State of Oregon
Oregon Department of Geology and Mineral Industries
Brad Avy, State Geologist

OPEN-FILE REPORT O-21-04

NATURAL HAZARD RISK REPORT FOR COOS COUNTY, OREGON

INCLUDING THE CITIES OF BANDON, COOS BAY, COQUILLE, LAKESIDE, MYRTLE POINT, NORTH BEND AND POWERS, AND TRIBAL LANDS OF THE CONFEDERATED TRIBES OF COOS, LOWER UMPQUA, AND SIUSLAW INDIANS AND THE COQUILLE INDIAN TRIBE, AND THE UNINCORPORATED COMMUNITIES OF BUNKER HILL, CHARLESTON, GLASGOW, GREEN ACRES, HAUSER, AND MILLINGTON

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2021

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Cover photo: Mouth of the Coos River and North Spit near the City of Coos Bay, Oregon.
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WHAT'S IN THIS REPORT?

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

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GEOGRAPHIC INFORMATION SYSTEM (GIS) DATA

See the digital publication folder for files.
Geodatabase is Esri® version 10.2 format. Metadata are embedded in the geodatabase and are also provided as separate .xml format files.

Coos_County_Risk_Report_Data.gdb

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

Raster data: Hazard_Data
FL_Depth_10
FL_Depth_50
FL_Depth_100
FL_Depth_500

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 Coos County, Oregon, with funding provided by the Federal Emergency Management Agency (FEMA). It describes the methods and results of the natural hazard risk assessment performed in 2018 by the Oregon Department of Geology and Mineral Industries (DOGAMI) within the study area. The purpose of this project was to provide communities with a detailed understanding of their risk from natural hazards, to give communities the ability to compare their risk across multiple hazards, and to prioritize and take actions that will reduce risk. The results of this study can also inform the natural hazard mitigation planning process.

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

To complete 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. Using this dataset, we were able to represent an accurate spatial location and vulnerability 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 some were produced using high-resolution lidar topographic data. While not all the data sources used in the report are countywide, each hazard dataset was the best available at the time the analysis was performed.

In the third task, we performed the risk assessment using Esri® ArcGIS Desktop® software. We used two risk assessment approaches: (1) estimated loss (in dollars) to buildings from flood (recurrence intervals) and earthquake scenarios using Hazus-MH methodology; and (2) calculated the number of buildings, their value, and associated populations exposed to earthquake, tsunami, flood, landslide, and wildfire hazards.

The findings and conclusions of this report show the potential impacts of hazards in communities within Coos County. A Cascadia Subduction Zone (CSZ) event (earthquake and tsunami) will cause extensive damage and losses throughout the county. Our findings indicate that most of the study area's critical facilities are at high risk from a CSZ event. We also found that the hazards with the highest potential of population displacement are earthquake, tsunami, and landslide hazards. We demonstrate the potential for the reduction in damages and losses from seismic retrofits through building code simulations in the Hazus-MH earthquake model. Flooding is a threat for some communities in the study area and we quantify the number of elevated structures that are less vulnerable to flood hazard. Our analysis shows that new landslide mapping based on improved methods and lidar information will increase the accuracy of future risk assessments. During the time of writing, the best available data show that wildfire risk is high for the upstream portions of the Coos River watershed. Lastly, we demonstrate that this risk assessment can be a valuable tool to local decisionmakers.

Results were broken out for the following geographic areas:

- Unincorporated Coos County (rural)
- Community of Charleston
- Community of Green Acres
- Community of Millington
- Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians
- City of Coquille
- City of Lakeside
- City of North Bend
- Community of Bunker Hill
- Community of Glasgow
- Community of Hauser
- City of Bandon
- City of Coos Bay
- Coquille Indian Tribe
- City of Myrtle Point
- City of Powers

Selected countywide results
Total buildings: 42,550
Total estimated building value: $11.5 billion

Cascadia Subduction Zone (CSZ) Magnitude (Mw) 9.0 Earthquake[a]
Red-tagged buildings[b]: 9,689
Yellow-tagged buildings[c]: 3,659
Loss estimate: $3.5 billion

100-year Flood Scenario
Number of buildings damaged: 1,870
Loss estimate: $125 million

Wildfire Exposure (High Risk)
Number of buildings exposed: 1,050
Exposed building value: $217 million

CSZ Tsunami Inundation
Number of buildings exposed: 1,286
Exposed building value: $612 million

Landslide Exposure (High and Very High Susceptibility)
Number of buildings exposed: 7,123
Exposed building value: $1.6 billion

[a]Results reflect damages caused by earthquake to buildings outside of the tsunami zone. Earthquake and tsunami results combined estimate the total damages from a CSZ Mw 9.0 event.
[b]Red-tagged buildings are considered to be uninhabitable due to complete damage.
[c]Yellow-tagged buildings are considered to be of limited habitability due to extensive damage.

1.0 INTRODUCTION

A natural hazard is a naturally occurring phenomenon that can negatively impact humans, which is typically characterized as risk. A natural hazard risk assessment analyzes how a hazard could affect the built environment, population, the cost of recovery, and identifies potential risk. In natural hazard mitigation planning, risk assessments are the basis for developing mitigation strategies and actions. A risk assessment informs the decision-making process, 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.

This is the first natural hazard risk assessment analyzing individual buildings and resident populations in Coos County. It is the most detailed and comprehensive analysis of natural hazard risk to date and provides a new, comparative perspective across hazards. In this report, we describe our assessment results, which quantify the various levels of risk that each hazard presents to Coos County communities.

The Oregon Coast, including its estuaries, and Oregon Coast Range are subject to several significant natural hazards, including riverine and coastal flooding, earthquake, tsunami, landslide, and wildfire. This region of the state is moderately developed, mostly in cities and unincorporated communities within the estuary of Coos Bay and along the Coos River. Natural hazards that pose a potential threat to development results in risk. The primary goal of the risk assessment is to inform communities of their vulnerability and risk to natural hazards and to be a resource for risk reduction actions.

1.1 Purpose

The purpose of this project is to help communities in the study area better understand their risk and increase resilience to natural hazards that are present in their community. This is accomplished by providing accurate, detailed, and up-to-date information about these hazards and by measuring 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 the methods and results for these objectives. We describe the methods for creating the building and population information used in this project. Two primary methods (Hazus-MH or 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** provides 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 county-wide hazard maps.

1.2 Study Area

The study area for this project is the entirety of Coos County, Oregon. Coos County is located in the south coast part of the state and is bordered by Curry County on the south, Douglas County on the east and south, and the Pacific Ocean on the west. The total area of Coos County is 1,626 square miles (4,211 square kilometers). A large percentage of the eastern part of Coos County is managed as industrial forest land.

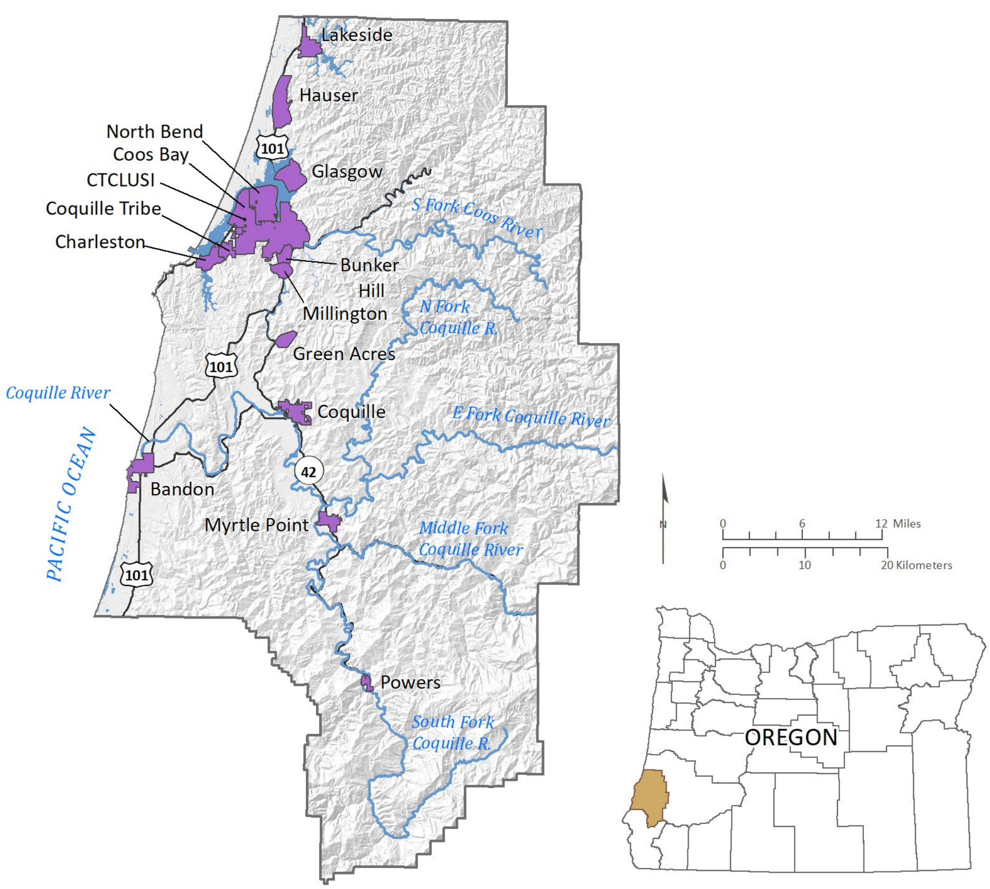
Coastal geography consists of rocky and irregular shores and dune-backed beaches, estuarine areas, and coastal lowlands. The heavily timbered interior of the county is very rugged and is comprised of portions of the Oregon Coast Range which transitions to the Klamath Mountains in the southern half of the county.

The population of Coos County is 63,043 according to the 2010 U.S. Census Bureau (2010a). The county seat is the City of Coos Bay, which is the largest city on the Oregon Coast. All the communities in the study, incorporated and unincorporated, are located near the Pacific Ocean or the Coos or Coquille rivers. The incorporated communities are Bandon, Coos Bay, Coquille, Lakeside, Myrtle Point, North Bend, and Powers (**Figure 1-1**). The unincorporated communities are Bunker Hill, Charleston, Glasgow, Green Acres, Hauser, and Millington.

The Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians ("CTCLUSI") and the Coquille Indian Tribe are two federally recognized tribes and communities within the study area. The areas that comprise the tribal lands used in the analyses are made up of several noncontiguous areas within Coos County. The cities of Coos Bay and North Bend have tribal lands adjacent to and within them (**Figure 1-1)**. It is for this reason that areas within the cities of Coos Bay and North Bend that are tribal lands are included in total counts for buildings and population for either the CTCLUSI or the Coquille Indian Tribe communities. No buildings or permanent residents are double counted in any of the individual hazard analyses. Results and analyses for either the CTCLUSI or the Coquille Indian Tribe are for all areas considered tribal lands, including those within the incorporated boundaries of the cities of Coos Bay or North Bend.

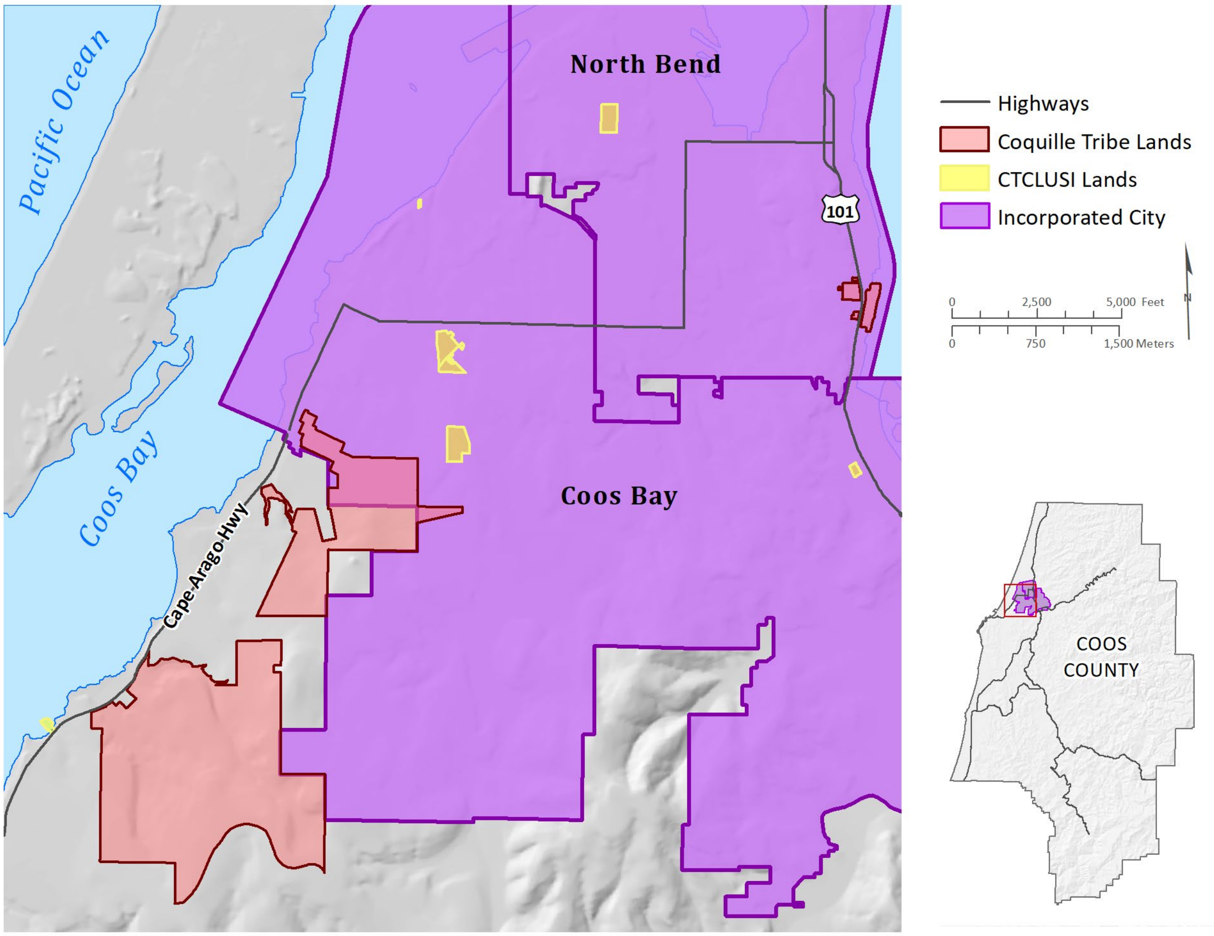
We selected these unincorporated communities on the basis of population size and density, which makes them distinct from the overall unincorporated county jurisdiction. We based the boundaries of these unincorporated communities primarily on the 2010 census block areas.

Figure 1-1. Study area: Coos County with communities in the study identified.



Note that "CTCLUSI" is the tribal community of the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians.

Figure 1-2. Cities of Coos Bay and North Bend with overlapping tribal lands.



Note that “CTCLUSI” is the tribal community of the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians.

1.3 Project Scope

For this risk assessment, we took a quantitative approach and applied it to buildings and population. 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, 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 (Hazards U.S., Multi-Hazard), 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) were associated with residential buildings.

A critical component of this risk assessment is a countywide building inventory developed from building footprint data and the Coos County tax assessor database. 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 natural hazards and the risk assessment methodologies that were applied. See **Table 1-1** for data sources.

Cascadia Subduction Zone (CSZ) Earthquake and Tsunami Risk Assessment

- Hazus-MH loss estimation from a CSZ earthquake magnitude (Mw) 9.0 event (includes liquefaction and coseismic landslides)
- Exposure to five potential CSZ tsunami scenarios

Flood Risk Assessment

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

Landslide Risk Assessment

- Exposure based on landslide susceptibility (low to very high)

Wildfire Risk Assessment

- Exposure based on Fire Risk Index (low to high)

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

Hazard	Scenario or Classes	Scale/Level of Detail	Data Source
Earthquake (includes liquefaction and coseismic landslides)	CSZ Mw 9.0	Statewide	DOGAMI (Madin and Burns, 2013)
Tsunami	Local Source: Small (300 yr) Medium (425-525 yr) Large (650-800 yr) Extra Large (1,050-1,200 yr) Extra Extra Large (1,200 yr)	Oregon Coast	DOGAMI (Priest and others, 2013)
Flood	Depth Grids: 10% (10-yr) 2% (50-yr) 1% (100-yr) 0.2% (500-yr)	Countywide	DOGAMI – derived from FEMA (2014) data, included in GIS data for this report
Landslide*	Susceptibility (Low, Moderate, High, Very High)	Statewide	DOGAMI (Burns and others, 2016)
Wildfire	Risk (Low, Moderate, High)	Regional (Western United States)	Oregon Department of Forestry (Sanborn Map Company, Inc., 2013)

CSZ Mw 9.0 is Cascadia Subduction Zone magnitude 9.0 earthquake.

*Landslide data comprise a composite dataset where the level of detail varies greatly from place to place within the state. Refer to Section 3.4.1 or the report by Burns and others (2016) for more information.

1.4 Previous Studies

One previous earthquake risk assessment has been conducted that included Coos County by DOGAMI. Wang and Clark (1999: DOGAMI Special Paper 29) ran two general level Hazus-MH earthquake analyses, a magnitude 8.5 CSZ earthquake and a 500-year probabilistic earthquake scenario, for the entire state of Oregon. In those analyses Coos County had a very high loss ratio relative to most counties in the state.

In 2010, DOGAMI updated FEMA's Flood Insurance Rate Maps (FIRM)s for Coos County. During this map update process, DOGAMI also produced a series of flood maps of the communities of Coos County that showed parcels and building exposure to the depth of flooding from a 1% annual-chance flood (Tilman, 2010: O-10-05, O-10-06, O-10-07, O-10-08, O-10-09, O-10-10, O-10-11). Exposure results were quantified by land value and real market value provided by the county assessor.

We did not compare the results of this project with the results of the previous studies because of limited time and funding and differences in methodologies.

2.0 METHODS

2.1 Hazus-MH Loss Estimation

> ***Key Terms:***
> - *Loss estimation:* Damage that occurs to a building in an earthquake or flood scenario, as modeled with Hazus-MH methodology.
> - *Loss ratio:* Percentage of estimated loss relative to the total value.

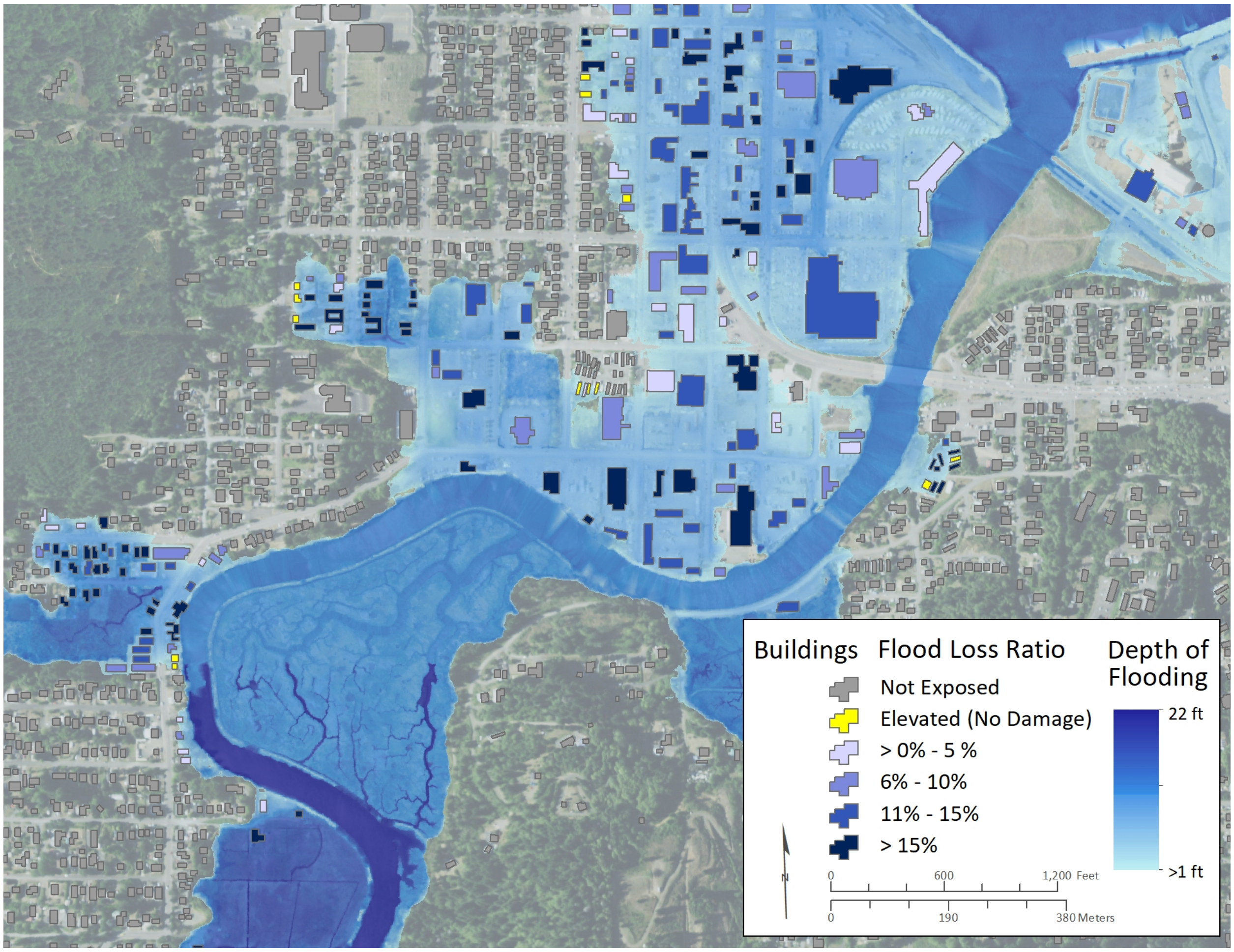
"Hazus provides nationally applicable, standardized methodologies for estimating potential wind, flood, and earthquake losses on a regional basis. Hazus can be used to conduct loss estimation for floods and earthquakes [...]. The multi-hazard Hazus is intended for use by local, state, and regional officials 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" (FEMA, 2012a, p. 1-1).

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 DOGAMI then aggregates to the community level to report loss ratios. Cost used in general building stock mode is associated with rebuilding using new materials, also known as replacement cost. 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-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. Estimates of loss are made by intersecting building locations with natural hazard layers and applying damage functions based on the hazard severity and building characteristics. **Figure 2-1** illustrates the range of building loss estimates from Hazus-MH flood analysis.

DOGAMI used Hazus-MH version 3.0 (FEMA, 2015), 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 the City of Coos Bay.



2.2 Exposure

Exposure methodology is calculating the buildings and population that are within a natural hazard zone. This is an alternative for natural hazards that do not have readily available damage functions and, therefore, loss estimation is not possible. 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 loss estimate because the loss ratio is unknown. For example, **Figure 2-2** shows buildings that are exposed to different tsunami scenarios.

> ***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 tsunami, landslide, and wildfire to quantify buildings and residents at risk. For comparison with loss estimates, exposure is also used for the 1% annual chance flood.

Figure 2-2. Tsunami inundation scenarios and building exposure example in the community of Charleston.

Note that larger scenarios include the buildings of the smaller scenarios.

2.3 Building Inventory

A key piece of the risk assessment is the countywide building inventory. This inventory consists of all buildings larger than 500 square feet (152 square meters), as determined from existing building footprints or tax assessor data. **Figure 2-3** shows an example of building inventory occupancy types used in the Hazus-MH and exposure analyses in Coos County. See also **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, 2012b, c) 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 **C.2.2**.

Figure 2-3. Building occupancy types, portion of City of Bandon.

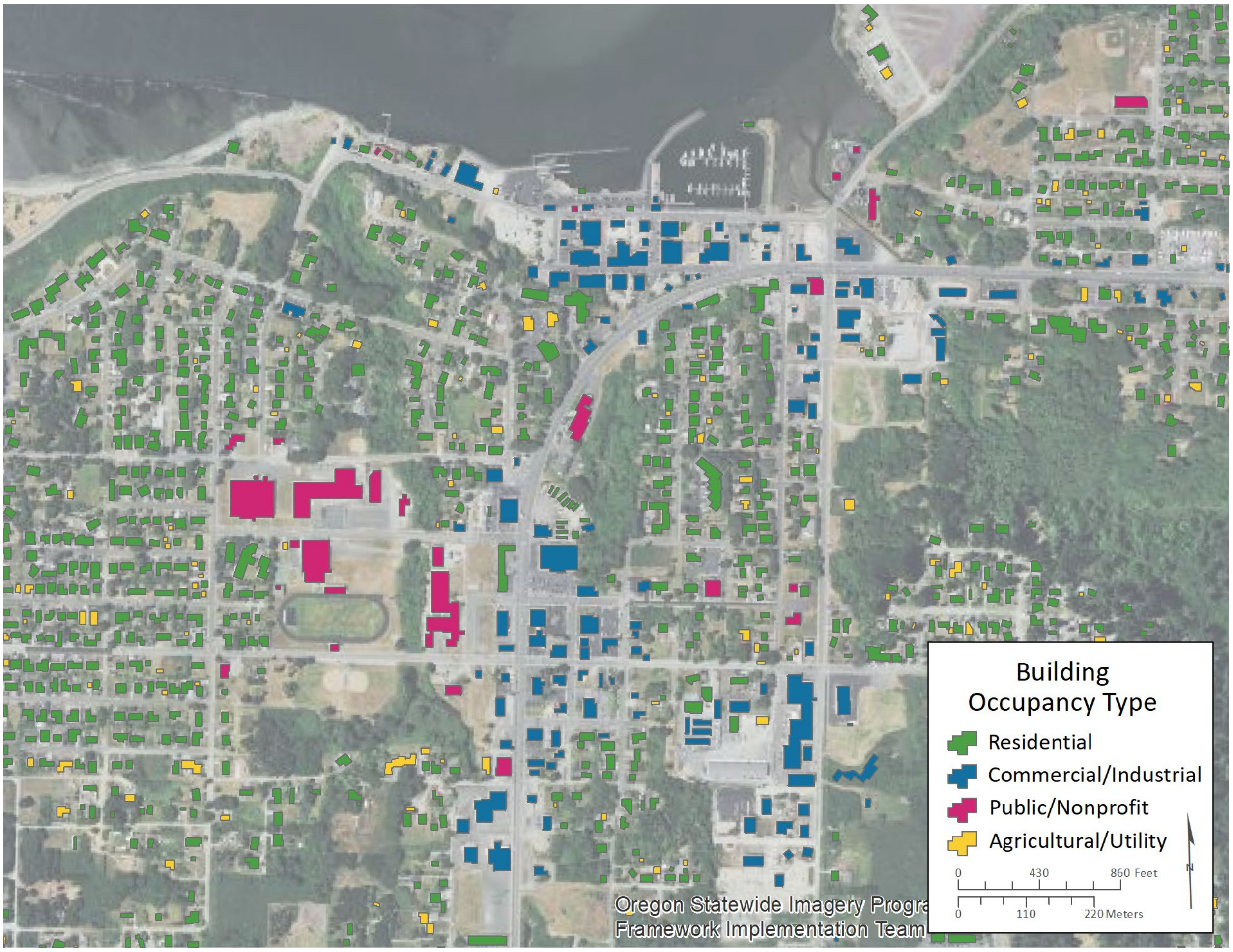


Table 2-1 shows the distribution of building count and value within the UDF database for Coos County. A table detailing the occupancy class distribution by community is included in **Appendix B: Detailed Risk Assessment Tables**.

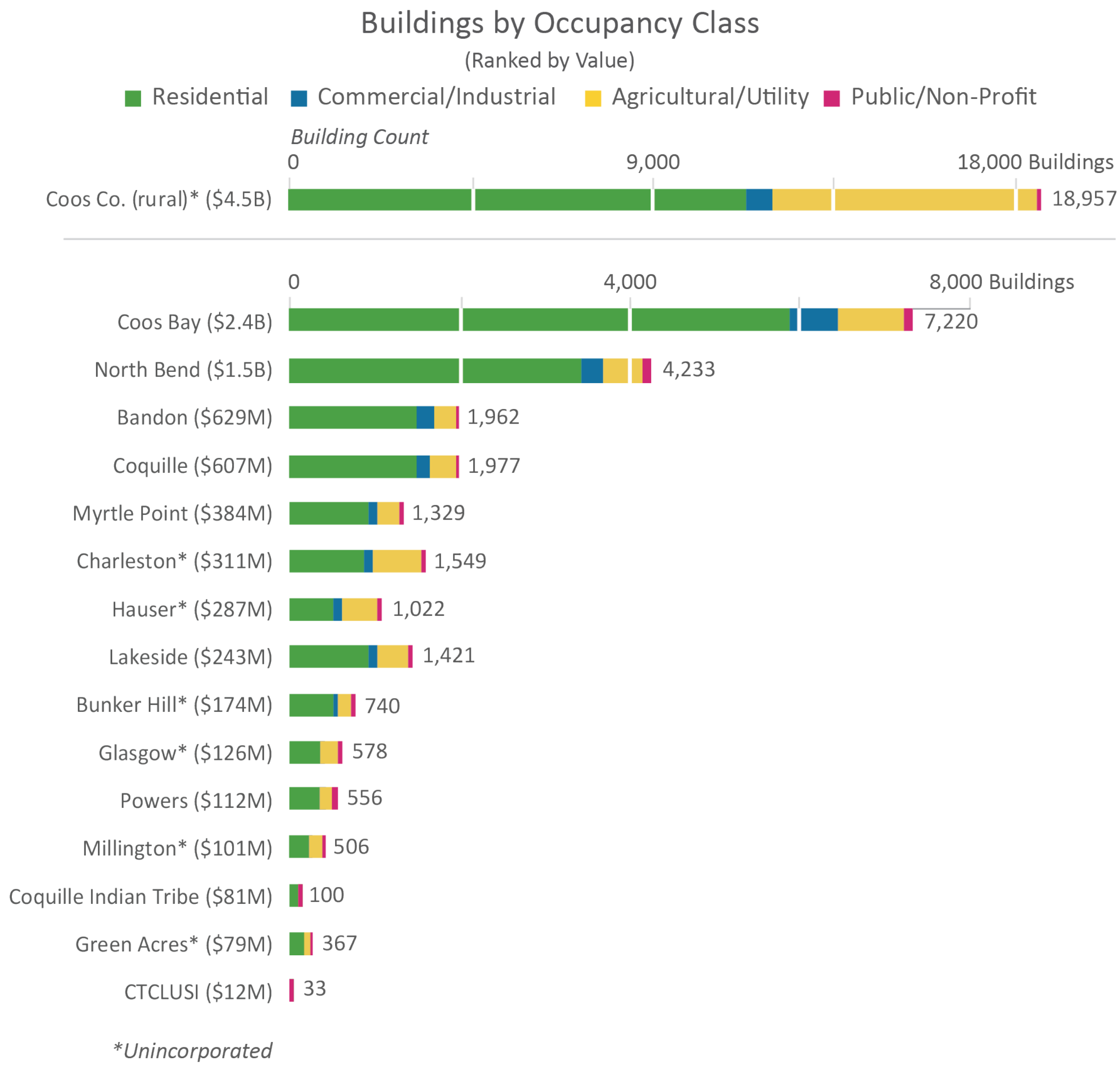
Table 2-1. Coos County building inventory.

Community	Total Number of Buildings	Percentage of Buildings of Coos County	Total Estimated Building Value ($)	Percentage of Building Value of Coos County
Unincorp. County (rural)	18,957	45%	4,476,885,000	39%
Bunker Hill	740	1.7%	173,872,000	1.5%
Charleston	1,549	3.6%	310,927,000	2.7%
Glasgow	578	1.4%	125,629,000	1.1%
Green Acres	367	0.9%	79,090,000	0.7%
Hauser	1,022	2.4%	286,877,000	2.5%
Millington	506	1.2%	100,571,000	0.9%
Total Unincorp. County	23,719	56%	5,553,851,000	48%
Bandon	1,962	4.6%	629,445,000	5.5%
CTCLUSI	33	0.1%	12,470,000	0.1%
Coos Bay	7,220	17%	2,420,579,000	21%
Coquille	1,977	4.6%	606,670,000	5.3%
Coquille Indian Tribe	100	0.2%	80,721,000	0.7%
Lakeside	1,421	3.3%	242,768,000	2.1%
Myrtle Point	1,329	3.1%	383,743,000	3.3%
North Bend	4,233	9.9%	1,494,790,000	13%
Powers	556	1.3%	111,516,000	1.0%
Total Coos County	42,550	100%	11,536,553,000	100%

The building inventory was developed from several data sources and was refined for use in loss estimation and exposure analyses. A database of building footprints for a significant portion of Coos County was already available from a previous DOGAMI project (Priest and others, 2013). Building footprints in the database were digitized from high-resolution lidar collected in 2009 (South Coast project, Oregon Lidar Consortium; see http://www.oregongeology.org/lidar/collectinglidar.htm). The building footprints provide a spatial location and 2D representation of a structure. The total number of buildings within the study area was 42,550.

Coos County supplied assessor data that we formatted 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, was obtained from the county assessor and was 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 assessment for both loss estimation and exposure analysis. **Figure 2-4** illustrates the variation of building value and occupancy across the communities of Coos County.

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



Note that "Coos Co. (rural)" excludes incorporated communities, tribal lands, Bunker Hill, Charleston, Glasgow, Green Acres, Hauser, and Millington.

We attributed critical facilities in the UDF database so that 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 attributed include hospitals, schools, fire stations, police stations, emergency operations, and military facilities. In addition to these standard building types, we considered other building types based on local input or special considerations that are specific to the study area that would be essential during a natural hazard event, such as public works and water treatment facilities. Critical facilities are important to note because these facilities play a crucial role in emergency response efforts. 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. **Table 2-2** shows the critical facilities on a community basis. Critical facilities are listed for each community (see **Community Risk Profiles**).

Table 2-2. Coos County critical facilities inventory.

	Hospital & Clinic		School		Police/Fire		Emergency Services		Military		Other*		Total	
Community	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)
(all dollar amounts in thousands)														
Unincorp. County (rural)	0	0	0	0	14	17,574	0	0	0	0	7	49,986	21	67,560
Bunker Hill	0	0	1	9,335	0	0	0	0	0	0	0	0	1	9,335
Charleston	0	0	0	0	1	783	0	0	1	3,551	0	0	2	4,333
Glasgow	0	0	0	0	1	1,754	0	0	0	0	0	0	1	1,754
Green Acres	0	0	0	0	1	815	0	0	0	0	0	0	1	815
Hauser	0	0	1	17,261	1	1,886	0	0	0	0	0	0	2	19,147
Millington	0	0	0	0	1	1,099	0	0	0	0	0	0	1	1,099
Total Unincorp. County	0	0	2	26,596	19	23,911	0	0	1	3,551	7	49,986	29	104,043
Bandon	1	7,414	3	38,553	2	3,813	0	0	0	0	2	1,024	8	50,804
CTCLUSI	0	0	0	0	0	0	0	0	0	0	1	3,164	1	3,164
Coos Bay	1	32,309	8	104,239	5	16,535	0	0	2	4,846	6	23,977	22	181,906
Coquille	1	7,858	3	44,644	2	3,300	1	2,647	0	0	1	6,424	8	64,872
Coquille Indian Tribe	0	0	0	0	0	0	0	0	0	0	1	3,315	1	3,315
Lakeside	0	0	0	0	1	1,628	0	0	0	0	2	2,476	3	4,103
Myrtle Point	0	0	2	29,743	1	1,882	0	0	0	0	3	3,650	6	35,275
North Bend	0	0	4	75,399	5	9,657	0	0	1	8,782	2	28,906	12	122,745
Powers	0	0	2	9,355	2	1,782	0	0	0	0	0	0	4	11,136
Total Coos County	3	47,581	24	328,529	37	62,508	1	2,647	4	17,179	25	122,922	94	581,363

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

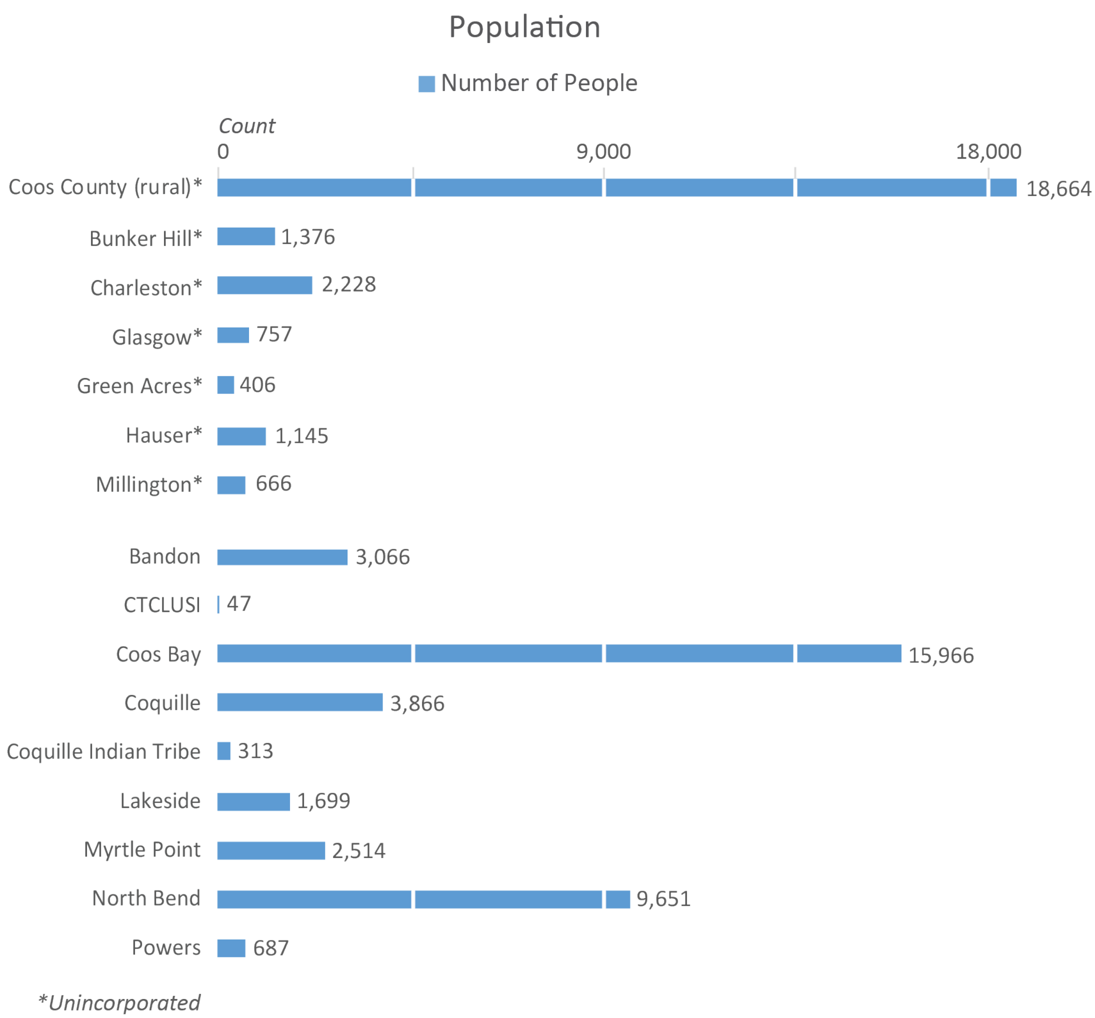
*Category includes buildings that are not traditional (emergency response) critical facilities but considered critical during an emergency based on input from local stakeholders (e.g. water treatment facilities or airports).

2.4 Population

Within the UDF database, the population of permanent residents reported per census block was distributed among residential buildings and pro-rated based on square footage (**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 coastal communities make up some of the total residential building stock. From information reported in the 2010 U.S. Census, American FactFinder regarding vacation rentals within the county and coastal communities, it is estimated that approximately 4% of residential buildings are vacation rentals in Coos County (U. S. Census Bureau, 2010b).

From the census data, DOGAMI analyzed the 63,043 residents within the study area who could be affected by a natural hazard scenario. For each natural hazard, with the exception of the CSZ Mw 9.0 earthquake scenario, a simple exposure analysis was used to find the number of potentially displaced residents within a hazard zone. For the CSZ Mw 9.0 earthquake scenario the potentially displaced residents were based on a combination of residents exposed to tsunami and those in buildings estimated to be significantly damaged by the earthquake.

Figure 2-5. Population by Coos County community.



3.0 ASSESSMENT OVERVIEW AND RESULTS

This risk assessment considers five natural hazards (earthquake, tsunami, flood, landslide, and wildfire) that pose a risk to Coos County. The assessment describes both localized vulnerabilities and the widespread challenges that impact all communities. 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 use the results to update plans as part of the work toward becoming more resilient to future disasters.

3.1 Hazards and Countywide Results

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

3.2 Cascadia Subduction Zone Earthquake

An earthquake is a sudden movement of rock on each side of a fault in the earth's crust that abruptly releases strain accumulated over a long period of time. The movement along the fault produces waves of strong 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).

Just off Oregon's coast, the Juan de Fuca tectonic plate slides under the North American plate. This area of interaction between the two plates is known as the Cascadia subduction zone (CSZ). The pressure and friction created by this convergent motion builds potential energy at the plate boundary until the overriding plate suddenly slips, releasing energy that manifests as strong shaking spread over a wide area. Earthquakes as large as Mw 8-9 occur along the CSZ on average every 230-540 years (Goldfinger and others, 2012, 2017).

> **Understanding the connection between CSZ earthquakes and tsunamis**
>
> During a large CSZ earthquake, the sudden uplift of the North American plate along the CSZ margin is likely to displace enough water to produce a tsunami that will have an impact along the Oregon coast. The proximity of the CSZ to the coastal areas of Oregon make them especially threatened by earthquakes and tsunamis (Madin and Burns, 2013).
>
> Although we discuss CSZ earthquakes and tsunamis as separate hazards in this report, these hazards are closely associated. Their widespread effects and almost simultaneous occurrence present a challenge to planners.

Two earthquake-induced 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, liquefaction, and landslide factors.

Another risk factor associated with the CSZ event is coseismic subsidence. According to Peterson and others (1997), a CSZ earthquake can result in coastal subsidence of up to 10 feet (1–3 meters). Low-lying developed areas near beaches and estuaries are most susceptible to this long-term hazard. A significant and permanent lowering of coastal terrain would expose buildings and infrastructure to tidal inundation in low-lying coastal areas that were formerly above high tide (Madin and Burns, 2013). Analysis of this potentially significant hazard is beyond the scope of this project.

3.2.1 Data sources

Most of the hazard data inputs for our Hazus-MH earthquake analysis were originally created for the 2012 Oregon Resilience Plan (ORP) for Cascadia Subduction Zone Earthquakes (Madin and Burns, 2013). In conducting their vulnerability assessment, the ORP seismic workgroup chose an earthquake scenario of Mw 9.0 off the coast of Oregon along the subduction zone.

Hazus-MH offers two methods for estimating loss from earthquake, probabilistic and deterministic (FEMA, 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, which in this case is the CSZ Mw 9.0 event. We selected the deterministic scenario method because the CSZ event is the most likely large earthquake to impact this area (Goldfinger and others, 2012, 2017). We used this method along with the UDF database so that loss estimates could be calculated on a building-by-building basis.

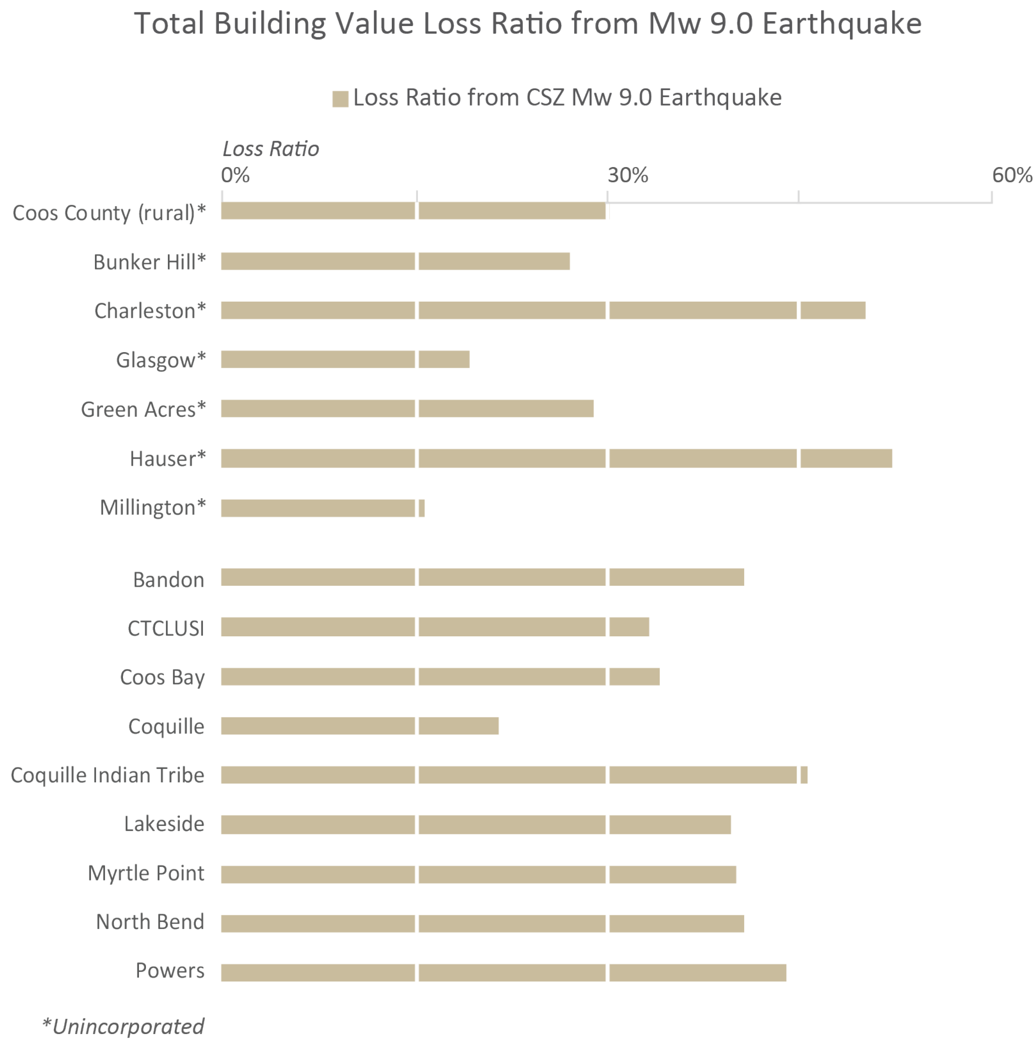
The following hazard layers used for our loss estimation are derived from work conducted by Madin and Burns (2013): National Earthquake Hazard Reduction Program (NEHRP) soil classification, peak ground acceleration (PGA), peak ground velocity (PGV), spectral acceleration at 1.0 second period and 0.3 second period (SA10 and SA03), and liquefaction susceptibility. We also used landslide susceptibility data derived from the work of Burns and others (2016). The liquefaction and landslide susceptibility layers together with PGA were used by the Hazus-MH tool to calculate probability and magnitude of permanent ground deformation.

While the loss estimates and exposure results of the earthquake and tsunami presented in this report both describe a single CSZ scenario, the hazard data used in these analyses are the product of different sources that equates to a slightly different event magnitude. The Medium-sized tsunami scenario was modeled with a CSZ Mw 8.9 earthquake (Priest and others, 2013). The earthquake bedrock ground motions from a Mw 9.0 CSZ earthquake were produced by Arthur Frankel of the USGS (personal communication, 2012) and then modified to include site class soil factors (Madin and Burns, 2013). While the tsunami scenario is associated with a specific amount of slip needed to generate a tsunami, the earthquake model is independent of slip with the earthquake energy distributed over the rupture zone. Irrespective of these differences, the two scenarios represent similar levels of severity and was a determining factor for their use in this report.

3.2.2 Countywide results

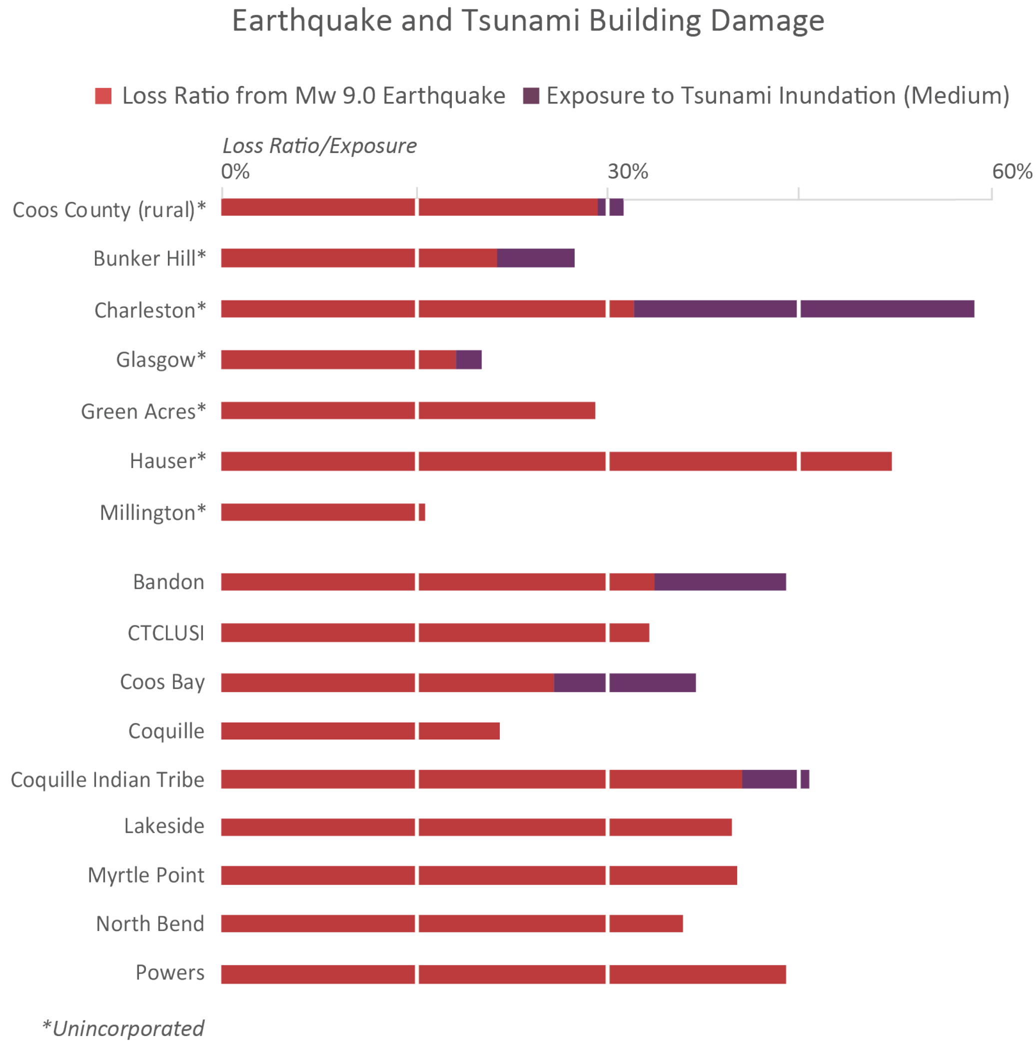
The CSZ event will produce severe ground shaking and ground failure, as well as a large and swift moving tsunami (Madin and Burns, 2013). Due to the nearly simultaneous timing of these two natural hazards, we have parsed loss estimate results to avoid double counting. That is, buildings within the (Medium-sized) tsunami zone are reported on the basis of exposure only, while buildings outside the tsunami zone are reported on the basis of Hazus-MH earthquake loss estimates. Based on recent tsunami events in Japan, Sumatra, and Chile, we assumed that tsunami losses to buildings are complete within the inundation area (Bauer and others, 2020). Tsunami results are provided in the subsequent tsunami section. **Figure 3-1** shows the loss estimates by community for Coos County from a CSZ Mw 9.0 event without the effects from tsunami.

Figure 3-1. Earthquake loss ratio by Coos County community.



Because an earthquake can affect a wide area, it is unlike other hazards in this report—every building in Coos County, to some degree, will be shaken by a CSZ Mw 9.0 earthquake (see Appendix E, **Plate 3**). Hazus-MH loss estimates (see **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 reported for earthquake are for buildings *outside* the (Medium-sized) tsunami inundation zone. **Figure 3-2** shows loss ratios from the CSZ event (both tsunami and earthquake) for the communities of Coos County.

Figure 3-2. CSZ Mw 9.0 event loss ratio in Coos County, for both earthquake and tsunami inundation.



Note: Due to the nearly simultaneous timing of a Cascadia subduction zone earthquake and tsunami, loss estimate results have been parsed to avoid double counting. That is, buildings within the (Medium-sized) tsunami zone are reported on the basis of tsunami exposure only, while buildings outside the tsunami zone are reported on the basis of Hazus-MH earthquake loss estimates. Tsunami losses to buildings are assumed to be complete within the inundation area.

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 in each community is based on an aggregation of probabilities and does not represent individual buildings (FEMA, 2012b).

Critical facilities were considered 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 number reported for nonfunctioning critical facilities is only for buildings outside the (Medium-sized) tsunami inundation zone.

The number of potentially displaced residents from the CSZ Mw 9.0 earthquake is based on the number of red-tagged and 90% of yellow-tagged residences that were determined in the Hazus-MH earthquake analysis results (FEMA, 2012b). The number reported for potentially displaced residents is only for residences outside the (Medium-sized) tsunami inundation zone. Displaced residents due to a tsunami are discussed in the CSZ tsunami hazard section.

Coos countywide CSZ Mw 9.0 earthquake results (not including buildings or population within the Medium-sized tsunami zone):

- Number of red-tagged buildings: 9,689
- Number of yellow-tagged buildings: 3,659
- Loss estimate: $3,516,968,000
- Loss ratio: 30%
- Nonfunctioning critical facilities: 70
- Potentially displaced population: 11,999

The results indicate that Coos County would incur significant losses (30%) due to a CSZ Mw 9.0 earthquake. These results are strongly influenced by the overall average age of the building stock, which is an important factor in earthquake vulnerability. The first seismic building codes were implemented in Oregon in the 1970s (Judson, 2012). By the 1990's modern seismic building codes were being enforced; more than 80% of Coos County's buildings were built before this time. Communities within Coos County that are composed of older buildings are expected to experience more damage from earthquake than newer ones.

Moderate to high susceptibility liquefaction zones exist throughout the county and in the densest populated areas, which increases the risk from earthquake. Liquefaction could also present difficulties for evacuation from the subsequent tsunami, since liquefaction areas correspond closely with the most likely tsunami inundation zone (Priest and others, 2015). This factor, as well as the overall age of the building stock, along with the proximity of Coos County to the CSZ, results in high levels of damage.

While damage caused by coseismic landslides was not specifically looked at in this report, it likely contributes a significant amount of the estimated damage from the earthquake hazard in Coos County. Landslide exposure results show that 14% of buildings in Coos County are within a very high or high susceptibility zone. This indicates that a similar percentage of the loss estimate calculated in this study may be due to coseismic landslide rather than earthquake shaking alone.

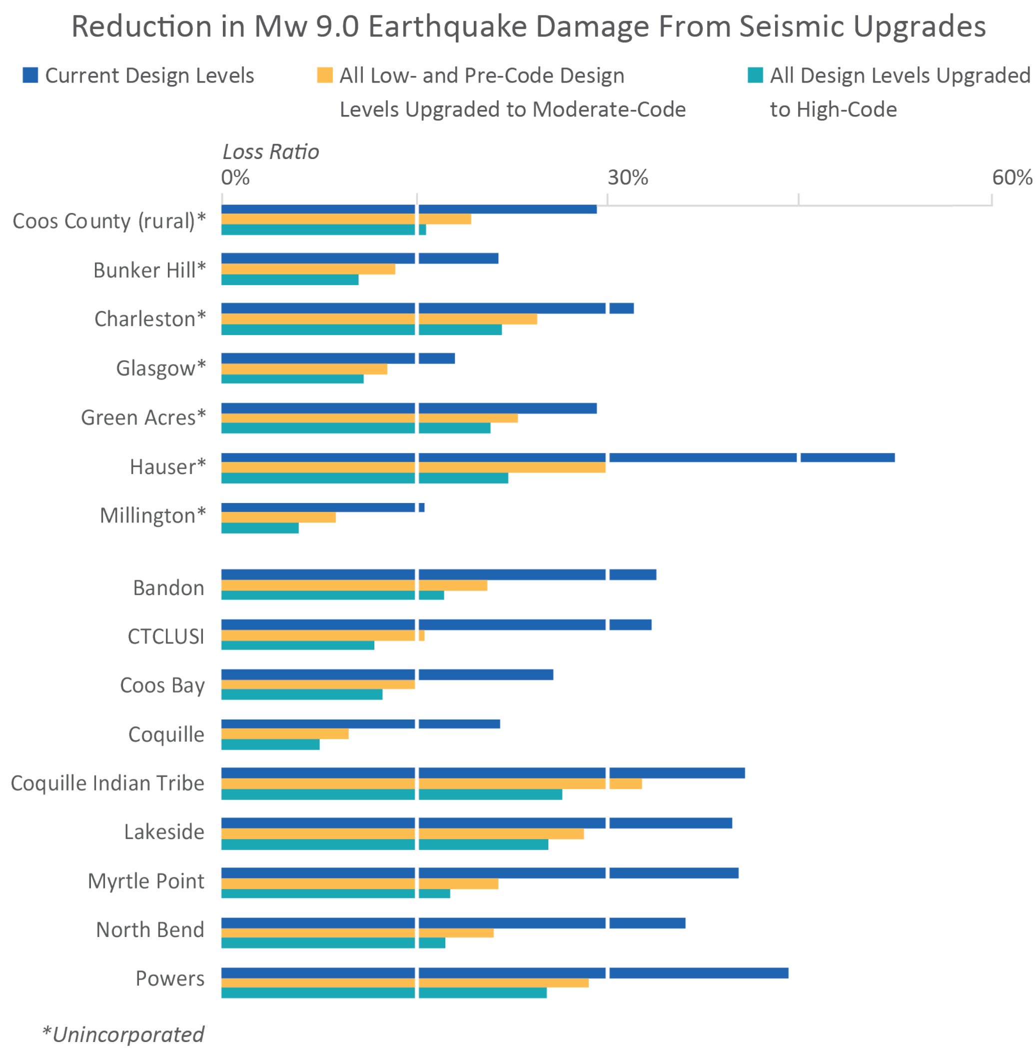
If buildings could be seismically retrofitted to moderate or high code standards, the impact of this event would be greatly reduced. In a simulation by DOGAMI, Hazus-MH earthquake analysis shows that loss ratios drop from 30% to 19%, when all buildings are upgraded to at least moderate code level. While retrofits can decrease earthquake vulnerability, for areas of high landslide or liquefaction, additional geotechnical mitigation may be necessary to have an effect on losses. **Figure 3-3** illustrates the reduction in loss estimates from a CSZ Mw 9.0 earthquake through two simulations where all buildings are upgraded to at least moderate code standards and then all buildings to high code standards.

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 Error! Reference source not found. for

Communities that are mostly within the tsunami hazard zone may need additional tsunami mitigation to reduce vulnerability.

Figure 3-3. CSZ Mw 9.0 earthquake loss ratio in Coos County, with simulated seismic building code upgrades.



Note: Loss ratios shown are for buildings outside the tsunami zone only and are reported on the basis of Hazus-MH earthquake loss estimates. Tsunami losses to buildings are assumed to be complete within the inundation area.

3.2.3 Areas of vulnerability or risk

We identified locations within the study area that are comparatively more vulnerable or at greater risk to CSZ Mw 9.0 earthquake hazard:

- Very high liquefaction soils are found throughout most of the populated estuarine portions of Coos County, which include the communities of Bandon, Bunker Hill, Charleston, Coos Bay, Millington, and North Bend.
- Building inventory for the cities of Coquille and Myrtle Point are relatively older than other communities in Coos County, which implies lower seismic building design codes and are more

vulnerable to damage during an earthquake. Myrtle Point's estimated loss ratio from a CSZ earthquake alone is 40%. Building code upgrade simulations show that Myrtle Point would benefit the most from seismic retrofits, loss estimates go from 40% to 22% when pre- and low-code buildings are upgraded to moderate code.

- Because of the liquefaction and landslides, communities will likely be "islands" disconnected from other communities by severed transportation routes. With losses up to 52%, it is very important for a community to be able to respond to emergencies with its own resources.
- Nearly all of the critical facilities (87%) in the communities of Coos County could be nonfunctioning due to a CSZ earthquake.

3.3 Cascadia Subduction Zone Tsunami

Tsunamis are a natural hazard threat that exists for many of the communities along the Oregon coast. The tsunami addressed in this report is caused by the abrupt movement of the seafloor accompanying an earthquake. In a megathrust earthquake, like the CSZ event, the sudden uplift of seafloor is converted into wave energy (Priest and others, 2013). While not included in this report, other important processes that may trigger a tsunami include landslides that start below the water surface and landslides that enter a deep body of water from above the water surface (Witter and others, 2011). Tsunamis can travel thousands of miles across oceans, so that a particular coastal area may be susceptible to two different types of tsunami hazard (Priest and others, 2013):

- Tsunamis caused by distant sources and that travel across the ocean basin, and
- Tsunamis caused by local sources such as the CSZ and that occur immediately adjacent to a coast.

During a CSZ earthquake, the sudden uplift of a portion of the North American plate along the CSZ margin is likely to produce a tsunami that will have an impact along the Oregon coast. This locally generated tsunami poses a significant risk to low-lying coastal and estuarine developed areas in Coos County due to the limited warning time of an approaching tsunami. Tsunami inundation zone maps created by DOGAMI can serve as a tool for planning and mitigation efforts. We chose the "Medium" tsunami scenario shown on these maps to describe the level of risk to communities, because, according to Priest and others (2013), the Medium scenario tsunami are the most likely to occur from a CSZ event.

3.3.1 Data sources

The tsunami hazard data used in this report are from Priest and others (2013). Priest and others modeled areas of expected inundation from five local (CSZ) tsunami scenarios and two distant source scenarios and created a series of inundation maps. The distant source tsunami scenarios were not used in this report. The local tsunami scenarios used in this report for exposure analysis were CSZ "t-shirt" sizes of Small (Sm), Medium (M), Large (L), Extra Large (XL), and Extra-Extra Large (XXL).

The slip deficit time intervals for each local source tsunami scenario is as follows (Priest and others, 2013):

- XXL 1,200 years
- XL 1,050–1,200 years
- L 650–800 years
- M 425–525 years
- Sm 300 years

The estimated recurrence rates are from Witter and others (2013) and are:

- XXL = unknown (not seen in 10,000-year record)
- XL = <1/10,000 = <0.01%
- L = 1/3,333 = 0.03%
- M = 1/1,000 = 0.1%
- Sm = 1/2,000 = 0.05%

For this risk assessment, DOGAMI compared the locations of buildings and critical facilities to the geographic extent of the local source tsunami inundation zones to assess the exposure for each community. The exposure results shown below are for the Medium scenario only (see **Table B-3** for all scenarios). The total dollar value of exposed buildings was summed for the study area and is reported below. We were also able to estimate the number of people at risk to tsunami hazard. See **Appendix B: Detailed Risk Assessment Tables** for cumulative multi-scenario analysis results.

3.3.2 Countywide results

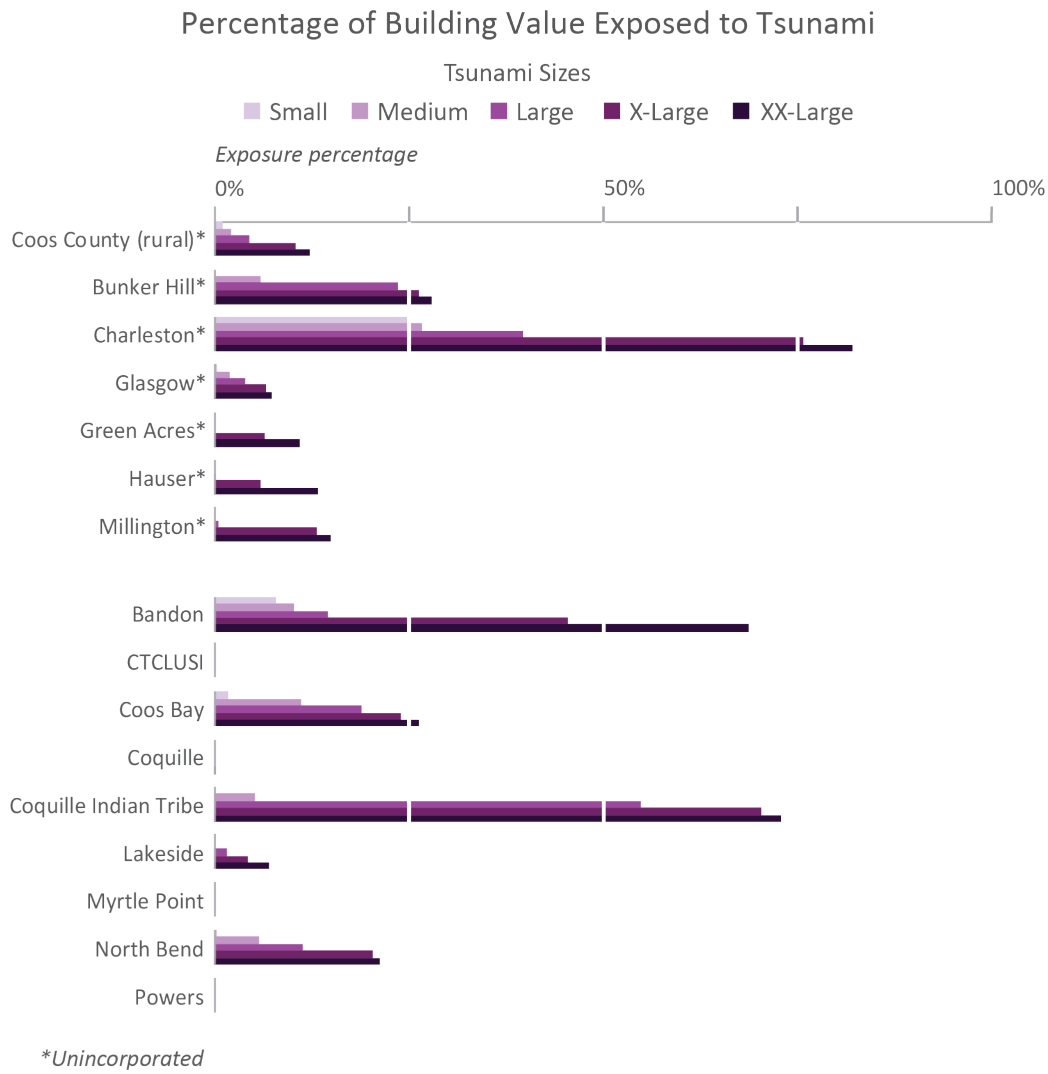
Most of the inhabited areas in Coos County are relatively near the Pacific Ocean and nearly all communities of the study area would be affected by the largest of the DOGAMI calculated tsunami scenarios. However, the Medium-sized tsunami was chosen as the primary scenario to describe the level of risk because that category represents the most likely to occur. Coos County's communities built along the open coast are at a higher risk to tsunami hazard than communities along the Coos River and Coquille River estuaries.

Coos countywide CSZ tsunami exposure (Medium tsunami scenario):

- Number of buildings exposed: 1,286
- Exposure value: $611,536,000
- Percentage of exposure value: 5.3%
- Critical facilities exposed: 13
- Potentially displaced population: 1,274

Many areas of development along Coos Bay and near the mouth of the Coquille River will be inundated by a tsunami. These areas could see exposure to the Medium-sized scenario as high as 25%. More than 1,200 permanent residents could be impacted from a CSZ tsunami event and require medical and shelter services. Because there is high risk of tsunami along the entire coast and estuarine areas of Coos County, awareness is important for the emergency response immediately after the event and for future planning and mitigation efforts in these areas (**Figure 3-4**).

Figure 3-4. Tsunami inundation exposure by Coos County community.



3.3.3 Areas of vulnerability or risk

We identified locations within the study area that are comparatively more vulnerable or at greater risk to CSZ Mw 9.0 tsunami hazard:

- The City of Bandon is expected to be impacted by a tsunami originating from a CSZ event. Exposure percentage is as high as 10% for the Medium tsunami scenario.
- Developments all along Coos Bay are exposed to tsunami hazard, with Charleston being the most exposed to this hazard.
- The developed area around the Highway 101 bridge near Lakeside is expected to be inundated by a tsunami.

3.4 Flooding

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 frequently occurring natural hazard in Coos County, and have the potential to create public health hazards, public safety concerns, close and damage major highways, destroy railways, damage structures, and cause major economic disruption. Flood issues like flash flooding, ice jams, post-wildfire floods, and dam safety were not looked at in this report.

A typical method for determining flood risk is to identify the probability of flooding and the impacts 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, a greater understanding of flood hazard, and longer periods of record for the stream or water body in question.

The major rivers within the county are the Coos, Coquille, East Fork Coquille, Middle Fork Coquille, North Fork Coquille, South Fork Coos, and South Fork Coquille rivers. All the listed rivers are subject to flooding and can cause damage to buildings within the floodplain. In addition to riverine flooding, there are lakes within the coastal margin that are subject to flooding, including North Tenmile Lake, Saunders Lake, and Tenmile Lake. Other flooding effects for low-lying coastal developments are due to coastal flooding from the Pacific Ocean and the Coos River and Coquille River estuaries.

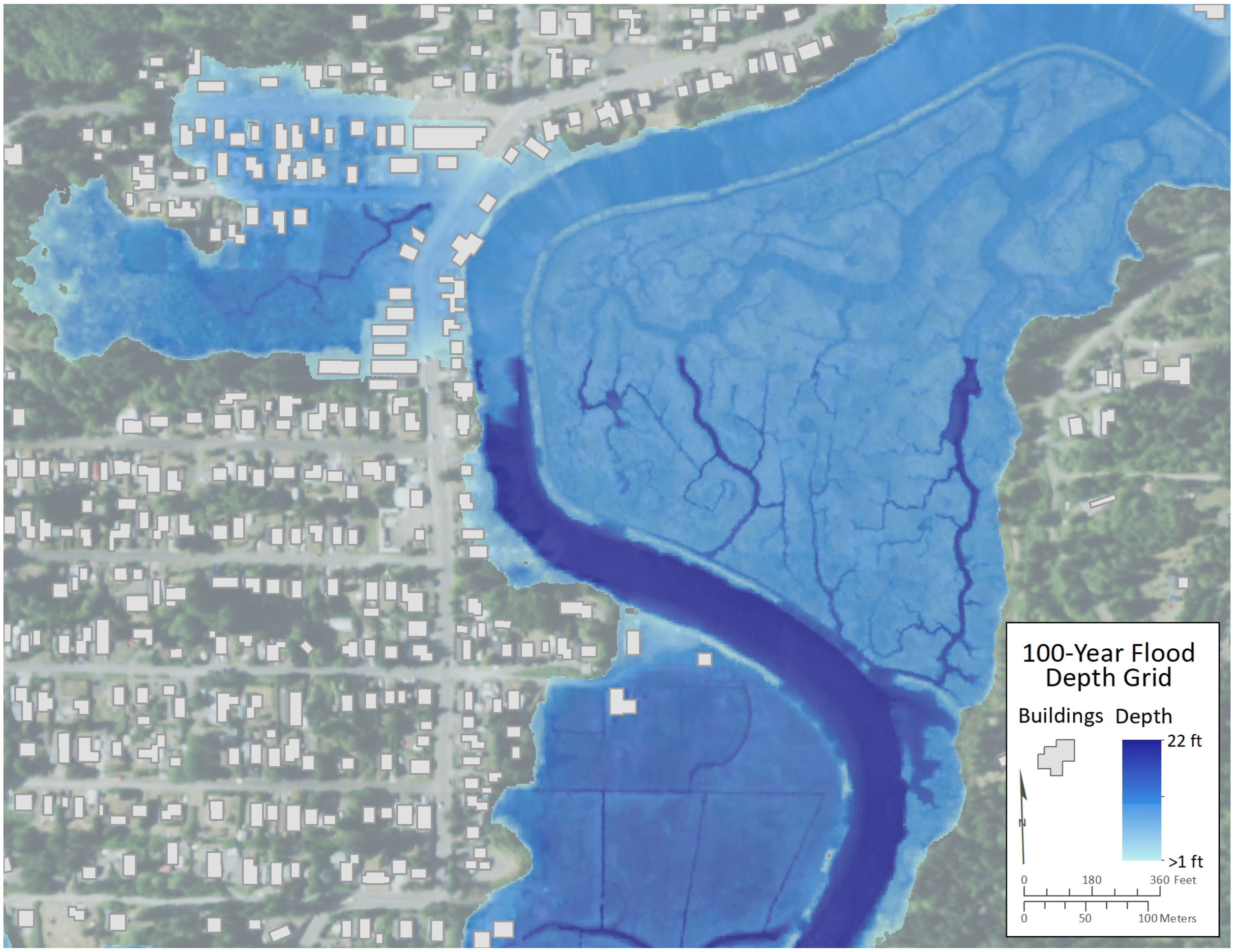
The impacts of flooding are determined by adverse effects to human activities within the natural and built environment. Through strategies such as flood hazard mitigation these adverse impacts can be reduced. Examples of common mitigating activities are to elevate structures above the expected level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

3.4.1 Data sources

The Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) for Coos County were updated in 2012 (FEMA, 2014) and included a recently completed study of coastal flooding (Allan and others, 2012); these were the primary data sources for the flood risk assessment in this report. These studies were adopted as effective flood maps for the communities of Coos County in 2014. Further information regarding the National Flood Insurance Program (NFIP) can be found on the FEMA website: https://www.fema.gov/flood-insurance. These were the only flood data sources that DOGAMI used in the analysis, but flooding does occur in areas outside of the detailed mapped areas.

Depth grids, developed by DOGAMI in 2018 and based on the effective map data, were used in this risk assessment to determine the level to which buildings are impacted by flooding. Depth grids are raster GIS datasets where each digital pixel value represents the depth of flooding at that location within the flood zone **(Figure 3-5)**. Though considered draft at the time of this analysis, the depth grid data are the best available flood hazard data. Depth grids for four flooding scenarios (10-, 50-, 100-, and 500-year) were used for loss estimations and, for comparative purposes, exposure analysis. The 100-year depth grid included coastal flood modeling that was not available for the other scenarios.

Figure 3-5. Flood depth grid example, portion of the City of Coos Bay.



Building loss estimates are determined in Hazus-MH by overlaying building data over 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 Coos 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 500 feet (152 meters) 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 properly 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, please see the **Exposure analysis** section below.

3.4.2 Countywide results

For this risk assessment, we imported the countywide UDF data and depth grids into Hazus-MH and ran a flood analysis for each of the 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 5**). 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 (FEMA, 2013). See **Table B-4** for multi-scenario cumulative results.

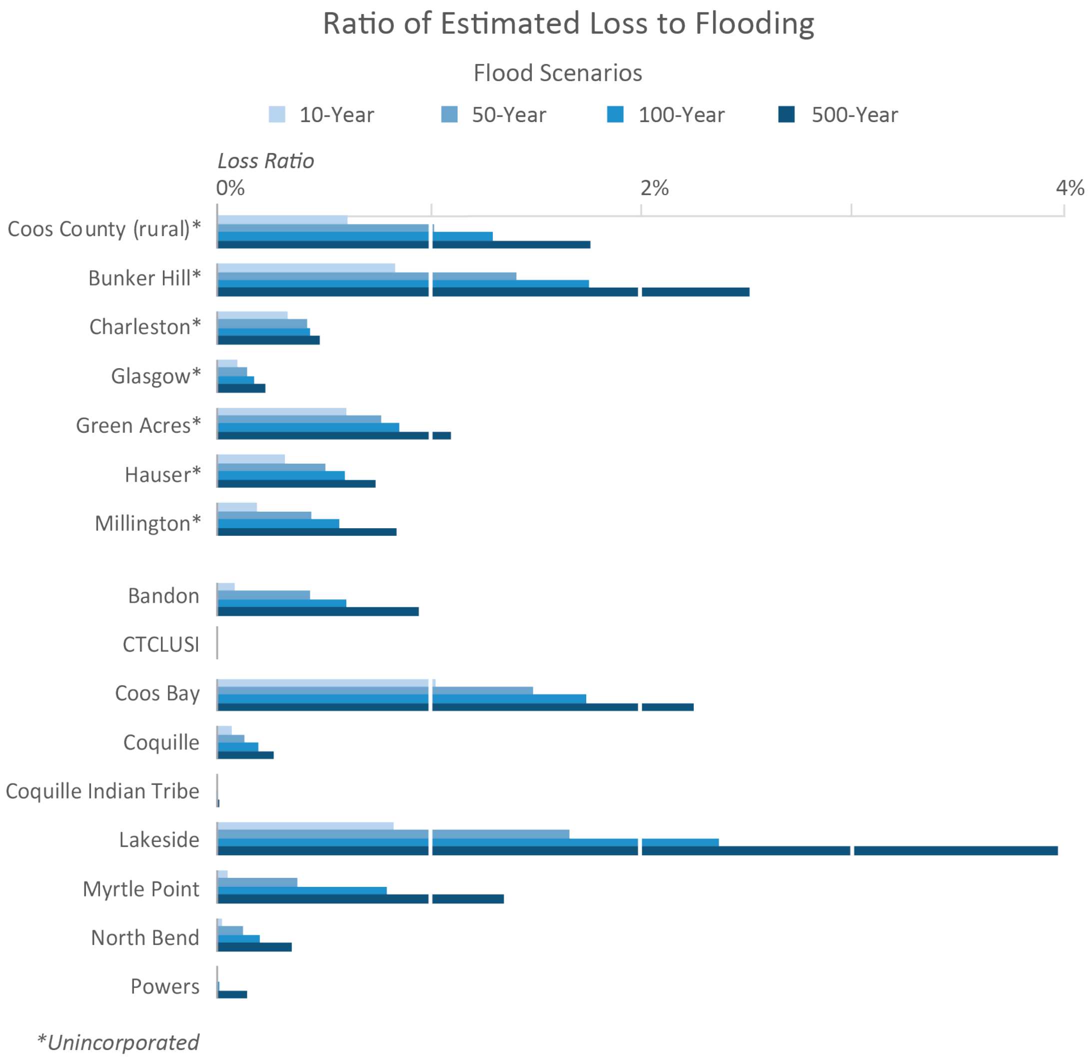
Coos countywide 100-year flood losses:

- Number of buildings damaged: 1,870
- Loss estimate: $125,349,000
- Loss ratio: 1.1%
- Damaged critical facilities: 13
- Potentially displaced population: 2,116

3.4.3 Hazus-MH analysis

The Hazus-MH loss estimate for the 100-year flood scenario for the entire county is approximately $125 million. Flooding in riverine and estuarine areas has the potential to significantly impact communities in Coos County. Most of the built environment along Coos Bay is potentially at risk to flooding hazard. A large concentration of buildings at risk to flooding is in the downtown portion of the City of Coos Bay. Flooding from coastal sources is limited to a few areas, like the low-laying coastal area south of Bandon (**Figure 3-6**). 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.

Figure 3-6. Ratio of flood loss estimates by Coos County community.



Note: In addition to the four riverine flood scenarios, coastal flooding information is available for the 100-year flood scenario for areas near of the mouth of the Coos and Coquille rivers.

3.4.4 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. We counted 2,055 of Coos County's buildings to be within designated flood zones, which was about 5% of the county's buildings. Of these buildings, 185 buildings were elevated above the height of the 100-year flood. Elevating more of these exposed structures would further reduce the potential damages sustained from flooding. This evaluation also estimates that 2,116 residents might have mobility or access issues due to surrounding water. See appendix **Table B-5** for community-based results of flood exposure.

3.4.5 Areas of vulnerability or risk

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

- A large portion of the downtown area of the City of Coos Bay is prone to flooding. A large estimated loss ($42 million) could result from 100-year flooding in the City of Coos Bay.
- 100-year flooding from Tenmile Creek and Tenmile Lake would damage many buildings in the City of Lakeside. This community has the highest loss ratios from flooding of any community in the study area.
- The commercial area by the marina in the City of Bandon is at risk to flooding.
- Several buildings in the communities of Coquille and Myrtle Point along the Coquille River are at risk to flooding.

3.5 Landslide Susceptibility

Landslides are mass movements of rock, debris, or soil most commonly downhill. There are many different types of landslides in Oregon. In Coos 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. Some factors that influence landslide type are hillside slope, water content, and geology. Many triggers can cause a landslide: intense rainfall, earthquakes, or human-induced factors like 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).

3.5.1 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. Modern methodology and lidar-based elevation data were used to map areas in the developed western half of the county in 2011. The eastern and mostly uninhabited part of the county was mapped in the 1970s.

Burns and others (2016) used SLIDO 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. SLIDO data directly define the Very High landslide susceptibility zone, while SLIDO 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.

We used the data from the statewide landslide susceptibility map (Burns and others, 2016) in this report to identify the general level of susceptibility of 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 (see **Table B-6**). The total dollar value of exposed buildings was calculated for the study area and is reported below. We also estimated the number of people threatened by landslides. Land value losses due to landslides were not examined for this report, in addition to potentially hazardous unmapped areas that may pose real risk to communities.

3.5.2 Countywide results

Many Coos County communities have some exposure to landslide hazard. Communities that developed in terrain with moderate to steep slopes or at the base of steep hillsides may be at risk to landslides. The Coast Range and Klamath Mountains run through eastern and central Coos County, so much of the area is steep and landslide prone. The combination of rugged terrain, historically active landslides, large amounts of rainfall, and frequent large earthquakes make landslides a serious threat.

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

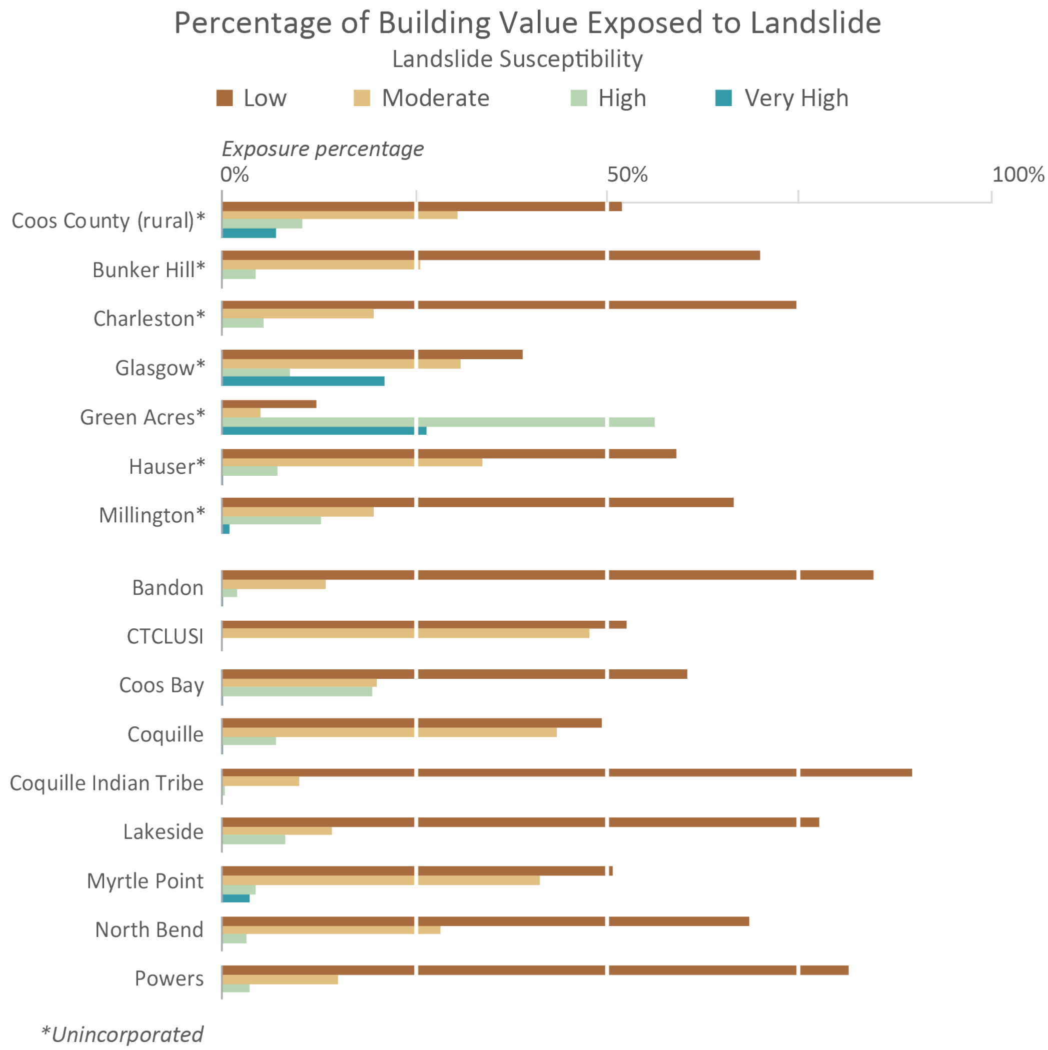
For this risk assessment we compared building locations to geographic extents of the landslide susceptibility zones (**Figure 3-7**). The exposure results shown below are for the high and very high susceptibility zones. See **Appendix B: Detailed Risk Assessment Tables** for multi-scenario analysis results.

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

- Number of buildings: 7,123
- Exposure value: $1,583,583,000
- Percentage of exposure value: 14%
- Critical facilities exposed: 16
- Potentially displaced population: 9,550

The majority of buildings in Coos County are located on estuaries and floodplains, which are flatter than the surrounding landscape and are low-susceptibility landslide zones. Still, approximately 14% of the county's buildings have exposure to high or very high susceptibility to landslides. Landslide hazard is ubiquitous in a large percentage of undeveloped land and 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 the county.

Figure 3-7. Landslide susceptibility exposure by Coos County community.



3.5.3 Areas of vulnerability or risk

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

- Several inhabited areas in the community of Glasgow are exposed to very high landslide susceptibility.
- The community of Green Acres has a significant amount of exposure (83%) to high and very high landslide susceptibility.
- Exposure to landslide hazard is present for buildings throughout the unincorporated county. Additionally, a large portion of undeveloped land in the unincorporated county is deemed high or very high landslide susceptibility, which can be a factor when determining future developments.

3.6 Wildfire

Wildfires are a natural part of the ecosystem in Oregon. However, wildfires can present a substantial hazard to life and property, because communities often grow into the transition areas between developed areas and undeveloped areas, commonly called the wildland-urban interface (WUI) (Sanborn Map Company, Inc., 2013). 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 (Sanborn Map Company, Inc., 2013). Post-wildfire geologic hazards can also present risk. These usually include flooding, debris flows, and landslides. Post-wildfire geologic hazards were not evaluated in this project.

There is potential for losses due to WUI fires in Coos County. Forests cover most of the undeveloped land in Coos County. According to the Coos County Community Wildfire Protection Plan, forests play an important role in the local economy but also surround homes and businesses (OPDR, 2011). In an effort to limit exposure to wildfire, The Coos County Comprehensive Plan provides guidance on reducing risk to wildfire (CCDP, 1985). Contact the Coos County Department of Planning for specific requirements related to the county's comprehensive plan.

3.6.1 Data sources

The West Wide Wildfire Risk Assessment (WWA; Sanborn Map Company, Inc., 2013) is a comprehensive report that includes a database developed over the course of several years for 17 Western states and some Pacific Islands. 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 Fire Risk Index (FRI) dataset, a dataset included in the WWA database, was used to measure the level of risk to communities in Coos County.

Using guidance from ODF, we categorized the FRI into low, moderate, and high hazard zones for the wildfire exposure analysis. The FRI hazard zones are based on a combination of the impacts of wildfire (Fire Effects Index) and the probability of wildfire (Fire Threat Index). Both indices are the result of an integration of several input datasets. Broadly, the Fire Effects Index is based on potentially impacted assets and the difficulty of suppression. The components that make up the Fire Threat Index are fire occurrence, fire behavior, and fire suppression effectiveness (Sanborn Map Company, Inc., 2013).

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 **Table B-7**). The total dollar value of exposed buildings in the study area is reported below. We also estimated the number of people threatened by wildfire. Land value losses due to wildfire were not examined for this project.

3.6.2 Countywide results

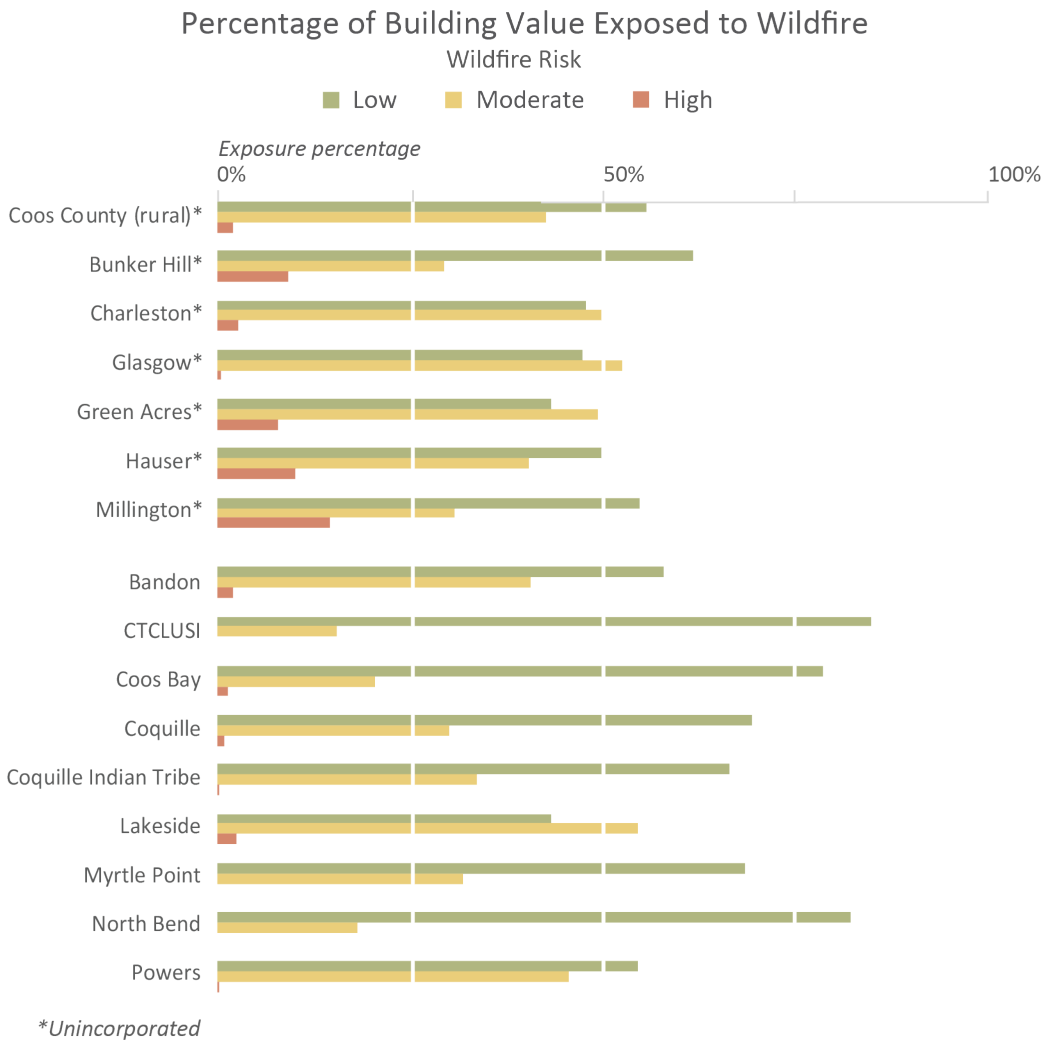
The high hazard category was chosen as the primary scenario for this report because that category represents areas that have the highest potential for losses. However, a large amount of loss would occur if the moderate hazard areas were to burn, as almost every community has ~30–50% of exposure to moderate wildfire hazard. Still, the focus of this section is on high hazard areas within Coos County to emphasize the areas where lives and property are most at risk.

Coos countywide wildfire exposure (high hazard):

- Number of buildings: 1,050
- Exposure value: $216,525,000
- Percentage of exposure value: 1.9%
- Critical facilities exposed: 1
- Potentially displaced population: 1,375

For this risk assessment, building locations were compared to the geographic extent of the wildfire hazard categories. We found that some of the communities in Coos County are exposed to wildfire hazard. The primary areas of exposure to this hazard are in the estuarine areas of the South Slough of the Coos River and some of the dunal areas in the north part of the county (see Appendix E, **Plate 7**). The communities of Bunker Hill, Hauser, Millington, and, to a certain degree, Green Acres are at a higher risk to wildfire than other communities in the county. **Figure 3-8** illustrates the level of risk from wildfire for the different communities of Coos County. See **Appendix B: Detailed Risk Assessment Tables** for multi-scenario analysis results.

Figure 3-8. Wildfire hazard exposure by Coos County community.



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 wildfire hazard:

- Wildfire risk is high for hundreds of homes in the low-laying forested areas of the floodplains south of the City of Coos Bay. This area includes Unincorporated Coos County (rural), Bunker Hill, Green Acres, and Millington.
- Many residential buildings in the dunal areas within the community of Hauser are exposed to high wildfire 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 to quantify expected damage to buildings and potential displacement of permanent residents, or determine which buildings and residents are exposed to a hazard. This comprehensive and detailed approach to the analysis provides new context for the county's risk reduction efforts. We note several important findings based on the results of this study:

- **Extensive overall damage and losses are expected from a Cascadia Mw 9.0 earthquake and tsunami -** Due to its proximity to the CSZ, every community in Coos County will experience significant impact and disruption from a CSZ Mw 9.0 earthquake event. We limited our analysis to the impacts of an Mw 9.0 earthquake (including liquefaction and coseismic landslides) and an accompanying tsunami. Results show that a CSZ Mw 9.0 event will cause approximately 35% to 50% in building value losses for most communities. The unincorporated community of Charleston can expect a very high percentage of losses (27%) due to tsunami hazard. Other communities like Lakeside, Myrtle Point, North Bend, Powers, and Hauser have little to no tsunami exposure, but still will have high losses from the earthquake alone. The high loss levels estimated in the study area are due to the highly vulnerable building inventory (primarily because of the age of construction), the proximity to the CSZ event, and the amount of development within tsunami zones.
- **Retrofitting buildings to modern seismic building codes can reduce damages and losses from earthquake -** Seismic building codes have a major influence on earthquake shaking damage estimated in this study. We examined potential loss reduction from seismic retrofits (modifications that improve building's seismic resilience) in simulations by using Hazus-MH building code "design level" attributes of pre, low, moderate, and high codes (FEMA, 2012b) in CSZ earthquake scenarios. The simulations were accomplished by upgrading every pre (non-existent) and low seismic code building to moderate seismic code levels in one scenario, and then further by upgrading all buildings to high (current) code in another scenario. We found that retrofitting to at least moderate code was the most cost-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 earthquake building value loss for the entire study area was reduced from 30% to 19%. We found further reduction in estimated loss in our simulation to 16% only by upgrading all buildings to high code. Some communities would see greater loss reduction than the study area as a whole due to older building stock constructed at pre or low code seismic building code standards. Some examples are the cities of Myrtle Point and North Bend, which would see a significant loss reduction (from 40% to 22% and 36% to 21%, respectively) by retrofitting all buildings to at least moderate code. While seismic retrofits are an effective strategy for reducing earthquake shaking damage, it should be noted that earthquake-induced tsunami, landslide, and liquefaction hazards will also be present in some areas, and these hazards require different geotechnical mitigation strategies. Future research focused on tsunami, landslide, and liquefaction hazard specific risk assessments are needed for a clear understanding of the hazard to inform local decisionmakers.
- **Flooding is a threat for some communities in Coos County** – Most of the communities in the study area are estimated to experience less than 1% of total building value loss from the 100-year flood. However, a few communities are estimated to experience higher levels of damage from

flood than other communities in the study area. Unincorporated Coos County (rural), Bunker Hill, Coos Bay, and Lakeside all are estimated to have 2% of building value losses due to 100-year flooding. At first glance, Hazus-MH flood loss estimates may give a false impression of risk because they show fairly low damages for a community relative to other hazards we examined. This is due to the difference between loss estimation and exposure results, as well as the limited area impacted from flooding. An average of 14% loss was calculated for buildings within the 100-year flood zone. Residents and buildings located near the riverine and estuarine portions of the Coos and the Coquille rivers are at a greater risk from flood than other locations within the study area. The highest concentrations of flood damage in the study area are downtown Coos Bay, the commercial area near the marina in the City of Bandon, and in the City of Lakeside near Tenmile Creek and Tenmile Lake.

- **Elevating structures in the flood zone reduces vulnerability -** Flood exposure analysis was used in addition to Hazus-MH loss estimation to identify buildings that were not damaged but that were within the area expected to experience a 100-year flood. By using both analyses in this way, the number of elevated structures within the flood zone could be quantified. This showed possible mitigation needs in flood loss prevention or the effectiveness of past activities. The City of Coos Bay has a high percentage (95%) of flood exposed buildings that are not elevated above the level of flooding, providing an opportunity to greatly reduce the estimated damages from a 100-year flood event. The exposure analysis also estimates the number of people that have limited mobility due to surrounding floodwaters. Many residents in the cities of Coos Bay (773), Lakeside (253), and Myrtle Point (119) may need evacuation assistance during a flood event.
- **New landslide mapping would increase the accuracy of future risk assessments -** Exposure analysis was used to assess the threat from landslides. Landslides are a widespread hazard and are present for some communities within the county. The communities of Glasgow and Green Acres have high levels of exposure to landslides. Landslide hazard is a very significant risk throughout the unincorporated rural parts of Coos County. The landslide hazard data for most of the areas used in this risk assessment were created before modern mapping technology; future risk assessments using lidar-derived landslide hazard data would provide more accurate results.
- **Wildfire risk is high for upstream portions of the Coos River watershed -** Exposure analysis shows that buildings south of Coos Bay are at risk to wildfires, especially around the communities of Bunker Hill and Millington. The western portion of the community of Hauser also has areas of higher risk to wildfires relative to the study area. Moderate wildfire hazard is present throughout the county, especially along transportation corridors. and is a potential threat for most communities. We estimate that most communities in Coos County have approximately 30–50% of exposure to moderate or higher wildfire hazard.
- **Most of the study area's critical facilities are at high risk from a CSZ earthquake and tsunami -** Critical facilities were identified and were specifically examined within this report. We have estimated that 88% (83) of Coos County's 94 critical facilities will be non-functioning after a CSZ event, with 13 of those located with the medium tsunami zone. For comparative purposes, 17% (16) of critical facilities are at risk to landslide, 14% (13) are exposed to flood hazard, and 1% (1) are exposed to wildfire.
- **The biggest causes of displacement to population are earthquake, tsunami, and landslide -** Potential displacement of permanent residents from natural hazards was estimated within this report. We estimated that 20% of the population in the county would be displaced due to a

combined earthquake and tsunami. Landslide hazard is a potential threat to 15% of permanent residents, flood hazard puts 3% at risk to displacement, and 2% are exposed to wildfire hazard.

- **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 associated with interpreting the results of this risk assessment.

- **Spatial and temporal variability of natural hazard occurrence** – Flood, landslide, coastal erosion, and wildfire are extremely unlikely to occur across the fully mapped extent of the hazard zones. For example, areas mapped in the 1% annual chance 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, the losses from a single hazard event probably will not be as severe and widespread. Exceptions to this are earthquake ground-shaking and tsunami inundation, which are expected to impact the entire study area, and loss estimates for this hazard are based on a single event.
- **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 un-reinforced 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. We note the tsunami hazard as a possible exception, given the extreme and widespread damage to buildings in recent events in Japan, Sumatra, and Chile.
- **Population variability** – Many coastal communities in Coos County are popular vacation destinations, particularly during the summer. Our estimates of potentially displaced people rely on permanent populations published in the 2010 U.S. Census (U.S. Census Bureau, 2010b). As a result, we are underestimating the number of people that may be at risk to hazards, especially during periods of high temporary population.
- **Data accuracy and completeness** – Some datasets in our risk assessment had incomplete coverage or lacked high-resolution data within the study area. We used lower resolution data to fill gaps where there was incomplete coverage or where high resolution was not available. Assumptions to amend areas of incomplete data coverage were made based on reasonable

methods described within this report. However, we are aware that some uncertainty has been introduced from these data amendments at an individual building scale. At community-wide scales the effects of the uncertainties are slight. We made certain assumptions regarding data layers to fill in data gaps for building footprints, population, some attributes derived from the assessor database, and landslide susceptibility. Many of the datasets included known or suspected artifacts, omissions and errors. Identifying or repairing these problems was beyond the scope of the project and require additional research.

6.0 RECOMMENDATIONS

The following areas of implementation are needed to better understand hazards and reduce risk to natural hazards 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.

6.1 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 in general is a much safer place to live. Awareness and preparation not only reduce the initial impact from natural hazards, but they also reduce the amount of time for a community to recover from a disaster—this ability is commonly referred to as “resilience.”

This report is intended to provide local officials 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/sub/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 partnering with local officials in the development of additional effective resources could help reach a broader community and user groups.

6.2 Planning

Information presented here are available for local decisionmakers in developing their local plans and help identify geohazards and associated risks to the community. The primary framework for accomplishing this is through the comprehensive planning process. The 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. Additionally, the information presented here can be a resource when updating the mitigation actions and inform 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.

6.3 Emergency Response

Critical facilities will 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 target for early warning. At the time of writing, DOGAMI is producing a series of tsunami evacuation maps for recommended pedestrian travel speeds to reach tsunami evacuation zones. The product is called “Beat the Wave” and is available at https://www.oregongeology.org/tsuclearinghouse/beatthewave.htm.

The building database that accompanies this report presents many opportunities for future pre-disaster mitigation, emergency response, and community resilience improvements. Vulnerable areas can be identified and targeted for awareness campaigns. These campaigns can be aimed at pre-disaster mitigation through, for example, improvements of the structural connection of the frame to the foundation. 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. Both reduction of the magnitude of the disaster and a decrease in the response time contribute to a community’s overall resilience.

6.4 Mitigation Funding Opportunities

Several funding options 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 Office 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 two programs that assist with mitigation funding for natural hazards: Hazard Mitigation Grant Program (HMGP) 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.

6.5 Hazard-Specific Risk Reduction Actions

6.5.1 CSZ Mw 9.0 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 88% of critical facilities (**Appendix A: Community Risk Profiles**) will be damaged by the CSZ event, 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.
- Improve the mapping of liquefaction and NEHRP datasets within the county.

6.5.2 CSZ Mw 9.0 Tsunami

- Use approved guides on preparing for tsunamis (e.g., Oregon Department of Land Conservation and Development (DLCD) guide on preparing for the CSZ tsunami) https://www.oregon.gov/LCD/OCMP/Pages/Tsunami-Planning.aspx
- Evaluate the community evacuation plan, including consideration for viable vertical evacuation options.

6.5.3 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.
- Map channel migration zones along rivers identified as having moderate or high susceptibility to channel migration (Roberts and Anthony, 2017).

6.5.4 Landslide

- Create modern landslide inventory and susceptibility maps based on lidar-derived topographic data.
- Monitor ground movement in high susceptibility areas.
- Consider land value losses due to landslide in future risk assessments.

6.5.5 Wildfire

- Evaluate post-wildfire geologic hazards including flood, debris flows, and landslides.

7.0 ACKNOWLEDGMENTS

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8.0 REFERENCES

Allan, J. C., Ruggiero, P., and Roberts, J. T., 2012, Coastal flood insurance study, Coos County, Oregon: Oregon Department of Geology and Mineral Industries Special Paper 44, 127 p. https://www.oregongeology.org/pubs/sp/p-SP-44.htm

Applied Technology Council, 2015, Rapid visual screening of buildings for potential seismic hazards: A handbook (3rd ed.): Redwood City, Calif., FEMA Publication 154. https://www.fema.gov/media-library-data/1426210695633-d9a280e72b32872161efab26a602283b/FEMAP-154_508.pdf

Bauer, J. M., Burns, W. J., and Madin, I. P., 2018, Earthquake regional impact analysis for Clackamas, Multnomah, and Washington Counties, Oregon: Oregon Department of Geology and Mineral Industries Open-File Report O-18-02, 96 p. https://www.oregongeology.org/pubs/ofr/p-O-18-02.htm

Bauer, J. M., Allan, J. C., Gabel, L. S., O'Brien, F. E., and Roberts, J. T., 2020, Analysis of earthquake and tsunami impacts for people and structures inside the tsunami zone for five Oregon coastal communities: Gearhart, Rockaway Beach, Lincoln City, Newport, and Port Orford: Oregon Department of Geology and Mineral Industries Open-File Report O-20-03, 185 p. https://www.oregongeology.org/pubs/ofr/p-O-20-03.htm

Burns, W. J., and Watzig, R. J., 2014, Statewide landslide information layer for Oregon, release 3 [SLIDO-3.0]: Oregon Department of Geology and Mineral Industries, 35 p., 1 pl., 1:750,000, geodatabase. https://www.oregongeology.org/slido/

Burns, W. J., Mickelson, K. A., and Madin, I. P., 2016, Landslide susceptibility overview map of Oregon: Oregon Department of Geology and Mineral Industries Open-File Report O-16-02, 48 p. https://www.oregongeology.org/pubs/ofr/p-O-16-02.htm

Business Oregon, 2015, Oregon benefit-cost analysis tool for evaluation of seismic rehabilitation grant program applications: User's guide: Salem, Oreg., Infrastructure Finance Authority Division, 34 p. http://www.orinfrastructure.org/assets/apps/IFA/2015Oregon-SRGP/BCAusersGuideAppend.pdf

Charest, A. C. (ed.), 2017, Square foot costs with RSMeans® data (38th annual edition): Rockland, Md., Gordian Group, Inc., 563 p. https://www.rsmeans.com/products/books/2017-cost-databooks/2017-square-foot-costs-book.aspx

Coos County Planning Department, 1985, Coos County Comprehensive Plan: Coos County, Oregon Volume 1, part 2, 778 p. http://www.co.coos.or.us/Portals/0/Planning/Vol%201%20Part%202%20-%20FINAL.pdf?ver=2015-05-19-132240-613

Federal Emergency Management Agency, 2012a, Hazus®-MH 2.1 User manual, Flood model: Washington, D.C., 382 p. https://www.fema.gov/media-library-data/20130726-1820-25045-8814/hzmh2_1_fl_um.pdf

Federal Emergency Management Agency, 2012b, Hazus®-MH 2.1 Technical manual, Earthquake model: Washington, D.C., 718 p. https://www.fema.gov/media-library-data/20130726-1820-25045-6286/hzmh2_1_eq_tm.pdf

Federal Emergency Management Agency, 2012c, Hazus®-MH 2.1, Technical manual, Flood model: Washington, D.C., 569 p. https://www.fema.gov/media-library-data/20130726-1820-25045-8292/hzmh2_1_fl_tm.pdf

Federal Emergency Management Agency, 2013, NFIP flood studies and maps, unit 3 *in* Managing floodplain development through the National Flood Insurance Program (Home Study Course): Washington, D.C., 59 p. https://www.fema.gov/media-library-data/20130726-1535-20490-4172/unit3.pdf

Federal Emergency Management Agency, 2014, Flood insurance study: Coos County, Oregon and incorporated areas: Washington D.C., Flood Insurance Study Number 41011CV000B, v. 1, 103 p. https://map1.msc.fema.gov/data/41/S/PDF/41011CV000B.pdf?LOC=c7a3fb47376c6a42889a701ac7d37851

Federal Emergency Management Agency, 2015, Hazus-MH software: FEMA's tool for estimating potential losses from natural disasters, version 3.0. https://www.fema.gov/media-library-data/1450218789512-a8b8b9976c9b2da6beb200555336004a/Hazus_3.0_USER_Release_Notes_v0.5.pdf

Goldfinger, C., and others, 2012, Turbidite event history: Methods and implications for Holocene paleoseismicity of the Cascadia subduction zone: U.S. Geological Survey Professional Paper 1661-F, 178 p. https://doi.org/10.3133/pp1661F

Goldfinger, C., Galer, S., Beeson, J., Hamilton, T., Black, B., Romsos, C., Patton, J., Nelson, C.H., Hausmann, R., and Morey, A., 2017, The importance of site selection, sediment supply, and hydrodynamics: A case study of submarine paleoseismology on the Northern Cascadia margin, Washington USA: Marine Geology, v. 384, p. 4–16, 17, 25–46.

Judson, S., 2012, Earthquake design history: A summary of requirements in the State of Oregon: State of Oregon, Building Codes Division, Feb. 7, 2012, 7 p. http://www.oregon.gov/bcd/codes-stand/Documents/inform-2012-oregon-sesmic-codes-history.pdf

Lewis, D., 2007, Statewide seismic needs assessment: Implementation of Oregon 2005 Senate Bill 2 relating to public safety, earthquakes, and seismic rehabilitation of public buildings: Oregon Department of Geology and Mineral Industries Open-File Report O-07-02, 140 p. Available from https://www.oregongeology.org/rvs/default.htm.

Madin, I. P., and Burns, W. J., 2013, Ground motion, ground deformation, tsunami inundation, coseismic subsidence, and damage potential maps for the 2012 Oregon Resilience Plan for Cascadia subduction zone earthquakes: Oregon Department of Geology and Mineral Industries Open-File Report O-13-06, 36 p. 38 pl., GIS data. https://www.oregongeology.org/pubs/ofr/p-O-13-06.htm

Oregon Building Codes Division, 2002, Oregon manufactured dwelling and park specialty code, 2002 ed.: Oregon Manufactured Housing Association and Oregon Building Codes Division, Department of Consumer and Business Services, 176 p. http://www.oregon.gov/bcd/codes-stand/Documents/md-2002-mdparks-code.pdf

Oregon Building Codes Division, 2010, 2010 Oregon manufactured dwelling installation specialty code: Department of Consumer and Business Services, Building Codes Division, 67 p. http://www.oregon.gov/bcd/codes-stand/Documents/md-2010omdisc-codebook.pdf

Oregon Partnership for Disaster Resilience, 2011, Coos County Community Wildfire Protection Plan: University of Oregon, Community Service Center, 71 p. https://www.oregon.gov/ODF/Documents/Fire/CWPP/CoosCounty.pdf

Peterson, C. D., Barnett, E. T., Briggs, G. G., Carver, G. A., Clague, J. J., and Darienzo, M. E., 1997, Estimates of coastal subsidence from great earthquakes in the Cascadia subduction zone, Vancouver Island, B. C., Washington, Oregon, and northernmost California: Oregon Department of Geology and Mineral Industries Open-File Report O-97-05, 44 p. https://www.oregongeology.org/pubs/ofr/O-97-05.pdf

Priest, G. R., Witter, R. C., Zhang, Y. J., Wang, K., Goldfinger, C., Stimely, L. L., English, J. T., Pickner, S. P., Hughes, K. L. B., Wille, T. E., and Smith, R. L., 2013, Tsunami inundation scenarios for Oregon: Oregon Department of Geology and Mineral Industries Open-File Report O-13-19, 18 p., GIS data. https://www.oregongeology.org/pubs/ofr/p-O-13-19.htm

Priest, G.R., Stimely, L. L., Madin, I. P., and Watzig, R. J., 2015, Local tsunami evacuation analysis of Seaside and Gearhart, Clatsop County, Oregon: Oregon Department of Geology and Mineral Industries Open-File Report O-15-02, 31p., GIS data. https://www.oregongeology.org/pubs/ofr/p-O-15-02.htm

Roberts, J.T., and Anthony, L. H., 2017, Statewide Subbasin-Level Channel Migration Screening for Oregon: Oregon Department of Geology and Mineral Industries Interpretive Map Series 56. 17 p., GIS data. https://www.oregongeology.org/pubs/ims/p-ims-056.htm

Sanborn Map Company, Inc., 2013, The West Wide Wildfire Risk Assessment, final report, report to Oregon Department of Forestry and others, 105 p. http://www.odf.state.or.us/gis/data/Fire/West_Wide_Assessment/WWA_FinalReport.pdf

Tilman, M. A., 2010, One-Percent Annual Flood Hazard and Exposure Risk Maps, Coos County, Oregon: Oregon Department of Geology and Mineral Industries Open-File Reports O-10-05, O-10-06, O-10-07, O-10-08, O-10-09, O-10-10, and O-10-11, 7 maps. https://www.oregongeology.org/pubs/ofr/p-O-10-05to11.htm

U.S. Census Bureau, 2010a, Master Address File/Topologically Integrated Geographic Encoding and Referencing system or database: Oregon census block: United States Census Bureau. ftp://ftp2.census.gov/geo/tiger/TIGER2010BLKPOPHU/tabblock2010_41_pophu.zip (login required)

U.S. Census Bureau, 2010b, American FactFinder: Profile of General Population and Housing Characteristics: United States Census Bureau. Web. 14 March 2018. https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml

U.S. Geological Survey, 2017, Earthquake hazards 101 — the basics. Retrieved from https://earthquake.usgs.gov/hazards/learn/basics.php

Wang, Y., and Clark, J. L., 1999, Earthquake damage in Oregon: Preliminary estimates of future earthquake losses: Oregon Department of Geology and Mineral Industries Special Paper 29, 59 p. https://www.oregongeology.org/pubs/sp/SP-29.pdf

Witter, R. C., Zhang, Y., Wang, K., Priest, G. R., Goldfinger, C., Stimely, L. L., English, J. T., and Ferro, P. A., 2011, Simulating tsunami inundation at Bandon, Coos County, Oregon, using hypothetical Cascadia and Alaska earthquake scenarios: Oregon Department of Geology and Mineral Industries Special Paper 43, 57 p. https://www.oregongeology.org/pubs/sp/p-SP-43.htm

Witter, R. C., Zhang, Y., Wang, K., Priest, G. R., Goldfinger, C., Stimely, L. L., English, J. T., and Ferro, P. A., 2013, Simulating tsunami inundation for a range of Cascadia megathrust earthquake scenarios at Bandon, Oregon, USA: Geosphere; 9 (6): 1783-1803. https://doi.org/10.1130/GES00899.1

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 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 Coos County (Rural)

Table A-1. Unincorporated Coos County hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Unincorporated Coos County	18,664	18,957	21	4,476,885,000

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	763	4.1%	890	0	58,390,000	1.3%
*Earthquake**	*CSZ Mw 9.0 Deterministic*	3,149	17%	5,862	16	1,310,768,000	29%
Earthquake (within Tsunami Zone)		136	0.7%	196	3	44,178,000	1.0%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Percent of Exposure
Tsunami	*CSZ Mw 9.0 – Medium*	365	2.0%	418	3	94,049,000	2.1%
Tsunami	Senate Bill 379 Regulatory Line	230	1.2%	264	3	62,355,000	1.4%
Landslide	High and Very High Susceptibility	3,411	18%	3,749	3	782,675,000	18%
Wildfire	High Hazard	457	2.4%	402	1	86,157,000	1.9%

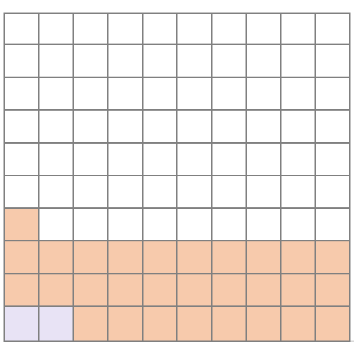
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure A-1.

[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).

Figure A-1. Unincorporated Coos County loss ratio from Cascadia subduction zone event.



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus-MH modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. To avoid double counting of buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

†Each cell represents 1% of building value

= Estimated losses due to tsunami.

= Estimated losses due to earthquake (outside of tsunami zone).

Table A-2. Unincorporated Coos County critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Tsunami CSZ Mw 9.0 – Medium Exposed	Landslide High and Very High Susceptibility Exposed	Wildfire High Hazard Exposed
Bandon RFPD	—	X	—	—	—
Bandon State Airport	—	X	—	—	—
Benham Airstrip	—	—	—	—	—
Bridge Rural Fire Department	—	X	—	—	—
Charleston RFPD	—	X	—	—	—
Charleston RFPD - 2	—	X	—	—	—
Coos RFD Station	—	X	—	—	—
Coquille RFD 1	—	X	—	—	—
Coquille RFD 2	—	X	—	X	—
Coquille RFD 3	—	X	—	X	—
Dora-Sitkum RFPD	—	X	—	—	—
Fairview RFPD	—	X	—	—	—
Millington RFD No. 5	—	X	—	—	—
Myrtle Point Fire 1	—	X	—	—	—
Myrtle Point RFPD Gravelford Station 3	—	X	—	—	—
ODOT - Davis Slough Maintenance	—	X	—	—	—
Port of Coos Bay 1	—	X	X	—	—
Port of Coos Bay 2	—	X	X	—	—
Port of Coos Bay 3	—	X	X	X	X
Powers Airstrip	—	X	—	—	—
Sumner RFPD	—	—	—	—	—

A.2 Unincorporated Community of Bunker Hill

Table A-3. Unincorporated community of Bunker Hill hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Bunker Hill	1,376	740	1	173,872,000

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	22	1.6%	50	0	3,061,000	1.8%
*Earthquake**	*CSZ Mw 9.0 Deterministic*	45	3.3%	146	1	37,528,000	22%
Earthquake (within Tsunami Zone)		0	0.0%	5	0	9,733,000	5.6%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Percent of Exposure
Tsunami	*CSZ Mw 9.0 – Medium*	9	0.7%	6	0	10,370,000	6.0%
Tsunami	Senate Bill 379 Regulatory Line	3	0.2%	2	0	508,000	0.3%
Landslide	High and Very High Susceptibility	84	6.1%	42	0	7,681,000	4.4%
Wildfire	High Hazard	185	14%	92	0	15,762,000	9.1%

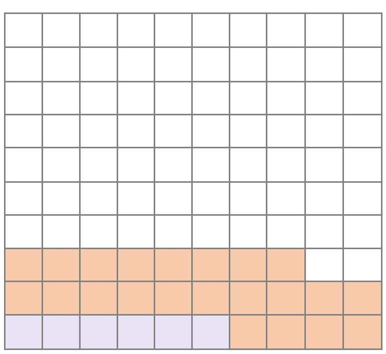
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure A-2.

[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).

Figure A-2. Unincorporated community of Bunker Hill loss ratio from Cascadia subduction zone event.



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus-MH modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. To avoid double counting of buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

†Each cell represents 1% of building value.

= Estimated losses due to tsunami.

= Estimated losses due to earthquake (outside of tsunami zone).

Table A-4. Unincorporated community of Bunker Hill critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Tsunami CSZ Mw 9.0 – Medium Exposed	Landslide High and Very High Susceptibility Exposed	Wildfire High Hazard Exposed
Bunker Hill Elementary	—	X	—	—	—

A.3 Unincorporated Community of Charleston

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

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Charleston	2,228	1,549	2	310,927,000

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	37	1.7%	18	1	1,381,000	0.4%
*Earthquake**	*CSZ Mw 9.0 Deterministic*	916	41%	686	0	99,432,000	32%
Earthquake (within Tsunami Zone)		91	4.1%	176	1	56,162,000	18%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Percent of Exposure
Tsunami	*CSZ Mw 9.0 – Medium*	255	11%	267	2	82,989,000	27%
Tsunami	Senate Bill 379 Regulatory Line	217	9.7%	220	2	72,984,000	24%
Landslide	High and Very High Susceptibility	112	5.0%	85	0	16,793,000	5.4%
Wildfire	High Hazard	57	2.6%	39	0	8,259,000	2.7%

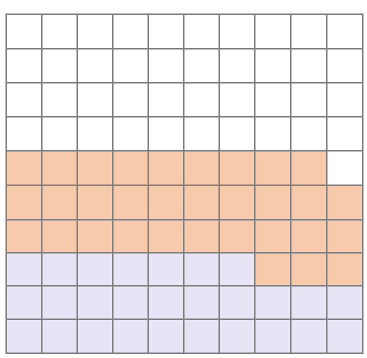
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure A-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).

Figure A-3. Unincorporated community of Charleston loss ratio from Cascadia subduction zone event.



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus-MH modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. To avoid double counting of buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

†Each cell represents 1% of building value.

= Estimated losses due to tsunami.

= Estimated losses due to earthquake (outside of tsunami zone).

Table A-6. Unincorporated community of Charleston critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Tsunami CSZ Mw 9.0 – Medium Exposed	Landslide High and Very High Susceptibility Exposed	Wildfire High Hazard Exposed
Charleston RFPD - 3	—	—	X	—	—
Coos Bay Coast Guard Station	X	X	X	—	—

A.4 Unincorporated Community of Glasgow

Table A-7. Unincorporated community of Glasgow hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Glasgow	757	578	1	125,629,000

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	6	0.7%	9	0	227,000	0.2%
*Earthquake**	*CSZ Mw 9.0 Deterministic*	92	12%	165	0	22,865,000	18%
Earthquake (within Tsunami Zone)		2	0.3%	9	0	1,542,000	1.2%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Percent of Exposure
Tsunami	*CSZ Mw 9.0 – Medium*	7	1.0%	13	0	2,537,000	2.0%
Tsunami	Senate Bill 379 Regulatory Line	3	0.4%	6	0	2,878,000	2.3%
Landslide	High and Very High Susceptibility	227	30%	194	0	37,475,000	30%
Wildfire	High Hazard	3	0.4%	2	0	550,000	0.4%

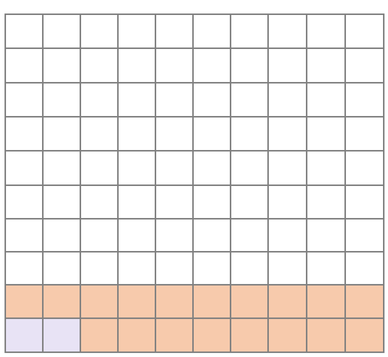
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure A-4.

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

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

Figure A-4. Unincorporated community of Glasgow loss ratio from Cascadia subduction zone event.



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus-MH modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. To avoid double counting of buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

†Each cell represents 1% of building value.

= Estimated losses due to tsunami.

= Estimated losses due to earthquake (outside of tsunami zone).

Table A-8. Unincorporated community of Glasgow critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ Mw 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**
North Bay RFPD	—	—	—	—	—

A.5 Unincorporated Community of Green Acres

Table A-9. Unincorporated community of Green Acres hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Green Acres	406	367	1	79,090,000

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	15	3.6%	16	0	681,000	0.9%
*Earthquake**	*CSZ Mw 9.0 Deterministic*	83	21%	112	0	23,040,000	29%
Earthquake (within Tsunami Zone)		0	0%	0	0	0	0%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Percent of Exposure
Tsunami	*CSZ Mw 9.0 – Medium*	0	0%	0	0	0	0%
Tsunami	Senate Bill 379 Regulatory Line	0	0%	0	0	0	0%
Landslide	High and Very High Susceptibility	342	84%	306	1	65,380,000	83%
Wildfire	High Hazard	33	8.2%	27	0	6,098,000	7.7%

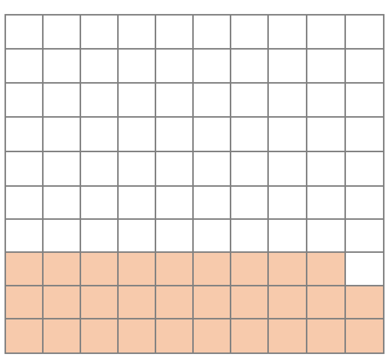
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure A-4.

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

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

Figure A-5. Unincorporated community of Green Acres loss ratio from Cascadia subduction zone event.



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus-MH modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. To avoid double counting of buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

†Each cell represents 1% of building value.

= Estimated losses due to tsunami.

= Estimated losses due to earthquake (outside of tsunami zone).

Table A-10. Unincorporated community of Green Acres critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ Mw 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**
Greenacres RFPD	—	—	—	X	—

A.6 Unincorporated Community of Hauser

Table A-11. Community of Hauser hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Hauser	1,145	1,022	2	286,877,000

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	11	1.0%	8	0	1,738,000	0.6%
*Earthquake**	*CSZ Mw 9.0 Deterministic*	422	37%	521	2	149,929,000	52%
Earthquake (within Tsunami Zone)		0	0%	0	0	0	0%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Percent of Exposure
Tsunami	*CSZ Mw 9.0 – Medium*	0	0%	0	0	0	0%
Tsunami	Senate Bill 379 Regulatory Line	0	0%	1	0	4,555,000	1.6%
Landslide	High and Very High Susceptibility	114	10%	102	0	20,917,000	7.3%
Wildfire	High Hazard	104	9.1%	123	0	29,007,000	10%

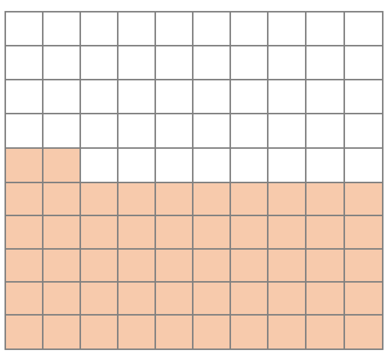
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure A-6.

[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).

Figure A-6. Community of Hauser loss ratio from Cascadia subduction zone event.



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus-MH modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. To avoid double counting of buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

†Each cell represents 1% of building value.

= Estimated losses due to tsunami.

= Estimated losses due to earthquake (outside of tsunami zone).

Table A-12. Community of Hauser critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ Mw 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**
Hauser RFPD	—	X	—	—	—
North Bay Light House Elementary School	—	X	—	—	—

A.7 Unincorporated Community of Millington

Table A-13. Community of Millington hazard profile.

Community Overview				
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Millington	666	506	1	100,571,000

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	13	1.9%	13	1	586,000	0.6%
*Earthquake**	*CSZ Mw 9.0 Deterministic*	28	4.2%	108	1	15,917,000	16%
Earthquake (within Tsunami Zone)		0	0%	0	0	0	0%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Percent of Exposure
Tsunami	*CSZ Mw 9.0 – Medium*	0	0%	0	0	0	0%
Tsunami	Senate Bill 379 Regulatory Line	0	0%	5	0	779,000	0.8%
Landslide	High and Very High Susceptibility	112	17%	67	0	13,834,000	14%
Wildfire	High Hazard	89	13%	90	0	14,703,000	15%

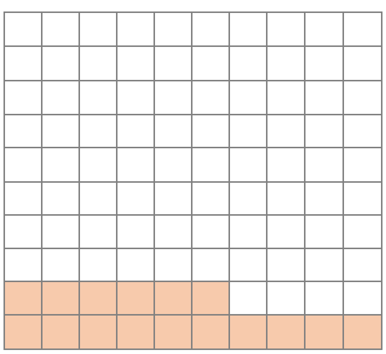
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure A-7.

[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).

Figure A-7. Community of Millington loss ratio from Cascadia subduction zone event.



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus-MH modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. To avoid double counting of buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

†Each cell represents 1% of building value.

= Estimated losses due to tsunami.

= Estimated losses due to earthquake (outside of tsunami zone).

Table A-14. Community of Millington critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ Mw 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**
Millington RFPD	X	X	—	—	—

A.8 City of Bandon

Table A-15. City of Bandon hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Bandon	3,066	1,962	8	629,445,000

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	60	2.0%	94	1	3,855,000	0.6%
*Earthquake**	CSZ Mw 9.0 Deterministic	837	27%	693	5	213,771,000	34%
Earthquake *(within Tsunami Zone)*		27	0.9%	116	2	43,296,000	6.9%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Percent of Exposure
Tsunami	*CSZ Mw 9.0 – Medium*	102	3.3%	185	2	64,742,000	10%
Tsunami	Senate Bill 379 Regulatory Line	82	2.7%	158	2	54,088,000	8.6%
Landslide	High and Very High Susceptibility	57	1.9%	51	0	13,379,000	2.1%
Wildfire	High Hazard	51	1.7%	45	0	11,825,000	1.9%

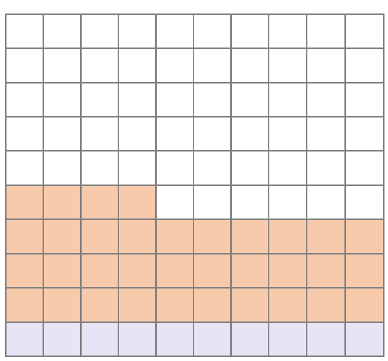
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure A-8.

[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).

Figure A-8. City of Bandon loss ratio from Cascadia subduction zone event.



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus-MH modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. To avoid double counting of buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

†Each cell represents 1% of building value.

= Estimated losses due to tsunami.

= Estimated losses due to earthquake (outside of tsunami zone).

Table A-16. City of Bandon critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ Mw 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**
Bandon Fire Department	—	X	—	—	—
Bandon Police Department	—	X	—	—	—
Bandon Senior High School	—	X	—	—	—
Bandon Water Plant	X	X	X	—	—
Harbor Lights Middle School	—	X	—	—	—
Ocean Crest Elementary School	—	X	—	—	—
Port of Bandon - Office	—	X	X	—	—
Southern Coos Hospital	—	—	—	—	—

A.9 Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians

Table A-17. Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians	47	33	1	12,470,000

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**	*CSZ Mw 9.0 Deterministic*	16	35%	15	1	4,271,000	34%
Earthquake (within Tsunami Zone)		0	0%	0	0	0	0%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Percent of Exposure
Tsunami	*CSZ Mw 9.0 – Medium*	0	0%	0	0	0	0%
Tsunami	Senate Bill 379 Regulatory Line	0	0%	0	0	0	0%
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Wildfire	High Hazard	0	0%	0	0	0	0%

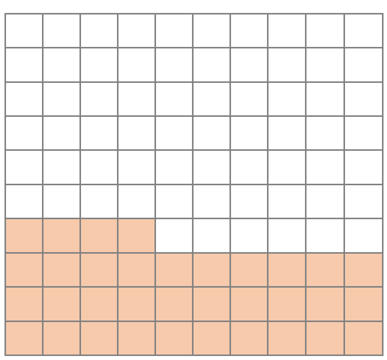
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure A-9.

[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).

Figure A-9. Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians loss ratio from Cascadia subduction zone event.



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus-MH modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. To avoid double counting of buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

†Each cell represents 1% of building value.

= Estimated losses due to tsunami.

= Estimated losses due to earthquake (outside of tsunami zone).

Table A-18. Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ Mw 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**
CTCLUSI Admin	—	X	—	—	—

A.10 City of Coos Bay

Table A-19. City of Coos Bay hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Coos Bay	15,966	7,220	22	2,420,579,000

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	773	4.8%	468	7	42,299,000	1.7%
*Earthquake**	*CSZ Mw 9.0 Deterministic*	2,732	17%	2,027	16	632,247,000	26%
Earthquake (within Tsunami Zone)		181	1.1%	226	3	203,853,000	8.4%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Percent of Exposure
Tsunami	*CSZ Mw 9.0 – Medium*	421	2.6%	319	3	267,595,000	11%
Tsunami	Senate Bill 379 Regulatory Line	53	0.3%	84	2	41,966,000	1.7%
Landslide	High and Very High Susceptibility	3,978	25%	1,890	6	477,292,000	20%
Wildfire	High Hazard	294	1.8%	163	0	32,642,000	1.3%

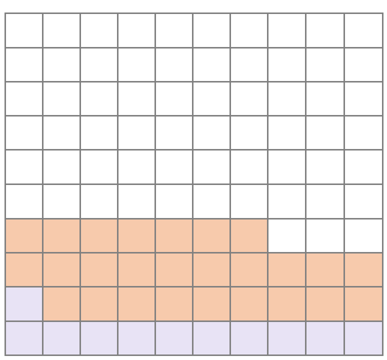
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure A-10.

[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).

Figure A-10. City of Coos Bay loss ratio from Cascadia subduction zone event.



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus-MH modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. To avoid double counting of buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

†Each cell represents 1% of building value.

= Estimated losses due to tsunami (tsunami damage negligible for this community).

= Estimated losses due to earthquake (outside of tsunami zone).

Table A-20. City of Coos Bay critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ Mw 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Hazard
	Exposed	>50% Prob.	Exposed	Exposed	Exposed
Bay Area Hospital	—	—	—	—	—
Blossom Gulch Elementary School	X	X	—	—	—
Coos Bay - North Bend Water Board	—	X	—	—	—
Coos Bay City Shop	X	X	—	—	—
Coos Bay Fire Station - Central	—	—	—	X	—
Coos Bay Fire Station - Eastside	—	X	—	X	—
Coos Bay Fire Station - Empire	—	X	—	—	—
Coos Bay Police Department	X	X	X	—	—
Coos Bay Wastewater Department	X	X	—	—	—
Coos Bay Wastewater Treatment	—	X	X	—	—
Eastside Elementary School	—	X	—	X	—
Harding Learning Center	—	X	—	X	—
Madison Elementary School	—	X	—	—	—
Marshfield Senior High School	—	X	—	X	—
Millicoma Intermediate School	—	X	—	X	—
Oregon Coast Technology School 2	—	X	—	—	—
Oregon International Port of Coos Bay - Port Office	X	X	—	—	—
Oregon State Police	—	—	—	—	—
Pacific Power	X	X	—	—	—
Sunset Middle School	—	X	—	—	—
U.S. Coast Guard Station - Cutter Orcas	X	X	X	—	—
U.S. Oregon Army National Guard	—	X	—	—	—

A.11 City of Coquille

Table A-21. City of Coquille hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Coquille	3,866	1,977	8	606,670,000

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	24	0.6%	23	1	1,207,000	0.2%
*Earthquake**	*CSZ Mw 9.0 Deterministic*	259	6.7%	357	6	131,036,000	22%
Earthquake (within Tsunami Zone)		0	0.0%	0	0	0	0.0%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Percent of Exposure
Tsunami	*CSZ Mw 9.0 – Medium*	0	0%	0	0	0	0%
Tsunami	Senate Bill 379 Regulatory Line	0	0%	0	0	0	0%
Landslide	High and Very High Susceptibility	323	8.4%	202	0	43,926,000	7.2%
Wildfire	High Hazard	51	1.3%	22	0	5,181,000	0.9%

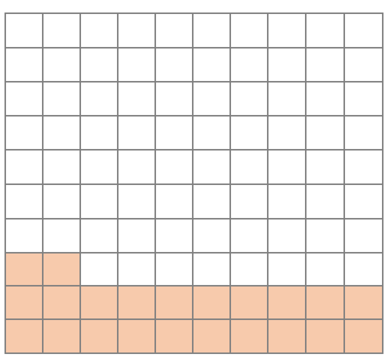
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure A-10.

[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).

Figure A-11. City of Coquille loss ratio from Cascadia subduction zone event.



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus-MH modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. To avoid double counting of buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

†Each cell represents 1% of building value.

= Estimated losses due to tsunami (tsunami damage negligible for this community).

= Estimated losses due to earthquake (outside of tsunami zone).

Table A-22. City of Coquille critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Tsunami CSZ Mw 9.0 – Medium Exposed	Landslide High and Very High Susceptibility Exposed	Wildfire High Hazard Exposed
Coos County Sheriff's Office and EOC	—	X	—	—	—
Coos Couny Road Department	—	X	—	—	—
Coquille City Police Department	—	—	—	—	—
Coquille Fire and Rescue Station No. 1	—	X	—	—	—
Coquille High School	X	X	—	—	—
Coquille Valley Hospital	—	—	—	—	—
Coquille Valley Middle School	—	X	—	—	—
Lincoln Elementary School	—	X	—	—	—

A.12 Coquille Indian Tribe

Table A-23. Coquille Indian Tribe hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Coquille Indian Tribe	313	100	1	80,721,000

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%	1	0	2,000	0%
*Earthquake**	*CSZ Mw 9.0 Deterministic*	44	14%	31	1	32,707,000	41%
Earthquake (within Tsunami Zone)		59	19%	2	0	4,080,000	5.1%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Percent of Exposure
Tsunami	*CSZ Mw 9.0 – Medium*	59	19%	3	0	4,147,000	5.1%
Tsunami	Senate Bill 379 Regulatory Line	0	0%	5	0	33,438,000	41%
Landslide	High and Very High Susceptibility	3	0.8%	1	0	291,000	0.4%
Wildfire	High Hazard	0	0%	1	0	61,000	0.1%

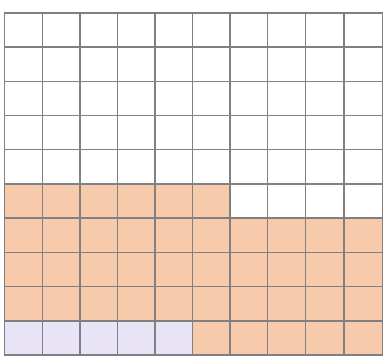
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure A-12.

[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).

Figure A-12. Coquille Indian Tribe loss ratio from Cascadia subduction zone event.



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus-MH modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. To avoid double counting of buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

†Each cell represents 1% of building value.

= Estimated losses due to tsunami.

= Estimated losses due to earthquake (outside of tsunami zone).

Table A-24. Coquille Indian Tribe critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ Mw 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**
Coquille Indian Tribe Admin Building	—	X	—	—	—

A.13 City of Lakeside

Table A-25. City of Lakeside hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Lakeside	1,699	1,421	3	242,768,000

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	253	15%	171	1	5,768,000	2.4%
*Earthquake**	*CSZ Mw 9.0 Deterministic*	572	34%	666	3	96,156,000	40%
Earthquake (within Tsunami Zone)		0	0%	0	0	0	0%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Percent of Exposure
Tsunami	*CSZ Mw 9.0 – Medium*	0	0%	0	0	0	0%
Tsunami	Senate Bill 379 Regulatory Line	12	0.7%	18	1	4,912,000	2.0%
Landslide	High and Very High Susceptibility	113	6.6%	105	0	20,042,000	8.3%
Wildfire	High Hazard	50	2.9%	43	0	6,144,000	2.5%

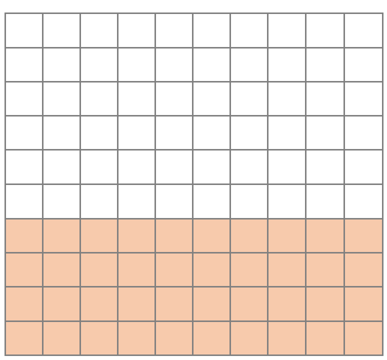
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure A-10.

[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).

Figure A-13. City of Lakeside loss ratio from Cascadia subduction zone event.



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus-MH modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. To avoid double counting of buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

†Each cell represents 1% of building value.

= Estimated losses due to tsunami (tsunami damage negligible for this community).

= Estimated losses due to earthquake (outside of tsunami zone).

Table A-26. City of Lakeside critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Tsunami CSZ Mw 9.0 – Medium Exposed	Landslide High and Very High Susceptibility Exposed	Wildfire High Hazard Exposed
Lakeside Airstrip	—	X	—	—	—
Lakeside RFPD	—	X	—	—	—
Lakeside Water Treatment	X	X	X	—	—

A.14 City of Myrtle Point

Table A-27. City of Myrtle Point hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Myrtle Point	2,514	1,329	6	383,743,000

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	119	4.7%	80	1	3,081,000	0.8%
*Earthquake**	*CSZ Mw 9.0 Deterministic*	455	18%	468	6	154,830,000	40%
Earthquake (within Tsunami Zone)		0	0%	0	0	0	0%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Percent of Exposure
Tsunami	*CSZ Mw 9.0 – Medium*	0	0%	0	0	0	0%
Tsunami	Senate Bill 379 Regulatory Line	0	0%	0	0	0	0%
Landslide	High and Very High Susceptibility	239	9.5%	131	2	30,609,000	8.0%
Wildfire	High Hazard	0	0%	0	0	0	0%

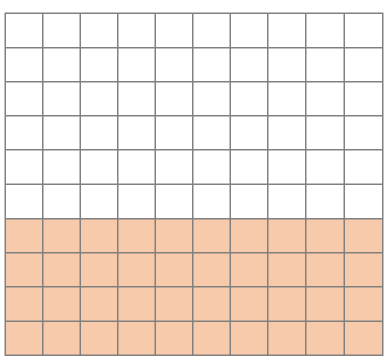
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure A-10.

[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).

Figure A-14. City of Myrtle Point loss ratio from Cascadia subduction zone event.



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus-MH modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. To avoid double counting of buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

†Each cell represents 1% of building value.

= Estimated losses due to tsunami (tsunami damage negligible for this community).

= Estimated losses due to earthquake (outside of tsunami zone).

Table A-28. City of Myrtle Point critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Tsunami CSZ Mw 9.0 – Medium Exposed	Landslide High and Very High Susceptibility Exposed	Wildfire High Hazard Exposed
Myrtle Crest School	—	X	—	X	—
Myrtle Point City Hall	—	X	—	—	—
Myrtle Point Fire Department	—	X	—	—	—
Myrtle Point High School	—	X	—	X	—
Myrtle Point Water Plant	X	X	—	—	—
Myrtle Point Water Plant 2	—	X	—	—	—

A.15 City of North Bend

Table A-29. City of North Bend hazard profile.

Community Overview				
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
North Bend	9,651	4,233	12	1,494,790,000

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	18	0.2%	27	0	3,063,000	0.2%
*Earthquake**	*CSZ Mw 9.0 Deterministic*	1,576	16%	1,225	9	542,929,000	36%
Earthquake (within Tsunami Zone)		25	0.3%	55	2	71,271,000	4.8%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Percent of Exposure
Tsunami	*CSZ Mw 9.0 – Medium*	55	0.6%	75	2	85,107,000	5.7%
Tsunami	Senate Bill 379 Regulatory Line	29	0.3%	51	2	72,394,000	4.8%
Landslide	High and Very High Susceptibility	408	4.2%	179	3	49,187,000	3.3%
Wildfire	High Hazard	0	0%	0	0	0	0%

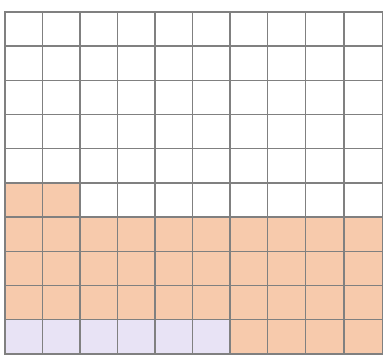
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure A-15.

[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).

Figure A-15. City of North Bend loss ratio from Cascadia subduction zone event.



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus-MH modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. To avoid double counting of buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

†Each cell represents 1% of building value.

= Estimated losses due to tsunami.

= Estimated losses due to earthquake (outside of tsunami zone).

Table A-30. City of North Bend critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ Mw 9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**
Airport Water Treatment Facility	—	X	X	X	—
Hillcrest Elementary School	—	X	—	—	—
North Bend Fire - Airport	—	X	—	—	—
North Bend Fire and Rescue	—	X	—	—	—
North Bend Fire Station 3	—	—	—	X	—
North Bend Middle School	—	X	—	—	—
North Bend Police Department	—	X	—	—	—
North Bend Senior High School	—	X	X	X	—
Oregon Coast Technology School	—	X	—	—	—
Oregon State Trooper Office	—	X	—	—	—
Southwest Oregon Regional Airport	—	X	—	—	—
U.S. Coast Guard Sector North Bend	—	X	—	—	—

A.16 City of Powers

Table A-31. City of Powers hazard profile.

Community Overview				
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Powers	687	556	4	111,516,000

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	4	0.6%	2	0	11,000	0%
*Earthquake**	*CSZ Mw 9.0 Deterministic*	252	37%	267	4	49,542,000	44%
Earthquake (within Tsunami Zone)		0	0%	0	0	0	0%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Percent of Exposure
Tsunami	*CSZ Mw 9.0 – Medium*	0	0%	0	0	0	0%
Tsunami	Senate Bill 379 Regulatory Line	0	0%	0	0	0	0%
Landslide	High and Very High Susceptibility	26	3.7%	19	1	4,102,000	3.7%
Wildfire	High Hazard	0	0%	1	0	135,000	0.1%

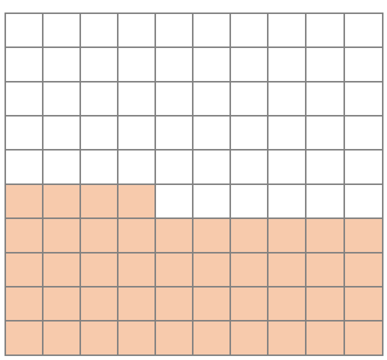
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

Rows with italicized text and shaded background indicate results should be considered in tandem as they are expected to occur within minutes of one another. Colors correspond to colors in Figure A-15.

[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).

Figure A-16. City of Powers loss ratio from Cascadia subduction zone event.



Each cell represents 1% of building value, so the grid represents 100% of total building value. The magnitude 9.0 CSZ event is predicted to simultaneously produce a damaging earthquake and tsunami. Hazus-MH modeling for loss ratio is available only for earthquake. Buildings with exposure to the tsunami inundation zone are assumed to be completely damaged, which would be 100% loss ratio. To avoid double counting of buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

†Each cell represents 1% of building value.

= Estimated losses due to tsunami.

= Estimated losses due to earthquake (outside of tsunami zone).

Table A-32. City of Powers critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Tsunami CSZ Mw 9.0 – Medium Exposed	Landslide High and Very High Susceptibility Exposed	Wildfire High Hazard Exposed
Powers Elementary School	—	X	—	—	—
Powers High School	—	X	—	X	—
Powers Police Department	—	X	—	—	—
Powers Volunteer Fire Department	—	X	—	—	—

APPENDIX B. DETAILED RISK ASSESSMENT TABLES

Table B-1. Coos 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 County Total	Building Value ($)	Building Value per County Total
Unincorp. County (rural)	11,513	2,443,296	55%	706	378,565	8.5%	6,655	1,594,035	36%	83	60,989	1.4%	18,957	45%	4,476,885	39%
Bunker Hill	501	91,415	53%	87	52,807	30%	146	19,028	11%	6	10,622	6.1%	740	1.7%	173,872	1.5%
Charleston	889	183,211	59%	107	45,254	15%	545	77,684	25%	8	4,777	1.5%	1,549	3.6%	310,927	2.7%
Glasgow	366	94,263	75%	10	3,624	2.9%	201	25,987	21%	1	1,754	1.4%	578	1.4%	125,629	1.1%
Green Acres	265	58,361	74%	2	2,386	3.0%	98	16,574	21%	2	1,769	2.2%	367	0.9%	79,090	0.7%
Hauser	507	116,877	41%	102	82,673	29%	409	62,173	22%	4	25,154	8.8%	1,022	2.4%	286,877	2.4%
Millington	292	59,020	59%	42	17,903	18%	170	22,548	22%	2	1,099	1.1%	506	1.2%	100,571	0.9%
Total Unincorp. County	14,333	3,046,443	55%	1,056	583,212	11%	8,224	1,818,029	33%	106	106,164	1.9%	23,719	56%	5,553,851	48%
Bandon	1,480	417,147	66%	188	109,241	17%	256	36,430	5.8%	38	66,627	11%	1,962	4.6%	629,445	5.5%
CTCLUSI	19	5,333	43%	6	2,171	17%	5	1,802	14%	3	3,164	25%	33	0.1%	12,470	0.1%
Coos Bay	5,817	1,440,007	59%	557	619,017	26%	728	100,335	4.1%	118	261,220	11%	7,220	17%	2,420,579	21%
Coquille	1,485	345,664	57%	151	129,958	21%	303	38,388	6.3%	38	92,661	15%	1,977	4.6%	606,670	5.3%
Coquille Indian Tribe	88	30,570	38%	5	38,992	48%	1	61	0.1%	6	11,098	14%	100	0.2%	80,721	0.7%
Lakeside	942	164,648	68%	68	20,309	8.4%	391	46,906	19%	20	10,905	4.5%	1,421	3.3%	242,768	2.1%
Myrtle Point	941	223,699	58%	102	67,707	18%	258	44,084	11%	28	48,254	13%	1,329	3.1%	383,743	3.3%
North Bend	3,398	950,809	64%	285	291,672	20%	451	58,263	3.9%	99	194,046	13%	4,233	10%	1,494,790	13%
Powers	352	66,890	60%	13	6,149	5.5%	176	24,443	22%	15	14,033	13%	556	1.3%	111,516	1%
Total Coos County	28,855	6,691,210	58%	2,431	1,868,428	16%	10,793	2,168,741	19%	471	808,172	7.0%	42,550	100%	11,536,553	100%

Table B-2. Cascadia subduction zone earthquake loss estimates.

(all dollar amounts in thousands)

			Total Earthquake Damage*		Earthquake Damage outside of Medium Tsunami Zone							
			Buildings Damaged		Buildings Damaged				Building Design Level Upgraded to at Least Moderate Code			
Community	**Total Number of Buildings**	**Total Estimated Building Value ($)**	**Sum of Economic Loss**	**Loss Ratio**	**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. County (rural)	18,957	4,476,885	1,354,946	30%	1,606	4,256	1,310,768	29%	1,273	2,752	873,272	20%
Bunker Hill	740	173,872	47,261	27%	86	61	37,528	22%	29	35	23,631	14%
Charleston	1,549	310,927	155,594	50%	124	561	99,432	32%	140	417	76,008	24%
Glasgow	578	125,629	24,408	19%	71	94	22,865	18%	21	71	16,247	13%
Green Acres	367	79,090	23,040	29%	25	87	23,040	29%	11	76	18,263	23%
Hauser	1,022	286,877	149,929	52%	91	429	149,929	52%	177	217	85,514	30%
Millington	506	100,571	15,917	16%	73	34	15,917	16%	18	19	8,930	9%
Total Unincorp. County	23,719	5,553,851	1,771,095	32%	2,076	5,522	1,659,479	30%	1,669	3,587	1,101,865	20%
Bandon	1,962	629,445	257,067	41%	142	551	213,771	34%	171	347	131,333	21%
CTCLUSI	33	12,470	4,271	34%	5	10	4,271	34%	3	5	2,026	16%
Coos Bay	7,220	2,420,579	836,100	35%	604	1,423	632,247	26%	464	886	375,844	16%
Coquille	1,977	606,670	131,036	22%	162	195	131,036	22%	62	113	59,419	10%
Coquille Indian Tribe	100	80,721	36,787	46%	10	21	32,707	41%	4	16	26,245	33%
Lakeside	1,421	242,768	96,156	40%	155	511	96,156	40%	186	327	68,136	28%
Myrtle Point	1,329	383,743	154,830	40%	129	339	154,830	40%	105	209	83,263	22%
North Bend	4,233	1,494,790	614,201	41%	328	898	542,929	36%	193	609	319,391	21%
Powers	556	111,516	49,542	44%	48	219	49,542	44%	68	140	32,084	29%
Total Coos County	42,550	11,536,552	3,951,085	34%	3,659	9,689	3,516,968	30%	2,925	6,239	2,199,606	19%

*All losses calculated from earthquake inside or outside of Medium tsunami zone.

Table B-3. Tsunami exposure.

(all dollar amounts in thousands)

			Small (Low Severity)			Medium (Moderate Severity)			Large (High Severity)			X Large (Very High Severity)			XX Large (Extreme Severity)		
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	Number of Buildings	Building Value ($)	Percent of Building Value Exposed	Number of Buildings	Building Value ($)	Percent of Building Value Exposed
Unincorp. County (rural)	18,957	4,476,885	234	46,762	1.0%	418	94,049	2.1%	918	200,079	4.5%	2,015	464,241	10%	2,337	544,997	12%
Bunker Hill	740	173,872	1	418	0.2%	6	10,370	6.0%	71	40,907	24%	96	45,748	26%	107	48,463	28%
Charleston	1,549	310,927	247	78,239	25%	267	82,989	27%	465	123,141	40%	1,122	235,075	76%	1,238	254,901	82%
Glasgow	578	125,629	5	407	0.3%	13	2,537	2.0%	24	4,838	3.9%	37	8,339	7%	42	9,270	7.4%
Green Acres	367	79,090	0	0	0%	0	0	0%	0	0	0%	32	5,177	6.5%	45	8,693	11%
Hauser	1,022	286,877	0	0	0%	0	0	0%	1	11	0%	19	16,933	5.9%	52	38,178	13%
Millington	506	100,571	0	0	0%	0	0	0%	3	506	0.5%	44	13,191	13%	54	14,961	15%
Total Unincorp. County	23,719	5,553,851	487	125,826	2.3%	704	189,945	3.4%	1,482	369,482	6.7%	3,365	788,704	14%	3,875	919,463	17%
Bandon	1,962	629,445	145	49,200	7.8%	185	64,742	10%	276	91,553	15%	925	285,412	45%	1,374	431,860	69%
CTCLUSI	33	12,470	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Coos Bay	7,220	2,420,579	79	43,133	1.8%	319	267,595	11%	624	455,071	19%	1,018	578,485	24%	1,238	634,178	26%
Coquille	1,977	606,670	0	0	0%	0	0	0%	0	0	0%	0	0	0%	1	447	0.1%
Coquille Indian Tribe	100	80,721	0	0	0%	3	4,147	5.1%	6	44,153	55%	37	56,737	70%	44	58,670	73%
Lakeside	1,421	242,768	0	0	0%	0	0	0%	7	4,044	1.7%	43	10,543	4.3%	76	16,944	7.0%
Myrtle Point	1,329	383,743	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%
North Bend	4,233	1,494,790	23	6,110	0.4%	75	85,107	5.7%	263	168,526	11%	558	304,613	20%	608	316,952	21%
Powers	556	111,516	0	0	0%	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Total Coos County	42,550	11,536,553	734	224,269	1.9%	1,286	611,536	5.3%	2,658	1,132,829	9.8%	5,946	2,024,494	18%	7,216	2,378,514	21%

Table B-4. 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. County (rural)	18,957	4,476,885	602	27,673	0.6%	825	45,993	1.0%	890	58,390	1.3%	948	79,270	1.8%
Bunker Hill	740	173,872	33	1,463	0.8%	41	2,465	1.4%	50	3,061	1.8%	52	4,379	2.5%
Charleston	1,549	310,927	14	1,050	0.3%	17	1,324	0.4%	18	1,381	0.4%	20	1,517	0.5%
Glasgow	578	125,629	7	120	0.1%	9	183	0.1%	9	227	0.2%	10	292	0.2%
Green Acres	367	79,090	12	485	0.6%	15	613	0.8%	16	681	0.9%	22	877	1.1%
Hauser	1,022	286,877	6	931	0.3%	7	1,475	0.5%	8	1,738	0.6%	8	2,148	0.7%
Millington	506	100,571	6	191	0.2%	11	449	0.4%	13	586	0.6%	18	853	0.8%
Total Unincorp. County	23,719	5,553,851	680	31,913	0.6%	925	52,502	0.9%	1,004	66,064	1.2%	1,078	89,336	1.6%
Bandon	1,962	629,445	21	544	0.1%	74	2,774	0.4%	94	3,855	0.6%	110	6,028	1.0%
CTCLUSI	33	12,470	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Coos Bay	7,220	2,420,579	344	25,021	1.0%	436	36,201	1.5%	468	42,299	1.7%	490	54,591	2.3%
Coquille	1,977	606,670	8	415	0.1%	19	799	0.1%	23	1,207	0.2%	23	1,619	0.3%
Coquille Indian Tribe	100	80,721	0	0	0%	0	0	0%	1	2	0%	1	9	0%
Lakeside	1,421	242,768	49	2,033	0.8%	119	4,044	1.7%	171	5,768	2.4%	248	9,661	4.0%
Myrtle Point	1,329	383,743	17	197	0.1%	60	1,474	0.4%	80	3,081	0.8%	88	5,224	1.4%
North Bend	4,233	1,494,790	12	385	0%	24	1,852	0.1%	27	3,063	0.2%	32	5,360	0.4%
Powers	556	111,516	0	0	0%	0	0	0%	2	11	0%	4	157	0.1%
Total Coos County	42,550	11,536,553	1,131	60,508	0.5%	1,657	99,646	0.9%	1,870	125,350	1.1%	2,074	171,985	1.5%

*1% results include coastal flooding source.

Table B-5. Flood exposure.

			1% (100-yr)*				
Community	**Total Number of Buildings**	**Total Population**	**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. County (rural)	18,957	18,664	763	4.1%	938	4.9%	48
Bunker Hill	740	1,376	22	1.6%	53	7.2%	3
Charleston	1,549	2,228	37	1.7%	20	1.3%	2
Glasgow	578	757	6	0.7%	10	1.7%	1
Green Acres	367	406	15	3.6%	21	5.7%	5
Hauser	1,022	1,145	11	1.0%	8	0.8%	0
Millington	506	666	13	1.9%	14	2.8%	1
Total Unincorp. County	23,719	25,242	867	3.4%	1,064	4.5%	60
Bandon	1,962	3,066	60	2.0%	123	6.3%	29
CTCLUSI	33	47	0	0%	0	0%	0
Coos Bay	7,220	15,966	773	4.8%	493	6.8%	25
Coquille	1,977	3,866	24	0.6%	23	1.2%	0
Coquille Indian Tribe	100	313	0	0.0%	1	1.0%	0
Lakeside	1,421	1,699	253	15%	233	16%	62
Myrtle Point	1,329	2,514	119	4.7%	85	6.4%	5
North Bend	4,233	9,651	18	0.2%	29	0.7%	2
Powers	556	687	4	0.6%	4	0.7%	2
Total Coos County	42,550	63,051	2,118	3.4%	2,055	4.8%	185

*1% results include coastal flooding source.

Table B-6. Landslide exposure.

(all dollar amounts in thousands)

Community	Total Number of Buildings	Total Estimated Building Value ($)	Very High Susceptibility			High Susceptibility			Moderate Susceptibility		
			Number of Buildings	Building Value ($)	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. County (rural)	18,957	4,476,885	1,406	314,141	7.0%	2,343	468,534	11%	6,435	1,372,990	31%
Bunker Hill	740	173,872	0	0	0%	42	7,681	4.4%	255	44,854	26%
Charleston	1,549	310,927	0	0	0%	85	16,793	5.4%	304	61,103	20%
Glasgow	578	125,629	131	26,504	21%	63	10,971	8.7%	198	39,009	31%
Green Acres	367	79,090	100	21,050	27%	206	44,330	56%	24	4,008	5.1%
Hauser	1,022	286,877	3	415	0%	99	20,502	7.1%	452	96,894	34%
Millington	506	100,571	4	942	0.9%	63	12,892	13%	110	19,876	20%
Total Unincorp. County	23,719	5,553,851	1,644	363,052	6.5%	2,901	581,703	11%	7,778	1,638,734	30%
Bandon	1,962	629,445	4	672	0.1%	47	12,707	2.0%	285	84,494	13%
CTCLUSI	33	12,470	0	0	0%	0	0	0%	20	5,935	48%
Coos Bay	7,220	2,420,579	15	4,255	0.2%	1,875	473,037	20%	1,701	484,382	20%
Coquille	1,977	606,670	4	1,179	0.2%	198	42,747	7.0%	982	263,510	43%
Coquille Indian Tribe	100	80,721	0	0	0%	1	291	0.4%	32	8,147	10%
Lakeside	1,421	242,768	0	0	0%	105	20,042	8.3%	192	34,725	14%
Myrtle Point	1,329	383,743	64	14,091	3.7%	67	16,518	4.3%	622	158,591	41%
North Bend	4,233	1,494,790	0	0	0%	179	49,187	3.3%	1,401	422,578	28%
Powers	556	111,516	0	0	0%	19	4,102	3.7%	85	16,701	15%
Total Coos County	42,550	11,536,553	1,731	383,249	3.3%	5,392	1,200,334	10%	13,098	3,117,797	27%

Table B-7. Wildfire exposure.

			(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**
Unincorp. County (rural)	18,957	4,476,885	402	86,157	1.9%	8,603	1,904,749	43%
Bunker Hill	740	173,872	92	15,762	9.1%	257	50,895	29%
Charleston	1,549	310,927	39	8,259	2.7%	858	154,453	50%
Glasgow	578	125,629	2	550	0.4%	286	65,751	52%
Green Acres	367	79,090	27	6,098	7.7%	189	38,881	49%
Hauser	1,022	286,877	123	29,007	10%	591	115,620	40%
Millington	506	100,571	90	14,703	15%	177	30,871	31%
Total Unincorp. County	23,719	5,553,851	775	160,536	2.9%	10,961	2,361,220	43%
Bandon	1,962	629,445	45	11,825	1.9%	892	254,314	40%
CTCLUSI	33	12,470	0	0	0%	7	1,921	15%
Coos Bay	7,220	2,420,579	163	32,642	1.3%	1,649	493,509	20%
Coquille	1,977	606,670	22	5,181	0.9%	681	181,451	30%
Coquille Indian Tribe	100	80,721	1	61	0.1%	78	27,107	34%
Lakeside	1,421	242,768	43	6,144	2.5%	792	131,891	54%
Myrtle Point	1,329	383,743	0	0	0%	532	121,994	32%
North Bend	4,233	1,494,790	0	0	0%	805	269,076	18%
Powers	556	111,516	1	135	0.1%	293	50,668	45%
Total Coos County	42,550	11,536,553	1,050	216,524	1.9%	16,690	3,893,151	34%

APPENDIX C. HAZUS-MH METHODOLOGY

C.1 Software

We performed all loss estimations using Hazus®-MH 3.0 and ArcGIS® Desktop® 10.2.2.

C.2 User-Defined Facilities (UDF) Database

We compiled a UDF database for all buildings in Coos County for use in both flood and earthquake modules of Hazus-MH. We used the Coos County assessor database (acquired in 2015) to determine which tax lots had improvements (i.e., buildings) and how many building points should be included in the UDF database.

C.2.1 Locating buildings points

We used the existing DOGAMI dataset of building footprints (unpublished) to help precisely locate the centroid of each building. Where the building footprint dataset lacked coverage in the eastern portion of the county, we used the centroid of the tax lot; for tax lots larger than 10 acres the building centroid was corrected by using orthoimagery. Extra effort was spent to locate building points along the 1% and 0.2% annual chance inundation fringe. For buildings partially within the inundation zone, we moved the building point to the centroid of the portion of the building within the inundation zone. We used an iterative approach 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

We populated the required attributes for Hazus-MH through a variety of approaches. We used the Coos County assessor database wherever 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 positions 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 = nonprofit/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 Coos County assessor database. Where data were not available, the default value of RES1 was applied throughout.
- **Cost** – The cost of an individual UDF. Loss ratio is derived from this value. The value was obtained from the Coos County assessor database. Where not available, cost was based on the square footage of the building footprint or from the square footage found in the Coos County assessor

database. When multiple UDFs occupied a single tax lot, the overall cost of the tax lot was distributed to the UDFs based on square footage.

- **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 Coos County assessor database. Where not available the year of "1900" was applied (12% of the UDFs).
- **Square feet** – The size of the UDF is used to pro-rate the total improvement value for tax lots with multiple UDFs. The value distribution method will ensure that UDFs with the highest square footage will be the most expensive on a given tax lot. 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 Coos 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 Coos County assessor database where available. For UDFs without assessor information for number of stories that are within the flood zone, closer inspection using the Google Street View™ mapping service 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, 2012c]). 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 Coos County assessor database where available. For UDFs without assessor information for basements that are within the flood zone, closer inspection using Google Street View™ mapping service or available oblique imagery was used to ascertain basement presence.
- **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: Hazus-MH overlays a UDF location on a depth grid and by using the **First floor height** determines the level of flooding occurring to a building. The **First floor height** is derived from the **Foundation type** attribute (Coos County assessor data) or observation via oblique imagery or the 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 to estimate earthquake losses by determining which damage function will be applied. This information was not in the Coos County assessor data, so instead Building type 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. (see "Seismic building codes" section below for more informatio*n*). This information is derived from the **Year built** attribute (Coos Assessor) and state 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 number of people affected by a given hazard. This attribute is derived from the default Hazus-MH database (United States Census Bureau, 2010a) of population per census block and distributed across residential UDFs.

- **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 Coos County. **Table C-1** outlines the benchmark years that apply to buildings within Coos County.

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

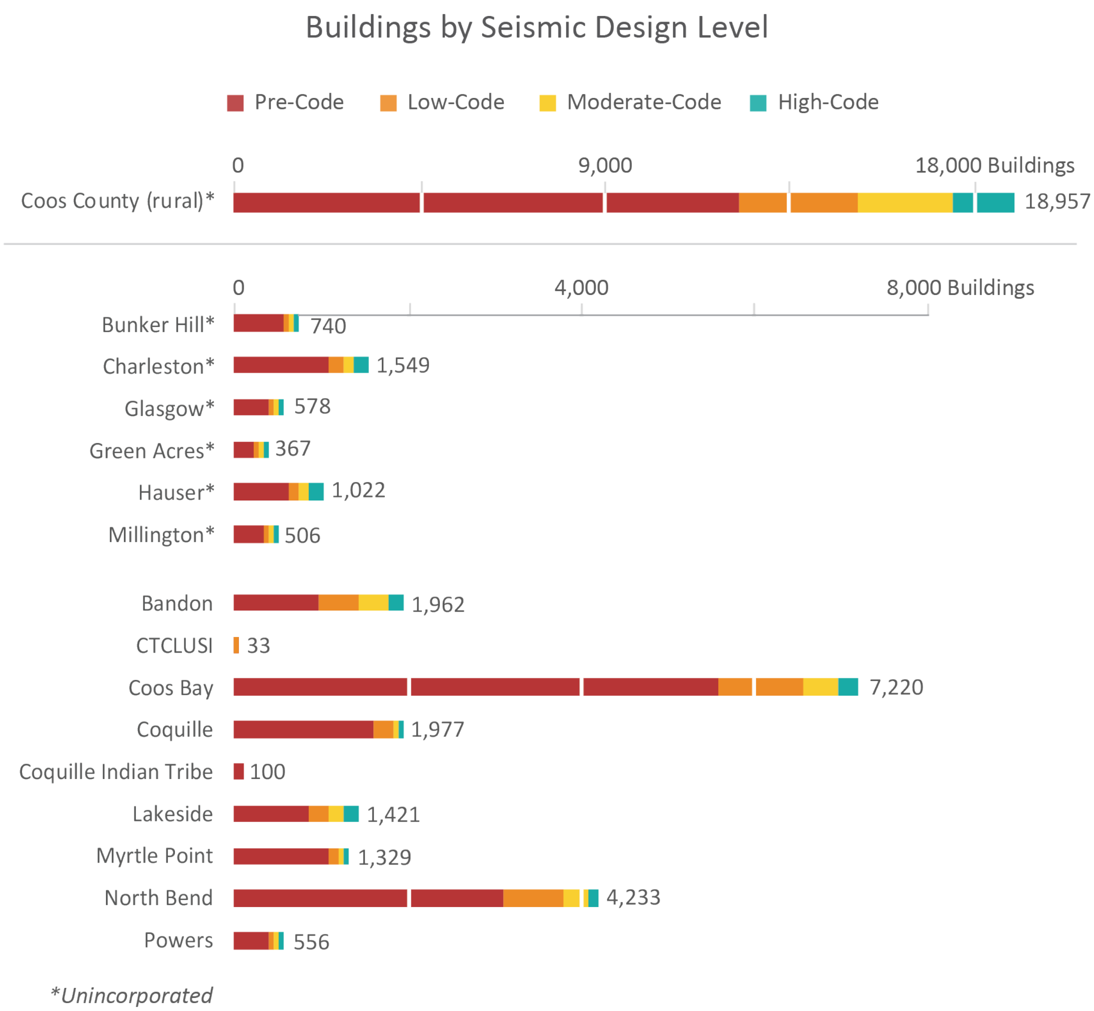
Building Type	Year Built	Design Level	Basis
Single Family Dwelling (includes Duplexes)	prior to 1976 1976–1991 1992–2003 2004–2016	Pre-Code Low-Code Moderate-Code High-Code	Interpretation of Judson (Judson, 2012)
Manufactured Housing	prior to 2003 2003–2010	Pre-Code Low-Code	Interpretation of OR BCD 2002 Manufactured Dwelling Special Codes (Oregon Building Codes Division, 2002)
	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 1976–1990 1991–2018	Pre-Code Low-Code Moderate-Code	Business Oregon 2014-0311 Oregon Benefit-Cost Analysis Tool, p. 24 (Business Oregon, 2015)

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 Coos County.

		Pre-Code		Low-Code		Moderate-Code		High-Code	
Community	**Total Number of Buildings**	**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. County (rural)	18,957	12,240	65%	2,906	15%	2,284	12%	1,527	8.1%
Bunker Hill	740	593	80%	77	10%	35	4.7%	35	4.7%
Charleston	1,549	1,094	71%	164	11%	152	10%	139	9.0%
Glasgow	578	422	73%	55	10%	63	11%	38	6.6%
Green Acres	367	268	73%	39	11%	38	10%	22	6.0%
Hauser	1,022	657	64%	127	12%	98	10%	140	14%
Millington	506	386	76%	31	6.1%	44	8.7%	45	8.9%
Total Unincorp. County	23,719	15,660	66%	3,399	14%	2,714	11%	1,946	8.2%
Bandon	1,962	991	51%	478	24%	297	15%	196	10%
CTCLUSI	33	22	67%	11	33%	0	0%	0	0%
Coos Bay	7,220	5,611	78%	952	13%	396	5.5%	261	3.6%
Coquille	1,977	1,624	82%	212	11%	86	4.4%	55	2.8%
Coquille Indian Tribe	100	100	100%	0	0%	0	0%	0	0%
Lakeside	1,421	870	61%	215	15%	183	13%	153	11%
Myrtle Point	1,329	1,081	81%	154	12%	55	4.1%	39	2.9%
North Bend	4,233	3,124	74%	664	16%	296	7.0%	149	3.5%
Powers	556	433	78%	63	11%	38	6.8%	22	4.0%
Total Coos County	42,550	29,516	69%	6,148	14%	4,065	10%	2,821	6.6%

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



C.3 Flood Hazard Data

DOGAMI developed flood hazard data in 2012 for a revision of the Coos County FEMA FIS (FEMA, 2014). The hazard data were based on a combination of previous flood studies and new riverine and coastal hydrologic and hydraulic analyses. For riverine areas, flood elevations for the 10-, 50-, 100-, and 500-year events for each stream cross-section were used to develop depth of flooding raster datasets or "depth grids." For coastal zones and other stillwater flood areas, a 100-year stillwater elevation was used to create the depth grid.

A countywide, 2-meter (~6.5 foot), 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. 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

Several data layers were used for the deterministic analysis conducted for this report. Data layers created for the ORP (Madin and Burns, 2013) provided most of the earthquake inputs for the CSZ magnitude 9.0 event modeled in Hazus-MH. Liquefaction susceptibility data came directly from the ORP, but site ground motion data (PGA: peak ground acceleration; PGV: peak ground velocity; SA10 and SA03: spectral acceleration at 1.0 second period and 0.3 second period) were derived from NEHRP site class soil data. The GIS procedure used to amplify the site ground motion data from NEHRP soil data are described in Appendix B of Bauer and others (2018): Site Ground Motion and Ground Deformation Map Development. The landslide susceptibility data from the ORP were replaced with newer and more accurate data (Burns and others, 2016).

The hazard layers were formatted for use in a Python script developed by DOGAMI to apply the Hazus-MH methodology. The earthquake hazard datasets used in the analysis were: ground motion data (PGA, PGV, SA03, and SA10), a landslide susceptibility map, and liquefaction susceptibility map. Permanent ground deformation (PGD) for landslide and liquefaction were both calculated using Hazus-MH methodology for each of the susceptibility maps. In addition to the earthquake data layers, Hazus-MH requires a water table parameter for PGD due to liquefaction. As water table data were unavailable, we set the water table value to a depth of 5 feet (1.5 meters).

A deterministic method for a CSZ Mw 9.0 event was deemed the most likely and impactful earthquake scenario for Coos County. Past work has shown that probabilistic models of a 500-year event for this area are roughly the same as the CSZ Mw 9.0 event.

During the Hazus-MH earthquake analysis, each UDF was analyzed given its site-specific parameters (ground motion and 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 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 tax lot 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

CPAC	Community Planning Advisory Committee
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
RFPD	Rural Fire Protection District
Risk MAP	Risk Mapping, Assessment, and Planning
SHMO	State Hazard Mitigation Officer
SLIDO	State Landslide Information Layer for Oregon
SLR	Sea level rise
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% 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% chance of being equaled or exceeded each year. Sometimes referred to as the 500-year flood.

Base flood elevation (BFE) – Elevation of the 1%-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 Special Flood Hazard Areas (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.

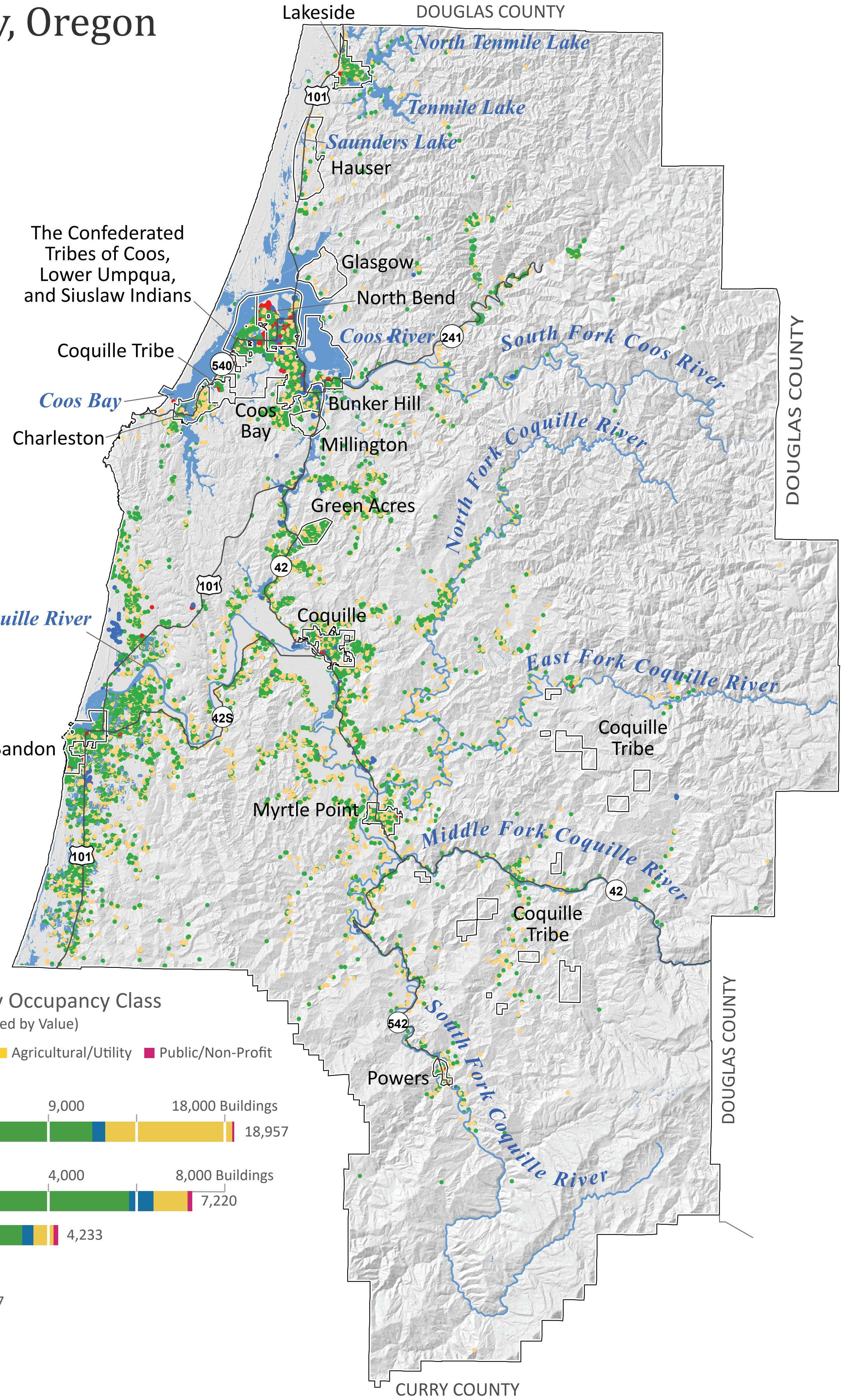
APPENDIX E. MAP PLATES

See appendix folder for individual map PDFs.

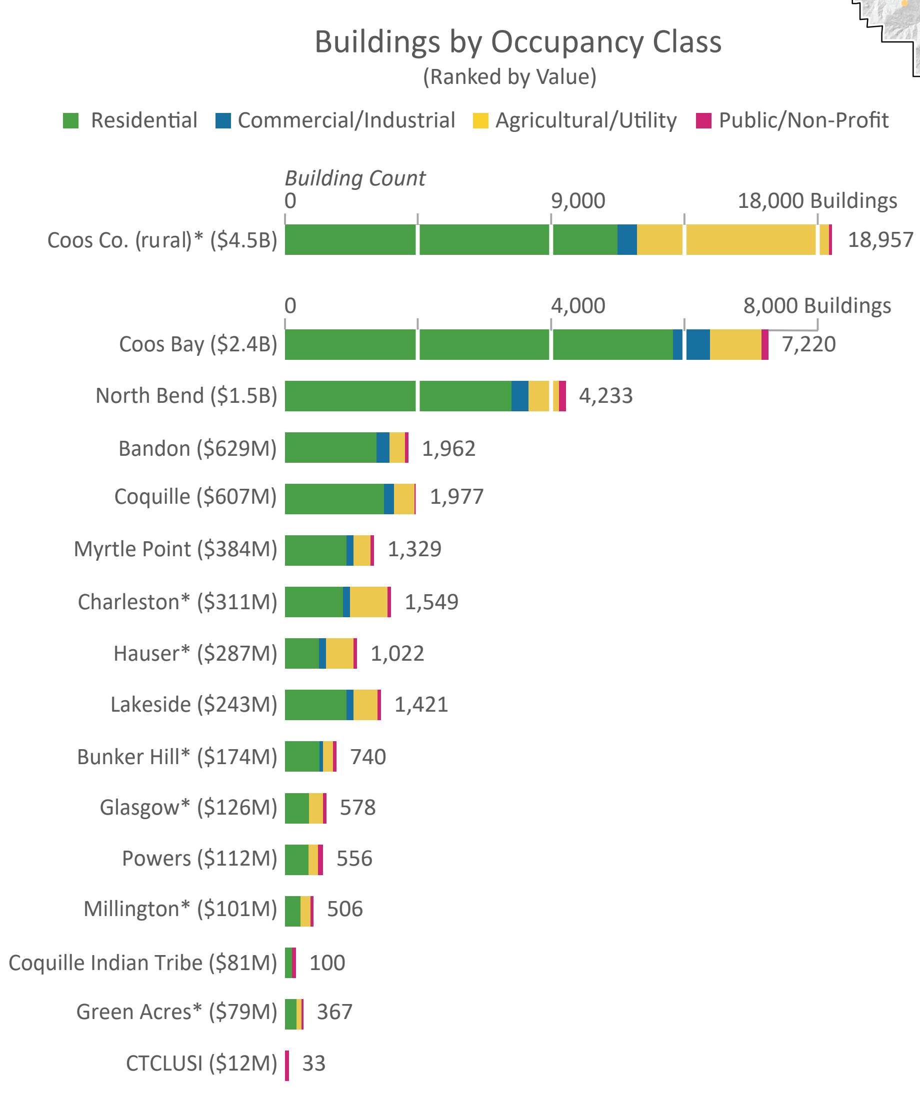
PLATE 1

Building Distribution Map of Coos County, Oregon

Building Occupancy
- Agricultural / Utility
- Commercial & Industrial
- Public & Non Profit
- Residential



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



Study Location Map

Data Sources:
Building footprints: Oregon Department of Geology (2010)
Roads: Oregon Department of Transportation (2014)
Place names: U.S. Geological Survey Geograpic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: U.S. Geological Survey and Oregon Lidar Consortium (2012)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 UTM Zone 10N
Software: Esri® ArcMap 10, Adobe® Illustrator CS6

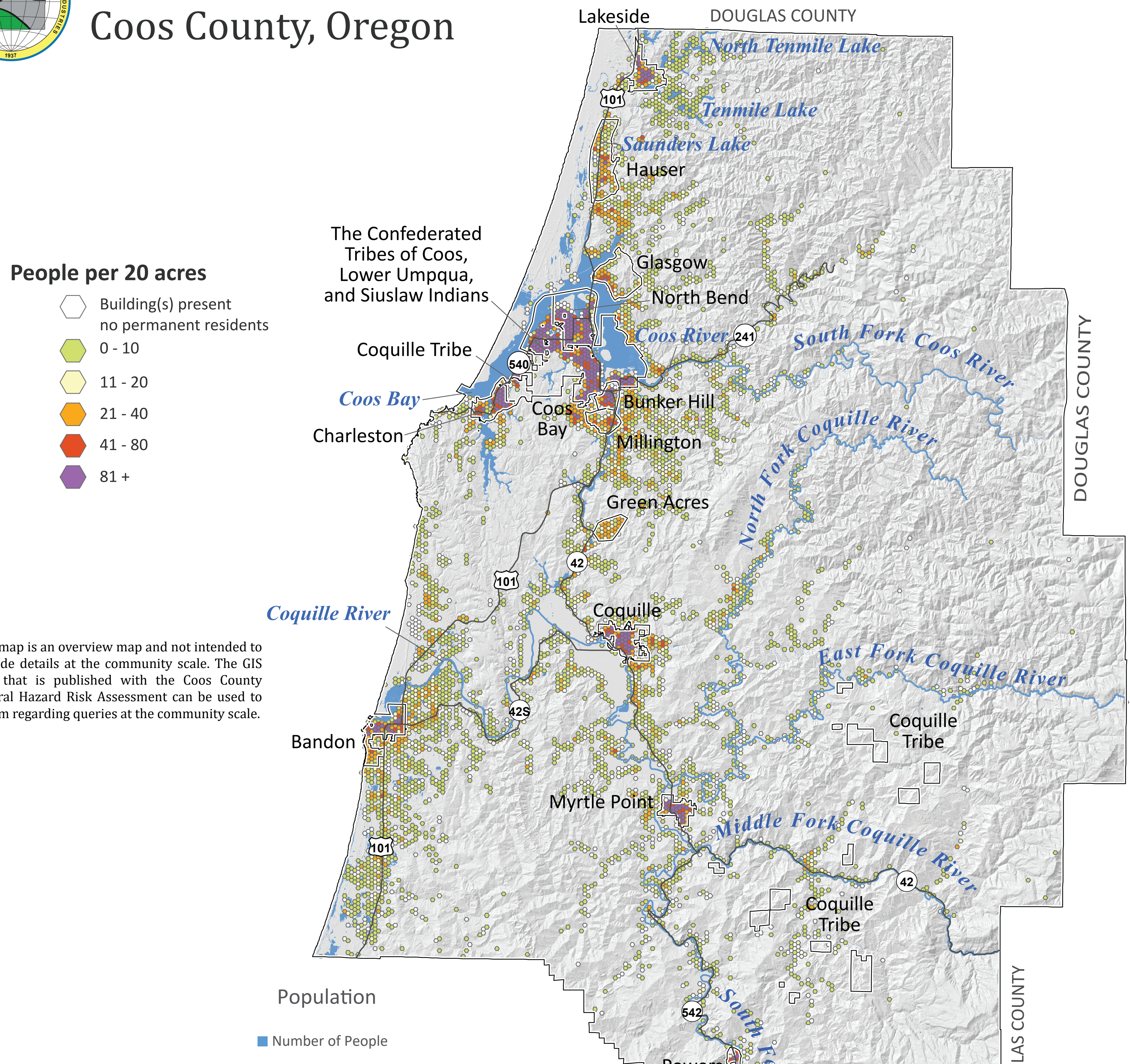
Cartography by: Lowell H. Anthony, 2018

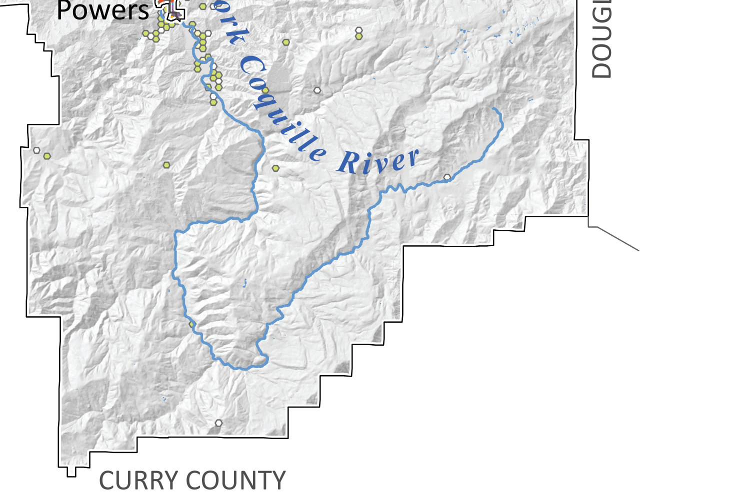
Disclaimer: This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information. This publication cannot substitute for site-specific investigations by qualified practitioners. Site-specific 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.

N
0 2.5 5 Miles
0 4 8 Kilometers

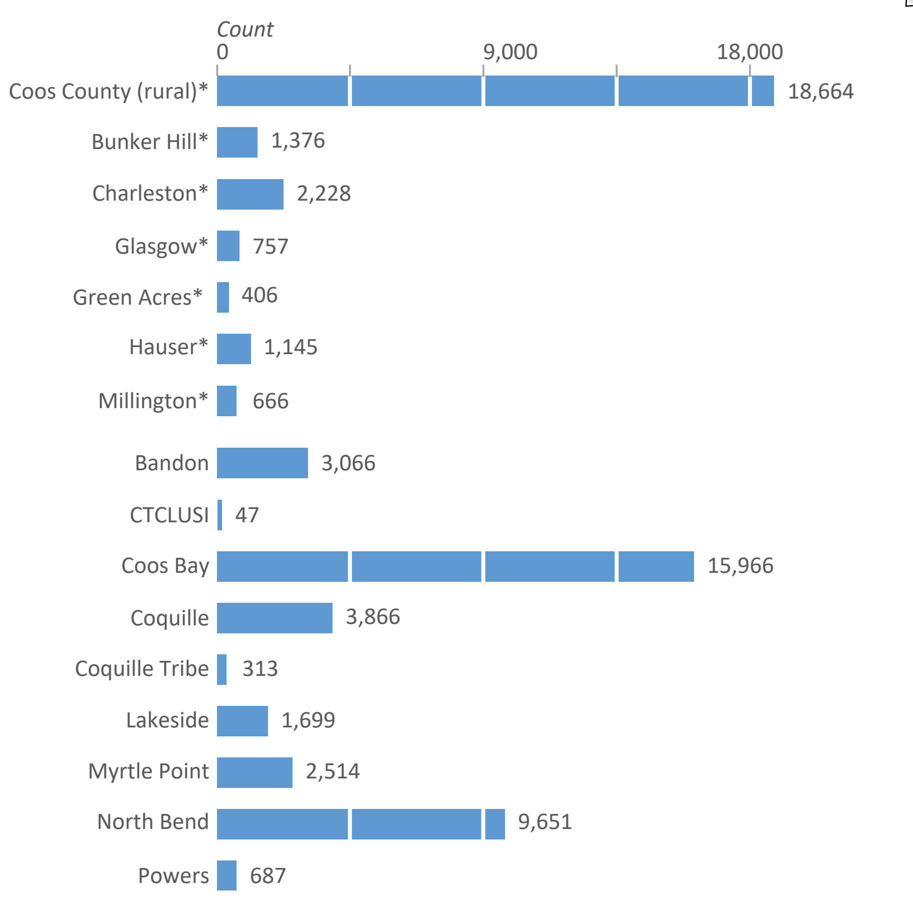
PLATE 2

Population Density Map of Coos County, Oregon





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



Data Sources:
Population data: U.S. Census (2010)
Roads: Oregon Department of Transportation (2014)
Place names: U.S. Geological Survey Geograpic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: U.S. Geological Survey and Oregon Lidar Consortium (2012)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 UTM Zone 10N
Software: Esri® ArcMap 10, Adobe® Illustrator CS6

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N
0 2.5 5 Miles
0 4 8 Kilometers

PLATE 3

Mw 9.0 CSZ Earthquake Shaking Map of Coos County, Oregon

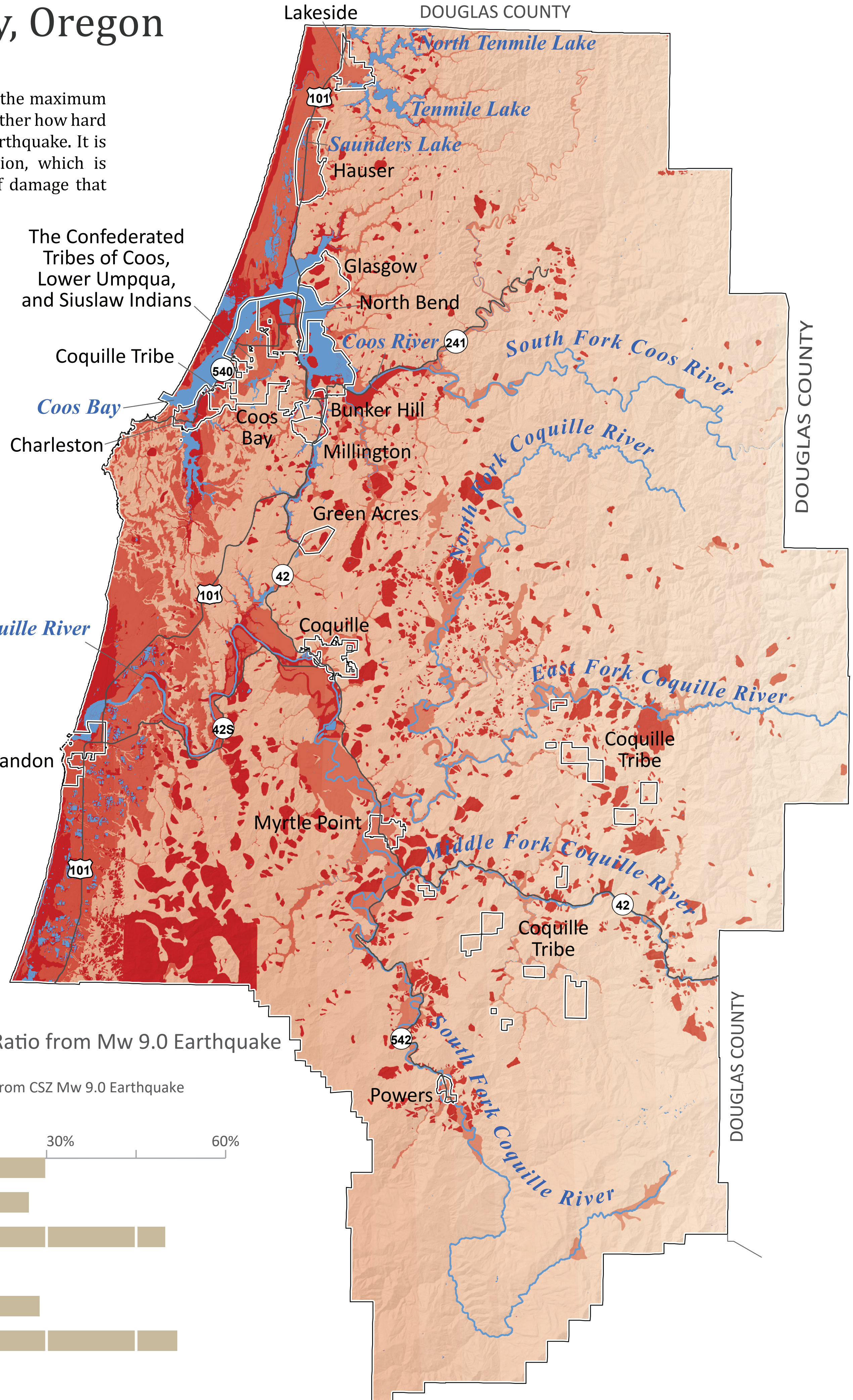
Peak Ground Acceleration (PGA) is the maximum acceleration in a given location or rather how hard the ground is shaking during an earthquake. It is one measurement of ground motion, which is closely associated with the level of damage that occurs from an earthquake.

Earthquake Peak Ground Acceleration

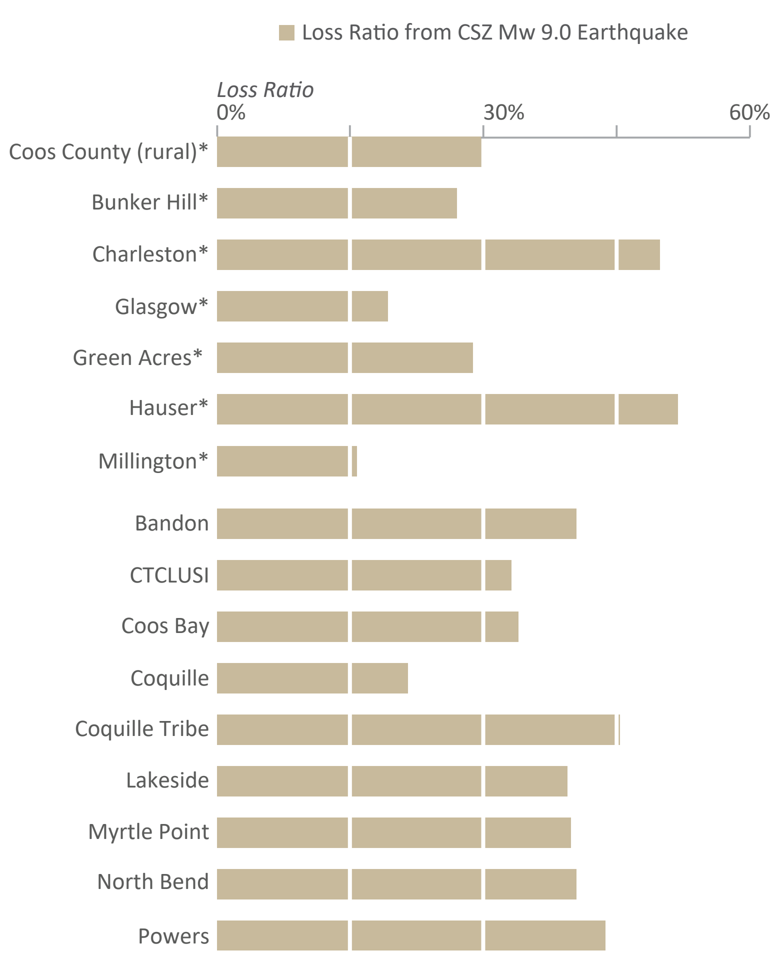
(Correlated Modified Mercalli Scale)

Very Strong — Severe

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



Total Building Value Loss Ratio from Mw 9.0 Earthquake



*Unincorporated

Study Location Map

Data Sources:
Earthquake peak ground acceleration: Oregon Department of Geology, Appleby and Bauer, unpub. data (2018)
Roads: Oregon Department of Transportation (2014)
Place names: U.S. Geological Survey Geograpic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: U.S. Geological Survey and Oregon Lidar Consortium (2012)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 UTM Zone 10N
Software: Esri® ArcMap 10, Adobe® Illustrator CS6
Cartography by: Lowell H. Anthony, 2018

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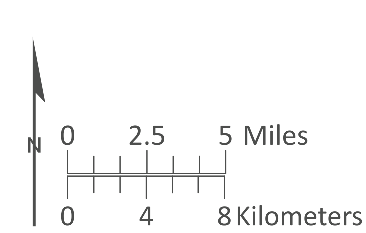


PLATE 4

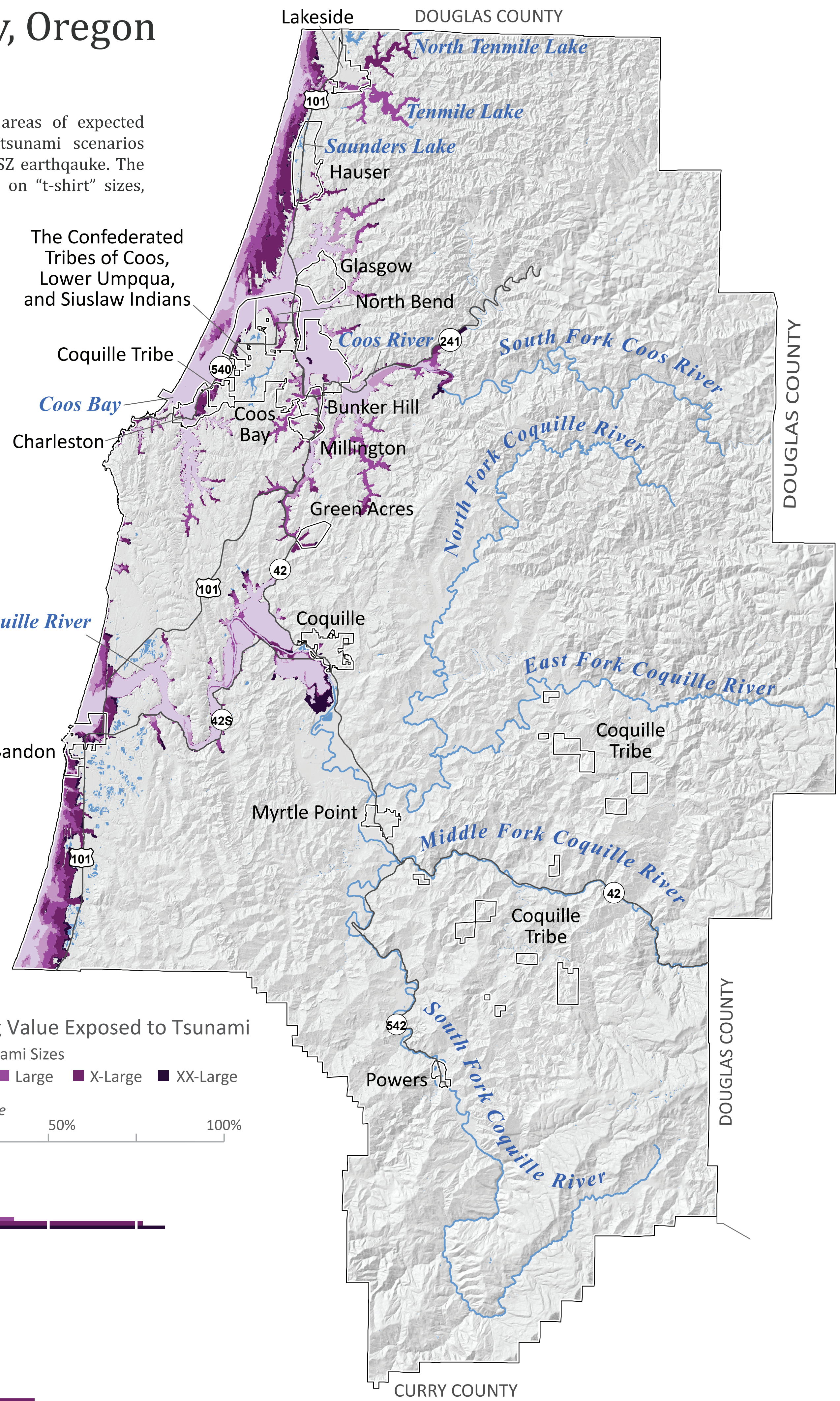
Tsunami Inundation Map of Coos County, Oregon

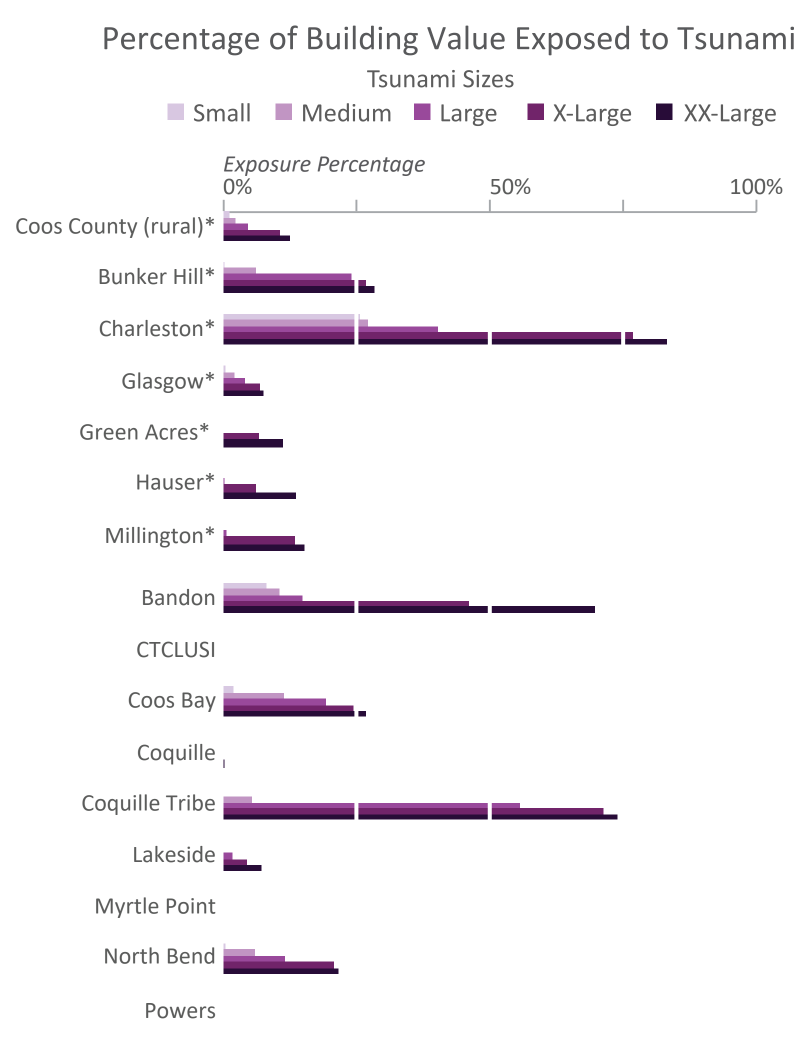
The tsunami hazard data show areas of expected innundation from several local tsunami scenarios produced from a magnitude 9.0 CSZ earthqauke. The scenarios were categorized based on "t-shirt" sizes, ranging from Small to XX-Large

Tsunami Hazard Zone

- Small
- Medium
- Large
- X-Large
- XX-Large

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





Data Sources:
Tsunami hazard zones: Oregon Department of Geology, Priest and others (2013)
Roads: Oregon Department of Transportation (2014)
Place names: U.S. Geological Survey Geograpic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: U.S. Geological Survey and Oregon Lidar Consortium (2012)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 UTM Zone 10N
Software: Esri® ArcMap 10, Adobe® Illustrator CS6
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PLATE 5

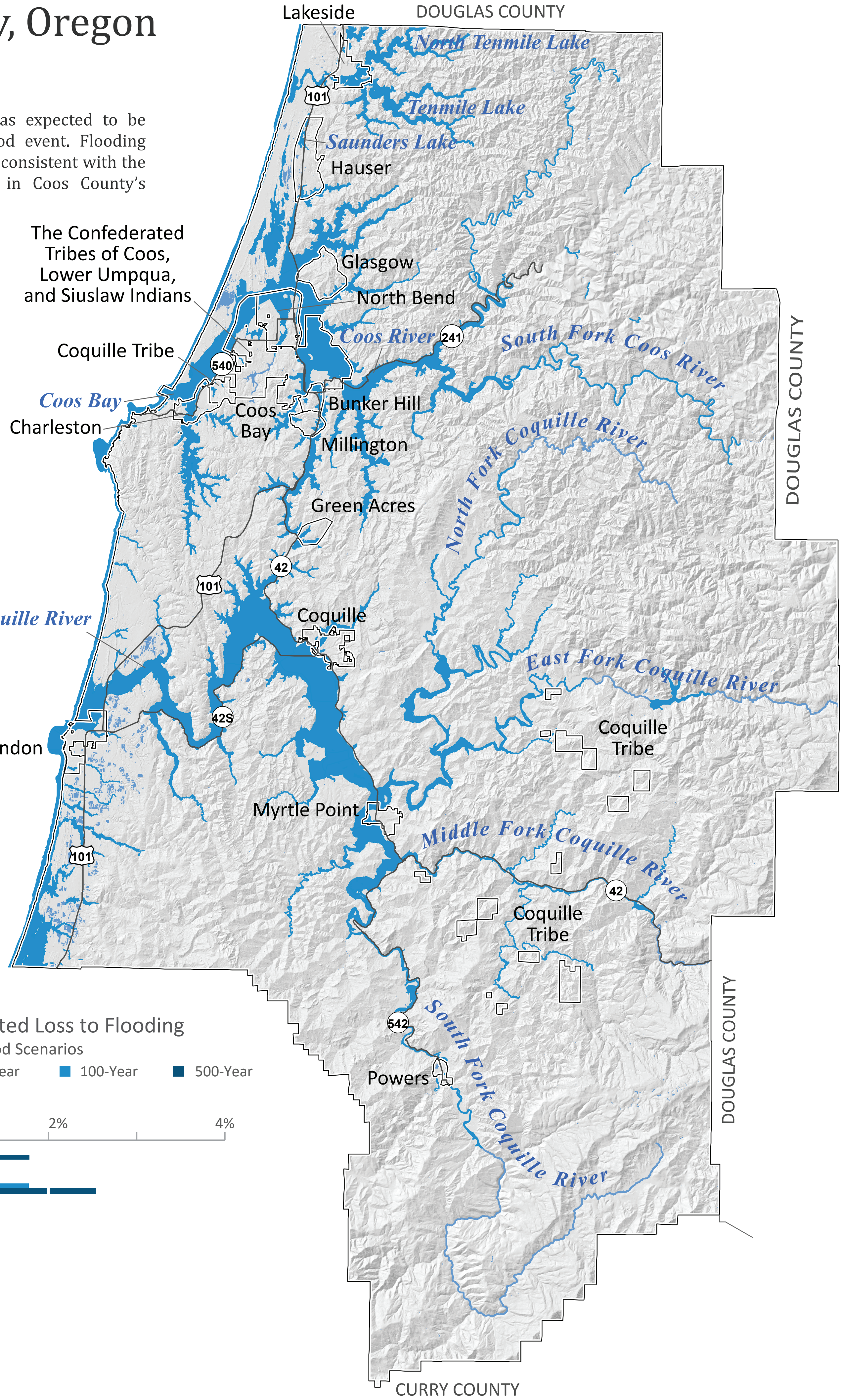
Flood Hazard Map of Coos County, Oregon

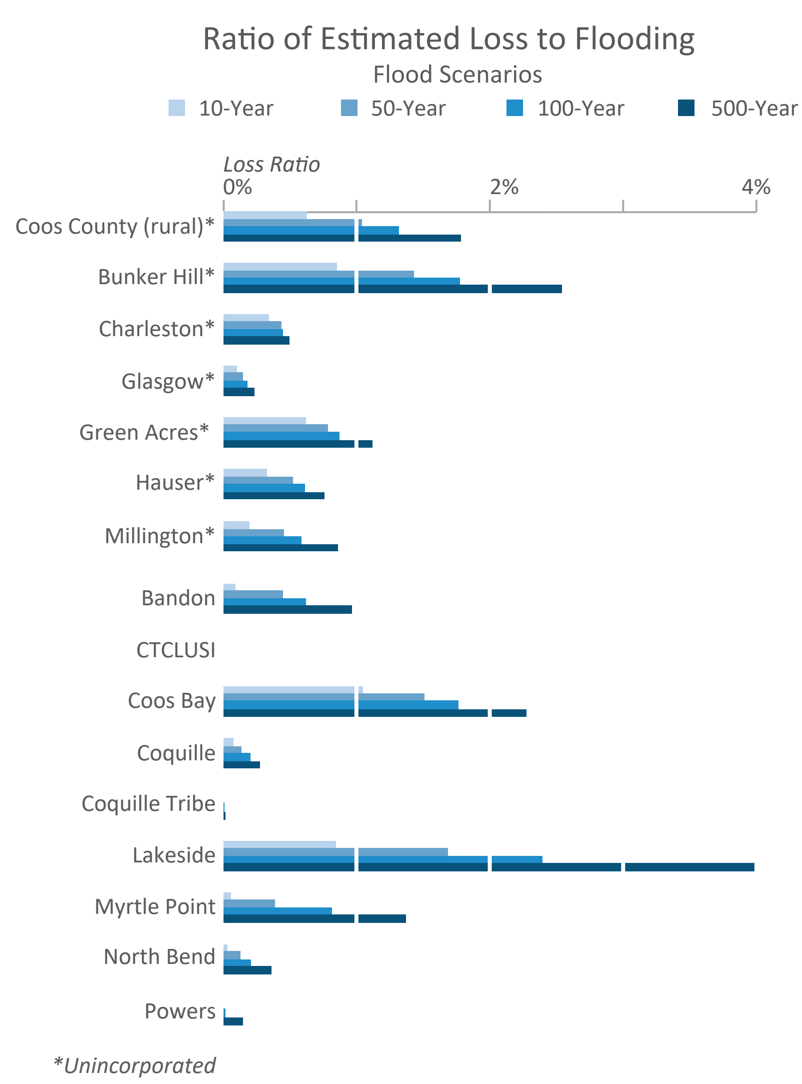
The flood hazard data show areas expected to be inundated during a 100-year flood event. Flooding sources include riverine. Areas are consistent with the regulatory flood zones depicted in Coos County's Digital Flood Insurance Rate Maps.

Flood Hazard Zone

100-Year Flood (1% annual chance)

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





Study Location Map

Data Sources:
Flood hazard zone (100-year): Coos County Flood Insurance Rate Map (2018)
Roads: Oregon Department of Transportation (2014)
Place names: U.S. Geological Survey Geograpic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: U.S. Geological Survey and Oregon Lidar Consortium (2012)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 UTM Zone 10N
Software: Esri® ArcMap 10, Adobe® Illustrator CS6

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N
0 2.5 5 Miles
0 4 8 Kilometers

PLATE 6

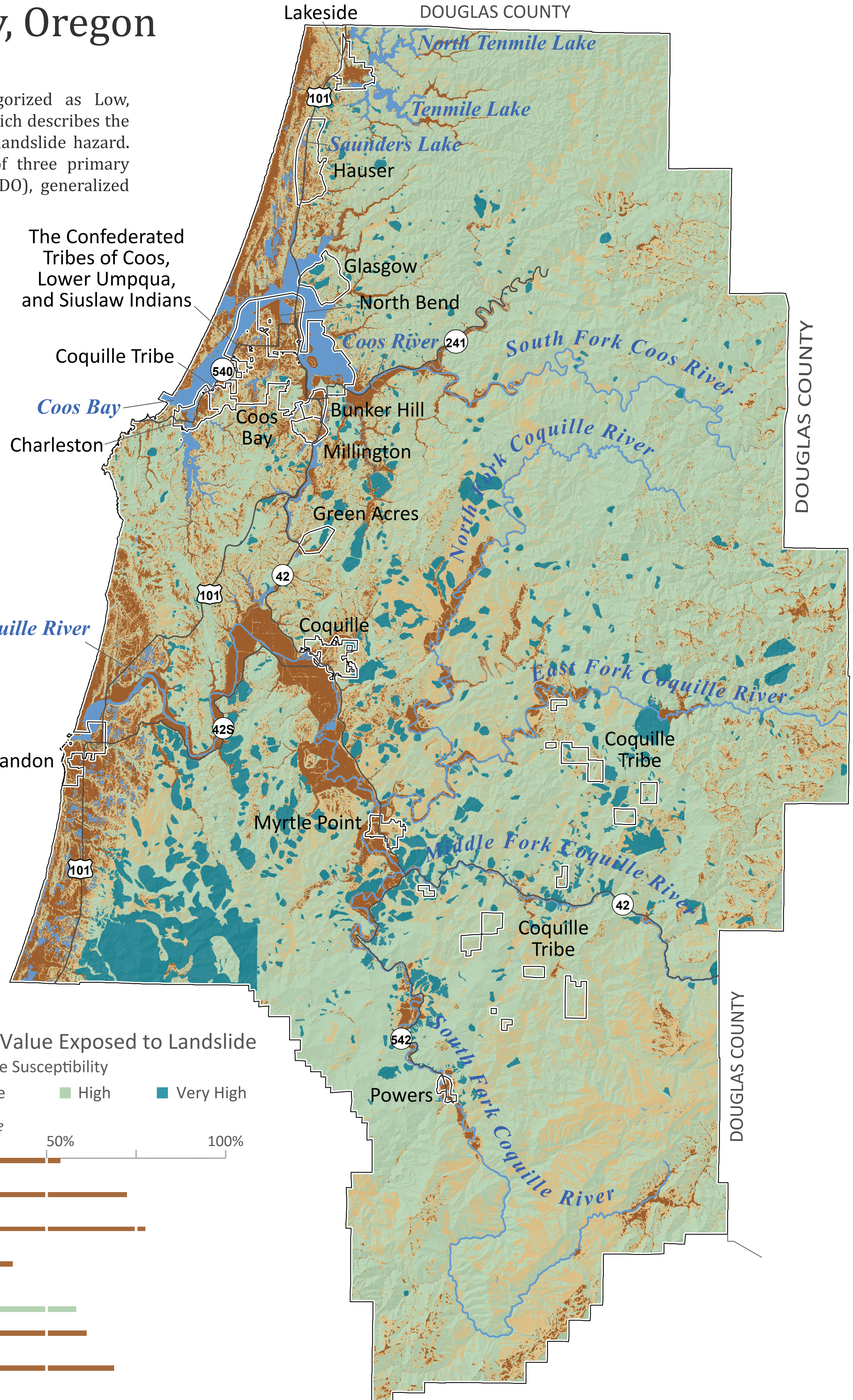
Landslide Susceptibility Map of Coos County, Oregon

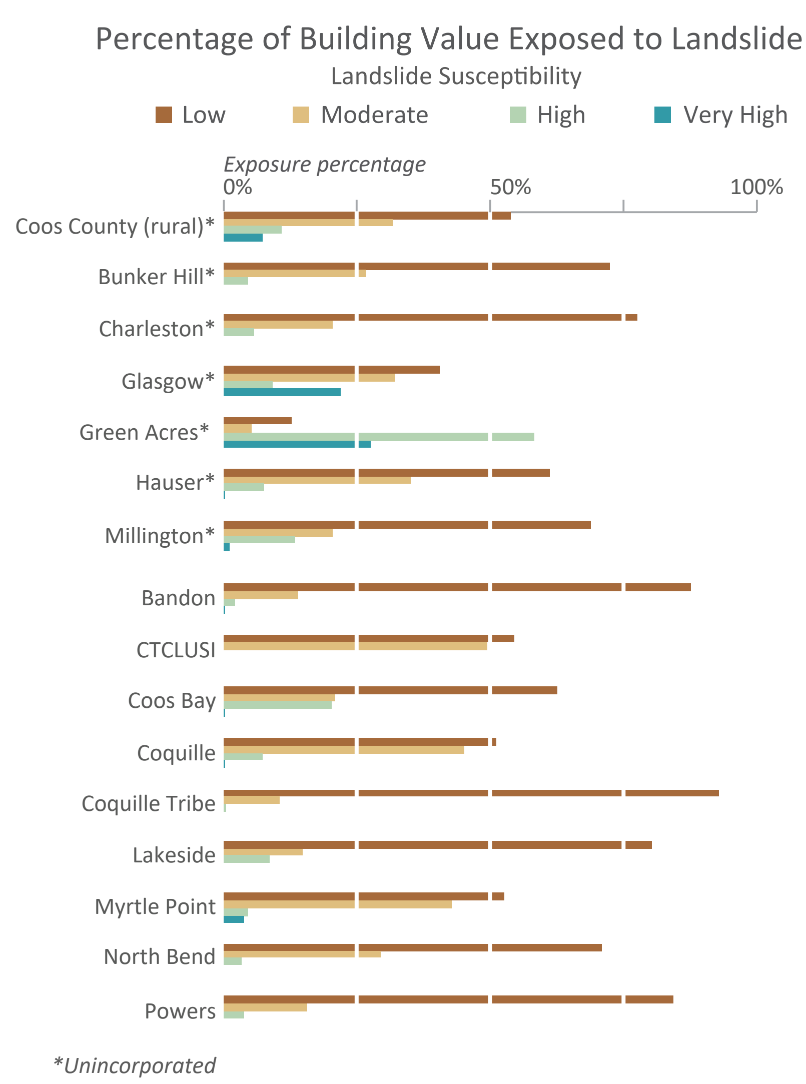
Landslide susceptibility is categorized as Low, Moderate, High, and Very High which describes the general level of susceptibility to landslide hazard. The dataset is an aggregation of three primary sources: landslide inventory (SLIDO), generalized geology, and slope.

Landslide Susceptibility

- Low
- Moderate
- High
- Very High

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





Study Location Map

Data Sources:
Landslide susceptibility: Oregon Department of Geology, Burns and others (2016)
Roads: Oregon Department of Transportation (2014)
Place names: U.S. Geological Survey Geograpic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: U.S. Geological Survey and Oregon Lidar Consortium (2012)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 UTM Zone 10N
Software: Esri® ArcMap 10, Adobe® Illustrator CS6

Cartography by: Lowell H. Anthony, 2018

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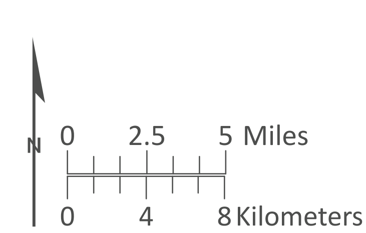


PLATE 7

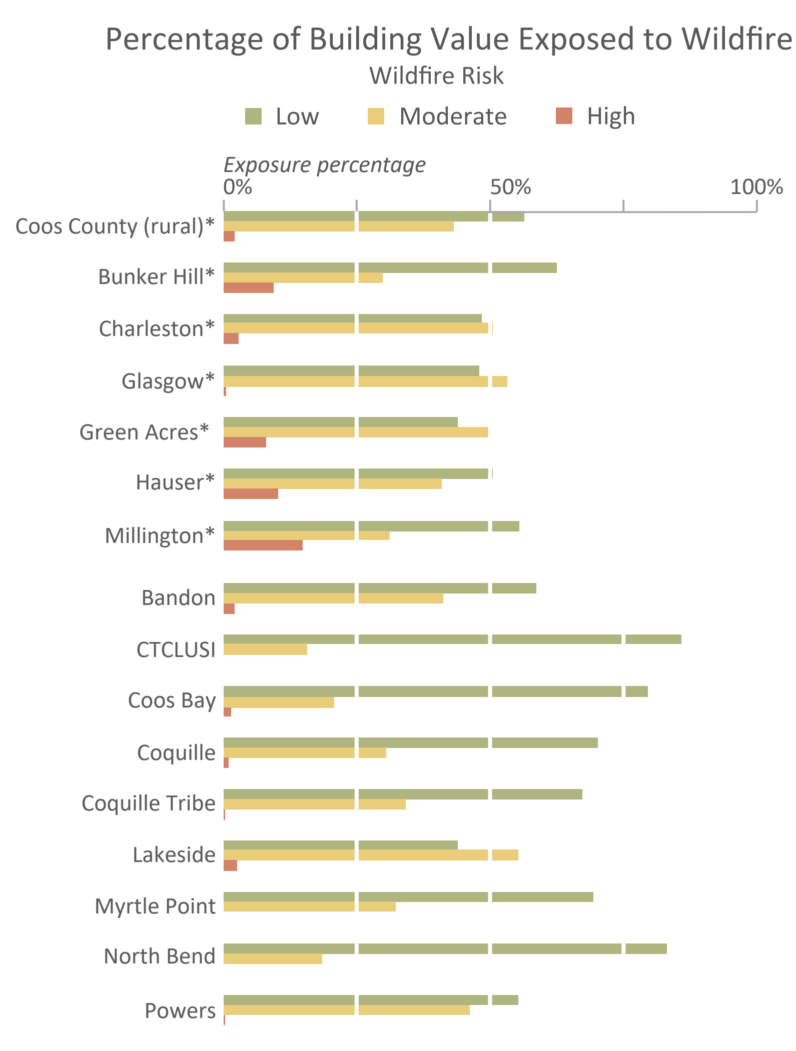
Wildfire Risk Map of Coos County, Oregon

Wildfire Risk is categorized as Low, Moderate, and High and indicates the level of risk a location has to wildfire hazard. The Wildfire Risk data layer (Fire Risk Index) is derived from a combination of the Fire Threat Index (fire history and behavior) and the Fire Effects Index (infrastructure and assets).

Wildfire Risk

- Low
- Moderate
- High

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



Study Location Map

Data Sources:
Wildfire risk data: Oregon Department of Forestry, Sanborn Map Company, Inc. (2013)
Roads: Oregon Department of Transportation (2014)
Place names: U.S. Geological Survey Geograpic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: U.S. Geological Survey and Oregon Lidar Consortium (2012)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 UTM Zone 10N
Software: Esri® ArcMap 10, Adobe® Illustrator CS6
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N
0 2.5 5 Miles
0 4 8 Kilometers