910	0	0	0%	5	1,224	0%	312	104,945	4.2%
Total Study Area	170,562	62,847,215	4,204	1,484,643	2.4%	3,266	1,178,402	1.9%	26,229	8,980,211	14%

Table B-6. Channel migration zone exposure.

Community	Total Number of Buildings	Total Population	Total Estimated Building Value ($)	Channel Migration Hazard (all dollar amounts in thousands): Potentially Displaced Residents From Channel Migration Exposure	% Potentially Displaced Residents From Channel Migration Exposure	Number of Buildings Exposed	Building Value ($)	Ratio of Exposure Value
Unincorp. Marion Co (rural)	43,387	47,599	16,042,238	263	0.6%	288	90,300	0.6%
Brooks	249	272	89,505	0	0.0%	0	0	0.0%
Butteville	193	352	78,691	0	0.0%	0	0	0.0%
Four Corners	6,508	9,385	1,801,596	0	0.0%	0	0	0.0%
Hayesville	7,876	11,677	2,382,452	0	0.0%	0	0	0.0%
Labish Village	167	232	43,407	0	0.0%	0	0	0.0%
Marion	244	230	64,728	0	0.0%	0	0	0.0%
Mehama	189	203	53,460	8	3.9%	12	3,051	5.7%
Total Unincorporated	58,813	69,950	20,556,076	271	0.4%	300	93,351	0.5%
Aumsville	1,459	4,215	509,635	0	0.0%	0	0	0.0%
Aurora	560	985	258,763	0	0.0%	1	118	0.1%
Detroit	315	205	69,925	0	0.0%	0	0	0.0%
Donald	490	995	195,528	0	0.0%	0	0	0.0%
Gates	326	540	71,352	53	10.0%	27	7,145	10.0%
Gervais	719	2,620	247,297	0	0.0%	0	0	0.0%
Hubbard	1,187	3,315	458,199	0	0.0%	0	0	0.0%
Idanha	159	155	35,338	23	15.0%	21	4,094	15.0%
Jefferson	1,243	3,280	389,441	62	1.9%	25	8,146	2.1%
Keizer	16,380	38,585	5,592,798	0	0.0%	0	0	0.0%
Mill City	1,269	1,915	299,237	196	10.0%	72	25,451	8.5%
Mt. Angel	1,219	3,520	539,815	0	0.0%	0	0	0.0%
Salem	58,163	141,565	22,532,083	0	0.0%	0	0	0.0%

Community	Total Number of Buildings	Total Population	Total Estimated Building Value ($)	Channel Migration Hazard (all dollar amounts in thousands): Potentially Displaced Residents From Channel Migration Exposure	% Potentially Displaced Residents From Channel Migration Exposure	Number of Buildings Exposed	Building Value ($)	Ratio of Exposure Value
Salem (West Salem)	10,797	27,405	3,194,904	4	0.0%	1	428	0.0%
Scotts Mills	242	385	63,043	0	0.0%	0	0	0.0%
Silverton	4,077	10,520	1,740,060	0	0.0%	0	0	0.0%
St. Paul	247	440	132,631	0	0.0%	0	0	0.0%
Stayton	3,043	7,880	1,546,547	866	11.0%	379	157,134	10.0%
Sublimity	1,157	3,050	546,449	0	0.0%	0	0	0.0%
Turner	1,365	2,410	421,185	0	0.0%	0	0	0.0%
Woodburn	7,332	25,185	3,446,910	0	0.0%	0	0	0.0%
Total Study Area	170,562	349,120	62,847,215	1,475	0.4%	826	295,868	0.5%

Table B-7. Wildfire exposure.

Community	Total Number of Buildings	Total Estimated Building Value ($)	High Hazard: Number of Buildings	High Hazard: Building Value ($)	High Hazard: Percent of Building Value Exposed	Moderate Hazard: Number of Buildings	Moderate Hazard: Building Value ($)	Moderate Hazard: Percent of Building Value Exposed
			(all dollar amounts in thousands)					
Unincorp. Marion Co (rural)	43,387	16,042,238	154	38,350	0.0%	1,396	378,590	2.0%
Brooks	249	89,505	0	0	0.0%	0	0	0.0%
Butteville	193	78,691	0	0	0.0%	0	0	0.0%
Four Corners	6,508	1,801,596	0	0	0.0%	0	0	0.0%
Hayesville	7,876	2,382,452	0	0	0.0%	7	1,209	0.0%
Labish Village	167	43,407	0	0	0.0%	0	0	0.0%
Marion	244	64,728	0	0	0.0%	1	408	1.0%
Mehama	189	53,460	9	1,787	3.3%	19	5,288	10.0%
Total Unincorp. County	58,813	20,556,076	163	40,137	0.0%	1,423	385,496	1.9%
Aumsville	1,459	509,635	0	0	0.0%	46	19,823	4.0%
Aurora	560	258,763	0	0	0.0%	14	8,339	3.0%
Detroit	315	69,925	111	23,075	33.0%	74	13,841	20.0%
Donald	490	195,528	0	0	0.0%	0	0	0.0%
Gates	326	71,352	52	12,128	17.0%	72	14,997	21.0%
Gervais	719	247,297	0	0	0.0%	0	0	0.0%
Hubbard	1,187	458,199	0	0	0.0%	0	0	0.0%
Idanha	159	35,338	62	13,003	36.8%	4	607	1.7%
Jefferson	1,243	389,441	0	0	0.0%	4	1,626	0.4%
Keizer	16,380	5,592,798	0	0	0.0%	6	2,191	0.0%
Mill City	1,269	299,237	13	3,993	1.3%	158	34,753	11.6%
Mt. Angel	1,219	539,815	0	0	0.0%	2	173	0.0%
Salem	58,163	22,532,083	67	26,292	0.1%	365	143,743	0.6%
Salem (West Salem)	10,797	3,194,904	0	0	0.0%	0	0	0.0%

			(all dollar amounts in thousands)					
			High Hazard			**Moderate Hazard**		
Community	**Total Number of Buildings**	**Total Estimated Building Value ($)**	**Number of Buildings**	**Building Value ($)**	**Percent of Building Value Exposed**	**Number of Buildings**	**Building Value ($)**	**Percent of Building Value Exposed**
Scotts Mills	242	63,043	0	0	0.0%	7	1,280	2.0%
Silverton	4,077	1,740,060	11	3,764	0.2%	95	40,887	2.3%
St. Paul	247	132,631	0	0	0.0%	0	0	0.0%
Stayton	3,043	1,546,547	0	0	0.0%	22	9,114	0.6%
Sublimity	1,157	546,449	0	0	0.0%	0	0	0.0%
Turner	1,365	421,185	0	0	0.0%	28	6,515	1.5%
Woodburn	7332	3,446,910	0	0	0.0%	20	8,217	0.2%
Total Study Area	170,562	62,847,215	479	122,391	0.2%	2,340	691,602	1.1%

Table B-8. Volcanic lahar - lahar exposure.

Community	Total Number of Buildings	Total Estimated Building Value ($)	Small: 1%-0.1% (100 to 1,000-yr)			Medium: 0.1%-0.007% (1,000 to 15,000-yr)			Large: >0.007% (>15,000-yr)		
			Number of Buildings	Loss Estimate	Loss Ratio	Number of Buildings	Loss Estimate	Loss Ratio	Number of Buildings	Loss Estimate	Loss Ratio
Unincorp. Marion Co (rural)	43,387	16,042,238	73	13,604	0.1%	175	43,913	0.30%	1,107	344,288	2.0%
Brooks	249	89,505	0	0	0.0%	0	0	0.00%	0	0	0.0%
Butteville	193	78,691	0	0	0.0%	0	0	0.00%	0	0	0.0%
Four Corners	6,508	1,801,596	0	0	0.0%	0	0	0.00%	0	0	0.0%
Hayesville	7,876	2,382,452	0	0	0.0%	0	0	0.00%	0	0	0.0%
Labish Village	167	43,407	0	0	0.0%	0	0	0.00%	0	0	0.0%
Marion	244	64,728	0	0	0.0%	0	0	0.00%	0	0	0.0%
Mehama	189	53,460	0	0	0.0%	0	0	0.00%	156	44,399	83.0%
Total Unincorp. County	58,813	20,556,076	73	13,604	0.1%	175	43,913	0.20%	1,263	388,686	1.9%
Aumsville	1,459	509,635	0	0	0.0%	0	0	0.00%	0	0	0.0%
Aurora	560	258,763	0	0	0.0%	0	0	0.00%	0	0	0.0%
Detroit	315	69,925	131	32,835	47.0%	198	47,132	67%	260	59,862	86.0%
Donald	490	195,528	0	0	0.0%	0	0	0.00%	0	0	0.0%
Gates	326	71,352	0	0	0.0%	216	49,569	70%	280	62,651	88.0%
Gervais	719	247,297	0	0	0.0%	0	0	0.00%	0	0	0.0%
Hubbard	1,187	458,199	0	0	0.0%	0	0	0.00%	0	0	0.0%
Idanha	159	35,338	108	23,151	66.0%	127	27,525	78%	151	33,496	95.0%
Jefferson	1,243	389,441	0	0	0.0%	0	0	0.00%	0	0	0.0%
Keizer	16,380	5,592,798	0	0	0.0%	0	0	0.00%	0	0	0.0%
Mill City	1,269	299,237	0	0	0.0%	1,069	245,855	82%	1,103	255,078	85.0%
Mt. Angel	1,219	539,815	0	0	0.0%	0	0	0.00%	0	0	0.0%
Salem	58,163	22,532,083	0	0	0.0%	0	0	0.00%	0	0	0.0%
Salem (West Salem)	10,797	3,194,904	0	0	0.0%	4	772	0.00%	4	772	0.0%

Community	Total Number of Buildings	Total Estimated Building Value ($)	Small: 1%-0.1% (100 to 1, 000-yr)			Medium: 0.1% -0.007% (1,000 t o 15,000-yr)			Large: >0.007% (>15,000-yr)		
			Number of Buildings	Loss Estimate	Loss Ratio	Number of Buildings	Loss Estimate	Loss Ratio	Number of Buildings	Loss Estimate	Loss Ratio
Scotts Mills	242	63,043	0	0	0.0%	0	0	0.00%	0	0	0.0%
Silverton	4,077	1,740,060	0	0	0.0%	0	0	0.00%	0	0	0.0%
St. Paul	247	132,631	0	0	0.0%	0	0	0.00%	0	0	0.0%
Stayton	3,043	1,546,547	0	0	0.0%	0	0	0.00%	2,228	1,184,906	77.0%
Sublimity	1,157	546,449	0	0	0.0%	0	0	0.00%	0	0	0.0%
Turner	1,365	421,185	0	0	0.0%	0	0	0.00%	0	0	0.0%
Woodburn	7,332	3,446,910	0	0	0.0%	0	0	0.00%	0	0	0.0%
Total Study Area	170,562	62,847,215	312	69,591	0.1%	1,789	414,766	0.70%	5,289	1,985,452	3.2%

APPENDIX C. HAZUS-MH METHODOLOGY

C.1 Software

We performed all loss estimations using Hazus®-MH 4.2 and ArcGIS® Desktop® 10.2.2.

C.2 User-Defined Facilities (UDF) Database

A UDF database was compiled for all buildings in Marion County for use in both the flood and earthquake modules of Hazus-MH. The Marion County assessor database (acquired in 2021) was used to determine which taxlots had improvements (i.e., buildings) and how many building points should be included in the UDF database.

C.2.1 Locating buildings points

The Oregon Department of Geology and Mineral Industries (DOGAMI) used the SBFO-1 (Williams, 2021) dataset to help precisely locate the centroid of each building. Extra effort was spent to locate building points along the 1% and 0.2% annual chance inundation fringe. When buildings were partially within the inundation zone, the building point was moved to the centroid of the portion of the building within the inundation zone. An iterative approach was used to further refine locations of building points for the flood module by generating results, reviewing the highest value buildings, and moving the building point over a representative elevation on the lidar digital elevation model to ensure an accurate first floor height.

C.2.2 Attributing building points

Populating the required attributes for Hazus-MH was achieved through a variety of approaches. The Marion County assessor database was used whenever possible, but in many cases that database did not provide the necessary information. The following is list of attributes and their sources:

- **Longitude** and **Latitude** – Location information that provides Hazus-MH the x and y-position of the UDF point. This allows for an overlay to occur between the UDF point and the flood or earthquake input data layers. The hazard model uses this spatial overlay to determine the correct hazard risk level that will be applied to the UDF point. The format of the attribute must be in decimal degrees. A simple geometric calculation using GIS software is done on the point to derive this value.
- **Occupancy class** – An alphanumeric attribute that indicates the use of the UDF (e.g. 'RES1' is a single family dwelling). The alphanumeric code is composed of seven broad occupancy types (RES = residential, COM = commercial, IND = industrial, AGR = agricultural, GOV = public, REL = non-profit/religious, EDU = education) and various suffixes that indicate more specific types. This code determines the damage function to be used for flood analysis. It is also used to attribute the Building Type field, discussed below, for the earthquake analysis. The code was interpreted from "Stat Class" or "Description" data found in the Marion County assessor database. When data was not available, the default value of RES1 was applied throughout.
- **Cost** – The replacement cost of an individual UDF. Loss ratio is derived from this value. Replacement cost is based on a method called RSMeans valuation (Charest, 2017) and is calculated by multiplying the building square footage by a standard cost per square foot. These standard rates per square foot are in tables within the default Hazus database.

- **Year built** – The year of construction that is used to attribute the Building Design Level field for the earthquake analysis (see "Building Design" below). The year a UDF was built is obtained from Marion County assessor database. When not available, the year of "1900" was applied.
- **Square feet** – The size of the UDF is used to pro-rate the total improvement value for taxlots with multiple UDFs. The value distribution method will ensure that UDFs with the highest square footage will be the most expensive on a given taxlot. This value is also used to pro-rate the **Number of People** field for Residential UDFs within a census block. The value was obtained from DOGAMI's building footprints; where (RES) footprints were not available, we used the Marion County assessor database.
- **Number of stories** – The number of stories for an individual UDF, along with Occupancy Class, determines the applied damage function for flood analysis. The value was obtained from the Marion County assessor database when available. For UDFs without assessor information for number of stories that are within the flood zone, closer inspection using Google Street View™ or available oblique imagery was used for attribution.
- **Foundation type** – The UDF foundation type correlates with First Floor Height values in feet (see Table 3.11 in the Hazus-MH Technical Manual for the Flood Model [FEMA Hazus-MH, 2012a]). It also functions within the flood model by indicating if a basement exists or not. UDFs with a basement have a different damage function from UDFs that do not have one. The value was obtained from the Marion County assessor database when available. For UDFs without assessor information for basements that are within the flood zone, closer inspection using Google Street View™ or available oblique imagery was used to ascertain if one exists or not.
- **First floor height** – The height in feet above grade for the lowest habitable floor. The height is factored during the depth of flooding analysis. The value is used directly by Hazus-MH, where Hazus-MH overlays a UDF location on a depth grid and using the **first floor height** determines the level of flooding occurring to a building. It is derived from the Foundation Type attribute or observation via oblique imagery or Google Street View™ mapping service.
- **Building type** – This attribute determines the construction material and structural integrity of an individual UDF. It is used by Hazus-MH for estimating earthquake losses by determining which damage function will be applied. This information was unavailable from the Marion County assessor data, so instead it was derived from a statistical distribution based on **Occupancy class**.
- **Building design level** – This attribute determines the seismic building code for an individual UDF. It is used by Hazus-MH for estimating earthquake losses by determining which damage function will be applied. This information is derived from the **Year Built** attribute (Marion County Assessor) and state/regional Seismic Building Code benchmark years.
- **Number of people** – The estimated number of permanent residents living within an individual residential structure. It is used in the post-analysis phase to determine the amount of people affected by a given hazard. This attribute is derived from default Hazus database (United States Census Bureau, 2010a) of population per census block and distributed across residential UDFs and adjusted based on population growth estimates from PSU Population Research Center.
- **Community** – The community that a UDF is within. These areas are used in the post-analysis for reporting results. The communities were based on incorporated area boundaries; unincorporated community areas were based on building density.

C.2.3 Seismic building codes

Oregon initially adopted seismic building codes in the mid-1970s (Judson, 2012). The established benchmark years of code enforcement are used in determining a "design level" for individual buildings. The design level attributes (pre code, low code, moderate code, and high code) are used in the Hazus-MH earthquake model to determine what damage functions are applied to a given building (FEMA, 2012b). The year built or the year of the most recent seismic retrofit are the main considerations for an individual design level attribute. Seismic retrofitting information for structures would be ideal for this analysis but was not available for Marion County. **Table C-1** outlines the benchmark years that apply to buildings within Marion County.

Table C-1. Marion County seismic design level benchmark years.

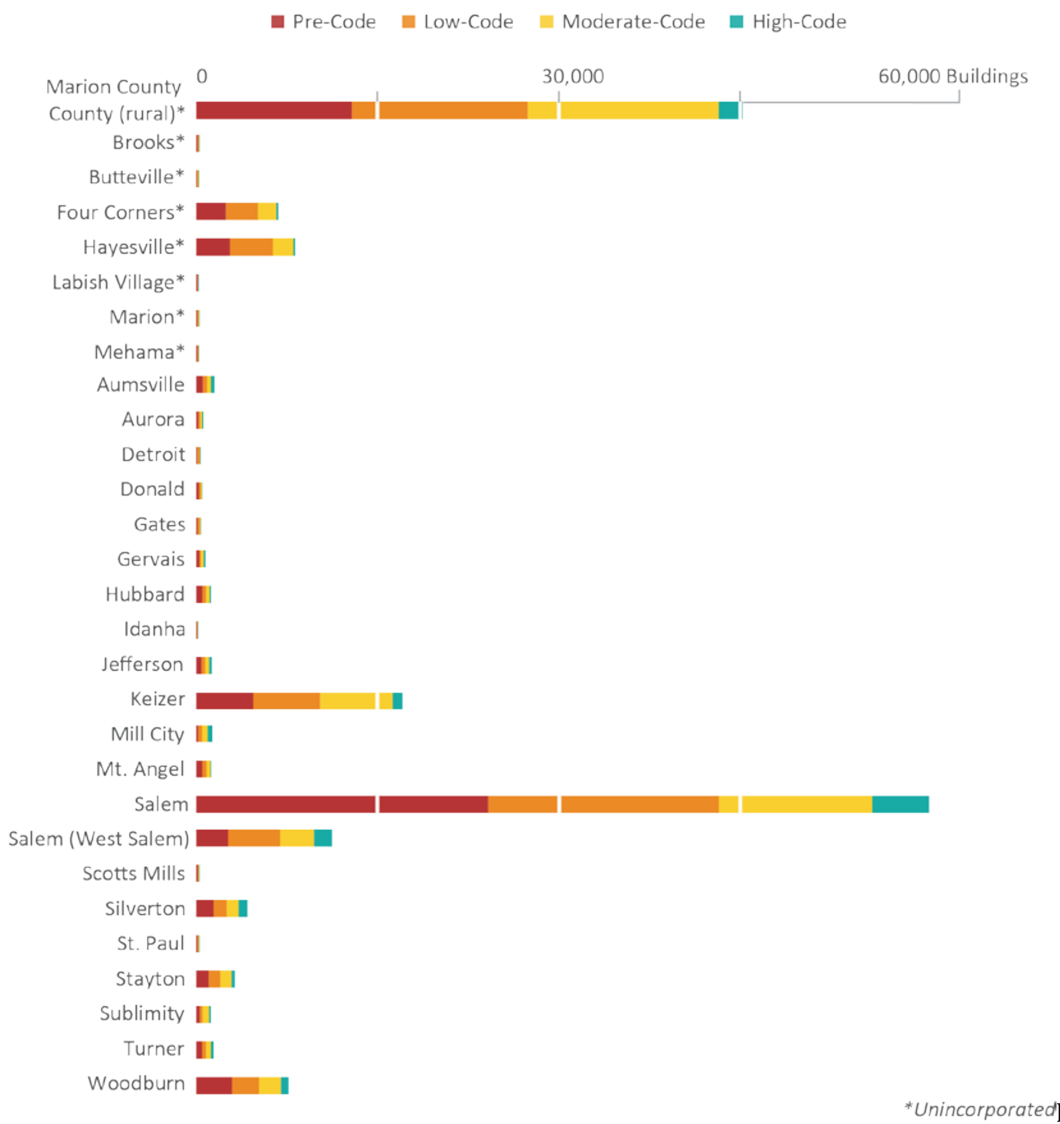
Building Type	Year Built	Design Level	Basis
Single-Family Dwelling (includes Duplexes)	prior to 1976	Pre Code	Interpretation of Judson (Judson, 2012)
	1976–1991	Low Code	
	1992–2003	Moderate Code	
	2004–2016	High Code	
Manufactured Housing	prior to 2003	Pre Code	Interpretation of OR BCD 2002 Manufactured Dwelling Special Codes (Oregon Building Codes Division, 2002)
	2003–2010	Low Code	
	2011–2016	Moderate Code	Interpretation of OR BCD 2010 Manufactured Dwelling Special Codes Update (Oregon Building Codes Division, 2010)
All other buildings	prior to 1976	Pre Code	Business Oregon 2014-0311 Oregon Benefit-Cost Analysis Tool, p. 24 (Business Oregon, 2015)
	1976–1990	Low Code	
	1991–2016	Moderate Code	

Table C-2 and corresponding **Figure C-1** illustrate the current state of seismic building codes for the county.

Table C-2. Seismic design level in Marion County.

Community	Total Number of Buildings	Pre Code		Low Code		Moderate Code		High Code	
		Number of Buildings	Percentage of Buildings	Number of Buildings	Percentage of Buildings	Number of Buildings	Percentage of Buildings	Number of Buildings	Percentage of Buildings
Unincorp. Marion Co (rural)	43,387	12,333	28%	13,978	32%	15,162	35%	1,914	4.4%
Brooks	249	100	40%	76	30.5%	56	22.5%	17	6.8%
Butteville	193	54	28%	56	29%	70	36%	13	6.7%
Four Corners	6,508	2,338	36%	2,575	40%	1,472	23%	123	1.9%
Hayesville	7,876	2,661	34%	3,393	43.1%	1,660	21.1%	162	2.1%
Labish Village	167	84	50%	58	35%	18	11%	7	4.2%
Marion	244	95	39%	45	18.4%	82	33.6%	22	9.0%
Mehama	189	81	43%	65	34%	33	17%	10	5.3%
Total Unincorporated County	58,813	17,746	30%	20,246	34%	18,553	32%	2,268	3.9%
Aumsville	1,459	526	36%	312	21.4%	316	22%	305	21%
Aurora	560	161	29%	126	22.5%	161	28.8%	112	20.0%
Detroit	315	55	17%	217	68.9%	24	7.6%	19	6.0%
Donald	490	199	41%	118	24.1%	119	24%	54	11.0%
Gates	326	101	31%	149	46%	60	18%	16	5%
Gervais	719	219	30%	109	15%	260	36%	131	18%
Hubbard	1,187	462	39%	303	26%	277	23%	145	12%
Idanha	159	55	35%	48	30%	37	23%	19	12%
Jefferson	1,243	390	31%	307	25%	296	24%	250	20%
Keizer	16,380	4,513	28%	5,268	32%	5,773	35%	826	5%
Mill City	1,269	110	9%	328	26%	466	37%	365	29%
Mt. Angel	1,219	453	37%	334	27%	314	26%	118	10%
Salem	58,163	23,168	40%	18,285	31%	12,217	21%	4,493	8%
Salem (West Salem)	10,797	2,498	23%	4,129	38%	2,735	25%	1,435	13%
Scotts Mills	242	116	48%	43	18%	61	25%	22	9%
Silverton	4,077	1,395	34%	997	24%	964	24%	721	18%
St. Paul	247	78	32%	68	28%	89	36%	12	5%
Stayton	3,043	980	32%	903	30%	933	31%	227	7%
Sublimity	1,157	254	22%	256	22%	488	42%	159	14%
Turner	1,365	432	32%	340	25%	369	27%	224	16%
Woodburn	7,332	2,850	39%	2,135	29%	1,730	24%	617	8%
Total Study Area	170,562	56,761	33%	55,021	32%	46,242	27%	12,538	7%

Figure C-1. Seismic design level by Marion County community.



C.3 Flood Hazard Data

Depth grids for "Zone A" designated flood zones, or approximate 100-year flood zones, were developed by the Strategic Alliance for Risk Reduction (STARR) in 2015 to revise the Marion County FIRMs (FEMA, 2018). DOGAMI developed depth grids from detailed stream model information within the study area. Both sets of depth grids were used in this risk assessment to determine the level to which buildings are impacted by flooding.

A study area-wide, 2-meter, lidar-based depth grid was developed for each of the 10-, 50-, 100-, and 500-year annual chance flood events. The depth grids were imported into Hazus-MH for determining the depth of flooding for areas within the FEMA flood zones.

Once the UDF database was developed into a Hazus-compliant format, the Hazus-MH methodology was applied using a Python (programming language) script developed by DOGAMI (Bauer, 2018). The analysis was then run for a given flood event, and the script cross-referenced a UDF location with the depth grid to find the depth of flooding. The script then applied a specific damage function, based on a UDF's

Occupancy Class [OccCls], which was used to determine the loss ratio for a given amount of flood depth, relative to the UDF's first-floor height.

C.4 Earthquake Hazard Data

The following hazard layers used for our loss estimation are derived from work conducted by Madin and others (2021): National Earthquake Hazard Reduction Program (NEHRP) soil classification, liquefaction susceptibility and wet landslide susceptibility. The liquefaction and landslide susceptibility layers together with NEHRP were used by the Hazus-MH tool to calculate ground motion layers and permanent ground deformation and associated probability. The default value of 5 feet was used for the water table depth value.

During the Hazus-MH earthquake analysis, each UDF was analyzed given its site-specific parameters (ground deformation) and evaluated for loss, expressed as a probability of a damage state. Specific damage functions based on Building type and Building design level were used to calculate the damage states given the site-specific parameters for each UDF. The output provided probabilities of the five damage states (None, Slight, Moderate, Extensive, Complete) from which losses in dollar amounts were derived.

C.5 Post-Analysis Quality Control

Ensuring the quality of the results from Hazus-MH flood and earthquake modules is an essential part of the process. A primary characteristic of the process is that it is iterative. A UDF database without errors is highly unlikely, so this part of the process is intended to limit and reduce the influence these errors have on the final outcome. Before applying the Hazus-MH methodology, closely examining the top 10 largest area UDFs and the top 10 most expensive UDFs is advisable. Special consideration can also be given to critical facilities due to their importance to communities.

Identifying, verifying, and correcting (if needed) the outliers in the results is the most efficient way to improve the UDF database. This can be done by sorting the results based on the loss estimates and closely scrutinizing the top 10 to 15 records. If corrections are made, then subsequent iterations are necessary. We continued checking the "loss leaders" until no more corrections were needed.

Finding anomalies and investigating possible sources of error are crucial in making corrections to the data. A wide range of corrections might be required to produce a better outcome. For example, floating homes may need to have a first-floor height adjustment or a UDF point position might need to be moved due to issues with the depth grid. Incorrect basement or occupancy type attribution could be the cause of a problem. Commonly, inconsistencies between assessor data and taxlot geometry can be the source of an error. These are just a few of the many types of problems addressed in the quality control process.

APPENDIX D. ACRONYMS AND DEFINITIONS

D.1 Acronyms

CRS	Community Rating System
CSZ	Cascadia subduction zone
DLCD	Oregon Department of Land Conservation and Development
DOGAMI	Department of Geology and Mineral Industries (State of Oregon)
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FRI	Fire Risk Index
GIS	Geographic Information System
NFIP	National Flood Insurance Program
NHMP	Natural hazard mitigation plan
NOAA	National Oceanic and Atmospheric Administration
ODF	Oregon Department of Forestry
OEM	Oregon Emergency Management
OFR	Open-File Report
OPDR	Oregon Partnership for Disaster Resilience
PGA	Peak ground acceleration
PGD	Permanent ground deformation
PGV	Peak ground velocity
Risk MAP	Risk Mapping, Assessment, and Planning
SHMO	State Hazard Mitigation Officer
SLIDO	State Landslide Information Layer for Oregon
UDF	User-defined facilities
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WUI	Wildland-urban interface
WWA	West Wide Wildfire Risk Assessment

D.2 Definitions

1% annual chance flood – The flood elevation that has a 1-percent chance of being equaled or exceeded each year. Sometimes referred to as the 100-year flood.

0.2% annual chance flood – The flood elevation that has a 0.2-percent chance of being equaled or exceeded each year. Sometimes referred to as the 500-year flood.

Base flood elevation (BFE) – Elevation of the 1-percent-annual-chance flood. This elevation is the basis of the insurance and floodplain management requirements of the NFIP.

Critical facilities – Facilities that, if damaged, would present an immediate threat to life, public health, and safety. As categorized in HAZUS-MH, critical facilities include hospitals, emergency operations centers, police stations, fire stations and schools.

Exposure – Determination of whether a building is within or outside of a hazard zone. No loss estimation is modeled.

Flood Insurance Rate Map (FIRM) – An official map of a community, on which FEMA has delineated both the SFHAs and the risk premium zones applicable to the community.

Flood Insurance Study (FIS) – Contains an examination, evaluation, and determination of the flood hazards of a community and, if appropriate, the corresponding water-surface elevations.

Hazus-MH – A GIS-based risk assessment methodology and software application created by FEMA and the National Institute of Building Sciences for analyzing potential losses from floods, hurricane winds, and earthquakes.

Lidar – A remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light. Lidar is popularly used as a technology to make high-resolution maps.

Liquefaction – Describes a phenomenon whereby a saturated soil substantially loses strength and stiffness in response to an applied stress, usually an earthquake, causing it to behave like liquid.

Loss Ratio – The expression of loss as a fraction of the value of the local inventory (total value/loss).

Magnitude – A scale used by seismologists to measure the size of earthquakes in terms of energy released.

Risk – Probability multiplied by consequence; the degree of probability that a loss or injury may occur as a result of a natural hazard. Sometimes referred to as vulnerability.

Risk MAP – The vision of this FEMA strategy is to work collaboratively with State, local, and tribal entities to deliver quality flood data that increases public awareness and leads to action that reduces risk to life and property.

Riverine – Of or produced by a river. Riverine floodplains have readily identifiable channels.

Susceptibility – Degree of proneness to natural hazards that is determined based on physical characteristics that are present.

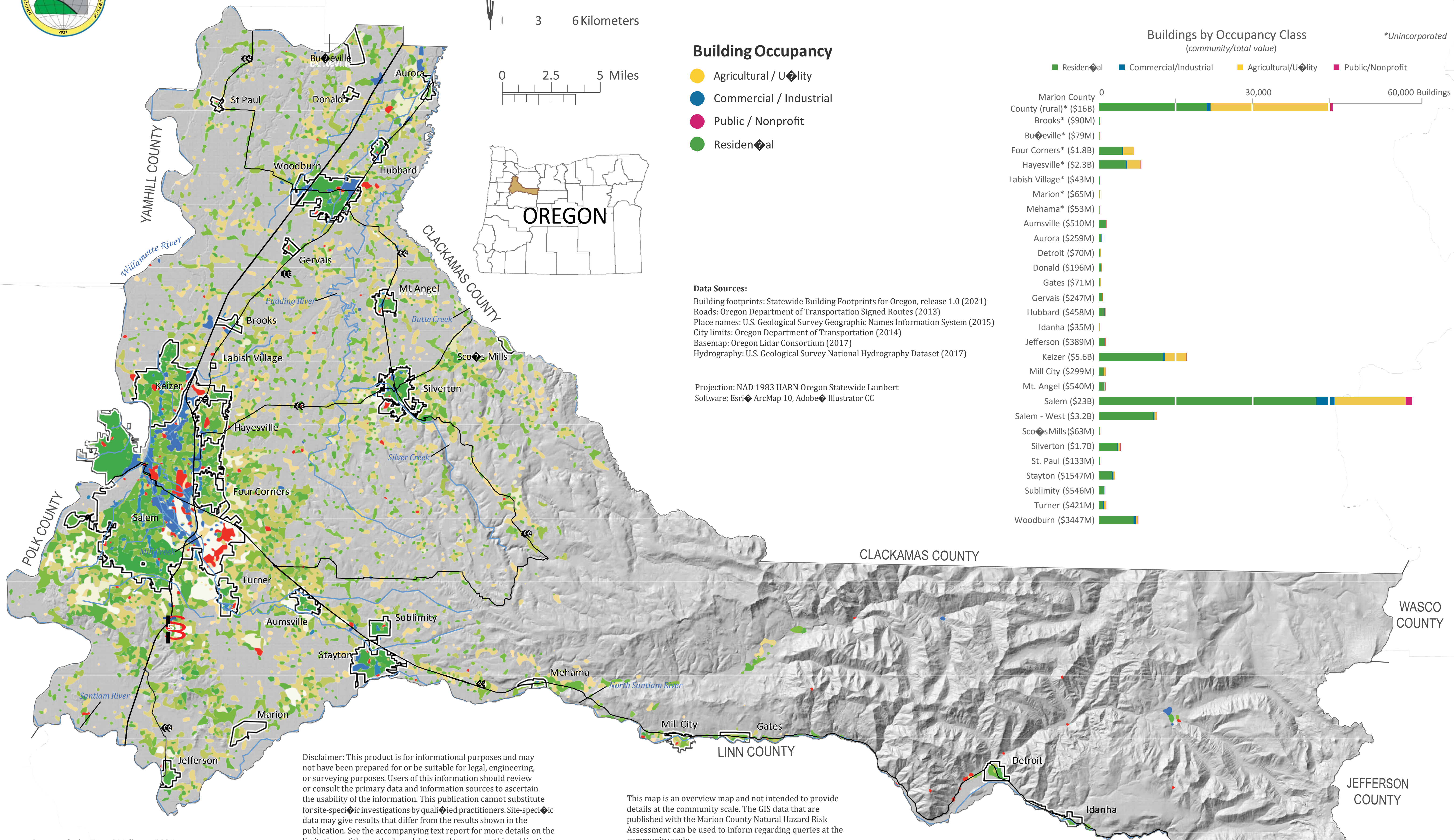
Vulnerability – Characteristics that make people or assets more susceptible to a natural hazard.

APPENDIX E. MAP PLATES

See appendix folder for individual map PDFs.

Building Distribution Map of Marion County, Oregon

PLATE 1



Data Sources:

Building footprints: Statewide Building Footprints for Oregon, release 1.0 (2021)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2017)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri� ArcMap 10, Adobe� Illustrator CC

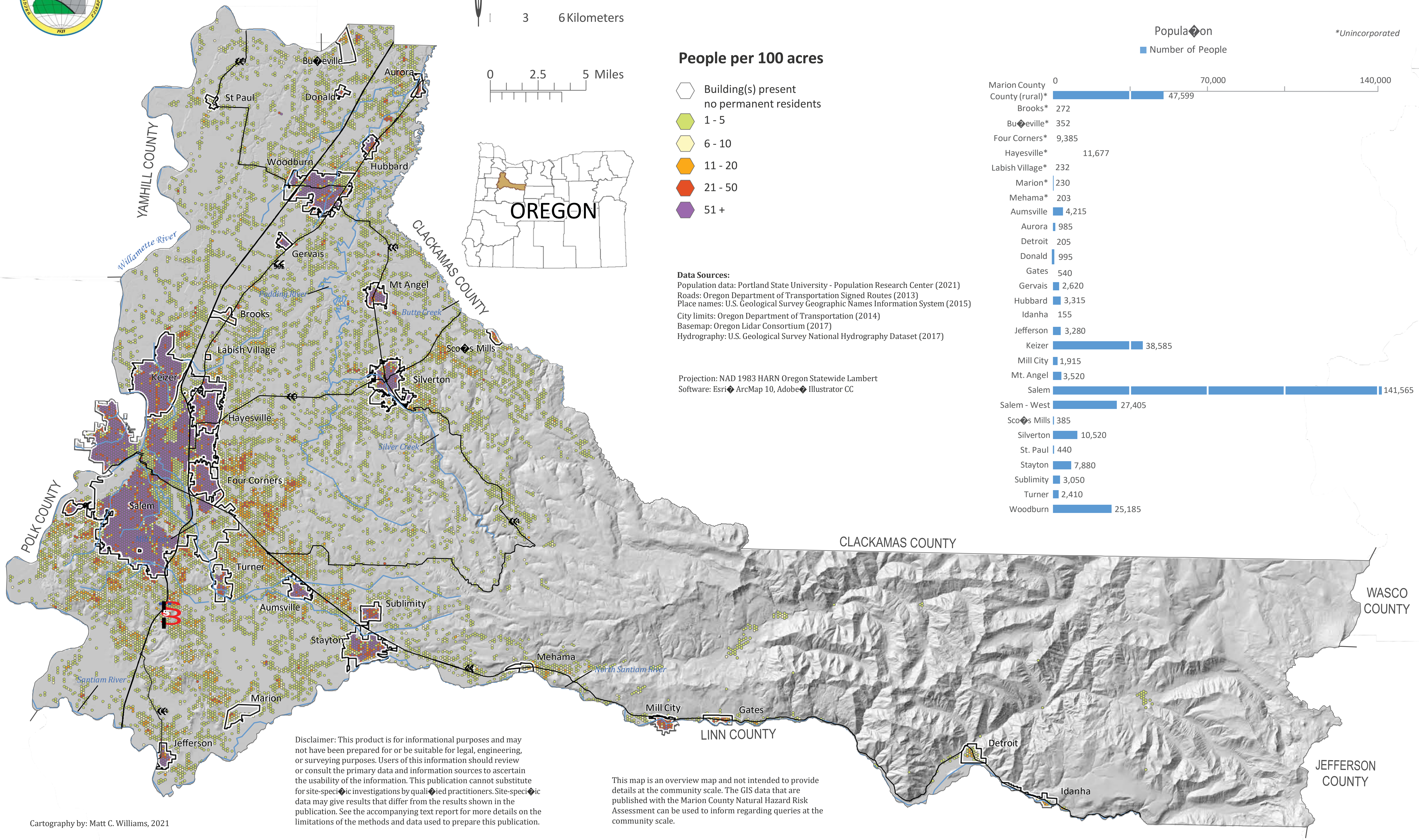
Disclaimer: This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information. This publication cannot substitute for site-speci�ic investigations by quali�ied practitioners. Site-speci�ic data may give results that differ from the results shown in the publication. See the accompanying text report for more details on the limitations of the methods and data used to prepare this publication.

This map is an overview map and not intended to provide details at the community scale. The GIS data that are published with the Marion County Natural Hazard Risk Assessment can be used to inform regarding queries at the community scale.

Cartography by: Matt C. Williams, 2021

Population Density Map of Marion County, Oregon

PLATE 2



Data Sources:
Population data: Portland State University - Population Research Center (2021)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2017)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri� ArcMap 10, Adobe� Illustrator CC

Disclaimer: This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information. This publication cannot substitute for site-speci�ic investigations by quali�ied practitioners. Site-speci�ic data may give results that differ from the results shown in the publication. See the accompanying text report for more details on the limitations of the methods and data used to prepare this publication.

This map is an overview map and not intended to provide details at the community scale. The GIS data that are published with the Marion County Natural Hazard Risk Assessment can be used to inform regarding queries at the community scale.

Cartography by: Matt C. Williams, 2021

Mt. Angel Fault Magnitude-6.8 Earthquake Shaking Map of Marion County, Oregon

PLATE 3

OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
1937

Butteville
Aurora
St Paul
Donald
Woodburn
Hubbard
YAMHILL COUNTY
Willamette River
Gervais
99E
CLACKAMAS COUNTY
OREGON
Mt Angel
Pudding River
Butte Creek
Brooks
Labish Village
Scotts Mills
Keizer
Silverton
Hayesville
Silver Creek
Four Corners
POLK COUNTY
Salem
Mill Creek
Turner
Aumsville
Sublimity
Stayton
Mehama
North Santiam River
Santiam River
Marion
Mill City
Gates
LINN COUNTY
Jefferson
CLACKAMAS COUNTY
WASCO COUNTY

0 2.5 5 Miles
0 3 6 Kilometers

Earthquake Peak Ground Acceleration

(Modified Mercalli Intensity Scale)
Moderate Severe

Peak Ground Acceleration (PGA) is the maximum acceleration in a given location, or rather, how hard the ground is shaking during an earthquake. It is one measurement of ground motion, which is closely associated with the level of damage that occurs from an earthquake.

Data Sources:
Peak ground acceleration: Oregon Department of Geology and Mineral Industries (2019)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2017)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri® ArcMap 10, Adobe® Illustrator CC

Total Building Value Loss Ratio from Mt. Angel Fault - Mw-6.8

*Unincorporated

Loss Ratio

0% 20% 40%

Marion County
County (rural)*
Brooks*
Butteville*
Four Corners*
Hayesville*
Labish Village*
Marion*
Mehama*
Aumsville
Aurora
Detroit
Donald
Gates
Gervais
Hubbard
Idanha
Jefferson
Keizer
Mill City
Mt. Angel
Salem
Salem - West
Scotts Mills
Silverton
St. Paul
Stayton
Sublimity
Turner
Woodburn

Cartography by: Matt C. Williams, 2021

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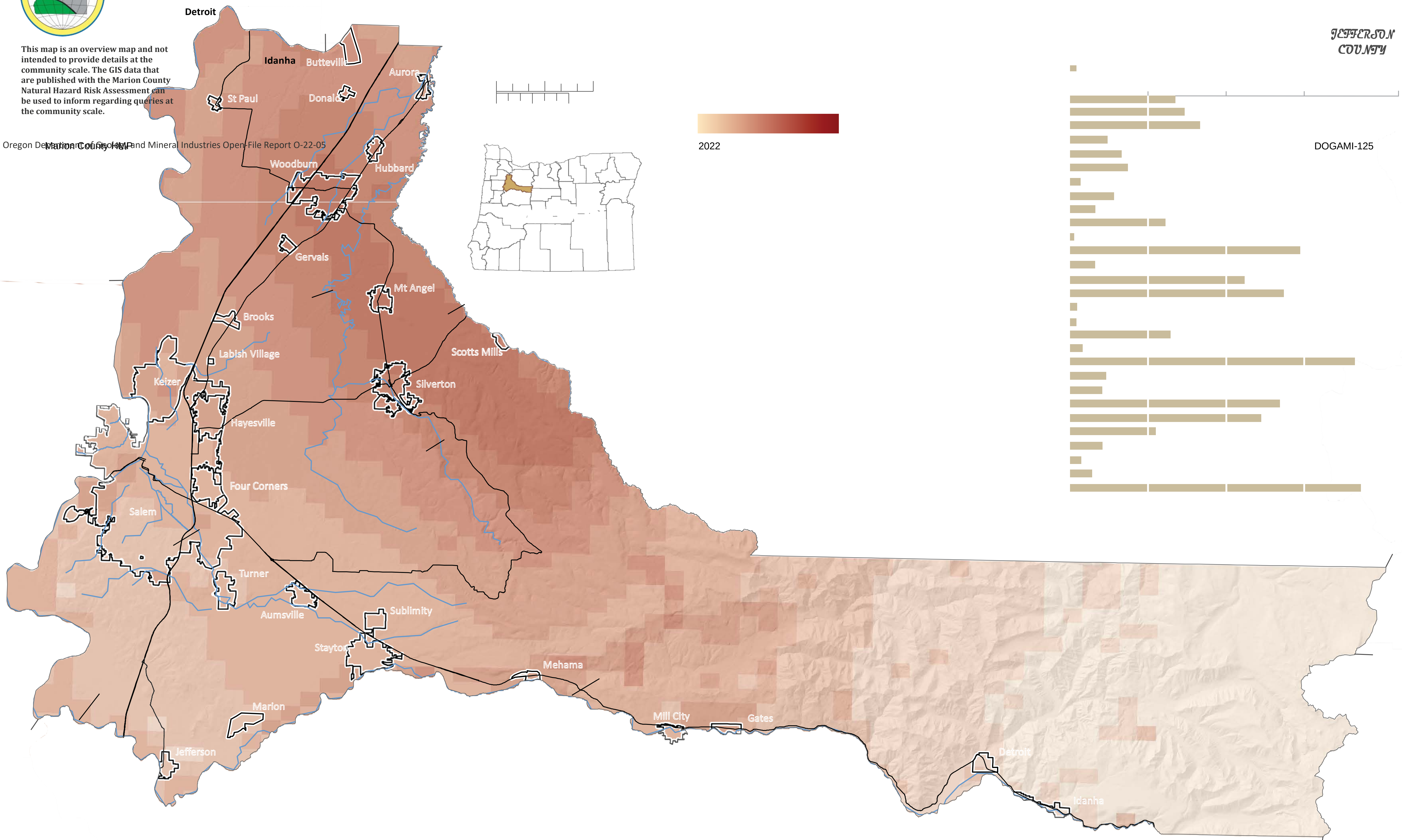
Oregon Department of Geology and Mineral Industries Open-File Report O-22-05

Marion County HMP

2022

DOGAMI-125



Flood Hazard Map of Marion County, Oregon

1937

| 3 6 Kilometers

0 2.5 5 Miles

Bu�eville

St Paul
Donald
Woodburn
Aurora
Hubbard

YAMHILL COUNTY

Gervais
99E
Pudding River
Mt Angel
OREGON
CLACKAMAS COUNTY
Willamette River
Brooks
Butte Creek
Labish Village
Sco�s Mills
Keizer
Silverton
Hayesville
Silver Creek
Four Corners
Salem
POLK COUNTY
Mill Creek
Turner
Aumsville
Sublimity
Stayton
Mehama
North Santiam River
Santiam River
Marion
Mill City
Gates
Jefferson
LINN COUNTY
CLACKAMAS COUNTY
WASCO COUNTY

Flood Hazard Zone

100-Year Flood

(1% annual chance)

The �lood hazard data show areas expected to be inundated during a 100-year �lood event. Flooding sources are riverine in origin. Areas are consistent with the regulatory �lood zones depicted in Marion County's Flood Insurance Rate Maps.

Data Sources:
Flood hazard zone (100-year): Marion County FEMA Flood Insurance Rate Maps (2019)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2017)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri� ArcMap 10, Adobe� Illustrator CC

Ra�o of Es�mated Loss to Flooding

*Unincorporated

Flood Scenarios

10-Year 50-Year 100-Year 500-Year

rooks*
Marion County County (rural)* B
Bu�eville*
Four Corners*
Hayesville*
Labish Village*
Marion*
Mehama*
Aumsville
Aurora
Detroit
Donald
Gates
Gervais
Hubbard
Idanha
Jefferson
Keizer
Mill City
Mt. Angel
Salem
Salem (West Salem)
Sco�s Mills
Silverton
St. Paul
Stayton
Sublimity
Turner
Woodburn

0% 3.5% 7%

C a r tography by: Matt C. Williams, 2021

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Detroit

Idanha

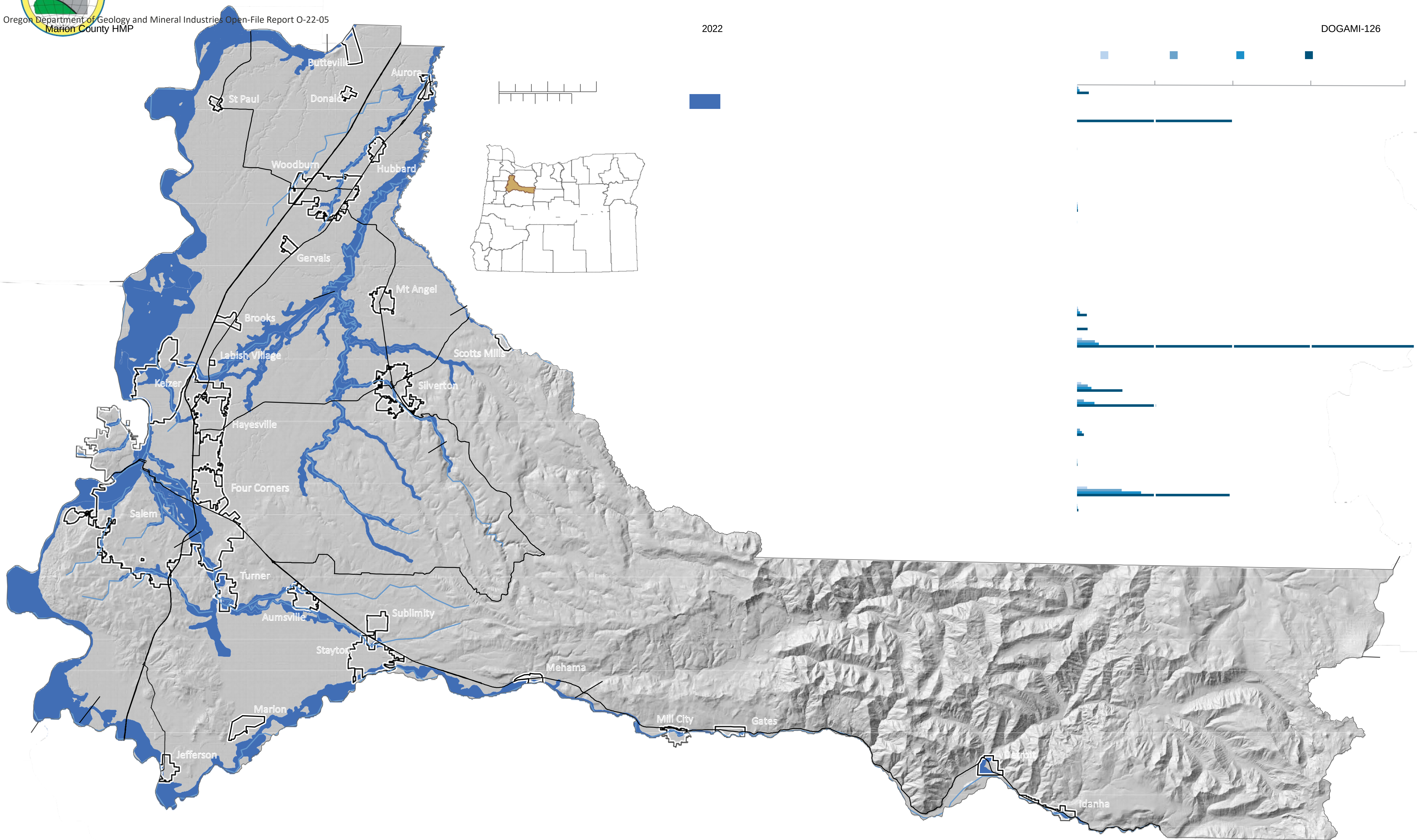
JEFFERSON COUNTY

Oregon Department of Geology and Mineral Industries Open-File Report O-22-05

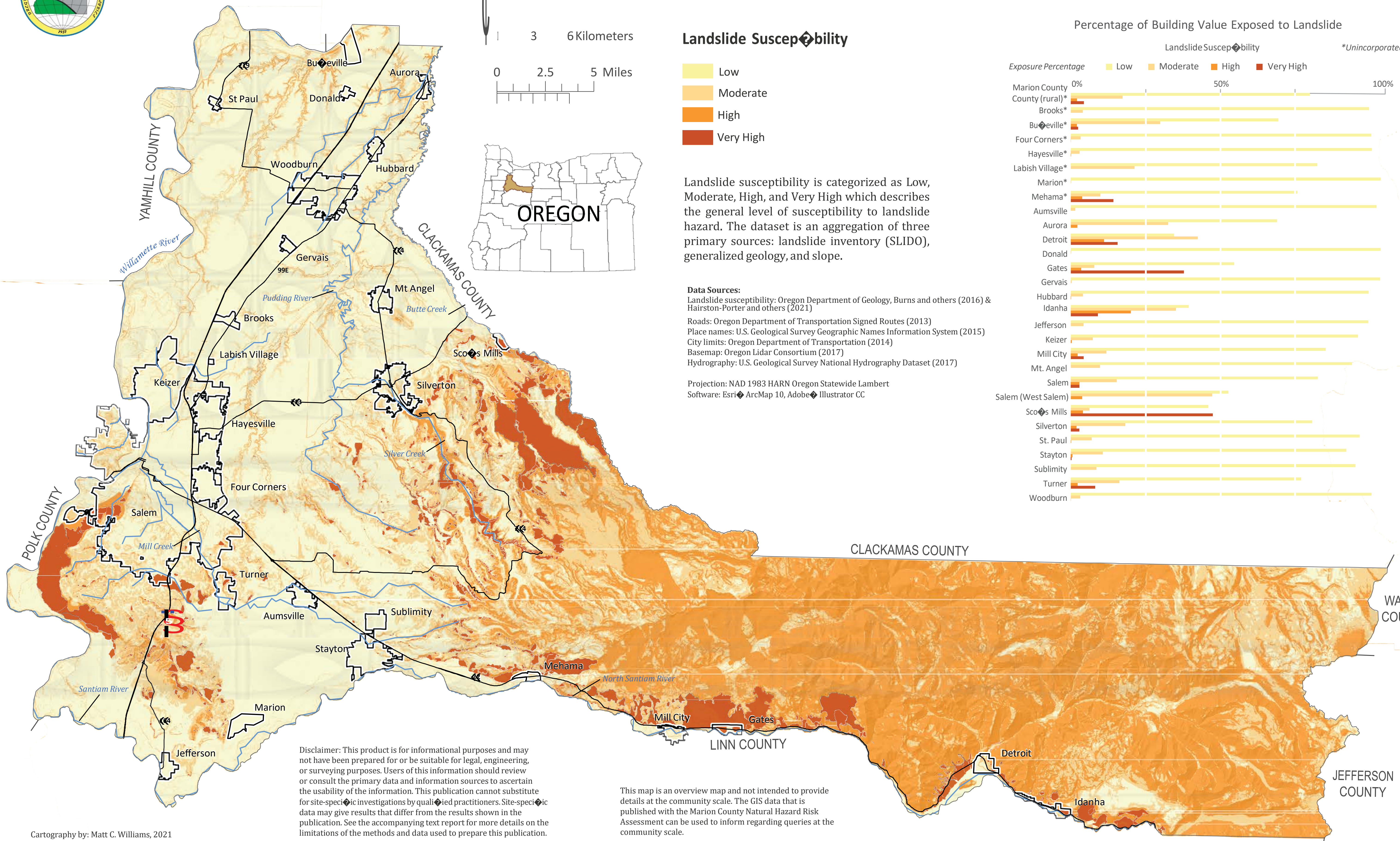
Marion County HMP

2022

DOGAMI-126



Landslide Susceptibility Map of Marion County, Oregon



Landslide susceptibility is categorized as Low, Moderate, High, and Very High which describes the general level of susceptibility to landslide hazard. The dataset is an aggregation of three primary sources: landslide inventory (SLIDO), generalized geology, and slope.

Data Sources:
Landslide susceptibility: Oregon Department of Geology, Burns and others (2016) & Hairston-Porter and others (2021)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2017)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri� ArcMap 10, Adobe� Illustrator CC

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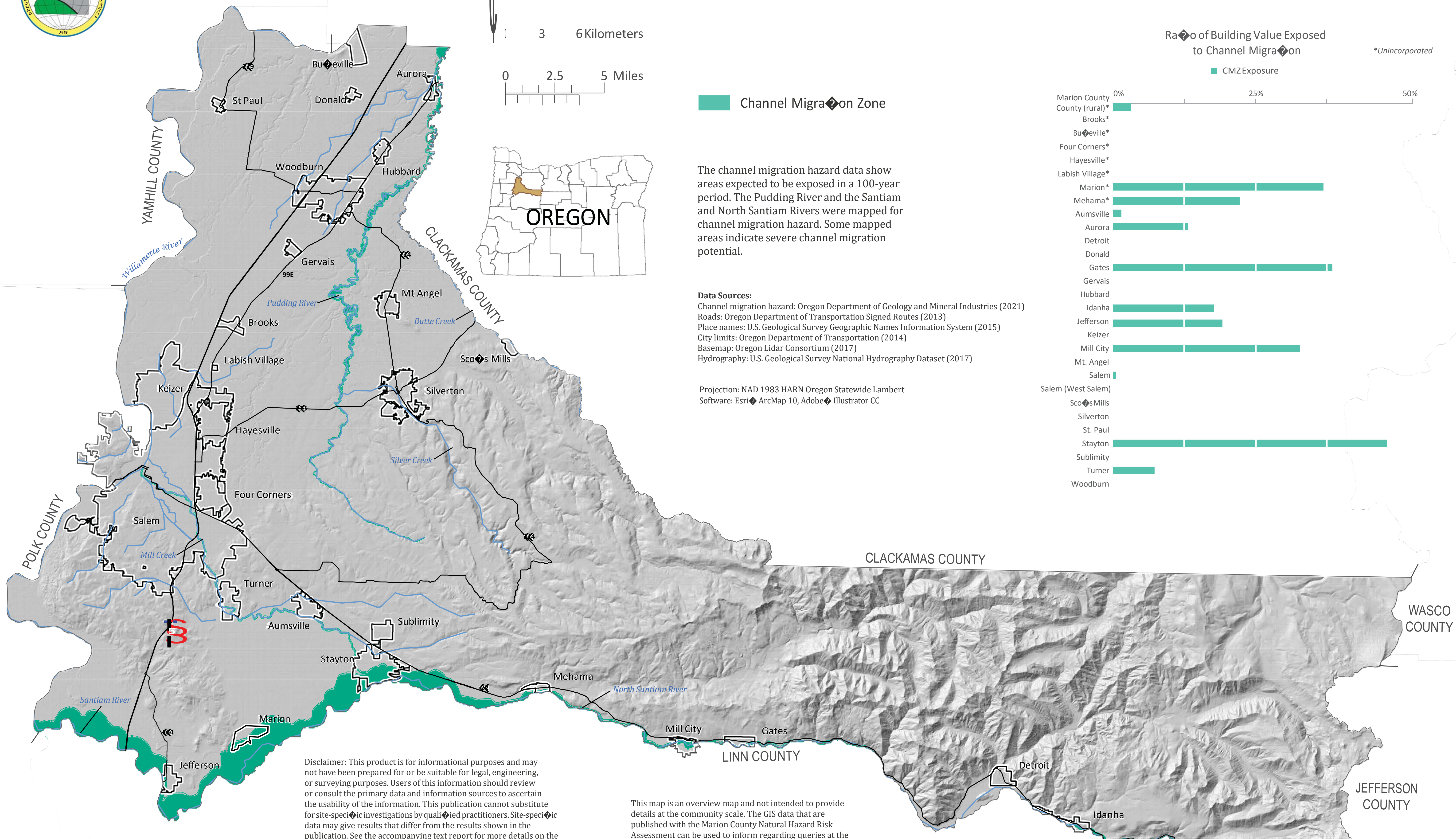
Cartography by: Matt C. Williams, 2021

Channel Migration Zone Map of Marion County, Oregon

PLATE 6



The channel migration hazard data show areas expected to be exposed in a 100-year period. The Pudding River and the Santiam and North Santiam Rivers were mapped for channel migration hazard. Some mapped areas indicate severe channel migration potential.

Data Sources:
Channel migration hazard: Oregon Department of Geology and Mineral Industries (2021)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2017)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri� ArcMap 10, Adobe� Illustrator CC

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Cartography by: Matt C. Williams, 2021

Wild�ire Risk Map of Marion County, Oregon

PLATE 7

Wildfire Risk

Low

Moderate

High

0 3 6 Kilometers

0 2.5 5 Miles

YAMHILL COUNTY

Aurora

Bu�eville

St Paul

Donald

Woodburn

Hubbard

OREGON

Gervais

99E

CLACKAMAS COUNTY

illamette River

Pudding River

Mt Angel

W

Brooks

Butte Creek

Labish Village

Sco�s Mills

Keizer

Silverton

Hayesville

Silver Creek

Four Corners

POLK COUNTY

Salem

Mill Creek

Turner

Aumsville

Sublimity

Stayton

Mehama

North Santiam River

Santiam River

Marion

Mill City

Gates

CLACKAMAS COUNTY

WASCO COUNTY

Overall Wild�ire Risk is categorized as Low, Moderate, and High and indicates the level of risk a location has to wild�ire hazard. The Overall Wild�ire Risk data layer is derived from a combination of the burn probability (�ire history and behavior) and �ire impacts (infrastructure and assets).

Data Sources:
Wild�ire risk data: Oregon Department of Forestry, Pyrologix, LCC. (2018)

Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2017)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri� ArcMap 10, Adobe� Illustrator CC

Percentage of Building Value Exposed to Wildfire

Wildfire Risk

Exposure Percentage

Low Moderate High

**Unincorporated*

0% 50% 100%

Marion County
County (rural)*
Brooks*
Bu�eville*
Four Corners*
Hayesville*
Labish Village*
Marion*
Mehama*
Aumsville
Aurora
Detroit
Donald
Gates
Gervais
Hubbard
Idanha
Jefferson
Keizer
Mill City
Mt. Angel
Salem
Salem - West
Sco�s Mills
Silverton
St. Paul
Stayton
Sublimity
Turner
Woodburn

Jefferson

Detroit

Idanha

JEFFERSON COUNTY

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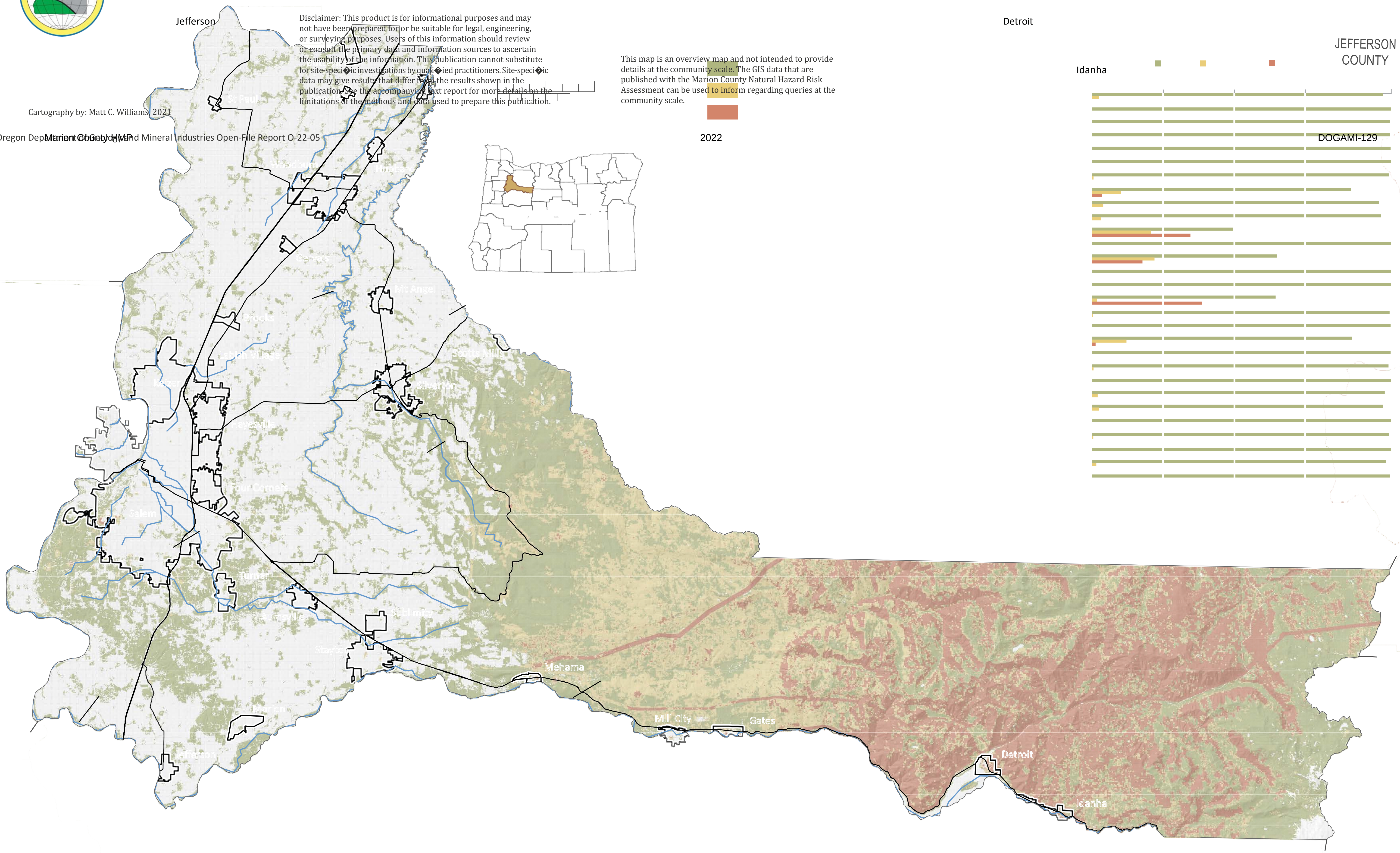
Cartography by: Matt C. Williams, 2021

Oregon Department of Geology and Mineral Industries Open-File Report O-22-05

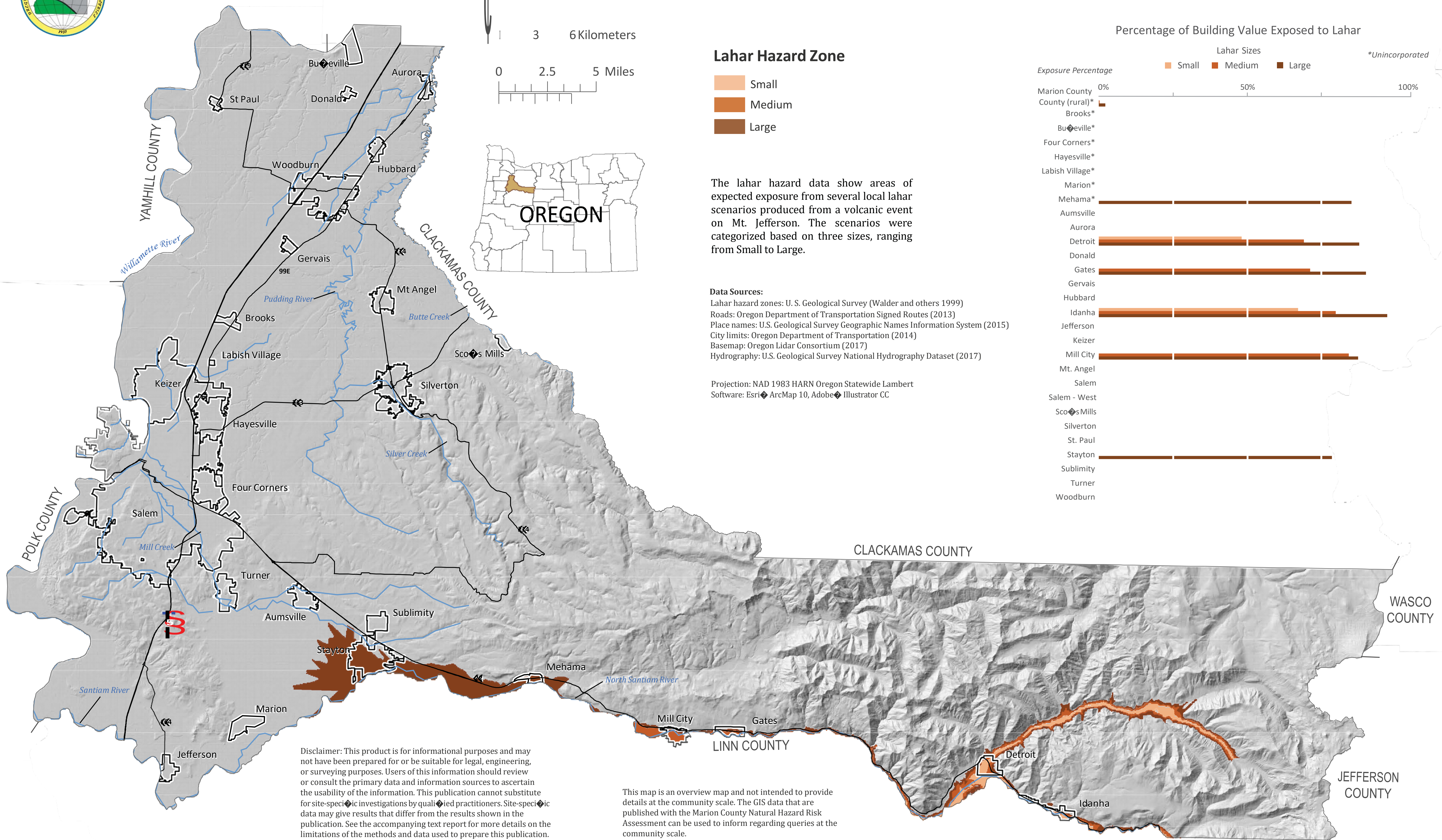
Marion County HMP

2022

DOGAMI-129



Lahar Exposure Map of Marion County, Oregon



Lahar Hazard Zone

- Small
- Medium
- Large

The lahar hazard data show areas of expected exposure from several local lahar scenarios produced from a volcanic event on Mt. Jefferson. The scenarios were categorized based on three sizes, ranging from Small to Large.

Data Sources:
Lahar hazard zones: U. S. Geological Survey (Walder and others 1999)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2017)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri� ArcMap 10, Adobe� Illustrator CC

Percentage of Building Value Exposed to Lahar

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Cartography by: Matt C. Williams, 2021

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