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

OPEN-FILE REPORT O-20-15

NATURAL HAZARD RISK REPORT FOR CURRY COUNTY, OREGON

INCLUDING THE CITIES OF BROOKINGS, GOLD BEACH, PORT ORFORD AND UNINCORPORATED COMMUNITIES OF HARBOR AND NESIKA BEACH

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2020

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DISCLAIMER

Cover photo: Aerial image of Garrison Lake and the shoreline at Port Orford, Oregon.
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WHAT'S IN THIS REPORT?

This report describes the methods and results of a natural hazard risk assessment for Curry 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 is embedded in the geodatabase and is also provided as separate .xml format files.

Curry_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_10yr
  - FL_Depth_50yr
  - FL_Depth_100yr
  - FL_Depth_500yr

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 Curry 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 2016 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 assessment.

To complete the first task, we created a comprehensive asset database for the entire study area by synthesizing assessor data, U.S. Census information, 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 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; 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 FEMA Hazus®-MH methodology, and (2) calculated number of buildings, their value, and associated populations exposed to earthquake, tsunami, flood, landslides, coastal erosion, and wildfire hazards.

The findings and conclusions of this report show the potential impacts of hazards in communities within Curry County. A Cascadia Subduction Zone (CSZ) event (earthquake and tsunami) will cause extensive damage and losses throughout the county. Our findings also indicate that most of the study area's critical facilities are at high risk to a CSZ event. We also found that the two biggest causes of population displacement are a CSZ event (earthquake and tsunami) and landslide hazard. 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. The risk from coastal erosion is higher for the community of Nesika Beach than others part of Curry County. During the time of writing, the best available data show that wildfire risk is moderate for the overall study area. Lastly, we demonstrate that this risk assessment can be a valuable tool for local decision-makers.

Results were broken out for the following geographic areas:

- Unincorporated Curry County (rural)
- Community of Nesika Beach
- City of Gold Beach
- Community of Harbor
- City of Brookings
- City of Port Orford

Selected Countywide Results
Total buildings: 20,767
Total estimated building value: $1.6 billion

Cascadia Subduction Zone Magnitude 9.0 Earthquake[a]
Red-tagged buildings[b]: 5,924
Yellow-tagged buildings[c]: 2,277
Loss estimate: $451 million

Cascadia Subduction Zone Tsunami Inundation (Medium-sized)
Number of buildings exposed: 1,755
Exposed building value: $169 million

100-year Flood Scenario
Number of buildings damaged: 410
Loss estimate: $5.9 million

Landslide Exposure (High and Very High-Susceptibility)
Number of buildings exposed: 3,969
Exposed building value: $309 million

Coastal Erosion Exposure (Moderate-Hazard)
Number of buildings exposed: 107
Exposed building value: $19 million

Wildfire Exposure (High Hazard)
Number of buildings exposed: 303
Exposed building value: $25 million

[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 M9.0 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 risk assessment analyzes how a hazard could affect the built environment, population, and local economy 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.

This is the first natural hazard risk assessment analyzing individual buildings and resident population in Curry 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 Curry County communities.

The Oregon coast and the Klamath Mountains are subject to several significant natural hazards, including riverine and coastal flooding, earthquake, tsunami, landslides, coastal erosion, and wildfire. This region of the state is moderately developed, mostly in the cities and unincorporated communities. 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. Two primary methods (Hazus-MH or exposure), depending on the type of hazard, were used to assess risk. We describe the methods for creating the building and population information used in this project. 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

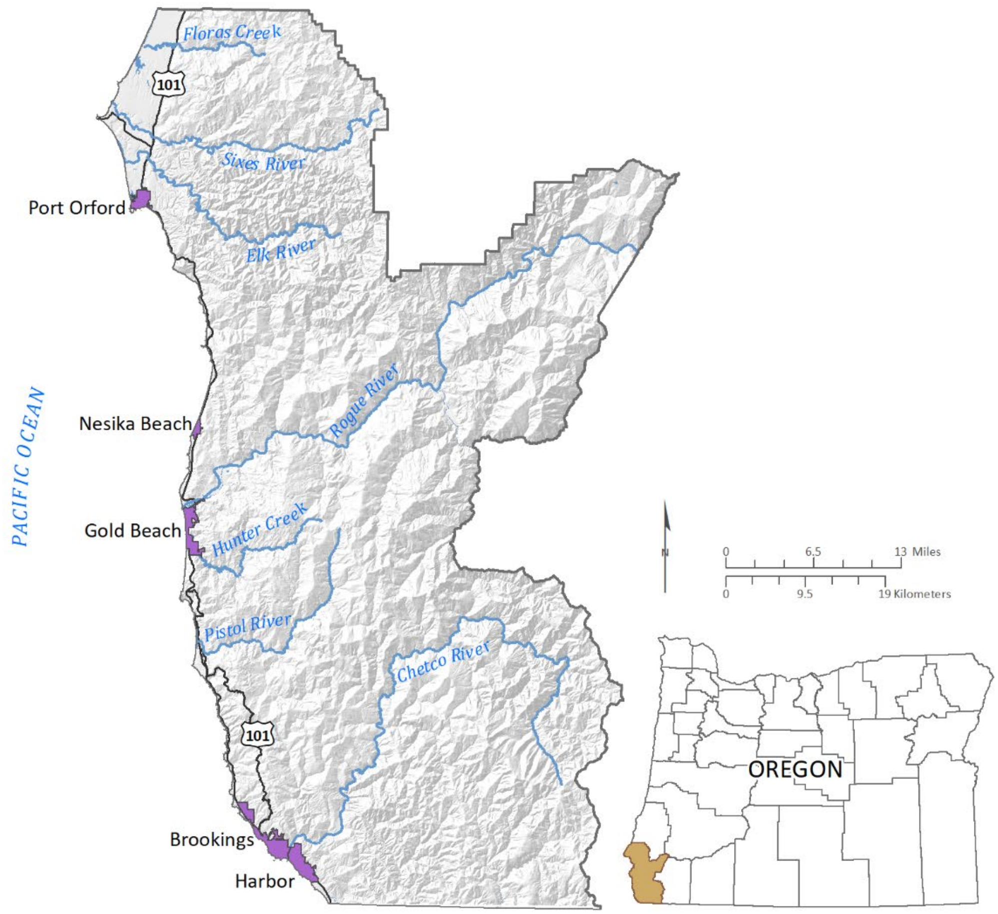
The study area for this project is the entirety of Curry County, Oregon. Curry County is a coastal county located in southwestern Oregon and is bordered by Coos County to the north, Douglas County to the northeast, Josephine County to the east, California to the south, and by the Pacific Ocean to the west. The total area of Curry County is 1,648 square miles (4,268 square kilometers). A significant portion of the county is within the Rogue River – Siskiyou National Forest.

The geography consists of a rugged coastline of bluffs, flat coastal inlands in the northwest, dune-backed beaches, and rocky offshore islands that make up the county's western boundary. Farther inland to the east and south, the Oregon Coast Range and the Klamath Mountains make up a large portion of the county.

The population of Curry County is 22,364 according to the 2010 U.S. Census (2010a). The county's largest community is the City of Brookings, and the county seat is the City of Gold Beach. All the communities in the study, incorporated and unincorporated, are located in the western portion of the county within a few miles of the Pacific Ocean. The incorporated communities are Brookings, Gold Beach, and Port Orford (**Figure 1-1**). The unincorporated communities are Harbor and Nesika Beach.

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 generally on the 2010 census block areas.

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



1.3 Project Scope

For this risk assessment, we took a quantitative approach and applied it to buildings and population. The decision to limit the project scope to buildings and population was driven by data availability, 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 Curry 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 (M) 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)

Coastal Erosion Risk Assessment

- Exposure based on coastal erosion zones (none to high)

Wildfire Risk Assessment

- Exposure based on fire risk index (low to high)

Table 1-1. Hazard data sources in Curry County.

Hazard	Scenario or Classes	Scale/Level of Detail	Data Source
Earthquake (includes liquefaction and coseismic landslides)	CSZ M9.0	Statewide	DOGAMI (Madin and Burns, 2013)
	Liquefaction	Coastal Curry Co.	DOGAMI – unpublished dataset (I. P. Madin, written communication, 2015)
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 (2018) data, included in GIS data for this report
Landslide*	Susceptibility (Low, Moderate, High, Very High)	Statewide	DOGAMI (Burns and others, 2016)
Coastal Erosion	Susceptibility (Not Exposed, Low, Moderate, High)	Portion of the coast within Curry County	DOGAMI (Priest and others, 2004)
Wildfire	Risk (Low, Moderate, High)	Regional (Western United States)	ODF (Sanborn Map Company, Inc., 2013)

CSZ M9.0 is Cascadia subduction zone magnitude 9 earthquake.

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

1.4 Previous Studies

One previous risk assessment that included Curry County has been conducted 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 Curry County had a very high loss ratio relative to most counties in the state.

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).

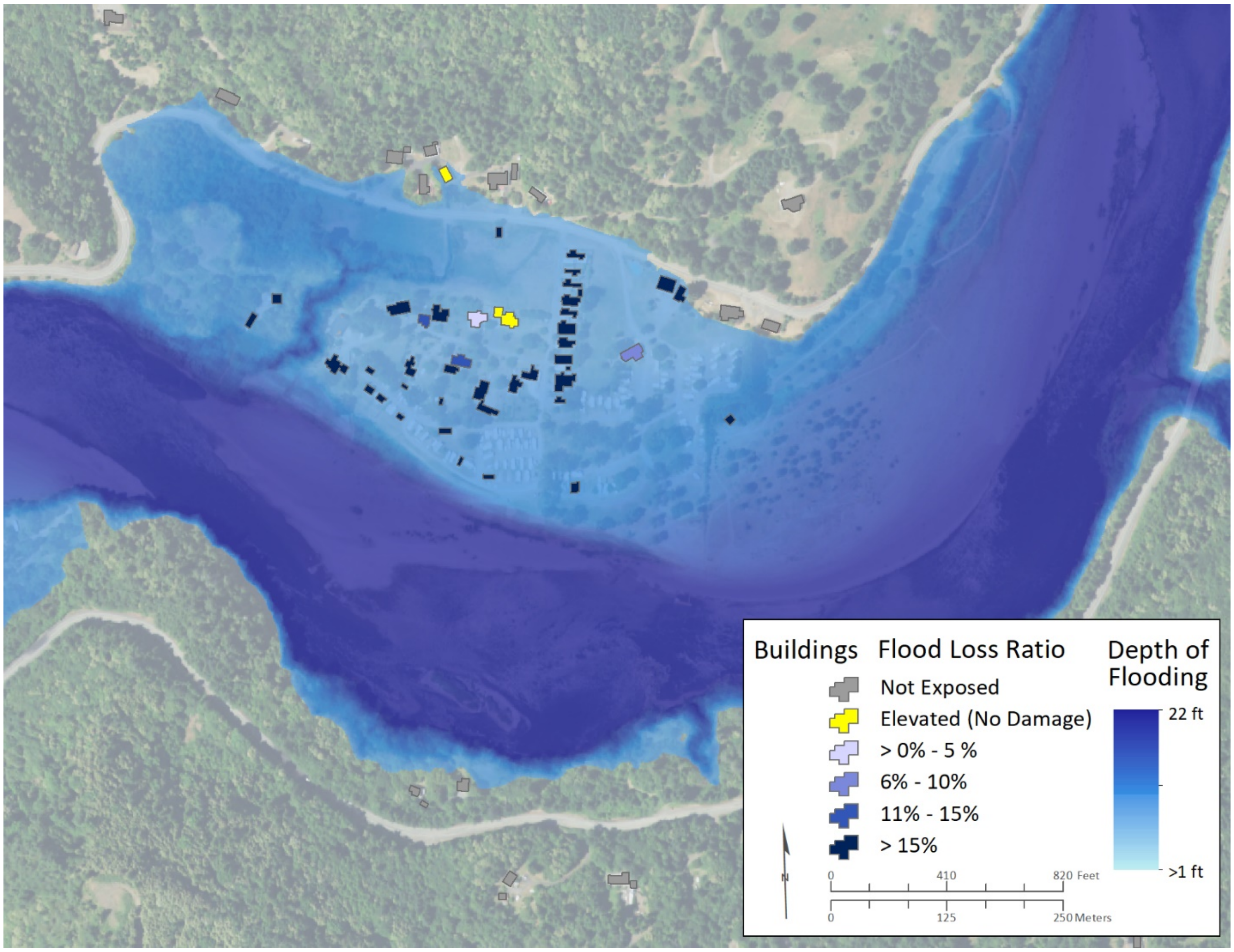
Hazus-MH can be used in different modes depending on the level of detail required. Given the high spatial precision of the building inventory data and quality of the natural hazard data, DOGAMI chose the user-defined facility (UDF) mode. This mode makes loss estimations for individual buildings relative 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. Within the UDF mode, DOGAMI derived cost from the assessed value rather than replacement cost due to the accessibility of Curry County’s assessor data.

The drawback of using the assessed value of a building is that the value of a building fluctuates based on the housing market from year to year, which is a different amount than how much it would cost to rebuild or repair a building. Loss estimations based on replacement cost are closer to the cost of recovery from a flood or earthquake. For Hazus-MH analysis using cost derived from assessed value, the loss estimation provides a better picture on the impact to the county’s tax revenue.

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 unincorporated Curry County (rural).



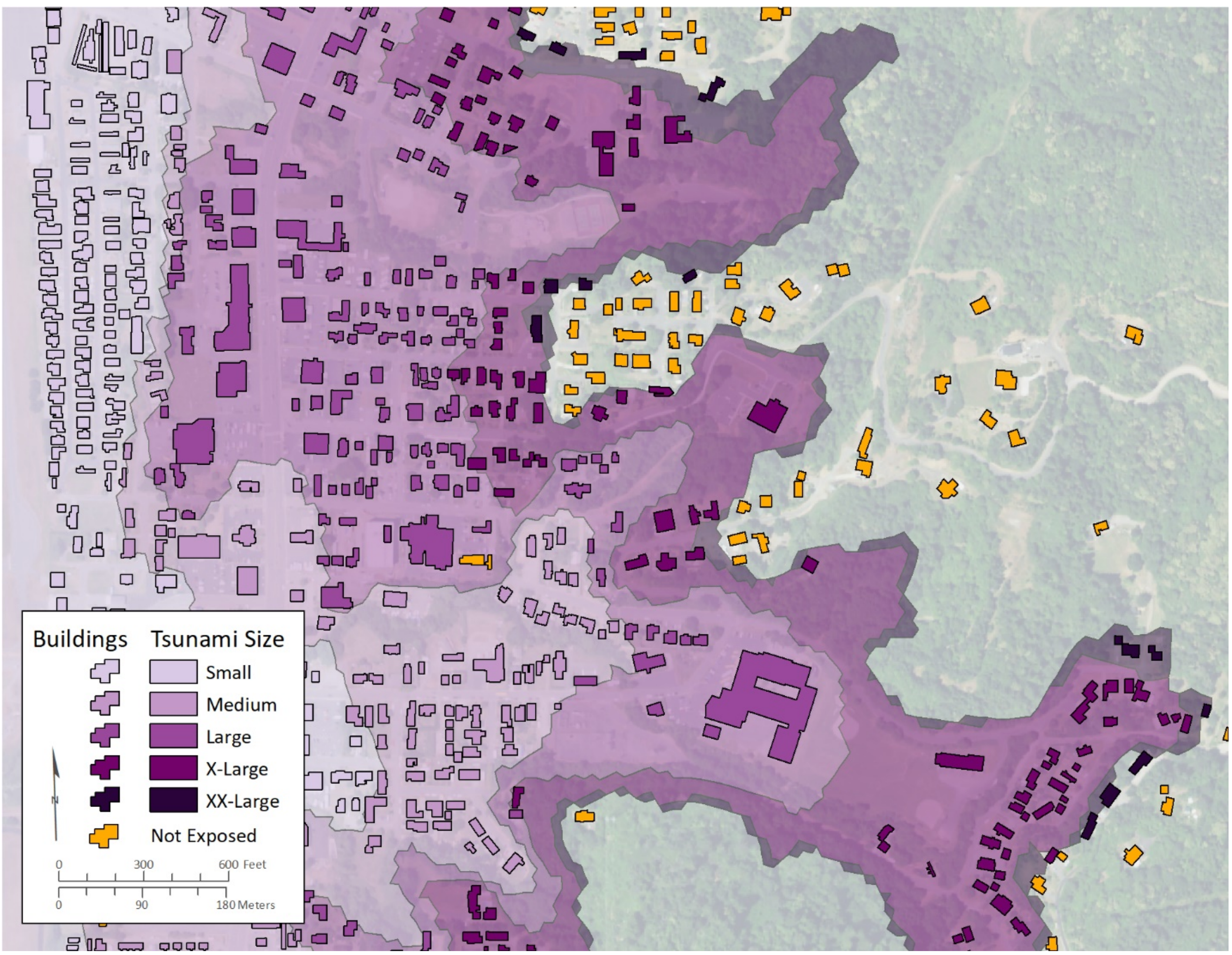
2.2 Exposure

> ***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 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.

Exposure is used for tsunami, landslide, coastal erosion, 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 City of Gold Beach. 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 (46.5 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 Curry County. See also Appendix E, **Plate 1** and **Plate 2**.

To use the building inventory within the Hazus-MH methodology, we converted the building footprints to points and migrated them into a UDF database with standardized field names and attribute domains. The UDF database formatting allows for the correct damage function to be applied to each building. Hazus-MH version 2.1 technical manuals (FEMA, 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 Appendix **C.2.2**.

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

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

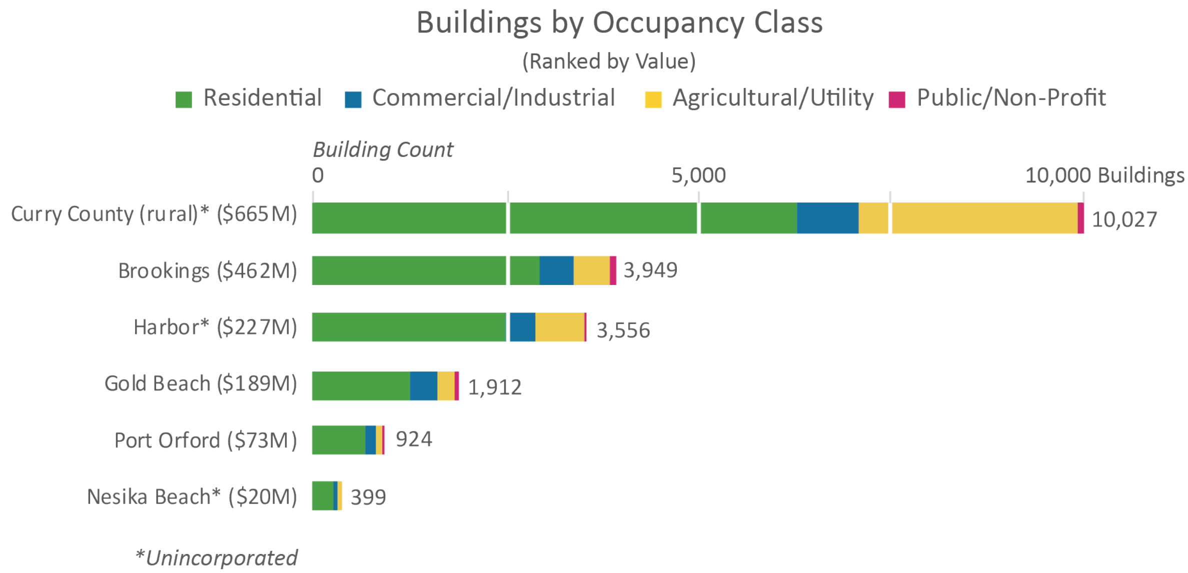
Table 2-1. Curry County building inventory.

Community	Total Number of Buildings	Percentage of Buildings	Total Estimated Building Value ($)	Percentage of Building Value
Unincorporated County (rural)	10,027	48%	665,168,000	41%
Harbor	3,556	17%	227,074,000	14%
Nesika Beach	399	2%	19,602,000	1%
Total Unincorporated County	13,982	67%	911,844,000	56%
Brookings	3,949	19%	462,342,000	28%
Gold Beach	1,912	9%	189,329,000	12%
Port Orford	924	5%	73,077,000	4%
Total Curry County	20,767	100%	1,636,592,000	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 Curry 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 20,767.

Curry 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). Taxlot data, containing 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 contains attributes for each building. These points are used in the risk assessment for both loss estimation and exposure analysis. **Figure 2-4** illustrates the building value by occupancy class across the communities of Curry County.

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



Note that “Curry Co. (rural)” excludes incorporated communities, Harbor and Nesika Beach.

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. Curry County critical facilities inventory.

Community	Hospital & Clinic		School		Police/Fire		Emergency Services		Military		Other*		Total	
	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)
(all dollar amounts in thousands)														
Unincorp. County (rural)	0	0	5	2,788	8	689	0	0	1	143	0	0	14	3,619
Harbor	0	0	0	0	1	495	1	4,975	1	749	0	0	3	6,219
Nesika Beach	0	0	0	0	1	112	0	0	0	0	0	0	1	112
Total Unincorp. County	0	0	5	2,788	10	1,295	1	4,975	2	892	0	0	18	9,951
Brookings	1	9,300	3	14,593	1	697	0	0	0	0	2	2,780	7	27,370
Gold Beach	2	30,189	2	7,586	3	1,029	1	97	0	0	2	3,109	10	42,011
Port Orford	1	178	1	998	2	446	0	0	0	0	1	2,234	5	3,857
Total Curry County	4	39,668	11	25,965	16	3,467	2	5,072	2	892	5	8,123	40	83,188

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

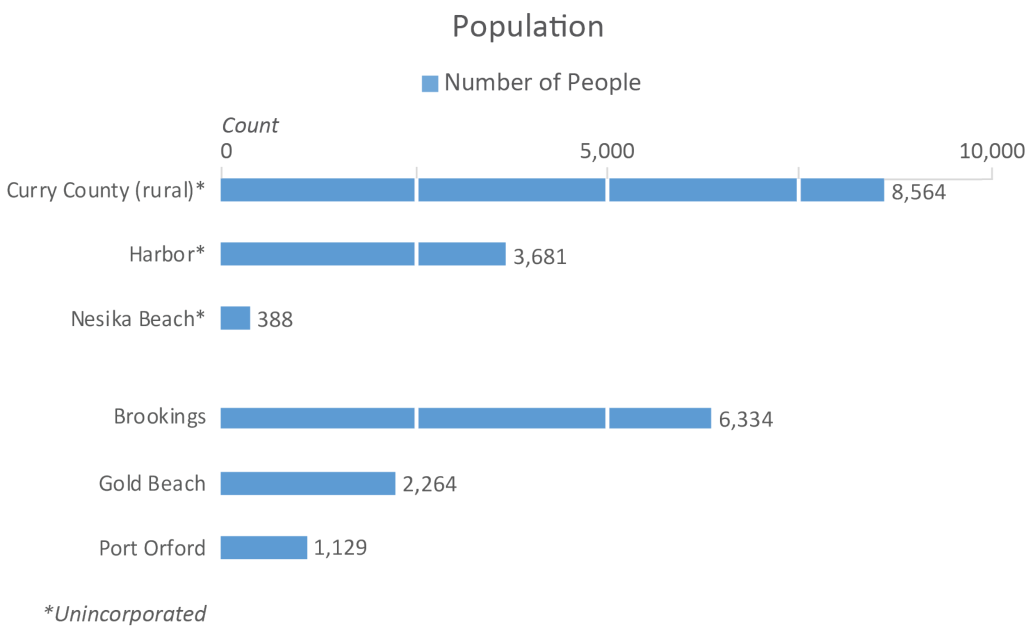
*Category includes buildings that are not traditional (emergency response) critical facilities but considered critical during an emergency based on input from local stakeholders (e.g. water treatment facilities or airports).

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 for this report the impacts from natural hazards to non-permanent 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 20% of residential buildings in Curry County are vacation rentals (U.S. Census Bureau, 2010b).

From the census data, DOGAMI analyzed the 22,364 residents within the study area who could be affected by a natural hazard scenario. For each natural hazard, with the exception of the CSZ M9.0 earthquake scenario, a simple exposure analysis was used to find the number of potentially displaced residents within a hazard zone. For the CSZ M9.0 earthquake scenario the number of potentially displaced residents was 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 Curry County community.



3.0 ASSESSMENT OVERVIEW AND RESULTS

This risk assessment considers six natural hazards (earthquake, tsunami, flood, landslide, coastal erosion, and wildfire) that pose a risk to Curry 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, unincorporated communities, and cities within Curry 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 along the CSZ occur on average every 500 years and can be extremely large (Clague and others, 2000).

Understanding the connection between Cascadia subduction zone 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 both 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 (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 M9.0 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, 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 M9.0 event. We selected the deterministic scenario method because the CSZ event is easily the highest seismic risk to this area (Clague and others, 2000). We used this method along with the UDF database so that loss estimates could be calculated on a building-by-building basis.

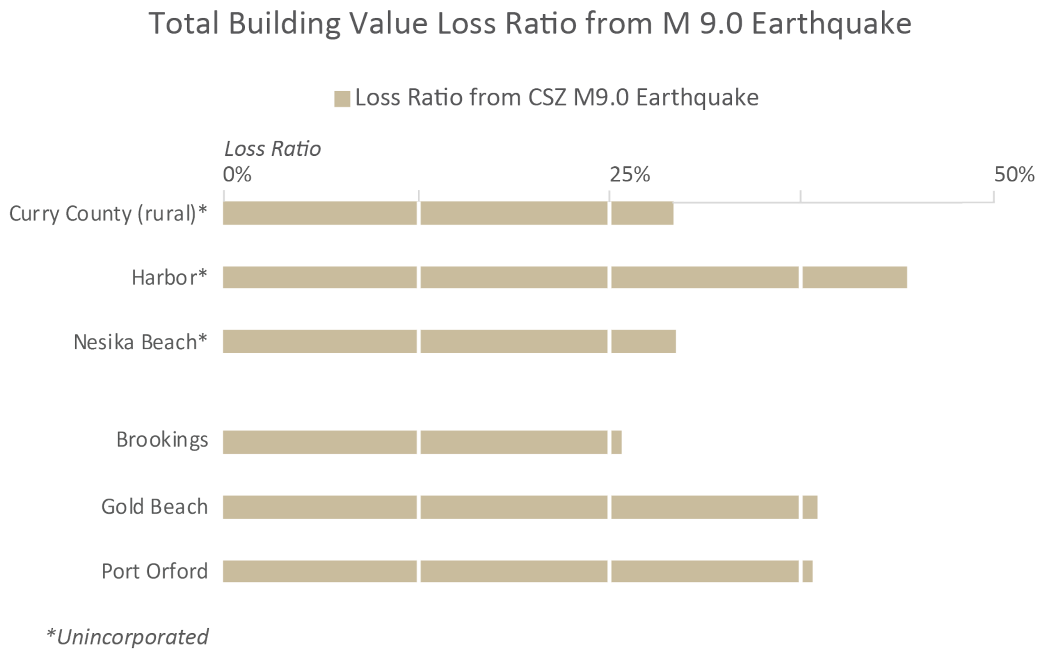
The following hazard layers used for our loss estimation are derived from work conducted by Madin and Burns (2013): National Earthquake Hazard Reduction Program (NEHRP) soil classification, peak ground acceleration (PGA), peak ground velocity (PGV), spectral acceleration at 1.0 second period and 0.3 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 permanent ground deformation and associated probability.

While the loss estimates and exposure results of the earthquake and tsunami presented in this report describe a singular 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 M8.9 earthquake (Priest and others, 2013). The earthquake bedrock ground motions from a M9.0 CSZ earthquake were produced by Arthur Frankel of the USGS (written 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 are comparable and are used in this report.

3.2.2 Countywide results

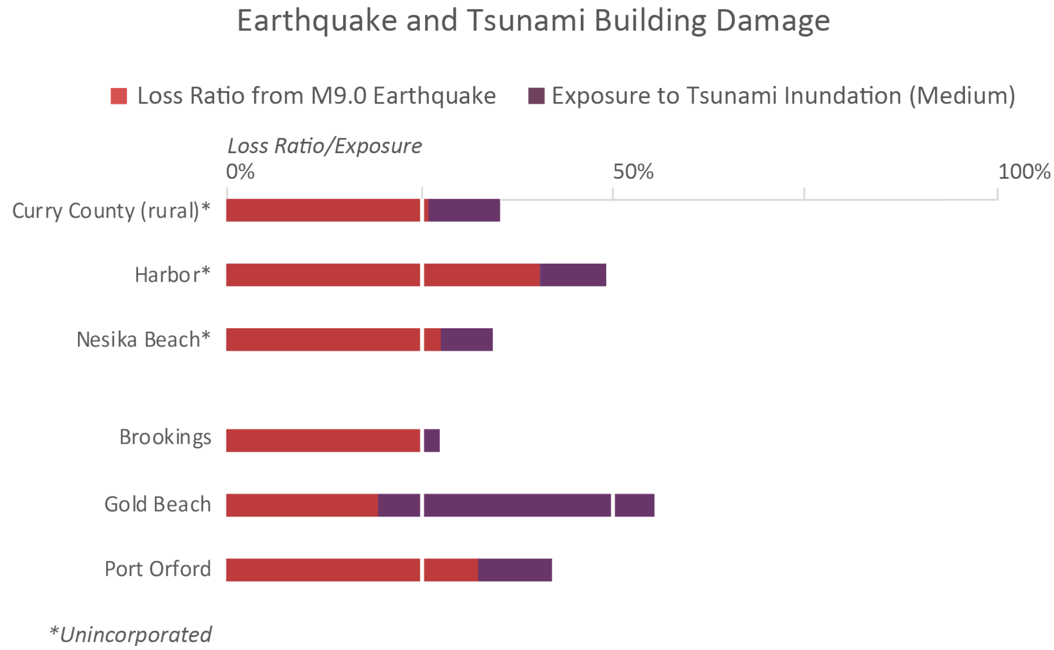
The CSZ event will produce severe ground shaking and ground failure, as well as a large and swift moving tsunami (Madin and Burns, 2013). Due to the nearly simultaneous timing of these two natural hazards, we have parsed loss estimate results to avoid double counting. That is, buildings within the (Medium-sized) 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. We assumed that tsunami losses to buildings are complete within the inundation area. Tsunami results are provided in the subsequent tsunami section. **Figure 3-1** shows the loss estimates by community for Curry County from a CSZ M9.0 event without the effects from tsunami.

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



Because an earthquake can affect a wide area, it is unlike other hazards in this report—every building in Curry County, to some degree, will be shaken by a CSZ M9.0 earthquake (see Appendix E, **Plate 3**). Hazus-MH loss estimates (see **Table B-2**) for each building are based on a formula in which 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 Curry County.

Figure 3-2. Loss ratio in Curry County, for both CSZ M9.0 earthquake and Medium-sized 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 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 buildings in each damage state is based on an aggregation of probabilities per community and does not represent individual buildings (FEMA, 2012b).

Critical facilities were considered non-functioning if the Hazus-MH earthquake analysis showed that a building or complex of buildings had a greater than 50 percent chance of being at least moderately damaged (FEMA, 2012b). The number reported for non-functioning critical facilities is only for buildings outside the (Medium-sized) tsunami inundation zone.

The number of potentially displaced residents from the CSZ M9.0 earthquake is based on the number of red-tagged and a percentage of yellow-tagged residences that were determined in the Hazus-MH earthquake analysis results. 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.

Curry countywide CSZ M9.0 earthquake results (not including buildings or population within the Medium-sized tsunami zone):

- Number of red-tagged buildings: 5,924
- Number of yellow-tagged buildings: 2,277
- Loss estimate: $450,992,000
- Loss ratio: 28%
- Non-functioning critical facilities: 28
- Potentially displaced population: 5,774

The results indicate that Curry County would incur significant losses (28%) due to a CSZ M9.0 earthquake. These results are strongly influenced by the overall average age of the building stock. This shows us that the age of the building stock is one metric of earthquake vulnerability for a community. Seismic building codes were implemented in Oregon in the 1970s (Judson, 2012); nearly 75% of buildings in Curry County were built before modern seismic building code enforcement. Communities within Curry County that are composed of an older building stock are expected to experience more damage from earthquake than newer ones.

There are very few areas of high or very high liquefaction zones within Curry County. Liquefiable soils can greatly increase the probability of damage from an earthquake, as well as presenting difficulties for safe evacuation from the subsequent tsunami. Liquefaction did not contribute a significant factor for estimating the damages from the CSZ event in Curry County.

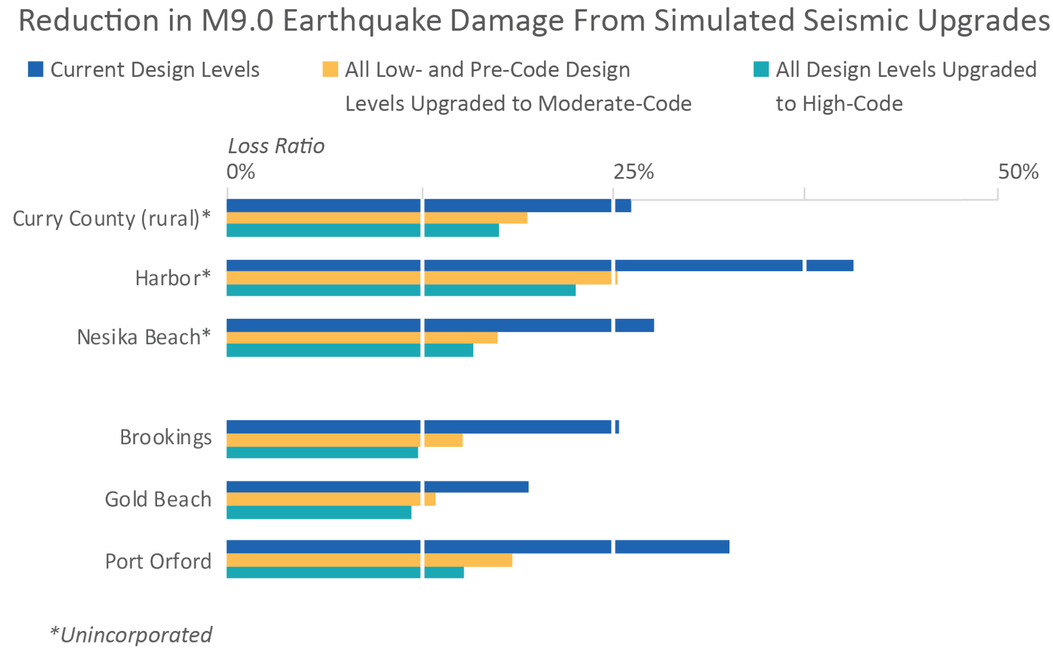
Although damage caused by coseismic landslides was not specifically looked at in this report, it likely contributes a significant amount of the estimated damage from the earthquake hazard in Curry County. Landslide exposure results show that nearly 20% of buildings in Curry County are within a very high or high susceptibility zone. This indicates that a similar percentage of buildings would be damaged primarily from 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 estimates drop from 28% to 18%, when all buildings are upgraded to at least moderate code level. While retrofits can decrease earthquake vulnerability, the benefits are minimized in landslide and liquefaction areas, where buildings would need additional geotechnical mitigation to have an effect on losses. **Figure 3-3** illustrates the reduction in loss estimates from a CSZ M9.0 earthquake through two simulations where all buildings are upgraded to moderate or high code standards. Communities that are mostly within the tsunami hazard zone may need additional tsunami mitigation to significantly reduce vulnerability.

Key Terms:

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

Figure 3-3. CSZ M9.0 earthquake loss ratio in Curry County, with simulated seismic building code upgrades.



Note: Loss estimates shown are for buildings outside the tsunami zone 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 M9.0 earthquake hazard:

- A high percentage of building inventories for the communities of Harbor, Gold Beach, and Port Orford are relatively older and may correlate to areas built to lower seismic building codes.
- The community of Harbor is estimated to see losses to total building inventory at 41% from the earthquake.
- Because of the liquefaction and landslides, many communities will likely be disconnected from other communities by severed transportation routes.
- Most of Curry County's critical facilities are predicted to be non-functioning following the CSZ earthquake.

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.

3.3 Cascadia Subduction Zone Tsunami

Tsunamis are a natural hazard threat for many communities along the Oregon coast. The tsunami addressed in this report is caused by the abrupt change in 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 Curry 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 report the results of our analysis, because, according to Priest and others (2013), the Medium scenario tsunami is 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

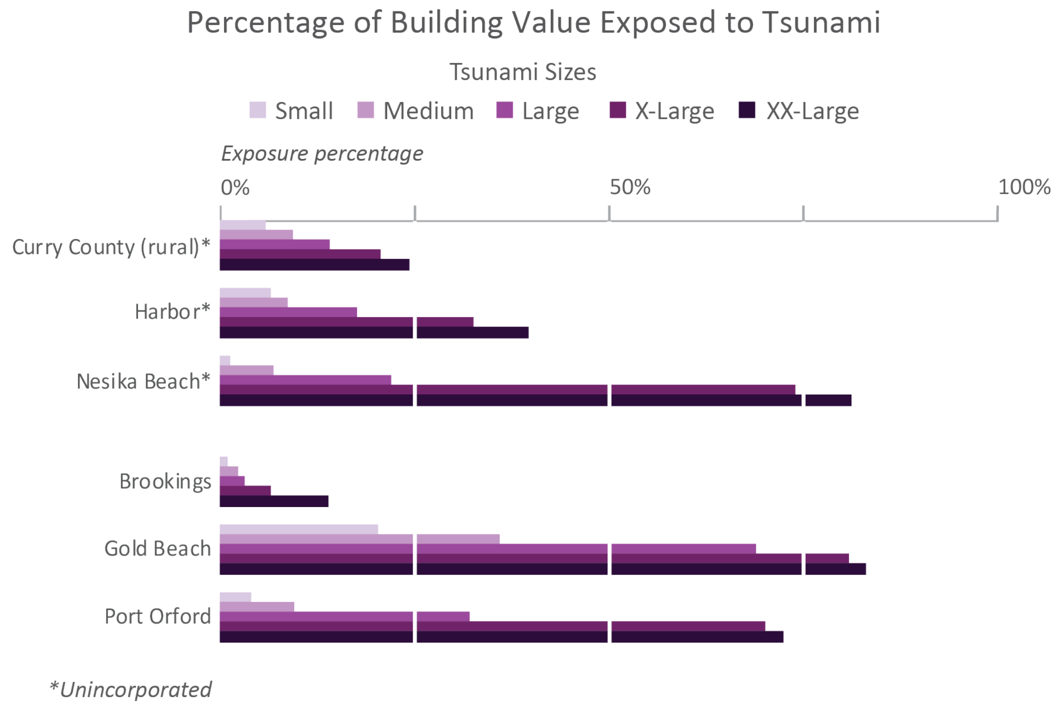
Because every community in this study is near the Pacific Ocean, all communities would be affected by the largest (XXL) of the DOGAMI calculated tsunami scenarios. However, the Medium-sized tsunami was chosen as the primary scenario for this report because that category represents areas that have the highest potential for losses. All communities built along the open coast and estuaries will be impacted from a tsunami.

Curry countywide CSZ tsunami exposure (Medium-sized tsunami scenario):

- Number of buildings exposed: 1,755
- Exposure value: $168,728,000
- Percentage of exposure value: 10%
- Critical facilities exposed: 9
- Potentially displaced population: 1,560

The combination of earthquake and tsunami will have a substantial impact to the entire coastal and estuarine portions of rural Curry County. Low-lying areas within coastal and estuarine communities are predicted to be inundated by the Medium-sized tsunami scenario. Approximately 10% of the county's buildings have exposure to tsunami inundation from the Medium-sized scenario. In Gold Beach a high percentage (36%) of buildings are exposed to tsunami hazard. Over 1,500 permanent residents could be impacted from a Medium-sized CSZ tsunami event and require medical and shelter services. Because there is high risk of tsunami along the entire coast and estuarine areas of Curry County, awareness is important for future planning and mitigation efforts in these areas (**Figure 3-4**).

Figure 3-4. Tsunami inundation exposure by Curry 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 a CSZ generated Medium-sized tsunami event:

- The coastal and low-lying areas of Gold Beach are predicted to be inundated by the most likely tsunami scenario. A significant portion (36%) of the community is exposed to the Medium-sized tsunami zone.
- Portions of the communities of Port Orford and Harbor are exposed to tsunami hazard.
- Many residential buildings at the mouth of the Winchuck River are threatened by the most likely tsunami scenario.

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 Curry County and have the potential to create public health hazards and public safety concerns, close and damage major highways, destroy railways, damage structures, and cause major economic disruption. A typical method for determining flood risk is to identify the probability of flooding and the impacts of flooding. The 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.

All the rivers in the county generally flow westward and eventually into the Pacific Ocean. The major rivers within the county are the Rogue and Chetco Rivers. Some notable minor streams are Floras Creek, Elk River, Sixes River, Euchre Creek, Turtle Creek, Hunter Creek, Pistol River, and Winchuck River. All the listed rivers are subject to flooding and causing damage to buildings within the floodplain. Other flooding effects are due to coastal flooding from the Pacific Ocean for low-lying coastal developments and within Curry County's two main estuaries.

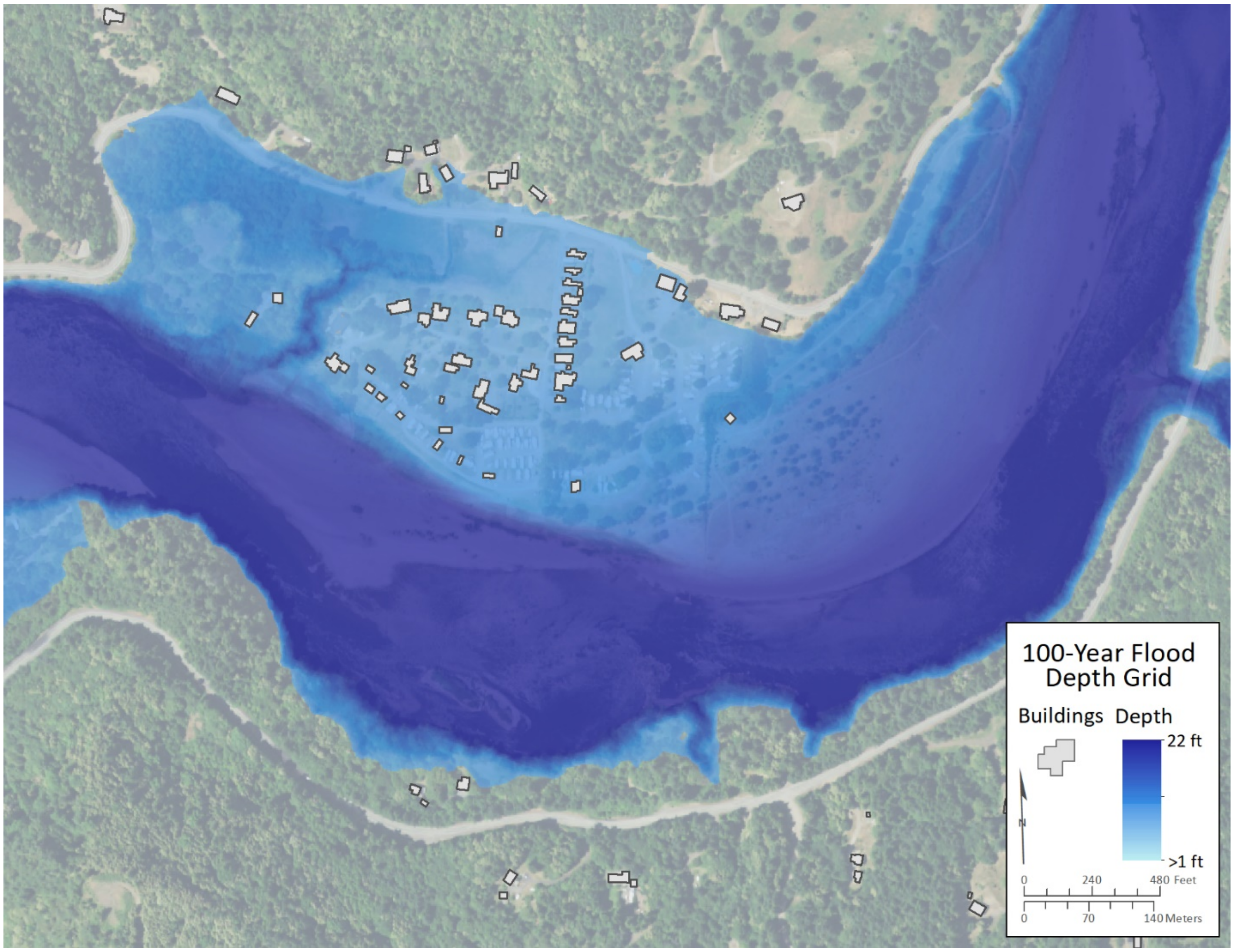
The ability to assess the probability of a flood and the level of accuracy of that assessment are influenced by modeling methodology advancements, better knowledge, and longer periods of record for the stream or water body in question. The impacts of flooding are determined by adverse effects to human activities within the area and the natural and built environment. 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. Flood issues like flash flooding, ice jams, post-wildfire floods, and dam safety were not looked at in this report.

3.4.1 Data sources

The Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) for Curry County were updated in 2016 (FEMA, 2018) and included a recently completed study of coastal flooding (Allan and others, 2015); these were the primary data sources for the flood risk assessment in this report. As of the completion of this report in 2018, the FIS and FIRMs were released as preliminary products. Between the period of completion of this report and publication of this report in 2020, the preliminary FEMA data were adopted in 2018 and currently represent the effective FIS and FIRM information. 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 detail mapped areas.

Depth grids, developed by DOGAMI in 2016 to revise the Curry County FIRMs, 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 in unincorporated Curry County (rural).



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 Curry 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, 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.

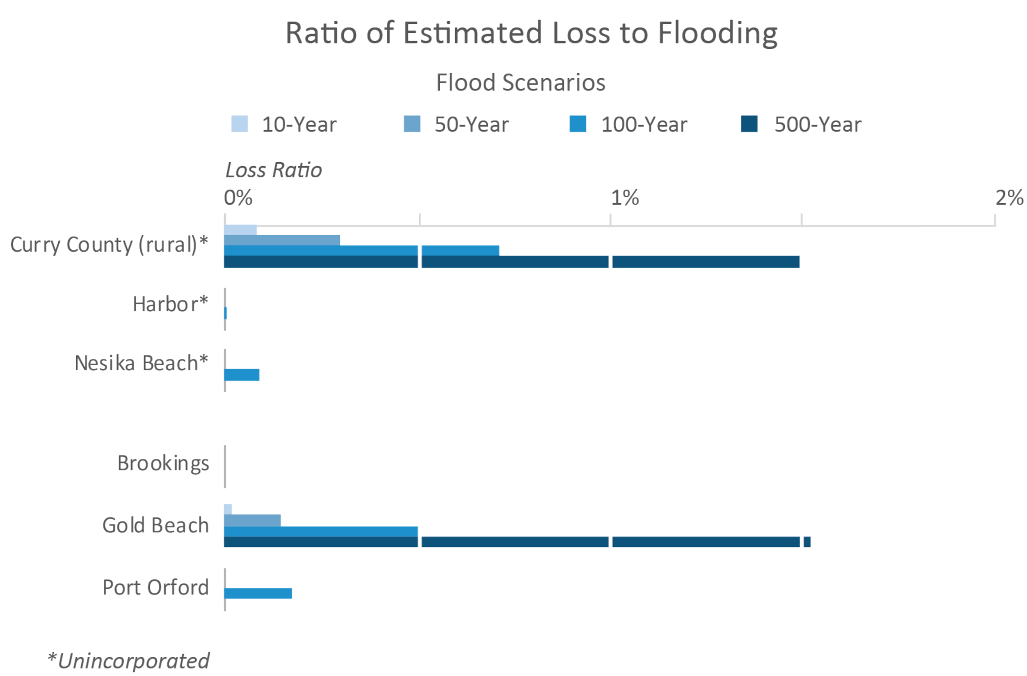
Curry countywide 100-year flood loss:

- Number of buildings damaged: 410
- Loss estimate: $5,869,000
- Loss ratio: 0.4%
- Damaged critical facilities: 1
- Potentially displaced population: 412

3.4.3 Hazus-MH analysis

The Hazus-MH loss estimate for the 100-year flood scenario for the entire county is approximately $5.9 million. Because there are not vast floodplains within the study area, buildings that are vulnerable to flooding are limited to a few areas. Areas of the county in the floodplain and low-lying coastal zones are estimated to have more problems due to flood than other parts of the county. Both riverine and coastal flooding have a significant impact on Curry County (**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. Flood loss estimates by Curry County community.



Note: In addition to the four riverine flood scenarios, coastal flooding information is available for the 100-year flood scenario for portions of Curry County (rural) and the community of Nesika Beach.

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 counted 464 of Curry County's buildings to be within designated flood zones, which was about 2% of the county's buildings. Of these buildings, 55 buildings were elevated above the height of the 100-year flood. This was done by comparing the number of non-damaged buildings from Hazus-MH with the number of exposed buildings in the flood zone. Elevating more of these exposed structures would further reduce the potential damages sustained from flooding. This evaluation also estimates that 411 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:

- Buildings along the Rogue River upstream of Gold Beach are threatened by the 100-year flood.
- Buildings at the mouth of the Winchuck River in unincorporated Curry County (rural) are threatened by the 100-year flood.

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 Curry 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 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. Most of the landslide inventory mapping in Curry County was done in 2014 with lidar and modern methods, so landslide hazard data for this area are more reliable than data for many other areas in the state.

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 mapped as 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 summed for the study area and is reported below. We also estimated the number of people threatened by landslides. Neither land value losses due to landslides nor potentially hazardous unmapped areas that may pose real risk to communities were examined for this report.

3.5.2 Countywide results

All of Curry County's 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 Klamath Mountains trend through much of Curry 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 landslide hazard 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 accurately depict 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.

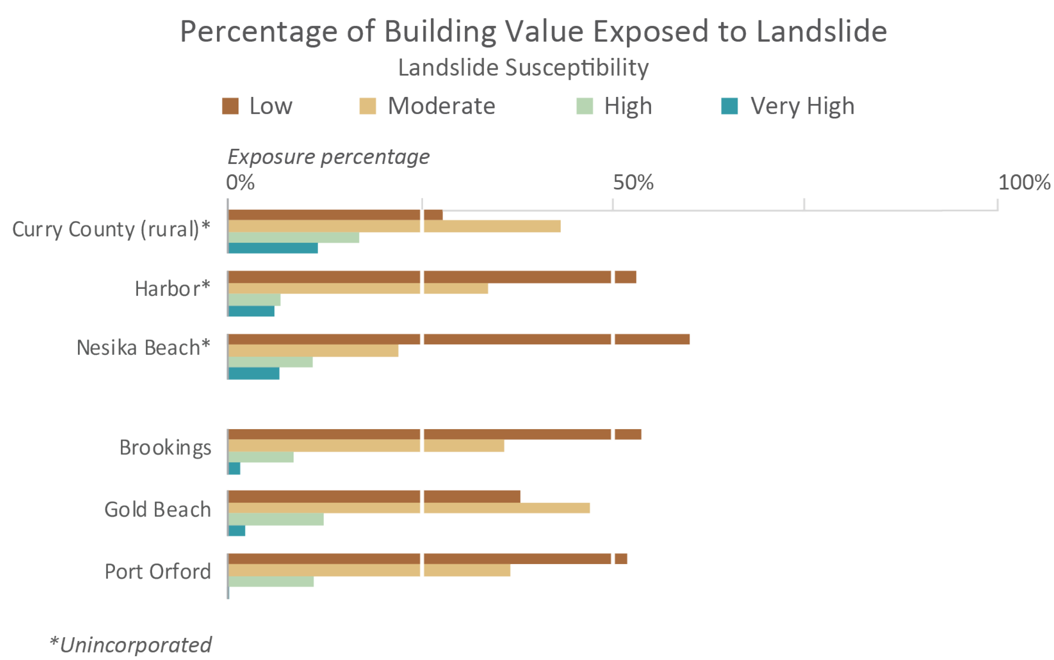
For this risk assessment we compared building locations to geographic extents of the landslide susceptibility zones (**Figure 3-7**). The exposure results shown below are for the high and very high susceptibility zones. See **Appendix B: Detailed Risk Assessment Tables** for multi-scenario analysis results.

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

- Number of buildings: 3,969
- Exposure value: $308,646,000
- Percentage of exposure value: 18%
- Critical facilities exposed: 5
- Potentially displaced population: 3,696

The majority of buildings in Curry County are located in low and moderate susceptibility landslide zones. Still, nearly 20% of the county's buildings have exposure to high or very high susceptibility to landslides. Landslide hazard is a threat for inland portions of the unincorporated county. 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 and when there are periods of heightened potential for landslides is beneficial to reducing risk for every community and rural area of Curry County.

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



3.5.3 Areas of vulnerability or risk

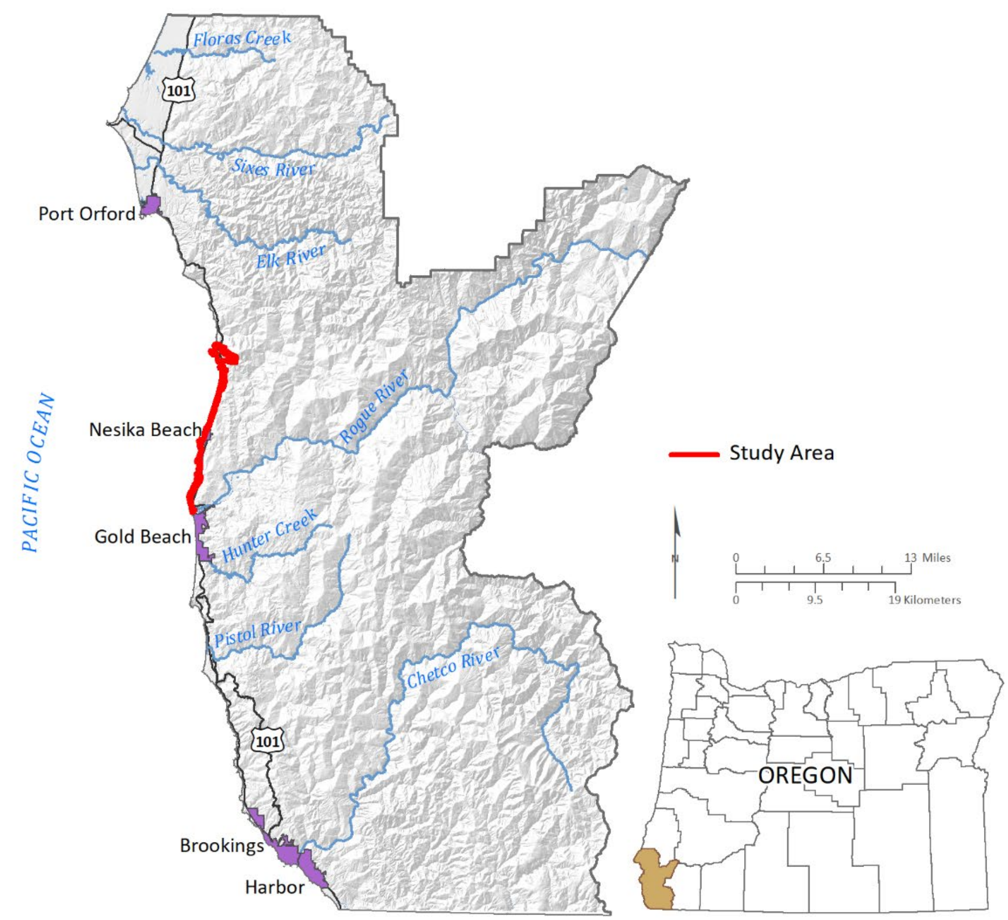
We identified locations within the study area that are comparatively more vulnerable or at greater risk to landslide hazard:

- Exposure to high and very high landslide hazard is present in the community of Harbor for many buildings located on the landward side of Highway 101.
- Developed areas in the inland part of unincorporated Curry County (rural) are far more likely to be exposed to high or very high landslide susceptibility than buildings located along the coast.

3.6 Coastal Erosion

Erosion along the coast is a continuous process that occurs through a complex interaction of many geologic, atmospheric, and oceanic factors (including sea level rise). Coastal erosion can be a gradual process or by landslides, but either form can cause loss of property. Beaches and dunes are highly susceptible to erosion, especially during large storms coupled with high ocean water levels. Coastal erosion is increasingly affecting people due to development near the beach or coastal bluffs. The steep nature of the dunes and bluffs adjacent to the ocean makes for dramatic scenery, but also contributes to coastal erosion hazards. Typically, shoreline stabilization efforts using riprap are not an effective long-term mitigation (Stimely and Allan, 2014). **Figure 3-8** shows the section of Curry County coastline studied for coastal erosion in a report by Priest and others (2004).

Figure 3-8. Priest and others (2004) coastal erosion study area extent.



3.6.1 Data sources

Coastal erosion hazard zones were determined by Priest and others (2004) using two approaches: dune-backed beaches and bluff-backed shorelines. The final derived hazard zones reflect the combined effect of both sets of processes. We categorized the coastal erosion hazard zones defined by Priest and others (2004) to indicate levels of probability as high, moderate, and low.

The high hazard zone for dune-backed beaches was based on a large storm wave event coincident with a 3.3 ft (1 m) storm surge. The high hazard zone for bluff-backed shorelines was based on only a relatively low mean rate of gradual erosion. The "active hazard zone" defined within the study was also included into the high hazard zone. The moderate hazard zone for dune-backed beaches was based on an extremely severe storm event coupled with a 5.6 ft (1.7 m) storm surge. The same zone for bluff-backed shorelines was based on an average amount of bluff retreat. The low hazard zone for dune-backed beaches was based on the same scenario as the moderate hazard and also incorporated 6.2 ft (1.9 m) of coastal subsidence from a CSZ event. The low hazard for bluff-backed shorelines was based on a maximum bluff slope failure and gradual bluff retreat for ~100 years (Priest and others, 2004).

We overlaid buildings and critical facilities on the coastal erosion hazard zones to assess the exposure for each community. The total dollar value of exposed buildings in the study area is reported below. We also estimated the number of people threatened by coastal erosion. Land value losses due to coastal erosion were not examined for this project.

3.6.2 Countywide results

The portion of Curry County's coast that was included in the Priest and others (2004) study is limited to the Nesika Beach area and so the coastal erosion exposure analysis was also limited to this area. It should be understood, however, that coastal erosion is occurring throughout the coastal areas of the county to varying degrees.

The Moderate hazard category (5.6 ft [1.7 m] storm surge or average bluff retreat) was chosen as the primary scenario for this report because it fits best for long-term planning purposes. The Moderate hazard zone represents an area of a reasonable level of probability with a high level of impact to a community.

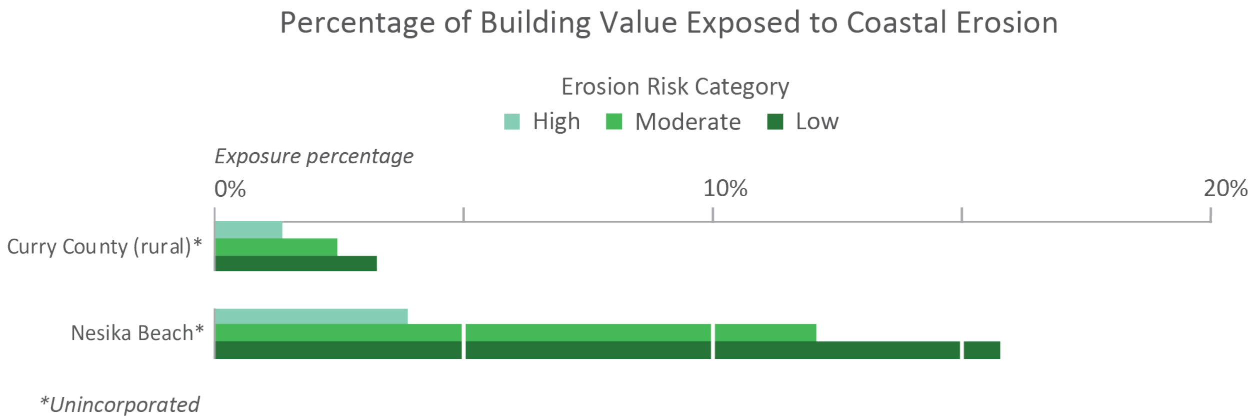
For this risk assessment, we limited the results of the exposure analysis to the communities included in the report by Priest and others (2004), which includes Nesika Beach and coastal areas a few miles north and south. The "percentage of exposure value" is the percentage of exposed building value relative to the total building value of the communities within the study area. We did not include building value from communities outside the study area in this calculation. See **Appendix B: Detailed Risk Assessment Tables** for multi-scenario analysis results.

Curry County (limited to Unincorporated Curry County (rural) and Nesika Beach) coastal erosion exposure (Moderate hazard):

- Number of buildings: 107
- Exposure value: $18,814,000
- Percentage of exposure value: 2.7%
- Critical facilities exposed: 0
- Potentially displaced population: 78

The coastal community of Nesika Beach and unincorporated areas of Curry County have significant exposure to coastal erosion. Awareness of this hazard is beneficial to reducing risk for future developments along Curry County's coastline. Long-term community plans that make allowance for coastal erosion encourage more resilience within the community. **Figure 3-9** illustrates the distribution of losses due to coastal erosion in the two communities of Curry County.

Figure 3-9. Coastal erosion exposure by Curry County community.



Note: Beyond the designated community of Nesika Beach, in unincorporated Curry County (rural), there is $9.2 million dollars of building value in areas of high coastal erosion hazard, $16.4 million dollars of building value in areas of moderate hazard, and $21.7 million dollars of building value in areas of low hazard.

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 coastal erosion hazard:

- The residential area in Nesika Beach along the coast is likely to experience coastal erosion.

3.7 Wildfire

Wildfires are a natural part of the ecosystem in Oregon. However, wildfires can present a substantial hazard to life and property in growing communities, because communities often grow in 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 Curry County. Forests cover a large percentage of Curry County. Forests play an important role in the local economy but also surround homes and businesses. In an effort to limit exposure to wildfire, Curry County's Comprehensive Plan provides guidance on reducing risk to wildfire (County Board of Commissioners, 2009). Contact Curry County Department of Community Development for specific requirements related to the county's comprehensive plan.

3.7.1 Data sources

The West Wide Wildfire Risk Assessment (WWA; Sanborn Map Company, 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 Curry County.

Using guidance from ODF, we categorized the FRI into low, moderate, and high hazard zones for the wildfire exposure analysis. The 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. This indicates areas that have minimal risk to wildfire hazard (see **Table B-8**). The total dollar value of exposed buildings 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.

3.7.2 Countywide results

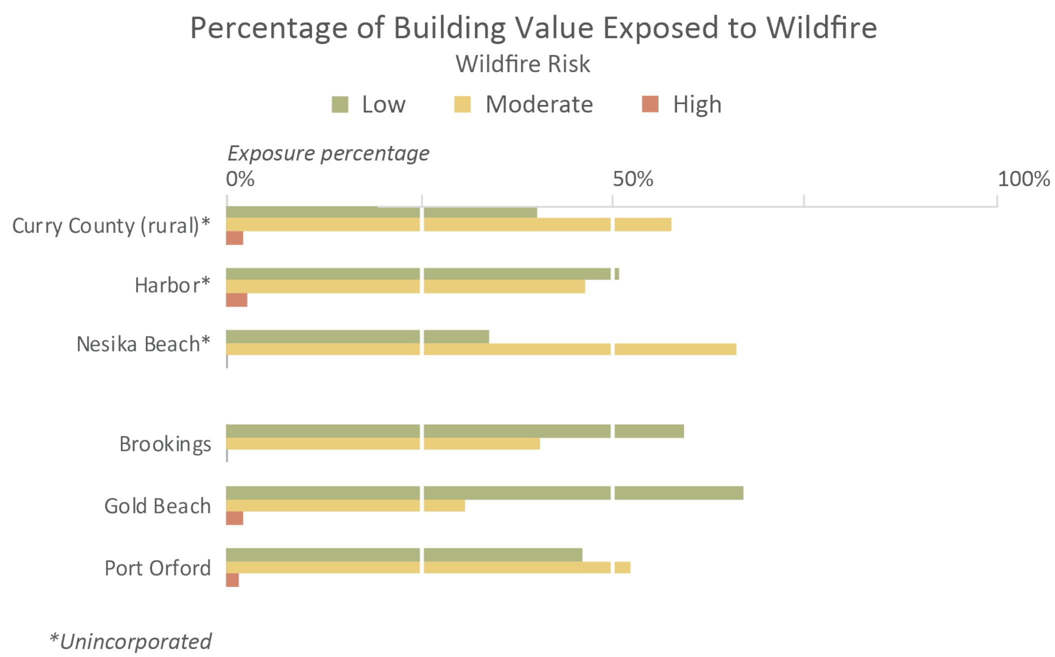
The high hazard category was chosen as the primary scenario for this report because that category represents areas that have the highest potential for losses. However, a large amount of loss would occur if the moderate hazard areas were to burn, as almost every community has ~40–50% of exposure to moderate wildfire hazard. Still, the focus of this section is on high hazard areas within Curry County to emphasize the areas where lives and property are most threatened.

Curry countywide wildfire exposure (High risk):

- Number of buildings: 303
- Exposure value: $25,118,000
- Percentage of exposure value: 1.5%
- Critical facilities exposed: 1
- Potentially displaced population: 271

For this risk assessment, building locations were compared to the geographic extent of the wildfire hazard categories. We found that most communities in Curry County are not exposed to high wildfire hazard. The primary areas of exposure to this hazard are in the forested unincorporated areas of the county (see Appendix E, **Plate 7**). The communities of Harbor, Gold Beach, and rural Curry County are at a higher risk to wildfire than other communities in the county. **Figure 3-10** illustrates the distribution of losses due to wildfire with the different communities of Curry County. See **Appendix B: Detailed Risk Assessment Tables** for multi-scenario analysis results.

Figure 3-10. Wildfire hazard exposure by Curry County community.



3.7.3 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 many homes in the heavily forested portions of unincorporated Curry County (rural).

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 accomplish this by using the latest natural hazard mapping and loss estimation tools to quantify expected damage to buildings and potential displacement of permanent residents. The comprehensive and fine-grained 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 loses are expected from a Cascadia M9.0 earthquake and tsunami** – Due to its proximity to the CSZ, every community in Curry County will experience significant impact and disruption from a CSZ M9.0 earthquake event. Event impacts that were examined are limited to earthquake (including landslides and liquefaction) and tsunami. Results show that a CSZ M9.0 event will cause building losses of 30% to 50% across all communities. The community of Gold Beach can expect a very high percentage of losses due to tsunami hazard. Other communities like the unincorporated community of Harbor have little to no tsunami exposure, but still will have high losses from earthquake alone. The high vulnerability of the building inventory (primarily because of the age of construction), the proximity to the CSZ event, and the amount of development within tsunami zones all contribute the estimated levels of losses expected in the study area.
- **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 by Hazus-MH, a software tool developed by the Federal Emergency Management Agency (FEMA) for calculating loss from natural hazards. 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 loss for the entire study area was reduced from 28% to 18%. Some communities would see greater loss reduction than the county as a whole due to older building stock constructed at pre or low code seismic building code standards. An example is the community of Harbor, where a significant loss reduction (from 41% to 25%) could occur by retrofitting all buildings to at least moderate code. This stands in contrast to a community with younger building stock, such as the City of Gold Beach, which would see loss reduction go from 20% to 14%. 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 areas needing a clear understanding of the hazard to inform local decision-makers.
- **Flooding is a threat for some areas in Curry County** – Every community is estimated to experience less than 1% of total building value loss from the 100-year flood. 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. The areas most vulnerable to flood hazard within the study are residential buildings along the Rogue River and around the mouth of the Winchuck River.

- **Elevating structures in the flood zone can reduce 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 and the effectiveness of past activities.
- **New landslide mapping would increase the accuracy of future risk assessments** – Exposure analysis was used to assess the threat from landslide hazard. Landsliding is a widespread hazard and is present for some communities within the county. The undeveloped fringe of communities in many areas are exposed to high or very high landslide susceptibility. Generally, these undeveloped fringes with landslide hazard occur on the east side of Highway 101. Landslide risk is high for buildings located on existing landslides along the Rogue River and the Chetco River. The landslide hazard data 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.
- **Areas in Nesika Beach are at risk to coastal erosion hazard** – Exposure analysis shows the community of Nesika Beach is vulnerable to high coastal erosion hazard. Some residential structures adjacent to the beach are located on areas deemed high for coastal erosion hazard.
- **Wildfire risk is moderate for the overall study area** – Exposure analysis shows that buildings in the eastern part of the county are vulnerable to wildfire hazard. High wildfire hazard is primarily limited to a few heavily forested rural areas. However, moderate wildfire hazard is present throughout the county and so is a potential threat for communities.
- **Most of the study area's critical facilities are at high risk to a CSZ earthquake and tsunami** – Critical facilities were identified and were specifically examined within this report. We have estimated that 93% of Curry County's 40 critical facilities will be non-functioning after a CSZ event, with 9 of those located within the tsunami zone. For comparative purposes, 13% (5) of critical facilities are at risk to landslide. There is little to no exposure to critical facilities from flooding, wildfire, or coastal erosion.
- **The two biggest causes of displacement to population are a CSZ event (earthquake and tsunami) and landslide** – Displacement of permanent residents from natural hazards was quantified within this report. We estimated that 33% of the population in the county to be displaced due to the combination of earthquake and tsunami. Landslide hazard is a potential threat to 17% of permanent residents, and 2% are vulnerable to flood hazard. A small percentage of residents are at risk to displacement from wildfire and coastal erosion.
- **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 between risks within communities and impacts from each natural hazard. Hazus-MH and exposure analysis results can assist in developing plans that address the concerns for individual communities.

5.0 LIMITATIONS

There are some limitations to keep in mind when 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 an entire community. While we report the overall impacts of a given hazard scenario, the losses from a single hazard event probably will not be as severe and widespread. An exception to this is earthquake ground-shaking, which is 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. Hazus-MH does not provide a site-specific analysis. 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** – Interpretation of exposure results should consider 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 and Sumatra.
- **Population variability** – Many coastal communities in Curry 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 no high-resolution data within the study area. We used lower-resolution data to fill gaps where there was incomplete coverage or where high-resolution data were 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 research are needed to better understand hazards and reduce risk to natural hazard through mitigation planning. These research 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, 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 with a comprehensive and authoritative profile of natural hazard risk to underpin their public outreach efforts.

Messaging can be tailored to stakeholder groups. For example, outreach to homeowners could focus on actions they can take to reduce risk to their property. The DOGAMI Homeowners Guide to Landslides (https://www.oregongeology.org/Landslide/ger_homeowners_guide_landslides.pdf) provides a variety of risk reduction options for homeowners who live in areas with high susceptibility to landslides. 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 is available for local decision-makers in developing their local plans and to 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 can 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 re-evaluate evacuation routes and to identify vulnerable populations to target for early warning. At the time of writing, DOGAMI is producing a series of tsunami evacuation maps, called "Beat the Wave," for recommended pedestrian travel speeds to reach tsunami evacuation zones.

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 structural improvements, such as connecting a building frame to its 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 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's Hazard Mitigation Assistant Grants program includes many subprograms that assist with mitigation funding for natural hazards such as the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM) grant program, Building Resilient Infrastructure and Communities (BRIC) program, and the Flood Mitigation Assistance (FMA) program (https://www.fema.gov/grants/mitigation). The OEM 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 M9.0 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 93% of critical facilities in the county (**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.

6.5.2 Tsunami

- Use approved guides on preparing for tsunamis (e.g., DLCD guide on preparing for the CSZ tsunami, https://www.oregon.gov/lcd/Publications/TsunamiLandUseGuide_2015.pdf)
- Evaluate the community evacuation plan, including consideration for viable vertical evacuation options.

6.5.3 Flood

- Map areas of potential flood water 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 Coastal erosion

- Monitor ground movement in high susceptibility areas, especially during or after large storms.
- Monitor erosion control structures that are already in place.
- Identify critical facilities and infrastructure near high coastal erosion areas.
- Consider land value losses due to coastal erosion in future risk assessments.

6.5.6 Wildfire related to geologic hazards

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

7.0 ACKNOWLEDGMENTS

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Many people contributed to this report at different points during the analysis phase and during the writing phase and at various levels. We are grateful to everyone who contributed, especially the following from DOGAMI: John Bauer, Jed Roberts, Bill Burns, Fletcher O'Brien, Deb Schueller, and Ian Madin.

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9.0 APPENDICES

APPENDIX A. COMMUNITY RISK PROFILES

A hazard 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 Curry County (rural)

Table A-1. Unincorporated Curry County hazard profile.

Community Overview				
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Unincorporated Curry County	8,564	10,027	14	665,167,000

Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	355	4.1%	343	0	4,753,000	0.7%
*Earthquake**	*CSZ M9.0 Deterministic*	2,403	28%	3,989	11	174,518,000	26%
Earthquake (within Tsunami Zone)		184	2.1%	323	2	20,603,000	3.1%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ M9.0 – Medium*	618	7.2%	726	2	62,363,000	9.4%
Tsunami	Senate Bill 379 Regulatory Line	413	4.8%	427	1	43,429,000	6.5%
Landslide	High and Very High Susceptibility	2262	26%	2841	1	191,546,000	29%
Coastal Erosion	Moderate Hazard	57	0.7%	79	0	16,445,000	2.4%
Wildfire	High Hazard	141	1.6%	178	0	14,076,000	2.1%

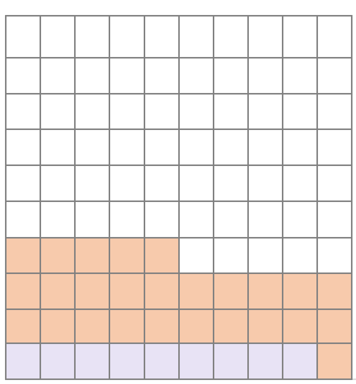
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

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-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 Curry 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 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. In order to avoid double counting to buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

= Estimated losses due to tsunami.

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

Table A-2. Unincorporated Curry County critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Tsunami CSZ M9.0 – Medium Exposed	Landslide High and Very High Susceptibility Exposed	Wildfire High Hazard Exposed	Coastal Erosion Moderate Hazard Exposed
Agness Elementary School		X				
Blanco School		X				
Cape Ferrelo RFPD		X				
Cedar Valley RFPD		X				
Coast Guard Office		X	X	X		
County Fire Dept. Garage		X				
Langlois RFPD		X				
Pacific High School		X				
Pistol River FD		X	X			
Sixes RFPD		X				
Upper Chetco Charter School		X				
Upper Chetco RFPD						
Wilderland Montessori School		X				
Winchuck RFPD		X				

A.2 Unincorporated community of Harbor

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

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Harbor	3,681	3,556	3	227,074,000

Hazus Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	2	0.1%	4	0	14,000	0%
*Earthquake**	*CSZ M9.0 Deterministic*	1765	48%	2,023	2	92,369,000	41%
Earthquake (within Tsunami Zone)		26	0.7	80	1	8,422,000	3.7%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ M9.0 – Medium*	71	1.9%	155	*1*	19,719,000	8.7%
Tsunami	Senate Bill 379 Regulatory Line	61	1.6%	136	1	21,844,000	9.6%
Landslide	High and Very High Susceptibility	375	10%	315	0	29,556,000	13%
Wildfire	High Hazard	64	1.7%	63	0	5,885,000	2.6%

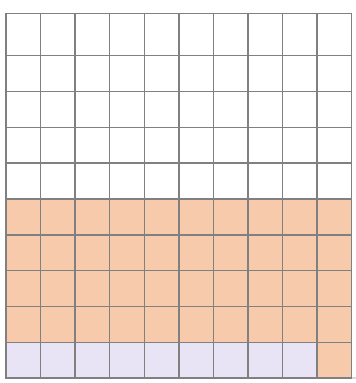
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

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 Harbor 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 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. In order to avoid double counting to buildings, the earthquake loss ratio was calculated only for buildings outside of the tsunami zone.

= Estimated losses due to tsunami.

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

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

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Tsunami CSZ M9.0 – Medium Exposed	Landslide High and Very High Susceptibility Exposed	Wildfire High Hazard Exposed
Harbor RFPD		X			
Sheriff Office		X			
U.S. Coast Guard Station – Chetco River		X	X		

A.3 Unincorporated community of Nesika Beach

Table A-5. Unincorporated community Nesika Beach hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Nesika Beach	388	399	1	19,602,000

Hazus Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	1	0.2%	1	0	18,000	0.1%
*Earthquake**	*CSZ M9.0 Deterministic*	115	30%	164	1	5,446,000	28%
Earthquake (within Tsunami Zone)		3	0.7%	7	0	313,000	1.6%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ M9.0 – Medium*	12	3.0%	20	0	1,344,000	6.9%
Tsunami	Senate Bill 379 Regulatory Line	2	0.4%	4	0	158,000	0.8%
Landslide	High and Very High Susceptibility	65	17%	70	0	3,499,000	18%
Coastal Erosion	Moderate Hazard	21	5.3%	28	0	2,369,000	12%
Wildfire	High Hazard	0	0%	0	0	0	0%

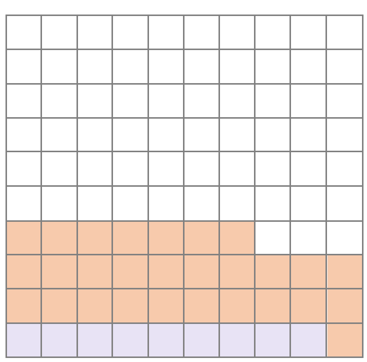
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

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-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 Nesika Beach 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 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. In order to avoid double counting to 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 Nesika Beach critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Hazard	Coastal Erosion Moderate Hazard
	Exposed	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Ophir RFPD		X				

A.4 City of Brookings

Table A-7. City of Brookings hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Brookings	6,334	3,949	7	462,342,000

Hazus 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 M9.0 Deterministic*	951	15%	1,203	6	117,620,000	25%
Earthquake (within Tsunami Zone)		5	0.1%	10	0	1,934,000	0.4%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ M9.0 – Medium*	44	0.7%	43	0	10,274,000	2.2%
Tsunami	Senate Bill 379 Regulatory Line	39	0.6%	33	0	9,087,000	2%
Landslide	High and Very High Susceptibility	494	7.8%	307	1	47,620,000	10%
Wildfire	High Hazard	0	0%	0	0	0	0%

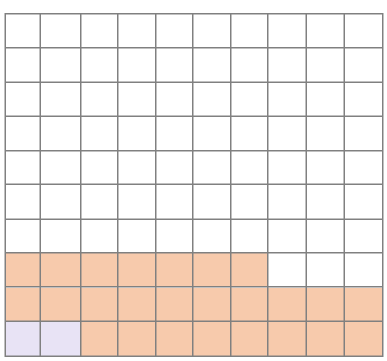
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

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-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. City of Brookings 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 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. In order to avoid double counting to 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. City of Brookings critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Tsunami CSZ M9.0 – Medium Exposed	Landslide High and Very High Susceptibility Exposed	Wildfire High Hazard Exposed
Azalea Middle School		X			
Brookings Airport		X		X	
Brookings-Harbor High School		X			
Brookings Police and Fire & Rescue		X			
Brookings Public Works		X			
Curry Medical Center					
Kalmiopsis Elementary School		X			

A.5 City of Gold Beach

Table A-9. City of Gold Beach hazard profile.

Community Overview				
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Gold Beach	2,264	1,912	10	189,329,000

Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	54	2.4%	58	0	956,000	0.5%
*Earthquake**	*CSZ M9.0 Deterministic*	363	16%	495	4	37,164,000	20%
Earthquake (within Tsunami Zone)		336	15%	470	5	35,825,000	19%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ M9.0 – Medium*	781	35%	774	5	68,015,000	36%
Tsunami	Senate Bill 379 Regulatory Line	256	11%	306	3	27,522,000	15%
Landslide	High and Very High Susceptibility	396	18%	336	2	28,101,000	15%
Wildfire	High Hazard	14	0.6%	44	1	3,992,000	2.1%

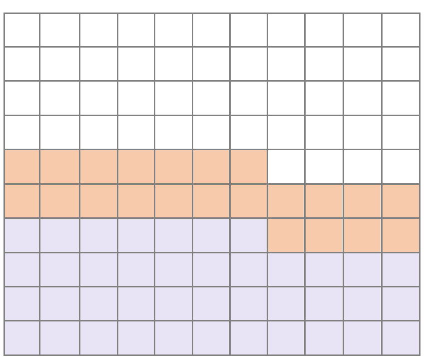
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

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-5.

[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-5. City of Gold Beach 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 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. In order to avoid double counting to 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. City of Gold Beach critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Tsunami CSZ M9.0 – Medium	Landslide High and Very High Susceptibility	Wildfire High Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**
Curry County Sheriff's Office		X			
Curry General Hospital - Gold Beach					
Gold Beach High School		X	X	X	
Gold Beach Medical Center		X			
Gold Beach Municipal Airport		X	X		X
Gold Beach PD and Volunteer FD		X	X		
Gold Beach Public Works		X	X	X	
Gold Beach Volunteer FD		X	X		
Oregon State Police		X			
Riley Elementary School		X			

A.6 City of Port Orford

Table A-11. City of Port Orford hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Port Orford	1,129	924	5	73,077,000

Hazus 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%	4	1	128,000	0.2%
*Earthquake**	*CSZ M9.0 Deterministic*	177	16%	327	4	23,874,000	33%
Earthquake (within Tsunami Zone)		5	0.4%	13	1	4,097,000	5.6%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Tsunami	*CSZ M9.0 – Medium*	34	3%	37	1	7,013,000	9.6%
Tsunami	Senate Bill 379 Regulatory Line	25	2.2%	24	1	2,542,000	3.5%
Landslide	High and Very High Susceptibility	104	9.2%	100	1	8,323,000	11%
Wildfire	High Hazard	52	4.6%	18	0	1,165,000	1.6%

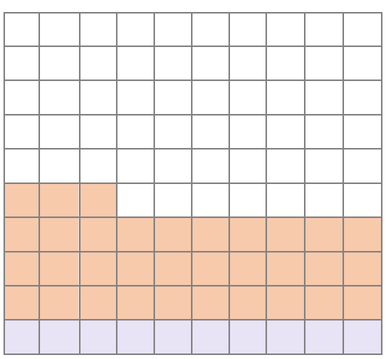
*Earthquake losses were calculated for buildings outside of Medium tsunami zone.

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. City of Port Orford 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 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. In order to avoid double counting to 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. City of Port Orford critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Tsunami CSZ M9.0 – Medium Exposed	Landslide High and Very High Susceptibility Exposed	Wildfire High Hazard Exposed
Curry Family Medical		X			
Driftwood Elementary School		X			
Port of Port Orford	X	X	X	X	
Port Orford Police Dept.		X			
Port Orford Rural Fire District		X			

APPENDIX B. DETAILED RISK ASSESSMENT TABLES

Table B-1. Curry County building inventory.

(all dollar amounts in thousands)

	Residential			Commercial and Industrial			Agricultural			Public and Non-Profit			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)	6,306	519,723	78%	783	59,631	9%	2,863	76,973	12%	75	8,840	1.3%	10,027	48%	665,167	41%
Harbor	2,500	163,127	72%	408	52,839	23%	629	8,800	4%	19	2,308	1.0%	3,556	17%	227,074	14%
Nesika Beach	277	17,038	87%	43	920	5%	79	1,644	8%	0	0	0%	399	1.9%	19,602	1.2%
Total Unincorp. County	9,083	699,888	77%	1,234	113,390	12%	3,571	87,417	10%	94	11,148	1.2%	13,982	67%	911,843	56%
Brookings	2,946	340,678	74%	457	94,674	20%	472	6,447	1%	74	20,543	4.4%	3,949	19%	462,342	28%
Gold Beach	1,278	96,612	51%	348	75,524	40%	216	3,743	2%	70	13,450	7.1%	1,912	9%	189,329	12%
Port Orford	679	47,550	65%	149	19,378	27%	78	1,715	2%	18	4,435	6.1%	924	4.4%	73,078	4.5%
Total Curry County	13,986	1,184,728	72%	2,188	302,966	19%	4,337	99,322	6%	256	49,576	3.0%	20,767	100%	1,636,592	100%

Table B-2. Cascadia subduction zone M9 earthquake loss estimates.

			(all dollar amounts in thousands)									
			Total Earthquake Damage*		**Earthquake Damage outside of Medium Tsunami Zone**							
		Total	**Buildings Damaged**		**Buildings Damaged**				**All Buildings Upgraded to At Least Moderate Code**			
Community	**Total Number of Buildings**	**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)	10,027	665,168	195,121	29%	1,040	2,949	174,519	26%	1118	1758	129,933	20%
Harbor	3,556	227,074	100,791	44%	470	1,554	92,369	41%	879	634	57,631	25%
Nesika Beach	399	19,602	5,759	29%	53	110	5,446	28%	60	46	3,449	18%
Total Unincorp. County	13,982	911,844	301,671	33%	1,563	4,613	272,334	30%	2057	2438	191,013	21%
Brookings	3,949	462,342	119,554	26%	446	757	117,620	25%	331	361	70,841	15%
Gold Beach	1,912	189,329	72,989	39%	149	347	37,164	20%	120	212	25,657	14%
Port Orford	924	73,077	27,971	38%	119	207	23,874	33%	92	100	13,553	19%
Total Curry County	20,767	1,636,592	522,185	32%	2,277	5,924	450,992	28%	2,600	3,112	301,064	18%

*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**
Unincorporated County (rural)	10,027	665,168	382	38,463	5.8%	726	62,363	9.4%	1,198	93,914	14%	1,996	137,504	21%	2,290	161,881	24%
Harbor	3,556	227,074	98	14,775	6.5%	155	19,719	8.7%	356	39,943	18%	999	73,893	33%	1,270	90,172	40%
Nesika Beach	399	19,602	5	238	1.2%	20	1,344	6.9%	73	4,309	22%	273	14,509	74%	322	15,932	81%
Total Unincorp. County	13,982	911,844	485	53,476	5.9%	901	83,426	9.1%	1,627	138,166	15%	3,268	225,907	25%	3,882	267,985	29%
Brookings	3,949	462,342	18	4,754	1.0%	43	10,274	2.2%	69	14,691	3.2%	181	30,283	6.5%	427	64,680	14%
Gold Beach	1,912	189,329	463	38,576	20%	774	68,015	36%	1,179	130,542	69%	1,507	153,078	81%	1,560	157,204	83%
Port Orford	924	73,077	12	2,935	4.0%	37	7,013	9.6%	271	23,459	32%	698	51,262	70%	732	52,957	73%
Total Curry County	20,767	1,636,592	978	99,741	6.1%	1,755	168,728	10%	3,146	306,858	19%	5,654	460,530	28%	6,601	542,826	33%

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)	10,027	665,168	60	555	0.1%	224	1,997	0.3%	343	4,753	0.7%	511	9,934	1.5%
Harbor	3,556	227,074	0	0	0%	0	0	0%	4	14	0%	0	0	0%
Nesika Beach	399	19,602	0	0	0%	0	0	0%	1	18	0.1%	0	0	0%
Total Unincorp. County	13,982	911,844	60	555	0.1%	224	1,997	0.2%	348	4,785	0.5%	511	9,934	1.1%
Brookings	3,949	462,342	0	0	0%	0	0	0%	0	0	0%	1	0	0.
Gold Beach	1,912	189,329	13	37	0%	38	277	0.1%	58	956	0.5%	143	2,881	1.5%
Port Orford	924	73,077	0	0	0%	0	0	0%	4	128	0.2%	0	0	0%
Total Curry County	20,767	1,636,592	73	592	0%	262	2,274	0.1%	410	5,869	0.4%	655	12,815	0.8%

*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)	10,027	8,564	355	4.1%	380	3.8%	38
Harbor	3,556	3,681	2	0.1%	9	0.3%	5
Nesika Beach	399	388	1	0.2%	1	0.3%	0
Total Unincorp. County	13,982	12,633	358	2.8%	390	2.8%	43
Brookings	3,949	6,334	0	0%	0	0%	0
Gold Beach	1,912	2,264	54	2.4%	70	3.7%	12
Port Orford	924	1,129	0	0%	4	0.4%	0
Total Curry County	20,767	22,361	411	1.8%	464	2.2%	55

*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 ($)	Very High Susceptibility: Number of Buildings	Very High Susceptibility: Building Value ($)	Very High Susceptibility: Ratio of Exposure Value	High Susceptibility: Number of Buildings	High Susceptibility: Building Value ($)	High Susceptibility: Ratio of Exposure Value	Moderate Susceptibility: Number of Buildings	Moderate Susceptibility: Building Value ($)	Moderate Susceptibility: Ratio of Exposure Value
Unincorp. County (rural)	10,027	665,168	1,127	77,859	12%	1,714	113,687	17%	4,470	287,534	43%
Harbor	3,556	227,074	87	13,901	6.1%	228	15,655	6.9%	1,452	76,850	34%
Nesika Beach	399	19,602	24	1,327	6.8%	46	2,172	11%	108	4,344	22%
Total Unincorp. County	13,982	911,844	1,238	93,087	10%	1,988	131,514	14%	6,030	368,728	40%
Brookings	3,949	462,342	51	7,848	1.7%	256	39,773	8.6%	1,473	166,031	36%
Gold Beach	1,912	189,329	52	4,461	2.4%	284	23,640	13%	815	89,243	47%
Port Orford	924	73,077	2	127	0.2%	98	8,196	11%	346	26,830	37%
Total Curry County	20,767	1,636,592	1,343	105,523	6.4%	2,626	203,123	12%	8,664	650,832	40%

Table B-7. Coastal erosion exposure.

(all dollar amounts in thousands)

Community*	Total Number of Buildings	Total Estimated Building Value ($)	High Hazard: Number of Buildings	High Hazard: Building Value ($)	High Hazard: Ratio of Exposure Value	Moderate Hazard: Number of Buildings	Moderate Hazard: Building Value ($)	Moderate Hazard: Ratio of Exposure Value	Low Hazard: Number of Buildings	Low Hazard: Building Value ($)	Low Hazard: Ratio of Exposure Value
Unincorp. County (rural)	10,027	665,167	44	9,166	1.4%	79	16,445	2.5%	106	21,680	3.3%
Nesika Beach	399	19,602	9	762	3.9%	28	2,369	12%	34	3,096	16%
Total Curry County	10,426	684,769	53	9,928	1.4%	107	18,814	2.7%	140	24,776	3.6%

*Does not include communities outside of study area defined by Priest and others (2004), these communities do not factor into total amounts and percentages.

Table B-8. Wildfire exposure.

			(all dollar amounts in thousands)					
			High Hazard			**Moderate Hazard**		
Community	**Total Number of Buildings**	**Total Estimated Building Value ($)**	**Number of Buildings**	**Building Value ($)**	**Ratio of Exposure Value**	**Number of Buildings**	**Building Value ($)**	**Ratio of Exposure Value**
Unincorp. County (rural)	10,027	665,168	178	14,076	2.1%	5,567	383,344	58%
Harbor	3,556	227,074	63	5,885	2.6%	1,389	105,511	47%
Nesika Beach	399	19,602	0	0	0%	272	12,952	66%
Total Unincorp. County	13,982	911,844	241	19,961	2.2%	7,228	501,807	55%
Brookings	3,949	462,342	0	0	0%	1,387	187,791	41%
Gold Beach	1,912	189,329	44	3,992	2.1%	767	58,386	31%
Port Orford	924	73,077	18	1,165	1.6%	480	38,210	52%
Total Curry County	20,767	1,636,592	303	25,118	1.5%	9,862	786,194	48%

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

C.2.1 Locating buildings points

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 taxlot; for taxlots 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 (100-year and 500-year scenarios) 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 Curry 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 = non-profit/religious, EDU = education) and various suffixes that indicate more specific types. This code determines the damage function to be used for flood analysis. It is also used to attribute the Building Type field, discussed below, for the earthquake analysis. The code was interpreted from "Stat Class" or "Description" data found in the Curry 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 Curry 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 Curry County assessor database. When multiple UDFs occupied a single taxlot, the overall cost of the taxlot 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 Curry County assessor database. Where not available the year of "1900" was applied (7.8% of the UDFs).
- **Square feet** – The size of the UDF is used to pro-rate the total improvement value for taxlots with multiple UDFs. The value distribution method will ensure that UDFs with the highest square footage will be the most expensive on a given taxlot. This value is also used to pro-rate the **Number of people** field for Residential UDFs within a census block. The value was obtained from DOGAMI's building footprints; where (RES) footprints were not available, we used the Curry 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 Curry 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 Curry 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 (Curry 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 Curry 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 (Curry 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 (U.S. 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

The years that seismic building codes are enforced within a community, called "benchmark" years, have a great effect on the results produced from the Hazus-MH earthquake model. 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 Curry County. **Table C-1** outlines the benchmark years that apply to buildings within Curry County.

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

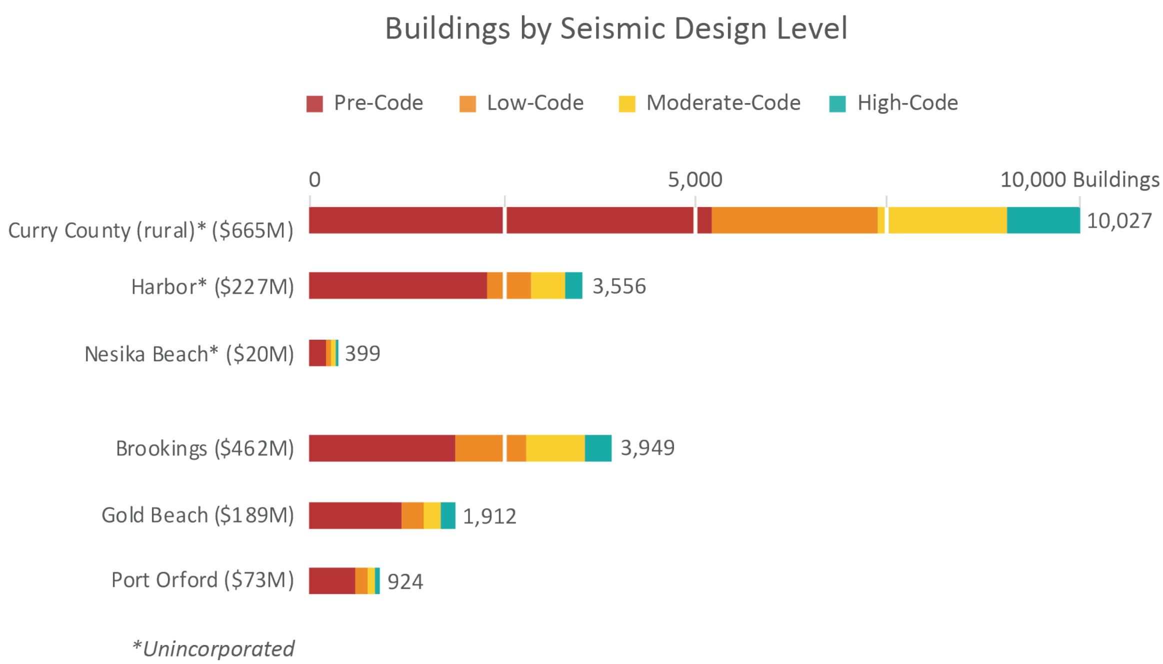
Building Type	Year Built	Design Level	Basis
Single Family Dwelling (includes Duplexes)	Prior to 1976	Pre Code	Interpretation of Judson (2012)
	1976–1991	Low Code	
	1992–2003	Moderate Code	
	2004 - Present	High Code	
Manufactured Housing	Prior to 2003	Pre Code	Interpretation of OR BCD 2002 Manufactured Dwelling Special Codes (Oregon Building Codes Division, 2002)
	2003–Present	Moderate Code	Interpretation of OR BCD 2010 Manufactured Dwelling Special Codes Update (Oregon Building Codes Division, 2010)
All other buildings	Prior to 1976	Pre Code	Business Oregon 2014-0311 Oregon Benefit-Cost Analysis Tool, p. 24 (Business Oregon, 2015)
	1976–1990	Low Code	
	1991 - 1999	Moderate Code	
	2000 - Present	High Code	

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

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

Community	Total Number of Buildings	Pre-Code Number of Buildings	Pre-Code Percentage of Buildings	Low Code Number of Buildings	Low Code Percentage of Buildings	Moderate Code Number of Buildings	Moderate Code Percentage of Buildings	High Code Number of Buildings	High Code Percentage of Buildings
Unincorp. County (rural)	10,027	5,248	52%	2,147	21%	1,659	17%	973	10%
Harbor	3,556	2,336	66%	566	16%	427	12%	227	6.4%
Nesika Beach	399	234	59%	59	15%	68	17%	38	10%
Total Unincorp. County	13,982	7,818	56%	2,772	20%	2,154	15%	1,238	8.9%
Brookings	3,949	1,901	48%	928	24%	771	20%	349	8.8%
Gold Beach	1,912	1,222	64%	288	15%	197	10%	205	11%
Port Orford	924	615	67%	148	16%	90	10%	71	7.7%
Total Curry County	20,767	11,556	56%	4,136	20%	3,212	15%	1,863	9.0%

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



C.3 Flood hazard data

DOGAMI developed flood hazard data in 2015 for a revision of the Curry County FEMA Flood Insurance Study (FEMA, 2018). The hazard data was based on some previous flood studies and new riverine and coastal hydrologic and hydraulic analyses. For riverine areas, the 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, 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 Oregon Resilience Plan (ORP; Madin and Burns, 2013) provided most of the earthquake inputs for the CSZ M9.0 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 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 M9.0 event was deemed the most likely and impactful earthquake scenario for Curry County. Past work has shown that probabilistic models of a 500-year event for this area are roughly the same as the CSZ M9.0 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 taxlot geometry can be the source of an error. These are just a few of the many types of problems addressed in the quality control process.

APPENDIX D. ACRONYMS AND DEFINITIONS

D.1 Acronyms

CRS	Community Rating System
CSZ	Cascadia subduction zone
DLCD	Oregon Department of Land Conservation and Development
DOGAMI	Department of Geology and Mineral Industries (State of Oregon)
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FRI	Fire Risk Index
GIS	Geographic Information System
NFIP	National Flood Insurance Program
NHMP	Natural hazard mitigation plan
NOAA	National Oceanic and Atmospheric Administration
ODF	Oregon Department of Forestry
OEM	Oregon Emergency Management
OFR	Open-File Report
OPDR	Oregon Partnership for Disaster Resilience
PGA	Peak ground acceleration
PGD	Permanent ground deformation
PGV	Peak ground velocity
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-percent chance of being equaled or exceeded each year. Sometimes referred to as the 100-year flood.

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

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

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

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

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

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

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

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

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

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

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

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

Risk MAP – The vision of this FEM 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.

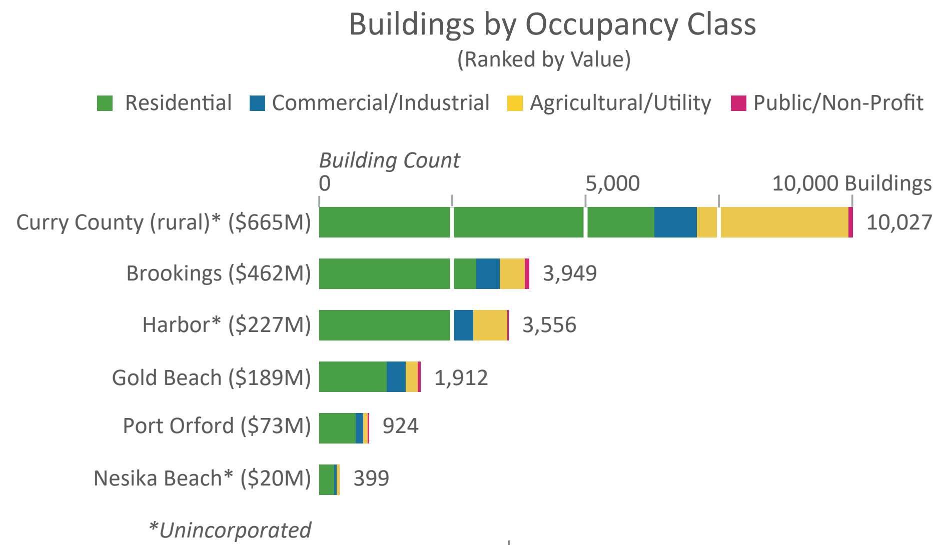
Vulnerability – Characteristics that make people or assets more susceptible to a natural hazard.

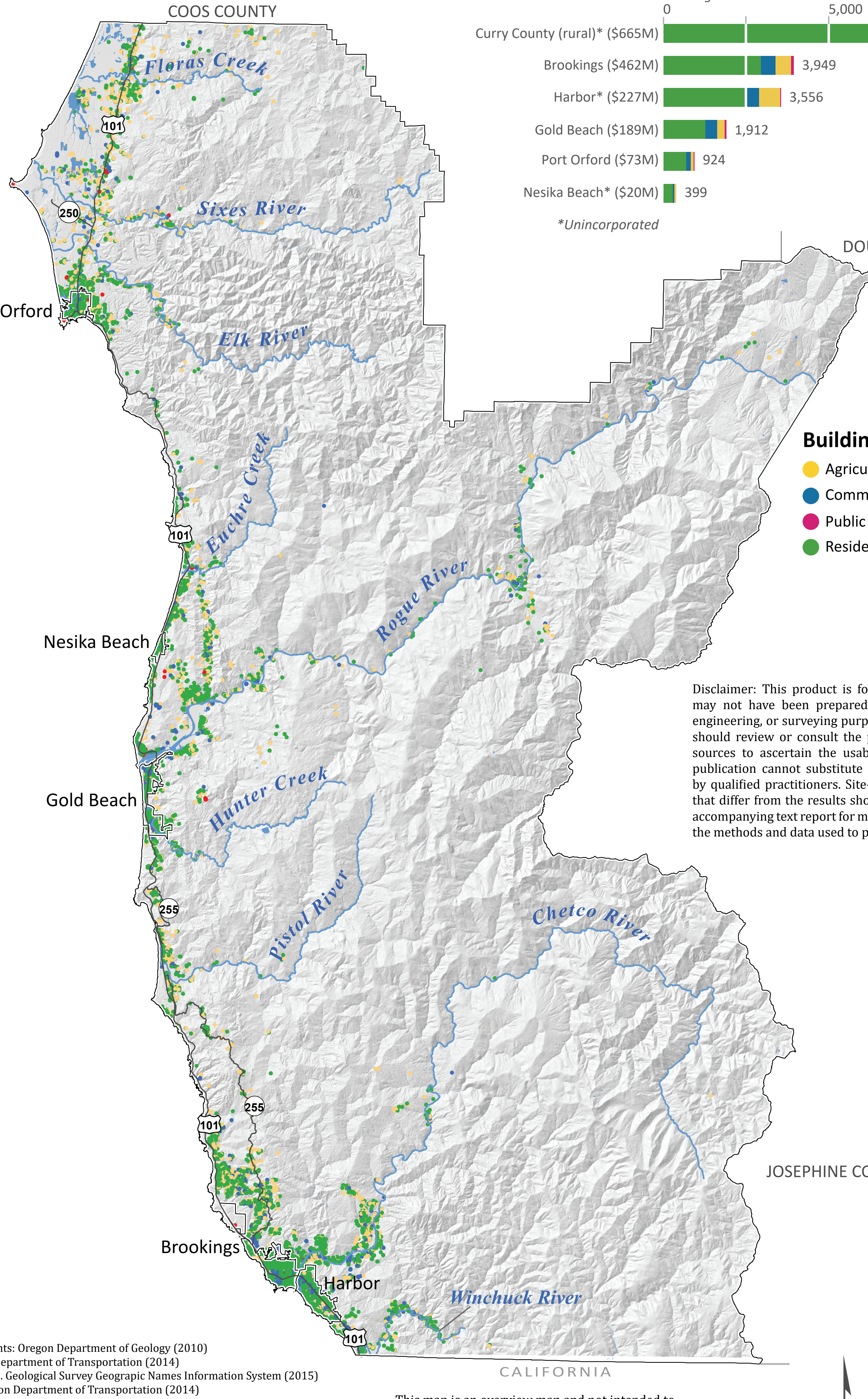
APPENDIX E. MAP PLATES

See appendix folder for individual map PDFs.

PLATE 1

Building Distribution Map of Curry County, Oregon





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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)

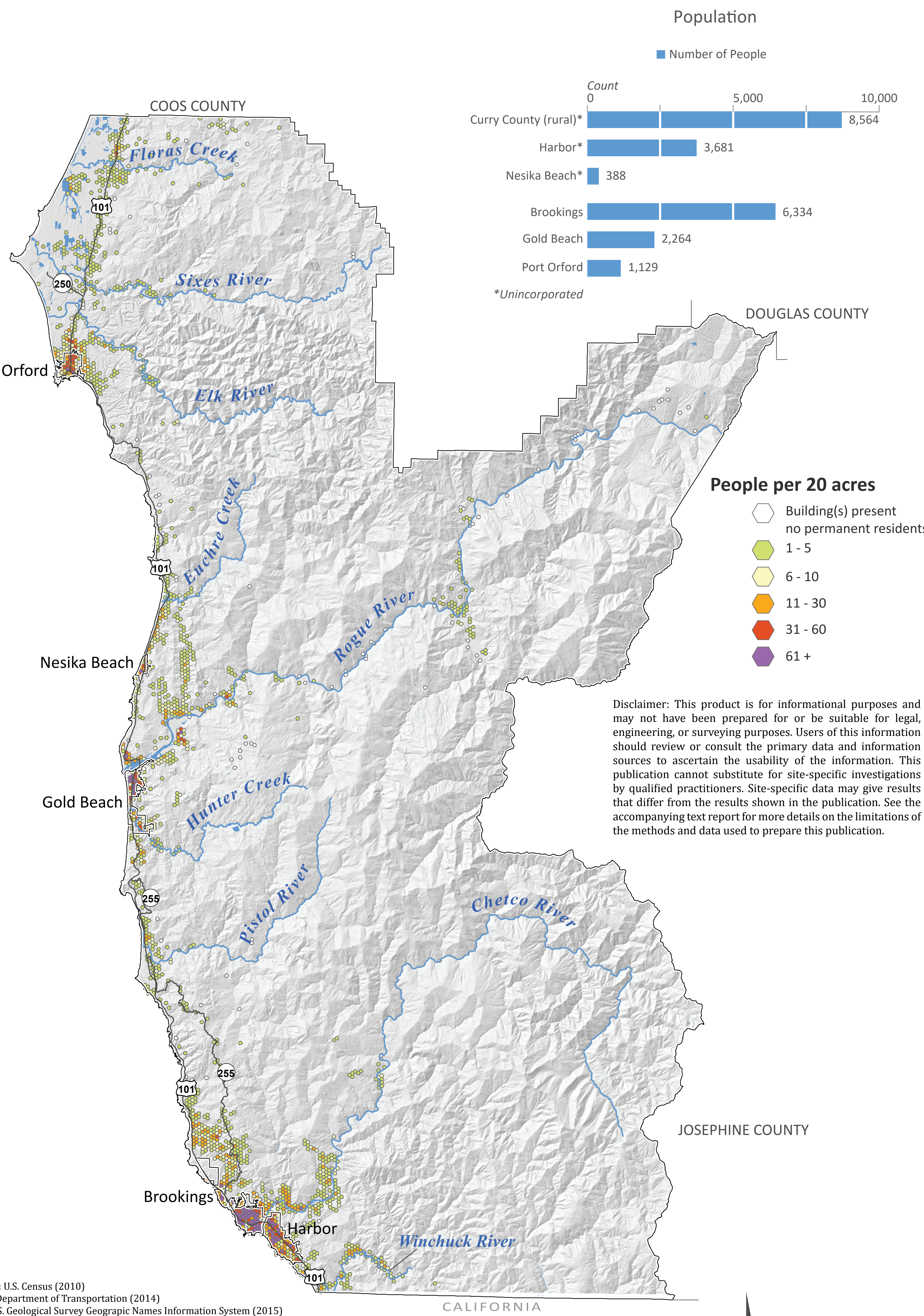
Projection: NAD 1983 UTM Zone 10N
Software: Esri® ArcMap 10, Adobe® Illustrator CS6

Cartography by: Lowell H. Anthony, 2018

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

PLATE 2

Population Density Map of Curry County, Oregon



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.

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

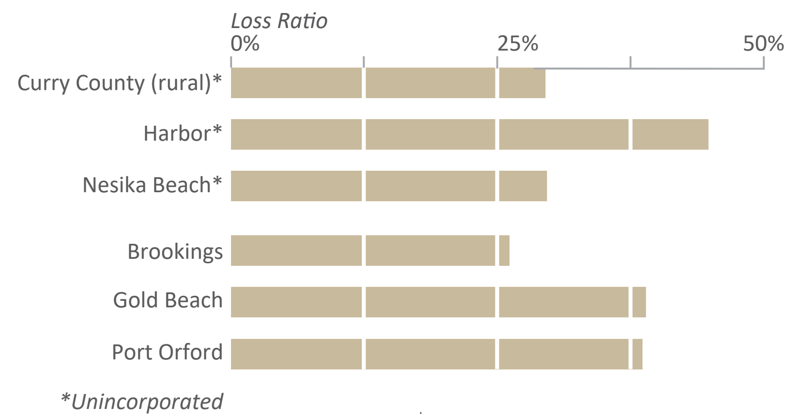
Cartography by: Lowell H. Anthony, 2018

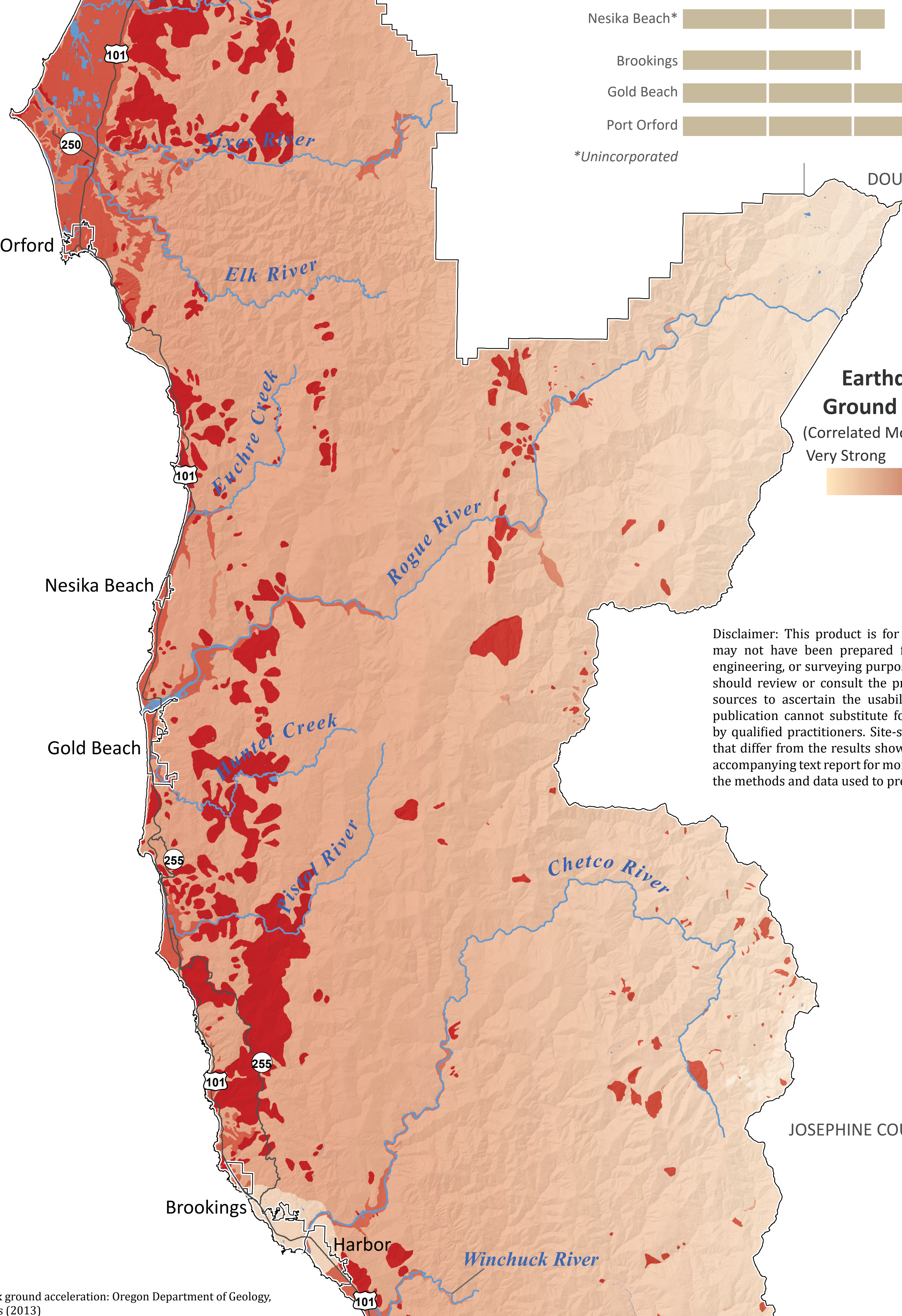
This map is an overview map and not intended to provide details at the community scale. The GIS data that is published with the Curry County Natural Hazard Risk Assessment can be used to inform regarding queries at the community scale.

PLATE 3

M9.0 CSZ Earthquake Shaking Map of Curry 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.





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Data Sources:
Earthquake peak ground acceleration: Oregon Department of Geology, Madin and Burns (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

Cartography by: Lowell H. Anthony, 2018

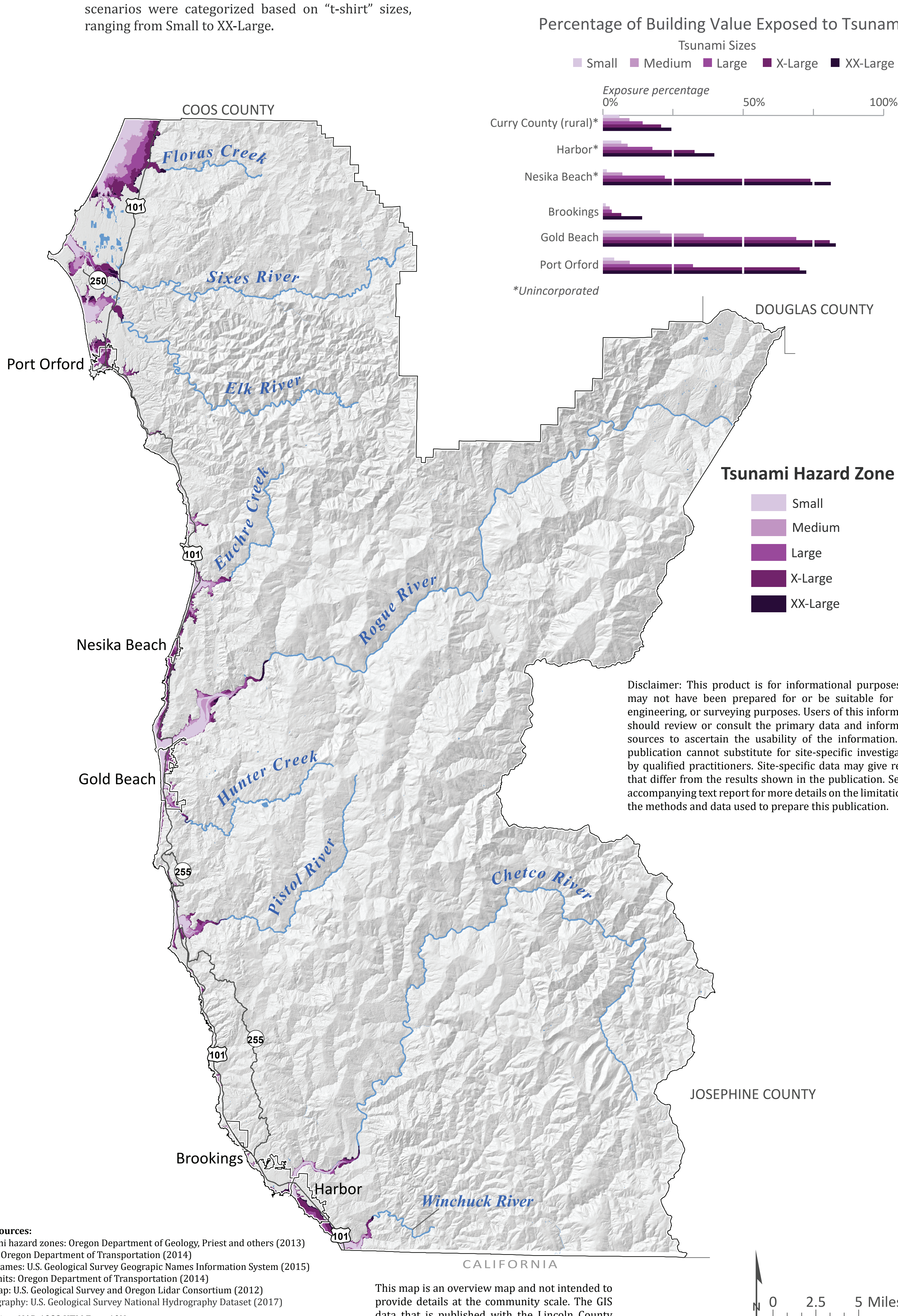
This map is an overview map and not intended to provide details at the community scale. The GIS data that is published with the Curry County Natural Hazard Risk Assessment can be used to inform regarding queries at the community scale.

N
0 2.5 5 Miles
0 3.5 7 Kilometers

PLATE 4

Tsunami Inundation Map of Curry County, Oregon

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



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.

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

Cartography by: Lowell H. Anthony, 2018

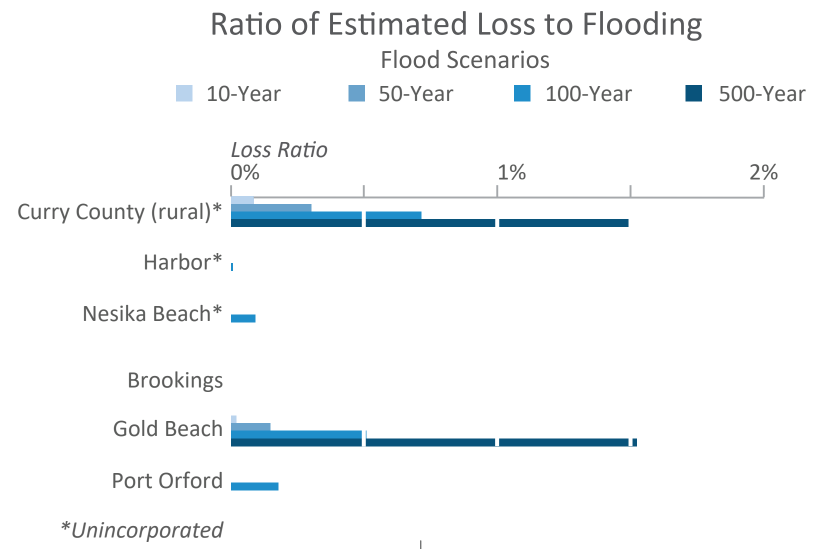
This map is an overview map and not intended to provide details at the community scale. The GIS data that is published with the Lincoln County Natural Hazard Risk Assessment can be used to inform regarding queries at the community scale.

N
0 2.5 5 Miles
0 3.5 7 Kilometers

PLATE 5

Flood Hazard Map of Curry 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 Curry County's Digital Flood Insurance Rate Maps.



Flood Hazard Zone

100-Year Flood (1% annual chance)

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.

Data Sources:
Flood hazard zone (100-year): Curry 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

Cartography by: Lowell H. Anthony, 2018

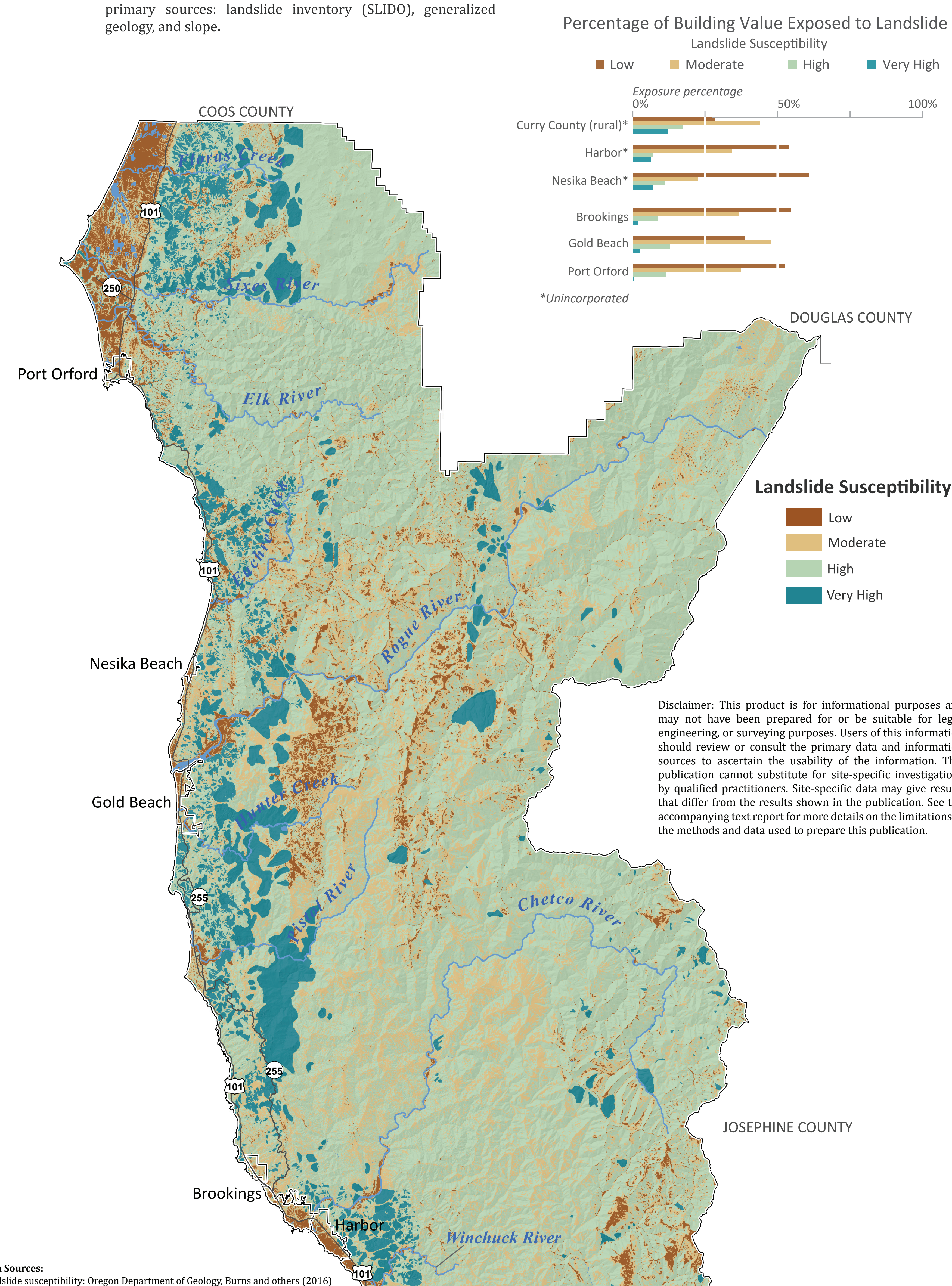
This map is an overview map and not intended to provide details at the community scale. The GIS data that is published with the Curry County Natural Hazard Risk Assessment can be used to inform regarding queries at the community scale.

N
0 2.5 5 Miles
0 3.5 7 Kilometers

PLATE 6

Landslide Susceptibility Map of Curry 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.



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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

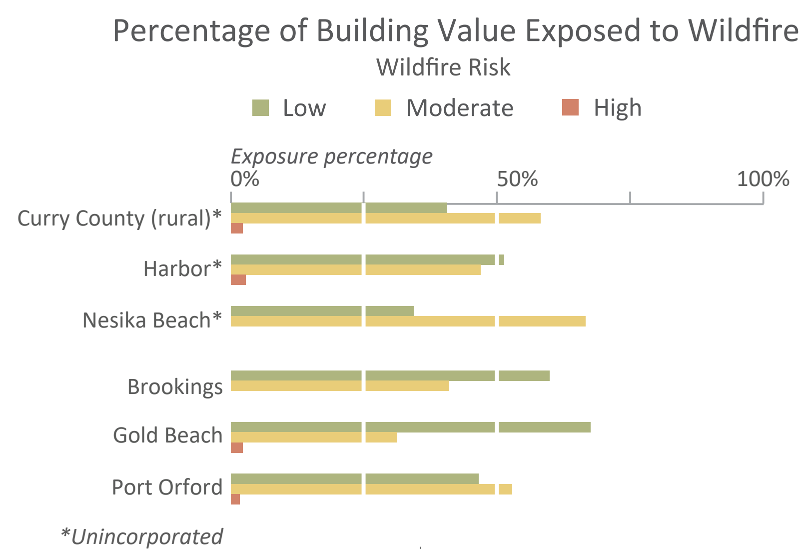
This map is an overview map and not intended to provide details at the community scale. The GIS data that is published with the Curry County Natural Hazard Risk Assessment can be used to inform regarding queries at the community scale.

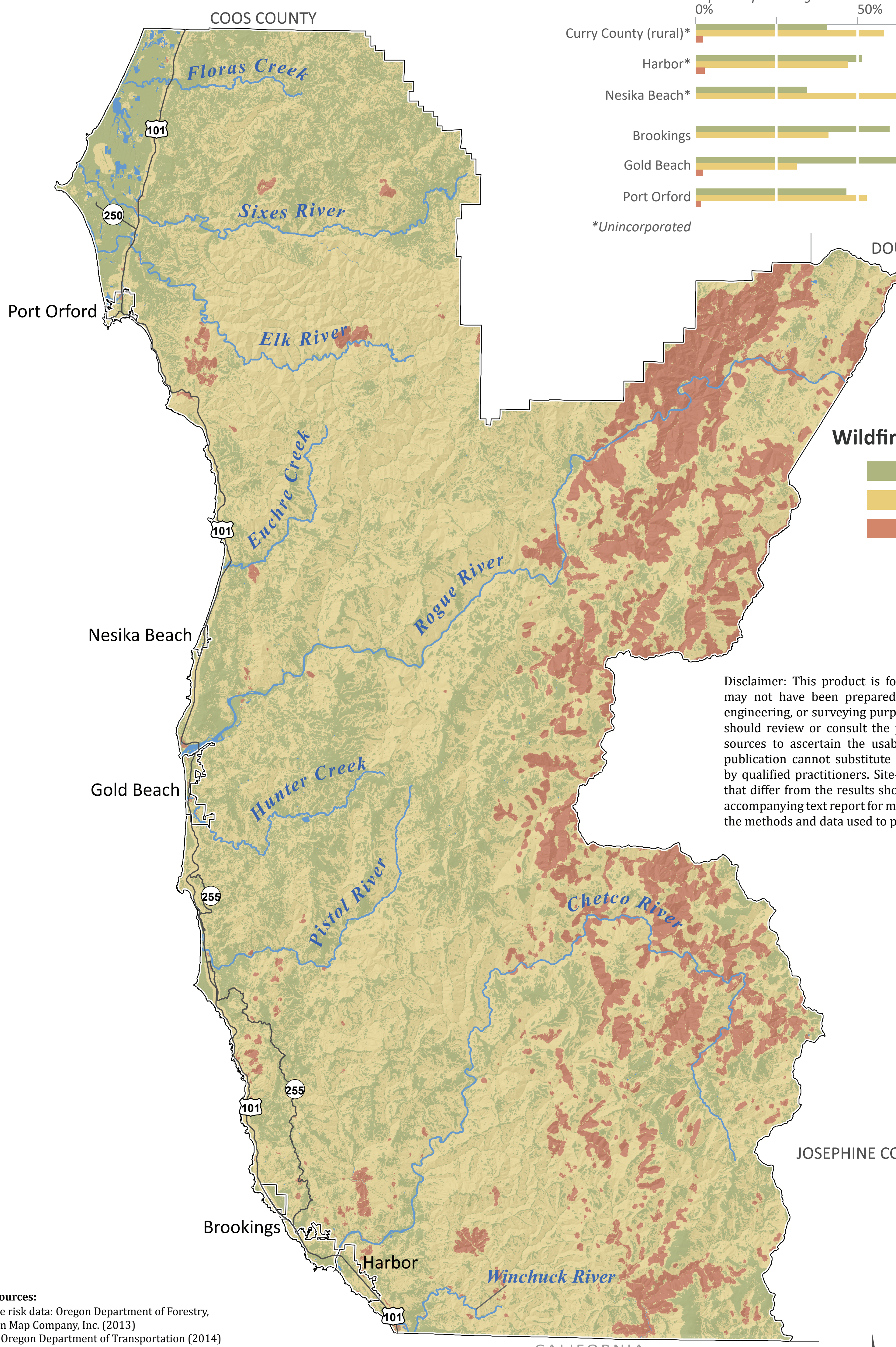
N
0 2.5 5 Miles
0 3.5 7 Kilometers

PLATE 7

Wildfire Risk Map of Curry 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).





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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

Cartography by: Lowell H. Anthony, 2018

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

N 0 2.5 5 Miles
0 3.5 7 Kilometers