

PREPARING FOR LANDSLIDE HAZARDS

**A LAND USE GUIDE
FOR OREGON COMMUNITIES**

October 2019



Guide Developers

Tricia R. Sears, Marian Lahav, Oregon Department of Land Conservation and Development (DLCD)
William J. Burns, Justin McCarley, Oregon Department of Geology and Mineral Industries (DOGAMI)

Important Notice

This *Guide* provides examples of comprehensive plan language and development code provisions that can serve to help communities reduce risk to landslide hazards. These examples provide general guidance allowing communities to tailor land use policies and regulations to their individual circumstances. In developing this *Guide*, every effort has been made to provide examples that conform to Oregon land use law. However, as always when developing land use regulations or other legislation for local adoption, local governments should consult with their legal counsel to ensure that proposals comply with applicable federal, state, and local requirements. Unless otherwise marked, examples and excerpts of city and county codes quoted in this document were current at time of *Guide* preparation.

The goal of this *Guide* is to help local communities throughout Oregon become more resilient to landslide hazards through community land use options and strategies. The *Guide* is focused on land use planning approaches to reduce landslide hazard risk and is not intended to address the full range of efforts needed for overall disaster preparedness. Adequately preparing for a local or catastrophic event requires a comprehensive community effort. This *Guide* can be used to develop land use options and strategies as one part of a community's comprehensive preparedness effort.

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Cover image modified from OCWebMaps, Oregon City GIS, <https://www.orcity.org/maps/geologic-hazards-map>. Layers shown are Basemap; Streams; Landslides (SLIDO) – Scarps; Landslides (SLIDO) – Scarp Flanks; Landslides (SLIDO) – Deposits; Geologic Hazards - Landslides; Slope Categories. **Figure 4-3** shows data layers that viewers of the interactive map can select and view.

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CHAPTER 1 INTRODUCTION TO THE *GUIDE*

Community leaders need to think holistically about planning for hazards, identify opportunities and resources to achieve their goals, treat mitigation as an investment in protection of public and private investments, and seek synergies that achieve those results in the most cost-effective ways possible. Focusing on thinking linkages is perhaps the most exciting and potent way to get there.

– *Hazard Mitigation: Integrating Best Practices into Planning*¹

Oregon is landslide country!

Landslides are a chronic problem in our state, affecting both infrastructure and private property. Approximately 13,048 documented landslides have occurred in Oregon in the last 150 years (Burns, 2017²). The combination of geology, precipitation, topography, and seismic activity makes portions of Oregon especially prone to landslides. The Coast Range and the Cascades Range have the most significant landslide hazards in Oregon; these geographic areas and the valley between them contain the bulk of Oregon’s population.



A landslide warning sign on Interstate 84 at the western edge of the Columbia River Gorge National Scenic Area reminds travelers to be alert for landslide hazards. (Photo credit: Tricia Sears)

We know that precipitation, earthquakes, and human activity are the main triggers of landslides. While we cannot control precipitation and earthquakes, we can change our human activity. Addressing landslide risk is everyone’s responsibility and is codified in Oregon Revised Statute (ORS) 195.253³:

The Legislative Assembly declares that it is the policy of the State of Oregon that: Each property owner, each highway user and all federal, state and local governments share the responsibility for making sound decisions regarding activities that may affect landslide hazards and the associated risks of property damage or personal injury.

¹ 2010, p. 134, https://www.fema.gov/media-library-data/20130726-1739-25045-4373/pas_560_final.pdf

² <http://www.oregongeology.org/slido/>

³ https://www.oregonlegislature.gov/bills_laws/ors/ors195.html

In the past few decades, Oregon’s population has increased rapidly, with just over 4 million people living here presently. Urban areas are seeing substantial increases in population and development pressure that encroach on nonurban areas. Development will continue, creating increasing complexity in addressing urban growth, environmental protection, natural hazards, housing cost and availability, social conditions, economic well-being, and equity issues. Without proper site evaluation and construction techniques, development in areas highly susceptible to landslides will significantly increase potential for loss of life and property damage, not only on the subject property but also on neighboring properties. Oregon’s land use laws, which will be discussed in Chapters 3 and 4, provide rules and guidance on how communities develop.

A. PURPOSE AND SCOPE OF THE *GUIDE*

One Size Does Not Fit All

Communities should consider their own strategies to reduce landslide hazard risk.

DOGAMI and DLCD collaborated on this *Guide* to help Oregon communities reduce potential losses from landslide events. To do this, we identify land use tools and strategies. The *Guide* is focused on land use planning approaches to reduce landslide hazard risk and is not intended to address the full range of efforts needed for overall landslide risk reduction and hazard preparedness.

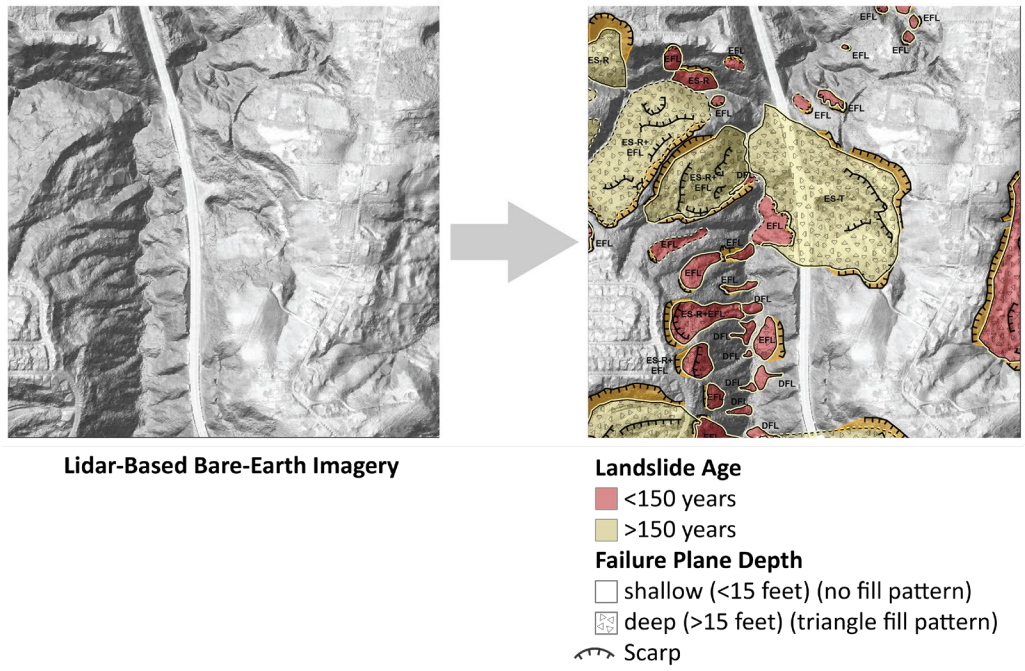
Land use planning to reduce landslide hazard risk uses comprehensive plan and implementation provisions (e.g., zoning code, building code, and so forth) and is based on science and policy. Science is a basis for policy, implementation, and decision-making, while policies also shape the science that is pursued and obtained. Much of the expressed need for this *Guide* (Chapter 4, section **C, Key Questions from Interviewees**, and Chapter 5, section **C, Landslide Guide Interviewees’ Key Points**) stemmed from communities that pursued and obtained lidar-based landslide mapping with DOGAMI.

Lidar, a form of laser technology, has significantly increased the ability to locate and map existing landslides. Lidar allows mappers to see the earth’s surface with a much higher level of detail than has ever been available, and as the technology continues to improve, so too does the level of detail. Lidar imagery even allows mappers to see the ground beneath vegetation and trees, as if the earth had been stripped bare. This gives geologists the ability to identify and map landslide features that may have previously been unrecognized or overlooked (**Figure 1-1**). See Chapter 2, section **C, Types of Landslide Maps** for a fuller discussion of lidar.

High-Resolution Lidar Mapping

Lidar is a relatively new technology that allows mappers to see the earth’s surface beneath vegetation and trees, as if the earth had been stripped bare. Lidar gives geologists the ability to identify and map landslide features that may have previously been unrecognized or overlooked.

Figure 1-1. Bare-Earth Lidar Map (left) and Bare-Earth Lidar with Mapped Landslides



Source: DOGAMI (Burns & Madin, 2009b⁴)

During the last decade, DOGAMI has produced lidar-based, detailed landslide inventory, shallow landslide susceptibility, and deep landslide susceptibility maps for many communities in Oregon. **Table 1-1** is a list of all the communities with DOGAMI lidar-based landslide inventory and landslide susceptibility maps. There are 46 cities and 14 counties with DOGAMI lidar-based inventory maps. There are 35 cities and 9 counties that have DOGAMI lidar-based landslide susceptibility maps.

Understanding the landslide hazard information is imperative to using it in comprehensive plans, zoning codes, and other documents that provide guidance, policy, and implementation measures for a community. The results of landslide mapping using lidar imagery commonly reveal that more of a community is within a landslide hazard area than was known previously. What then, is a community to do with this information?

Chapter 3, Mitigation Planning, describes the importance of comprehensive planning, Oregon’s Statewide Planning Goals, and natural hazard mitigation planning, then discusses integrating landslide map information to reduce risk.

Chapter 4, Implementation, describes measures such as zoning code, stormwater management code, erosion control code, and so forth, which are implemented as

⁴ <https://www.oregongeology.org/pubs/sp/p-SP-42.htm>

regulations. Examples of codes from jurisdictions that incorporate landslide map information are provided.

Chapter 5, Resources, contains model code and comprehensive plan information, summary information related to the code review, a list of interviewees' key points (collected via research during this *Guide* and additional resources related to landslides. This *Guide* is not intended to address the full range of efforts needed for overall landslide risk reduction and hazard preparedness”?

Chapter 6, Glossary, and **Chapter 7, References**, are self-explanatory.

Chapter 8, Landslide Code Review Details Table, contains the list of communities (cities and counties) in a code review performed by DLCD and DOGAMI. The table contains information from 28 cities and 6 counties; it does not include every community that has either DOGAMI lidar-based landslide inventory maps and/or DOGAMI lidar-based landslide susceptibility maps.

Table 1-1. DOGAMI Lidar-Based Landslide Mapping for Oregon Communities (Cities and Counties). This list contains cities and counties that are partially or completely mapped. These communities and counties were the basis for the Code Review for this Guide, but not all of these communities are in the Code Review. Newport and Salem do not have lidar-based landslide mapping but are included in the Code Review because of their unique geologic hazard codes.

Lidar-Based Landslide Inventory Maps —

DOGAMI has produced partial or complete lidar-based landslide maps for:

Cities:

Astoria	Eugene	Lake Oswego	Silverton
Banks	Fairview	Maywood Park	Springfield
Barlow	Florence	Milwaukie	Tigard
Beaverton	Forest Grove	Mount Angel	Troutdale
Brookings	Gladstone	North Plains	Tualatin
Canby	Gold Beach	Oregon City	Vernonia
Clatskanie	Gresham	Port Orford	Warrenton
Coburg	Happy Valley	Portland	West Linn
Cornelius	Hillsboro	Rivergrove	Wilsonville
Damascus	Johnson City	Sandy	Wood Village
Durham	Junction City	Scappoose	
Estacada	King City	Sherwood	

Counties:

Curry	Columbia	Lane	Multnomah
Benton	Coos	Lincoln	Washington
Clackamas	Crook	Marion	Yamhill
Clatsop	Hood River		

Lidar-Based Landslide Susceptibility Maps —

DOGAMI has produced partial or complete lidar-based landslide maps for:

Cities:

Astoria	Fairview	Maywood Park	Springfield
Barlow	Gladstone	Milwaukie	Tigard
Beaverton	Gresham	Mount Angel	Troutdale
Canby	Happy Valley	Oregon City	Tualatin
Clatskanie	Hillsboro	Portland	Warrenton
Coburg	Johnson City	Rivergrove	West Linn
Damascus	Junction City	Sandy	Wilsonville
Estacada	King City	Sherwood	Wood Village
Eugene	Lake Oswego	Silverton	

Counties:

Clackamas	Hood River	Multnomah
Clatsop	Lane	Washington
Columbia	Marion	Yamhill

B. HOW TO USE THE *GUIDE*

This *Guide* is intended to assist, in particular, the growing list of Oregon communities with new lidar-based landslide inventory and susceptibility maps. However, the majority of the information and examples presented represent best available science and practices and may be used by communities throughout Oregon regardless of the age or quality of their landslide hazard maps and data. In fact, the older the maps and the lower the data quality, the more important it is for a community to adopt prudent and protective policies and regulations.

What Will You Find in This *Guide*?

- Explanations of the general types of landslide hazards. (Chapter 2)
- Explanation of lidar. (Chapter 2)
- Information about engineering geology reports and geotechnical engineering reports, the professionals who author them, and how to use them. (Chapter 2)
- Results of a limited review of Oregon landslide regulations primarily in Oregon communities with the new lidar-based maps. See **Table 5-1** through **Table 5-4**, **Figure 4-7**, and **Table 8-1**. (Chapters 4, 5, and 8)
- Key issues in implementing landslide hazard risk reduction identified through conversations with professionals primarily in jurisdictions with the new lidar-based maps. (Chapter 4 and 5)
- Discussions of comprehensive plan and implementation (e.g., zoning codes, building codes, and so forth) issues and approaches to reducing landslide risk through non-regulatory and regulatory steps. (Chapters 3 and 4)
- Elements of a strong comprehensive plan related to landslide hazards, examples of comprehensive plan provisions from Oregon communities, and a model framework for comprehensive plan revisions. (Chapters 3 and 5)
- Elements of a strong landslide hazard ordinance, example code provisions from Oregon communities, and a model framework for a landslide hazard ordinance. (Chapters 4 and 5)
- Key ways to reduce a community's risk from landslide hazards. (Chapter 4)
- Other resources to aid communities and individuals in reducing (mitigating) landslide hazard risks. (Chapter 5)

When using this *Guide*, be familiar with and understand a community's landslide policies and regulations and specific landslide risks. Local policies, regulations, and plans are typically available at a community's planning, building, public works, and emergency management departments; often this information is also available online

on the jurisdiction's website. Documents such as but not limited to comprehensive plans, zoning codes, grading and erosion control manuals, and natural hazards mitigation plans provide a substantial amount of information about a community's policies and regulations. Local maps may also be available at the jurisdiction's offices and their website. The maps released by DOGAMI are available on the DOGAMI website⁵.

C. KEY DEFINITIONS

Throughout this *Guide* we use the engineering geology terms *hazard*, *susceptibility*, and *risk*.

Hazard is something that has the potential to cause harm; it is a possible source of danger. Hazard is defined in this *Guide* as the frequency and magnitude at which landslides will happen.

The term **susceptibility** is defined here as capable of being affected by a specified action or process, and in this *Guide* the process is mass wasting by means of slope failure or landsliding.

The term **risk** is defined here as the probability of loss or injury. In this *Guide* risk is the intersection of the hazard with assets (such as buildings) and their vulnerability to the hazard (Burns, Hughes, Olsen, McCloughry & others, 2016⁶). Risk is an expression of the potential magnitude of a disaster's impact. **Figure 2-8** shows risk as the intersection of natural hazards and vulnerable systems.

Some other frequently used terms in this *Guide* include vulnerability, exposure, mitigation, and resilience:

Vulnerability is the potential to be harmed. Some people and places are more vulnerable to landslide hazards than are others.

Exposure is the spatial overlap of landslide hazard and assets.

Mitigation is the action of reducing the severity of the landslide hazard to reduce impacts of hazards on people, property, and the environment.

Resilience is the capacity to withstand and recover from a disaster.

⁵ <https://www.oregongeology.org>

⁶ <http://www.oregongeology.org/pubs/ofr/p-O-11-16.htm>

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CHAPTER 2 LANDSLIDE HAZARDS

Houses and other structures should not be placed in locations where the owners might as well paint a bull's-eye on the outside wall.

—Ray Wilkeson⁷

The general term *landslide* refers to a range of slope movement processes including rock falls, debris flows, earth slides, and other mass movements (Varnes, 1978⁸). The main triggers of landslides are precipitation, earthquakes, and human activity.

Landslides not caused by humans are a natural process; they shape the landscape and contribute to the overall environmental quality of our world. There are benefits to landslides: “The ecological role that landslides play is often overlooked. Landslides contribute to aquatic and terrestrial biodiversity. Debris flows and other mass movement play an important role in supplying sediment and coarse woody debris to maintain pool/riffle habitat in streams. As disturbance agents, landslides engender a mosaic of seral stages, soils, and sites (from ponds to dry ridges) to forested landscapes” (Geertsema, Highland, & Vaugeouis, 2009⁹).

However, when a landslide impacts people, property, or assets (e.g., roads, buildings, and infrastructure), and the environment in a harmful way, it is a natural hazard.

And, although landslides are generally thought of as localized events, occurring on individual hillsides or slopes, big rainstorms or earthquakes can cause large, catastrophic landslides (such as the 2014 Oso landslide in Washington State) or hundreds of smaller landslides within a relatively short time across a wide region (such as the Portland metropolitan area in the winter storms of 1996). These are but two of the ways landslides can be natural disasters.

A. TYPES OF LANDSLIDES

All landslides can be classified into six types of movement: 1) falls, 2) topples, 3) slides, 4) spreads, 5) flows, and 6) complex (**Figure 2-1**). Most slope failures are

⁷ Oregon Forest Industries Council, quoted in *Oregonian* newspaper article (Mapes, March 3, 1999)

⁸ <http://onlinepubs.trb.org/Onlinepubs/sr/sr176/176-002.pdf>

⁹ https://link.springer.com/chapter/10.1007/978-3-540-69970-5_31

complex combinations of these six distinct types, but the generalized groupings provide a useful means for framing discussion of the type of hazard and potential mitigation actions. Movement type should be combined with other landslide characteristics such as type of material, rate of movement, depth of failure, and water content to understand more fully the landslide behavior. For a more complete description of the different types of landslides, see *U.S. Transportation Research Board Special Report 247, Landslides: Investigation and Mitigation* (Turner & Schuster, 1996¹⁰), which has an extensive chapter on landslide types and processes.

One type of landslide that is commonly life threatening is channelized debris flow, sometimes referred to as a *rapidly moving landslide* or RML. They are more prevalent and impactful than most people recognize. Channelized debris flows normally initiate on a steep slope, move into a steep channel (or drainage), increase in volume by incorporating channel materials, and then deposit material, usually at the mouth of the channel on existing fans. Debris flows can be mobilized by other types of landslides that occur on slopes near a channel. Debris flows can also initiate within channels from accelerated erosion during heavy rainfall or snowmelt. These debris flows move fast enough that they are difficult to outrun.

Slopes that have failed in the past often remain in a weakened state, and many of these areas tend to fail repeatedly over time. For example, a channel with a debris flow fan at its mouth indicates a history of debris flows in that channel. The formation of talus slopes indicates that numerous rock falls have occurred above the slope. Talus is “[a]n outward sloping and accumulated heap or mass of rock fragments of any size or shape (usually coarse and angular) derived from and lying at the base of a cliff or very steep, rocky slope, and formed chiefly by gravitational falling, rolling, or sliding” (USGS¹¹).

Keys to Future Landslides

Knowing the locations and understanding the types of past landslides are the keys to understanding future landslides.

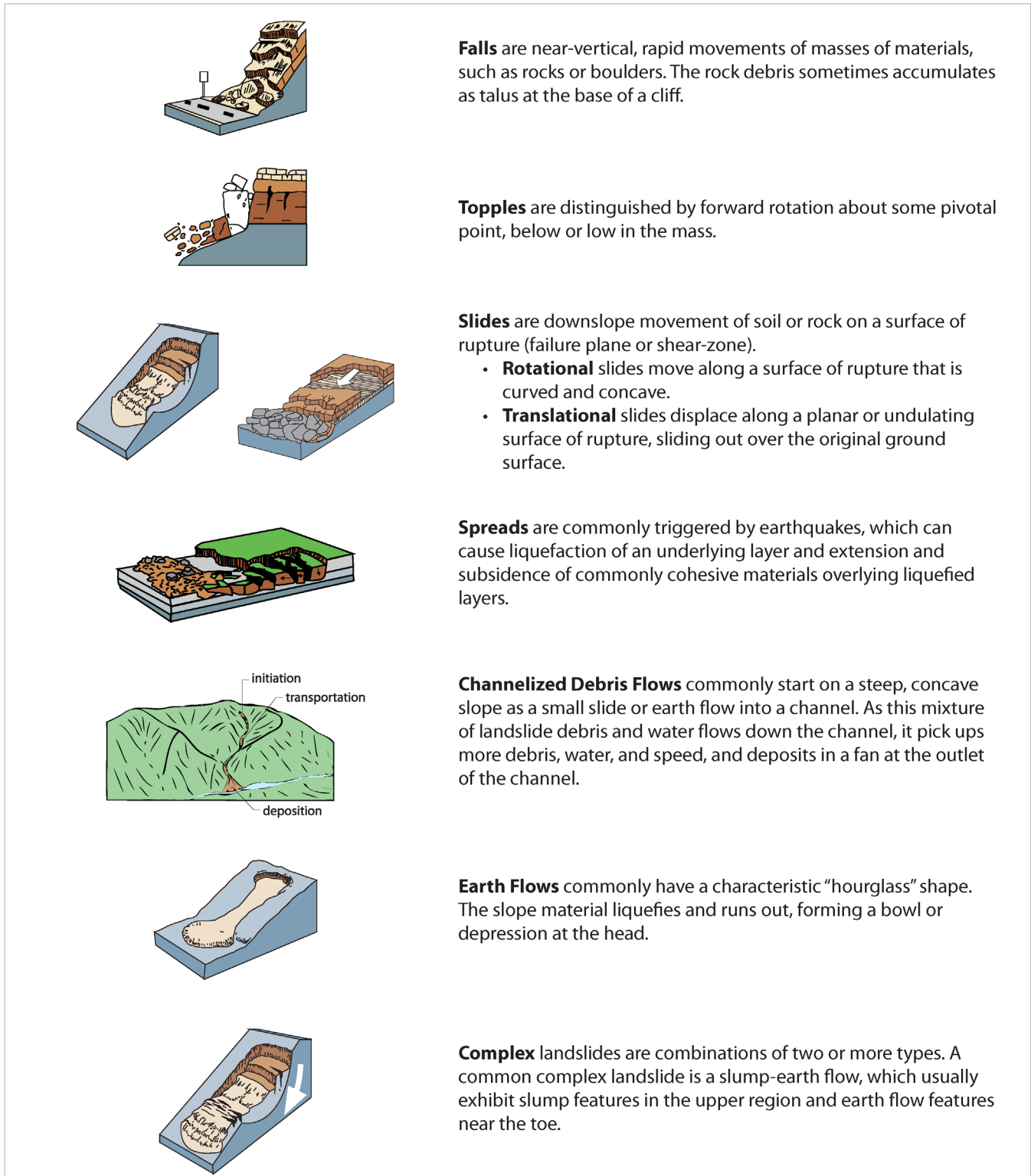
The tendency for failures to reoccur is true for all types of landslide movements and over periods much longer than human recorded history. Large landslide complexes may have moved dozens of times over thousands of years, with long periods of stability punctuated by episodes of movement. In some cases, areas that have previously failed have subtle topographic morphology now, making them difficult to identify. However, technological advances such as lidar have greatly helped in the process of identifying and mapping older landslides. Identifying and mapping both historical and ancient landslide areas – many of which will move again – is of great importance for mitigating the risk these natural hazards pose.

Potential slope instability is not limited to past landslide sites. Areas near previous landslides and of similar geology and topography are also at higher risk for slope failure. This makes it even more important to locate previous landslides and study them: Mapping landslide locations can identify nearby or similar areas susceptible to slope instability.

¹⁰ <http://onlinepubs.trb.org/Onlinepubs/sr/sr247/sr247-007.pdf>

¹¹ <https://mrdata.usgs.gov/geology/state/sgmc-lith.php?code=1.5.5>

Figure 2-1. Types of Common Landslides in Oregon



Falls are near-vertical, rapid movements of masses of materials, such as rocks or boulders. The rock debris sometimes accumulates as talus at the base of a cliff.

Topples are distinguished by forward rotation about some pivotal point, below or low in the mass.

Slides are downslope movement of soil or rock on a surface of rupture (failure plane or shear-zone).

- **Rotational** slides move along a surface of rupture that is curved and concave.
- **Translational** slides displace along a planar or undulating surface of rupture, sliding out over the original ground surface.

Spreads are commonly triggered by earthquakes, which can cause liquefaction of an underlying layer and extension and subsidence of commonly cohesive materials overlying liquefied layers.

Channelized Debris Flows commonly start on a steep, concave slope as a small slide or earth flow into a channel. As this mixture of landslide debris and water flows down the channel, it pick ups more debris, water, and speed, and deposits in a fan at the outlet of the channel.

Earth Flows commonly have a characteristic “hourglass” shape. The slope material liquefies and runs out, forming a bowl or depression at the head.

Complex landslides are combinations of two or more types. A common complex landslide is a slump-earth flow, which usually exhibit slump features in the upper region and earth flow features near the toe.

Source: Modified after Highland (2004, <https://doi.org/10.3133/fs20043072>)

B. EFFECTS OF LANDSLIDES

B.1. EFFECTS ON PEOPLE

Landslides lead to an estimated 25–50 deaths per year in the United States (Spiker and Gori, 2003¹²). In Oregon, the average annual loss of life is estimated to be nearer to one or two lives per year (Beaulieu and Olmstead, 1999¹³). However, larger scale events have the potential to cause mass casualties. The winter storms of 1996 led to eight deaths in Oregon due to several individual landslides (Beaulieu & Olmstead, 1999¹⁴).

As the state’s population grows, easy-to-develop lands tend to be the first areas developed, leaving more difficult-to-develop areas such as landslide- or other hazard-prone areas. Landslide hazard areas are often areas with steep slopes and higher elevation. These areas can be desirable lands for development, e.g., view properties, that command high prices. They can be complicated to develop, but they become “worth it.” Developing in landslide hazard areas puts more people, structures, and infrastructure in hazard areas.

Landslides can have direct and indirect effects on people. Landslide materials blocking roads are probably the most common impacts from landslides. A landslide in January 2017 undermined a section of NW Newberry Road in Multnomah County, forcing a road closure until April 2019 (Multnomah County, 2018¹⁵). For people who use these roads to commute and transport goods, the effect can be costly in both time and money.

B.2. EFFECTS ON THE ECONOMY

In the United States, landslides cause over \$2 billion in economic losses annually (Turner & Schuster, 1996¹⁶; Spiker & Gori, 2003¹⁷). Oregon is a landslide-prone state, with economic losses potentially exceeding \$100 million in direct damage from landslides during severe winter storms (Wang, Summers & Hofmeister, 2002¹⁸). Even without these large events, landslides are a chronic hazard in Oregon, with annual average maintenance and repair costs for landslides in the state estimated at over \$10M (Wang et al., 2002¹⁸).

Landslides are a Chronic Hazard

Landslides are a chronic hazard in Oregon, with annual average maintenance and repair costs for landslides in the state estimated at over \$10M (Wang et al., 2002¹⁸).

¹² <https://pubs.usgs.gov/circ/c1244/>

¹³ <https://www.oregongeology.org/pubs/sp/SP-31.pdf>

¹⁴ <https://www.oregongeology.org/pubs/sp/SP-31.pdf>

¹⁵ <https://multco.us/roads/webform/newberry-road-slide-repair>

¹⁶ <http://onlinepubs.trb.org/Onlinepubs/sr/sr247/sr247-007.pdf>

¹⁷ <https://pubs.usgs.gov/circ/c1244/>

¹⁸ <https://www.oregongeology.org/pubs/ofr/O-02-05.pdf>

Landslide risk analysis by Burns, Calhoun, Franczyk, Lindsey & Ma (2018¹⁹) indicates the loss estimates by Wang et al. (2002¹⁸) for the state of Oregon are likely minimum estimates. A study for the Portland region found approximately 1,700 landslides have occurred within the City of Portland during the last 90 years (1928–2016). Of these landslides, approximately 830 occurred during the severe storms in 1996. From these historical data, Burns et al. (2018¹⁹) estimated an average of 20 landslides per year in the City of Portland. They also estimate annual loss from landslides in the City of Portland ranges from \$1.5M to \$3M. In years with extreme winter storms, this estimate can increase to approximately \$64M to \$81M. Burns et al. (2018¹⁹) found that approximately \$1.65B in land and buildings and almost 6,700 people are located on existing landslides in the Portland metropolitan area. They also found that in some communities, almost 50% of modeled damage and losses in a major earthquake are from landslides triggered by earthquakes.

Because the effects of individual landslides are commonly localized, landslides are rarely individually declared disasters. The bulk of the responsibility for clean-up and reconstruction remains at the local level and most commonly on the individual property owner. Additionally, there is typically no insurance or very limited landslide insurance available for homeowners (see Chapter 5, section **D, Landslide Insurance**). Without insurance coverage to pay for damages or complete loss of structure, people sometimes seek compensation from the local government or neighboring landowners. There are often concerns about economic well-being and liability in landslide hazard events. For example, who, if anyone, is liable if a house is either demolished by the landslide or damaged so severely as to be a complete loss? Will the homeowner have to move, or will the homeowner or others suffer great economic impacts? For these and other reasons, pre-disaster landslide hazard mitigation is of utmost importance to local planners and community leaders.

B.3. EFFECTS ON THE ENVIRONMENT

The natural environment is fundamental to many business sectors in Oregon. Environmental assets like drinking water, hydroelectric power, and lumber and rock for construction, to name a few, are needed for infrastructure. Eco-tourism relies on the environment. Landslides are a part of the natural process but can affect environmental assets. For example, mass erosion due to landslides may be the source of as much as 50% of the sediment found in a watershed (Nelson & Booth, 2002²⁰; Mackey & Roering, 2011²¹).

Human behavior and urbanization may lead to removal of vegetation, alteration of topography (e.g., grading, cutting, and filling), erosion, addition of impervious surface, alteration of natural waterways, changes in stormwater flow, increase in people living in an area (compacting soil, increase in trash) and other activities that

¹⁹ <https://www.oregongeology.org/pubs/ims/p-ims-057.htm>

²⁰ [https://doi.org/10.1016/S0022-1694\(02\)00059-8](https://doi.org/10.1016/S0022-1694(02)00059-8)

²¹ <https://doi.org/10.1130/B30306.1>

may result in landslides that impact people, property, and the environment. These factors of human behavior and urbanization are precursors that increase the risk of landslides. This can result in a single landslide event or a series of cascading events, which may be more than one landslide, or a landslide and another hazard. One environmentally specific result of a landslide can be a dramatic increase in the overall amount of sediment deposited into waterways. Sediment can affect surface drinking water collection systems, fish and wildlife, and the natural environment.

C. TYPES OF LANDSLIDE MAPS

The first step in developing a comprehensive strategy for reducing the danger landslides pose is identifying landslides and determining their risk. The second step is incorporating landslide maps into safer community planning policies and development standards. Reducing landslide risk starts with having accurate, detailed, and comprehensive landslide hazard maps such as DOGAMI's lidar-based landslide inventory and shallow and deep landslide susceptibility maps.

What is Lidar?

Lidar is light detection and ranging, which uses lots of accurate measurements made with a laser rangefinder to produce detailed and accurate depictions of the earth's surface.

Lidar is light detection and ranging, which uses many accurate measurements made with a laser rangefinder to produce detailed and accurate depictions of the earth's surface. A laser rangefinder is commonly used in surveying, construction, and riflescopes. Millions of measurements are made from a precisely located aircraft, producing a three-dimensional map of the earth's surfaces as a "point cloud." The aircraft altitude is precisely measured by an Inertial Motion Unit, so that the exact position and orientation of the laser rangefinder is always known. The rangefinder scans across the surface at 100,000 to 200,000 samples per second. The on-ground GPS base stations broadcast corrections to the airborne GPS unit. There are multiple angles of lasers. Lasers can get through branches to reach the ground. Computers can then identify non-ground points to do "virtual deforestation" and the multiple returns per pulse add to the detailed 3-D image (Bill Burns, DOGAMI, personal communication, October 2018).

The DOGAMI lidar-based inventory and the shallow and deep susceptibility maps were developed following standardized protocols, so meaningful comparisons can be made between results on the maps in different areas of Oregon (Burns & Madin, 2009b²²; Burns, Madin & Mickelson, 2012²³; Burns & Mickelson, 2016²⁴). The protocols were developed with the goal of producing maps suitable for land use planning. Using both state and local level maps, with the corresponding reports, provides communities with science-based information that can be used for developing policies, plans, regulations, and programs. DOGAMI plans to continue following these protocols, producing lidar maps and the corresponding reports for more communities in Oregon. The need for this *Guide* was identified through these

²² <https://www.oregongeology.org/pubs/sp/p-SP-42.htm>

²³ <https://www.oregongeology.org/pubs/sp/p-SP-45.htm>

²⁴ <https://www.oregongeology.org/pubs/sp/p-SP-48.htm>

map-making collaborations. By providing examples of how to use the maps and reports effectively, DOGAMI and DLCD anticipate the maps will be embraced and adopted by local governments to protect the public from the impacts of landslides.

Burns and Madin (2009b²²) developed a method for using airborne lidar to map landslides and published it in 2009 as DOGAMI Special Paper 42, *Protocol for Inventory Mapping of Landslide Deposits from Light Detection and Ranging (Lidar) Imagery*. This is a resource for more detailed information about how the state of Oregon currently maps landslides.

Landslide Inventory Maps

Landslides have been mapped in Oregon for decades. In the beginning, mapping was undertaken mostly as part of standard geologic mapping or as a subset commonly referred to as “geologic hazards.” Traditionally, creating landslide inventory maps required many hours of laborious fieldwork and examination of aerial photographs. Their quality could vary significantly, but they still do represent the best available data for many locations in Oregon.

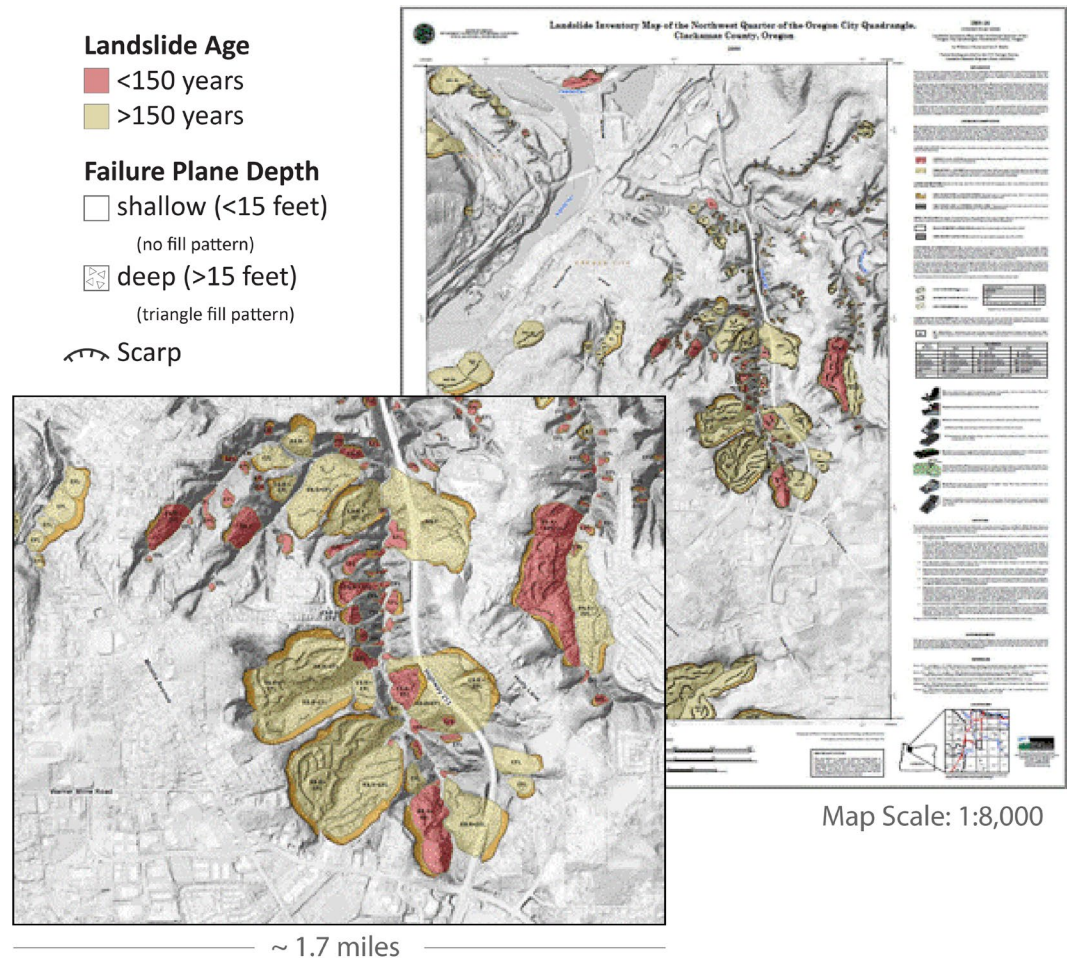
Today, landslide inventory mapping as a stand-alone product has become more common. These maps (**Figure 2-2**) show the locations of past landslide events and often include common landslide features, such as deposits, scarps, and flanks, that have been identified by geologists.

Landslide inventory maps show the location and boundary of individual existing or past landslides, along with features associated with the slide. Each landslide also has as much information recorded about it as possible, such as the date the landslide occurred, the size of the slide, the volume of material that was displaced, the direction of the slide, and the underlying geology. Landslide inventory maps are produced through site surveys on location or are derived from remote sensing data such as aerial photos, lidar, or satellite data. Previously, landslide inventory mapping was limited by technology and the time-consuming and costly task of field surveying. As a result, landslide maps were sometimes simplified so that large areas were generally denoted as landslide topography. With modern lidar-based mapping, however, it is possible to outline individual landslide features with much greater precision and accuracy (**Figure 2-2**).

A DOGAMI fact sheet, *Understanding Landslide Deposit Maps*²⁵, can assist in understanding how to read a landslide inventory map. Landslide inventory maps are produced to be used at a map scale of 1:8,000, which is a local scale. The scale was selected because it allows the user to make a decision on next steps on a lot by lot basis.

²⁵ <https://www.oregongeology.org/pubs/fs/landslide-inv-factsheet.pdf>

Figure 2-2. Landslide Inventory Map: Northwest Quarter of the Oregon City Quadrangle. Inset shows detail of landslide mapping.



Source: DOGAMI (Burns and Mickelson, 2010²⁶)

Once a landslide feature has been recognized and mapped using lidar, several attributes about the slide, such as type of movement and material, depth of failure, direction of movement, volume of material, and initial slope angle are recorded to aid in the creation of landslide susceptibility maps for the local area. The estimated depth of failure or landslide thickness is used to classify some of the landslides as shallow (less than 15 feet depth) or deep (greater than 15 feet depth) (Burns & Madin, 2009b²⁷; **Figure 2-3**). This is done for several reasons. First, different models for shallow and deep landslides are needed to estimate areas of future susceptibility. Second, deep and shallow landslides usually have different hazards associated with them. For example, shallow landslides tend to move more rapidly, and deep landslides tend to move more slowly but commonly cover a much larger

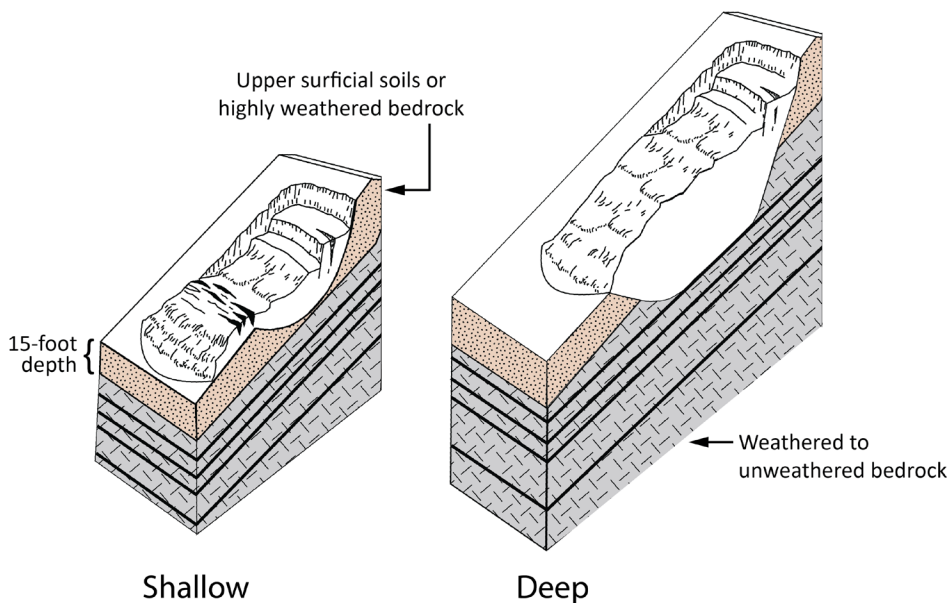
²⁶ <https://www.oregongeology.org/pubs/ims/p-ims-030.htm>

²⁷ <https://www.oregongeology.org/pubs/sp/p-SP-42.htm>

area. This is not always true; the 2014 Oso, Washington, landslide was both rapid and deep. Third, mitigation techniques are also different for shallow and deep landslides. These three reasons are further described in the following paragraphs.

To recap, the deep and shallow susceptibility maps are produced using the landslide inventory data combined with models and highlight the relative risk of a landslide occurring at any given point within the mapped area. These susceptibility maps work in conjunction with landslide inventory maps to provide jurisdictional staff, community leaders, and residents information necessary to reduce the risk of landslides impacting people, property, and the environment.

Figure 2-3. Block Diagrams Showing Examples of Shallow and Deep Landslides



Shallow and Deep Landslides

The estimated depth of failure or landslide thickness is used to classify some of the landslides as shallow (less than 15 feet depth) or deep (greater than 15 feet depth).

Source: DOGAMI (Burns, Madin & Mickelson, 2012²⁸)

Shallow Landslide Susceptibility Maps

Shallow landslides are those with failure planes at a depth of less than 15 feet (4.5 meters). They represent a specific subset of landslide types that commonly involve a relatively thin surface layer of soil and weathered rock. Shallow slides can manifest as slumps, flows, translational slides, or a combination of these types (referred to as a complex slide). Generally, shallow slides travel at a higher velocity and often cover much less area than deep landslides. However, they can travel long distances, especially if they get into a drainage and become channelized, making them

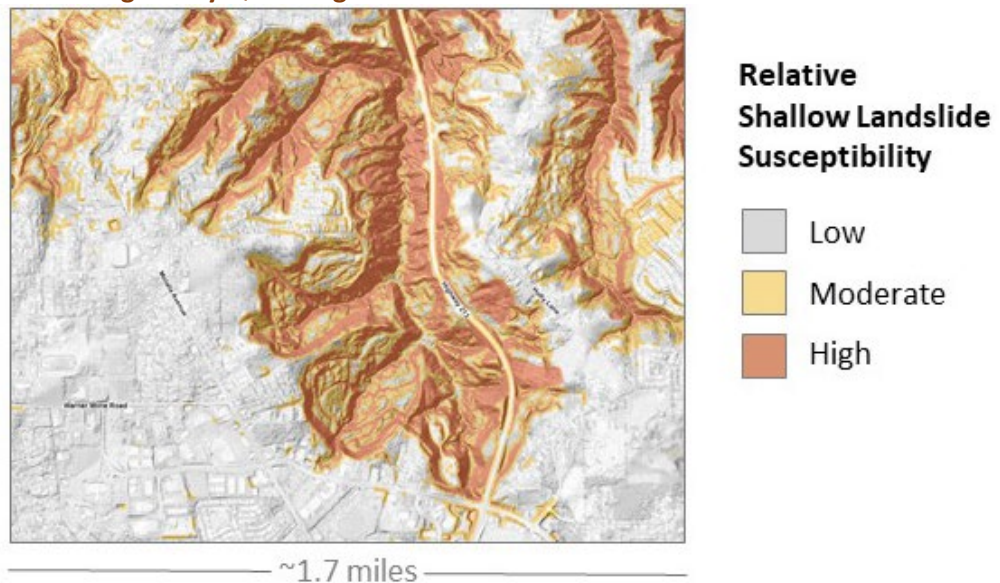
²⁸ <https://www.oregongeology.org/pubs/sp/p-SP-45.htm>

particularly dangerous to people, property (especially structures), and the environment.

DOGAMI's shallow landslide susceptibility maps can be produced only in areas where detailed lidar-based landslide inventory maps have been completed (**Figure 2-4**). Data from the inventory map is combined with slope stability analysis to produce a zone map that highlights areas of high, moderate, and low susceptibility. The method DOGAMI uses to produce shallow landslide susceptibility maps was implemented in 2012 and is described in DOGAMI *Special Paper 45, Protocol for Shallow-Landslide Susceptibility Mapping*²⁹ (SP-45; Burns et al., 2012).

Shallow landslide susceptibility maps are produced to be used at the local scale of 1:8,000 to aid in community and regional development, planning, and emergency response. This includes identifying areas at very high risk of shallow landslides, estimating potential losses from specific hazards events, prioritizing mitigation measures, developing policies and regulations, and identifying areas that may require special planning considerations.

Figure 2-4. Part of the Shallow Landslide Susceptibility Map of the Northwest Quarter of the Oregon City Quadrangle



Source: DOGAMI (Burns, Mickelson, Jones, Pickner, Hughes & Sleeter, 2013³⁰)

²⁹ <https://www.oregongeology.org/pubs/sp/p-SP-45.htm>

³⁰ <https://www.oregongeology.org/pubs/ofr/p-O-13-08.htm>

Deep Landslide Susceptibility Maps

Deep landslides and landslides with failure planes at depths of greater than 15 feet (4.5 meters). Deep landslides generally affect larger areas than do shallow landslides. Deep landslides commonly are relatively slower moving slope failures that creep at annual rates of millimeters to meters or lurch forward during extreme rain or earthquakes. However, they can also fail suddenly and catastrophically, presenting a significant hazard for the Pacific Northwest. The March 22, 2014, Oso, Washington, landslide is an example of a deep landslide that failed suddenly and catastrophically, killing 43 people (USGS, 2019³¹).

It is important to note that both deep and shallow landslides can manifest through similar types of movement, such as flows, rotational and translational slides, and spreads. For the purpose of mapping shallow and deep landslides, the only differentiating factor used is the depth to the failure plane.

The method used to denote slopes susceptible to deep landslides is different than for shallow landslides because “there are more differences, structurally and geometrically, between one deep-seated landslide and another than between shallow landslides [...] deep-seated landslides tend to be less related to a single triggering event or group of events than populations of shallow landslides” (Baum, Galloway & Harp, 2008³², p. 7). Therefore, the protocol used to denote areas of deep landslide susceptibility is different from the one used to denote shallow landslide susceptibility, and the resulting deep and shallow susceptibility maps highlight different types of hazards. Both are produced to be used at the local scale of 1:8,000.

Slopes susceptible to deep landslides are mapped by using locations of known deep-seated landslides from the landslide inventory map and combining those data with engineering geologic data and slope and aspect values. Deep landslides have the potential to fail retrogressively upslope, which means a slide can fail from the bottom to the top of the slope. The mapping protocol is designed to take this into account. The result is a map that highlights three ranges of relative susceptibility, high, moderate, and low (**Figure 2-5, Figure 2-6**). The method DOGAMI uses to create these maps was implemented in 2016 and is described in DOGAMI Special Paper 48, *Protocol for Deep Landslide Susceptibility Mapping* (Burns et al., 2016³³).

Shallow and deep susceptibility zones include buffers, as described in DOGAMI Special Papers 45³⁴ and 48³³.

Landslide Hazard Map

When information from the shallow and deep susceptibility maps is used in conjunction with the inventory map, and the IMS-22 (rapidly moving landslides) map, a comprehensive landslide hazard map is created.

Jurisdictions determine which areas from each of the respective maps are to be included (e.g., low, moderate, high, and very high hazard areas) in their jurisdiction’s landslide hazard map.

³¹ https://www.usgs.gov/news/five-years-later-oso-sr-530-landslide-washington?qt-news_science_products=1#qt-news_science_products

³² <https://pubs.usgs.gov/of/2008/1164/>

³³ <https://www.oregongeology.org/pubs/sp/p-SP-48.htm>

³⁴ <https://www.oregongeology.org/pubs/sp/p-SP-45.htm>

Figure 2-5. What Are the Relationships Between Historic Landslides, Prehistoric Landslides, and Deep Landslide Susceptibility Zones?

This image represents a map of areas of known landslides that have moved in recent times.



Historic (< 150 years old) landslides

Older as well as younger landslides have been mapped here. Sometimes (left area of image) new landslides are partial reactivations of older and perhaps larger landslides. Other times (right area) entire ancient slides can reactivate, so these areas are also hazardous.



Historic (< 150 years old) landslides on top of Prehistoric (> 150 years old) landslides

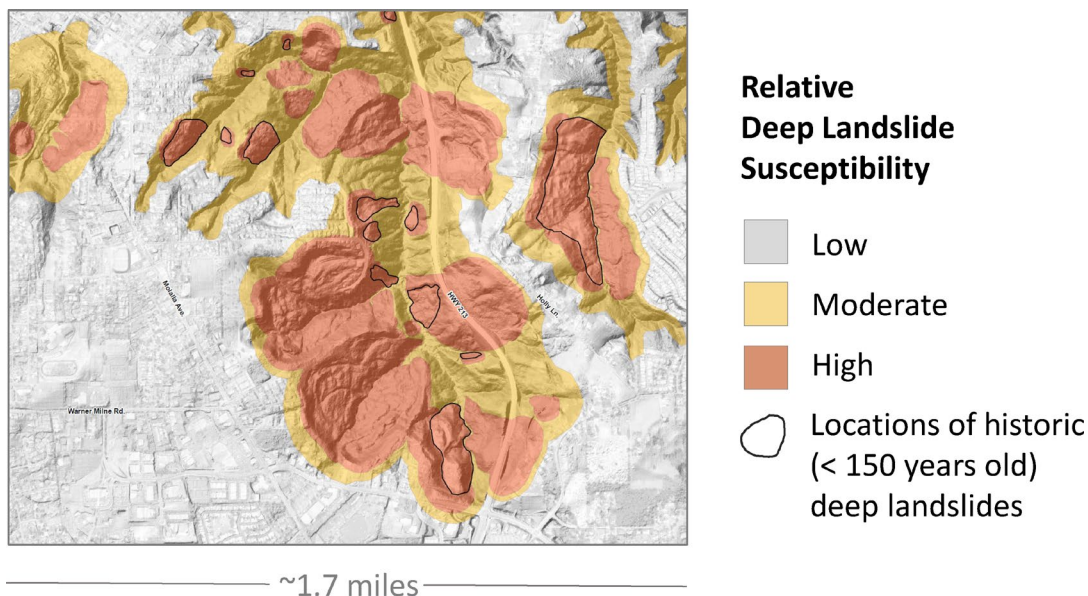
Landslide susceptibility zones are created from landslide inventory data (both historic and prehistoric slides) combined with slope stability analysis and other factors to produce a zone map that highlights areas of high, moderate, and low susceptibility.

The high susceptibility zone comprises all known landslides. The moderate susceptibility zone is a buffer around each high zone. The low susceptibility is outside the buffers.



Susceptibility zone map

- High (all mapped landslides of any age)
- Moderate (buffer around all mapped landslides)
- Low
- Historic (< 150 years old) landslides



Source: DOGAMI (Burns et al., 2013³⁵)

C.1. STATEWIDE LANDSLIDE INFORMATION DATABASE (SLIDO)

In 2008, DOGAMI compiled all the state's landslide inventory maps into a single database called the Statewide Landslide Information Database for Oregon (SLIDO³⁶) (Burns, Madin & Ma, 2008³⁷). The first release of this database combined data from a variety of sources, including federal, state, and local entities and contained approximately 15,000 landslides from 257 publications (Burns & Madin, 2009b³⁸).

SLIDO is a compilation of landslides in Oregon that have been identified on published maps. The database contains only landslides that have been located on these maps. Many landslides have not yet been located or are not on these maps and therefore are not in this database. The SLIDO database does not contain information about relative hazards.

An online interactive map of SLIDO data lets people view information on location, type, and other attributes related to identified landslides in Oregon. The original studies vary widely in scale, scope, and focus, and these differences are reflected in the wide ranges in the accuracy, detail, and completeness with which the landslides are mapped.

Whenever new landslide inventory maps are completed by using the techniques described in DOGAMI Special Paper 42, the data are published by DOGAMI and are

**DOGAMI Special Paper 42 –
Landslide Inventory Protocol**
<https://www.oregongeology.org/pubs/sp/p-SP-42.htm>

³⁵ <https://www.oregongeology.org/pubs/ofr/p-O-13-08.htm>

³⁶ <https://www.oregongeology.org/slido/>

³⁷ <https://www.oregongeology.org/pubs/dds/p-slido3.htm>

³⁸ <https://www.oregongeology.org/pubs/sp/p-SP-42.htm>

**DOGAMI Special Paper 45 –
Shallow Landslide
Susceptibility Protocol**

<https://www.oregongeology.org/pubs/sp/p-SP-45.htm>

made available online by updating the SLIDO interactive map³⁹. Currently SLIDO is at release 3.4 and has been updated to contain 13,048 historic landslide points and 44,929 landslide polygons. So far, 2,986 square miles of Oregon have been mapped. Oregon is 95,988 square miles⁴⁰.

The result of this effort is a continually updated landslide inventory dataset that provides planners, emergency managers, and the public access to information about potential landslide hazards in Oregon.

C.2. STATEWIDE LANDSLIDE SUSCEPTIBILITY OVERVIEW MAP

The *Statewide Landslide Susceptibility Overview Map of Oregon* (Burns, Mickelson & Madin, 2016⁴¹) is similar to more detailed landslide susceptibility maps (DOGAMI SP-45 and SP-48 based), in the sense that they are both attempting to identify areas that may have landslides in the future. However, the susceptibility overview map is intended not for local planning but to assist in understanding the regional landslide hazard, to compare to other communities in Oregon, and to identify where future detailed mapping (DOGAMI SP-45 and SP-48 based) is needed.

The susceptibility overview map and accompanying report were published in 2016 after DOGAMI combined several different landslide datasets, including SLIDO, and analyzed geologic and topographic maps to create the map (**Figure 2-7**).

The susceptibility overview map classifies Oregon into four different susceptibility zones: low, moderate, high, and very high. The results show the following for these susceptibility zones: 37% low, 28% moderate, 30% high, and 5% very high (the very high zone by definition consists of mapped landslides). Most areas classified as moderate or higher landslide susceptibility are located in the Cascade Mountains, the Coast Range, the Klamath Mountains, and portions of central and northeastern Oregon. The zones highlight which communities – cities and counties – are at a higher or lower relative susceptibility for future landslides. This generalized, regional-scale landslide susceptibility information – the overview map and the report – is meant to provide jurisdictional staff, community leaders, and planners with a broad understanding of the relative hazard for their region in addition to highlighting areas where more detailed mapping is needed (Burns et al., 2016⁴²).

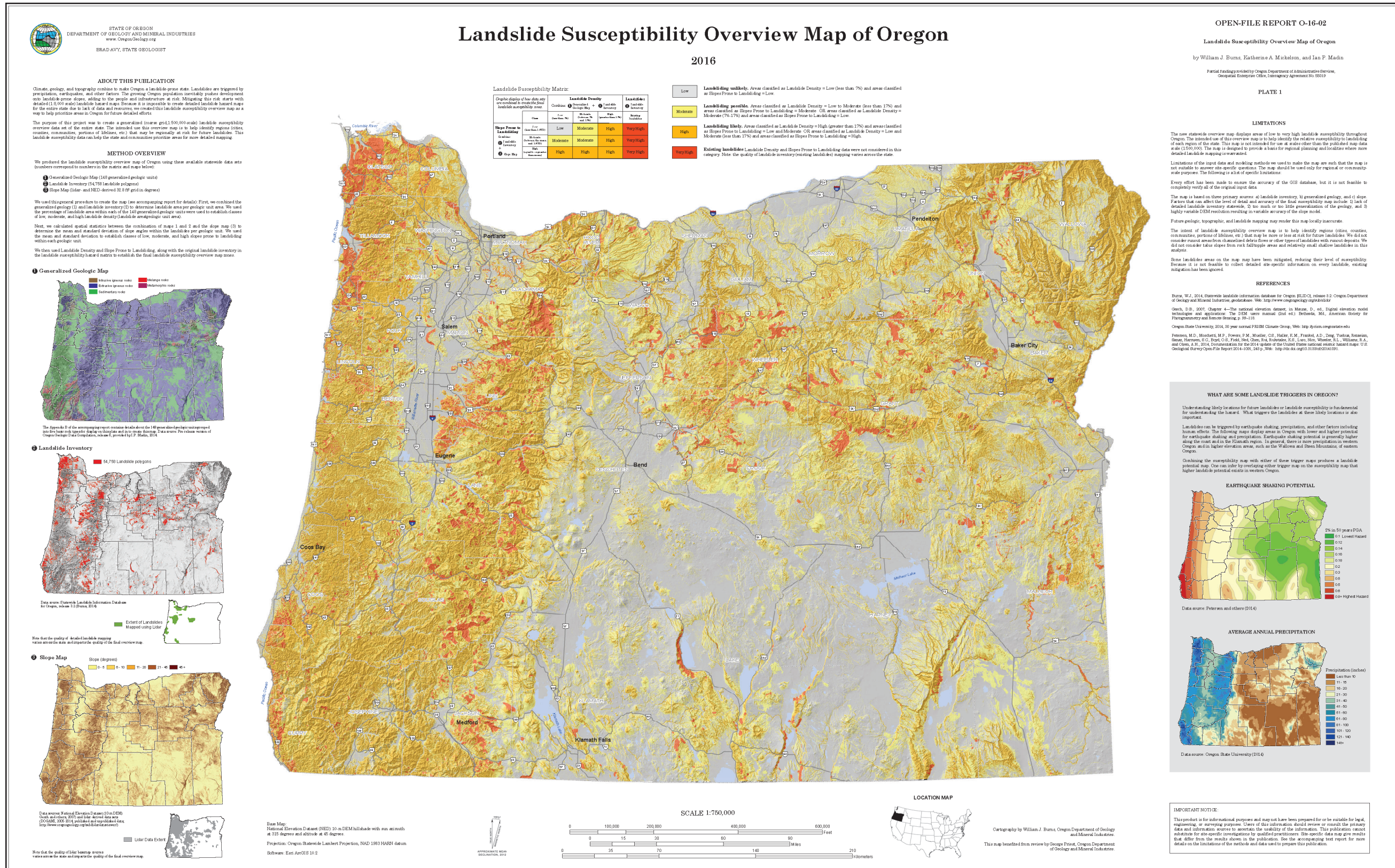
³⁹ <https://www.oregongeology.org/pubs/dds/p-slido3.htm>

⁴⁰ <https://www.indexmundi.com/facts/united-states/quick-facts/oregon/land-area#map>

⁴¹ <https://www.oregongeology.org/pubs/ofr/p-O-16-02.htm>

⁴² <https://www.oregongeology.org/pubs/ofr/p-O-16-02.htm>

Figure 2-7. Oregon's Statewide Landslide Susceptibility Map. The full-size version of this map is available as a PDF file from DOGAMI (<https://www.oregongeology.org/pubs/ofr/p-O-16-02.htm>).

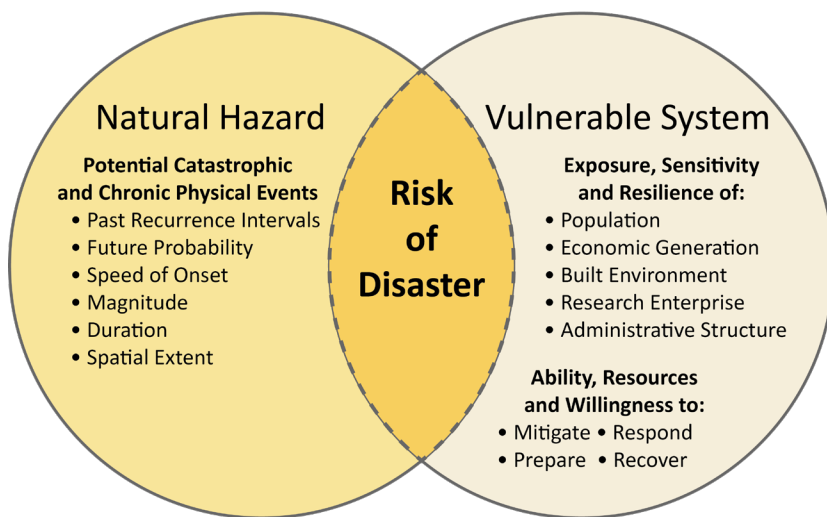


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The report accompanying the susceptibility overview map contains data from an exposure analysis for 242 Oregon cities and the state’s 36 counties (Burns et al., 2016⁴³). The exposure analysis identifies landslide hazard *susceptibility*, but not the landslide hazard *risk* present in each area. *Exposure* is about identifying the spatial overlap of the assets we are concerned about (e.g., buildings, roads, people, the environment, and so forth) and the hazard zones from an inventory or susceptibility map. *Susceptibility* is the relative rating of the entire landscape for the level of potential of future landslides; it is usually categorized as low, moderate, and high. In other words, an area might have a very high landslide susceptibility, but its general lack of people, buildings, and infrastructure means it has a low exposure and a low degree of risk. This exposure analysis provides insight into the relative potential for landslide exposure in each of the analyzed portions of the state. **Figure 2-8** illustrates risk as the intersection of natural hazards and vulnerable systems.

Risk
 In this *Guide*, risk is defined as the probability of loss or injury, and risk is the overlap of the hazard with assets (such as buildings) and their vulnerability to the hazard.

Figure 2-8. Understanding Risk



Source: USGS Fact Sheet, Understanding Risk and Resilience to Natural Hazards (Wood, 2011⁴⁴)

⁴³ <https://www.oregongeology.org/pubs/ofr/p-O-16-02.htm>

⁴⁴ <https://pubs.usgs.gov/fs/2011/3008/>

D. SITE-SPECIFIC GEOTECHNICAL ENGINEERING AND ENGINEERING GEOLOGIC REPORTS

D.1. HOW DO I DECIDE IF A SITE-SPECIFIC REPORT IS NEEDED?

In this *Guide*, the general term *geoprofessional* refers to a Registered Geologist (RG), Certified Engineering Geologist (CEG), Professional Engineer (PE), and Geotechnical Engineer (GE). Also in this *Guide*, the general term *geologic report* refers to the engineering geologic report⁴⁵ and the geotechnical engineering report.

Engineering geologic reports and geotechnical engineering reports refer to different but related services performed by geoprofessionals with different professional certifications. Engineering geologic reports focus on how the earth (e.g., landforms, water table, soil, and bedrock) and earth processes (e.g., landslides and earthquakes) impact structures or potential structures and describe the degree of risk, while geotechnical engineering reports focus on the design of building products (e.g., structures, retaining walls, pavements) that can withstand or mitigate for subsurface and geologic conditions. Depending on local conditions and ordinances, both kinds of reports may be required for a site.

Sections **D.4, What goes into engineering geologic reports?** and **D.5, What goes into geotechnical engineering reports?** of this chapter describe the general content of the two kinds of reports.

Each jurisdiction has its own criteria for triggering its geologic report (engineering geologic report or geotechnical engineering report) requirement on a site by site basis. For example, some communities adopt landslide hazard maps produced by DOGAMI and use these maps to determine if a site is in a hazard zone. If a site is in a hazard zone, generally a report is required. Communities may also use criteria such as percent slope or soil type to trigger a report requirement.

When a community has no adopted map or criteria, a situation falls outside the norm, a land use review is not required, or there is another reason to believe that a report is necessary, consult the building official or other appropriate staff at the jurisdiction to determine whether an engineering geologic report and/or a geotechnical engineering report can and should be required.

⁴⁵ This report may also be known as an engineering geology report.

D.2. WHICH TYPE OF GEOLOGY PROFESSIONAL CAN DO THE JOB?

Local ordinances typically identify which type of geoprofessional is allowed to perform site-specific reports for that community. Although the exact requirement varies between communities, it is common to require that the report be performed by either a *Registered Geologist (RG)*, *Certified Engineering Geologist (CEG)*, or *Geotechnical Engineer (GE)*. Because the State of Oregon has strict laws and regulations about the work that can be performed by each type of professional, it is important that local governments determine the right professional is hired for the type of study needed.

Types of Geoprofessionals

- Registered Geologist (RG)
- Certified Engineering Geologist (CEG)
- Geotechnical Engineer (GE)
- Professional Engineer (PE)

Geoprofessionals

The applicable professionals can be summarized as follows:

- Registered Geologists (RG) provide geologic maps and documents and are licensed by the Oregon State Board of Geologist Examiners (OSBGE).
- Certified Engineering Geologists (CEG) provide engineering geologic reports and are licensed by the Oregon State Board of Geologist Examiners (OSBGE).
- A Geotechnical Engineer (GE) is a Professional Engineer (PE) with the specific training, expertise, and experience to qualify as a Geotechnical Engineer (GE). GEs provide geotechnical engineering reports and are licensed by the Oregon Board of Examiners for Engineering and Land Surveying (OSBEELS).

According to Oregon state law, a *Registered Geologist (RG)* is someone registered by the State of Oregon as a geologist after having met education, examination, and experience requirements as determined by the Oregon State Board of Geologist Examiners (OSBGE). An RG is thereby legally allowed to provide, prepare, and officially stamp or seal geologic maps, plans, reports, or documents. An RG can work in any geology discipline or area of specialty where qualified by experience and training, except for in engineering geology.

A *Certified Engineering Geologist (CEG)* is someone who has fulfilled all of the requirements for, and has all the rights of, a Registered Geologist and has met additional examination and experience requirements to obtain a certification in the specialty of engineering geology. A CEG “applies geologic data, principles and interpretation to naturally occurring materials so that geologic factors affecting planning, design, construction and maintenance of civil engineering works are properly recognized and utilized” (ORS 672.505.3⁴⁶).

⁴⁶ <https://www.oregonlaws.org/ors/672.505>

The State of Oregon does not allow RGs to practice engineering geology. If geologic work is being completed to provide recommendations for the siting, design, modification, or construction of a structure (e.g., building roads, dams, retaining walls, etc.), this is engineering geology work and requires a CEG. An RG can only identify relative hazards and cannot imply or provide recommendations for the siting, design, modification, or construction of structures. For example, a CEG would be the appropriate type of geologist to map and interpret geologic hazards for land use planning purposes or to assess coastal hazards including landslides, erosion, and accretion.

Geotechnical engineers also commonly participate in site evaluations, detailed project design, and development planning. *Professional Engineers (PEs)* must be licensed by the State of Oregon, similar to geologists (ORS 672.098⁴⁷). A *Geotechnical Engineer (GE)* is a registered Professional Engineer who has specific training, expertise, and experience in this engineering specialty. The Oregon Board of Examiners for Engineering and Land Surveying (OSBEELS) sets the education, examination, and experience requirements for PEs. OSBEELS offers a GE specialty endorsement that a PE can pursue as a way to readily show to the public the expertise in geotechnical engineering. However, unlike geologists, a PE is not required to hold the GE specialty endorsement to practice geotechnical engineering.

The practice of Geotechnical Engineering is defined by OSBEELS in Oregon Administrative Rules (OAR 820-040-004⁴⁸) as:

the investigation and the evaluation of the physical and engineering properties of earth materials, such as soil and rock, including impacts of ground water and earthquakes, and their application to the design and construction of civil engineering works, such as foundations, earth dams, retaining walls, and similar, using soil and rock mechanics and earthquake engineering principles and related engineering laws, formula, and procedures. (§ 820-040-0040)

Code Reminder

It is very important that local governments make sure their codes require the appropriate geoprofessional(s) for each report.

Geotechnical engineers specialize in reviewing and creating development plans, including those for site grading, construction of foundations and support structures, ensuring structures will be stable against earthquakes, floods, and landslides, ensuring that development will not have an adverse effect on site erosion or slope stability, and developing mitigation plans for potential slope instability.

Although the work performed by RGs, CEGs, and GEs, can overlap, a local government more often than not will need to require that site-specific reports in landslide hazard areas be completed by either a CEG or a CEG working with a PE who has experience and expertise in geotechnical engineering. A CEG can generally evaluate the site and make recommendations about site development. A CEG may

⁴⁷ <https://www.oregonlaws.org/ors/672.098>

⁴⁸ <https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=201381>

also recommend that a PE with geotechnical knowledge be engaged to design the development, such as retaining walls or foundations.

Both engineering geologists and geotechnical engineers practice in “geotechnics,” which refers to applied scientific work involving soil and rock mechanics, geology, geophysics, hydrology, and related sciences as applied to the solution of civil works problems. The prediction, prevention, and monitoring of landslides are examples of geotechnics work. Generally, the appropriate professional person to have involved in landslide hazard analysis related to proposed development is a specialist such as a CEG and a PE.

Licensed professionals are generally required to stamp and sign their work products to identify for the public responsibility for the work. OSBGE and OSBEELS have requirements for stamp design and use. For geology work products, stamping requirements are as follows:

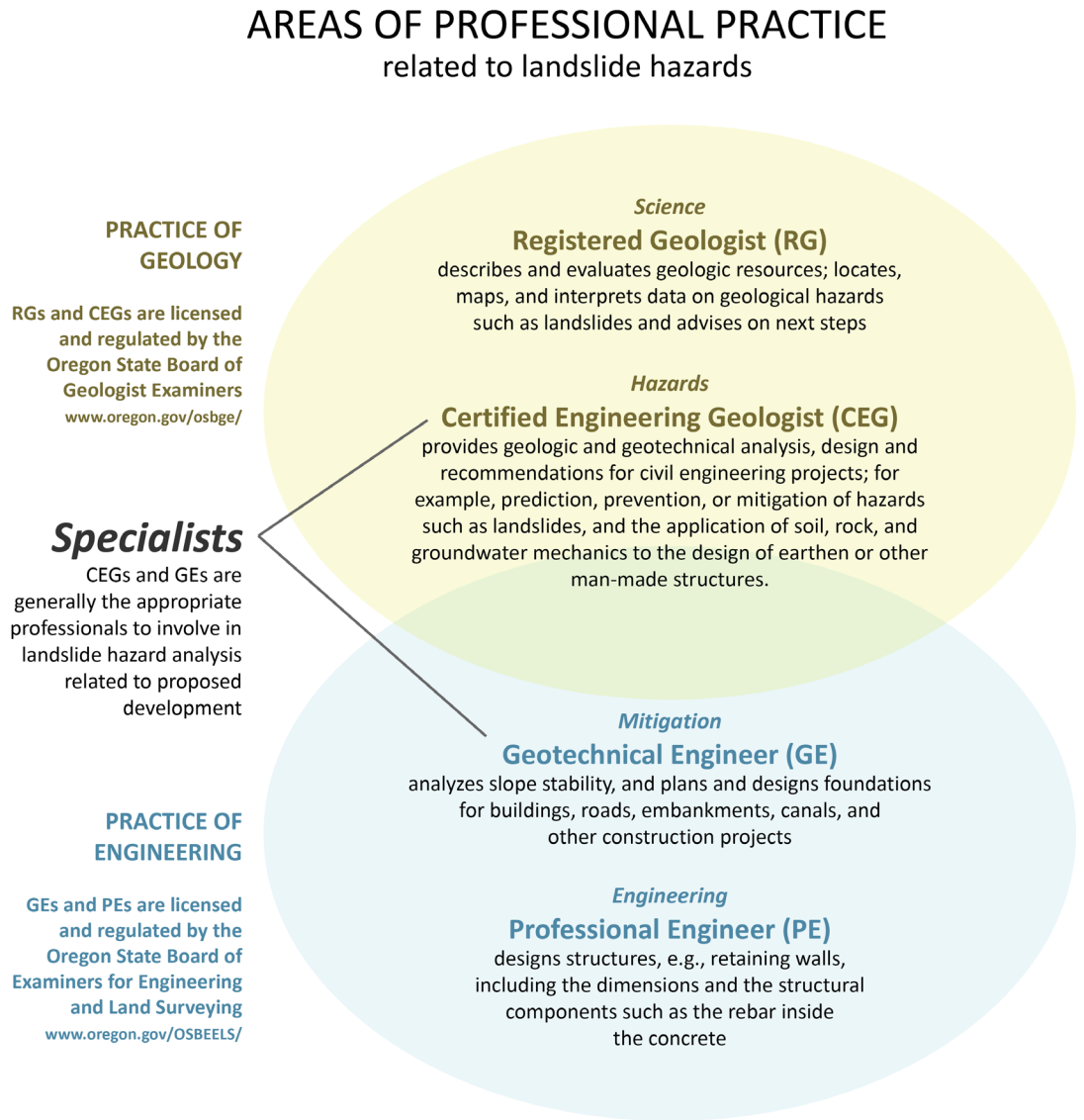
- When one geologist prepares all the geology work products in a report, that geologist must stamp and sign the final report.
- When multiple licensed professionals contribute work products to a report (for example, an RG or PE/GE contributing work products to a final report signed and stamped by a CEG), each professional must individually sign and stamp their own work products.

An example of a project and the type of geology professional needed would be the evaluation and design of a retaining wall for shallow slope stability mitigation. An RG could be involved for regional evaluation of the geology. A CEG could complete a regional evaluation as well as site specific analysis and design recommendations. The CEG and/or the PE with geotechnical expertise would evaluate the site conditions and make recommendations for drainage control, bearing capacity, and global slope stability. Finally, the GE or PE would design the retaining wall including the dimensions and the structural components such as the rebar inside the concrete or the building foundation (**Figure 2-9**).

Legal Note

In the jurisdiction’s codes be sure to identify the geoprofessional needed for the requirement and to understand the distinctions of each to practice within their area of expertise. These professionals are obligated to work within their area of expertise.

Figure 2-9. Relationships and Areas of Professional Practice: RGs, CEGs, GEs, and PEs



D.3. HOW CAN I FIND A GEOLOGIST OR ENGINEER TO HIRE?

Geologists (RG and CEG) and geotechnical engineers (PE and GE), are required to have specific education, expertise, and experience to be properly licensed.

Geologists for hire can usually be located through property development firms (that often require geological services and may keep lists of geologists they regularly use), from the OSBGE website⁴⁹, where there is an online license lookup tool to obtain a list of all geologists licensed by the OSBGE and through online searches for consulting companies that offer geologic services. Commonly, geologists work all over the state, so it may not be necessary to hire one based on the site location.

Engineers for hire can be located in property development firms, architecture firms, and consulting companies. The OSBEELS website has an online license look up tool to find the professionals they license.

When looking for a geologist or an engineer to hire in the state of Oregon, there are a few things to keep in mind to **ensure a reputable professional** who is current with developments in the science is hired.

- Most importantly, a geologist needs to be registered by OSBGE. Registration is required by law to publicly practice geology in Oregon. Look for whether the geologist uses designatory letters *RG* (Registered Geologist) or *CEG* (Certified Engineering Geologist) after his or her name. Verify the registration and license through the OSBGE website or by contacting the OSBGE office. Also, check that the registered professional has liability insurance.

Geotechnical engineers should likewise be certified or registered. This will be done by the OSBEELS, and PE (Professional Engineer) or GE (Geotechnical Engineer) will follow a licensed geotechnical engineer's name.

- It is generally a good idea to inquire about the prospective geoprofessional's resume of experience as well as professional organizations. Inquire about their background. Check if the geoprofessional is familiar with the area and its geology and landslides. Find out if they have done similar geologic reports previously. Check for references or referrals from previous clients with similar projects. It may be useful to read the Consumer Guide⁵⁰ available on the OSBGE website and review the information on OSBEELS website⁵¹.
- Ensure that a contract is prepared and agreed upon before any work is done. The contract should outline a clear purpose and scope of work, so that both parties are fully aware of the extent, requirements, and limitations of the

Hiring Tips

1. Registered? Certified?
2. Liability insurance?
3. Professional memberships?
4. Familiar with the local area?
5. Familiar with the local code?
6. Similar work done?
7. References? Referrals?
8. Written contract?

⁴⁹ <https://www.oregon.gov/osbge/Pages/default.aspx>

⁵⁰ <https://www.oregon.gov/osbge/Resources/Pages/ConsumerGuide.aspx>

⁵¹ <https://www.oregon.gov/osbeels/Pages/default.aspx>

report. The contract should also state that the report is intended to provide the information necessary to fulfill permitting questions and requirements.

D.4. WHAT GOES INTO ENGINEERING GEOLOGIC REPORTS?

While there are no specific laws regarding what information should be included in an engineering geologic report, the OSBGE, which is responsible for setting standards regarding the practice of geology in Oregon, has published a guideline for preparing these reports. OSBGE's *Guideline for Preparing Engineering Geologic Reports*⁵² recommends content, suggests formats, and identifies the topics that should be addressed in most reports.

The exact content of an engineering geologic report can vary based on the requirements of the local jurisdiction for the report. Generally speaking, however, reports should minimally have the following:

Introduction

- The client who commissioned the report
- The names of the geologists who did the mapping and investigating
- Statement disclosing any potential conflicts of interest of the geologist producing the report
- Dates when the work was done
- Purpose and scope of the study
- Proposed use of the site

Site Description

- Location and size of the study area
- Geologic setting of the study area
- Topography and drainage of the study area
- Nature, abundance, and distribution of earth materials within the study area

Site Investigation

- All related subsurface information and geologic maps with sources
- Disclosure of known or suspected geologic hazards within the area
- Structural performance of existing facilities in the immediate vicinity
- Locations of excavations, drilling, or sample collection sites
- All data interpreted to reach conclusions
- Identification of sources used for the report with proper citations

Assessment

- All field and laboratory methods and results
- Interpretations of data and results

⁵² https://www.oregon.gov/osbge/Documents/engineeringgeologicreports_5.2014.pdf

- Discussion of regulatory framework and any locally adopted landslide hazard map used to trigger the requirement for the Engineering Geologic Report

Conclusions

- Clearly stated assumptions, interpretations, and professional judgements
- Limitations and potential risks associated with the proposed development
- Potential onsite and offsite impacts currently and with changing future conditions

Recommendations

- Whether any additional study is necessary before drawing firm conclusions or recommendations, and if so what and why
- Whether construction plans and documents should be reviewed by the geology professional before the permit is issued
- Whether monitoring during construction is recommended and if so, continuously or at what points and for what purpose(s)
- Mitigation measures for addressing the potential risks and limitations

Signature and Seal

- Signature and seal of the certified engineering geologist conducting the study.

D.5. WHAT GOES INTO GEOTECHNICAL ENGINEERING REPORTS?

A Geotechnical Engineer is a Professional Engineer with a specific training, expertise, and experience in this engineering specialty. Unlike a geologist, a PE is not required to hold the GE specialty endorsement to practice geotechnical engineering, although that endorsement would be beneficial. These professionals are the ones providing geotechnical reports.

The geotechnical report is the tool used to communicate the site conditions and design and construction recommendations to the roadway design, bridge design, and construction personnel. Site investigations for transportation projects have the objective of providing specific information on subsurface soil, rock, and water conditions. Interpretation of the site investigation information, by a geotechnical engineer, results in design and construction recommendations that should be presented in a project geotechnical report. The importance of preparing an adequate geotechnical report cannot be overstressed. The information contained in this report is referred to often during the design period, construction period, and frequently after completion of the project (resolving claims). Therefore, the report should be as clear, concise, and accurate. Both an adequate site investigation and a comprehensive geotechnical report are necessary to

Design Life

The geotechnical engineering report and/or the engineering geologic report could have a design life timeline on the proposal, the recommendations, and the mitigation.

construct a safe, cost-effective project. Engineers need these reports to conduct an adequate review of geotechnical related features, e.g., earthwork and foundations. (U.S. Department of Transportation, 1988/2003⁵³)

For background, the following is from the 2014 *Oregon Structural Specialty Code*, Chapter 18⁵⁴:

SECTION 1803

GEOTECHNICAL INVESTIGATIONS

1803.1 General. Geotechnical investigations shall be conducted in accordance with Section 1803.2 and reported in accordance with Section 1803.6. Where required by the *building official* or where geotechnical investigations involve in-situ testing, laboratory testing or engineering calculations, such investigations shall be conducted by a *registered design professional*.

[...]

1803.6 Reporting. Where geotechnical investigations are required, a written report of the investigations shall be submitted to the *building official* by the owner or authorized agent at the time of *permit* application. This geotechnical report shall include, but need not be limited to, the following information:

1. A plot showing the location of the soil investigations.
2. A complete record of the soil boring and penetration test logs and soil samples.
3. A record of the soil profile.
4. Elevation of the water table, if encountered.
5. Recommendations for foundation type and design criteria, including but not limited to: bearing capacity of natural or compacted soil; provisions to mitigate the effects of expansive soils; mitigation of the effects of liquefaction, differential settlement and varying soil strength; and the effects of adjacent loads.
6. Expected total and differential settlement.
7. Deep foundation information in accordance with Section 1803.5.5.
8. Special design and construction provisions for foundations of structures founded on expansive soils, as necessary.

⁵³ <https://www.fhwa.dot.gov/engineering/geotech/pubs/reviewguide/checklist.pdf>

⁵⁴ http://ecodes.biz/ecodes_support/free_resources/Oregon/14_Structural/PDFs/Chapter%2018%20-%20Soils%20and%20Foundations.pdf

9. Compacted fill material properties and testing in accordance with Section 1803.5.8.
10. Controlled low-strength material properties and testing in accordance with Section 1803.5.9.

D.6. HOW DO I READ AND UNDERSTAND AN ENGINEERING GEOLOGIC REPORT AND A GEOTECHNICAL ENGINEERING REPORT?

Although OSBGE's *Guideline for Preparing Engineering Geologic Reports*⁵⁵ should not be used as a checklist for a specific report, it can be used to help understand the information that should be contained in each section of the report being reviewed. Make sure the report is complete and logical, and contains the information needed to process the application. To determine how complete the report is, compare the sections of the submitted report to OSBGE's guideline and to the list of minimally included items noted above as: Introduction, Site Description, Site Investigation, Assessment, Conclusions, Recommendations, and the Signature and Seal.

The first thing to check is that the report covers the right property and surrounding area, and then that the report's stated purpose and scope are appropriate for the project proposal. Do an initial check for the following: the permitting questions and requirements that initially triggered the report are addressed; the report contains a description of the site and its geologic characteristics; the methodology is described and results presented; results are evaluated and interpreted; conclusions are drawn and recommendations made; the report is stamped and signed by all contributors.

Now go back to the beginning and read the report carefully.

Double-check that the report covers the subject property and surrounding area and that the purpose and scope of the report reflect the proposed project and need for the report, including permitting questions and requirements.

While reading the site description or characterization, look for the features described on any maps included in the report and submitted with the permit application. Note any discrepancies.

The site investigation and assessment sections may be highly technical and hard to understand. Relate them to the need for the report and the site description as much as possible. List questions.

Focus on the results and assessment. Does the report differentiate between facts, interpretations, and professional judgments? Does it discuss the results and interpret them fully? Is there an assessment of the results in the context of the regulatory framework and any locally adopted landslide hazard map? Note any needed clarifications and any permitting questions that still need to be addressed.

⁵⁵ https://www.oregon.gov/osbge/Documents/engineeringgeologicreports_5.2014.pdf

Now review the conclusions. Do the conclusions follow logically from the results and assessment? Are facts, interpretations, and professional judgments stated clearly? What are the limitations and potential risks associated with project development? Does the report evaluate the project's immediate onsite and offsite impacts as well as potential future impacts considering changing conditions? Would development of this project create restrictions for development existing on adjacent or nearby properties or future development of those properties? Would mitigating strategies be necessary for reducing risk onsite or off? Note any clarifications or additional information needed and any remaining questions pertinent for processing the application.

Turning to the recommendation section: Do the recommendations follow logically from and address the conclusions? Are mitigation measures needed to reduce risk to life and property identified? How much mitigation would be necessary and how effectively would it reduce the risk described in the conclusion section? Is the anticipated final risk level within the jurisdiction's risk tolerance? Are recommendations made to mitigate the other impacts described in the conclusions?

And, finally, have all the geoprofessionals who contributed geology products stamped and signed their products? Has the geoprofessional with overall responsibility for the report signed and stamped it?

The last step is to review and organize a list of questions and the additional information needed to be able to fully understand the report (especially its conclusions and recommendations) and process the application. Contact the geoprofessional with overall responsibility for the report and make an appointment to discuss the questions and information requests. If the geoprofessional cannot or is unwilling to answer the questions or provide additional information that addresses the questions and satisfies the reviewer, consider obtaining a second professional opinion.

D.7. HOW DO I KNOW WHEN I NEED TO GET A SECOND PROFESSIONAL OPINION?

Ideally, all pre-development geologic and geotechnical engineering reports would be reviewed by an independent geologist or geotechnical engineer hired by the jurisdiction to ensure the information contained within the report is complete, that the report conforms to standards, and that the conclusion and recommendations are reasonable. While some communities may include such a stipulation in their codes, fiscally constrained communities can require the property owner or applicant to bear the cost of an independent professional review.

It is generally suggested that a professional review and second opinion be sought for the following reasons: 1) if there is concern that there may be a conflict of interest in the geoprofessional's work; 2) if the results of the geoprofessional report differ greatly from previous reports or known conditions at the site; 3) if the data within the report do not appear to support the conclusions; 4) if the field work or report

appears to be incomplete; or 5) if the reviewer cannot obtain satisfactory answers to the questions or additional information needed for processing the application from the geoprofessional is not provided.

- If it is suspected that a geoprofessional has violated Oregon laws or rules regarding the practice of geology in Oregon, or has committed fraud, negligence, incompetence, or some other misconduct, the concerned party should notify the Oregon State Board of Geologist Examiners (OSBGE) in writing. OSBGE is tasked with protecting the public by investigating complaints against geologists and enforcing the rules set forth in Oregon state statutes regarding geology. Information on how to file a complaint with OSBGE can be found on the OSBGE website⁵⁶.
- If it is suspected that a geoprofessional has violated Oregon laws or rules regarding the practice of engineering in Oregon, or has committed fraud, negligence, incompetence, or some other misconduct, the concerned party should contact the Oregon State Board of Examiners for Engineering and Land Surveying (OSBEELS). Information on how to file a complaint with OSBEELS can be found on the OSBEELS website⁵⁷.

⁵⁶ <https://www.oregon.gov/osbge/Resources/Pages/ConsumerGuide.aspx>

⁵⁷ <https://www.oregon.gov/osbeels/rulesstatutes/Pages/Rule-and-Statute-Enforcement.aspx#file>

D.8. HOW DO I APPLY AN ENGINEERING GEOLOGIC REPORT AND/OR THE GEOTECHNICAL ENGINEERING REPORT TO A PROJECT APPLICATION?

The engineering geologic report and/or the geotechnical engineering report will likely contain a great deal of data and research about the proposed development site, along with conclusions and recommendations based on this information. Typically, jurisdictions more commonly receive geotechnical engineering reports unless they specifically require an engineering geologic report.

The information in the report, particularly the conclusions and recommendations, will help determine whether the project is within the community's risk tolerance level. If it is, use what has been learned from reading the report and discussing it with the geologist or engineer to determine whether and how the project, by following the report recommendations, meets permitting requirements.

All local government staff with regulatory interest in the project (planning, zoning, public works, engineering, building, transportation, etc.) should be provided a copy of the report as early in the planning process as possible to ensure that the project is appropriately conditioned. This can be done easily as part of the pre-application process in communities that have one. If the jurisdiction does not have a pre-application process, ask all staff with regulatory interest to review the report and provide any necessary conditions. Department staff can be asked for assurance (such as initialing a statement) that they have read and understand the report and that any project conditions related to the landslide hazard are based upon the report's conclusions and recommendations.

Also be sure that the applicant provides the report and all other conditions to the developer as soon as possible to maximize compliance. The developer will need to address the recommendations and conditions in construction documents and during development.

Further, staff may ask the geologist or engineer to review construction documents and monitor construction to ensure the report recommendations and project conditions are being followed. The cost of the professional's review and monitoring could be borne by the property owner or applicant. Some jurisdictions require a final statement to be submitted from the professional that states the project is in compliance with requirements, once the project is done.



CHAPTER 3 MITIGATION PLANNING

Landslides... are among the most widespread, chronic, and damaging natural hazards in Oregon.

– *Lidar Data and Landslide Inventory Maps of the North Fork Siuslaw River and Big Elk Creek Watersheds, Lane, Lincoln, and Benton Counties, Oregon*⁵⁸

Postponing the confrontation with reality that hazard mitigation planning entails is simply unsound public policy. Tomorrow may be the day when an earthquake strikes, a flood inundates, or an unstable hillside tumbles and falls. ...The best time to begin reshaping the current development pattern to create a more resilient community is now.

– *Hazard Mitigation: Integrating Best Practices into Planning*⁵⁹

A. THE IMPORTANCE OF COMPREHENSIVE PLANNING IN RISK REDUCTION

A comprehensive plan establishes the long-term land use vision and aspirations, goals and policies of a city or county. In Oregon, state law requires each city and county to have a comprehensive plan and implementing ordinances. Comprehensive plans must be consistent with Oregon's 19 Statewide Planning Goals. Most of the Goals are accompanied by guidelines, which are suggestions on how the Goals might be applied. The implementing ordinances (e.g., zoning code, zoning map, and capital improvements plan) must be consistent with both the Goals and comprehensive plan, and adequate to carry out the comprehensive plan. State law also strongly encourages coordination between local jurisdictions so that the comprehensive plan is compatible with other community plans and programs (Oregon DLCD, n.d.-c)⁶⁰.

The Oregon Land Conservation and Development Commission (LCDC) reviews comprehensive plans to ensure consistency with the Statewide Planning Goals. Once a comprehensive plan of the city or county is acknowledged, it is considered the controlling land use document. Local governments must revise comprehensive

⁵⁸ 2012, <https://www.oregongeology.org/pubs/ofr/p-O-12-07.htm>

⁵⁹ 2010, p. 134, https://www.fema.gov/media-library-data/20130726-1739-25045-4373/pas_560_final.pdf

⁶⁰ <https://www.oregon.gov/lcd/OP/Pages/Goals.aspx>

plans to reflect new needs and circumstances. Under Oregon law, the post-acknowledgement plan amendment and periodic review processes keep plans current.

- With the post-acknowledgement plan amendment, cities and counties must provide the Department of Land Conservation and Development (DLCD) notice of proposed comprehensive plan and ordinance changes.
- Depending on the size of the population, periodically cities and counties must re-evaluate their plans and ordinances and submit the revisions to DLCD for approval. This process, called “periodic review,” is designed to ensure that local governments update plans to reflect new information and changing needs and circumstances.

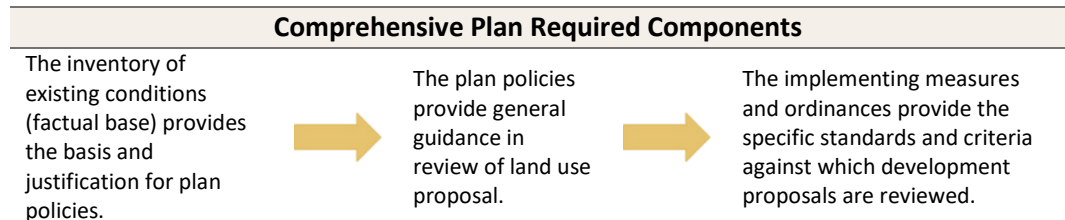
Landslides and other natural hazard events have consequences that relate to issues addressed by many of the 19 Statewide Planning Goals. Hazard mitigation policies in a comprehensive plan direct proactive actions to reduce risk to people, property, and the environment ahead of a hazard event. Establishing hazard mitigation policies that are supported by scientific inventories, maps, other factual information, and implementation measures (e.g., zoning, building, grading, and erosion control codes) is vital for accomplishing actions that reduce risk of natural disasters.

With comprehensive plans, the required components are: an inventory of existing conditions (factual base); goals and objectives; plan policies; and implementation measures and ordinances. The inventory of existing conditions (factual base) provides the basis and justification for plan policies. The plan policies provide general guidance in review of land use proposals. The implementing measures and ordinances provide the specific standards and criteria against which development proposals are reviewed.

Comprehensive Plan Required Components

- an inventory of existing conditions (factual base)
- goals and objectives;
- plan policies; and
- implementing measures and ordinances.

Figure 3-1. Understanding the Sequence of Required Components in Comprehensive Plans



Source: Modified from LeDuc et al. (2001⁶¹)

For natural hazards, the key parts of the inventory of existing conditions (factual base) are the community-wide hazard identification (what and where are the natural hazards); the community wide vulnerability assessment (with each hazard, what is the risk to new and existing development); and the risk analysis (estimating

⁶¹ <https://scholarsbank.uoregon.edu/xmlui/handle/1794/1909>

the damage, injuries, and cost over a period of time). In addition to these three community-wide levels of assessment, communities need to evaluate potential risk from natural hazards when siting new development. Therefore, communities may require site specific evaluation in areas of known hazards prior to allowing new development to proceed. All of this supports the comprehensive plan policies, and the implementing measures and ordinance. Stronger inventories of existing conditions (factual bases) provide stronger support for policies and implementing measures and codes.

B. GOAL 7: AREAS SUBJECT TO NATURAL HAZARDS

B.1. INTRODUCTION TO GOAL 7

Goal 7, Areas Subject to Natural Hazards (Oregon DLCDC, n.d.-a)⁶², is one of the 19 Oregon Statewide Planning Goals (n.d.-c)⁶³. It contains both requirements and guidelines.

Goal 7 has four mandatory sections:

- A. Natural Hazards Planning
- B. Response to New Hazard Information
- C. Implementation
- D. Coordination

Section A *requires* local governments to adopt comprehensive plans and implementation measures for reducing risk to people and property from – at minimum – floods (coastal and riverine), landslides, earthquakes and related hazards, tsunamis, coastal erosion, and wildfires. It *allows* local governments to identify and plan for additional natural hazards. In the Goal 7 document, a footnote pertaining to landslides states: “For ‘rapidly moving landslides’ the requirements of ORS 195.250-195.275 (1999 edition) apply.”⁶⁴ The ORS provisions are specifically related to rapidly moving landslides. Rapidly moving landslides are described in **Chapter 2, Landslide Hazards**, and a definition is provided in **Chapter 6, Glossary**.

To understand this ORS footnote, a short history about rapidly moving landslides (RMLs) is needed. After the 1996 flood and landslide events, then Governor Kitzhaber issued the Debris-Avalanche Action Plan (DAAP) in a March 4, 1997, press release. The press release or DAAP directed the Oregon Department of Forestry (ODF), the Oregon Department of Transportation (ODOT), DLCDC, the Office of Emergency Management (OEM), DOGAMI, the Governor’s Office, Oregon State University, and the Oregon Building Codes Division to accomplish certain tasks “to

Goal 7 Requirements

Planning: Local government adopts comprehensive plan to reduce risk from natural hazards.

Response: DLCDC notifies local government of need to respond to new hazard information.

Implementation: Within 36 months of notice, local government evaluates new information and adopts or amends policies and regulations as necessary.

Coordination: DLCDC provides information and technical assistance. Local government complies with goals and rules.

⁶² <https://www.oregon.gov/lcd/OP/Pages/Goal-7.aspx>

⁶³ <https://www.oregon.gov/lcd/OP/Pages/Goals.aspx>

⁶⁴ <https://www.oregon.gov/lcd/OP/Documents/goal7.pdf>, p. 1

reduce the occurrence of these slides and reduce the risk to the public when these slides do occur.”⁶⁵

Senate Bill 1211⁶⁶, relating to public safety in high risk areas, was approved in 1997. It required the creation of a task force, the Joint Interim Task Force on Landslides and Public Safety (henceforth Task Force). It directed ODF to provide information “on the hazards of construction for sites that could be affected by landslides or debris torrents” (Oregon Legislative Administration Committee, 1997⁶⁷). It also provided the option for the State Forester to prohibit a timber harvest or road construction to “prevent risk to human life from landslides.”⁶⁷ The Task Force identified five areas to amend state statutes. The Task Force changed the disclosure provisions in ORS 105.465, the seller’s responsibility for disclosure of information to the purchaser. The Task Force also recommended that the Land Conservation and Development Commission (LCDC) make changes to Goal 7 during the 1999–2001 biennium.

In 1999, Oregon Senate Bill 12⁶⁸, relating to protection of public from landslide hazards, was approved. SB 12 directed DOGAMI to establish maps of hazard areas termed “further review areas.” The DOGAMI Governing Board adopted “Further Review Area” maps in 2002. However, the ORS provisions established under SB 12 and related to rapidly moving landslides in these further review areas were controversial. DOGAMI suspended the further review area maps by temporary rule shortly after adoption, and made the suspension permanent in 2003.

The map names were changed from “further review areas” to “overview hazard areas” in December 2002, when the Oregon legislature agreed with DOGAMI’s recommendation to remove the term “further review area” from the draft report, *Map of Rapidly Moving Landslide Hazards for Western Oregon: GIS Outputs and Summary Report*⁶⁹. With the name change, the timeframes and requirements of SB 12 were not triggered.

Just over one year later, the Oregon legislature passed HB 3375, relating to regulation of construction in landslide areas; it became effective on January 1, 2004. It eliminated the provisions of the state statute that passed as SB 12. Specifically, HB 3375 eliminated mitigation measures (ORS 195.263), transfer of development rights and recording (ORS 195.266 and 195.270), and the moratorium on development (195.275).

⁶⁵ Oregon Governor's Office. (1997). Governor's Debris Avalanche Action Plan-summary (referenced in Governor Kitzhaber’s office March 4, 1997 press release: “Governor releases recommendations to address dangerous debris avalanches”)

⁶⁶ https://www.oregonlegislature.gov/bills_laws/archivebills/1997_sb1211.en.html

⁶⁷ <http://library.state.or.us/repository/2010/201010061538333/1997.pdf>

⁶⁸ https://www.oregonlegislature.gov/bills_laws/archivebills/1999_sb0012.en.html

⁶⁹ <https://www.wou.edu/las/physci/taylor/erth350/IMS-22.pdf>

ORS 195.250⁷⁰ currently states,

Note: 195.250 (Definitions for ORS 195.250 to 195.260) to 195.260 (Duties of local governments, state agencies and landowners in landslide hazard areas) to were enacted into law by the Legislative Assembly but were not added to or made a part of ORS chapter 195 or any series therein by legislative action. See Preface to Oregon Revised Statutes for further explanation.

The “overview hazard areas” maps and related final report (DOGAMI Interpretive Map Series 22 [IMS-22] (Hofmeister, Miller, Mills, Hinkle, & Beier, 2002⁷¹) are used by local governments. In terms of examples of county and city codes, provided in **Chapter 4, Implementation**, the Salem zoning code specifically references IMS 22; Salem does not have lidar-based landslide inventory maps from DOGAMI. Oregon City has lidar-based inventory landslide maps from DOGAMI (IMS-26 [Burns & Madin, 2009a⁷²], IMS-29 [Burns, 2009⁷³], IMS-30 [Burns & Mickelson, 2010⁷⁴]) and references debris flows in its zoning code. Newport does not have lidar-based landslide inventory maps but does refer to a DOGAMI open-file report (O-04-09; Priest and Allan, 2004⁷⁵). Astoria has lidar maps from DOGAMI. Some of that information is shown on Astoria’s Geologic Hazards Map, but Astoria’s code provisions do not specifically reference the DOGAMI information. Multnomah County has received lidar maps from DOGAMI but has not yet updated its code; it is a forthcoming project. The City of Portland has lidar maps from DOGAMI and is in the process of determining the most effective way to use them. Portland is considering referencing IMS-22 (Hofmeister et al., 2002⁷⁶) as part of its map base.

Section B of Goal 7 requires the Department of Land Conservation and Development (DLCD) to review new hazard information provided by state and federal agencies in consultation with affected state agencies and local governments and decide whether the new information requires a local response. If it does, DLCD will notify the local government of its decision (“trigger Goal 7”) and the local government will have 36 months to respond. Typically and historically, DLCD has taken an informative, educational, and collaborative approach with local governments when new information is available and local governments have been made aware of it.

Section C of Goal 7 outlines the requirements for local government response. Briefly, those are to evaluate risk to people and property based on the new information; allow the public to comment on the new information and results of the evaluation; and adopt or amend policies and regulations as necessary.

⁷⁰ <https://www.oregonlaws.org/ors/195.250>

⁷¹ <https://www.oregongeology.org/pubs/ims/p-ims-022.htm>

⁷² <https://www.oregongeology.org/pubs/ims/p-ims-026.htm>

⁷³ <https://www.oregongeology.org/pubs/ims/p-ims-029.htm>

⁷⁴ <https://www.oregongeology.org/pubs/ims/p-ims-030.htm>

⁷⁵ <https://www.oregongeology.org/pubs/ofr/O-04-09.zip> (.zip file)

⁷⁶ <https://www.oregongeology.org/pubs/ims/p-ims-022.htm>

Newly adopted or amended policies and regulations must be consistent with these principles: 1) avoid development in hazard areas where risk cannot be mitigated; and 2) prohibit siting of essential facilities, major structures, hazardous facilities, and special occupancy structures in identified hazard areas except in very narrow circumstances.

Section D of Goal 7 requires state agencies to coordinate natural hazards plans and programs with local governments and provide technical assistance. For their part, local governments must follow Statewide Planning Goals and rules to reduce risk to people and property from natural hazards.

Goal 7's Guidelines provide advice and best practices under two headings, *Planning* and *Implementation*.

The Planning section encourages local governments, when adopting plan policies and implementing measures, to think about the interaction between natural hazards and natural resources in terms of

- the benefits of maintaining hazard areas as open space;
- the beneficial effects of natural hazards on natural resources and the environment; and
- the potential impacts of mitigation actions on natural resource management.

This section also reminds local governments to consider all phases of the emergency management cycle – preparation, mitigation, response, and recovery – and coordinate land use planning processes and decisions.

The Implementation section calls out several best practices for local governments to consider implementing for risk reduction:

- Considering emergency access in planning for development in hazard areas;
- Managing stormwater runoff to mitigate flood and landslide hazards;
- Requiring site-specific professional reports for proposed development in hazard areas to assess risk (both the risk to the site and the risk the proposed development may pose to other properties) and recommend mitigation measures;
- Considering establishing or making greater use of existing programs to retrofit, relocate, or acquire buildings in hazard areas;
- Providing financial incentives and disincentives;
- Providing public information and education materials; and
- Adopting flood mitigation requirements that provide greater protection than the minimum standards of the National Flood Insurance Program (NFIP).

C. GOAL 7 INTERACTION WITH OTHER STATEWIDE PLANNING GOALS

When Goal 7 meets other Statewide Planning Goals complexity and complications arise. Legal questions abound for local jurisdictions, for example: Should our community adopt the new landslide hazard maps? Should our community make a new hazard map using a combination of several sources of information? What level of risk tolerance is appropriate for our community? How do we use the new landslide information in our buildable lands inventory? How do we balance social equity, housing availability, protection of natural resources, and economic growth? Are there clear and objective standards for residential development in landslide hazard areas? How do we write the most effective implementing measures? What kind of liability do we have?

Both development and questions will continue; these illuminate the ways in which natural hazards intersect with other Statewide Planning Goal requirements, e.g., buildable land supply, housing inventory and residential development standards, natural resource protection, economic opportunity, and social equity. In these planning efforts, local jurisdictions must analyze the trade-offs inherent in working to reduce and minimize potential damage to life, property, and the environment which may result in locating development in or away from hazard areas.

Analyze the Trade-Offs

In all these planning efforts, local jurisdictions must analyze the trade-offs inherent in working to reduce and minimize potential damage to life, property, and the environment – which may result in locating development in or away from hazard areas.

D. NATURAL HAZARDS MITIGATION PLANNING

Natural hazards mitigation planning is accomplished at the local, regional, state, and federal levels. Cities, counties, tribes, special districts, and other entities engage in natural hazards mitigation planning to identify natural hazard events likely to affect them and act ahead of time to reduce impacts and avert disaster.

Natural hazards mitigation planning is any sustained action taken to reduce or remove the short- and long-term risk to people, property, and the environment from natural hazards.

Natural hazards mitigation planning is the responsibility of the “whole community” – individuals and families; private businesses and industries; non-profit groups; schools and academia; media outlets; faith based and community organizations; and federal, state, and local governments⁷⁷.

The planning process is a method for involving the “whole community” in identifying, characterizing, and analyzing potential hazard events and losses, then determining and prioritizing actions that can be taken to mitigate potential losses.

⁷⁷ <https://www.fema.gov/whole-community>

Natural Hazards Mitigation Planning

Natural hazards mitigation planning is any sustained action taken to reduce or remove the short- and long-term risk to people, property, and the environment from natural hazards.

Natural hazards mitigation planning involves either developing a natural hazards mitigation plan (NHMP) or updating one.

A natural hazard mitigation plan describes the hazards a community is most likely to face; identifies their potential impacts on people, property, and the environment; and establishes a strategy to reduce those impacts. The NHMP is also developed as a condition for receiving certain types of non-emergency disaster assistance through federal Hazard Mitigation Assistance (HMA) Programs. The HMA programs are the Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant Program (PDM), and the Flood Mitigation Assistance Program (FMA).

NHMPs are not required by state or federal law. Beyond the broad goal of protecting public health, safety, and welfare, the incentive for producing an NHMP is establishing eligibility for certain federal mitigation grant funds. Eligibility is established when a jurisdiction's NHMP has met federal process and content requirements, been adopted by the jurisdiction, and been approved by FEMA. NHMPs must be updated, re-adopted, and re-approved by the Federal Emergency Management Agency (FEMA) every five years to maintain eligibility.

Effective NHMPs

NHMPs are most effective when they have been integrated into other plans.

NHMPs are most effective when they have been integrated into other plans (e.g., comprehensive plans, capital facilities plans, stormwater plans, grading and erosion control plans, transportation plans, and emergency operations plans). Integration helps ensure that mitigation strategies are considered, prioritized, and funded. Examples of mitigation strategies are policy changes, such as updated ordinances; projects, such as seismic retrofits to critical facilities; and education and outreach to targeted audiences, such as Spanish speaking residents or the elderly. Implementing mitigation actions can also reduce the length of time that essential services are unavailable after a disaster; protect critical facilities; reduce economic hardship; speed recovery; and reduce post-disaster construction costs. As noted in *Hazard Mitigation: Integrating Best Practices into Planning* (Schwab, 2010, p. 132)⁷⁸,

“...[w]hen coordination of plans is absent...a community may not be treating hazards as a planning priority; especially in land use planning. The best way to change that signal is to establish clear references in community plans to programs and planning activities addressing hazards and to use a hazards or safety element in the comprehensive plan and the local hazard mitigation plan to reinforce each other...”

⁷⁸ https://www.fema.gov/media-library-data/20130726-1739-25045-4373/pas_560_final.pdf

E. INTEGRATING RISK REDUCTION INTO COMPREHENSIVE PLANNING

To integrate risk reduction into comprehensive planning it is best to have a multi-pronged effort that includes scientific data and information to support local policy decisions and implementation measures. Understanding the other factors involved, such as political support, is also key. Linking the risk reduction information to land use planning, building, transportation, stormwater, grading, erosion control, economic, social, and environment factors enables a multi-disciplinary and synergistic effect. A jurisdiction will get a lot of “bang for its buck” and have coordinated planning efforts that avoid conflicts in implementation. For example, comprehensive plans and the zoning codes can reference specific DOGAMI lidar-based landslide maps and reports. Other code provisions will also benefit from consideration of landslide information. See **Chapter 4, Implementation**, for more detailed discussion of the integration and implementation of risk reduction into the zoning code.

Updating a comprehensive plan typically occurs less frequently than updating a zoning code and varies from jurisdiction to jurisdiction. With that in mind, the first step may be adopting lidar maps, reports, and other supporting information with revisions to the zoning code. There is uniqueness in the comprehensive plan and in the zoning code that incorporates the community’s priorities. Specificity is needed for both comprehensive plan and zoning code provisions and their updates. Identify the information supporting the provisions that go into one or the other, or both. Sometimes language in the comprehensive plan defers to more detailed information in the zoning code.

One example of successful integration of a NHMP and a comprehensive plan comes from the City of Medford (2017⁷⁹). The *2017 Medford NHMP* includes text and maps related to the natural hazards identified as a risk to Medford. On November 1, 2018, the City of Medford adopted an ordinance approving “a legislative amendment to the Environmental Element and the Conclusions, Goals, Policies, and Implementation Strategies of the Medford Comprehensive Plan to incorporate the 2017 Natural Hazards Mitigation Plan” (Medford City Council, 2018⁸⁰).

A finding in the corresponding council staff report (File no. CP-18-063⁸¹) stated “the number of potential natural hazards analyzed in the 2017 NHMP includes hazards that were not previously contemplated or discussed in the Comprehensive Plan.” Another noted “the NHMP also establishes a coordinated process (a plan) to implement actions to reduce impacts of natural disasters on the people and resources of the community.” Furthermore, the staff report stated that three of the

⁷⁹ <http://www.ci.medford.or.us/SIB/files/3357Medford%20NHMP%20FINAL%20Approved%209-13-2017.pdf>

⁸⁰ <http://www.ci.medford.or.us/Agendas.asp?AMID=7935&Display=Minutes>

⁸¹ <http://www.ci.medford.or.us/files/DOC.pdf>

eight hazards identified in the NHMP were not previously included in the comprehensive plan (Ordinance No. 2018-125 and File No. CP-18-063⁸²). See **E.2.a, City of Medford Comprehensive Plan** of this chapter for additional information.

E.1. USING DOGAMI'S LIDAR-BASED MAPS IN COMPREHENSIVE PLAN POLICY FOR RISK REDUCTION

The main purpose of many DOGAMI lidar-based studies is to help communities in a study area become more resilient to landslide hazards by providing detailed, digital databases locating the landslide hazards as well as community assets and the risk that exists where the two overlap (**Figure 2-8**).

The studies alert people to the need to be prepared for landslides. Landslides can be triggered by human activities, earthquakes, and high precipitation. Recognizing where areas are susceptible to landslides can help reduce the impacts to people, property, and the environment.

DOGAMI's lidar-based landslide hazard maps (inventory, shallow landslide susceptibility, and deep landslide susceptibility) and associated reports provide a strong basis for comprehensive plan policies and zoning code implementation measures, as well as other provisions.

In comprehensive planning, a community establishes a long-range vision. It projects population growth, housing and economic development needs, and carries out other land use studies. A local community designates areas for general types of development (e.g., residential, commercial, industrial, recreational, institutional, public facilities) and for conservation.

Inventory and factual basis support the comprehensive plan policies that, in turn, support the implementing measures and ordinances (see **Chapter 3**, section **A**). The zoning code, zoning map, and capital improvement plans are approved ordinances that comply with the comprehensive plan and thus comply with Statewide Planning Goals. DOGAMI's lidar landslide maps and corresponding reports could be categorized as inventory and factual information. They could also be adopted as implementing measures that carry out the comprehensive plan policies.

⁸² <http://www.ci.medford.or.us/files/DOC.pdf>

If used as implementation measures, the maps could be used as is, or excerpts could be used to form a new map. For example, the new map created by the local jurisdiction may be show high risk areas from the shallow landslide susceptibility map, high risk areas from the deep landslide susceptibility map, and rapidly moving landslides (RMLs) from DOGAMI's IMS-22⁸³ map, or some other combination of available information.

With the hazard area ranges of low, moderate, and high for both shallow and deep landslide susceptibility maps, a local jurisdiction can use these categories (reference them in their codes) as thresholds for level and extent of geologic review requirements, as well as for land use purposes such as types of allowed uses in high hazard areas (e.g., not allowing hospitals or energy production plants in high susceptibility areas). DOGAMI's reports typically include the percentage of a city and study area in low, moderate, and high susceptibility zones. This is information can reveal a startling amount of land in a community subject to landslide hazards.

A local government can make more effective decisions with the awareness of the extent of the natural hazards. The newly adopted policies and regulations need to be consistent with the two principles of Goal 7 (this chapter, section **C, Goal 7 Interaction with Other Statewide Planning Goals**): avoiding development in hazards areas and prohibiting the siting of certain structures (this chapter, section **B.1, Introduction to Goal 7**).

In **Chapter 2, Landslide Hazards**, inventory, shallow landslide susceptibility maps, and deep landslide susceptibility maps are described in detail. Here a brief recap is provided.

A landslide inventory map shows the locations of all identified landslide deposits for an area along with characteristics for each landslide. One characteristic is the type of landslide such as slide, flow, fall, topple, and spread; these were discussed **Chapter 2**.

A shallow landslide susceptibility map shows the locations of landslides with failure plane depth less than 15 feet (4.5 meters), while a deep landslide susceptibility map shows the locations of landslides with failure plane depth greater than 15 feet (4.5 meters). These maps also show landslide features such as head scarp lines, head scarp zones, and slide extents.

Once a community has lidar-based imagery, DOGAMI can create a series of landslide hazard maps as shown in **Figure 3-2**. The landslide inventory is prepared and provided in a report with maps. This is followed by a shallow landslide susceptibility report and maps, and a deep landslide susceptibility report and maps. The full process can take years. A community may take steps to adopt and implement any one of these one at a time or it may choose to wait and adopt them all at once. Again, adoption is key to implementation. The process shown in **Figure**

Landslide Hazard Map

When information from the shallow and deep susceptibility maps is used in conjunction with the inventory map and the IMS-22 (rapidly moving landslides) map, a comprehensive landslide hazard map is created.

Each jurisdiction determines which areas from each of the maps are included (e.g., low, moderate, high, and very high hazard areas) in the jurisdiction's landslide hazard map.

Legal Matter

As always when developing land use regulations or other legislation for local adoption, local governments should consult with their legal counsel to ensure that proposals comply with applicable federal, state, and local requirements.

⁸³ <https://www.oregongeology.org/pubs/ims/p-ims-022.htm>

3-2 is collaborative: as maps and reports are prepared by DOGAMI, they are shared with the jurisdiction’s staff and the community.

The landslide hazard maps can help determine areas where development may need to be conditioned or avoided to alleviate the potential for loss of life, property damage, and damage to the environment. As part of the map-making process between DOGAMI and the community, there is active discussion about community concerns, what information goes into the map, and potential ways to use the maps.

Figure 3-2. Landslide Risk Reduction Process Overview



Source: Modified from Burns (2015⁸⁴)

Landslide inventory maps can be used as an early step in landslide risk reduction because they provide basic information for identifying areas of higher and lower hazards. If a site is within a landslide area identified on these maps, or even if the site is in an area adjacent to or surrounded by landslide hazard areas, then additional investigation into the hazard may be necessary. These landslide hazard areas are likely to be at higher risk for landslides, but it is not a certainty that these areas will have landslides or be impacted by them.

DOGAMI does not typically create a channelized debris flow susceptibility map. However, the combination of the shallow susceptibility map and the landslide inventory map showing debris flow fans might be used to identify where these types of landslides could initiate and where they might deposit. In addition, DOGAMI Interpretive Map Series-22 (Hofmeister et al., 2002⁸⁵) could be used with these other datasets to evaluate potential channelized debris flow or rapidly moving

Recognize Hazard Areas

Recognizing where areas are susceptible to landslides can help reduce the impacts to people, property, and the environment.

⁸⁴ <https://cdn.ymaws.com/www.aegweb.org/resource/resmgr/Events2015/aeg-ls-forum-program-abstrac.pdf>

⁸⁵ <https://www.oregongeology.org/pubs/ims/p-ims-022.htm>

landslides hazards. In many cases, debris flow fan areas have the potential risk for impacting people, property, and the environment, and therefore a local government should take extra caution in these areas.

When information from the lidar-based shallow and deep susceptibility maps is used in conjunction with the lidar-based inventory map and the IMS-22 map, a comprehensive landslide map is created. Jurisdictions can then determine which areas (e.g., low, moderate, high, and very high hazard areas) from each of the respective maps are included in their landslide hazard map.

For example, a jurisdiction may choose to use information from the lidar-based inventory map, from the high and very high areas on the lidar-based shallow and deep susceptibility maps, and areas on the *GIS overview map of potential rapidly moving landslide hazards in western Oregon* (IMS-22).

E.2. EXAMPLE COMPREHENSIVE PLAN POLICIES

E.2.a. City of Medford Comprehensive Plan

The City of Medford amended the *Medford Comprehensive Plan* to integrate the plan with information from their *2017 City of Medford Natural Hazards Mitigation Plan* (2017 Medford NHMP). This integration was approved by the Medford City Council on November 1, 2018. In the report prepared for City Council, staff stated under the heading “Analysis,”

Preparation of the 2017 NHMP resulted in mitigation plans for eight natural hazards. Similar to what was done with the Leisure Services Plan, the proposed amendment would incorporate (by reference) the 2017 NHMP into the Comprehensive Plan, and would update various sections of the Environmental Element to include information on all eight natural hazards analyzed in the NHMP (e.g., the Comprehensive Plan’s section on Air Quality has not been updated for many years and therefore contains some information that is no longer accurate). Finally, the amendment updates the Comprehensive Plan’s Conclusions, Goals, Policies and Implementation Strategies for Air Quality and for Disasters and Hazards.⁸⁶

The City of Medford has posted online a portion of the updated *Medford Comprehensive Plan* called “Environmental Element”⁸⁷; it includes the “Conclusions, Goals, Policies, and Implementation Strategies.”

⁸⁶ <http://www.ci.medford.or.us/files/DOC.pdf>, p. 72

⁸⁷ http://www.ci.medford.or.us/SIB/files/3_Environmental%20Element_2019.pdf

The first part of the Environmental Element includes the Purpose section. Below, part of the Purpose section is shown. Note the statement about Statewide Planning Goals and relationship of plans:

This “Environmental Element” of the Medford Comprehensive Plan provides goals, policies, and implementation strategies for improving and maintaining environmental quality in Medford, while accommodating continued growth. The Statewide Planning Goals that oversee the protection and conservation of natural resources in Oregon are Goal 5: Open Spaces, Scenic and Historic Areas, and Natural Resources, and Goal 6: Air, Water and Land Resources Quality. Consistent with the objectives of Goals 5 and 6, the “Environmental Element” is a guiding document that strives to protect the natural environment and ensure that long-term growth does not adversely affect the natural resources that contribute to Medford’s livability. Other Statewide Planning Goals that are pertinent to the “Environmental Element” include Goal 3: Agricultural Lands; Goal 7: Areas Subject to Natural Hazards; and Goal 13: Energy Conservation. Most of these Statewide Planning Goals are also addressed in other elements of the Comprehensive Plan, such as in the “Public Facilities Element,” and in related plan documents such as the Medford Parks, Recreation, and Leisure Services Plan, and the City of Medford Natural Hazards Mitigation Plan.⁸⁸

⁸⁸ http://www.ci.medford.or.us/SIB/files/3_Environmental%20Element_2019.pdf

Excerpts from City of Medford Comprehensive Plan, Environmental Element, December 20, 2018⁸⁹:

DISASTERS AND HAZARDS CONCLUSIONS

1. The Medford Urban Growth Boundary contains streams and waterways that have a history of flooding occasionally.
2. The *National Flood Insurance Program* is available in communities that implement comprehensive floodplain regulations to reduce flood damage. As a participant in this program, Medford adopted regulatory provisions to minimize flood losses through development controls such as building codes and development regulations that place restrictions on new construction or improvements to flood-prone structures.
3. According to seismologists, the likelihood of an earthquake of serious magnitude in the Northwest is high. Medford is at risk for potential earthquake damage because many older buildings have not been built or upgraded to current earthquake standards. Medford's emergency management planning recognizes this possibility.
4. The threat of wildland-urban interface fires within the Medford Urban Growth Boundary will increase as development abuts or increases in areas prone to wildland fire dangers, such as steep slopes, dense natural vegetation, etc.
5. The threat of loss of life and/or property damage in areas that may be impacted by wildland-urban interface fires can be reduced through the use of ignition-resistant construction methods/materials, adequate fire response apparatus, availability of fire protection water, adequate fuel breaks surrounding structures, appropriate road widths to accommodate fire fighting vehicles, and response and evacuation plans that are understood by the residents of these areas.
6. The eastern boundary of Jackson County coincides with the crest of the Cascade Mountains, a volcanic range that has a number of still active volcanoes. According to the Oregon Department of Geology and Mineral Industries, Crater Lake and Mount Shasta are the two biggest volcanic hazards known for Medford, both of which are composite, active volcanoes relatively near the city.
7. While there are several potential hazards associated with volcanic eruptions, the one deemed most likely to affect Medford is that of ashfall. Likely hazards associated with ashfall include respiratory problems, impacts on transportation networks, power outages, and damage to building air filtration systems.
8. Severe weather is the most frequently occurring natural hazard in Medford. Typically, storms are short-term in nature, lasting one to two days, and can be managed with local emergency response resources.

⁸⁹ http://www.ci.medford.or.us/SIB/files/3_Environmental%20Element_2019.pdf

9. Snowstorms and windstorms can disrupt the region's utilities, telecommunications and roadway systems. Damage from wind storms is typically related to the hazard of falling trees and limbs, and the consequent downing of utility infrastructure and power outages. Late summer and early fall wind storms, occurring during the dry season, often increase wildfire risks.
10. Severe weather events, including those exacerbated by climate change, are becoming more common. All persons and critical facilities are at risk from severe weather impacts, especially those that result in power outages.
11. Emerging infectious diseases have been identified in the top five hazard vulnerabilities within our healthcare systems, and overall it is probable a person will have one or more during their lifetime. People with access and functional needs (e.g., the elderly, the very young and medically fragile persons) are more susceptible to impacts, as are critical facilities such as hospitals, airports, and fire and police forces. Furthermore, water, air, and land can be contaminated by emerging infectious diseases.
12. As a regional employment, recreational, residential, retail and health care hub, Medford draws many non-residents on a daily basis into the area, multiplying the opportunities for further disease exposure and transmission among both visitors and residents.
13. The most common noise sources in Medford are transportation-related, and include automobiles, trucks, motorcycles, railroads, and aircraft. Motor vehicle noise is a pressing concern, because it often occurs in areas sensitive to noise exposure, such as residential areas, and continues to increase with urban growth and increasing numbers of motor vehicles.
14. The City of Medford has adopted noise reduction strategies in the *Land Development Code* to mitigate the harmful effects of noise, including a noise ordinance, which regulates the level of commercial and industrial noise based on the proximity to noise-sensitive properties; buffer yards, which use setbacks, fencing/walls/berms, and vegetation to mitigate adverse impacts between adjacent land use types, and agricultural buffering, in which Medford and Jackson County jointly implement policies to minimize the impacts of urban development on abutting agricultural uses.
15. Airports can adversely impact residential and other sensitive development through noise and accident hazards. Future airport expansion plans could create land use conflicts as flights increase.

DISASTERS AND HAZARDS GOALS, POLICIES, AND IMPLEMENTATION MEASURES

Goal 12: To protect the citizens of Medford from the potential damage caused by hazards such as flooding, earthquakes, wildland-urban interface fires, volcanic eruptions, severe weather, emerging infectious diseases, noise, and airport hazards.

Policy 12-A: The City of Medford shall assure that hazard mitigation standards are formally adopted as public policy through comprehensive planning, land development ordinances, permit review, and fire/building safety codes.

Implementation 12-A (1): Continue to conduct hazard risk analysis, including identifying the types, magnitude, and probability of hazards which the Medford Urban Growth Boundary is susceptible to over the long term, including assessing the degree of risk that the citizens find acceptable.

Policy 12-B: The City of Medford shall ensure that the potential impacts of flooding are adequately analyzed when considering development projects.

Implementation 12-B (1): Maintain and, when necessary, update the city's requirements for development in floodplains, consistent with federal and state regulations, and the *Uniform Building Code* (UBC).

Implementation 12-B (2): Adhere to the policies outlined in the *Medford Comprehensive Drainage Master Plan* to minimize flood losses through development controls.

Implementation 12-B (3): Encourage the re-mapping of flood-prone areas in Medford using data from the most recent flood(s) of record.

Implementation 12-B (4): Consider flood hazards when installing public improvements such as parks and paths in flood-prone areas. Design these amenities to withstand a certain flood level.

See also the Policies of the *Storm Water Drainage* section of the "Public Facilities Element."

Policy 12-C: The City of Medford shall continue to utilize building and development standards to mitigate the potentially damaging effects of earthquakes. New construction is required to meet the standards of seismic zone 3 of the *Uniform Building Code* (UBC).

Policy 12-D: The City of Medford shall strive to upgrade all city-owned buildings and facilities to meet earthquake standards.

Policy 12-E: The City of Medford shall continue to update and enforce noise attenuation strategies.

Implementation 12-E (1): Periodically review the city's noise ordinances for adequacy.

Policy 12-F: The City of Medford shall strive to minimize the loss of life and property resulting from wildland-urban interface fires within the Urban Growth Boundary.

Implementation 12-F (1): Undertake efforts to educate the public in wildland-urban interface fire safety.

Implementation 12-F (2): Develop and adopt fire safety performance standards for development in those areas identified as being at risk of wildland-urban interface fires.

Policy 12-G: The City of Medford shall designate future residential areas in coordination with the *Rogue Valley International-Medford Airport Master Plan* to minimize conflicts with flight patterns, hazard areas, and airport expansion areas.

The *City of Medford 2017 Natural Hazards Mitigation Plan (2017 Medford NHMP)*, approved September 2017, has mitigation actions related to tracking the amount of development in earthquake, flood, wildfire, and landslide hazard areas on a yearly basis. As part of the maintenance of the *2017 Medford NHMP*, the NHMP Steering Committee is to meet one to two times a year to check the status of all the mitigation actions. One particular mitigation action regarding landslides is: “Update the ‘Summary of Impact on Exposed Assets’ information each year (# structures, # tax lots, total improved value). The data are based on properties with slopes 25% or more.”⁹⁰

Keeping track of the amount of development in natural hazard areas will provide helpful information for the City of Medford to use for decision-making purposes that can identify ways to mitigate impacts of natural hazards to people, property, and the environment. Avoiding development in hazard areas is one way to reduce risk; minimizing development is another way to reduce risk. If development is within hazard areas, then mitigating risk through a variety of methods such as regulatory and non-regulatory means is appropriate. Each jurisdiction must ascertain its tolerance level of acceptable risk.

E.2.b. City of Astoria Comprehensive Plan

The City of Astoria has a detailed description of geologic hazard provisions in the *Astoria Comprehensive Plan*⁹¹, which was adopted in 1979 (Ord 79-10) and has not been altered since then. The text describes the City’s experience with many landslides in their history and specifically identifies two kinds of landslides common in Astoria. At the time of the *Astoria Comprehensive Plan* adoption, it was noted that houses, streets, and infrastructure have been extensively damaged by landslides over the years.

The *Astoria Comprehensive Plan* states that the City has acquired “much of the active landslide areas on the north slope” and “[t]he City and other public agencies own most of the lands on the south slope.” The language links the landslide hazard to high rainfall and resulting stormwater runoff, which is common in Astoria. There are provisions that allow the City Engineer and/or Planning Commission to require a site investigation and report by a licensed engineering geologist or soils engineer. In the Background Summary of the *Astoria Comprehensive Plan*, it states “[p]reventing construction in landslide areas is the best deterrent.” The full text of the Geologic and Flood Hazards provisions in the *Astoria Comprehensive Plan* is provided below.

In a telephone conversation with Jeff Harrington, City of Astoria, Public Works Director, and John Edwards, City of Astoria, Engineering Designer (personal communication, May 31, 2019), they described that *Astoria Comprehensive Plan*

⁹⁰ <http://www.ci.medford.or.us/SIB/files/3357Medford%20NHMP%20FINAL%20Approved%209-13-2017.pdf>, p. 3.52, Table 53

⁹¹ http://www.astoria.or.us/Comprehensive_Plan.aspx

provision 395, in #3 (see below), which refers to the “known landslide potential,” should be further clarified. Staff would like to provide more clarity in the *Astoria Comprehensive Plan* that the City will not sell city-owned land with known landslide potential. Staff said that revisions to the *Astoria Comprehensive Plan* text will include identifying specific information, such as which maps and data layers are the best ones to reference, so that reference and supporting information are easily identifiable.

Excerpts from City of Astoria Comprehensive Plan CP.390 ⁹²:

GEOLOGIC AND FLOOD HAZARDS

CP.390. Background Summary.

The area on which the City of Astoria is located has experienced many earth slides throughout its history. The sharp escarpment on the north side and near the top of the main ridge indicates that a major movement of land took place many years ago. These areas gradually returned to an appearance of stability, but several major slides have occurred in recent years. The most damaging slides have been the West Commercial Street and the Irving Street slides. Some 50 homes were destroyed or displaced in these slides. Most of these slide areas are in a siltstone and claystone sedimentary rock unit (TOMS), although a basaltic sill (an igneous rock outcropping) underlies Coxcomb Hill, Clatsop Community College, and an area in the western part of the City. Even in these basaltic areas, landslides have been recorded on steeper slopes.

There are two types of slides common to Astoria: 1) the shallow earth slippage, generally not more than two feet in depth, caused by sudden saturation, freezing and thawing, or erosion of cover material. 2) the deep (and much more serious) landslide caused by rotation or movement along a slippage plane caused by water pressure build up within the earth, often as a result of excavation. Installation of drainage systems, and weighting down of the "toe" of the slide by rock fill are the most common means of correcting landslides, although these are often just stopgap measures. Preventing construction in landslide areas is the best deterrent.

Earthquake hazards are not common in coastal Oregon, but a fault line does run in a northeasterly direction past Tongue Point. An earthquake of intensity IV (Mercalli Scale) was recorded on July 23, 1938; with its epicenter near Astoria. The main concern with earthquakes in this area is their potential for triggering landslides.

Flood hazards exist only in a small portion of the City, near the Alderbrook area. One hundred year flood elevations are generally about 13 feet. The City has enacted a Flood Prevention Ordinance as part of the Federal Flood insurance Program, which requires new structures to have their first floor joists at least a foot above this level.

CP.395. Conclusions and Problems.

1. Since 1950, it is estimated that sixty to seventy homes have been seriously damaged by earth movement. The resulting cost to the various owners is estimated to be between 500,000 and 1,000,000 dollars. Cost of street and utility repairs is estimated to be over \$2,000,000.

⁹² http://www.astoria.or.us/Assets/dept_1/pm/pdf/cp%20390%20to%20400.geologic%20and%20flood%20hazards.pdf

2. The City of Astoria has a variety of means of dealing with geologic hazards: the Engineering Department has detailed information on recent landslides (during the last 50 years); the City has acquired, though the years, much of the active landslide areas on the north slope; the City Engineer, land agent and Building official all have access to geologic data. It is used in public works, for land sales, and for the issuance of building permits. The City and other public agencies own most of the lands on the south slope.
3. The City has made good use of landslide areas on the north side by purchasing land, and converting the slide area into parks or open space. Areas of known landslide potential are not permitted to be sold.
4. The City has an opportunity, through the use of undeveloped public property, to control how new subdivisions are designed, thereby reducing landslide hazards. These methods including the platting of streets and utility lines along land contours, the requirement of complete storm drainage systems, and the evaluation of the land prior to development by qualified engineering geologists or other qualified persons. Many of these steps can also be taken with regard to private development through the use of the City's land division ordinance.
5. Geological information indicates that the bedding planes under Astoria generally dip toward the south, and that the landslide potential on the south slope (which is mostly undeveloped at present) could be considerable as development increases. Great care should be taken to insure this area does not experience the same problems encountered on the north slope of the City.
6. The City's major flood hazard area is a small portion of Alderbrook, with small areas around the streams on the south slope. The City has enacted a Flood Hazard Ordinance (Ord. 09-03) and participates in the Federal flood insurance program.
7. The Federal Flood Insurance Program does not presently cover landslides or mudslides, although these hazards are closely related with the high rainfall and resulting storm water runoff in the Astoria area. The City is pursuing the possibility of including landslides and mudslides in the program, with the assistance of the Congressional delegation.

CP.400. Geologic and Flood Hazard Policies.

1. The City will take reasonable precautions to protect life and property from natural hazards or disasters, through the use of the City Flood Hazards Ordinance (Ord. 09-03), the Uniform Building Code, and the policies for the management of geologic hazard areas.
2. Where it appears a landslide, or other earth movement hazard may be present, the approval of the City Engineer will be obtained before a building or development permit is issued. The City Engineer and/or Planning Commission may require a site investigation and report by a City approved licensed engineering geologist or soils engineer in such cases.
3. The City Engineer will file copies of all geologic and soils reports which are submitted, and be prepared to furnish copies of them to interested persons at the cost of reproduction.

4. Land divisions in areas of steep slopes, unstable soils, weak foundation soils, or landslide potential will be permitted only after a favorable site investigation report has been completed. The Planning Commission will submit site investigation reports to the City Engineer for evaluation. Recommendations of the City Engineer will be used in the review of land division requests. The Planning Commission may require changes in proposed subdivision plats based on the City Engineer's recommendations. Site investigation reports will be filed in the office of the City Engineer, and used in the evaluation of future building permits within the development.
5. The City Engineer and/or Planning Commission may require the submission of detailed topographic maps in steep slope areas, indicating the location of drainages, springs or other natural features. Detailed drainage plans showing the location of proposed storm water disposal will be a part of building permit or land division applications.
6. Clustering of development on stable or less steep portions of sites is encouraged in order to maintain steeper slopes in their natural condition.
7. General development policies for areas of steep slopes will be as follows:
 - a. Construction excavation will be held to the minimum necessary to build footings efficiently.
 - b. Removal of vegetation will be kept to the minimum necessary for the placement of roads, utilities, and structures. Erosion control measures as required by the City Engineer will be employed during and after construction.
 - c. Access roads and driveways will be constructed with a minimum amount of grading.
 - d. No development will be allowed to block stream drainages in any area or divert storm water across adjacent property.
8. Guidelines for site investigation reports will be provided by the City Engineer's office. The individual site reports will generally indicate where construction may take place without enhancing earth movement hazard, the location of feasible building sites, the location of evidence of potential or past earth movement, the recommended method of construction. Where necessary, the City Engineer may require certification by a professional engineer or architect accompany building plans.

E.2.c. City of Portland Comprehensive Plan

The Portland *2035 Comprehensive Plan*⁹³ is Portland’s primary tool to implement the *Portland Plan*⁹⁴, which “provides a structure for aligning budgets and projects across numerous public agencies, guiding policies with an eye toward the year 2035, and a five-year action plan to get things started. The *Portland Plan* is organized around an equity framework, three integrated strategies, and a set of measurable objectives to track progress.” (p. I-3)

The Portland *2035 Comprehensive Plan* has five guiding principles “to recognize that implementation of this Plan must be balanced, integrated and multi-disciplinary.” These principles are economic resilience, human health, environmental health, equity, and resilience. Resilience is described as: “Reduce risk and improve the ability of individuals, communities, economic systems, and the natural and built environments to withstand, recover from, and adapt to changes from natural hazards, human-made disasters, climate change, and economic shifts” (p. I-7)⁹³. The *2035 Comprehensive Plan* was adopted by Portland City Council on June 15, 2016, and extends to the year 2035.

With the *2035 Comprehensive Plan*, policies work together to improve Portland’s resilience through such things as provision of city greenways and urban habitat corridors; growth in compact centers and corridors; expansion of living wage employment; investments to fill infrastructure gaps in underrepresented and underserved communities; and responsiveness to differences among Portland’s neighborhoods.

The Resilience section describes that resilience reduces vulnerability of people, places, and property to withstand challenges that may result from hazardous events. A resilient community can bounce back, recover, and move forward. In the *2035 Comprehensive Plan*, resilience includes prosperity, human health, and environmental health as essential components.

The Resilience section identifies that Portland faces many natural and human-caused risks, and that these risks can have environmental, social, and economic impacts. The five hazards listed are floods or landslides; a significant earthquake; extreme heat events; economic and energy shocks; and Oregon’s changing climate. There are five ways identified that the *2035 Comprehensive Plan* helps manage risk: low-carbon economy; resilience in natural systems; neighborhood resilience; invest to reduce risks; and direct growth in lower risk areas.

“Effectively managing risks involves assessing the likelihood that an event will occur, as well as the potential consequences such as injury or fatalities, environmental degradation or economic loss. Certain populations, including low-income households, communities of color, people with disabilities, renters and older adults may be less able to prepare for and recover from impacts

⁹³ <https://www.portlandoregon.gov/bps/2035-comp-plan.pdf>

⁹⁴ <https://www.portlandonline.com/portlandplan/index.cfm?c=58776&a=398384>

from natural hazards, economic disruption and climate change impacts” (p. I-30)⁹⁵.

E.3. COMPREHENSIVE PLAN MAPS

Statewide Planning Goal 2, Land Use Planning requires four key components in comprehensive plans, as summarized in *The Planning for Natural Hazards: Oregon Technical Resource Guide* (LeDuc et al., 2001)⁹⁶:

- An inventory of existing conditions (factual base);
- General goals and objectives;
- Policies; and
- Implementing ordinances and regulations.

Map are part of these key components: maps can be part of the inventory/factual base that leads to plan policies, and maps can be part of the implementing ordinances and regulations (e.g., zoning maps, maps of natural hazards). Zoning codes and maps are discussed in more detail in **Chapter 4, Implementation**.

DOGAMI’s landslide inventory and maps could be part of both the factual basis for the policies and the implementing ordinances in the zoning code. Because of the differences of information in the inventory, shallow susceptibility map, and deep susceptibility map, a jurisdiction may consider having implementation provisions that vary with the types of landslides. In this way, the codes would relate more specifically to type of landslide, the type of proposed development, the type of jurisdictional review, and the requirements for geotechnical review.

Chapter 4, Implementation in this *Guide* provides examples of zoning and other codes from jurisdictions in Oregon and identifies the elements of strong landslide hazard codes.

Chapter 5, Resources includes the full range of city and county code provisions examined during the research for this *Guide*.

Table 5-1 through **Table 5-4** provide a summary, while **Chapter 8, Landslide Code Review Details Table** provides more details for that same code information. The research primarily focused on comprehensive plans, zoning code provisions, as well as building code, stormwater management provisions, and grading and erosion control provisions.

⁹⁵ <https://www.portlandoregon.gov/bps/2035-comp-plan.pdf>

⁹⁶ <https://scholarsbank.uoregon.edu/xmlui/handle/1794/1909>

F. KEY ISSUES

F.1. COMMUNITY RISK TOLERANCE

Depending on a community's need, DOGAMI conducts increasingly detailed lidar-based landslide hazard projects that result in tiered sets of products:

- Landslide inventory;
- Landslide inventory, shallow susceptibility map, and deep susceptibility map; and
- Landslide inventory, shallow susceptibility map, deep susceptibility map, and landslide risk analysis.

(See **Figure 3-2, Landslide Risk Reduction Process Overview.**) The community reviews the information received from DOGAMI and ascertains the most effective way to use the information. For example, in the *Landslide Hazard and Risk Study of Eugene-Springfield and Lane County, Oregon* (Calhoun, Burns, Franczyk & Monteverde, 2018)⁹⁷, the primary landslide hazard in the study area is exposure of existing structures to deep landslides. What could be done to alleviate risk?

Substantive risk reduction activities for this type of landslide hazard include 1) controlling the input of water onto slopes within the moderate and deep landslide susceptibility zones and on existing deep landslides and 2) avoiding adding material (weight) to the tops of susceptible slopes or, conversely, removing material from the bottoms of slopes (excavation or grading). By evaluating the hazard study information, the community can decide on the acceptable level of risk (its risk tolerance) and the best way to integrate and implement the information.

The community's risk tolerance is of considerable importance in decision-making and plays a key role in how the mapped information is used. Factors such as land use and development requirements, scientific information available, political situation of the jurisdiction, support of local land use and building officials, available technical assistance, the number of people and structures that already exist in the hazard area, and the potential for more development to occur in the hazard area. Other factors may also play into a jurisdiction's risk tolerance determination. Identifying where the critical infrastructure is in relationship to the hazard areas is important. In addition, these factors are considered in the kind and extent of risk reduction and mitigation efforts that will be included in the comprehensive plan and implementation measures.

As discussed in this chapter, section **E.3, Comprehensive Plan maps**, there are pros and cons to adopting ordinances, maps, and other implementation measures. Compliance with regulations is strong factor in adopting and using new information, as is reducing natural hazard impacts to people, property, and the environment.

⁹⁷ <https://www.oregongeology.org/pubs/ims/p-ims-060.htm>

F.2. PROPERTY OWNER RESPONSIBILITY

Oregon law (ORS 195.253⁹⁸) makes it clear that making sound decisions related to landslide hazards and associated risks is everyone’s shared responsibility: federal, state, and local governments, property owners, and highway users. This is a solemn responsibility; Oregonians’ lives and assets, both individual and community, are at stake.

How a property owner alters or develops their property in a landslide hazard area has potentially significant and detrimental impacts on other people, properties, and the environment. A property owner’s shared responsibilities extend to the community; compliance with community regulations and risk tolerance decisions can avoid potentially causing damage to property and endangering lives.

F.3. WHAT CAN LOCAL JURISDICTIONS DO AFTER RECEIVING THE NEW MAPS?

A jurisdiction can act to implement the information on upon receipt of DOGAMI landslide hazard maps; it does not have to wait for DLCD to “trigger Goal 7.” A jurisdiction can follow the steps listed in the text of Goal 7 (Oregon DLCD, n.d.-a⁹⁹) in that document’s section C, Implementation, section and use the Goal 7 Planning Guidelines listed in the text of Goal 7 (and within this chapter, in section **B, Goal 7: Areas Subject to Natural Hazards**) to evaluate the risks to people, property, and the environment communicated by new landslide hazard maps and their accompanying report.

The next implementation steps are: Make the maps, report, and evaluation available for public comment. Identify alternatives for addressing the risks incorporating best practices from the Goal 7 Implementation Guidelines. Review landslide hazard related comprehensive plan policies and zoning codes from other jurisdictions; compare those to the existing provisions; consider the community risk tolerance; and evaluate other factors that play into decision-making in the community. How do the jurisdictional staff and the community want to reduce natural hazard impacts to people, property, and the environment? Discuss the maps, report, evaluation, and alternatives for addressing the landslide hazard and the risks with the Planning Commission and City Council or Board of County Commissioners and recommend a course of action.

F.4. THE PROS AND CONS OF ADOPTING LANDSLIDE HAZARD MAPS

If the preferred alternative for addressing the risks identified on DOGAMI landslide hazard maps requires new or revised comprehensive plan policies or implementing measures such as regulations, a local jurisdiction must adopt (Goal 7) the DOGAMI

Goal 7 Compliance

Newly adopted or amended policies and regulations must be consistent with these principles: 1) avoid development in hazard areas where risk cannot be mitigated; and 2) prohibit siting of essential facilities, major structures, hazardous facilities, and special occupancy structures in identified hazard areas except in very narrow circumstances.

⁹⁸ https://www.oregonlegislature.gov/bills_laws/ors/ors195.html

⁹⁹ <https://www.oregon.gov/lcd/OP/Documents/goal7.pdf>

maps and report. The maps and report may be used to amend the comprehensive plan designation map showing where development is and is not envisioned over the life of the comprehensive plan (generally 20 years) and policies to achieve that vision. In this case, a comprehensive plan amendment would be required to incorporate the maps and report that support the new comprehensive plan vision and policies. DLCDC must be notified when the jurisdiction proposes to change its comprehensive plan.

If the comprehensive plan map and policies are consistent with the new maps and report, only the new maps may need to be adopted into the development code and development regulations may be adjusted to employ them effectively.

Adopting DOGAMI's lidar-based landslide hazard maps and corresponding report(s) is (are) key to the broader awareness and use. Adoption provides a sound basis for using the maps and reports for establishing risk-reduction policies and regulations.

Jurisdictions often face these kinds of barriers to adoption:

- Limited staff and resources to do the work;
- Need for technical assistance (e.g., model codes, advice, and reviewing draft codes);
- Competing priorities; and
- Public perception that adoption will lead to negative outcomes for individuals.

DLCDC and DOGAMI offer this *Guide* to answer the call for technical assistance and address specific concerns expressed by city and county staff and geoprofessionals. Both agencies have staff available to answer questions and strive to meet additional technical assistance needs related to implementing Goal 7.

The benefits of adoption include:

- Safeguarding human life, critical infrastructure, and property to the best of the jurisdiction's ability;
- Having a firm legal basis for developing policies and regulations;
- Basing policies and regulations on the most up-to-date scientific data, analysis, and mapping;
- Defending the jurisdiction against claims or lawsuits based on the fact that the danger was known to the jurisdiction and yet no action was taken to protect the public health, safety, and welfare.

The disadvantages of adoption include dealing with the:

- Public's perception that property values will decline;
- Potential for takings claims or lawsuits;
- Public's concern that property owners may not be able to obtain insurance or that insurance premiums will be prohibitively expensive; and
- Concerns of property owners that the cost of construction will increase.

Why Adopt Landslide Hazard Maps?

By adopting the best available science-based maps and information and using them to formulate far-sighted land use policies and development regulations, community leaders are strengthening the community's social and physical condition, setting the stage for long-term stability and resiliency. Rather than *avoiding* the hard choices, local leaders are *making* the hard choices necessary to keep people safe, their property intact, and essential public services operating.

These disadvantages are similar to concerns raised about regulations protecting against other natural hazards, protecting natural resources, and conserving farm and forest lands.

F.5. BUILDABLE LANDS INVENTORIES

Development in Hazard Areas

Hazard areas need to be fully considered when identifying the locations best suited for development.

Consideration of what lands are included in the Buildable Lands Inventories (BLI) is important. “The failure to account adequately for hazards when vulnerable areas are developed sets the stage for disaster losses” (Schwab, 2010¹⁰⁰). The *2015 State Natural Hazards Mitigation Plan* (Oregon DLCDC, 2015¹⁰¹) contains a high-priority mitigation action that expressly focuses on the intersection of hazard areas with buildable lands inventories.

Mitigation action #11 (Oregon DLCDC, 2015¹⁰¹) states:

Develop guidance for local governments on how to use Goal 7 together with other pertinent Statewide Land Use Planning Goals to classify lands subject to natural hazards in the buildable lands inventory and adjust urban growth boundaries in a manner that minimizes or eliminates potential damage to life, property, and the environment while continuing to provide for efficient development patterns.

The hazard areas need to be fully considered when identifying the locations best suited for different types of development.

Natural hazards mitigation plans (described in Chapter 3, section **D, Coordination**) require jurisdictions to review and address “changes in development,” an exercise that plays into buildable lands inventories. A jurisdiction examines the number and type of structures in their hazard areas. Looking at this over time, say, in 1- to 5-year increments, a community can see if more or less development is occurring in hazard areas. The goal is to decrease (or at least not increase) vulnerability by demonstrating that jurisdictions are fully considering ways to avoid encouraging development in natural hazard areas and that this approach has been successful.

F.6. URBAN GROWTH AREAS

Every city in Oregon is required to have an Urban Growth Boundary (UGB), which sets a physical limit based upon a city’s 20-year need for land to accommodate population and employment growth. Each city establishes its own UGB. In the Portland region, 24 cities share a UGB managed by Metro (the regional government). Inside of an urban growth boundary, cities plan their communities. The UGB can be expanded if a city can justify a need for more developable land to accommodate 20-year projections of population and employment growth. Local governments are tasked with finding that without UGB expansion, 20-year land

¹⁰⁰ https://www.fema.gov/media-library-data/20130726-1739-25045-4373/pas_560_final.pdf

¹⁰¹ https://www.oregon.gov/LCD/NH/Documents/Approved_2015ORNHMP_15_MitStrat.pdf

needs cannot be reasonably accommodated within the UGB. DLCD and LCDC directly review larger UGB expansions, and smaller ones are subject to review by the Oregon Land Use Board of Appeals (LUBA) if challenged. Managing growth includes such things as addressing people’s housing needs, providing suitable amounts and types of land for projected employment growth, using existing land efficiently, having adequate citizen engagement, and choosing land with minimal impacts to farms and forests.

One main purpose of the UGB is to protect Oregon’s farms and forests from encroachments that will diminish their economic effectiveness and the other, non-economic values they provide to the state. The UGB must also contain enough land for the number of people expected to live in the city over the next 20 years.

The first step in evaluating whether a UGB is the right size is to inventory buildable lands in each plan designation. If more land is needed, a study area is established to determine which adjacent lands are most suitable for development. OAR 660-024-0065¹⁰² describes lands to be included or excluded in the study area. Notably, areas subject to landslides, flooding, and tsunamis may be excluded from the study area. Jurisdictions without comprehensive plan policies or regulations protecting people and property from landslide, flooding, and tsunami hazards must adopt regulations for those hazards along with the buildable lands inventory, to be able to exclude those hazard areas from the study area.

F.7. CLEAR AND OBJECTIVE STANDARDS

ORS 197.307, Effective Need for Certain Housing in Urban Growth Areas,¹⁰³ was recently amended by Senate Bill 1051. The previous language,

[...] a local government may adopt and apply only clear and objective standards, conditions and procedures regulating the development of needed housing on buildable land described in subsection (3) of this section. [...]

was amended¹⁰⁴ to read

[...] a local government may adopt and apply only clear and objective standards, conditions and procedures regulating the development of housing, including needed housing. [...]

SB 1051 is only applicable within urban growth boundaries.

The amendment has provoked discussion about clear and objective standards, which is a particular challenge for regulating development in natural hazard areas. In many cases, a geotechnical report is the only way to determine whether the risk

¹⁰² <https://secure.sos.state.or.us/oard/displayDivisionRules.action?selectedDivision=3074>

¹⁰³ https://www.oregonlegislature.gov/bills_laws/ors/ors197.html

¹⁰⁴ <https://olis.leg.state.or.us/liz/2017R1/Downloads/MeasureDocument/SB1051/House%20Amendments%20to%20Introduced>

inherent in a development proposed in a landslide hazard area is within the community's level of risk tolerance. Basing a development permitting decision on a required geotechnical report is not considered a "clear and objective standard."

Local governments must have a clear and objective standard for permitting residential development and may also provide a discretionary pathway. A recent Land Use Board of Appeals (LUBA) case (subsequently affirmed by the Oregon Court of Appeals) involving a residential development in a landslide hazard area determined that a local government cannot enforce development standards, even if those standards were adopted to protect environmental resources (or involve other constraints such as natural hazards/landslides) if those standards are not clear and objective.¹⁰⁵

Conversely, a local government is allowed to adopt clear and objective standards that greatly limit, or even prohibit, development on lands constrained by environmental resources, steep slopes, or natural hazards/landslides, and offer as an alternative a "discretionary" set of review standards that are not clear and objective.¹⁰⁶ In such a case, a local government's clear and objective standard may be to prohibit development, and a discretionary pathway may be afforded by providing and following the recommendations of a geotechnical report performed by a qualified professional.

Questions remain about clear and objective standards. For example, perhaps an engineering geologic report includes a factor of safety rating. Does a report demonstrating that the proposed project site conditions can meet a factor of safety of 1.5 or higher mean that the clear and objective criteria are met? Legal questions such as this should be reviewed by the jurisdiction's attorney.

Acceptable Risk

Legal questions should be reviewed by the local jurisdiction's attorney. Each jurisdiction must determine its own level of acceptable risk.

F.8. TAKINGS, LIABILITY, AND MEASURE 49

DLCD and DOGAMI staff are often asked about liability and takings issues related to mapping and implementation of natural hazards. Under state law, much of what a local jurisdiction does regarding natural hazards, beyond required actions, is left up to the jurisdiction. Local control of land use and other provisions is very important in Oregon.

Protection of public health and safety are reasons for establishing regulations around natural hazards. The first statement in Oregon's Statewide Land Use Planning Goal 7 (Areas Subject to Natural Disasters and Hazards) is to "protect people and property from natural hazards."¹⁰⁷ One of the commonly voiced concerns from local jurisdictions to DLCD is how much regulation a local

¹⁰⁵ *Warren v. Washington County*, LUBA No. 2018-089, November 14, 2018, *Affd.* 296 Or App 595 (2019)

¹⁰⁶ *Dreyer v. City of Eugene*, LUBA 2018-074, decided November 20, 2018, *Affd. without opinion*, 296 Or App 290 (2019).

¹⁰⁷ <https://www.oregon.gov/lcd/OP/Documents/goal7.pdf>

government should establish around any given issue. If a local jurisdiction regulates to an extent that seems too heavy, there is a concern about takings. If a local jurisdiction regulates to an extent that seems too light, or regulates at all, there is a concern about liability.

Legal questions should be reviewed by an attorney. The *Planning for Natural Hazards: Oregon Technical Resource Guide* (LeDuc et al., 2001¹⁰⁸) discusses the liability and takings issue in depth.

The potential legal liability of a local government for a decision to enact an ordinance, or an action to enforce an ordinance, depends on whether the local government (through its officers, employees, or agents) is performing a discretionary or ministerial act. The words ‘discretionary’ and ‘ministerial’ have legal meanings quite distinct from their ordinary, everyday meanings. A government employee almost always exercises some discretion when acting or not taking action, but only those actions viewed as creating policy, rather than enforcing existing policy, are likely to be viewed as discretionary and therefore immune from liability. (p. 3-14)

This description of liability leads to a discussion of immunity and intent.

The issue of whether a local government is performing a discretionary, and therefore an immune, act can be answered by asking two questions:

- Is the local government creating a policy (immune) or merely enforcing policy (not immune)?
- Is the local government addressing the policy matter based on its own initiative (generally immune) or is it required by law to consider and/or address the policy matter (generally not immune)? (p. 3-14)

In Oregon,

Generally speaking, if a local government is performing a discretionary act, any decision made or action taken is granted immunity from financial liability by the Oregon Tort Claims Act (OTCA). If, instead, the local government is performing a ministerial act, it will not be immune from legal liability and may be held financially liable if it does not act reasonably ‘so as to avoid creating foreseeable risk of harm to others.’ Simply because a local government’s action is ministerial, and not immune from liability, does not mean that the local government will automatically be held liable. In order to be liable, a tort must be proven against the local government. (LeDuc et al., 2001¹⁰⁹)

¹⁰⁸ <https://scholarsbank.uoregon.edu/xmlui/handle/1794/1909>

¹⁰⁹ <https://scholarsbank.uoregon.edu/xmlui/handle/1794/1909>, p. 3-18

Turning to takings, according to the *Planning for Natural Hazards: Oregon Technical Resource Guide*¹¹⁰,

The Fifth Amendment to the United States Constitution prohibits the taking of “private property” [U.S. Const. Amend. V.] ... for public use, without just compensation.” A parallel provision in the Oregon Constitution provides: “Private property shall not be taken for public use nor the particular services of any man be demanded, without just compensation...” [Or. Const. Art. I, Sect. 18] (It is important to note that the action of taking private property for public use is *not* a violation of the Constitution. Rather, it is the failure of government to provide *compensation* that results in a constitutional violation).

There are three main categories of takings: physical, regulatory, and exaction. With the regulatory taking category,

There are two tests for determining whether a regulatory taking has occurred:

- Does the regulation result in a “per se” taking?
- If not, does the regulation fail a balancing test?¹¹¹

An important situation for natural hazards planning is where a local government’s regulation denies a property owner all reasonable economic use of their property. What is all reasonable economic use of a property? This is generally something that varies with each site-specific situation and thus is commonly a point of litigation. It may involve full or partial reduction of property value or economic use of the property. There are legal cases about takings that can be examined, but this *Guide* will not address those. When questions arise, seek legal counsel.

As required by Goal 7 of the Statewide Planning Goals and in a general liability sense, a community must make policy decisions based on the information it is aware of rather than ignoring or not acting upon the information. For example, a county could have information that it faces both landslide and wildfire hazards, but the county has enough resources to mitigate for only one of these natural hazards. If the county decides to fund wildfire instead of landslide mitigation, it would be protected from liability even if a landslide occurred in a known landslide hazard zone¹¹².

According to the *Planning for Natural Hazards: Oregon Technical Resource Guide*,

[t]raditionally, all state and local governments have been protected from tort claims by the doctrine of sovereign immunity, which generally prevented private parties from raising claims against them in court. With the passage of the Oregon Tort Claims Act (OTCA) in 1967, Oregon law was modified to grant private parties the right to sue the state or a local government for torts, but

¹¹⁰ <https://scholarsbank.uoregon.edu/xmlui/handle/1794/1909>, p. 3-18

¹¹¹ <https://scholarsbank.uoregon.edu/xmlui/handle/1794/1909>, p. 3-19

¹¹² Chris Crean of Beery Elsner & Hammond, LLP and Renee France of Radler White Parks & Alexander LLP, personal communication, December 7, 2018, OAPA Legal Issues Workshop, Portland, Oregon.

only if the claim arises under the limited circumstances set forth by the law. If a private party sues the state or local government on a matter that is not authorized by the OTCA, the government body will be immune from the claim, and the courts will dismiss the case. (LeDuc et al., 2001¹¹³)

Discretionary immunity applies when a policymaker exercises discretion to set or take a policy direction. Essentially, if a policymaker makes a choice between courses of action, the policymaker is immune from liability arising from the choice as long as the policy is followed.

In Oregon, the takings issue comes up repeatedly. Currently, Ballot Measure 49 is in effect and is incorporated into Oregon Revised Statute (ORS) 195.300-336. In summary, Measure 49 (Oregon DLC, n.d.-d¹¹⁴) provides that:

If a state or local government enacts a land use regulation that restricts a residential use, or a farm or forest practice, and reduces the fair market value of a property, then the landowner may qualify for compensation under Ballot Measure 49.

The form of compensation may consist of monetary relief or waiver of the regulations as determined by the state or local government. However, compensation is not due if the land use regulations were enacted to protect public health and safety. Measure 49 stipulates a specific definition for this exemption in “Definitions for ORS 195.300 to 195.336”¹¹⁵:

- (21) “Protection of public health and safety” means a law, rule, ordinance, order, policy, permit or other governmental authorization that restricts a use of property in order to reduce the risk or consequence of fire, earthquake, landslide, flood, storm, pollution, disease, crime or other natural or human disaster or threat to persons or property including, but not limited to, building and fire codes, health and sanitation regulations, solid or hazardous waste regulations and pollution control regulations.

In summary, establishing inventories, policies, and implementing measures related to natural hazards is required under Goal 7 and is a proactive step to protect people and property in the community. Furthermore, each jurisdiction must determine its own level of acceptable risk, and legal questions should be reviewed by the local jurisdiction’s attorney.

F.9. BUYOUTS

Property acquisitions by a local, state, or federal government to minimize or eliminate losses from hazards are commonly called buyouts. Property acquisition is a mitigation action – an action that reduces or alleviates the impacts of a hazard –

Decision-Making

Making a decision to act or not act upon known natural hazards information is, in and of itself, a policy decision.

¹¹³ <https://scholarsbank.uoregon.edu/xmlui/handle/1794/1909>, p. 3-15

¹¹⁴ <https://www.oregon.gov/lcd/Measure49/Pages/index.aspx>

¹¹⁵ <https://www.oregonlaws.org/ors/195.300>

because it moves people from being in harm's way to a safer location. The structures are removed from the property and the land becomes open space in perpetuity. This reduces risk, as well as future emotional and financial costs associated with the community's disaster response and recovery. Often times, this method is used after a disaster occurs; however, this can occur prior to a disaster. Property acquisition after flooding is common, but property acquisition for landslide hazards can also happen.

Under the Hazard Mitigation Assistance (HMA) grant programs, property acquisition and structure demolition, and property acquisition and structure relocation, are eligible to be funded. HMA funds are awarded via the Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation (PDM) program, and the Flood Mitigation Assistance (FMA) program. Activities eligible to be funded are listed in the FEMA (July 2015¹¹⁶) *Hazard Mitigation Assistance Grant Programs* brochure.

Federal law requires properties acquired with FEMA funds in structure demolition or relocation projects to be maintained as open space in perpetuity; the recipients and subrecipients are responsible for oversight in ensuring and enforcing proper land use and for coordinating with FEMA on any future land use or property disposition issues (FEMA, February 2015¹¹⁷).

There must be a determination of "immediate threat" before FEMA funds can be used for property acquisition with landslides. The *FY 15 Hazard Mitigation Assistance Guidance* document (FEMA, 2015¹¹⁸) states that "properties in landslide hazard areas where there is an immediate threat of catastrophic slope failure (within 5 years of application development)" are eligible. A specific benefit-cost ratio is used by FEMA for this. The "applicants are required to attest that the structure is within 5 years of imminent collapse because of landslide hazards. They may obtain this determination from a state or local professional geologist or engineer" (FEMA, 2015¹¹⁸, p. 68).

After a presidentially declared disaster, local officials may decide to request money from FEMA to purchase properties that have been damaged by the disaster. Property acquisitions or buyouts are voluntary, and no one is required to sell their property. For example, a city or county community development manager or planner may approach the homeowner to see if they are interested in a buyout. In turn, the staff from the city or the county talk to the state about the properties, funding options, and landowners of potential interest.

¹¹⁶ https://www.fema.gov/media-library-data/1441133724295-0933f57e7ad4618d89debd1ddc6562d3/FEMA_HMA_Grants_4pg_2015_508.pdf

¹¹⁷ https://www.fema.gov/media-library-data/1424983165449-38f5dfc69c0bd4ea8a161e8bb7b79553/HMA_Addendum_022715_508.pdf

¹¹⁸ https://www.fema.gov/media-library-data/1424983165449-38f5dfc69c0bd4ea8a161e8bb7b79553/HMA_Guidance_022715_508.pdf

After discussion, the decision to offer buyouts is made. The state uses money that FEMA allocates through its Hazard Mitigation Grant Program (HMGP), as a result of the presidentially declared disaster, to reduce future disaster losses by purchasing property and removing the structures from the property. Seventy-five percent of any buyout cost is paid by FEMA and the rest is paid by the state and/or local government. The process requires agreement by the local government officials, the state, and FEMA. Note that funding is limited and requests for funding may exceed available resources.¹¹⁹

FEMA has regulatory oversight of the HMGP. However, states are responsible for administering the HMGP and prioritizing and selecting project applications from communities. States then forward project applications to FEMA for final approval (FEMA, 2018¹²⁰).

Other options for mitigating hazards involve avoiding development in hazard areas, and those may be funded by sources other than FEMA. Some communities have established transfer of development rights (TDR) programs, purchase of development rights (PDR) programs, and conservation easements.

F.10. REAL ESTATE DISCLOSURES

The State of Oregon has a real estate disclosure form¹²¹, which is essentially a checklist of items required to be disclosed by a seller to a buyer when a property is sold. Specific to landslides, the disclosure form asks, “Is the property in a designated slide or other geologic hazard zone?” It is the seller’s responsibility to disclose truthfully and the buyer’s responsibility to understand the information. A related topic is covenants; see Chapter 4, section **B.2.a(ix), Covenants for new development and additions**.

F.11. EXISTING AND FUTURE DEVELOPMENT

Land use and building regulations are applied on a lot by lot basis, as development is proposed. A jurisdiction may have different thresholds for review processes related to existing and future development, and for individual lots or subdivisions. Future development, such as a proposed subdivision, commonly requires a public hearings process for land use review and would be subject to analysis for such things as hazards; water, sewer, stormwater drainage requirements; and transportation requirements so that development is appropriately situated. Generally, reports provided by certified professionals are required to be submitted from the applicant and then reviewed by local jurisdictional staff.

¹¹⁹ <https://www.fema.gov/news-release/2018/11/13/fact-sheet-acquisition-property-after-flood-event>

¹²⁰ https://www.fema.gov/media-library-data/20130726-1507-20490-4551/fema_317.pdf

¹²¹ <https://orefonline.com/wp-content/uploads/2018/01/OREF-020-january-changes-sample.pdf>

If a land use application is not required, there may be applicable building department and public works requirements. Lots with existing development, whether individual or subdivision, may or may not have a land use review process. Generally, a building department and or public works review is needed when development is proposed on lots with existing development.

Having requirements in the implementing ordinances that can be triggered and used by land use planners, building department staff, and public works staff is a comprehensive approach. Also, having a tiered approach to implementing provisions, such as those used by the City of Salem (Chapter 4, section **A.4.a, City of Salem**) in the Landslide Hazards Code, is a good way to have review correspond to hazard levels of risk. See Chapter 4, section **D, Summary of Key Ways to Reduce Your Community's Risk from Landslide Hazards**.



CHAPTER 4 IMPLEMENTATION

The Legislative Assembly declares that it is the policy of the state of Oregon that: Each property owner, each highway user and all federal, state and local governments share the responsibility for making sound decisions regarding activities that may affect landslide hazards and the associated risks of property damage or personal injury.

—Local Government Planning Coordination, Landslide Hazard Areas, Policy¹²²

Once the public accepts hazard mitigation and preparedness as essential elements of civic culture... other benefits flow from that cultural change.

—Hazard Mitigation: Integrating Best Practices into Planning¹²³

A. INTRODUCTION: ZONING FOR RISK REDUCTION

A.1. INTRODUCTION

We cannot predict when natural disasters will occur or to the extent to which they will affect communities. However, with thoughtful planning it is possible to reduce the losses that can occur from natural hazards such as landslides. Hazard mitigation reduces risk to people, property, and the environment. Risk can be lessened in a variety of ways. In this *Guide* we focus on risk reduction efforts through effective comprehensive plan policies, inventories, maps, and codes (e.g., zoning, grading, erosion control, stormwater management, and building).

Zoning for natural hazards is often accomplished through zoning overlays, with other related maps, and with corresponding text in the zoning code. A better understanding of the causes and characteristics of landslides, as well as recognizing the locations, types, and extents of landslides leads to more effective plans, policies, and implementing measures. Identifying hazard areas and evaluating proposed development in these areas reduces risk and better protects a community. Zoning ordinances can be a powerful tool for protecting community and private assets against landslides and other hazards.

¹²² ORS 195.253, <https://www.oregonlaws.org/ors/195.253>

¹²³ Schwab, 2010, p. 133, https://www.fema.gov/media-library-data/20130726-1739-25045-4373/pas_560_final.pdf

A.2. OREGON'S BUILDING CODE

A.2.a. Minimum/Maximum

Updated building codes that regulate the design, construction, and landscaping of new construction and the renovation of existing structures can improve the ability of structures in hazard-prone areas to withstand hazard events. In Oregon, local jurisdictions must use the Oregon State Building Code¹²⁴:

The Building Codes Division adopts, amends, and interprets 11 specialty codes that make up the Oregon State Building Code. The division administers each code through specialized code programs. Program staff members work with local building officials, industry professionals, advisory boards, and the public to adopt new codes and standards, approve new methods and materials, and maintain a uniform building code throughout the state.

Local governments cannot require building codes that are either more stringent or less stringent than the Oregon State Building Code. This was established to provide a level playing field for building code requirements across the state. This provision is often referred to as the “min/max building code” provision; the official language is in ORS 455.040¹²⁵.

Current Building Code

It is recommended that local jurisdictions change their code references to the current IBC so the code contains specific reference to more up-to-date building code regulations.

A.2.b. Correct Building Code and Citation

Uniform Building Code (UBC) Chapter 70 is commonly referenced in the local government zoning codes; it was identified as the standard to which all building practices need to conform. However, the last version of the UBC was published in 1997. The UBC was replaced in 2000 by the new International Building Code (IBC) published by the International Code Council (ICC). The ICC merged three different building codes published by three different organizations:

- The Uniform Building Code published by the International Council of Building Officials (ICBO);
- The BOCA National Building Code published by the Building Officials and Code Administrators International (BOCA); and
- The Standard Building Code published by the Southern Building Code Congress International (SBCCI).

The new ICC was intended to provide consistent standards for safe construction and to eliminate differences between the three different predecessor codes. Of note for zoning codes that reference chapter contents in the UBC, the UBC contents varied greatly from one publication year to the next so it may not be clear, without a specific year reference, which UBC regulations are being used¹²⁶. UBC 1988 Chapter

¹²⁴ <https://www.oregon.gov/bcd/codes-stand/Pages/index.aspx>

¹²⁵ <https://www.oregonlaws.org/ors/455.040>

¹²⁶ https://en.wikipedia.org/wiki/Uniform_Building_Code

70, Excavation and Grading, is the document referenced in most city and county codes, and some codes do include this chapter title in the reference section.

A.2.c. Lack of Grading Provisions

A lack of grading provisions can result in landslides as well as other development impacts such as soil movement downslope; soil flowing into water bodies and causing silt to accumulate, clouding water and injuring fish; and blowing soil, limiting visibility and causing respiratory distress.

Grading provisions can reduce the detrimental impacts from cutting and moving soil. In the code review performed for this *Guide*, 24 of the 34 communities evaluated required pre-development grading plans. Some of these communities did not have ordinances specifically addressing geohazards or geologic reports. Some communities have grading provisions with exceptions or exemptions. Trigger thresholds are established for requiring when the applicant will have to obtain and provide grading information. Permits are often required for grading work.

A.2.d. 2014 and 2019 Oregon Structural Specialty Code (OSSC)

The *2014 Oregon Structural Specialty Code*¹²⁷ is effective through December 31, 2019. The *2019 Oregon Structural Specialty Code*, based on the 2018 International Building Code, is effective October 31, 2019, with a three month phase-in period¹²⁸. For the 2019 OSSC, the Building Codes Structures Board appointed a committee to review the scientific and technical provisions of each proposed change, model code change, and existing Oregon amendment. The Building Codes Structures Board reviewed the committee's findings and made a final recommendation to the Building Codes Division for adoption¹²⁹.

The following information in the 2019 OSSC is unchanged from the 2014 OSSC:

Chapter 18, Soils and Foundations¹³⁰, Section 1803, Geotechnical Investigations:

Geotechnical investigations shall be conducted in accordance with Section 1803.2 and reported in accordance with Section 1803.6. Where required by *the building official* or where geotechnical investigations involve in-situ testing, laboratory testing or engineering calculations, such investigations shall be conducted by a *registered design professional*.

¹²⁷ http://ecodes.biz/ecodes_support/free_resources/Oregon/14_Structural/14_ORStructural_main.html

¹²⁸ <https://www.oregon.gov/bcd/codes-stand/code-adoption/Documents/19ossc-18ifc-guide.pdf>

¹²⁹ <https://www.oregon.gov/bcd/codes-stand/code-adoption/Pages/2019-osscc-adoption.aspx>

¹³⁰ <https://codes.iccsafe.org/content/ORSSC2019P/chapter-18-soils-and-foundations>

Section 1803.5.11, Seismic Design Categories C through F:

For structures assigned to Seismic Design Category C, D, E, or F, a geotechnical investigation shall be conducted, and shall include an evaluation of all the following potential geologic and seismic hazards:

1. Slope instability.
2. Liquefaction.
3. Total and differential settlement.
4. Surface displacement due to faulting or seismically induced lateral spreading or lateral flow.

A.3. CONSEQUENCES OF A WEAK ZONING CODE

When zoning codes are weak or unenforced with respect to development in natural hazard areas, the public will be insufficiently protected, leaving the jurisdiction potentially vulnerable to liability claims. When code is unclear, staff, property owners, and developers can become easily embroiled in conflict over interpretation, leading to legal challenges. Neither of these situations serves the public well. Although it can be politically difficult to adopt strong regulations to protect people, property, and the environment, in the long term it will prove much more pragmatic and advantageous.

A.4. EXAMPLES OF STRONG LANDSLIDE RISK REDUCTION ZONING CODES IN OREGON

Strong Code Features

Strong zoning codes protecting people, property, and the environment from landslide hazards have several common features listed in this section.

Strong codes contain language that refers to current data and information such as maps and reports from DOGAMI and other relevant sources. Strong codes connect and integrate the maps with the codes, plans, and policies at a jurisdiction. Strong codes have clear and specific statements about requirements, thresholds, and professional certifications needed. Strong codes are crafted with a variety of thresholds and tiers of review. They also have follow-up actions to the requirements like inspections and certifications of compliance. These codes are most effective when implemented consistently. Revisions to codes are considered as needed and on a regular basis to further improve the code and to respond to community feedback.

Strong zoning codes protecting people, property, and the environment from landslide hazards have several common features (**Figure 4-1**). These common features are evident in many of the codes examined during the *Landslide Guide* research. The *Guide's* **Chapter 8** contains information from the reviewed city and county codes. Information from **Table 8-1, Landslide Code Review Details Table** is summarized in **Table 5-1** through **Table 5-4**.

Figure 4-1. Features of Strong Zoning Codes

Features of Strong Zoning Codes

- Are supported by and incorporate the best available science-based landslide hazard maps and analysis.
- Have clear submittal requirements and approval criteria.
- Employ factors in addition to slope to determine when a geotechnical report is required.
- Define and establish the qualified geoprofessional(s) for the required report in accordance with state licensing regulations.
- Require geotechnical reports to determine whether a proposed development is within the community's risk tolerance level and to properly condition development.
- Link requirements to degree of risk and geotechnical report recommendations.
- Address soil stabilization through grading, erosion control, vegetation management, and water management.
- Require monitoring by the geotechnical report author during construction.
- Are enforced.
- Contain strong grading, erosion control, and land use planning codes. These codes provide clarity in what is applicable; protect the people, property, and environment; and are effective in limiting or preventing deleterious soil movement.
- Are based on maps and reports that provide details on the hazard areas.
- Include specific references to the materials used to establish the code provisions (such as maps and reports) and have those materials adopted and incorporated into the regulatory provisions;
- Have clearly identified application materials (with checklists and handouts to help explain the information) and processes of review.
- Have information located on the community's website so that the code is clear and accessible.
- Have replaced outdated Unified Building Code or UBC references with current International Building Code or IBC references in the code.

In this section of the *Guide*, we explore six codes in more detail: City of Salem, City of Newport, City of Oregon City, Multnomah County, City of Portland, and City of Astoria. Salem and Newport do not have DOGAMI lidar maps. Interestingly, one of these six jurisdictions has lidar maps from DOGAMI already integrated (Oregon City), and one jurisdiction has partially integrated the DOGAMI lidar maps (Astoria),

while two of the jurisdictions recently obtained lidar maps from DOGAMI (Multnomah County and the City of Portland) and are in the process of ascertaining the best way to integrate the information.

A.4.a. City of Salem

After the heavy rains, flooding, landslides, and winter storms of February 1996 (FEMA disaster declaration DR-1099¹³¹), both state and local jurisdictions took actions to recover, but also to be proactive by using lessons learned and looking ahead to mitigate future impacts from such events. One example of this proactive activity is that Salem and Marion County initiated development of their landslide hazard ordinances. They obtained funding from FEMA through the Hazard Mitigation Grant Program (HMGP).

After the 1996 disaster, Salem and Marion County worked with DOGAMI and DLCDC to map and characterize hazard areas and to create landslide hazard ordinances. The collaborative effort included local government and a broad group of stakeholders that comprised the citizen advisory committee. The State Board of Geologists Examiners and Engineering and Surveying Examiners Board were also asked for input on the ordinance. The resulting ordinances for Salem and Marion County use a tiered approach involving a cumulative score from several tables and then categorization of the landslide hazard risk, with requirements related to those categories¹³².

The City of Salem Landslide Hazards Code, Chapter 810 of the Unified Development Code¹³³, was originally established in the year 2000, and implements the Geologic Hazards Policy of the Scenic and Historic Areas, Natural Resources, and Hazards section of the *Salem Area Comprehensive Plan*¹³⁴.

The stated purpose of the Landslide Hazards Code is:

- (a) Assessing the risk that proposed uses or activities will adversely affect the stability and slide susceptibility of an area;
- (b) Establishing standards and requirements for the use and development of land within landslide hazard areas; and
- (c) Mitigating risk within landslide hazard areas. (§ 810.001)

A.4.a(i) Where Code Provisions Apply

The code factors the degree of hazard at a site with the level of proposed development activity to determine the extent of geological study needed before development can occur on the site. The code applies to all areas of land designated

¹³¹ <https://www.fema.gov/disaster/1099>

¹³² <https://scholarsbank.uoregon.edu/xmlui/handle/1794/1909>

¹³³ <https://www.cityofsalem.net/salem-revised-code>

¹³⁴ https://library.municode.com/or/salem/codes/code_of_ordinances?nodid=TITXUNDECO_UDC_CH810LAHA

as Moderate Landslide Hazard Risk or High Landslide Risk as described by the code. Of note, the maps and studies used and referenced were made prior to the use of lidar; the City of Salem does not have lidar-based landslide hazard maps from DOGAMI.

The code further states in the Map Adoption section:

Areas subject to this chapter shall be shown on landslide hazard susceptibility maps, which shall be adopted by administrative rule by the Director pursuant to SRC chapter 20J. The landslide hazard susceptibility maps shall indicate the general location of areas of low, moderate, and high susceptibility to landslides, areas of known slide hazards, and slope contours. These maps shall be based on the best available information. (§ 810.015)

Salem's code states:

Where any portion of a proposed activity is identified under multiple landslide susceptibility ratings, the highest rating shall apply. (§ 810.025(a))

A.4.a(ii) Data Used and Referenced

DOGAMI produces geology-based Interpretive Map Series (IMS) maps at a variety of scales that depict interpretations of natural hazards or risks. The DOGAMI maps and reports referenced in Salem's code in the Graduated Response Tables include IMS-5 (Harvey & Peterson, 2000¹³⁵), IMS-6 (Harvey & Peterson, 1998¹³⁶), IMS-17 (Hofmeister, Wang & Keefer, 2000¹³⁷), IMS-18 (Hofmeister & Wang, 2000¹³⁸), and IMS-22 (Hofmeister et al., 2002¹³⁹). The maps are adopted. The code has a reference to slopes greater than 25%. Salem's code contains definitions such as certified engineering geologist, geotechnical engineer, geological assessment, and geological report. The definitions and the specifically referenced maps and reports provide clarity for the basis of the code provisions.

A.4.a(iii) Permits Required and the Review Process

A Landslide Hazard Construction Permit is required; the code provides details on applicability, exemptions, procedure type, submittal requirements, approval criteria, the authority's ability to request additional information, and the connection to land use approvals related to the Landslide Hazard Construction Permit. The City does not have an informational handout about this permit.

¹³⁵ <https://www.oregongeology.org/pubs/ims/IMS-005.pdf>

¹³⁶ <https://www.oregongeology.org/pubs/ims/IMS-006.pdf>

¹³⁷ <https://www.oregongeology.org/pubs/ims/IMS-017.pdf>

¹³⁸ <https://www.oregongeology.org/pubs/ims/IMS-018.pdf>

¹³⁹ <https://www.oregongeology.org/pubs/ims/p-ims-022.htm>

The code contains standards for geological assessments and geotechnical reports. Graduated Response Tables are used to determine the total landslide risk and required level of site investigation for regulated activities. The five tables are: Earthquake-Induced Landslide Susceptibility Ratings (Table A); Water-Induced Landslide Susceptibility Ratings (Table B); Activity Susceptibility Ratings (Table C); Cumulative Score (Table D); and Total Landslide Hazard Risk (Table E).

The Total Landslide Hazard Risk table (reproduced here as **Table 4-1**) contains the cumulative score, which is calculated in Tables A–D, and relates it to the landslide hazard risk and the requirements.

Table 4-1. City of Salem, Unified Development Code, Table 810.1E, Total Landslide Hazard Risk

Cumulative Score (From [Salem] Table 810-1D)	Landslide Hazard Risk	Requirement
4 or fewer points	Category A – Low	No Requirements
5–8 points	Category B – Moderate	Geologic Assessment/ Geotechnical Report
9 or more points	Category C – High	Geotechnical Report

Source: City of Salem, Unified Development Code, Chapter 810, Landslide Hazards, accessed June 12, 2019, https://library.municode.com/or/salem/codes/code_of_ordinances?nodeId=TITXUNDECO_UDC_CH810LAHA

Once the total landslide hazard risk score is obtained, the code stipulates the following requirements:

(b) After determining the total landslide hazard risk under subsection (a) of this section, the following shall be required:

(1) *Low landslide hazard risk.* If application of Table 810-1E indicates a low landslide hazard risk, all regulated activities may proceed without further investigation, permitting, or approval required by this chapter.

(2) *Moderate landslide hazard risk.* If application of Table 810-1E indicates a moderate landslide hazard risk, a geological assessment shall be submitted for all regulated activities. If the geological assessment indicates that mitigation measures are necessary to safely undertake the regulated activity, a geotechnical report prepared by a certified engineering geologist and geotechnical engineer shall be submitted.

(3) *High landslide hazard risk.* If application of Table 810-1E indicates a high landslide hazard risk, a geotechnical report prepared by a certified engineering geologist and geotechnical engineer shall be submitted for all regulated activities. (§ 810.025 Landslide Hazard Risk Assessment)

Certification of compliance is required:

No regulated activity requiring a geotechnical report shall receive final approval or be permitted for properties located in areas of high landslide hazard risk until the Director receives a written statement by a geotechnical engineer that all measures contained in the geotechnical report are completed, in place, and operable. (§ 810.035)

When the City receives a geologic assessment or geotechnical report, Public Works staff enter the property into the GIS system, number it, and keep an electronic copy of it in the permit system (attached to the property address) and a paper copy in a file in the Building and Safety Division of the Community Development Department. If staff have concerns about a particular property based on either historical knowledge of a location or a citizen report, Public Works' design standards allow the City to hire one of the consultants of record to review the assessment or report.

Public Works has 181 reports on file as of December 27, 2018. The Building and Safety Division also receives reports separately from this list, specifically for building designs, but these are not always related to landslide hazard areas (Lyle Misbach, City of Salem, Assistant Chief of Development Engineer, personal communication, December 27, 2018).

The City does not require the applicant to record a geological assessment or geotechnical report nor does it require a covenant to be signed and recorded. Currently, the City believes having the geological assessment or geotechnical report along with the certificate of compliance is sufficient. The Public Works Department and the Building and Safety Division of the Community Development Department work together as a check and balance system. If one department misses something, the other will catch it. Sometimes they notice a landslide risk area that does not trigger the requirement but might be of interest to the building official (Lyle Misbach, City of Salem, personal communication, December 27, 2018).

The City of Salem Landslide Hazards Code is one of the seven example codes contained in *Landslide Mitigation Strategies*¹⁴⁰ prepared by the Minnesota Department of Natural Resources in collaboration with FEMA's contractor Stentec and published in December 2016 (Eric Waage, Hennepin County, Minnesota, Emergency Manager, personal communication, May 1, 2019).

¹⁴⁰ https://files.dnr.state.mn.us/waters/watermgmt_section/shoreland/landslide-mitigation.pdf

A.4.b. City of Newport

In 2009, the then newly arrived Community Development Director set out to revise the 1970s-era geologic hazards code. Through this two-year effort, many but not all the proposed changes were approved. The Community Development Director used DOGAMI's Open-File Report O-04-09 (Priest & Allan, 2004¹⁴¹) as a basis for the updates. The report is from 2004; it contains maps, aerial photos, and other information. The maps are not lidar based. Newport does not have lidar-based landslide hazard maps.

The current code, Chapter 14.21, Geologic Hazards Overlay (GHO)¹⁴², defines a geologic hazard as

[a] geologic condition that is a potential danger to life and property which includes but is not limited to earthquakes, landslides, erosion, expansive soils, fault displacement, and subsidence.

A.4.b(i) Data Used and Referenced

The code provisions describe numerous thresholds that trigger the Geologic Hazard Regulations. The code also refers to DOGAMI Open-File Report O-04-09 (Priest & Allan, 2004). The data layer used to depict the geologic hazards on the Natural Hazard Overlay Zones maps (dated June 29, 2016) for North Newport and South Newport was taken from the open-file report. The code references the open-file report when defining hazards (NMC 14.21.020(A)).

The geologic hazards areas on the Natural Hazards Overlay Zones maps have active and high hazard bluff and dune-backed shoreline areas, active or potential landslides, prehistoric landslides, and other landslide risk areas identified in DOGAMI Open-File Report O-04-09. A handful of other documented geologic hazard areas on file with the City of Newport are on the map too. Localized landslides that occurred after the current code was adopted are not illustrated on the maps. However, the localized landslides are linked in the permit files so that if someone proposes development on a property, an existing report about the geologic hazards on the property would be identified.

NMC 14.21.020, Applicability of Geologic Hazards Regulations, identifies the scope of the city's geologic hazards overlay.

- A. The following are areas of known geologic hazards or are potentially hazardous and are therefore subject to the requirements of Section 14.21:

¹⁴¹ <https://www.oregongeology.org/pubs/ofr/O-04-09.zip> (.zip file)

¹⁴² https://www.newportoregon.gov/dept/cdd/documents/NMC_Chap14_Zoning.pdf

1. Bluff or dune backed shoreline areas within high or active hazard zones identified in the Department of Geology and Mineral Industries (DOGAMI) Open File Report O-04-09 Evaluation of Coastal Erosion Hazard Zones along Dune and Bluff Backed Shorelines in Lincoln County, Oregon: Cascade Head to Seal Rock, Technical Report to Lincoln County, dated 2004.
2. Active or potential landslide areas, prehistoric landslides, or other landslide risk areas identified in the DOGAMI Open File Report O-04-09.
3. Any other documented geologic hazard area on file, at the time of inquiry, in the office of the City of Newport Community Development Department.

A documented geologic hazard area

means a unit of land that is shown by reasonable written evidence to contain geological characteristics/conditions which are hazardous or potentially hazardous for the improvement thereof. (§ 14.21.020.A)

Open-File Report O-04-09 ((Priest & Allan, 2004¹⁴³) is used to determine when a geologic report is needed on property prior to development; it is not intended as a site-specific analysis tool. The site-specific analysis is obtained through the Geologic Report.

According to the Community Development Director, when Newport adopted the current geologic code, the City decided to forgo a blanket slope threshold for triggering geologic permits because they did not have sufficient scientific analysis to support such a requirement (Derrick Tokos, City of Newport, personal communication, November 5, 2018).

However, at this time, when they see residential development on steep slopes that are not in a mapped geologic hazard area, there is invariably geotechnical engineering involved in the design of the residence because (a) the owner, contractor, or lender requires it; or (b) they cannot use one of the prescriptive foundation options in the *Oregon Residential Specialty Code* and therefore, the building code requires an engineered solution (ORSC 301.1.3, 401.4.1, etc.). Commercial and multifamily construction on steep slopes will necessarily involve geotechnical engineering per the terms of the 2014 *Oregon Structural Specialty Code*.

¹⁴³ <https://www.oregongeology.org/pubs/ofr/O-04-09.zip> (.zip file)

The Newport code has an unusual provision:

If the results of a Geologic Report are substantially different than the hazard designations contained in the DOGAMI Open File Report 0-04-09 then the city shall provide notice to the Department of Geology and Mineral Industries (DOGAMI) and Department of Land Conservation and Development (DLCD). The agencies will have 14 days to provide comments and the city shall consider agency comments and determine whether or not it is appropriate to issue a Geologic Permit... (§ 14.21.020.D)

A.4.b(ii) Permits Required and the Review Process

To date, the Community Development Director says the issue has not arisen (Derrick Tokos, City of Newport, personal communication, October 21, 2016).

The Newport code requires:

All persons proposing development, construction, or site clearing (including tree removal) within a geologic hazard area as defined in 14.21 .010 shall obtain a Geologic Permit. (§ 14.21.030 Geologic Permit Required)

The Geologic Permit requires:

A Geologic Report prepared by a certified engineering geologist, establishing that the site is suitable for the proposed development;” and “An engineering report, prepared by a licensed civil engineer, geotechnical engineer, or certified engineering geologist (to the extent qualified), must be provided if engineering remediation is anticipated to make the site suitable for the proposed development. (§ 14.21.050 Application Submittal Requirements)

The Geologic Report has requirements described in the code:

Geologic Reports shall be prepared consistent with standard geologic practices employing generally accepted scientific and engineering principles and shall, at a minimum, contain the items outlined in the Oregon State Board of Geologist Examiners (2014¹⁴⁴) *Guideline for Preparing Engineering Geologic Reports in Oregon*, in use on the effective date of this section. Such reports shall address subsections 14.21.070 to 14.21.090, as applicable. (§ 14.21.060)

Oceanfront property has additional provisions for the Geologic Report:

For oceanfront property, reports shall also address the “Geological Report Guidelines for New Development on Oceanfront Properties,” prepared by the Oregon Coastal Management Program of the Department of Land Conservation and Development, in use as of the effective date of this section. (§ 14.21.060)

¹⁴⁴ https://www.oregon.gov/osbge/Documents/engineeringgeologicreports_5.2014.pdf

Newport requires certification of compliance:

No development requiring a Geologic Report shall receive final approval (e.g., certificate of occupancy, final inspection, etc.) until the city receives a written statement by a certified engineering geologist indicating that all performance, mitigation, and monitoring measures contained in the report have been satisfied. If mitigation measures involve engineering solutions prepared by a licensed professional engineer, then the city must also receive an additional written statement of compliance by the design engineer.” The certification of compliance helps ensure that requirements are satisfactorily met by the development. (§ 14.21.130)

The City of Newport does not have a provision that requires property owners developing in geologic hazards areas to acknowledge or to disclose reports to future buyers or record this information. The 2009-2010 code revisions initially proposed that a property owner disclose reports to future buyers, and that they agree that the City of Newport is not liable for any damage or loss they may experience from natural hazards. However, this language was dropped from the code during the update process due to concerns vocalized by the community such as potential changes in property value and in rates of insurance. (Derrick Tokos, City of Newport, personal communication, October 21, 2016).

A.4.c. City of Oregon City

The Oregon City code, Chapter 17.44 Geologic Hazards, identifies when permits or approvals are needed, the procedures for those, the exemptions to the provisions, and the application requirements. It also describes requirements for new utilities, for stormwater drainage, and construction standards. It states what is required for the approval of development and what the liability is. Further, it states that compliance with laws is necessary, noting that in case of conflict the most restrictive law applies (Oregon City code, Title 17, section 44, Geologic Hazards)¹⁴⁵. These provisions clearly articulate the process for development proposed in areas with geologic hazards.

There are definitions for landslide, geologic assessment, geologic hazard areas, Geologic Hazards Overlay Zone, geotechnical engineer, geotechnical report, and geotechnical remediation. Definitions are very useful in providing clarity in code provisions; several of these definitions are shown below.

In the Oregon City code (§ 17.04.625),

Landslide means the downslope movement of soil, rocks, or other surface matter on a site. Landslides may include, but are not limited to, slumps, mudflows, earthflows, debris flows, rockfalls and the source areas for above.

A.4.c(i) Where Code Provisions Apply

The code (§ 17.04.510) defines "Geologic hazard areas" to mean:

1. Any area identified on the city's steep slope and landslide area map;
2. Area within two hundred feet of the crest or toe of a slope that is twenty-five percent or greater;
3. Areas with a slope of twenty-five percent or more;
4. Geologic Hazards areas identified by the State of Oregon Department of Geology and Mineral Industries (DOGAMI) in Bulletin 99, Geology and Geologic Hazards of Northwestern Clackamas County, Oregon (1979);
5. Any other area that is identified by a suitably qualified geotechnical engineer or engineering geologist who is licensed in Oregon and derives his or her livelihood principally from that profession as being subject to soil instability, slumping or earth flow, high groundwater level, landslide, or seismic activity.

¹⁴⁵https://library.municode.com/or/oregon_city/codes/code_of_ordinances?nodetid=TIT17ZO_C_H17.44EOHA

The code (§ 17.04.515) defines “Geologic Hazards Overlay Zone” as:

Geologic means the zone mapped by the City of Oregon City that is subject to review pursuant to Oregon City Municipal Code Chapter 17.44 Geologic Hazards as follows:

1. The following areas identified on the city's slope and geology map which represents:
 - a. Areas within fifty feet of the crest or toe of a slope that is twenty-five percent or greater, or within two hundred feet of the crest or toe of a landslide geologic units Q1s and Qf identified by DOGAMI and derived from LIDAR IMS-29 and IMS-26 publications in 2009, whichever is greater;
 - b. Areas with a slope of twenty-five percent or more;
 - c. Geologic Hazards areas identified by the State of Oregon Department of Geology and Mineral Industries (DOGAMI) as landslide or debris flow fan (Q1s and Qf geologic units derived from LIDAR IMS-29 and IMS-26 publications in 2009);
 - d. Geologic Hazards areas identified in Bulletin 99, Geology and Geologic Hazards of Northwestern Clackamas County, Oregon (1979); and;
2. Any other area that is identified by a suitably qualified geotechnical engineer or engineering geologist who is licensed in Oregon and derives his or her livelihood principally from that profession as being subject to soil instability, slumping or earth flow, high groundwater level, and landslide.

Data Used and Referenced

Oregon City has adopted parts of the DOGAMI lidar-based landslide hazard maps and has specifically referenced them in their code. Oregon City has several hazard maps available online¹⁴⁶. The *Geologic Hazards Map* (**Figure 4-2**) (titled “Slope & Geology Map” on the map itself) shows the official geologic hazards map for Oregon City, as adopted through ordinance 10-1003 on August 6, 2010. The *Geologic Hazards Map* shows information from DOGAMI’s online landslide inventory map, SLIDO¹⁴⁷ (historic landslide points, scarps, scarp flanks, and deposits), slopes greater than 25% with a 50-foot buffer, landslide sites with a 200-foot buffer, and the Geologic Hazard overlay districts. In **Figure 4-3** the layers of Geologic Hazards are shown with their symbols.

¹⁴⁶ <https://www.orcity.org/maps/hazards>

¹⁴⁷ <https://www.oregongeology.org/slido/index.htm>

Other links on the Hazards portion of the website are the Slope Map, the Earthquake Hazard Map, Hazardous Materials Map, DOGAMI Landslide Hazard and Risk Study, DOGAMI Geologic Map and Report, and the DOGAMI Landslide Inventory Maps.

Oregon City has had lidar maps since 2006 when DOGAMI published Open-File Report O-06-27, *Map of landslide geomorphology of Oregon City, Oregon, and vicinity interpreted from lidar imagery and aerial photographs*¹⁴⁸. Additional information from DOGAMI included by reference in Oregon City's Geologic Hazards provisions are IMS-26, *Landslide inventory map of the northwest quarter of the Oregon City quadrangle, Clackamas County, Oregon*¹⁴⁹; IMS-30, *Landslide inventory maps for the Oregon City quadrangle, Clackamas County, Oregon*¹⁵⁰; and Special Paper 42, *Protocol for Inventory Mapping of Landslide Deposits from Light Detection and Ranging (Lidar) Imagery*¹⁵¹.

The Oregon City Geologic Hazards *Slope and Geology Map*, shown in **Figure 4-2**, contains multiple hazard layers but it does not contain the shallow or deep susceptibility maps that were prepared by DOGAMI along with the landslide inventory. This approach to using the DOGAMI information is an example of the Oregon City staff determining which parts of the DOGAMI information Oregon City wanted to use for their maps, plans, and code provisions.

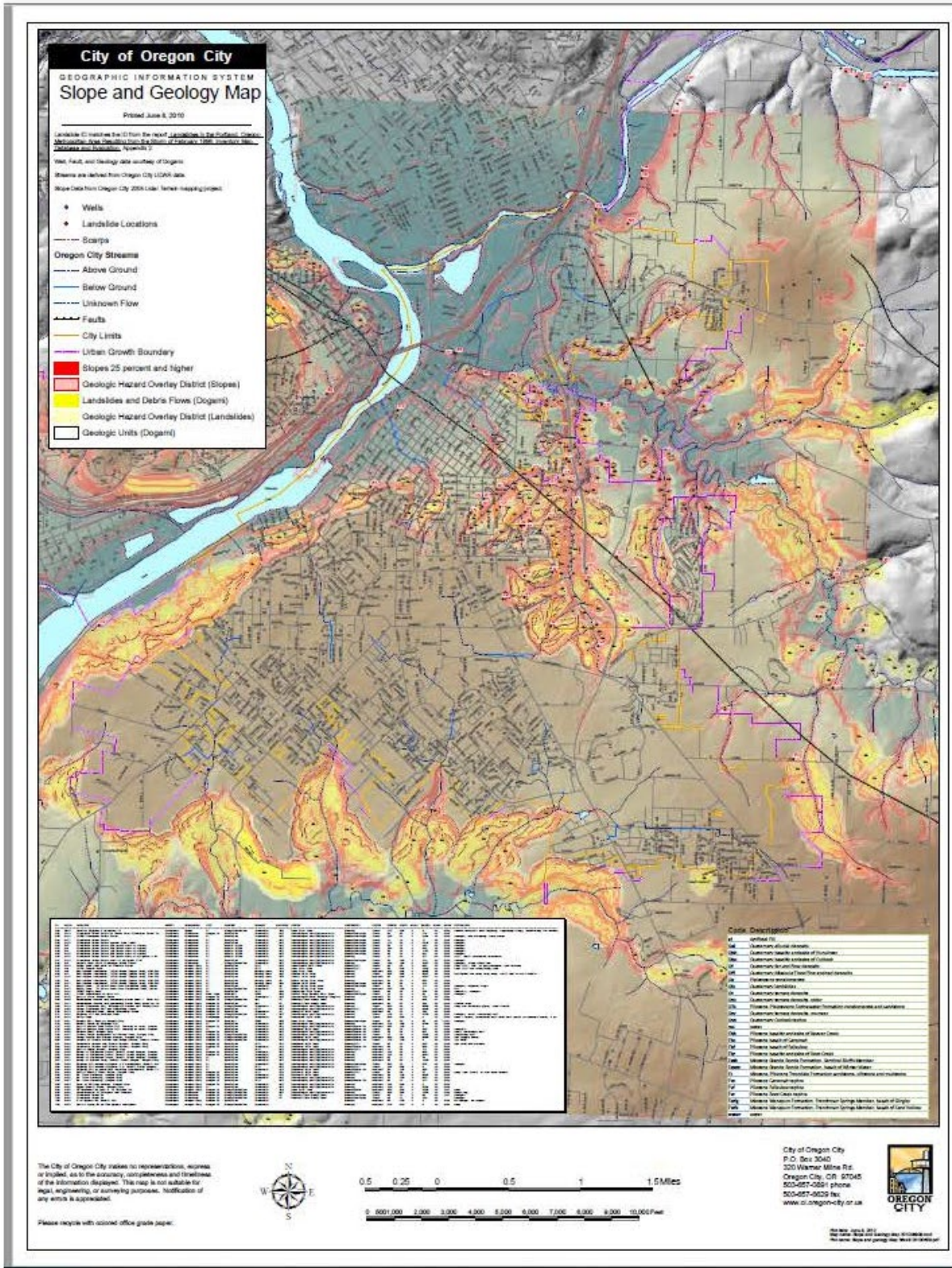
¹⁴⁸ <https://www.oregongeology.org/pubs/ofr/O-06-27.zip> (.zip file)

¹⁴⁹ <https://www.oregongeology.org/pubs/ims/p-ims-026.htm>

¹⁵⁰ <https://www.oregongeology.org/pubs/ims/p-ims-030.htm>

¹⁵¹ <https://www.oregongeology.org/pubs/sp/p-SP-42.htm>

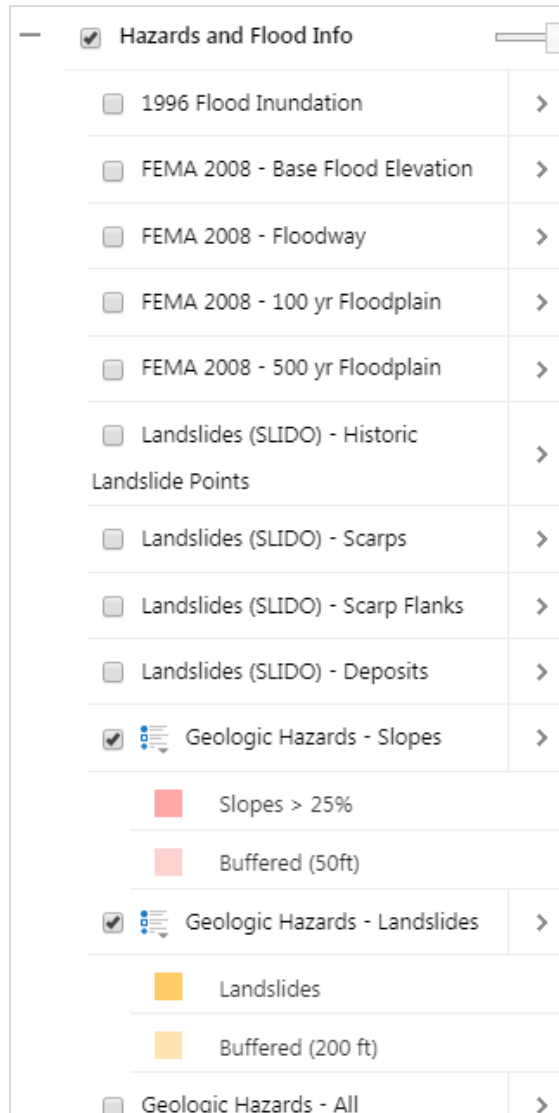
Figure 4-2. Oregon City Geologic Hazards (Slope and Geology) Map



Source: Oregon City, Maps, Geologic Hazards Map, <https://www.orcity.org/maps/geologic-hazards-map>

The geologic hazard layers on the Oregon City GIS system are listed as shown in **Figure 4-3** below.

Figure 4-3. Oregon City GIS System Geologic Hazard Layers. The screenshot shows the landslide inventory and hazard data layers that viewers of the interactive map can select and view.



Source: Josh Wheeler, City of Oregon City, Public Works Development Projects Manager, personal communication, November 8, 2018.

Permits Required and the Review Process

Oregon City's zoning code (§ 17.44.060.H and I) describes the relationship between steep slopes and density.

H. Density shall be determined as follows:

- 1) For those areas with slopes less than twenty-five percent between grade breaks, the allowed density shall be that permitted by the underlying zoning district;
- 2) For those areas with slopes of twenty-five to thirty-five percent between grade breaks, the density shall not exceed two dwelling units per acre except as otherwise provided in subsection I of this section;
- 3) For those areas with slopes over thirty-five percent between grade breaks, development shall be prohibited except as otherwise provided in subsection I.4 of this section.

I. For properties with slopes of twenty-five and thirty-five percent between grade breaks:

- 1) For those portions of the property with slopes of twenty-five to thirty-five percent, the maximum residential density shall be limited to two dwelling units per acre; provided, however, that where the entire site is less than one-half acre in size, a single dwelling shall be allowed on a lot or parcel existing as of January 1, 1994 and meeting the minimum lot size requirements of the underlying zone;
- 2) An individual lot or parcel with slopes between twenty-five and thirty-five percent shall have no more than fifty percent or four thousand square feet of the surface area, whichever is smaller, graded or stripped of vegetation or covered with structures or impermeable surfaces.
- 3) No cut into a slope of twenty-five to thirty-five percent for the placement of a housing unit shall exceed a maximum vertical height of fifteen feet for the individual lot or parcel.
- 4) For those portions of the property with slopes over thirty-five percent between grade breaks:
 - a. Notwithstanding any other city land use regulation, development other than roads, utilities, public facilities and geotechnical remediation shall be prohibited; provided, however, that the review authority may allow development upon such portions of land upon demonstration by an applicant that failure to permit development would deprive the property owner of all economically beneficial use of the property. This determination shall be made considering the

entire parcel in question and contiguous parcels in common ownership on or after January 1, 1994, not just the portion where development is otherwise prohibited by this chapter. Where this showing can be made on residentially zoned land, development shall be allowed and limited to one single-family residence. Any development approved under this chapter shall be subject to compliance with all other applicable city requirements as well as any applicable state, federal or other requirements;

- b. To the maximum extent practicable as determined by the review authority, the applicant shall avoid locating roads, utilities, and public facilities on or across slopes exceeding thirty-five percent.

Oregon City's zoning code states that:

Conclusions and recommendations stated in an approved assessment or report shall then be directly incorporated as permit conditions or provide the basis for conditions of approval for the regulated activity. (§ 17.44.050.B.2)

All geologic assessments and geotechnical reports shall be reviewed by an engineer certified for expertise in geology or geologic engineering and geotechnical engineering, respectively, as determined by the city. The city will prepare a list of prequalified consultants for this purpose. The cost of review by independent review shall be paid by the applicant. (§ 17.44.050.B.3)

Also that:

The city engineer may waive one or more requirements of subsections A and B of this section if the city engineer determines that site conditions, size or type or development of grading requirements do not warrant such detailed information. If one or more requirements are waived, the city engineer shall, in the staff report or decision, identify the waived provision(s), explain the reasons for the waiver, and state that the waiver may be challenged on appeal and may be denied by a subsequent review authority. (§ 17.44.050)

In the development standards the code states:

The geotechnical engineer of record shall review final grading, drainage, and foundation plans and specifications and confirm in writing that they are in conformance with the recommendations provided in their report. (§ 17.44.060)

Also in the development standards,

At the city's discretion, peer review shall be required for the geotechnical evaluation/investigation report submitted for the development and/or lot plans. The peer reviewer shall be selected by the city. The applicant's geotechnical engineer shall respond to written comments provided by the city's peer reviewer prior to issuance of building permit.

The review authority shall determine whether the proposed methods of rendering a known or potential *hazard* site safe for construction, including proposed geotechnical remediation methods, are feasible and adequate to prevent *landslides* or damage to property and safety. The review authority shall consult with the city's geotechnical engineer in making this determination. Costs for such consultation shall be paid by the applicant. The review authority may allow development in a known or potential *hazard* area as provided in this chapter if specific findings are made that the specific provisions in the design of the proposed development will prevent *landslides* or damage. The review authority may impose any conditions, including limits on type or intensity of land use, which it determines are necessary to assure that *landslides* or property damage will not occur. (§ 17.44.060)

For approval of the development,

The city engineer shall review the application and verify, based on the applicant's materials and the land use record, whether the proposed development constitutes a hazard to life, property, natural resources or public facilities. If, in the city engineer's opinion, a particular development poses such a hazard, the city engineer shall recommend to the review authority permit conditions designed to reduce or eliminate the hazard. These conditions may include, but are not limited to, prohibitions on construction activities between November 1st and March 31st. (§ 17.44.110)

The geotechnical review procedure determines if City staff can make a determination of waiver; if they need the third-party geotechnical consultant to make a determination of waiver; or if the third-party geotechnical consultant makes a determination of the need for full review.

- If the City determines that the proposed development will not be affected at all by the geohazard, the City will provide the waiver memo to the applicant at no charge. The City has a waiver form "Waiver of Geological Assessment and Geotechnical Report" it fills out.
- If the City determines that it cannot readily make a determination of waiver based on their expertise level and submitted materials, or if it is unknown whether the waiver is appropriate, the proposal will be provided to the City's geotechnical consultant for review. The applicant will be charged the geotechnical consultant review fee. If the geotechnical consultant determines there is little risk or impact, then the consultant will provide a memo granting a waiver.

- If the geotechnical consultant reviews the proposal and determines that a geohazard review cannot be waived, the applicant will need to apply for a geohazard permit. There will be a full land use review. The applicant will pay for the geotechnical consultant review (consultant invoices the City). An approved development in the geologic hazards areas is required to have a signed “Declaration of Covenant of Release and Indemnity for Geologic Hazards” form recorded at the Clackamas County Recorder’s office.

The “Declaration of Covenant Release and Indemnity for Geologic Hazards” is required to be supplied to the City with a document recording fee for all new private development constructing anything relating to City Code 17.44 with a geologic hazard. The City will record the document with the County. The document indemnifies the City if anything were to happen to the property due to its geologic conditions.¹⁵²

Oregon City began using this tier of options for the geotechnical review procedure in 2013 according to the Development Projects Manager. Currently, the covenants, as noted, are recorded to the property and therefore, in a title search, a person could find the covenant. However, the GIS database system that Oregon City uses to track parcel information does not contain notes that identify which parcel has had a covenant or had a waiver. Without that information, the City cannot run a query to see how many properties have had covenants or waivers established. As a result of the conversation with DLCD, the Development Projects Manager will talk with staff to ascertain the usefulness of including the waivers and covenants information on each parcel (Josh Wheeler, City of Oregon City, personal communication, November 8, 2018).

¹⁵² <https://www.orcity.org/publicworks/indemnity-geologic-hazards>

A.4.d. Multnomah County

The Multnomah County Zoning Code provisions related to landslides are found in the Hillside Development and Erosion Control (HD) sections of each of the four area plans and the Columbia River Gorge National Scenic Area¹⁵³. The applicable chapters of the Zoning Code are:

- Chapter 33 West Hills Rural Plan Area;
- Chapter 34 Sauvie Island / Multnomah Channel Rural Plan Area;
- Chapter 35 East of Sandy River Rural Plan Area;
- Chapter 36 West of Sandy River Rural Plan Area; and
- Chapter 38 Columbia River Gorge National Scenic Area.

A.4.d(i) Where Code Provisions Apply

Text from the West Hills Rural Plan Area is selected as an example here. A Hillside Development Permit (HDP) is required for:

All persons proposing development, construction, or site clearing (including tree removal) on property located in hazard areas as identified on the "Slope Hazard Map", or on lands with average slopes of 25 percent or more... unless specifically exempted ... (MCC § 33.5505 Permits Required)

There are three kinds of exemptions (with multiple subcategories): development activities approved prior to February 20, 1990; general exemptions; and categorical exemptions.

A.4.d(ii) Data Used and Referenced

The County's mapped Slope Hazard Area is based on research from the 1970s. The Hillside Development and Erosion Control (HD) provisions have had little change since the early 2000s. In the past several years Multnomah County has increasingly recognized the need for updated maps and potential revisions to the zoning code.

A.4.d(iii) Permits Required and the Review Process

The code describes the required application information. A geological report or completion of the HDP Form-1 (provided by the County) may be submitted to meet the HDP requirements, so long as either are prepared by a Certified Engineering Geologist or Geotechnical Engineer. The code states it must be determined that "the site is suitable for the proposed development." If further information is needed for a decision, then the Director can request that a geotechnical report be submitted. The geotechnical report must be prepared by a Certified Engineering Geologist or Geotechnical Engineer. The requirements of the geotechnical report are described in

¹⁵³ <https://multco.us/landuse/zoning-codes>; <https://multco.us/file/76583/download>

the code (see below). The code uses the terms, but does not contain definitions, of suitable, geological report, and geotechnical report.

Section 33.5515 states that a Hillside Development Permit may be approved only after the applicant provides:

- (1) Additional topographic information showing that the proposed development to be on land with average slopes less than 25 percent, and located more than 200 feet from a known landslide, and that no cuts or fills in excess of 6 feet in depth are planned. High groundwater conditions shall be assumed unless documentation is available, demonstrating otherwise; or
- (2) A geological report prepared by a Certified Engineering Geologist or Geotechnical Engineer certifying that the site is suitable for the proposed development; or,
- (3) An HDP Form– 1 completed, signed and certified by a Certified Engineering Geologist or Geotechnical Engineer with his/her stamp and signature affixed indicating that the site is suitable for the proposed development.
 - (a) If the HDP Form– 1 indicates a need for further investigation, or if the Director requires further study based upon information contained in the HDP Form– 1, a geotechnical report as specified by the Director shall be prepared and submitted.

Section 33.5515 F includes the Geotechnical Report Requirements:

- (1) A geotechnical investigation in preparation of a Report required by MCC 33.5515 (E) (3) (a) shall be conducted at the applicant's expense by a Certified Engineering Geologist or Geotechnical Engineer. The Report shall include specific investigations required by the Director and recommendations for any further work or changes in proposed work which may be necessary to ensure reasonable safety from earth movement hazards.
- (2) Any development related manipulation of the site prior to issuance of a permit shall be subject to corrections as recommended by the Geotechnical Report to ensure safety of the proposed development.
- (3) Observation of work required by an approved Geotechnical Report shall be conducted by a Certified Engineering Geologist or Geotechnical Engineer at the applicant's expense; the geologist's or engineer's name shall be submitted to the Director prior to issuance of the Permit.
- (4) The Director, at the applicant's expense, may require an evaluation of HDP Form– 1 or the Geotechnical Report by another Certified Engineering Geologist or Geotechnical Engineer.

Of note, the development plans must be consistent with the design standards for grading and erosion control in the code.

In the future, Multnomah County will change their codes to most effectively use DOGAMI lidar-based landslide inventory and landslide susceptibility maps.

In 2017, DOGAMI released Open-File Report O-17-03 (Burns & Lindsey, 2017¹⁵⁴), a landslide inventory for eastern Multnomah County. In 2018, DOGAMI released IMS-57 (Burns et al., 2018¹⁵⁵), which contains maps and a report covering central and western Multnomah County, including the City of Portland, Gresham, Troutdale, Fairview, and Wood Village.

The summary from DOGAMI Open-File Report O-17-03 states:

Eastern Multnomah County is home to the iconic Columbia River Gorge and its linked tourism and recreational opportunities, the I-84 transportation corridor, and significant permanent population and industry. This area is also home to significant landslide hazards. The high landslide hazard combined with dense development results in high risk. The purpose of this project is to provide accurate, detailed landslide inventory maps to help communities in this region become more aware of and resilient to landslide hazards.

Multnomah County will use the information to craft stronger zoning code and other implementation measures. Multnomah County held a Planning Commission briefing on November 5, 2018, to set the stage for an upcoming legislative project where they will very likely update the County landslide hazard maps based on recent DOGAMI mapping. They will also update the landslide development regulations for unincorporated Multnomah County. In a recent discussion, the Interim Planning Director stated the update to the landslide development regulations will happen but the update was put on hold in April-May 2019 due to workload issues (Adam Barber, Multnomah County, Interim Planning Director, personal communication, December 7, 2018, and August 23, 2019).

¹⁵⁴ <https://www.oregongeology.org/pubs/ofr/p-O-17-03.htm>

¹⁵⁵ <https://www.oregongeology.org/pubs/ims/p-ims-057.htm>

A.4.e. City of Portland

A.4.e(i) Where Code Provisions Apply

Section **B, Code Review for the Landslide Guide**, of this chapter, describes where Portland's code provisions apply related to landslide hazards, including the required permits and review processes.

Portland staff has prepared the *Slope Stability Code Guide* provisions for Title 24, Building Regulations.¹⁵⁶ The *Code Guide* has been finalized and became effective on May 28, 2019.¹⁵⁷ The *Code Guide* has been formulated to address the questions: When is a slope hazard evaluation required? What are the requirements for slope hazard evaluations?

The *Code Guide* states:

A slope hazard evaluation is required for Building, Site Development, and Development Review permit applications for new construction, additions and alterations to existing structures, grading, and other ground disturbing activities as described in sections B.1 through B.7.¹⁵⁸

Sections B.1 through B.7 list the potential hazards that slope hazard evaluations must, at a minimum, address: surficial slope stability, general slope stability, seismic slope stability, pre-historic and deep-seated landslides, soil creep, soil/debris flow inundation, and temporary excavation slopes. The *Code Guide* contains requirements for the Slope Hazard Evaluations. There are exceptions identified for situations when a Slope Hazard Evaluation is not required. The Slope Hazard Evaluation must be conducted by or under the supervision of a Professional Engineer or a Certified Engineering Geologist with demonstrated experience in slope stability investigation and analysis. The reporting requirements are listed in the *Code Guide*. An Engineering Geologic report may be required, in accordance with City of Portland Code 24.70.050.

The Portland Zoning Code does not yet have language that connects to the lidar maps and reports. There is a proposed code change in process related to the Landslide Hazard Study (LHS), which is required for subdivisions proposed in the Potential Landslide Hazard Area map. The existing map is outdated and does not use lidar. The proposal is to use information from the lidar-based landslide hazard maps. The new code language would change the referenced map used to determine if a LHS is required. The map may contain information from the Shallow Susceptibility Map, the Deep Susceptibility Map, and the Rapidly Moving Landslides Map from 2002 (produced by DOGAMI) (Ericka Koss, City of Portland, personal

¹⁵⁶ <https://www.portlandoregon.gov/bds/article/597690>

¹⁵⁷ <https://www.portlandoregon.gov/bds/article/727610>

¹⁵⁸ <https://www.portlandoregon.gov/bds/article/727610>

communication, January 2, 2019). A LHS is required to have the stamp of both a PE and a CEG.

The City of Portland's Bureau of Planning and Sustainability staff are considering how to use the lidar-based landslide hazard maps. One use of the maps is for the Residential Infill Project (RIP) as part of the compilation of data layers in the "constrained" or "z" overlay. The RIP contains a proposal that on parcels that meet certain parameters, a duplex, triplex, or fourplex could be allowed, unless the parcel is within the constrained or z overlay. This overlay includes the 100-year floodplain, natural resource areas, steep slopes, and landslide hazard areas. The landslide hazard areas information comes from the high hazard area on the Deep Susceptibility Map, the Inventory Map, and the Rapidly Moving Landslides Map from 2002 (Morgan Tracy, City of Portland, personal communication, January 4, 2019).

The City of Portland updated their buildable lands inventory as part of their periodic review update that was acknowledged by the Land Conservation and Development Commission (LCDC) in June 2016. Portland staff stated that this acknowledgement would need to be amended with the lidar maps and reports, for the City to implement them fully. The City is in the process of updating the existing Potential Landslide Hazard Areas map with the lidar information (Al Burns, City of Portland, personal communication, January 4, 2019).

A.4.e(ii) Data Used

Portland has landslide inventory maps and landslide susceptibility maps for shallow and deep landslides released by DOGAMI in 2018 as IMS-57¹⁵⁹. An excerpt from the summary of the report is shown below.

At least 1,700 landslides have occurred within the City of Portland during the last 90 years (1928–2016). Of these landslides, approximately 830 occurred during the severe storms in 1996. From these historical data, we estimate an average of 20 landslides per year in the City of Portland. We estimate annual loss from landslides in the City of Portland ranges from \$1.5M (million) to \$3M. In years with extreme winter storms, this estimate can increase to approximately \$64M to \$81M. These historical data are a clear indication of a significant landslide risk and thus the need for continued landslide risk reduction.

Most of the work on this mapping project took place during 2015-2016. The study area contains the Cities of Portland, Gresham, Fairview, Wood Village, Troutdale, and portions of Multnomah County and covers approximately 300 square miles. The City of Portland is divided into risk reporting areas roughly defined by the nine neighborhood coalitions. The purpose of the project was to assist the communities in the study area to understand better the landslide hazard and risk and to continue landslide risk reduction.

¹⁵⁹ <https://www.oregongeology.org/pubs/ims/p-ims-057.htm>

Deliverables of the study are:

- report text, appendices, and map plates;
- Geographic Information System (GIS) datasets including:
 - landslide inventory—map of locations of landslides that have occurred at some time in the past;
 - shallow landslide susceptibility—map of areas prone (low, moderate, high) to future shallow landslides;
 - deep landslide susceptibility—map of areas prone (low, moderate, high) to future deep landslides; and
 - landslide risk analysis.

Portland is using the DOGAMI IMS-57 landslide inventory maps to determine if new development or substantial improvements to structures are in the identified deep-seated landslide areas. If located on a deep-seated landslide, the stability of the landslide must be evaluated. Alternatively, quantitative analysis of the landslide may be waived if the owners sign and record a covenant, and if a qualitative analysis performed by a qualified professional determines that the development will have no adverse impact to the stability of the landslide and that the probable character of the slope movement is unlikely to result in a life safety risk to the occupants.

The covenant runs with the land; it contains an acknowledgement and acceptance of risk, waiver, indemnity, and duty to inform. It is recorded at the Office of Elections and Records at Multnomah County. Title 33, the Zoning Code, does not yet have language that connects it to the requirement for a covenant and it is uncertain it will be established. Currently, the Site Development (non-land use) staff implement the Potential Landslide Hazard Area Covenant; it is not available online.

A.4.f. City of Astoria

The City of Astoria has several provisions in their existing Development Code¹⁶⁰ that relate to the geologic hazards. Article 1, Basic Provisions states:

The purposes of this Code is to promote orderly city growth; to conserve and stabilize the value of property; to encourage the most appropriate use of land; to establish standards for population density; to provide adequate open space for light, air, and appropriate landscaping; to facilitate fire and police protection; to avoid traffic congestion; to provide for community facilities; and to promote and protect the public health, safety, convenience, and general welfare. (§ 1.020)

A.4.f(i) Where Code Provisions Apply

The City of Astoria Development Code contains 16 articles. In Article 2, Zoning¹⁶¹, is the requirement, within specific zoning types (e.g., residential, commercial, and so forth), in the subsection “Other Applicable Use Standards” that:

Where new development is within 100 feet of a known landslide hazard, a site investigation report will be prepared by a registered geologist. Recommendations contained in the site report will be incorporated into the building plans. (§ 2.050)

The Development Code contains the following zones that have the above reference:

- R-1, R-2, and R-3 - Residential,
- C-1, C-2, C-3, and C-4 - Commercial
- GI – General Industrial
- IN – Institutional Zone
- LS – Local Service
- AH-MP – Attached Housing (Mill Pond)
- A – Family Activities
- HR – Hospitality/Recreation
- CA – Education/Research/ Health Care Campus
- HC – Health Care
- MH – Maritime Heritage
- AH-HC – Attached Housing/Health Care

The above list includes zones that may or may not be appropriate for requirements due to the types of development that are permitted (John Edwards, City of Astoria, Engineering Designer, personal communication, May 31, 2019).

Zones that do not contain the reference language about the “known landslide hazard” within the City of Astoria Development Code are as follows:

¹⁶⁰ http://astoria.or.us/Development_Zoning.aspx

¹⁶¹ http://astoria.or.us/Development_Zoning.aspx

- S1 – Marine Industrial Shorelands
- S2 – General Development Shorelands Zone
- S-2A – Tourist-oriented Shorelands Zone
- S5 – Natural Shorelands Zone
- A1 – Aquatic One Development Zone
- A2 – Aquatic Two Development Zone
- A-2A – Aquatic Two-A Development Zone
- A3 – Aquatic Conservation Zone
- A4 – Aquatic Natural Zone

In the Astoria Development Code in Article 3, Additional Use and Development Standards, in Sections 3.300 through 3.330, Erosion Control and Stormwater Management provisions were adopted on October 4, 2001, and address the requirement for a grading permit for various site work. The code identifies the erosion control methods to be used.

Section 3.305.A, Permits Required, subsection 3, states a permit is required for:

Any proposed clearing, grading, filling, stripping, or excavating (regulated activity) within 100 feet of a known geologic hazard as indicated on the City's "Areas of High Water and Past Slides" map[.]

Section 3.310.D, Grading Plan in Steep Areas, states:

The City shall require a grading plan prepared by a Registered Professional Engineer and/or Registered Engineering Geologist where the disturbed area has an average slope of 35% or greater, the disturbed area is located in known geologic hazard area, or is part of a partition or subdivision. Such grading plan shall, at a minimum, include the following additional information:

1. Existing and proposed contours of the property at two foot contour intervals;
2. Location of existing structures and buildings, including those within 25 feet of the development site on adjacent property;
3. Design details for proposed retaining walls;
4. The direction of drainage flow and detailed plans and location of all surface and subsurface drainage devices to be constructed.

Section 3.315.A.3, Grading Standards for Cuts, states:

The slope of cut surfaces shall not be steeper than is necessary for the intended use and shall not be steeper than two horizontal to one vertical (2:1) unless an engineering geology report determines that a steeper slope will be reasonably stable and not create a hazard to public or private property.

Section 3.315.B.2, Grading Standards for Fills, states:

The slope of fill surfaces shall not be steeper than two horizontal to one vertical (2:1) unless an engineering geology report determines that a steeper slope will be reasonably stable and not create a hazard to public or private property. Fill slopes shall not be constructed on natural slopes steeper than two horizontal to one vertical.

Section 3.330.E, Additional Costs, states:

Where the City Engineer, Community Development Director, or Building Official deem it necessary, in the interest of public health, safety, or welfare, to incur additional costs such as, but not limited to, the hiring of independent geotechnical experts or other technical expertise, or costs to complete or correct work not completed by the applicant during the course of the project, such costs shall be borne by the applicant. Such costs shall not exceed actual costs.

Article 9, Administrative Procedures, Section 9.090, Additional Costs, states:

Where the City Manager deems it necessary, in the interest of public health, safety or welfare, to incur additional costs, such as the hiring of independent geotechnical experts or other technical expertise during the course of land use proceedings, such costs shall be borne by the applicant or appellant, as determined by the City Manager. Such costs shall not exceed actual costs.

Article 11, Conditional Uses, Section 11.030.A.4, Basic Conditional Use Standards, states:

The topography, soils, and other physical characteristics of the site are appropriate for the use. Where determined by the City Engineer, an engineering or geologic study by a qualified individual may be required prior to construction.

Article 12, Variances, Section 12.030.B.2.a, Variance General Criteria, states:

Relevant factors to be considered in determining whether development consistent with the request is substantially injurious to the neighborhood include:

The physical impacts such development will have, such as visual, noise, traffic and the increased potential for drainage, erosion and landslide hazards.

Article 13, Subdivisions and Land Partitions, Section 13.110.C.6, Subdivision, Preliminary Plat – Information on Preliminary Plat, Supplemental Information, states:

Geologic investigations as required by the Community Development Director and City Engineer. Where such an investigation indicates the potential for erosion, an erosion control plan shall also be submitted.

Article 13, Subdivisions and Land Partitions, Section 13.220.B.3, Major Land Partition Preliminary Plat – Information on Preliminary Plan, Supplemental Information, states:

Site investigations as required by the Community Development Director and City Engineer. Where such an investigation indicates the potential for erosion an erosion control plan shall also be submitted.

A.4.f(ii) Data Used and Referenced

There have been many landslides in Astoria over the years. One more recent specific time of increased landslides motivated the City of Astoria to seek additional landslide hazard information. In December 2007, there were approximately 3,000 landslides in northwest Oregon and southwest Washington. Astoria was impacted greatly. The existing 1st and Commercial Street landslide started to move, affecting the water lines and natural gas main in the area.

After those events, DOGAMI and the City of Astoria met to discuss a grant proposal. They then applied for and received funds from FEMA for a landslide hazard and risk study. The study was performed from April 2008 to April 2009. As a result of the landslide hazards study, DOGAMI prepared these maps: a landslide inventory, and shallow and deep landslide susceptibility maps. Also, a report, DOGAMI Open-File Report O-13-05, *Landslide Inventory, Susceptibility Maps, and Risk Analysis for the City of Astoria, Clatsop County, Oregon* (Burns & Mickelson, 2013¹⁶²), was prepared.

The results of the landslide hazard and risk study showed 120 landslide deposits were found within the city limits: 69 were classified as deep and 51 were classified as shallow. Of these 120 landslides, 83 landslides in the inventory are estimated to have moved during the past 150 years (historical time). This is a very high number of active-historical landslides for a small city like Astoria. Seventeen of these eighty-three have recorded dates of movement in the landslide inventory database from 1932 to 2007. Several of these 17 landslides caused significant damage.

Areas on the susceptibility maps are identified as high, medium, and low. In Astoria, of the areas within the landslide susceptibility area, 55% is within the high area for shallow landslides and 37% in the high area for the deep landslides. Again, these results indicate a high susceptibility to both shallow- and deep-seated landslides.

¹⁶² <https://www.oregongeology.org/pubs/ofr/p-O-13-05.htm>

After the landslide inventory and susceptibility maps were completed, they were used to conduct a landslide risk assessment. The results of this analysis indicate that roughly 27% of the city is at risk to landslides. The basic process involves the identification of hazard (i.e., landslide hazards), the inventory of assets, and estimation of damage and losses based on the overlap of the hazard and assets.

On August 17, 2015, the City Council accepted rather than adopted the City of Astoria Geologic Hazards Map (**Figure 4-4**). This map is used in implementing the development codes, which allow the City Engineer and Building Official to require geological reports in areas of concern¹⁶³. The Development Code contains this provision in the “Other Applicable Use Standards” for each zone:

Where new development is within 100 feet of a known landslide hazard, a site investigation report will be prepared by a registered geologist. Recommendations contained in the site report will be incorporated into the building plans. (§ 2.050)

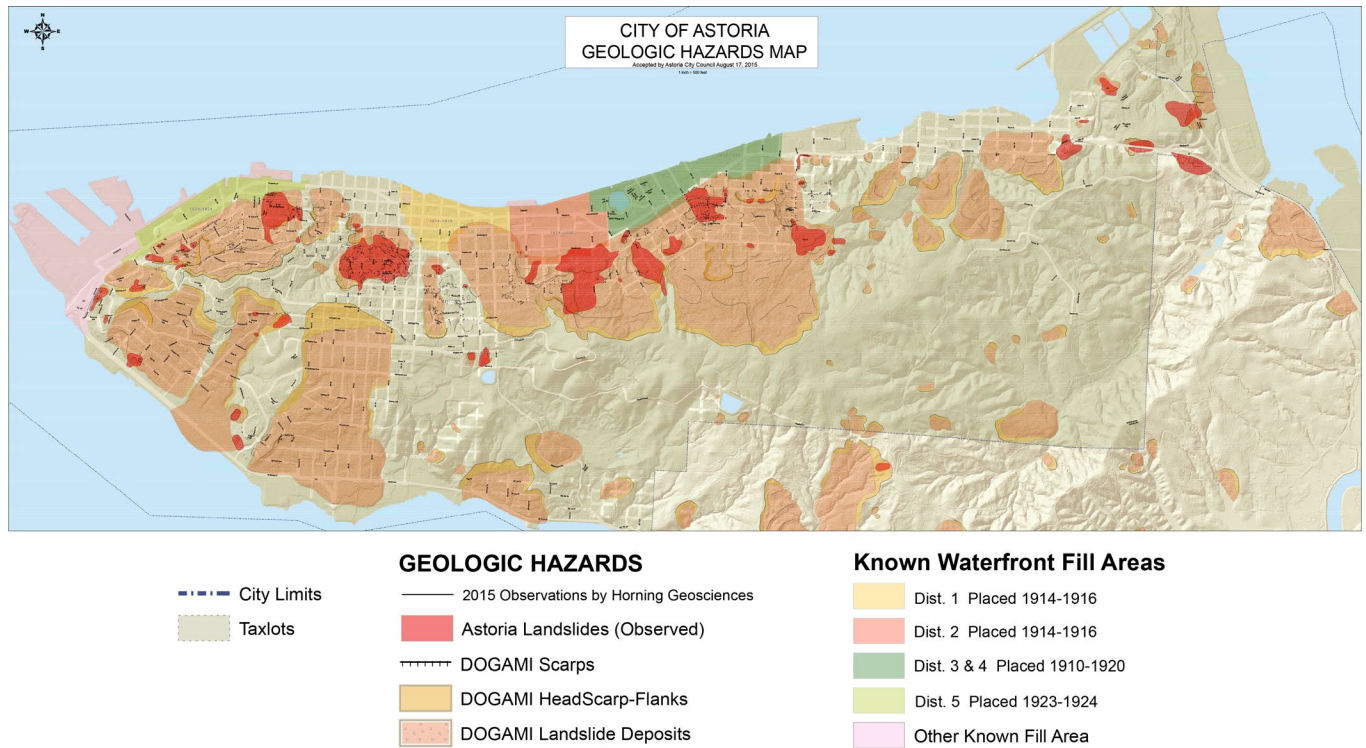
This Geologic Hazards Map (**Figure 4-4**) was put together using portions of the 2008-2009 DOGAMI study and City of Astoria information. The map key shows mapped geologic hazard areas: observed Astoria landslides (bright salmon color), DOGAMI scarps, DOGAMI headscarps/flanks, and DOGAMI landslide deposits. The code statement of “known landslide hazard” refers only to the “Astoria Landslides (Observed)” layer shown on the map; that layer is thus linked to the Astoria code provisions. The Astoria Landslides (Observed) layer was ground-truthed by Tom Horning, a Registered Engineering Geologist (RE) and Certified Engineering Geologist (CEG). The DOGAMI information is not specifically referenced in Astoria’s codes (zoning, building, grading, erosion control, and stormwater management).

A.4.f(iii) Permits Required and Review Process

In general, subdivisions, commercial development, and new construction in landslide and fill areas require a geotechnical report. Most architects/structural teams will not design without a geotechnical report. Astoria still needs to finalize the Geohazards Ordinance. Astoria will also review the references in the *Astoria Comprehensive Plan* and the *Astoria City Code* regarding the different geologic professionals to make sure they are correctly stated.¹⁶³

¹⁶³ Jeff Harrington, City of Astoria, Public Works Director, personal communication, April 15, 2019.

Figure 4-4. City of Astoria Geologic Hazards Map (accepted by City Council 2015)



Source: City of Astoria, Public Works Department. Map accepted by Astoria City Council August 17, 2015. Scale: 1 inch = 500 feet in the original map. Original map dimensions: 60 inches by 24 inches. Figure modified to remove street labels illegible at this scale and to enlarge the legend.

Recommendations from DOGAMI Open-File Report DOGAMI Open-File Report O-13-05, *Landslide Inventory, Susceptibility Maps, and Risk Analysis for the City of Astoria, Clatsop County, Oregon* (Burns & Mickelson, 2013¹⁶⁴) include the statement that the maps and GIS databases in that report are particularly suitable for:

- Public awareness campaigns,
- City development regulation-ordinance,
- Issuance of building permit or proposed grading permit conditions,
- Public works planning and operations,
- Environmental and sustainability issues,
- Regional risk-reduction planning and activities,
- Neighborhood scale risk-reduction activities,
- Avoidance of very high hazard areas,
- Emergency management, and
- Buyouts in very high or life threatening hazard areas.

¹⁶⁴ <https://www.oregongeology.org/pubs/ofr/p-O-13-05.htm>

B. CODE REVIEW FOR THE *LANDSLIDE GUIDE*

B.1. CODE REVIEW SELECTION CRITERIA

Thirty-four Oregon communities were selected for the code review. These included many of the communities with DOGAMI lidar-based landslide inventory and landslide susceptibility maps. The Cities of Salem and Newport have not yet obtained DOGAMI lidar-based landslide maps but were selected to be included because of their unique geologic hazard codes. We reviewed code information for 28 cities and 6 counties; see **Figure 4-7**, **Table 5-1** through **Table 5-4**, and **Table 8-1**. The majority of the code review occurred between May and December of 2017. Overall, there are 46 cities and 14 counties with DOGAMI lidar-based landslide *inventory* maps. There are 35 cities and 9 counties with DOGAMI lidar-based landslide *susceptibility* maps. See **Table 1-1**.

B.2. SUMMARY OF COMPONENTS OF REVIEWED STRONG CODES

From reviews of existing codes (e.g., zoning, building, and grading) and discussion with local jurisdiction staff, consultants, and DLC and DOGAMI staff, and noting the requests for guidance from communities, information about strong codes is shown in four ways in this *Guide*:

- Examples of existing code from local jurisdictions (**Chapter 4, Implementation**);
- A short summary of the code review in **Figure 4-7, Oregon Community Landslide Code Provisions – Summary of Results**, the code review summary tables (**Table 5-1** through **Table 5-4**), and the Code Review Details Table (**Table 8-1**);
- A list of strong code components in summary (**Figure 4-1**) and
- A model code framework (**Figure 5-3**).

Model codes are not one size fits all. Actual code examples are provided instead. Portions of any of the codes referenced in the code review and the model code framework can be modified to fit local jurisdiction needs. In addition, recognition is given to the variety of terrain, types of landslides, other hazards, capacity and resources available, local and statewide existing best available information, the political will of the jurisdiction, the burden of cost in implementation, and the flexibility of the code provisions.

In the next sections, we identify elements or features of the codes we analyzed as part of the *Landslide Guide*.

Legal Matters

As always when developing land use regulations or other legislation for local adoption, local governments should consult with their legal counsel to ensure that proposal comply with applicable federal, state, and local requirements.

B.2.a. Clear and precise requirements, definitions, submittal, and approval criteria

Clear and precise requirements are useful, as has been illustrated in the example codes (Chapter 4, section **A.4**) and noted in the zoning code features that a strong code should contain (**Figure 4-1**). Requirements for submittal and approval should be clear and understandable. They should reference the necessary information such as maps and reports as applicable. Reports should be stamped by the appropriate geoprofessional. Including definitions in the code provides clarity for how terms are used in the code provisions. Checklists and informational handouts are useful.

B.2.a(i) Map data

Eleven of the twenty-eight cities and four of the six counties in the code review reference DOGAMI publications when determining where geologic studies are required. Communities that use data from geologic maps generally incorporate the data into a community hillslope or geologic hazards overlay zone, or, when combined with the community's Flood Insurance Rate Map (FIRM), a general hazards overlay. Fourteen communities in the study have a hazards overlay zone. Development within this zone automatically triggers the requirement for a geologic report prior to application approval.

In this code review, communities that reference mapped landslide hazards or landslide prone areas tend, in general, to reference maps that are several decades old although the communities have the newer lidar-based maps. A majority of these date from the 1970s, but some are as current as 2017. Most communities use maps from past DOGAMI publications, but a few make specific reference to current DOGAMI landslide inventory and susceptibility maps.

Astoria specifically sources data from 2008 DOGAMI maps in the *City of Astoria Geologic Hazards Map*. This work was done in conjunction with DOGAMI and is an excellent example of use of the scientific data that is implemented. Sandy requires geologic assessments for "mapped DOGAMI slide hazard areas" without specific reference to the publication from which the data are sourced. As written in Sandy's code, it is not clear the most current DOGAMI publications are being used. It would be better to establish a clear reference like "as mapped and described in DOGAMI report [report name] and dated [year]."

Overall, a pattern in the code review reveals that in many jurisdictions the references to mapped data are outdated and need to be revised and updated with newer lidar-based landslide hazard data. Also, that newer mapped data from DOGAMI is not always fully connected to existing codes and regulations for implementation. In most jurisdictions, the codes, plans, and policies could be updated for more effective use of the mapped data.

Update and Connect Information

Overall, a pattern in the code review reveals that in many jurisdictions the references to mapped data are outdated and need to be revised and updated with newer lidar-based landslide hazard data. Also, that newer mapped data from DOGAMI is not always fully connected to existing codes and regulations for implementation.

B.2.a(ii) Geologic study requirement thresholds

This code review looked at the city and county codes for regulations about geologic hazards assessment studies or reports (herein referred to as geologic reports) prior to site development. Twenty of the twenty-eight cities and all six of the counties evaluated in this review require that a geologic report be submitted as part of the development permitting process on land parcels or lots where development is to take place. Some communities simply apply a blanket requirement for all new development, while others stipulate specific site conditions that trigger such a report. These site conditions typically include one or more of the following: parcel slope, known preexisting geologic hazards, and presence of mapped landslides as shown in DOGAMI or other publications.

Communities that use specific landslide hazard maps to trigger geologic reports tend to use maps that were published decades ago, most commonly in the 1970s. Oregon established 19 Statewide Planning Goals in 1973. These goals both inspired and required communities to establish local regulations and maps related to them. In relationship to landslides, the applicable provision is Statewide Planning Goal 7, Areas Subject to Natural Hazards. Goal 7 states “[l]ocal governments shall adopt comprehensive plans (inventories, policies, and implementing measures) to reduce risk to people and property from natural hazards” (Oregon DLCD, n.d.-a)¹⁶⁵. Goal 2, Land Use Planning, requires cities and counties to develop a factual base, including inventories, as part of their comprehensive plans.

A few communities in this code review use the general statement that reports must be done in locations with slope hazards mapped by DOGAMI, without citing a specific publication. Some jurisdictions have maps and reports prepared by the jurisdiction and/or with a consultant (e.g., Astoria, Multnomah County, and others). Commonly, codes state that a geologic report must be done in areas where a known geologic hazard exists. Codes sometimes refer to a map but do not always provide a method by which to determine where hazards might be.

Land use development typically occurs on a parcel by parcel basis, while maps are broad in scale. Some codes use a detailed approach to determining the hazard situation on a parcel. For example, Salem’s maps are called Landslide Hazard Susceptibility Maps and they are clearly linked to code provisions. Salem uses a relatively complex risk calculation method that derives values from three matrices, the sum of which is the total landslide susceptibility risk value. On the basis of this value, the development application process may require the inclusion of a geologic report or additional reports. The matrices include values assigned for earthquake induced landslide susceptibility, water induced landslide susceptibility, and activity susceptibility (i.e., required grading, vegetation removal, etc.).

Slope steepness is the most commonly used factor determining whether a geologic report is required. However, what constitutes a steep slope varies widely from one

Slope Steepness

Slope steepness is the most commonly used factor for determining if a geologic report is required, but slope steepness alone is not an indicator of the full scope and scale of a potential landslide hazard.

¹⁶⁵ <https://www.oregon.gov/lcd/OP/Documents/goal7.pdf>

community to the next; the range is from 5% to 33%. The most common values are 15% and 20%. Rarely do the communities provide specific methods by which to derive the lot slope value. Oregon City's code¹⁶⁶ does provide specifics, stating;

For lots or parcels individually or cumulatively greater than ten thousand square feet in size, between grade breaks, obtain the vertical distance, divide by the horizontal distance and multiply by one hundred. The horizontal distance to be used in determining the location of grade breaks shall be fifty feet. For lots or parcels ten thousand square feet or smaller in size, obtain the vertical distance across the lot or parcel, divide by the horizontal distance and multiply by one hundred. (§ 17.04.1145)

However, in general, codes reviewed during this code review did not specify whether slope steepness was to be averaged over the entire parcel, or if excessive steepness at any specific point in the parcel could trigger study requirements. This lack of detail can be a challenge for consistent application of the requirements on parcel by parcel development proposals.

In general, Willamette Valley communities tend toward a lower slope threshold to trigger the requirement for a geologic report (or require no assessment at all). Gresham forbids development of any kind on slopes greater than 35%, with exceptions for public utilities or facilities and a few specific instances dealing with lot size. Likewise, Tigard bans all development on slopes greater than 25%. Multiple communities allow exemptions from the geologic report requirements. For example, Eugene allows exemptions for things such as residential building alterations or additions to preexisting structures that will not disturb soil, emergency actions which are time sensitive, and maintenance or reconstruction of preexisting streets or utility lines.

In Portland, landslides often happen in environmental areas, which are regulated by the zoning code. The Portland Zoning Code does not describe exemptions to the land use regulations for landslides or a geologic study. However, a City of Portland December 9, 2002, memo "Landslides in Environmental Zones"¹⁶⁷ provides guidance on actions related to landslides that occur in environmental overlay zones. A landslide can be repaired immediately, but the actions taken in the environmental overlay zone will be reviewed to see if the actions are exempt from a land use review. If not exempt from land use review, then which level of review (Type I, II, or III) is applicable will be determined.

¹⁶⁶ https://library.municode.com/or/oregon_city/codes/code_of_ordinances?nodeId=TIT17ZO_CH17.44EOHA

¹⁶⁷ <ftp://ftp02.portlandoregon.gov/BDS/Geotechnics%20Data%20Transfer/landslide%20protocol%20in%20environmental%20zones.doc>

The Portland City Code, Chapter 24.70, Clearing, Grading, and Retaining Walls, contains the Hazards provision¹⁶⁸:

The Director may determine that any clearing, grading, retaining wall, or geologic condition on private property has or may become a hazard to life and limb, or endanger property, or cause erosion, or adversely affect drainage or the safety, use, stability of a public way or drainage channel. Upon receipt of notice in writing from the Director, the owner shall mitigate the hazard and be in conformity with the requirements of this Title. The Director may require that plans and specifications and engineering reports be prepared in compliance with this Chapter. (§ 24.70.030)

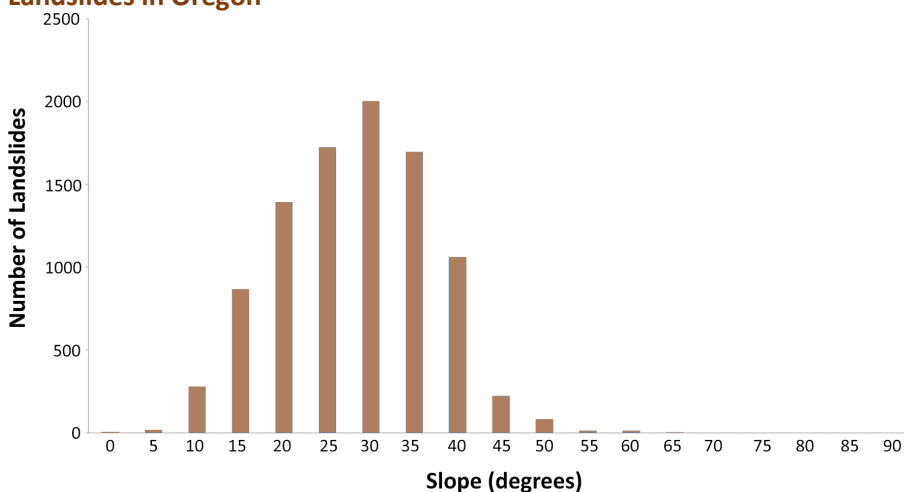
The same chapter defines a geologic hazard as:

a potential or apparent risk to persons or property because of geological or soil instability either existing at the time of construction or which would result from construction. (§ 24.70.040)

In further analysis of the slope steepness factor as a code threshold, it becomes apparent that the use of slope steepness as the sole factor to determine if the area is a landslide hazard area is insufficient to recognize the hazard.

According to SLIDO 3.4 data (Burns, 2017), 10,335 *deep* landslides have been mapped in Oregon. The mean slope angle is 27 degrees, and 95% of these deep landslides occur on 10–45 degree slopes (**Figure 4-5**).

Figure 4-5. Number of Landslides and Corresponding Slope Angles for 10,335 Deep Landslides in Oregon

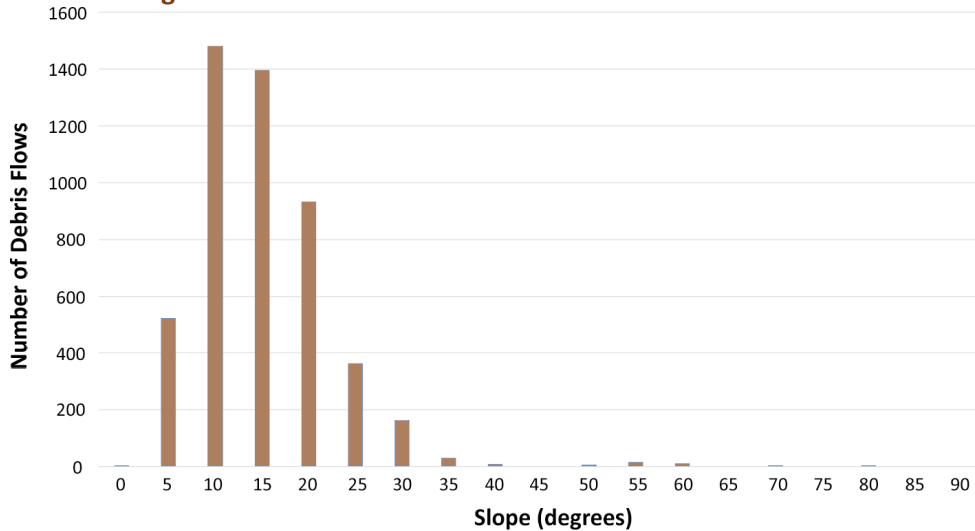


Source: Burns, Calhoun, Franczyk, Koss, & Bordal (2017)

¹⁶⁸ https://www.portlandoregon.gov/citycode/28670#cid_682170

Also according to SLIDO 3.4, 4,904 *debris flow* type landslides have been mapped in Oregon (Burns, 2017). The mean slope angle is 13 degrees, and 95% of these debris flow type landslides occur on slopes less than 26 degrees (**Figure 4-6**).

Figure 4-6. Number of Debris Flows and Corresponding Slope Angles for 4,904 Debris Flows in Oregon



Source: Burns et al. (2017)

Other factors to be considered along with slope steepness are the type of development, the size and scale of the development, the weight and extent of the construction, the location of the vulnerable population, the location of the critical facilities, erosion (natural and human caused), grading, geotechnical reports on file, and the information on the statewide *Landslide Susceptibility Overview Map of Oregon* (Burns et al., 2016¹⁶⁹), released in February 2016. It may also be useful to check the most current version of SLIDO¹⁷⁰.

B.2.a(iii) Geologic study types

In this code review, 26 communities out of the 34 reviewed require a geologic report (see **Chapter 5, Resources; Table 5-1** through **Table 5-4**; and **Table 8-1**). However, some jurisdictions, such as Medford, require multiple types of reports. Medford requires a “geology and soils report” and a “hydrology and grading report.” Several communities use a matrix based on site conditions to determine what type or types of reports are required. Eugene and Sandy have three tiers of requirements for geologic report. In these communities, initial-tier geologic reports are used to determine need for higher-tier, more in depth, studies. Salem uses a tiered

¹⁶⁹ <https://www.oregongeology.org/pubs/ofr/p-O-16-02.htm>

¹⁷⁰ <https://www.oregongeology.org/slido/index.htm>

approach. In other communities, the tiers are simply based on site slope, where steeper slopes require a greater amount of study.

Beaverton's City Code, in Chapter 9.05, Site Development, states that a permit application requires, among other items,

[a]n engineering geological investigation, based on the plan for the work proposed under the permit. The engineering geological report shall include an adequate description of the geology of the site, and conclusions and recommendations regarding the effect of geologic conditions, including consideration of seismic hazards and slope stability in natural materials on the proposed development. All reports shall be subject to approval by the city engineer and supplemental reports and data may be required as the city engineer considers necessary. Recommendations included in the report and approved by the city engineer shall be incorporated in the grading plan. This requirement may be waived by the city engineer when it appears from the condition of the property that such a report is not necessary. (§ 9.05.035.B.10)

The requirements for the content of a geologic report also vary greatly. Astoria, for example, requires a "site investigation by a registered geologist" while other communities specifically request a "landslide hazards study" or "engineering geologic assessment." Astoria contains a Registered Geologist requirement in the provisions listed in the "Other Applicable Use Standards" for each zone (residential, commercial, and industrial). See this chapter, section **A.4.f, City of Astoria**.

The Eugene Code¹⁷¹ has requirements for geological and geotechnical analyses:

The purpose of geological and geotechnical analyses is to ensure that public and private facilities in developments in areas of known or potential unstable soil conditions are located, designed, and constructed in a manner that provides for public health, safety, and welfare. (§ 9.6710(1))

The Eugene Code, in Section 9.6710 Geological and Geotechnical Analysis, contains the requirements of who must prepare the analysis and describes the categories of the analysis:

(2) Geological and Geotechnical Analysis Required. Except for those activities exempted under EC 9.6710(3) Exemptions from Geological and Geotechnical Requirements, a geological and geotechnical analysis, prepared by an Oregon licensed Engineering Geologist or an Oregon licensed Civil Engineer with geotechnical experience, conforming with standards, procedures and content as defined in the Standards for Geological and Geotechnical Analysis adopted by the city in the manner set forth in EC 2.019 City Manager - Administrative and Rulemaking Authority and Procedures, is required for any of the following:

¹⁷¹ <https://www.eugene-or.gov/DocumentCenter/View/2704/Chapter-9-Land-Use>

- (a) All proposed tentative planned unit development, site review, or subdivision applications on properties with slopes equal to or greater than 5%.
- (b) All proposed development that includes dedication or construction of a public street or alley or the construction of public drainage systems or public wastewater sewers.”

[...]

(4) Categories of Geological and Geotechnical Analysis. The analysis required in geological and geotechnical analyses is based on the following categories, and shall be prepared in the manner required in the rules referenced in subsection (2) of this section:

- (a) A Level One Analysis shall consist of a compilation of record geotechnical data, on-site verification of the data and site conditions, and a report discussing site and soil characteristics in relation to the proposed development and other applicable standards.
- (b) A Level Two Analysis shall consist of a compilation of record geological data, analysis of site characteristics, sub-surface investigation and testing to establish soil types and distribution, and a report that includes site and soil characteristics in relation to the proposed development, identification of potential problems, and recommendations for design and construction techniques and standards consistent with other standards applicable to the development proposal.”
- (c) A Level Three Analysis shall consist of a Level Two Analysis and additional site-specific geotechnical design of facilities such as, but not limited to, streets, foundations, utilities, retaining walls and structures due to geologic constraints.

(§ 9.6710)

Establishing clear requirements is an important part of having a robust code that provides the jurisdiction with the information needed for decision-making in landslide hazard areas.

Other communities, such as Sandy and Gold Beach, include relatively highly detailed requirements for what the geologic report must contain. These include a site geologic history, a report of any field reconnaissance, discussion of geologic hazards, and recommendations to address geologic problems. Sandy includes the *Guidelines for Preparing Engineering Geologic Reports in Oregon*¹⁷² by the Oregon State Board of Geologist Examiners as an appendix to the Hillside Development chapter of their city code, and is the only community of the thirty-four reviewed to do so. Gold Beach provides clear, concise expectations for their geologic report requirements as well. Establishing clear requirements is an important part of having a robust code that

¹⁷² https://www.oregon.gov/osbge/Documents/engineeringgeologicreports_5.2014.pdf

provides the jurisdiction with the information needed for decision-making in landslide hazard areas.

Multnomah County and the City of Portland provide informational sheets (see sidebar) that describe the requirements for geologic studies.

The *Portland Zoning Code* requires a Landslide Hazard Study (LHS) when properties are in the Potential Landslide Hazard Area and a land division is proposed. Both Land Use Planning and Site Development staff will review the submitted LHS, which has to be signed by both a Certified Engineering Geologist (CEG) and a Geotechnical Engineer (GE). When a proposed development is not a land division, the site is still reviewed for landslide hazards. This is done through the Site Development Staff; the staff have the ability to ask for a geologic report.

Multnomah County's Hillside Development Permit Application (also called HDP Form-1) is required to be completed when the site has 25% slope or is shown on the Slope Hazard Map. The HDP Form-1 must be completed by a CEG or a GE. Multnomah County provides a Hillside Development Permit Worksheet to help applicants; it is an optional form that can be used in conjunction with the required geologic report. The *Multnomah County Zoning Code* states that the geologic report must certify the site is "suitable for the proposed development." The determination of what is suitable or appropriate development for that situation is generally interpreted by staff to be a properly signed geologic report.

Twenty-two of the twenty-six codes that require geologic reports have a certification level requirement for the person completing the report. In most cases, the requirement is listed as a geologist, registered geologist (RG), geotechnical engineer (GE), or a certified engineering geologist (CEG). Some communities only generally define these titles, while others are more specific and require a professional certified under Oregon Revised Statutes (ORS 672.002 to ORS 672.705).

Several communities allow reports to be completed by a civil engineer with geotechnical experience. The most common requirement is that the report be completed by either a geotechnical engineer or certified engineering geologist. Silverton and Portland require the report be stamped by both a geotechnical engineer and certified engineering geologist. In Salem's tiered approach to geologic studies, the geological assessment must be done by a CEG and the geotechnical report must be signed by both the CEG and GE. Astoria's code states that the City Engineer has the discretion to require a CEG or a Soils Engineer to do the geologic study.

Having both the CEG and GE sign the geologic report provides a solid scientific analysis about the site. As described in **Chapter 2, Landslide Hazards**, while the work of RGs, GEs, and CEGs can overlap, a local government generally will need to require that site-specific reports in landslide hazard areas be completed by either a CEG or a CEG working with a PE that has experience and expertise in geotechnical

Multnomah County and City of Portland Geologic Studies Information Sheets

[Multnomah County Geologic Hazards Permit Information Sheet](#)

[Multnomah County Geologic Hazards Permit Form-1](#)

[Multnomah County Geologic Hazards Permit Worksheet](#)

[City of Portland Landslide Hazard Information](#)

[City of Portland Landslide Hazard Study Information Sheet](#)

[Sites in Potential Landslide Hazards Areas Information Sheet](#)

Zoning Codes

It is very important that local governments make sure their codes require the appropriate geoprofessional(s) for each study and report.

engineering. It is very important that local governments make sure their codes require the appropriate geoprofessional(s) for each report.

Ordinances for land or lot division requirements tend to parallel the requirements for site development. Communities that do not simply wrap lot division requirements into the same report requirements as the site development permit application process may require either a less robust study or an additional/alternate set of concerns that must be addressed. A less robust study might contain requirements only for site contours/topography, natural features, and a grading plan. Alternatively, a jurisdiction may require, for example, a mitigation plan that protects each lot or parcel from geologic hazards, lot size regulations based on slope. Or, in the case of West Linn, a map showing “earth slides, mud flows, land slumping, slope failure, or other earth movement that is likely to leave the property of origin” is required (West Linn Municipal and Community Development Code (CDC) § 85.160.F.2.c¹⁷³).

Commonly, communities request that developers adjust the parcel sizes and shapes to fit the geology and environmental aspects of the site. This can mean smaller lot sizes and adjustments, or that variances to setbacks can be approved to accommodate the geologic and environmental constraints. The city of Banks Zoning Code, under the Modification to the Development Standards, promotes the “incorporation of natural features into subdivision design or avoidance of natural hazards (e.g., geological hazards, stream corridor, or flood hazards) necessitating flexible lots sizes, cluster development plan, or other innovative design” (Banks Zoning Code § 151.138.B.4).

B.2.a(iv) Drainage plan

Water and Landslides

Water flowing on a site is often, in fact, most commonly, the factor that triggers the landslide.

Managing the water that comes on a site is key.

Water can infiltrate the soil in concentrated form; when soil is saturated, water moves with gravity downslope. Factors that increase water flowing on site, particularly a landslide-prone site, increase the risk of landslides. Water can be on a site through many avenues such as rainfall, broken or leaking sewer or water lines, water retention facilities that direct water onto slopes, lawn irrigation, and streams or creeks. It is important to recognize that water flow can affect the natural geology and/or exacerbate the altered conditions of the site that resulted from grading and construction. Water flow may need to be directed off the site or controlled through construction, erosion control, and grading requirements such as mulching and seeding disturbed areas or other methods. Keep this in mind for effective risk reduction through codes and other implementing measures, as well as education and awareness efforts.

Eighteen of the twenty-six codes that require a geologic report also contain regulations addressing the drainage and hydrology of the site. Typically, this includes a predevelopment site drainage plan to ensure that surface hydrologic

¹⁷³ <https://www.codepublishing.com/OR/WestLinn/#!/WestLinnCDC/WestLinnCDC85.html#85.160>

behavior after development either matches that of the predevelopment site or does not adversely affect neighboring properties or streets. These plan contents must include such things as:

- data on the direction of drainage flow;
- locations of all surface and sub-surface drainage devices currently on site and to be constructed;
- requirements to emulate predevelopment conditions to the greatest extent possible;
- requirements that drainage plans be completed by a civil engineer; and
- protections for neighboring properties and public streets and utilities.

Medford has a unique requirement that on steep slopes, water and sewer lines must be “keyed into” hillsides. This entails the burying of a concrete anchor into the subsurface rock, a structural technique that holds the lines in place.

DOGAMI’s Open-File Report O-13-05, *Landslide Inventory, Susceptibility Maps, and Risk Analysis for the City of Astoria, Clatsop County, Oregon* (Burns & Mickelson, 2013¹⁷⁴) states that “stormwater runoff improvements are generally the least costly mitigation. An increase in stormwater management will result in a decrease in landslide risk.” Other studies such as the *Seattle Landslide Study* (Shannon & Wilson, 2000¹⁷⁵) and the *Landslides in the Portland, Oregon Metropolitan Area Resulting from the Storm of February 1996: Inventory Map, Database and Evaluation* (Burns, Burns, James, & Hinkle, 1998¹⁷⁶) also discuss the importance of controlling surface stormwater.

B.2.a(v) Soil study

Soil strength test results and other soil attributes are not commonly referenced in the codes. However, 13 communities either require a soils study report prior to development or include that information as a required part of the geologic report. Additionally, the Oregon Board of Geologist Examiners, as part of their 2014 publication *Guideline for Preparing Engineering Geologic Reports*¹⁷⁷ contains the suggestion that site soil unit descriptions include “pertinent physical and engineering characteristics such as color, grain size, grain lithology, density/consistency, cementation, structure, strength, thickness, and variability” as part of the report. Soil permeability traits are also commonly considered, both to inform erosion control methods and to ensure that site permeability is unaltered by development, thereby preserving preexisting drainage patterns. Beaverton’s code¹⁷⁸ states that when it is applicable, under a Site Development Permit, issued by the City

¹⁷⁴ <https://www.oregongeology.org/pubs/ofr/p-O-13-05.htm>

¹⁷⁵ <http://www.seattle.gov/Documents/Departments/SDCI/About/LandslideStudy.pdf>

¹⁷⁶ <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.694.3602&rep=rep1&type=pdf>

¹⁷⁷ https://www.oregon.gov/osbge/Documents/engineeringgeologicreports_5.2014.pdf

¹⁷⁸ § 9,05.035.B.11, <https://www.codepublishing.com/OR/Beaverton/#!/Beaverton09/Beaverton0905.html#9.05>

Engineer, there must be a soil engineering investigation report. The report has data on soil types, strength, distribution, and proposed corrective measures.

B.2.a(vi) Grading plan

Excavation and grading are normal and generally needed actions for development such as constructing buildings and roads. The act of grading alters the natural and or existing slopes, often making them steeper and less stable. Steep slopes are often cited as a major factor in creating an increased risk for landslides. Adding soil on these slopes, either natural or fill, increases the weight on the slope and also increases the risk for landslides. Steep slopes are often mapped and or regulated with code provisions that require a determination of the slope steepness on the site, and potentially, an evaluation to be performed.

Twenty-four of the thirty-four communities in the code review specify requirements for predevelopment grading plans, some of which have no ordinances specifically addressing geohazards or geologic reports. Additionally, the Uniform Building Code Chapter 70 is commonly referenced as the standard to which all grading practices need to conform. These references need to be updated to the International Building Code (IBC). Some communities have minor exemptions, for example, Cornelius (§ 18.05.060(E)) municipal code allows “minor clearing or grading for purposes of site surveying, or exploratory excavations under direction of a soil engineer or engineer geologists, provided said grading or excavation is consistent with building code requirements.”¹⁷⁹

Appendix J, Grading, in the IBC was adopted by the State of Oregon. If local jurisdictions have code provisions related to grading, then the jurisdictions can enforce them. E.g., the City of Portland has a grading section in Chapter 24 of the Portland City Code. If the local jurisdiction does not have a grading code, there is no state code upon which to enforce grading requirements at the local level.

Once again, the degree to which communities define the requirements for the grading plan is variable. In their municipal code, Fairview provides the following detailed expectation (§ 19.425.0209(D) Site design review information):

A preliminary grading plan prepared by a registered engineer shall be required for developments which would result in the grading (cut or fill) of 1,000 cubic yards or greater. The preliminary grading plan shall show the location and extent to which grading will take place, indicating general changes to contour lines, slope ratios, slope stabilization proposals, and location and height of retaining walls, if proposed. Surface water detention and treatment plans may also be required.

Astoria requires preliminary development plans with site investigation by a registered geologist; the plans must show potential geologic hazards and the information will be submitted to the Planning Commission. The Astoria code states

¹⁷⁹ <https://www.codepublishing.com/OR/Cornelius/html/Cornelius18/Cornelius1805.html>

that where new development is proposed within 100 feet of a known landslide, as mapped on the *City of Astoria Geologic Hazards Map*, a geologic report is required.

Canby allows the Planning Commission to impose bonding requirements to ensure that grading will create no hazard where slopes or unstable soils exist. Silverton restricts grading activities to summer months to reduce erosion and sedimentation rates from rainfall. West Linn specifically prohibits grading on slopes greater than 12% that removes the toe of any slope where a severe landslide or erosion hazard exists. Beaverton's code has the stipulation that all grading and excavation sites must conform to city, county, and state DEQ erosion control standards, whichever is greater (see 9.05.110.D¹⁸⁰).

Medford allows exemptions to the grading permit requirement for the types of excavation or grading exempted in Appendix J¹⁸¹ of the *2007 Oregon Structural Specialty Code*. In Section J103.2 Exemptions, the list of exemptions is: grading in an isolated, self-contained area with no danger to the public or risk to adjoining properties; excavation for structures permitted under this code; cemetery graves; refuse disposal sites; excavation for wells and trenches for utilities; mining and quarrying provided it is controlled by other regulations and there is no risk to adjoining properties; and exploratory excavations done under the supervision of a registered professional.

B.2.a(vii) Erosion control plan

In addition to the requirement for a grading plan, it is also common for communities to require an erosion control or mitigation plan. Twenty-six of the thirty-four codes in this code review contain these. Some codes wrap this into the geologic report, while others treat it as a standalone requirement. Generally, when needed, this erosion control plan is to be completed by a certified professional (not necessarily a geologist, registered geologist, geotechnical engineer, or a certified engineering geologist). Some cities have exemptions for the professional certification on small residential projects.

Typically, communities have the requirement that development remove a minimal amount of vegetation at the site and/or revegetate the site as soon as practically possible and that soil erosion control features such as silt fencing, hay bales, berms, holding ponds, terraces, ditches, hydro seeding, or permanent cover be used as needed. The city of Brookings has Chapter 17.100, Hazardous Building Site Protection Hillside Development Standards, in the Brookings Municipal Code¹⁸² (BMC). Within that chapter, subsection 17.100.070, Engineered Plans Required, describes the requirements for engineered plans. In summary, the requirements

¹⁸⁰ <https://www.codepublishing.com/OR/Beaverton/#!/Beaverton09/Beaverton0905.html#9.05.110>

¹⁸¹ http://ecodes.biz/ecodes_support/free_resources/Oregon/07_Structural/07_PDFs/Appendix%20J_Grading.pdf

¹⁸² <https://www.codepublishing.com/OR/Brookings/#!/Brookings17/Brookings17100.html>

state that no material should be deposited on another property; that the plans shall be prepared by an Oregon civil engineer; that only a minimal amount of vegetation should be removed; and measures for controlling runoff should be used.

17.100.070 Engineered plans required

- A. No property shall be disturbed, graded, excavated, filled, stormwater drainage redirected or developed within the city so as to cause slides of mud, soil, rock, vegetative material or any eroded or depositional material to be deposited on the property of another.
- B. The applicant shall submit plans prepared by an Oregon-licensed civil engineer prior to any site preparation, including vegetation removal, except as allowed for survey purposes in BMC 17.100.060. Note: On a lot or parcel with hazardous conditions as defined in BMC 17.100.020(F) and on any proposed partition or subdivision. At the discretion of the site plan committee, this requirement may be waived or modified on lots or parcels greater than one acre in size. The plans must be approved by the city and shall include the following information:
 - 1. An erosion control plan showing the area to be denuded of vegetation, erosion control measures and implementation time table. Erosion and sedimentation caused by stormwater runoff shall be minimized by employing the following measures, or substitute measures deemed acceptable by the city manager or his or her qualified designee:
 - a. Only the minimal removal of vegetation cover, particularly tree cover, necessary for building placement or access shall be done. Removal of trees and brush for view enhancement can be a part of the grading plan if such an action does not increase the potential hazard and/or mitigation can be applied. The city shall observe this in the development of streets and building pads.
 - b. Measures for controlling runoff, such as silt fencing, hay bales, berms, holding ponds, terraces, ditches, hydroseeding or permanent cover, shall be used as required, particularly in areas having slopes of 15 percent or greater. The applicant shall contact the Oregon Department of Environmental Quality (DEQ) concerning the possible need for a 1200-C stormwater general permit.

Eugene's City Code¹⁸³ requires that:

The construction site management plan shall identify: potential water quality impacts associated with the proposed construction activities; techniques and methods to be used to prevent and control erosion, sedimentation, and other pollutants associated with construction activity; and the location, design, and construction schedule for all erosion, sedimentation, and other construction site management control measures to be implemented and maintained.
(§ 6.635 (1)(c)2.)

Eugene's *Construction Site Management Plan (CSMP) General Notes* information sheet¹⁸⁴ describes that erosion control measures should prevent sediment and sediment-laden water from going off the site, that materials do not enter stormwater systems and roadways, and that materials do not violate water quality standards:

ESC measures shown on this CSMP must be constructed in conjunction with all clearing and grading activities, in such a manner as to ensure that sediment and sediment laden water does not enter the stormwater system, roadways, adjacent property or violate applicable water quality standards. When designing and implementing measures, the CSMP designer, permit holder and/or the contractor shall consider the seasonal variation of rainfall, temperature, and other climatic factors relative to the timing of land disturbance activities.

The information sheet has additional information about requirements.

Some communities include percentage of slope parameters that correspond to requirements. For example, the code might say that above 20% slope, vegetation cannot be removed unless certain erosion control measures are implemented. Clatskanie's Development Code, section 9-9C-10, General Development Standards, under B.1 Review of Uses, states "within fifty feet of any protected water resources, excavation and vegetation removal shall be prohibited on slopes of 25 percent or greater in slide hazard areas, except where necessary to construct public facilities or to ensure slope stability."¹⁸⁵ Beaverton's City Code, Title 9, Community Development, Chapter 9.05 Site Development, contains the stipulation that all grading and excavation sites must conform to city, county, and state DEQ erosion control standards, whichever is greater (see 9.05.110.D¹⁸⁶).

¹⁸³ <https://www.eugene-or.gov/DocumentCenter/Home/Index/282>

¹⁸⁴ <https://www.eugene-or.gov/DocumentCenter/View/44154/11---CSMPgeneralnotesProof2>

¹⁸⁵ https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/8805/Clatskanie_Development_Code_2007.pdf?sequence=1&isAllowed=y

¹⁸⁶ <https://www.codepublishing.com/OR/Beaverton/#!/Beaverton09/Beaverton0905.html#9.05.110>

B.2.a(viii) Monitoring

Monitoring development is a good way to continue the relationship between the applicant/developer and the jurisdiction so that requirements are implemented fully. This may be done through requiring inspections during the construction process and after the development is built. Requiring a final report from a geotechnical professional is another way to have information demonstrating that the development has been done in accordance with requirements. Enforcement of the requirements is a key part of upholding them. For example, the City of Portland requires a final report (24.70.130 Completion of Work): “Upon completion of the rough grading work and the final completion of the work the Director may require the following reports and drawings supplemental thereto: ...an as-graded grading plan prepared by the civil engineer...a soil grading report prepared by the soil engineer... a geological grading report prepared by the engineering geologist”¹⁸⁷.

B.2.a(ix) Covenants for new development and additions

Covenants in land use are tools that can assist communities in natural hazards planning and mitigation. Covenants are contractual agreements that commonly establish a requirement for disclosure of information, and they typically run with the land. Generally, covenants are required to be recorded or otherwise filed into the legal binding records of the city or county. In this manner, regardless of who owns the property, the information is available to the public. When agreements such as this are recorded with a county’s tax assessor or records office, they can be found through a query of records for the property. Oregon City and the City of Portland have covenant requirements; those were described earlier in this chapter.

DLCD and DOGAMI recognize that Washington has similar concerns with landslides and thus include this brief description about Seattle. The City of Seattle, Washington, currently requires a covenant to be signed when a person chooses to develop on a property in a landslide hazard area or when a property in a landslide hazard area is for sale (Chris Robertson, Shannon & Wilson Geotechnical, Vice President, PE, GE, LEG, and Bill Laprede, Shannon & Wilson Geotechnical, Senior Vice President, CEG, LEG, personal communication, January 22, 2018). The covenant is recorded at the Office of Records and Elections of King County, Washington, and a copy is returned to the Seattle Department of Construction and Inspections¹⁸⁸.

Susan Chang, Geotechnical Engineer Supervisor with the Department of Planning and Development, is quoted in a 2014 article describing the efforts Seattle has made with regard to landslides¹⁸⁹, particularly since the landslide events that occurred during the winter of 1996-1997. The events of that winter led Seattle to make an extensive study of landslide hazards dating back to 1890. “So we know areas where

¹⁸⁷ <https://www.portlandoregon.gov/citycode/article/664761>

¹⁸⁸ <http://www.seattle.gov/Documents/Departments/SDCI/Forms/PotentialLandslideAreaCovenant.pdf>

¹⁸⁹ <https://www.knxx.org/post/worried-about-landslides-seattle-has-map>

we've historically had landslides. And they went out and did some mapping and field checking and helped come up with these areas of the city where landslides are more likely to happen," she said. The areas are now designated as environmentally critical areas for landslide hazard in the city of Seattle. To build in one of these areas, the covenant language states that all owners of record must sign a covenant, indicating awareness of the risks and agreeing to mitigate and inform future owners. See the City of Seattle, Department of Construction and Inspections, Potential Landslide Area Covenant form: *Covenant Running with the Land, with Acknowledgement and Acceptance of Risk, Duty to Inform, Need for Insurance, Indemnity and Waiver (Potential Landslide Area)*¹⁹⁰.

Figure 4-7. Oregon Community Landslide Code Provisions – Summary of Results

Landslide Code Review – Summary of Results

Table 1-1 lists communities and counties that have complete or partial DOGAMI lidar-based landslide mapping. Many communities with DOGAMI lidar-based mapping and two jurisdictions without DOGAMI lidar-based mapping* were included in the code review. The majority of the code review occurred between May and December of 2017. In total, codes and plans from 34 communities were reviewed. Of those,

- 20 of the 28 cities and all 6 of the county plans reviewed require a geologic report as part of the development permitting process for land parcels or lots.
- 22 of the 26 codes that require geologic reports include a certification requirement for the person completing the report. In most cases, this was listed as a geologist, registered geologist (RG), engineering geologist (CEG), or a geotechnical engineer (PE or GE).
- 18 of the 26 codes that require a geologic report also include regulations addressing drainage and hydrology of the site.
- 13 communities either require a soils study report prior to development or include that information as a required part of the geologic report.
- 24 of the 34 communities in the code review include requirements for predevelopment grading plans.
- 26 of the 34 codes include a requirement for an erosion control plan.
- 11 of 28 cities and 4 of 6 counties referenced DOGAMI publications in their codes when deciding where geologic reports are required.
- 14 communities implement their provisions through a hazards overlay zone.
- Sandy is the only community of the 34 to include the Oregon State Board of Geologist Examiners Guidelines for Preparing Engineering Geologic Reports in Oregon as an appendix to the hillside development chapter of the city code.

*Although the Cities of Newport and Salem have not received DOGAMI lidar-based landslide inventory and landslide susceptibility maps, these two cities were included because of their unique geologic hazard codes.

¹⁹⁰ <https://www.seattle.gov/Documents/Departments/SDCI/Forms/PotentialLandslideAreaCovenant.pdf>

B.2.b. Inclusive permitting process (include all departments/officials with approval authority over portions of the project)

Inclusive permitting processes involve the full range of jurisdictional staff that would review a development proposal and communication between them. Typically, staff that would review a development would be in Planning, Public Works, and Building Divisions. With strong code provisions it will be clear who to engage in this development review and permitting process.

B.2.c. Strong enforcement provisions both during and after construction (should not discourage people from reporting violations)

Strong enforcement of the codes (zoning, building, and other) is a method that can provide consistency and strength to the development review and permitting process. Applicants can expect that they need to provide the identified information, that it will be reviewed fully and by the applicable authority, and that their proposal may be inspected or have other requirements to support and illustrate compliance.

C. KEY QUESTIONS FROM INTERVIEWEES

⇒ *Can DOGAMI lidar-based landslide hazard maps be used to create jurisdiction specific maps and/or as a basis for requiring landslide hazard related reports for development?*

- The DOGAMI lidar-based landslide maps and other maps may be used to create a new map that becomes the landslide hazard map for the jurisdiction. For example, a jurisdiction may use the information from the inventory map, from the high and very high areas on the shallow and deep susceptibility maps, and areas on the *GIS overview map of potential rapidly moving landslide hazards in western Oregon (IMS-22)* to create the landslide hazard map for the jurisdiction. The map may be related to zoning, building, stormwater, erosion control and/or other codes, and may be used as a basis for requiring landslide hazard related reports.

⇒ *How do we facilitate coordination between departments, the developer, the owner, and the applicant?*

- Communication, clarity, and coordination is important. Establish and identify the players, authorities, responsibilities, and timelines of the process.
- In the Pre-Application process require the applicant, property owner, and the people hired by the applicant and the property owner (e.g., architect, engineer, geologist) to sign a document stating that they have read the engineering geologic report and understand what is required to develop the site.
- Ensure that the Building Official knows that site must be inspected by geologist who wrote the report (1) after the cuts are made and before building is started and (2) after the foundation is in and before framing.)

⇒ *What do we do if we are not getting the information we need from the geology professional?*

- Use local authority for the jurisdiction to require a second opinion, e.g., a third party review, of the geologic report or a new geologic report from another geology professional at the applicant's expense.

⇒ *How do we deal with contractors that will not follow the recommendations in the engineering geologic report?*

- Require recommendations to be followed as a condition of permit approval.
- Have the geologist monitor during construction at the applicant's expense.

- Have the local jurisdiction inspect the work during construction.
- ⇒ *How do we keep people from grading or clearing before coming in for permits?*
- Emphasize the benefit of complying with the requirements.
- Consider peer and public pressure as well as regulatory enforcement tools like fines, stop work orders, restoration, and mitigation actions.
- ⇒ *What can we do about enforcing the code?*
- Building Officials cannot enforce zoning code. They can communicate with land use planning staff for zoning code enforcement. Planning staff can communicate with the Building Official about building codes. Grading, erosion control, and stormwater management authorities should also be identified as to which departments are responsible.
- Sources of funding for enforcement of codes could be fees for applications and inspections.
- ⇒ *How do we resolve conflicts between landslide risk reduction and other regulations?*
- Communication, clarity, and coordination is important.
- There are many examples of codes such as fire siting standards, fire department access, structure/wildfire fuel reduction standards, environmental standards, transportation standards, landscaping and screening standards, and other standards. Finding the basis of the requirement (such as, is there a state or federal requirement of compliance) is useful.
- Work through the issues.
- Having a Pre-Application process for a development can provide a good, early in the process discussion avenue.

D. SUMMARY OF KEY WAYS TO REDUCE YOUR COMMUNITY'S RISK FROM LANDSLIDE HAZARDS

- **Identify the hazard** – Know what the hazard is, where it is located, what causes it, what are its characteristics, when and where has it occurred historically, and when and where might it happen again.
- **Assess the vulnerabilities** – Inventory and analyze the existing and planned property and populations exposed to a hazard, and estimate how they will be affected by the hazard.
- **Assess the level of risk** – Risk is the expression of the potential magnitude of a disaster's impact. A natural hazards risk assessment involves

characterizing the natural hazards, assessing the vulnerabilities, and describing the risk either quantitatively or qualitatively or both.

- **Avoid the hazard** – Stay away from the hazard area if possible.
- **Reduce the level of risk** - Minimize development, reduce density, and implement mitigation measures. Manage the water on the site. Coordinate land use planning efforts with other planning efforts such as emergency operations plans, transportation plans, economic development plans, stormwater management plans, and so forth.
- **Evaluate development in landslide-prone areas** – Use technical information such as maps and reports, including site specific studies as well as broader scale information.
- **Require geotechnical investigations** – When development is proposed for locations that have landslide hazards, require site specific reports by a certified engineering geologist engineer (geotechnical assessment) or a certified engineering geologist and a geotechnical engineer (geotechnical report).
- **Adopt land use policies and enact regulations** – Regulatory tools such as overlay zones, incentive zoning, grading and erosion control provisions, stormwater management, restrictions on the types of uses and development in landslide-prone areas, size and weight of structures, management of vegetation, and other means can reduce risk of landslides. Incentive zoning requires developers to exceed limitations imposed upon them by regulations, in exchange for specific concessions. For example, if the developer avoids building on a landslide-prone area of the property then they could build on another portion of the land at a higher density than is allowed by the zoning.
- **Consider non-regulatory strategies** – Sharing information, incentives, and purchasing high hazard lands to keep them as open space are examples of strategies that can reduce risk.
- **Provide public outreach and education** – Information about the landslide hazards should be available to all inhabitants of the jurisdiction. Post it on the website, have handouts, etc.

E. RECOMMENDATIONS

- Work with DOGAMI to obtain lidar mapping information.
- Identify ways the maps and information can be integrated into the jurisdiction's plans, policies, and programs.
- Look at the plans, policies, and programs of other jurisdictions.
- Adopt the maps.
- Follow the common features listed in **Examples of strong landslide risk reduction zoning codes in Oregon** (Chapter 4, section A.4).
- Follow the **Summary of Key Ways to Reduce Your Community's Risk from Landslide Hazards** (Chapter 4, section D).

F. INTEGRATED IMPLEMENTATION

Hazard Mitigation: Integrating Best Practices into Planning¹⁹¹ by James C. Schwab, Editor, American Planning Association (APA) Planning Advisory Service Report Number 560, May 2010

From Chapter 9, Findings and Recommendations (p. 131), by James C. Schwab:

Hazards of any kind – natural or otherwise – are almost never the public’s top planning priority except when a disaster is unfolding. It is far easier to focus on any number of issues affecting the daily quality of life in a community, including economic development, transportation, and what is built next to what or whom. The reality, however, is that hazards suffuse our lives and our development patterns. They inevitably constitute part of the background for many of the other priorities planners must address and should be a consideration when those issues are on the table. Ignoring them does not make them go away. Consequently, finding ways to integrate the consideration of hazards into planning discussions is the most effective way to ensure that they are addressed when the community is in the best position to forestall problems.

Schwab (p. 132) summarizes the findings of the research conducted for that report:

What Works?

- Complementary Goals and Objectives in the Local Hazard Mitigation Plan and Comprehensive Plan
- Implementing Hazard Mitigation through Government Expenditures and Development Regulations
- Documenting Existing and Predicted Future Conditions and Raising Awareness of What Can be Done about Them
- Mutual Reinforcement Between Hazard Mitigation and Other Planning Goals
- Sustaining Leadership for Hazard Mitigation
- Strong Culture of Preparedness and Mitigation
- Using External Drivers as Leverage While Focusing on Community Needs
- Proactive Outreach and Stakeholder Involvement in Planning

What Does Not Work?

- Procrastination
- Failure to involve Planners in Local Hazards Planning
- Failure to Engage Public Participation or to Communicate about Hazards

¹⁹¹ <https://www.fema.gov/media-library/assets/documents/19261>

- Investment in Redevelopment without Accounting for Hazards
- Failure to Use Other Plans to Address Hazards

The Road Ahead

- Learn from Disasters
- Start Change Now
- Strengthen Integration of Hazards with Other Planning Activities
- Think Linkages

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CHAPTER 5 RESOURCES

In the end, it is important both to focus on hazards in a specific element devoted to identifying and assessing the hazards a community faces and to integrate those concerns more broadly into other elements, since hazards do not operate in isolation from the built environment.

—*Hazard Mitigation: Integrating Best Practices into Local Planning*¹⁹²

A. FRAMEWORK FOR COMPREHENSIVE PLAN AND ZONING CODE PROVISIONS

Chapter 3, section **E.2, Example Comprehensive Plan policies**, contains three examples of jurisdictions with strong landslide hazard language in their comprehensive plans: Medford, Astoria, and Portland. **Table 5-1** and **Table 5-2** (Cities) and **Table 5-3** and **Table 5-4** (Counties) provide links to other plans evaluated for this *Guide*.

This section provides a framework for a comprehensive plan.

Comprehensive plans guide overall growth and development by addressing social, economic, and environmental issues. Integrating hazard mitigation and risk reduction into comprehensive plans is a key approach that provides an overarching policy framework for various other planning tools. Since the comprehensive plan is a policy document, it is fundamentally different from many of the other planning tools, yet is linked to those tools, for example, but not limited to, zoning code, building code, stormwater management, capital improvement programs, and grading and erosion control provisions.

“General considerations for integrating hazards into comprehensive plans include:

- Hazard mitigation measures are not only infrastructure-related. They can include community level communication, preparedness planning, and other non-structural measures.
- Whenever possible, mitigation measures should work to mimic natural processes rather than engineered solutions, such as reconnecting a creek to its floodplain for natural flood control rather than channelizing it.

¹⁹² Schwab & Topping, 2010, p. 23, https://www.fema.gov/media-library-data/20130726-1739-25045-4373/pas_560_final.pdf

- The safety of vulnerable communities related to natural hazard risks and other stressors should receive particular attention in the comprehensive plan.”¹⁹³

When reviewing the comprehensive plan to strengthen plan policies and the related implementing regulations, consider the features listed in **Figure 5-1**.

Figure 5-1. Features of Strong Comprehensive Plans

Features of Strong Comprehensive Plans

- Make use of technical information and assistance provided by local, regional, state, and federal agencies regarding natural hazards.
- Clearly link to the implementing provisions (zoning code, building code, etc.).
- Include specific references (e.g., title and date of information) to supporting documents and maps.
- Include or refer to documents, maps, or technical assistance needed to understand impacts of natural hazards.
- Create opportunities to guide growth and development away from natural hazard areas and/or provide for appropriate review of the growth and development when it is in or near a hazard area.
- Consider climate change and the impacts of climate change on natural hazards, and the subsequent vulnerabilities and risks to the community.

Comprehensive plans and implementing regulations can build the resilience of a community by using existing information about the location, frequency, and severity of hazards into consideration. Establishing and maintaining the importance of not increasing risks to people, property, and the environment is a key theme.

Natural hazards can be integrated into comprehensive plans in the areas of land use and future development, natural resources protection, transportation, housing, economic development, historic properties and cultural resources, and public facilities and infrastructure.

Chapter 4, section **A.4, Examples of strong landslide risk reduction zoning codes in Oregon**, contains six examples of jurisdictions with strong landslide hazard zoning code provisions. There are examples of three jurisdictions with covenants, Oregon City, Portland, and Seattle. All three of these jurisdictions also have strong zoning codes.

¹⁹³ <https://planningforhazards.com/comprehensive-plan>

Here we offer both a model comprehensive plan outline for landslide hazards in Oregon and a model zoning code outline for landslide hazards in Oregon. These model outlines provide key points recommended for inclusion in comprehensive plans and zoning codes related to landslide hazards. These can be adapted to each jurisdiction's needs.

NOTE:

IMS-22 is the best available information about debris flows (also identified as rapidly moving landslides). IMS-22 is *GIS Overview Map of Potential Rapidly Moving Landslide Hazards in Western Oregon* (DOGAMI, 2002). In the future, DOGAMI plans to have a debris flow susceptibility map of Oregon; the debris flow susceptibility map will replace IMS-22.

Figure 5-2. Outline of Model Comprehensive Plan Provisions for Landslide Hazards in Oregon

Outline of Model Comprehensive Plan Provisions for Landslide Hazards in Oregon

- Describes goals, policies, and implementing measures.
- Has information about and describes the interrelationship of land use, social, economic, environmental, resilience, and climate change impacts.
- Has a specific section about disasters and hazards, and identifies and describes the natural hazards that have occurred in the past and could in the future, impact the community.
- Specifically refers to community plans that include natural hazard information such as the Natural Hazard Mitigation Plan, the Emergency Operations Plan, the Transportation System Plan, the Capital Facilities Plan, the Open Space Plan, and the Water and Sewer Plan.
- Identifies maps and reports that support the goals, policies, and implementing measures of the community.
- Uses information from DOGAMI's lidar-based landslide maps and reports such as the landslide inventory, shallow susceptibility landslides, deep susceptibility landslides, and IMS-22. IMS-22 is GIS Overview Map of Potential Rapidly Moving Landslide Hazards in Western Oregon (DOGAMI, 2002).
- Includes recommendations about mitigating hazards such as but not limited to avoiding and minimizing construction in landslide hazard areas.
- Includes information about grading and erosion control, stormwater management, removal of vegetation, and installing vegetation.
- Describes who can request additional geologic reports (engineering geology report and geotechnical engineering report) and maps during review processes, such as the Planning Director, Public Works Director, City Engineer, and Building Official.
- Describes which geoprofessional should sign and stamp the required reports and maps.
- Has information about and links the topics of stormwater management and grading and erosion control to the natural hazards.
- Recognizes that steep slopes are not the only factor that should be used to identify landslide hazard areas. Other factors to be considered along with slope steepness include: the type of development, the size and scale of the development, the weight and extent of the construction, the location of the vulnerable population, the location of the critical facilities, erosion (natural and human caused), and grading. Also consult geotechnical reports on file, and the information on DOGAMI's Statewide Landslide Susceptibility Map (<https://www.oregongeology.org/pubs/ofr/p-O-16-02.htm>) released in February 2016. It may also be useful to check the most current version of SLIDO (<https://www.oregongeology.org/slido/index.htm>).

Figure 5-3. Outline of Model Zoning Code Provision for Landslide Hazards in Oregon

Outline of Model Zoning Code Provision for Landslide Hazards in Oregon

- **Intent and Purpose** — why is this code provision here.
- **When Required (Regulated Activities) or Applicability of Landslide / Geologic Hazard Regulations** — when do these provisions apply, what kind of activity requires a permit, clearly identifies reference maps and reports here.
- **Landslide and/or Geologic Hazard Reference Maps and Reports** — uses information from DOGAMI's lidar-based landslide maps and reports such as the landslide inventory, shallow susceptibility landslides, deep susceptibility landslides, and IMS-22. IMS-22 is GIS Overview Map of Potential Rapidly Moving Landslide Hazards in Western Oregon (DOGAMI, 2002)].
- **Landslide and/or Geologic Hazard Permit Submittal Requirements and Procedures** — what information must be submitted for the permit, and what is the process that will be followed (this may include the geologic assessment or geotechnical report requirements or it may be a separate section).
- **Exemptions** — when do the provisions not apply, what kind of activity does not require a permit.
- **Prohibitions** — if applicable.
- **Development Standards** — how to construct, build, move earth materials and vegetation on the site, e.g., cut/fill/grading, retaining walls etc.
- **Access to Property** — minimize disturbance related to driveways by sharing driveways and limiting cut and fill, make sure emergency services can access to the site.
- **Stormwater Drainage** — how will the stormwater be managed.
- **Erosion Control Measures** — minimize disturbance and removal of soil and vegetation, avoid off-site impacts, identify the temporary and permanent groundcovers and plantings.
- **Utilities** — will there be utilities on the site, if so which ones and where will they be located, will they be above or below ground.
- **Approval Authority** — who reviews and approves the permit application.
- **Appeals** — is the permit appealable and if so, what are the procedures.
- **Liability, Waivers, Covenants** — releasing the city or county from liability, waiver of damages with indemnity and hold harmless agreement or covenant, requirements to record the waivers or covenants with a County Recorder, requirements to file with city or county.
- **Certification of Compliance** — all laws and regulations must be complied with, if there is a conflict of regulations then the more restrictive one applies, proof that the development has been constructed in compliance with the requirements must be submitted prior to issuance of final approval, inspections if applicable.

B. SUMMARY OF CITY AND COUNTY CODE REVIEW

In Chapter 4, section **B, Code Review for the Landslide Guide**, is a description of the results of the DOGAMI and DLCD review of the 34 city and county codes cited in Table 4-7, **Table 5-1** through **Table 5-4**, and in **Chapter 8, Landslide Code Review Details Table**. These 34 cities and counties are included within the larger listing of communities in **Table 1-1**, which includes Oregon communities with DOGAMI lidar-based landslide inventory and landslide susceptibility maps.

Table 5-1. City Plans Examined for This Guide. The selected communities represent those currently with shallow and deep landslide susceptibility mapped areas. The majority of the code review occurred between May and December of 2017. See Chapter 8 for expanded table. Also see Table 5-2 for landslide map information. Note that Salem and Newport do not have landslide susceptibility maps.

Document	Percent Slope	Landslide Study	Certification	Landslide Study Process	Drainage and Soil Types	Grading & Erosion Control	Land Division	Building Code	Connected to Other Codes	Other Relevant Codes/Provisions
Astoria Comprehensive Plan	NA	yes	yes	yes	yes	yes	yes	NA	yes	
Astoria Development and Zoning Codes	yes	yes	yes	yes	yes	yes	yes	yes		yes
City of Banks Code of Ordinances	NRC	NRC	NRC	NRC	NRC	yes	yes	yes	NA	yes
Beaverton Comprehensive Plan	yes	NRC	NRC	NRC	NRC	NRC	NRC	NA	NA	yes
Beaverton City Code	NA	yes	yes	yes	yes	yes	yes	NA	NA	yes
Brookings Municipal Code	yes	yes	yes	yes	yes	yes	yes	NA	NA	yes
Canby City Code	yes	NRC	NRC	yes	yes	yes	yes	NA	NA	yes
Clatskanie Development Code	NA	yes	yes	yes	yes	yes	yes	NA	NA	yes
Clatskanie Comprehensive Plan (1978)	yes	NR	NR	NR	NR	NR	NR	NA	NA	yes
Cornelius Comprehensive Plan	NA	NA	NA	NA	yes					yes
Cornelius Municipal Code	NA	NA	NA	yes		yes	yes			yes
Durham Development Code	yes	as necessary	NRC	NRC	yes	yes	yes	yes		yes
Comprehensive Land Use Plan	NR	yes	NR	NR	yes	NR	NR	NR	NR	
Estacada Comprehensive Plan	yes	yes	NR	NR	yes	yes	yes	yes		
Estacada Development Code	yes	yes	yes	yes	yes	yes	yes	yes		
Eugene City Code	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Fairview City Code	yes	yes	NA	NA		yes	yes	NA	NA	
Fairview Comprehensive Plan	NR	NR	NR	NR	yes	yes	NR	NR	NA	
City of Forest Grove City Code	NR	NR	NR	NR	NR	yes	NR	NR	NA	
Gladstone City Code	NR	yes	yes	yes	yes	yes	yes	NR	NA	
City of Gold Beach Comprehensive Plan (1982)	NR	yes	NR	NR	yes	NR	NR	NA	NA	yes
City of Gold Beach Zoning Ordinance	NR	yes	yes	yes	NR	yes	yes	NR	NA	yes
City of Gresham Development Code	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Article 5 - Overlay Districts										
Maywood Park Ordinances	NR	NR	NR	NR	NR	NR	NR	NR	NR	yes
Land Development Code	yes	yes	yes	yes	yes	yes	yes	yes	yes	
Newport Municipal Code: Chapter 14.21 Geologic Hazards Overlay	no	yes	yes	yes	yes	yes	NR	yes	yes	yes
Oregon City Municipal Code	NA	yes	yes	yes	yes	yes	yes	NR	yes	yes
Port Orford Municipal Code	yes	yes	yes		yes	yes	yes			
Portland Zoning Code (Title 33 of the City Code)	no	yes	yes	yes	yes	yes	yes	no	yes	yes
Portland City Code, Title 24						yes		yes		
City of Portland Erosion Control Manual (March 2008)								yes		
Salem Revised Code	NA	yes	yes	yes	yes	yes	yes		yes	
Sandy Title 17 Development Code	yes	yes	yes	yes	yes	yes	yes	yes		yes
Silverton Municipal Code	yes	yes	yes	yes	yes	yes	yes	NR	NA	yes
Springfield Development Code	yes	yes	yes	yes	yes	yes	yes	yes	yes	
Community Development Code	yes	yes	NA	yes	yes	yes	NR	NR	NR	
City of Vernonia Ordinances	NRC	NRC	NRC	NRC	NRC	NRC	NRC			
West Linn community Development Code	yes	yes	yes	yes	NRC	yes	yes	NRC		

Notes: NA = not applicable; NRC = Not referenced in code; NR – none/not referenced.

Table 5-2. City Plans Examined – Landslide Hazard Area Map Criteria

Document	Is the Landslide Hazard Area Mapped?	Associated Overlays	Associated Maps	Map Dates in Document
Astoria Comprehensive Plan	yes		yes	NR
Astoria Development and Zoning Codes	yes		yes	2015
City of Banks Code of Ordinances	no		NRC	NR
Beaverton Comprehensive Plan	no	yes	NRC	
Beaverton City Code	no		NRC	
Brookings Municipal Code	no		NRC	
Canby City Code	no	yes	NRC	
Clatskanie Development Code	no		NRC	NA
Clatskanie Comprehensive Plan (1978)	no		NR	
Cornelius Comprehensive Plan	yes, partial?		yes	1974
Cornelius Municipal Code	no		NA	NA
Durham Development Code	no		NA	NA
Comprehensive Land Use Plan	no		NA	NA
Estacada Comprehensive Plan	yes		yes	Undated
Estacada Development Code	yes		yes	1979
Eugene City Code	no	yes	NA	NA
Fairview City Code	NR		NA	NA
Fairview Comprehensive Plan	NR		NA	NA
City of Forest Grove City Code	NR		NA	NA
Gladstone city Code	no		NA	NA
City of Gold Beach Comprehensive Plan (1982)	yes	no	yes	1982
City of Gold Beach Zoning Ordinance	yes	yes	yes	"Bulletin 90 - 1976
City of Gresham Development Code Article 5 - Overlay Districts	yes	yes	yes	NR
Maywood Park Ordinances	NR		NA	NA
Land Development Code	yes		yes	
Newport Municipal Code: Chapter 14.21 Geologic Hazards Overlay	yes	yes	yes	
Oregon City Municipal Code	yes	yes	yes	2009 and 1979
Port Orford Municipal Code	yes	yes		2014 (both)
Portland Zoning Code (Title 33 of the City Code)	yes	yes	yes	On Portland Maps, the dates are generally showing the data are updated through April 2017.
Portland City Code, Title 24				
City of Portland Erosion Control Manual (March 2008)				
Salem Revised Code	yes	yes	yes	IMS-5: 2000; IMS-6: 1998; IMS-17: 2000; IMS-18: 2000; IMS-22: 2002
Sandy Title 17 Development Code	yes	yes		
Silverton Municipal Code	maybe ??	yes	NA	NA
Springfield Development Code	no	yes	NR	NA
Community Development Code	NR		NA	NA
City of Vernonia Ordinances	NRC		NRC	
West Linn community Development Code	NRC	yes	NRC	

Notes: NA = not applicable; NRC = Not referenced in code; NR – none/not referenced.

Table 5-3. County Plans Examined . The selected counties represent those currently with shallow and deep landslide susceptibility mapped areas. The majority of the code review occurred between May and December of 2017. See Chapter 8 for expanded table. Also see Table 5-4 for landslide map information.

Document	Percent Slope	Landslide Study	Certification	Landslide Study Process	Drainage and Soil Types	Grading & Erosion Control	Land Division	Building Code	Connected to Other Codes	Other Relevant Codes/Provisions
Coos County Comprehensive Plan Volume 1 Part 1	NR	yes	yes	yes	NR	NR	yes	NR		
Curry County Zoning Ordinance Lane Code	no	yes	yes	yes	yes	yes	yes	NR		yes
Multnomah County Zoning Code	yes	yes	yes	yes	yes	yes	yes	no	yes	yes
Tillamook County Development Standards	yes	yes	yes	yes	yes	yes	yes	NRC	NA	
Tillamook County Comprehensive Plan Goal 7 Hazards	NR	yes	NR	NR	yes	yes		yes	NA	yes

Notes: Notes: NA = not applicable; NRC = Not referenced in code; NR – none/not referenced.

Table 5-4. County Plans Examined – Landslide Hazard Area Map Criteria

Document	Is the Landslide Hazard Area Mapped?	Associated Overlays	Associated Maps	Map Dates in Document
Coos County Comprehensive Plan Volume 1 Part 1	NR		NR	
Curry County Zoning Ordinance Lane Code	yes	yes	yes	
Multnomah County Zoning Code	Slope Hazard Map	yes	yes	1970s[?]
Tillamook County Development Standards	yes		yes	1972
Tillamook County Comprehensive Plan Goal 7 Hazards	maybe		yes	

Notes: NR = Not referenced.

C. LANDSLIDE GUIDE INTERVIEWEES' KEY POINTS

As part the research for the *Guide*, including the code review, DLCDC and DOGAMI staff interviewed staff at local jurisdictions and consultants, and collected input from the staff presentations for Oregon American Planning Association (OAPA) on October 19, 2018, and December 7, 2018. The interviewees' key points can be bundled into categories: enforcement, maps, real estate issues, code issues, process and regulations, outreach and education, authority, insurance, and other. These key points were used to inform the topics addressed by this *Guide*.

C.1. ENFORCEMENT

- Enforcement is lacking for existing codes. Enforcement is a big issue in smaller and under-resourced jurisdictions. Sometimes violations cannot be seen because they are hidden by the landscape. Sometimes violations go unreported because they have to be reported in writing.
- Enforcement is also an issue with respect to earthwork contractors who design on the go, do not follow report recommendations, and do not ensure a site is stabilized before development.
- Enforcement is also an issue with contractors in general who do not follow the geotechnical report recommendations.

C.2. MAPS

- Jurisdictions are not using the lidar-based landslide maps that have been created by DOGAMI, or have been using them without adopting them officially.
- Clarity on what the minimum requirement is that a jurisdiction has to do when they get the maps. Not because they want to do the minimum, but because it is not clear if there is a requirement for them to implement the DOGAMI map information in a certain way. They want guidance, best practices examples, and legal advice.
- Landslide maps and the ramifications of what the maps show as it relates to available housing and buildable lands; e.g., decrease the residential density of landslide areas and change the options for what can be built in all types of zoning in hazard areas (such as no hospitals in high hazard areas).
- When the local jurisdiction has good maps, codes, etc. then the burden is on the applicant to provide information that it is ok to build/do work on the site. When local jurisdictions do not have the strong local maps and codes, then the burden is on the jurisdiction when the applicant information comes in.

C.3. REAL ESTATE ISSUES

- Jurisdictions have concerns about takings lawsuits of property, claims from people saying property values are decreasing when their property is shown in hazard areas, and applicant's burden related to cost of doing geotechnical evaluations of the site.
- Suggest that the state require that properties with landslide hazard must be disclosed and that information be recorded to the property deed. There is a real estate disclosure form with landslide hazard identification requirements, but it could be made stronger. Language could be added that says in landslide hazard areas the water has to be managed (not allowed to concentrate on the site). Real estate agents look the other way – they do not want to know. Some will tell applicants to get a geotechnical report.
- Recognize that people have investment in their property; people get scared about potential impacts to their property and about change in general.
- Is there an option to buy out properties in identified high hazard areas before the landslide occurs? For example, do something in advance rather than waiting for the structures on the property to be destroyed.

C.4. CODE ISSUES

C.4.a. Grading

- General contractor liability/grading and erosion control issues/responsibility of their actions/codes are concerns. Seems like their actions can severely alter the terrain of a site, but they do not end up on the hook for their work, which can have great impacts.
- Could the state require each jurisdiction to have a grading and erosion control requirement? Or adopt a statewide grading code. Implement other parameters at the state level with contractor licensing requirements?
- Suggest looking to Washington and California for grading codes and state guidelines.
- Typically, people grade and clear then come in for a permit (grading and enforcement issues).

C.4.b. Policies and regulations

- Jurisdictions have asked for examples of zoning code and comprehensive plan language to use in the local codes and plans.
- What makes a landslide hazard code robust? Give examples of robust landslide hazard code.
- Building codes could be strengthened. That would happen at a state level and through the appropriate process. There is the *Oregon Structural Specialty Code*, the *Oregon Residential Specialty Code*, and other codes.
- Address “clear and objective standards” issue.

- Address impacts of landslide policies and regulations on other Statewide Planning Goals.
- Landslide regulations could conflict with fire siting standards in timber zones.

C.5. PROCESS AND REGULATIONS

- Early assistance to applicants (pre-application process) to discuss the information is good; providing it so that other options can be evaluated and selected, and so that they know what the situation is they are getting into when they propose to develop new or modify structures on a site, and to alter the shape of the land or watercourse.
- Require a signed statement from the architect, developer, applicant, etc. that they have read the geotechnical report.
- Authorize 3rd party review in code.
- Require contractors to follow recommendations as a condition of permit approval.
- Require a RG, GE, or CEG inspect the site during construction to ensure recommendations are followed.
- Communication between planners and building officials needs to be improved.

C.6. OUTREACH AND EDUCATION

- Outreach and education materials have been requested by jurisdictions: direction and guidance on how to integrate landslide information with NHMPs, comprehensive plans, and zoning codes; also how to implement the information on landslides – the maps, data, and other materials – e.g., zoning code, building code, non-regulatory options etc.
- People from Seattle and California retire here and assume they are taken care of (since that is what they are used to) but they are not.
- Need training – include grading codes as a training topic.

C.7. AUTHORITY

- It was noted by jurisdictions that having state guidance and state requirements can provide the local jurisdiction with support and weight to the subject matter. As in, the state has determined this is a hazard, this is important, and this needs to be addressed, so the local level should do take action about it.
- Jurisdictions want the assistance but want to do it in their way to fit the local situation.

C.8. INSURANCE

- People want to know more about landslide insurance.
- Noted that Lloyd’s of London has landslide insurance available for purchase.

C.9. OTHER

- Suggest that as we prepare the *Landslide Guide* we reach out to the licensing boards for engineers to see what thoughts, experiences, and interest they have in these issues and potential changes that could be made. Could their requirements be tightened up? Do they have suggestions for local jurisdictions?
- Suggest that we do a *Wildfire Guide* after this statewide *Landslide Guide*.
- Address impacts of landslides after a wildfire.

D. LANDSLIDE INSURANCE

While the research for this *Guide* did not include a broad or deep review of insurance available to homeowners within, near, or outside of designated landslide hazard areas, it appears that landslide insurance is not widely available to homeowners in Oregon and Washington. Property damage due to landslides is not covered under the usual homeowners or commercial property policies. Landslide coverage is typically not available through admitted insurance carriers such as State Farm and All State.

Landslide coverage can be obtained under a Difference in Coverage (DIC) policy, which is a supplemental insurance option that provides expanded coverage for some perils not covered by standard insurance policies. DIC insurance is designed to fill in gaps where the broader insurance market does not provide coverage and is most frequently used by larger organizations looking for protection from catastrophic perils. This type of coverage goes beyond the purchase of additional coverage limits, since standard coverage typically excludes certain perils¹⁹⁵.

DIC policies are typically offered through the surplus lines market¹⁹⁶. One of the largest surplus lines insurers that offer landslide insurance is Lloyd’s of London.

Annual Landslide Losses

According to the American Geosciences Institute website¹⁹⁴, “More recently, the U.S. Geological Survey estimated annual losses to be between \$2 billion and \$4 billion per year. However, landslide costs across the country are not currently tracked or measured in a uniform way by any one agency, so this figure is likely to be an underestimate.”

¹⁹⁴ <https://www.americangeosciences.org/critical-issues/faq/how-much-do-landslides-cost-terms-monetary-losses>

¹⁹⁵ <https://www.investopedia.com/terms/d/difference-conditions-dic-insurance.asp>

¹⁹⁶ The surplus lines market offers insurance to consumers and businesses that cannot obtain coverage from insurers that are certified and regulated in each state (Alex Cheng, Division of Financial Regulations, Oregon Department of Consumer and Business Services, personal communication, May 15, 2019). See <https://dfr.oregon.gov/business/licensing/insurance/institutions/Pages/surplus-lines-insurance.aspx>.

Lloyd's of London Insurance provides insurance coverage to a broad range of items. According to their website,

Lloyd's is not a single insurance company; it is a market place where insurance and reinsurance risks are underwritten by syndicates of underwriting members. Subject to certain exceptions, only Lloyd's brokers can arrange insurance cover directly with Lloyd's underwriters, although other firms known as coverholders may be authorized to enter into contracts of insurance on behalf of Lloyd's underwriters¹⁹⁷.

DIC policies in Oregon totaled \$25 million in premium in 2016 and \$27.2 million in 2017 (Alex Cheng, Oregon Department of Consumer and Business Services, Division of Financial Regulations, personal communication, May 15, 2019).

This statement provides a framework for standard versus supplemental insurance.

With auto and homeowners insurance, a very large number of people are exposed to the same risks but only a random few in any geographic area ever experience a loss. Thus the premium of each policyholder is relatively low. With the risk of landslides, floods and earthquakes the situation is reversed. For example, with landslides, few people are exposed to these events but where there is a risk, many living in the area are likely to suffer when a landslide occurs. And only the people in an area vulnerable to landslides are likely to purchase the coverage. So the premium needed to cover all the potential claims must be high. When the premium is high, fewer people purchase it. The same is true with flood and earthquake insurance.¹⁹⁸

The Oregon Division of Financial Regulation, Consumer Business and Business Services provides insurance information for people in Oregon¹⁹⁹. The website notes that homeowner insurance pays for damage to the homeowner's home and other structures on the property.

It also may cover:

- Damage to or loss to contents of the homeowner's home,
- The liability for accidents that occur on the homeowner's property or for damage to others' property.

The website also notes what the insurance may not cover:

- **Floods:** Flood insurance is typically provided through the National Flood Insurance Program. The homeowner must buy flood insurance through an agent. Get a referral at 888-379-9531 (toll-free).

¹⁹⁷ <https://www.lloyds.com/help-and-glossary/faqs>

¹⁹⁸ <https://www.iii.org/article/spotlight-on-catastrophes-insurance-issues>, "Spotlight on: Catastrophes - Insurance issues", June 6, 2018; accessed May 2, 2019

¹⁹⁹ <https://dfr.oregon.gov/insure/home/Pages/index.aspx>

- **Earthquakes:** The homeowner can buy earthquake insurance as a separate endorsement to their homeowner or renter policy or as a stand-alone policy separate from the homeowner policy.
- **Landslides** (earth movement) *are not covered*. This type of coverage may be difficult to obtain. Talk to an agent.
- There may be coverage gaps when insuring cannabis related properties.

There are numerous resources available from this website.

In Washington, the place to find landslide insurance information is the Washington Office of the Insurance Commissioner²⁰⁰. The website has information about earthquake, flood, and landslide insurance. Of note, the website states:

- **Landslide insurance:** A standard homeowner policy will not cover damage caused by land movement or a landslide due to: rain runoff, snowmelt, flooding, and earthquakes. It suggests that homeowners think about buying additional insurance to protect property from potential damage.
- **Content coverage:** This is a special rider for a homeowner policy that includes coverage for the contents of the home from all perils, including earth movement. This rider only covers contents, not the structure. Some insurance companies may not offer this option; the homeowner may need to shop around.
- **Separate earth-movement coverage:** This coverage includes structures, such as the house or any other unattached buildings on the property. It is commonly called a "Difference in Conditions" (DIC) policy. DIC policies include coverage for landslide, mudflow, earthquake, and flood. An agent or broker may be able to get the homeowner this coverage in the surplus market. These are companies that insure risks the industry traditionally does not insure.
- **Flood insurance:** Standard homeowner policies do not cover flood damage, so homeowners must buy coverage separately. Flood insurance may apply to some kinds of earth movement, such as water-related erosion, mudflows, and flash floods.
- **Earthquake insurance:** Homeowners also must buy earthquake insurance separately, either as an additional policy or as an endorsement to the regular homeowner policy.

²⁰⁰ <https://www.insurance.wa.gov/landslide-insurance>

E. TAX INCENTIVES, EXEMPTIONS, AND ABATEMENTS

A tax incentive is a “[d]eduction, exclusion, or exemption from a tax liability, offered as an enticement to engage in a specified activity (such as investment in capital goods) for a certain period”²⁰¹. Tax incentives can be a tool to motivate a person to action and to compensate them for doing so. Creating a tax incentive for not developing in hazard areas could be one way to encourage property owners to not develop or to develop a property less intensively and to mitigate hazard impacts by avoiding or reducing the potential impacts to people, property, and the environment. A deduction tax incentive can also be called a tax abatement.

A tax abatement “is a reduction of taxes granted by a government to encourage economic development. The most common type of tax abatement is a property tax abatement granted to a business as an incentive to come to a city or expand existing operations within the city. Tax abatements last for a defined period for owners invest additional capital in the business”²⁰².

“Property tax abatement is a reduction or exemption from property taxes granted by the taxing authority. Because property taxes are local taxes imposed through the authority of state law, tax abatement programs vary largely by state. Tax abatement programs are directed at classes of property owners—such as veterans—as well as classes of property—such as historic landmarks”²⁰³.

Exemptions provide an exclusion from obligation. A property tax exemption is one example. It “is a legislatively approved program that relieves qualified individuals or organizations from all or part of their property taxes.”²⁰⁴ Exemptions can be either full or partial, depending on the program requirements and the extent to which the property is used in a qualifying manner. There are over 100 property tax exemptions in Oregon.

Most exemptions granted to non-governmental entities are granted to religious, fraternal, literary, benevolent, or charitable organizations. The exempt property must be reasonably necessary and used in a way to achieve the organization's purpose. Any portion of the property that does not meet the requirements of the exemption the program is taxable.²⁰⁵

Some property is taxed at a reduced value through a special assessment program. In that case, the lower assessed value results in a reduced tax liability. Examples of special assessment programs include “historic property, farmland, forest land, and conservation easement” according to the Oregon Department of Revenue, Property Tax Exemptions website²⁰⁴.

²⁰¹ <http://www.businessdictionary.com/definition/tax-incentive.html>

²⁰² <https://www.thebalancecareers.com/tax-abatement-1669487>

²⁰³ <https://homeguides.sfgate.com/property-tax-abatement-programs-3245.html>

²⁰⁴ <https://www.oregon.gov/dor/programs/property/Pages/exemptions.aspx>

²⁰⁵ <https://www.oregon.gov/DOR/programs/property/Pages/exemptions.aspx>

F. OTHER SOURCES OF INFORMATION ABOUT ENGINEERING GEOLOGIC REPORTS AND GEOTECHNICAL ENGINEERING REPORTS

It may be useful to look at the resources that other states use for engineering geologic reports and geotechnical engineering reports.

- California – County of Los Angeles, July 1, 2013 rev., *Manual for Preparation of Geotechnical Reports*. Geotechnical and Materials Engineering Division, 163 p. <http://dpw.lacounty.gov/gmed/manual.pdf>
- Utah – Utah Section of the Association of Engineering Geologists, 1986, *Guidelines for Preparing Engineering Geologic Reports in Utah*: Utah Geological and Mineral Survey Miscellaneous Publication MP-m, 2 p. https://ugspub.nr.utah.gov/publications/misc_pubs/mp-m.pdf
- Utah – Utah Geological Survey, 2016, Chapter 4, Guidelines for Evaluating Landslide Hazards in Utah, in *Guidelines for Investigating Geologic Hazards and Preparing Engineering-Geology Reports, with a Suggested Approach to Geologic-Hazard Ordinances in Utah*, Circular C-122, Steve D. Bowman and William R. Lund, eds, 217 p. <https://ugspub.nr.utah.gov/publications/circular/c-122.pdf>
- Washington – Washington State Geologist Licensing Board, 2006, *Guidelines for Preparing Engineering Geology Reports in Washington*: Department of Licensing, 15 p. <https://www.dol.wa.gov/business/geologist/docs/georptguide.pdf>
- Nationwide – *AEG Professional Practice Handbook*. <https://cdn.ymaws.com/www.aegweb.org/resource/resmgr/Publications/aegpph.pdf>

G. ADDITIONAL RESOURCES

G.1. TECHNICAL GUIDES FOR AGENCIES

G.1.a. Planning for Natural Hazards: Oregon Technical Resource Guide – Landslide Chapter

The *Planning for Natural Hazards: Oregon Technical Resource Guide*²⁰⁶ was published in 2000 by DLCD and the Oregon Partnership for Disaster Resilience / Community Planning Workshop. The purpose of this project was to develop technical resource guides (TRGs) for Oregon cities and counties to plan for, and limit the effects of,

²⁰⁶ <https://scholarsbank.uoregon.edu/xmlui/handle/1794/1909>

threats posed by natural hazards. The project intended to provide resource guides and plan evaluation tools written for local staff and officials to assist jurisdictions across the state in developing policies, plans, and non-regulatory mitigation strategies to prevent high-risk development and to understand the legal ramifications of regulating development in potential hazard areas.

G.1.b. Landslides after Wildfires

The *Oregon Post Wildfire Flood Playbook*²⁰⁷ was published by the U.S. Army Corps of Engineers (USACE) Silver Jackets on September 30, 2018. The *Playbook* contains resources for local governments to address increased flood risk and debris flows that can occur after large wildfires. This *Playbook* is a resource to communities affected by a wildfire that need to navigate the complex web of federal and state programs and agencies.

G.1.c. Landslide Mitigation Strategies

*Landslide Mitigation Strategies*²⁰⁸, prepared for Minnesota Department of Natural Resources, December 2016, provides guidance for county and municipal officials ready to take action to reduce exposure to landslide impacts. The guide recommends (p. 4):

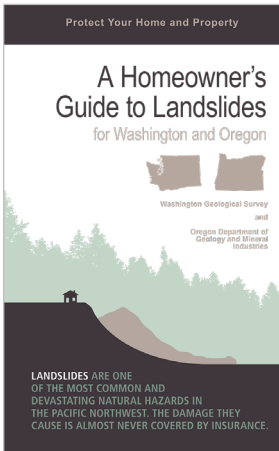
New landslide-related regulations should build on existing policy and may include the following:

- Development restrictions and moratoriums;
- Minimum structure and impervious surface setbacks based on an assessment of risk – including permit reviews and approvals with geotechnical assessment;
- Vegetation standards (native plants with strong, deep root systems);
- Open space requirements that protect sensitive slopes;
- Real estate disclosure requirement;
- Stormwater management and impervious surface restrictions;
- Landslide maintenance easements and deed restrictions; and
- Landslide hazard area building code with minimum foundation, grading, and drainage requirements.

²⁰⁷ https://silverjackets.nfrmp.us/doc/Oregon/PostFireFloodPlaybook_2018-09-30.pdf

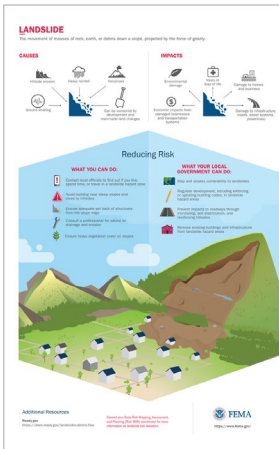
²⁰⁸ https://files.dnr.state.mn.us/waters/watermgmt_section/shoreland/landslide-mitigation.pdf

G.2. OUTREACH AND EDUCATIONAL MATERIAL FOR THE PUBLIC



A Homeowner's Guide to Landslides for Washington and Oregon was published in April 2017 and is a 12-page collaboration between the Washington Geological Survey and DOGAMI.

https://www.oregongeology.org/Landslide/ger_homeowners_guide_landslides.pdf



Landslide Information Sheet is an older FEMA sheet about causes and impacts of landslides and ways to reduce risk.

https://www.commerce.alaska.gov/web/Portals/4/pub/RiskMAP/RX_Landslide_Info-Sheet.pdf



How to Stay Safe When a Landslide Threatens

is a 2-page FEMA flyer about preparation. https://www.fema.gov/media-library-data/1527865658413-99f5517964a3e8402b7f00333eb2e3fc/Landslide_may_2018.pdf

G.3. AGENCY WEBSITES

Oregon Department of Geology and Mineral Industries (DOGAMI)

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

Oregon Department of Land Conservation and Development (DLCD)

<https://www.oregon.gov/lcd/Pages/index.aspx>

Oregon Department of Forestry (ODF)

<https://www.oregon.gov/ODF/Pages/index.aspx>

Oregon Department of Consumer and Business Services – Building Codes Division

<https://www.oregon.gov/BCD/pages/index.aspx>

Oregon Department of Transportation (ODOT)

<https://www.oregon.gov/odot/pages/index.aspx>

Oregon Office of Emergency Management (OEM)

<https://www.oregon.gov/OEM/Pages/default.aspx>

Portland State University, Department of Geology

<https://www.pdx.edu/geology/welcome-to-psu-geology>

Federal Emergency Management Agency (FEMA)

<https://www.fema.gov/>

National Resource Conservation Service (NRCS)

<https://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/>

United States Geological Survey (USGS)

<https://www.usgs.gov/>

Natural Hazards Center

<https://hazards.colorado.edu/>

Minnesota Department of Natural Resources, Landslide Mitigation Strategies, 2016.

https://files.dnr.state.mn.us/waters/watermgmt_section/shoreland/landslide-mitigation.pdf

H. MORE BACKGROUND INFORMATION

H.1. LANDSLIDE TYPES AND PROCESSES

U.S. Geological Survey *Landslide Types and Processes* fact sheet, at <https://pubs.usgs.gov/fs/2004/3072/> is a good introductory guide.

For more information about landslide types and processes:

The U.S. Geological Survey Landslide Program has information, publications, and educational information on its website. Please see <https://landslides.usgs.gov/> or phone toll-free: 1-800-654-4966.

For general information about slides, debris flows, rock falls, or other types of landslides in an area, contact the city or county geology or planning office. In addition, all 50 states have state geological surveys that can be accessed through a link at the USGS website, <https://landslides.usgs.gov/>.

- For an assessment of the landslide risk to an individual property or homesite, obtain the services of a State-licensed geotechnical engineer or engineering geologist. These professionals can be found through the membership listings of two professional societies, the American Society of Civil Engineers (ASCE), <https://www.asce.org/>, and the Association of Engineering Geologists (AEG), <https://www.aegweb.org/>. Often, personnel in state or county planning or engineering departments can refer competent geotechnical engineers or engineering geologists.
- For more information about the design and construction of debris-flow mitigation measures, which may include debris basins, debris fences, deflection walls, or other protective works, consult the city or county engineer, local flood-control agency, or the U.S. Department of Agriculture, Natural Resources Conservation Service²⁰⁹.
- For photos of landslide types, see USGS Circular 1325, *The Landslide Handbook—A Guide to Understanding Landslides*²¹⁰.
- For more detailed information on landslide processes, see “Slope movement types and processes” (Varnes, 1978²¹¹).

How to Get Lidar Data

Contact Jacob Edwards, DOGAMI Lidar Project and Database Coordinator, phone 971-673-1557.

How to Get lidar-Based Landslide Maps

If lidar imagery exists for the area and lidar-based landslide maps are wanted, contact Bill Burns, DOGAMI Landslide Hazards Section Supervisor, phone 971-277-0062.

²⁰⁹ <https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/ngce/>

²¹⁰ <https://pubs.usgs.gov/circ/1325/>

²¹¹ <http://onlinepubs.trb.org/Onlinepubs/sr/sr176/176-002.pdf>

H.2. COMMUNICATING LANDSLIDE HAZARD

It is important to convey landslide and other natural hazard information in a way that is useful and is understood effectively. According to the *The Landslide Handbook – A Guide to Understanding Landslides*, USGS Circular 1325²¹², a successful translation of information conveys three elements:

- Likelihood of the occurrence of an event of a size and in a location that would cause casualties, damage, or disruption to an existing standard;
- Expected location and extent of the effects of the event on the ground, structures, or socioeconomic activity; and
- Estimated severity of the effects on the ground, structures, or socioeconomic activity.

These elements are needed so that property owners, engineers, planners, and decision-makers become aware and concerned about the potential hazard. Potential hazards that are rare, have an unknown location, or a slight severity are unlikely to be of concern. When communicating landslide hazard information, identify the hazard and the location, and recognize the vulnerabilities and risks. For people to take aboard the information, they must be able to perceive the likelihood, the location, and severity of the hazard so they can become aware of the danger, convey that risk to others, and use the information to mitigate the risk.

H.3. MITIGATING LANDSLIDE HAZARDS

Oregon Interagency Hazard Mitigation Team (IHMT)²¹³

Prior to the spring of 1996, many of the agencies that now comprise the State Interagency Hazard Mitigation Team (State IHMT) each had hazard mitigation responsibilities. These agencies convened as a group only following presidentially declared major disasters to work with their federal and local government counterparts on the development of Interagency Hazard Mitigation Team Reports or Hazard Mitigation Survey Team Reports. The floods of February 1996 prompted Governor Kitzhaber to convene a hazard mitigation policy task group, which met several times during the spring of 1996.

The current membership of the State IHMT (**Table 5-5**) grew out of the events of the disastrous autumn and winter of 1996-1997. Their initial emphasis was on mitigating fast-moving debris flows like those that led to the loss of five lives in Douglas County in 1996²¹⁴. On March 4, 1997, Governor Kitzhaber directed OEM to

²¹² <https://pubs.usgs.gov/circ/1325/>

²¹³ <https://www.oregon.gov/oem/Councils-and-Committees/Pages/IHMT.aspx>

²¹⁴ <https://www.oregongeology.org/Landslide/LandslideTaskForceResults.pdf>

“make the...Interagency Hazard Mitigation Team a permanent body”²¹⁵ and directed the team to establish regular meeting dates.

Today the member agencies of the State IHMT generally meet quarterly.

The purpose of the State IHMT is to recognize and understand losses resulting from natural hazards, including cascading effects and particularly those that affect technological systems and critical infrastructure. Another purpose of IHMT is to recommend, collaboratively discuss, and provide feedback on mitigation strategies to lessen loss of life, property, economic, and natural resources in the State of Oregon. A primary way the State IHMT accomplishes these purposes is by maintaining the FEMA-approved and Governor-adopted *Oregon Natural Hazards Mitigation Plan (Oregon NHMP)*²¹⁶. The team continually reviews policies and plans, and makes recommendations in appropriate areas with mitigation and education as the cornerstone²¹⁷.

Table 5-5. Oregon Interagency Hazard Mitigation Team (IHMT) Member Agencies²¹⁷

Entity	Abbreviation
Department of Administrative Services	DAS
Oregon Department of Agriculture	ODA
Department of Consumer and Business Services, Building Codes Division	DCBS-BCD
Department of Consumer and Business Services, Insurance Division	—
Oregon Military Department, Office of Emergency Management	OEM
Department of Environmental Quality	DEQ
Office of the State Fire Marshal	OSFM
Oregon Department of Fish and Wildlife	ODFW
Oregon Department of Forestry	ODF
Department of Geology and Mineral Industries	DOGAMI
Oregon Health Authority, State Public Health Division	OHA
Department of Land Conservation and Development	DLCD
Oregon Parks and Recreation Department	OPRD
Oregon Public Utility Commission	PUC
Department of State Lands	DSL
Oregon Department of Transportation	ODOT
University of Oregon, Emergency Management and Continuity	—
University of Oregon, Oregon Partnership for Disaster Resilience	—
Water Resources Department	WRD

²¹⁵ Oregon Governor's Office. (1997). Governor's Debris Avalanche Action Plan-summary (referenced in Governor Kitzhaber's office March 4, 1997 press release: "Governor releases recommendations to address dangerous debris avalanches")

²¹⁶ <https://www.oregon.gov/lcd/NH/Pages/Mitigation-Planning.aspx>

²¹⁷ <https://www.oregon.gov/oem/Councils-and-Committees/Pages/IHMT.aspx>.

Oregon Landslide Risk Reduction Team (OLRRT) ²¹⁸

The Oregon Landslide Risk Reduction Team (OLRRT) is a subcommittee of the Oregon IHMT. OLRRT is a permanent team, recommended as a mitigation action item in the 2015 *Oregon NHMP* (DLCD, 2015), that engages state and federal agencies, university researchers, cities, counties, private consultants, and others working to reduce landslide risks. Landslide risk reduction is focused on, but not limited to, protecting natural resources and water quality, land use, transportation, and public safety. OLRRT meetings are open to the public and have an open comment period as an agenda item.

The mission of OLRRT is to work together to improve the ability of Oregonians to reduce landslide risk. To reduce risk, OLRRT commits to the following goals:

- Foster collaboration, transfer of geoscience and technical information, and productive linkages between stakeholders.
- Promote landslide awareness, education, preparedness, and risk reduction.

OLRRT is guided by a Leadership Team of eight members representing seven state agencies and the Governor's Office (**Table 5-6**). The Oregon Department of Geology and Mineral Industries (DOGAMI) provides administration for OLRRT.

Table 5-6. Oregon Landslide Risk Reduction Team (OLRRT) Member Agencies

Entity	Abbreviation
Oregon Department of Geology and Mineral Industries	DOGAMI
Oregon Department of Land Conservation and Development	DLCD
Oregon Department of Transportation	ODOT
Oregon Office of Emergency Management	OEM
Oregon Department of Forestry	ODF
Oregon Department of Environmental Quality	DEQ
Oregon Geospatial Enterprise Office	GEO
Governor's Office	—

Oregon Lidar Consortium (OLC) ²¹⁹

The Oregon Lidar Consortium (OLC), develops cooperative agreements for lidar collection. The business model leverages funding from multiple partners to cost effectively obtain lidar data. One use of lidar data is to create base maps for DOGAMI's landslide hazard mapping.

²¹⁸ <https://www.oregongeology.org/Landslide/olrrt.htm>

²¹⁹ <https://www.oregongeology.org/lidar/collectinglidar.htm>

H.4. ADDITIONAL RESOURCES BY TYPE

H.4.a. State of Oregon Laws, Statutes, and Rules; Codes

ORS 195.253, <https://www.oregonlaws.org/ors/195.253>

In ORS 195.250 the definition of rapidly moving landslide is “a landslide that is difficult for people to outrun or escape”,
<https://www.oregonlaws.org/ors/195.250>

Oregon Administrative Rule (OAR) 660-007-0045, Computation of Buildable Lands,
<https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=175194>

OAR 660-024-0065, Establishment of Study Area to Evaluate Inclusion in the UGB,
<https://secure.sos.state.or.us/oard/displayDivisionRules.action?selectedDivision=3074>

ORS 197.307, https://www.oregonlegislature.gov/bills_laws/ors/ors197.html

In Oregon, local jurisdictions must use the Oregon State Building Code,
<https://www.oregon.gov/bcd/codes-stand/Pages/index.aspx>

ORS 455.040, <https://www.oregonlaws.org/ors/455.040>

Uniform Building Code, https://en.wikipedia.org/wiki/Uniform_Building_Code

State of Oregon real estate disclosure form, <https://orefonline.com/wp-content/uploads/2018/01/OREF-020-january-changes-sample.pdf>

H.4.b. Oregon Community Laws, Statutes, Plans, Rules; Codes

City of Salem, Unified Development Code, Chapter 810, Landslide Hazards
https://library.municode.com/or/salem/codes/code_of_ordinances?nodeId=TITXUNDECO_UDC_CH810LAHA

Oregon City has adopted the DOGAMI lidar maps and has specifically referenced them in their code. Oregon City has several hazard maps available online:
<https://www.orcity.org/maps/hazards>

Oregon City Zoning Code, Title 17, Section 44, Geologic Hazards,
https://library.municode.com/or/oregon_city/codes/code_of_ordinances?nodeId=TIT17ZO_CH17.44EOHA

Oregon City, Declaration of Covenant Release and Indemnity for Geologic Hazards, <https://www.orcity.org/publicworks/indemnity-geologic-hazards>. The document indemnifies the City if anything were to happen to the property due to its geologic conditions.

City of Newport Zoning Code, Chapter 14.21, Geologic Hazards Overlay (GHO),
https://www.newportoregon.gov/dept/cdd/documents/NMC_Chap14_Zoning.pdf

Multnomah County Code, <https://multco.us/landuse/zoning-codes>

City of Portland, Code Guide (draft) for Requirements and Acceptance Standards for Slope Hazard Evaluations,
<https://www.portlandoregon.gov/bds/article/597690>

City of Medford adopted an ordinance to integrate the 2017 Natural Hazards Mitigation Plan (NHMP) into the Medford Comprehensive Plan,
<http://www.ci.medford.or.us/files/DOC.pdf>

H.4.c. Multnomah County and the City of Portland Resources

Multnomah County Geologic Hazards Permit Information Sheet
<https://multco.us/file/27933/download>

Multnomah County Geologic Hazards Permit Form-1
<https://multco.us/file/27934/download>

Multnomah County Geologic Hazards Permit Worksheet
<https://multco.us/file/27932/download>

City of Portland Landslide Hazard Information
<https://www.portlandoregon.gov/bds/article/485456>

City of Portland Landslide Hazard Study Information Sheet
<https://www.portlandoregon.gov/bds/article/403947>

City of Portland Title 33 criterion for land divisions in potential landslide hazard areas <https://www.portlandoregon.gov/bps/article/53436>

City of Portland Sites in Potential Landslide Hazards Areas Information Sheet
<https://www.portlandoregon.gov/bds/article/72539>

H.4.d. Insurance and Business

Oregon Division of Financial Regulation, Consumer Business and Business Services,
<https://dfr.oregon.gov/insure/home/Pages/index.aspx>
and from the same website, under the Flood page
<https://dfr.oregon.gov/insure/home/storm/Pages/flood.aspx>

Washington Office of the Insurance Commissioner,
<https://www.insurance.wa.gov/landslide-insurance>

Contact Trusted Choice, www.trustedchoice.com, for the member locator for the Independent Insurance Agents Association

American Modern Insurance Group (AMIG), <https://www.amig.com/insurance/full-time-home/> and <https://www.amig.com/insurance/full-time-home/full-time-home-details/>

Lloyd's of London, <https://www.lloyds.com/help-and-glossary/faqs>

Esurance web article, "Does Homeowners Insurance Cover Landslides and Mudslides?", <https://www.esurance.com/info/homeowners/does-homeowners-insurance-cover-landslides-and-mudslides>.

The Balance Small Business web article "Landslide and Mudflow, What's the Difference?", Marianne Bonner, December 21, 2018, <https://www.thebalancesmb.com/landslide-and-mudflow-what-s-the-difference-462686>

The Balance Small Business web article "The Commercial Property Policy," Marianne Bonner, November 30, 2018, <https://www.thebalancesmb.com/the-commercial-property-policy-462357>

Definition of tax abatement, <https://www.thebalancecareers.com/tax-abatement-1669487>

Definition of tax incentive, <http://www.businessdictionary.com/definition/tax-incentive.html>

Definition of property tax abatement, <https://homeguides.sfgate.com/property-tax-abatement-programs-3245.html>

Oregon Department of Revenue, Property Tax Exemptions, <https://www.oregon.gov/dor/programs/property/Pages/exemptions.aspx>

H.4.e. USGS Landslide Types and Processes Website and Glossary

Website: <https://pubs.usgs.gov/fs/2004/3072/fs-2004-3072.html>

Landslides Glossary, https://www.usgs.gov/natural-hazards/landslide-hazards/science/landslides-glossary?qt-science_center_objects=0#qt-science_center_objects

H.4.f. Federal and State Agencies and Industry Groups

Code of Federal Regulations, Mitigation Planning (44 C.F.R. Sect. 201) (2002), <https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=12&SID=840cfde8a73a0699ee3c22af2ada7df5&ty=HTML&h=L&mc=true&n=pt44.1.201&r=PART>

Also see: 44 CFR: Emergency management and assistance: Excerpts for Floodplain Managers annotated. (2017, May 19). [For flood or flooding, mudslide (mudflow), mudslide (mudflow) area management, and mudslide (mudflow) prone areas.] Retrieved from <https://www.twdb.texas.gov/flood/doc/44CFR.pdf>

- Association of Engineering Geologists (AEG), *Professional Practice Handbook*, <https://cdn.ymaws.com/www.aegweb.org/resource/resmgr/Publications/aepph.pdf>
- Association of Engineering Geologists (AEG), *Landslides: Putting experience, knowledge and emerging technologies into practice*, AEG Special Publication No. 27, p. 473–482
- Federal Emergency Management Agency (FEMA), <https://www.fema.gov/>
- Federal Emergency Management Agency (FEMA), *Building community resilience by integrating hazard mitigation into the local comprehensive plan*, <https://www.fema.gov/media-library-data/20130726-1908-25045-9918/factsheet1.pdf>
- Federal Emergency Management Agency (FEMA), *Integrating hazard mitigation into local planning: Case studies and tools for community officials*, https://www.fema.gov/media-library-data/20130726-1908-25045-0016/integrating_hazmit.pdf
- Federal Emergency Management Agency (FEMA), *What is mitigation?* Web page, <https://fema.gov/what-mitigation>
- Federal Emergency Management Agency (FEMA). (2011 October). *Local mitigation plan review guide*, https://www.fema.gov/media-library-data/20130726-1809-25045-7498/plan_review_guide_final_9_30_11.pdf
- Geological Survey of Canada, Canadian technical guidelines and best practices related to landslides: a national initiative for loss reduction (series of open-file reports): <https://geoscan.nrcan.gc.ca/starweb/geoscan/servlet.starweb?path=geoscan/shorte.web&search1=REPNO=6765;7623;7359;7311;7058;6981;6996;7059;7312>
- Oregon Department of Geology and Mineral Industries (DOGAMI), <https://www.oregongeology.org/>
- Oregon Department of Geology and Mineral Industries (DOGAMI). HazVu [Hazards Viewer] interactive map, <https://www.oregongeology.org/hazvu/index.htm>
- Oregon Department of Geology and Mineral Industries (DOGAMI). (2009). *Landslides in Oregon* (Fact Sheet FS-1), <https://www.oregongeology.org/pubs/fs/landslide-factsheet.pdf>
- Oregon Department of Forestry (ODF) <https://www.oregon.gov/ODF/Pages/index.aspx>
- Oregon Department of Consumer and Business Services – Building Codes Division, <https://www.oregon.gov/BCD/pages/index.aspx>
- Oregon Department of Land Conservation and Development (DLCD), <https://www.oregon.gov/lcd/Pages/index.aspx>

Oregon Department of Transportation (ODOT),

<https://www.oregon.gov/odot/pages/index.aspx>

Oregon Office of Emergency Management (OEM),

<https://www.oregon.gov/OEM/Pages/default.aspx>

Oregon State Board of Geologist Examiners

Guidelines for Preparing Engineering Geologic Reports in Oregon is a suggested guide for the preparation of an engineering geologic report in Oregon: [https://www.newportoregon.gov/dept/cdd/documents/Guidelines for Preparing Geologic Reports.pdf](https://www.newportoregon.gov/dept/cdd/documents/Guidelines%20for%20Preparing%20Geologic%20Reports.pdf)

Portland State University, Department of Geology,

<https://www.pdx.edu/geology/welcome-to-psu-geology>

National Resource Conservation Service (NRCS),

<https://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/>

Natural Hazards Center, <https://hazards.colorado.edu/>

Tillamook County, 2017 *Tillamook County Multi-Jurisdictional Natural Hazards Mitigation Plan*,

https://www.co.tillamook.or.us/gov/ComDev/NHMP/PlanFiles/FULL9_7_17.pdf

United States Geological Survey (USGS), <https://www.usgs.gov/>

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CHAPTER 6 GLOSSARY

ACRONYMS AND ABBREVIATIONS

AEG	Association of Environmental and Engineering Geologists
AGI	American Geosciences Institute
AIR	American Modern Insurance Group
AMIG	Medford-Ashland Air Quality Maintenance Area
APA	American Planning Association
AQMA	Air Quality Management Area
AQMP	Air Quality Management Plans
ASCE	American Society of Civil Engineers
BCD	Building Codes Division
BLI	Buildable Lands Inventories
BMC	Brookings Municipal Code
BOCA	Building Officials and Code Administrators
CDC	Community Development Code
CEA	California Earthquake Authority
CEG	Certified Engineering Geologist
CFR	Code of Federal Regulations
CGS	Canadian Geological Survey
CO	carbon monoxide
CP	Comprehensive Plan
CSMP	[Eugene] Construction Site Management Plan
CTP	FEMA Cooperating Technical Partner
DAAP	Debris Avalanche Action Plan [Governor Kitzhaber's Office]
DAS	Oregon Department of Administrative Services
DCBS	Oregon Department of Consumer and Business Services
	DCBS-BCD DCBS-Building Codes Division
DEQ	Oregon Department of Environmental Quality
DIC	Difference in Conditions
DLCD	Oregon Department of Land Conservation and Development

DOGAMI	Oregon Department of Geology and Mineral Industries
DR	FEMA Disaster Declaration
DSL	Oregon Department of State Lands
EPA	Environmental Protection Agency
ESC	Erosion and Sediment Control
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
FY	Fiscal Year
GE	Geotechnical Engineer
GEO	Geologic Hazards Overlay [Newport Code]
GEO	Oregon Geospatial Enterprise Office
GHO	Geologic Hazards Overlay
GIS	Geographic Information Systems
GPS	Global Positioning System
HB	Oregon House Bill
HD	Hillside Development and Erosion Control
HDP	Hillside Development Permit
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program (FEMA)
IBC	International Building Code
ICBO	International Council of Building Officials
ICC	International Code Council
IHMT	Oregon Interagency Hazard Mitigation Team
IMS	DOGAMI Interpretive Map Series publication
LCDC	Oregon Land Conservation and Development Commission
LEG	Licensed Engineering Geologist
LHS	Landslide Hazard Study
LUBA	Land Use Board of Appeals
MCC	Multnomah County Code
NAAQS	National Ambient Air Quality Standards
NFIP	National Flood Insurance Program
NHMP	Natural Hazards Mitigation Plan
NMC	Newport Municipal Code
NRCS	National Resource Conservation Service

OAPA	Oregon American Planning Association
OAR	Oregon Administrative Rule
ODA	Oregon Department of Agriculture
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OEM	Oregon Military Department, Office of Emergency Management
OFR	Open-File Report
OHA	Oregon Health Authority
OLC	Oregon Lidar Consortium
OLRRT	Oregon Landslide Risk Reduction Team
OPRD	Oregon Parks and Recreation Department
ORS	Oregon Revised Statute
ORSC	Oregon Residential Specialty Code
OSBEELS	Oregon State Board of Examiners for Engineering and Land Surveying
OSBGE	Oregon State Board of Geologist Examiners
OSFM	Office of the State Fire Marshal
OSLAB	Oregon State Landscape Architect Board
OSSC	Oregon Structural Specialty Code
OTCA	Oregon Tort Claims Act
PDM	Pre-Disaster Mitigation
PE	Professional Engineer
PUC	Oregon Public Utility Commission
RE	Registered Engineering Geologist
RG	Registered Geologist
RIP	Residential Infill Project
RML	rapidly moving landslide
SB	Oregon Senate Bill
SBCCI	Southern Building Code Congress International
SDCI	Seattle Department of Construction and Inspections
SIP	State Implementation Plan
SLIDO	Statewide Landslide Information Database for Oregon
SP	DOGAMI Special Paper series
SRC	Salem Revised Code
TPR	Oregon Transportation Planning Rule

TRG	Planning for Natural Hazards: Oregon Technical Resource Guide
UBC	Uniform Building Code
UDC	Unified Development Code
UGB	urban growth boundary
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WRD	Oregon Water Resources Department
WUI	wildland urban interface

TERMS

Certified Engineering Geologist – A *Certified Engineering Geologist (CEG)* has fulfilled all of the requirements for, and has all the rights of, a Registered Geologist and has met additional examination and experience requirements to obtain certification in the specialty of engineering geology. A CEG “applies geologic data, principles and interpretation to naturally occurring materials so that geologic factors affecting planning, design, construction and maintenance of civil engineering works are properly recognized and utilized” (ORS 672.505.3²²⁰). Only a CEG can publicly practice engineering geology in Oregon.

comprehensive plan – A comprehensive plan establishes the long-term land use vision and aspirations, goals and policies of a city or county. In Oregon, state law requires each city and county to have a comprehensive plan and implementing ordinances. Comprehensive plans must be consistent with Oregon’s 19 Statewide Planning Goals.

debris flows – have a source area (where the slide originates), a transport zone (the path of the flow), and a deposition zone (the area where the landslide terminates).

Sources of slides commonly have steep or concave slopes, a relatively large up-slope drainage area, and a thick soil profile. Transport zones occur directly down-slope of the source area and are often high-gradient, first order stream channels. The transport zone is where debris flows “bulk up” and get significantly larger, due to channel and bank scouring. When debris flows do not have enough energy to transport themselves past a flow resistance area, the transport zone is extensively disturbed, but not scoured to bedrock. The deposition zone of a debris flow is its terminus. It is where the mass comes to rest. Depending on the magnitude of the debris flow, the deposition zone may contain large trees and boulders, or small gravel and vegetation.²²¹

deep landslide – In this *Guide*, deep landslides are slides with a failure plane at a depth of more than 15 feet (4.5 meters)

drainage plan – typically a site plan that visually shows the areas where drainage occurs. Requirements for drainage plans vary from jurisdiction to jurisdiction.

erosion control plan – typically a site plan that visually shows the areas where erosion control measures are shown and described. Requirements for erosion control plans vary from jurisdiction to jurisdiction.

²²⁰ <https://www.oregonlaws.org/ors/672.505>

²²¹ <https://www.oregongeology.org/Landslide/LandslideTaskForceResults.pdf>

exposure – in this *Guide*, the spatial overlap of the hazard and the assets. Illustrated in **Figure 2-8**.

further review area – At the current time, there are no official further review area maps. As a result, the ORS referenced in this definition and the reference in the *2014 Oregon Structural Specialty Code*²²² (2014 OSSC) in Chapter 18, Section 1083, on page 402 are not functional.

This definition is from Oregon Senate 12 (SB 12) that was approved in 1991 by the legislature. SB 12 directed DOGAMI to establish maps called *further review areas*. These areas of land were identified within which further site specific review should occur before land management or building activities begin. The area of land was designated this because either DOGAMI or the State Forestry Department determined that the area reasonably could have been expected to have sites that experience rapidly moving landslides (as defined in ORS 195.250) as a result of excessive rainfall.

The term further review area was changed to overview hazard areas in the final maps and report (*GIS Overview Map of Potential Rapidly Moving Landslides in Western Oregon, IMS-22*). Therefore, the ORS and 2014 OSSC provisions are not functional because they use a different term, further review area, while the final map and report use the term overview hazard areas.

engineering geologic report – While the exact requirement can vary between localities, it is common to require that an engineering geologic study be performed by a *Certified Engineering Geologist*. A local jurisdiction may also require a geotechnical engineering report by a *Geotechnical Engineer*. A geologic engineering report would be one done by or overseen by a geologic engineer. As used in this *Guide*, a geologic study is a term that means reports done by a geoprofessional.

geologic hazard layer – This is a term that local jurisdictions may sometimes use to indicate an overlay zone (a layer of zoning that is not specific to base zones such as residential, industrial, or commercial zoning); it is often used in zoning and other codes as well as maps. Supporting information such as data and reports are used as the basis for establishing the location of the geologic hazard layer.

²²² http://ecodes.biz/ecodes_support/free_resources/Oregon/14_Structural/PDFs/Chapter%2018%20-%20Soils%20and%20Foundations.pdf

Geotechnical Engineer – A *Geotechnical Engineer (GE)* is a registered Professional Engineer who has specific training, expertise, and experience in this engineering specialty. The Oregon Board of Examiners for Engineering and Land Surveying (OSBEELS) offers a GE specialty endorsement that a PE can pursue as a way to readily show to the public the expertise in geotechnical engineering. However, a PE is not required to hold the GE specialty endorsement to practice geotechnical engineering in Oregon. See OAR 820-040-0040²²³). From the OSBEELS definition of *Geotechnical Engineering*.

geotechnical engineering – The investigation and the evaluation of the physical and engineering properties of earth materials, such as soil and rock, including impacts of ground water and earthquakes, and their application to the design and construction of civil engineering works, such as foundations, earth dams, retaining walls, and similar, using soil and rock mechanics and earthquake engineering principles and related engineering laws, formula, and procedures (OAR 820-040-004).

geotechnical engineering report – The geotechnical report, provided by the *Geotechnical Engineer*, is the tool used after the site investigation to communicate the site conditions and design and construction recommendations. The information contained in this report is referred to often during the design period, construction period, and frequently after completion of the project.

The 2019 *Oregon Structural Specialty Code (OSSC)*, Chapter 18 describes geotechnical investigations and how to report them. Of note, “geotechnical investigations shall be conducted in accordance with Section 1803.2 and reported in accordance with Section 1803.6. Where required by the *building official* or where geotechnical investigations involve in-situ testing, laboratory testing or engineering calculations, such investigations shall be conducted by a *registered design professional*.” (OSSC Chapter 18, Section 1803.1).

Goal 7 – State of Oregon Planning Goal 7 (of 19). Goal 7, Areas Subject to Natural Hazards, has four mandatory sections: Natural Hazards Planning; Response to New Hazard Information; Implementation; and Coordination.

geologic report – As used in this *Guide*, a geologic report is a report – either an engineering geologic report or a geotechnical engineering report – performed by a geoprofessional.

geoprofessional – In this *Guide*, the term geoprofessional refers to a Registered Geologist (RG), Certified Engineering Geologist (CEG), Professional Engineer (PE), and a Geotechnical Engineer.

²²³ <https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=201381>

grading plan – typically a site plan that visually shows the areas where grading will occur. Cut and fill areas and amounts are identified. Erosion control measures are shown and described. Requirements for grading plans vary from jurisdiction to jurisdiction.

hazard – something that has the potential to cause harm; it is a possible source of danger. Hazard is defined in this *Guide* as the frequency and magnitude at which landslides will happen.

landslide – refers to a range of landslide types including rock falls, debris flows, earth slides, and other mass movements. ORS 195.250 defines a landslide as any detached mass of soil, rock or debris that is of sufficient size to cause damage and that moves down a slope or a stream channel.

landslide map – The USGS identifies several kinds of maps used to depict danger from landslides. “These maps might be as simple as a map that uses the locations of old landslides to indicate potential instability, or as complex as a map incorporating probabilities based on variables such as rainfall, slope angle, soil type, and levels of earthquake shaking.”²²⁴ The maps are:

landslide hazard maps – indicate the possibility of landslides occurring throughout a given area. An ideal landslide hazard map shows not only the chances that a landslide may form at a particular place, but also the chance that it may travel downslope a given distance.

landslide inventory maps – show landslide locations and may show the dimensions and geographical extent of each landslide. One clue to the location of future landsliding is the distribution of past movement, so maps that show the location and size of landslides are helpful for identifying areas that may have landslides in the future.

landslide susceptibility maps – describe the relative likelihood of future landsliding based solely on the intrinsic properties of a locale or site. Some organizations use the term “landslide potential map” for maps of this kind. Prior failure (from a landslide inventory), rock or soil strength, and steepness of slope are three of the more important site factors that determine susceptibility.

landslide risk maps – show landslide potential along with the expected losses to life and property, should a landslide occur. Risk maps combine the probability information from a landslide hazard map with an analysis of all possible consequences (property damage, casualties, and loss of service).

²²⁴ https://www.usgs.gov/faqs/what-a-landslide-hazard-map?qt-news_science_products=0#qt-news_science_products

landslide movement – All landslides can be classified into six types of movement (see **Figure 2-1**; and <https://pubs.usgs.gov/fs/2004/3072/pdf/fs2004-3072.pdf>):

falls – near-vertical, rapid movements of masses of materials, such as rocks or boulders. The rock debris sometimes accumulates as talus at the base of a cliff.

topples – distinguished by forward rotation about some pivotal point, below or low in the mass.

slides – downslope movement of soil or rock on a surface of rupture (failure plane or shear-zone).

rotational slides – move along a surface of rupture that is curved and concave.

translational slides – displace along a planar or undulating surface of rupture, sliding out over the original ground surface.

spreads – commonly triggered by earthquakes, which can cause liquefaction of an underlying layer and extension and subsidence of commonly cohesive materials overlying liquefied layers.

channelized debris flows – Commonly start on a steep, concave slope as a small slide or earth flow into a channel. As this mixture of landslide debris and water flows down the channel, it picks up more debris, water, and speed, and deposits in a fan at the outlet of the channel.

earth flows – commonly have a characteristic "hourglass" shape. The slope material liquefies and runs out, forming a bowl or depression at the head.

complex landslides – combinations of two or more types. A common complex landslide is a slump-earth flow, which usually exhibit slump features in the upper region and earth flow features near the toe.

landslide inventory – a data set that shows the locations of past landslide events and often contains common landslide features such as deposits, scarps, and flanks that have been identified by geologists.

lidar – lidar is light detection and ranging, which uses lots of accurate measurements made with a laser rangefinder to produce detailed and accurate depictions of the earth's surface. A laser rangefinder is commonly used in surveying, construction, and riflescopes. Millions of measurements are made from a precisely located aircraft, producing a three-dimensional map of the earth's surfaces as a "point cloud."

mitigation – the action of reducing the severity of the landslide hazard to reduce impacts of hazards on people, property, and the environment.

natural disaster – A disaster²²⁵ is a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources. Though often caused by nature, disasters can have human origins. When a landslide or other natural hazard impacts people, property, or assets (e.g., roads, buildings, and infrastructure), and the environment, it is a natural hazard and often it results in a natural disaster.

natural hazard – Natural hazards²²⁶ are natural events that threaten lives, property, and other assets²²⁷. Natural hazards are naturally occurring phenomena caused by either rapid or slow onset events which can be geophysical (earthquakes, landslides, tsunamis and volcanic activity), hydrological (avalanches and floods), climatological (extreme temperatures, drought, and wildfires), metrological (cyclones and storms/wave surges), or biological (disease epidemics and insect/animal plagues)²²⁸. When a landslide or other natural hazard impacts people, property, or assets (e.g., roads, buildings, and infrastructure), and the environment, it is a natural hazard and often it results in a natural disaster.

natural hazards mitigation plan (NHMP) – A natural hazard mitigation plan describes the hazards a community is most likely to face, identifies their potential impacts on people and property, and establishes a strategy to reduce those impacts. The NHMP is also developed as a condition for receiving certain types of non-emergency disaster assistance through the federal Hazard Mitigation Assistance (HMA) Programs. The HMA programs include the Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant Program (PDM), and the Flood Mitigation Assistance Program (FMA).

rapidly moving landslide (RML) – a landslide that is difficult for people to outrun or escape. [1999 c.1103 § 1] (defined in ORS 195.250). In **Figure 2-1** of this *Guide*, the types of common landslides in Oregon are shown in illustrated form with a text description. In that figure, the now more commonly used term, channelized debris flow is used instead of the term rapidly moving landslides. See IMS-22 for maps of areas that have the potential to have rapidly moving landslides or debris flows. IMS-22 is the best available information.

²²⁵ <https://www.ifrc.org/en/what-we-do/disaster-management/about-disasters/what-is-a-disaster/>

²²⁶ https://www.fema.gov/media-library-data/20130726-1549-20490-4629/natural_hazards_1.pdf

²²⁷ https://www.fema.gov/media-library-data/20130726-1549-20490-4629/natural_hazards_1.pdf

²²⁸ <https://www.ifrc.org/en/what-we-do/disaster-management/about-disasters/definition-of-hazard/>

Registered Geologist – According to Oregon state law, a *Registered Geologist (RG)* is someone registered by the state of Oregon as a geologist after meeting education, examination, and experience requirements as determined by the Oregon State Board of Geologist Examiners OSBGE. An RG is thereby legally allowed to provide, prepare, and officially stamp or seal geologic maps, plans, reports, or documents. An RG can work in any geology discipline or area of specialty where qualified by experience and training, except for in engineering geology.

resilience – the capacity to withstand and recover from a disaster.

risk – the probability of loss or injury. In this *Guide*, risk is the overlap of the hazard with assets (such as buildings) and their vulnerability to the hazard. The probability of loss or injury is the intersection of natural hazards and vulnerable systems. Risk is an expression of the potential magnitude of a disaster’s impact. **Figure 2-8** shows risk as the intersection of natural hazards and vulnerable systems.

shallow landslide – In this *Guide*, shallow landslides are slides with a failure plane at a depth of less than 15 feet (4.5 meters).

soil study – a study or report that examines the types of soil on a particular property or area identified in the document. It is a generalized term that may be defined by a local jurisdiction and have requirements that vary by jurisdiction.

susceptibility – in this *Guide*, defined as capable of being affected by a specified action or process; and in this *Guide* the process is mass wasting by means of slope failure or landsliding.

vulnerability – the potential to be harmed. Some people and places are more vulnerable to landslide hazards than others are.

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CHAPTER 8 LANDSLIDE CODE REVIEW

DETAILS TABLE

A. INTRODUCTION

The Landslide Code Review Details Table contains the list of communities (cities and counties) in the code review performed by DLCD and DOGAMI. The majority of the code review occurred between May and December of 2017.

During the last decade, DOGAMI has produced lidar-based, detailed landslide inventory, shallow landslide susceptibility, and deep landslide susceptibility maps for many communities in Oregon. Table 1-1 is a list of all the communities with DOGAMI lidar-based landslide inventory and landslide susceptibility maps.

- There are 46 cities and 14 counties with DOGAMI lidar-based inventory maps.
- There are 35 cities and 9 counties that have DOGAMI lidar-based landslide susceptibility maps.

The Code Review Details Table contains information from 28 cities and 6 counties; it does not include every community that has either DOGAMI lidar-based landslide inventory maps and/or DOGAMI lidar-based landslide susceptibility maps. The Cities of Newport and Salem are listed in the Code Review Details Table, but they have not received DOGAMI lidar-based landslide inventory and landslide susceptibility maps. Staff included them because staff also included them as examples of jurisdictions with strong zoning codes (see **Chapter 4, Implementation**).

The Code Review Details Table is a large table split over 68 tabloid-size (11 by 17 inches) pages.

B. KEY TO CODE REVIEW DETAILS TABLE

To find information in the table on the following pages, use column A in the table key below to locate the community (city or county) of interest, note the row number, then navigate to that row in the table. Alternatively, locate in columns B through V the kind of information of interest, then navigate to that column.

Example: To find what Oregon City’s Municipal Code says about land division requirements, navigate to row 29, column Q.

	Column A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	
1	Community																						
2	CITIES																						
3	Astoria Comp Plan	Columns in this group are:							Columns in this group are:							Columns in this group are:				Columns in this group are:			
4	Astoria Dev & Zoning Codes	B - Estimated Population							I - What certification do they require for the landslide study? E.g., CEG, registered geologist etc.							O - What do the provisions say about drainage and soils types?				S - What are the connections between the landslide code info and the other codes?			
5	Banks Code of Ordinances																						
6	Beaverton Comp Plan	C - Document name							J - What is the process for the landslide study? Who reviews it and who approves it?							P - What do the provisions say about grading and erosion control?				T - Are there any disconnections between codes and maps?			
7	Beaverton City Code																						
8	Brookings Municipal Code	D - Document Web Address							K - Is the landslide hazard area mapped? If so, what is it called? Date made?							Q - What do the provisions say about land division requirements?				U - Other relevant codes/provisions			
9	Canby City Code																						
10	Clatskanie Dev Code	E - Code type							L - Associated Overlays							R - Are there any building code related provisions referenced in the land use code?				V - Other observations			
11	Clatskanie Comp Plan (1978)																						
12	Cornelius Comp Plan	F - Percent slope used as threshold for the applicable codes							M - Associated maps														
13	Cornelius Municipal Code																						
14	Durham Dev Code	G - Is there a method to calculate slope? What is it?							N - Map Dates														
15	Durham Comp Land Use Plan																						
16	Estacada Comp Plan	H - When does the requirement for a landslide study kick in?																					
17	Estacada Dev Code																						
18	Eugene City Code																						
19	Fairview City Code																						
20	Fairview Comp Plan																						
21	Forest Grove City Code																						
22	Gladstone City Code																						
23	Gold Beach Comp Plan																						
24	Gold Beach Zoning Ord.																						
25	Gresham Dev Code, Art. 5																						
26	Maywood Park Ordinances																						
27	Medford Land Dev Code																						
28	Newport Mun Code, Ch 14.21																						
29	Oregon City Municipal Code																						
30	Port Orford Municipal Code																						
31	Portland Zoning Code																						
32	Portland City Code, Title 44																						
33	Portland Eros. Cont. Manual																						
34	Salem Revised Code																						
35	Sandy Title 17 Dev Code																						
36	Silverton Municipal Code																						
37	Springfield Dev Code																						
38	Tigard Dev Code																						
39	Vernonia Ordinances																						
40	West Linn Dev Code																						
41	COUNTIES																						
42	Clackamas County																						
43	Coos County																						
44	Curry County																						
45	Lane County																						
46	Multnomah County																						
47	Tillamook County																						
48	Tillamook																						

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Table 8.1. Landslide Code Review Details Table

	A	B	C	D	E	F	G	H
1	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
2	Astoria	9,802	Astoria Comprehensive Plan	http://www.astoria.or.us/Comprehensive_Plan.aspx	Comprehensive Plan	NA	No.	CP.400.02 - Where there appears to be a landslide
3	Astoria	9,802	Astoria Development and Zoning Codes	http://www.astoria.or.us/Development_Zoning.aspx	Development/Zoning	3.310.D - The City shall require a grading plan prepared by a Registered Professional Engineer and/or Registered Engineering Geologist where the disturbed area has an average slope of 35% or greater	No.	2.050.05 - Where new development is within 100 feet of a known landslide hazard. NOTE: applies to all building zone types (Residential, Commercial, institutional, etc.) except general industrial, aquatic, conservation, natural, and shorelands
4	Banks	1,987	City of Banks Code of Ordinances	http://www.amlegal.com/codes/client/banks_or/	City Code	Not referenced in code	No.	Not referenced in code

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
2	Astoria	CP.400.02 - City engineer, but may require CEG or Soils Engineer certification at CE discretion	CP.400 - City engineer, planning commission	CP.030 - West End Area CP.040 - Central Residential Area CP.060 - South Slope Area		Astoria Comprehensive Plan Geologic Hazards	Not Referenced
3	Astoria	2.050.05 - Site investigation report by a registered Geologist. NOTE: Applies to all building zone types	1.125.A.08 - The City planning commission retains permitting and zoning powers as laid out under ORS 227.175 2.905.A.01 - Preliminary development plan with site investigation by registered geologist, showing potential geologic hazards, submitted to PC.	Yes. The Astoria Geologic Hazards Map		The Astoria Geologic Hazards Map was put together using the DOGAMI and Astoria info. The map was approved by the Astoria City Council in August 2015. The key shows mapped areas that include: Astoria landslides observed (bright salmon color), DOGAMI scarps (line with hooks), DOGAMI headscarp / flanks (yellow), and DOGAMI landslide deposits (peach with dots). The code statement of "known landslide hazard" only refers to the Astoria landslides observed.	2015
4	Banks	Not referenced in code	Not referenced in code	not mapped		Not referenced in code	Not Referenced

Table 8.1. Landslide Code Review Details Table

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
2	Astoria	CP.390 - Drainage systems and rock fill are stop-gap measures and avoiding construction on LS prone areas is the best deterrent.	CP.400.07 - Excavation, removal of vegetation, and grading should be kept to a minimum. Erosion control measure will be employed as required by CE. No stream or drainage blockage, or stream diversion is allowed.	CP.400.04 - Divisions in areas of steep slopes, unstable soils, or landslide potential are permitted only after favorable site investigation is complete. CP.400.06 - Clustering of development on stable or less steep slopes is encouraged.	NA
3	Astoria	3.310.D.4 - Geologic reports should include the direction of drainage flow and detailed plans and locations of all surface and subsurface drainage devices to be constructed.	3.300 - 3.330 - Sections contain much information about grading permit application requirements, grading best practices, erosion control best practices, city responsibilities, and enforcement. Proposed development must include an erosion control plan.	13.480 - The Planning Commission may refuse to approve a subdivision or partition if the property is deemed unsuitable for the reason that it is in an actual landslide area.	3.305.E - All excavation permits shall be reviewed and approved by both the Engineering Department and Community Development Department for compliance with this Ordinance and other City codes and building codes.
4	Banks	Not referenced in code	152.055 - Grading of building sites, and excavation of the placement of fill, shall conform to the requirements of Chapter 70 of the Uniform Building Code. 152.055.A - cut slopes shall not exceed 2 to 1 ratio. 1513139.B.3 - Site concept plan submission requires a grading plan.	151.206.C.7.d - Division applications require ground elevations shown by contour lines at 2-foot vertical interval. May be waived when grades, on average, are less than 6%	152.206.C.8.h - Division applications require, on slopes exceeding an average grade of 10%, evidence that future development can meet minimum required setbacks and engineering design standards for streets, driveways, drainage, and retaining walls.

Table 8.1. Landslide Code Review Details Table

	A	S	T	U	V
1	Community	What are the connections between the landslide code info and the other codes?	Are there any disconnections between codes and maps?	Other relevant codes/provisions	Other observations:
2	Astoria	CP.400.01 - The city will take reasonable precautions to protect life and property from natural disasters (References City Code Ordinance 09-03)	Geologic hazards map included in Comprehensive Plan but not referenced,		Tricia: I included the City of Astoria as an example in the presentation I made on October 27, 2016 at the Oregon-Washington APA conference, "Landslides in Oregon: Integrating Science and Policy."
3	Astoria		The Astoria Geologic Hazards Map dated August 2015 is not linked fully to the Astoria code.	12.030.B.02.a - Increased potential for landslide hazard is cause to deny a variance.	DOGAMI and the City of Astoria got together to apply for and receive funds from FEMA for a landslide hazard and risk study. The study was performed from April 2008 to April 2009. As a result of the landslide hazards study, DOGAMI prepared these maps: landslide inventory, shallow and deep landslide susceptibility. Also, an open file report. 120 landslide deposits were found within the city limits. 69 were classified as deep and 51 were classified as shallow. 83 landslides in the inventory are estimated to have moved during the past 150 years (historical time). This is a very high number of active-historical landslides for a small city like Astoria. Seventeen of these eighty-three have recorded dates of movement in the landslide inventory database from 1932 to 2007. Several of these 17 landslides caused significant damage. Areas on the susceptibility maps are identified as high, medium, and low (see the DOGAMI 2013 report). In Astoria, of the areas within the landslide susceptibility area, 55% is within the high area for shallow landslides and 37% in the high for the deep landslides. Again, these results indicate a high susceptibility to both shallow- and deep-seated landslides. After the landslide inventory and susceptibility maps were complete, they were used to conduct a landslide risk assessment. The results of this analysis indicate that roughly 27% of the city is at risk to landslides. The basic process involves the identification of hazard (i.e., landslide hazards), inventory of assets, and estimation of damage and losses based on the overlap of the hazard and assets. DOGAMI created maps" Red: Historic and or active <150 years ago: Yellow: prehistoric or ancient >150 years: Orange: head scarp and flank zones. See OPEN-FILE REPORT O-13-05 LANDSLIDE INVENTORY, SUSCEPTIBILITY MAPS, AND RISK ANALYSIS FOR THE CITY OF ASTORIA, CLATSOP COUNTY, OREGON.
4	Banks	NA	NA	151.038.C.4 - Incorporation of natural features into subdivision design, or avoidance of natural hazards (e.g., geological hazards , stream corridor, or flood hazards) necessitating flexible lots sizes, cluster development plan, or other innovative design;	

Table 8.1. Landslide Code Review Details Table

	A	B	C	D	E	F	G	H
1	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
5	Beaverton	97,590	Beaverton Comprehensive Plan	http://www.beavertonoregon.gov/461/Comprehensive-Plan	Comprehensive Plan	8.6.1.a Action 3 - Adopt and apply land use regulations requiring that building sites, streets and other improvements in areas with 25% or greater slopes have best management practices for erosion control integrated into the design.	No.	Not referenced in comp plan
6	Beaverton	97,590	Beaverton City Code - The City Code contains Title 9 Community Development, and within Title 9 is Chapter 9.05 Site Development	https://www.beavertonoregon.gov/463/Development-Code AND THE FULL CITY CODE	City Code	NA	No.	(http://www.codepublishing.com/OR/H7Beaverton/html/pdfs/beavertonfullcode0117.pdf#page=391) ("9.05.035.B.10 - An engineering geological investigation, based on the plan for the work proposed under the permit. The engineering geological report shall include an adequate description of the geology of the site, and conclusions and recommendations regarding the effect of geologic conditions, including consideration of seismic hazards and slope stability in natural materials on the proposed development. All reports shall be subject to approval by the city engineer and supplemental reports and data may be required as the city engineer considers necessary. Recommendations included in the report and approved by the city engineer shall be incorporated in the grading plan. This requirement may be waived by the city engineer when it appears from the condition of the property that such a report is not necessary;") Chapter 9.05 is the Site Development Chapter in Title 9 of the City Code

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
5	Beaverton	Not referenced in comp plan	Not referenced in comp plan	not mapped	Natural Hazards Map - https://www.beavertonoregon.gov/DocumentCenter/View/874	Not referenced in code	
6	Beaverton	http://www.codepublishing.com/OR/Beaverton/html/pdfs/beavertonfullcode0117.pdf#page=391 9.05.035.B.10 - Engineering geological investigation. 9.05.035.E - The persons supplying information to the City Engineer 'shall be qualified with regard to education, training, and experience'	HYPERLINK("http://www.codepublishing.com/OR/Beaverton/html/pdfs/beavertonfullcode0117.pdf#page=391", C12 https://C11/Local Codes and Policies!/H13/default/files/fileattachments/community_development_amp_planning/page/521/https://Local Codes and Policies!/Local Codes and Policies!/Local Codes and Policies!/H36/ http://www.ci.cornelius.or.us/sites/default/files/fileattachments/community_development_amp_planning/page/521/comp_plan_final_updated_2018_20180205.pdf 'Local Codes and Policies' 'Local Codes and Policies'!G36!F36	not mapped		Not referenced in code	

Table 8.1. Landslide Code Review Details Table

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
5	Beaverton	Not referenced in comp plan	Not referenced in comp plan	Not referenced in comp plan	NA
6	Beaverton	9.05.110.D - All building permit applications must contain a soil engineering investigation report, including data on soil type, strength, distribution, and proposed corrective measures. 5.05.110.A - No owner or person in charge of any building or structure shall cause, suffer or permit rain water, ice or snow to fall from the building or structure onto a street or public sidewalk or to allow concentrated water flow across the sidewalk.	9.05.110.D - All grading/excavation sites must conform to City, County, and Oregon DEQ erosion control standards , whichever is greater. Also lists city requirements and construction activities triggering this ordinance.	9.05.060.C - Subdivision requirements are lumped into general site development codes. However, in areas of flooding, special requirements exist for subdivisions. No mention of special requirements for landslides.	NA

Table 8.1. Landslide Code Review Details Table

	A	S	T	U	V
1	Community	What are the connections between the landslide code info and the other codes?	Are there any disconnections between codes and maps?	Other relevant codes/provisions	Other observations:
5	Beaverton	NA	NA	https://www.beavertonoregon.gov/DocumentCenter/View/1188/CP-Vol-I-Chpt-8-Environl-Qual--Safety-Element?bidId= "Geological hazards include unstable steep slopes, erosion and deposition, and weak foundation soils. In the interest of public safety, the location of natural hazards should be determined, and the degree of hazard present should be evaluated. Based on this evaluation, decisions should be made about the amount of development, if any, that should be allowed at the location. If development is to be allowed, consideration should be given to conditioning development approval to limit potential losses resulting from natural disasters." made about the amount of development, if any, that should be allowed at the location. If allowed, limit potential losses resulting from natural disasters.")	8.6.1.a - The plan lays out unstable slope identification, periodic update, and regulation as a goal.
6	Beaverton	NA		9.05.115.A - All fills and excavations may not have an exposed slope steeper than 1.5 to 1. 8.05.070 - No swimming pool can be installed within the angle of repose(determined by City Engineer) of the soil supporting nearby structures.	9.05.035.E - The City Engineer may request any additional soil/geologic reports deemed necessary. Note: Integration of the Flood Insurance Rate Map (FIRM) with their development code is similar to other cities and could provide a template for our work.

Table 8.1. Landslide Code Review Details Table

	A	B	C	D	E	F	G	H
	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
7	Brookings	6,526	Brookings Municipal Code	http://www.codepublishing.com/OR/Brookings/	City Code	17.100.020.B - Where lot average slopes are 15% or greater, or development is specifically on a slope of >15% but lot average slopes are <15% .	Yes. 17.100.020.A - "Average slope" means the overall increase/ decrease in elevation over the area proposed for development or the subject property, expressed as a percentage based on the following formula: difference in elevation over horizontal distance. 17.100.020.B - "Determination of 15 Percent Slopes." The applicant may be required to provide a topographic map prepared by a licensed engineer or surveyor. The topographic map shall contain lines drawn approximately perpendicular to the contours indicating the percent of slope. In some instances, the city engineer may accept a sketch and/or certificate prepared by a licensed individual indicating the average slope of the property.	17.100.060.A - When developing on a site with average slopes of 15% or greater, or where known hazards exist (as defined by 17.100.020 and 010), or when required by city manager (17.100.050).
8	Canby	17,653	Canby City Code	http://www.amlegal.com/code/client/canby_or/	City Code	15.20.080.A.1 - 10%	No.	Not referenced in code

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
7	Brookings	17.100.020.D - "Geologic report" means a report prepared by a qualified professional geologic consultant – A geologist or engineering geologist working under their professional guidelines, and registered by the state of Oregon.	HYPERLINK("http://www.codepublishing.com/OR/Brookings/#!/Brookings17/Brookings17100.html#17.100.040", "17.100.040 - (A)The city manager reviews land use applications, (B) AND the planning commission reviews land use applications, (C) Planning commission decisions can be appealed to city council.")	not mapped		Not referenced in code	
8	Canby	Not referenced in code	HYPERLINK("http://canbyoregon.gov/Chap16/Title16Complete3.22.13.pdf#page=351", "16.89.020 - Issuance of building permits is considered a Type I Procedure and made by the Planning Director.")	not mapped	Hazard Overlay Zone (covers steep slopes and flooding) – https://www.canbyoregon.gov/Chap16/16.40HAZARD_OVERLAY_ZONE(H).pdf	Not referenced in code	

Table 8.1. Landslide Code Review Details Table

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
7	Brookings	17.100.070.B.3.a - Site drainage must be designed by a civil engineer. References city comprehensive plan and chapter 8.10 'Watercourses, Drainage channel maintenance, storm drain protection.' See also 13.35.027	17.100.030.B - Prior to development, applicant must provide erosion mitigation plan. 17.100.070 - Lays out in detail the requirements for erosion control and plans mentioned above. Includes required use of erosion mitigation methods.	17.172.060.A.9 - Land division parcels must conform to the provisions of chapter 17.100. 17.100.060.B - Geologic report required when dividing property w/ slope >15% and adjacent to ocean or Chetco River.	NA
8	Canby	16.64.070.D.2 - Stormwater management should focus on emulating predevelopment hydrologic conditions using site design and stormwater management practices.	16.64.050 - Planning commission may impose bonding requirements to ensure that grading will create no hazard where slopes or unstable soils exist. 15.20 - Section deals with erosion control. Includes detailed requirements for sediment control during development.	16.64.070.L.5 - Public facilities/utilities associated with subdivisions in an area subject to slope instability shall be designed to protect such facility/utility. Adverse effects on wildlife/Natural areas shall be considered in design.	NA

Table 8.1. Landslide Code Review Details Table

	A	S	T	U	V
1	Community	What are the connections between the landslide code info and the other codes?	Are there any disconnections between codes and maps?	Other relevant codes/provisions	Other observations:
7	Brookings	NA		17.100.080 - Lays out enforcement of hazard area development related ordinances.	
8	Canby	NA		16.40.20 - Low density housing, agriculture, accessory structures, Sewer inflow and outflow structures permitted outright within HOZ.	16.40 - Flood and Slide dangers are both incorporated into a 'Hazard Overlay Zone' which triggers specific code requirements. However, while this incorporates the FIRM, there is no relevant landslide map and no regulations requiring hazard studies pertaining to slope stability.

Table 8.1. Landslide Code Review Details Table

	A	B	C	D	E	F	G	H
1	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
9	Clatskanie	1,792	Clatskanie Development Code	http://www.sterlingcodifiers.com/cod ebook/m_index.php?book_id=702 PDF: https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/8805/Clatskanie_Development_Code_2007.pdf	City Code	NA	Yes. 9-2-2 - A steep slope is defined as: "A slope with a gradient of twenty five percent (25%) or greater (see definition of Grade)" 9-2-2 - Grade is defined as: The degree or rise of a sloping surface (see illustration, appendix A, on file at city hall).	9-16-10.B - 'Where the site is subject to landslides or other potential hazards'
10	Clatskanie	1,792	Clatskanie Comprehensive Plan (1978)	Not online. Download available at: https://scholarsbank.uoregon.edu/xmlui/handle/1794/9275	Comprehensive Plan	Page 26,1st Para.: Excessive sloping terrain is defined as >20%.		Not referenced
11	Cornelius	12,414	Cornelius Comprehensive Plan	http://www.ci.cornelius.or.us/vertical/sites/%7B74DDA728-822C-4D15-9791-000615642E9D%7D/uploads/Comp_Plan_Final_updated_2016_20160726.pdf	Comprehensive Plan	NA	No.	NA
12	Cornelius	12,414	Cornelius Municipal Code	http://www.codepublishing.com/OR/Cornelius/	City Code	NA	No.	NA
13	Durham	1,935	Durham Development Code	https://durham-oregon.us/wp-content/uploads/2018/09/DevelopmentCode-Revised-10.24.17.pdf	City Code	4.2.3 - All permit application require submission of site map contour lines. Contour interval less for slopes below 5%.	No.	None required - but the city may require any study or analysis it deems necessary before approving a land use application of any kind.

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
9	Clatskanie	9-16-8.D.1 - Development plan approval may require 'soils and/or an engineering geologic study' if site subject to slumping or sliding.	9-9B-3.A - The planning commission shall grant or deny development permit applications. 9-3-2.D - May be appealed to City Council.	not mapped		Not referenced in Code	NA
10	Clatskanie	Not referenced	Not referenced	not mapped		Not referenced	
11	Cornelius	NA	NA	Cornelius Area		The 1974 Community Development Plan Map	1974
12	Cornelius	NA	18.10.010.C - The community development director shall be responsible for the coordination of the development permit application and decision-making procedure.	Not Mapped		NA	NA
13	Durham	Not referenced in code	Not referenced in code	not mapped		NA	NA

Table 8.1. Landslide Code Review Details Table

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
9	Clatskanie	9-11-3.E - Building permit applications require a 'Grade and drainage' plan.	9-13-7 - Requires vegetative cover on slopes greater than 20% for stability and erosion control. Outlines when and how to reseed/plant.	9-15-4.B.5 - Subdivision plans require locations of rock outcrops, floodplains, and drainageways (but not landslides) 9-15-4.B.10 - Slopes of >10% require submission of 2ft. contour lines with division plans.	NA
10	Clatskanie	Not referenced	Not referenced	Not referenced	NA
11	Cornelius	Soils are primarily Class I-IV, and erosion hazards are very low because the area is so flat			
12	Cornelius		18.05.060.E - Minor clearing or grading is exempt from approval if under direction of soils engineer or geologist. 18.100.040.A.8 - The grading and contouring of the site takes place and site surface drainage and on-site storage of surface waters facilities are constructed so there is no adverse affect on neighboring properties, public rights-of-way or the public storm drainage system and that said site development work will take place in accordance with the city site development code;	17.05.030.E - In cases where physical conditions warrant it, special soils analysis or engineering designs may be required by the city engineer.	
13	Durham	7.2.13.8 - Building crawlspace design must include adequate drainage for floodwaters through either permeable soils or man made drainage system.	4.5.3 - Project areas within the Natural Resources Overlay zone and a flood management area must provide proposed methods for controlling erosion. 4.2.3 - All development projects must include a preliminary grading plan. 10.4.3.3 - Building addition or alteration work must conform to erosion control as per current Clean Water Services district standards.	Land division is included in the general land use provisions. Permitting process applies to both site development and division in the same manner.	7.4.2 - The site design and structural requirements of a live-work residence shall conform to the Uniform Building Code (UBC) as enforced in the City. In case of any conflict the UBC requirements shall control.

Table 8.1. Landslide Code Review Details Table

	A	S	T	U	V
1	Community	What are the connections between the landslide code info and the other codes?	Are there any disconnections between codes and maps?	Other relevant codes/provisions	Other observations:
9	Clatskanie	NA		9-9C-10.B.1 - Within fifty feet (50') of any protected water resources, excavation and vegetation removal shall be prohibited on slopes of twenty five percent (25%) or greater in slide hazard areas, with exceptions.	City code sites specific report and maps for flood insurance requirements as well as Significant Wetland and Riparian Corridors, so a similar provision could be added for landslide susceptibility maps. They also contain more detailed provisions for these mapped areas. (Chapter 9, Articles B and C)
10	Clatskanie	NA		Page 71, Action 2: City plan includes 'Define and map those locations within the urban growth boundary and the existing city limits that are known or suspect to be subject to natural disasters and hazards such as floods, slides and subsidence, and the like.	
11	Cornelius			There are no other major hazards (other than floods) in Cornelius. The 1974 plan shows there are no major slope areas greater than five percent in the area. Soils are primarily Class I-IV, and erosion hazards are very low because the area is so flat.	
12	Cornelius			18.160.020.D.1 - Shade point adjustment for Solar panels can be altered based on soil instability.	According to Cornelius comprehensive plan, besides flooding, there are not other major hazards in Cornelius. Therefore, the city defers to the Uniform Building Code for safety regulations and standards. 18.195.210 - "Undevelopable area" means an area that cannot be used practicably for a habitable structure because of natural conditions, such as slopes exceeding 20 percent in a direction greater than 45 degrees east or west of true south or severe topographic relief.
13	Durham		No LS Maps	3.2.4.1 - Common open space required for all developments should avoid geologic hazards.	Landslides and mitigation thereof are not directly referenced in the city code.

Table 8.1. Landslide Code Review Details Table

	A	B	C	D	E	F	G	H
	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
14	Durham	1,935	Comprehensive Land Use Plan	http://www.durham-oregon.us/LinkClick.aspx?fileticket=BbvQLR0Ew4Y%3d&tabid=6076&mid=13607&language=en-US	Comprehensive Plan	Not referenced	No.	Pg. 30 D.2.b - Natural hazards, including landslides, should be adequately incorporated into project design.
15	Estacada	3,313	Estacada Comprehensive Plan	http://www.cityofestacada.org/sites/default/files/fileattachments/administration/page/5771/2009_comprehensive_plan.pdf	Comprehensive Plan	Pg.118 - A review of excess slope (20% +) or drainage basins are considered to be unbuildable. The Uniform Building Code, Chapter 40, will preclude the development of these lands without having to designate them on the Plan Map.	No.	Pg42, #9 - The city will require site-specific information from applicants seeking approval to develop known hazard areas.
16	Estacada	3,313	Estacada Development Code	http://www.cityofestacada.org/sites/default/files/fileattachments/city_hall/page/5501/title_16_updated_with_r_added_in.pdf	City Code	33%	No.	Any property identified as a geological natural hazard area as listed in Section 16.68.030 or any property that has a slope of thirty-three (33) percent or greater.

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
14	Durham	Not referenced	Not referenced	not mapped		NA	NA
15	Estacada	Not referenced	Not Referenced	The Estacada comprehensive plan slopes map, undated, Figure 8 and the Estacada comprehensive plan hazards map, undated, Figure 9		The Estacada comprehensive plan slopes map, undated, Figure 8 and the Estacada comprehensive plan hazards map, undated, Figure 9	Undated
16	Estacada	Varies: 16.68.030.D.1 - Locations of recent landslide (or slope greater than 33%) activity require a site specified geotechnical analysis by a qualified professional geologist or engineering geologist. 16.68.030.D.1 - Areas of weak foundational soil require a detailed soils analysis by a qualified soils expert.	15.12.020.B - The building official receives and makes determinations on building permit applications.	Yes - Code refers to two maps, the Estacada comprehensive plan hazards map, undated, and the DOGAMI Bulletin 78, Environmental Hazard Inventory, Clackamas County, Oregon (This second map may be mislabeled and actually refer to bulletin 99, Geology and Geologic Hazards of Northwestern Clackamas County, Oregon. 1979)		Estacada comprehensive plan hazards map DOGAMI Bulletin 78, Environmental Hazard Inventory, Clackamas County, Oregon (This second map may be mislabeled and actually refer to bulletin 99, Geology and Geologic Hazards of Northwestern Clackamas County, Oregon. 1979)	1979

Table 8.1. Landslide Code Review Details Table

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
14	Durham	Appendix Table 1: Soils and Slopes table outlining soil types and slopes in various areas around Durham. Appendix Figure 1: Soils map. Not included with Comprehensive Plan PDF.	Not referenced	Not referenced	Not referenced
15	Estacada	Provisions primarily focus on preserving soil types I-IV for agricultural zoning. Pg.33 - Outlines general soil types and their distribution in city. Pg.42, #9 - References soil types as a factor in determining slide hazards area on Fig. 9 Map.	Pg. 18 - The city will consider erosion control measures in all development proposals. The city has adopted Chapter 70 of the uniform Building Code which sets forth regulations to control excavation, grading, and earthwork construction, including erosion control and drainage requirements	Pg.118 - Subdivided lots will be reviewed during the subdivision process.	Pg.18 - City has adopted UBC Chapter 70. Pg.118 - UBC Chapter 40 precludes development on excessive slopes.
16	Estacada	16.68.030.D - Areas of weak foundational soil require a soils expert study prior to development. 16.108.020.C.2 - Before subdividing property, consideration must be given to the erosion potential, stability, bearing qualities of the soil and geologic formations; soil permeability and infiltration rates.	16.52.030.A.3.c - Development proposals require submission of a grading concept plan. 16.108.020.C.2 - proposed subdivisions should include an impact statement taking into consideration erosion potential, stability, bearing qualities of the soil and geologic formations; soil permeability and infiltration rates.	16.108.020.C.2 - proposed subdivisions should include an impact statement taking into consideration erosion potential, stability, bearing qualities of the soil and geologic formations; soil permeability and infiltration rates.	15.04.030 - Excavation and Grading. The city adopts by reference Chapter 33 of the Uniform Building Code adopted by the International Conference of Building Officials, 1994 Edition, and as amended.

Table 8.1. Landslide Code Review Details Table

	A	S	T	U	V
1	Community	What are the connections between the landslide code info and the other codes?	Are there any disconnections between codes and maps?	Other relevant codes/provisions	Other observations:
14	Durham	Not referenced			
15	Estacada				
16	Estacada		Uncertain if referenced DOGAMI map is correctly labeled		

Table 8.1. Landslide Code Review Details Table

	A	B	C	D	E	F	G	H
	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
17	Eugene	166,575	Eugene City Code	https://www.eugene-or.gov/523/City-Code	City Code	9.6710.2.a - properties with slopes equal to or greater than 5%	No.	9.6710.2 - Required for all proposed tentative planned unit development, site review, or subdivision applications, on properties with slopes equal to or greater than 5%, or ALL proposed development that includes dedication or construction of a public street or alley or the construction of public drainage systems or public wastewater sewers - with exemptions (see notes).
18	Fairview	9,290	Fairview City Code	https://www.codepublishing.com/OR/Fairview/	City Code	19.425.020.A.3 - Site design review application must include "Identification of slopes greater than 25%". No specific trigger for further study is mentioned. Professional geologic study not required.		19.425.020.A.5 - Site design review application must include "potential natural hazard areas, including... areas mapped by the city, county, or state as having a potential for geologic hazards". No specific requirement for a professional geologic landslide study are included.
19	Fairview	9,290	Fairview Comprehensive Plan	http://fairvieworegon.gov/DocumentCenter/Home/View/1461	Comprehensive Plan	Not referenced		Not referenced
20	Forest Grove	24,058	City of Forest Grove city code	http://www.forestgrove-or.gov/sites/default/files/fileattachments/planning/page/701/a_code.maste r.update.2014.pdf	city code	Not referenced		Not referenced

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
17	Eugene	9.6710.2 - Geotechnical analysis must be done by an Oregon licensed Engineering Geologist or an Oregon licensed Civil Engineer with geotechnical experience, and must conform with standards, procedures and content as defined in the Standards for Geological and Geotechnical Analysis adopted by the city in the manner set forth in EC 2.019 City Manager - Administrative and Rulemaking Authority and Procedures. See "other notes" for info on survey levels.	Varies depending on permit and development type: 9.8100 - Conditional use permit - Hearings Official 9.8215,8220 - Partition, tentative Plan approval - Planning director 9.8320,8325 - Tentative Planned Unit Development - Hearings Official 9.8440,8445 - Site review Approval - Planning Director 9.8515,8520 - Subdivision, Tentative Plan - Planning Director See "other notes" for info on survey levels	No maps specifically addressing landslides included in chapter 9 Land use map packet: https://www.eugene-or.gov/DocumentCenter/View/2704 https://www.eugene-or.gov/DocumentCenter/View/2702	Hillside development overlay zone - https://www.eugene-or.gov/DocumentCenter/View/2704	NA	NA
18	Fairview	NA	NA	Not referenced		NA	NA
19	Fairview	Not referenced	Not referenced	Not referenced		NA	NA
20	Forest Grove	Not referenced	Not referenced	Not referenced		NA	NA

Table 8.1. Landslide Code Review Details Table

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
17	Eugene	<p>9.6710.4.b - Level two geotechnical analysis includes a required sub-surface investigation to determine soil type and distribution.</p> <p>9.6710.5.c - "variation in soil type" triggers a level three geotechnical report requirement.</p> <p>9.4780.4.c.1 - Per water quality standards, pervious surfaces of construction sites within the WQ overlay zone shall be returned to pre-construction permeability and sheet-flow conditions.</p> <p>No specific code regarding relationship between slides and drainage.</p>	<p>6.625 - Section lays out erosion control standards and construction permitting related to erosion control. Denotes applicable construction activities, permitting classes and requirements, application method and fees, review and issuance, duration, appeal process and exemptions, enforcement and rule adoption process.</p> <p>9.4780.2 - Areas of bare soil existing as a result of plant or vegetation removal shall be protected or covered consistent with EC 6.625 through EC 6.645 or replanted as soon as practicable, but no later than March 15 of the calendar year following disturbance; and If not replanted within 15 days of disturbance, areas of bare soil shall be mulched and seeded with straw mulch and native seed for temporary stabilization within 15 days of disturbance.</p>	<p>9.6710.2.a - geotech report requirement are applicable for subdivision applications as well as development. The same standards apply for unit construction or subdivision proposals.</p>	<p>9.9590.1.c.1 - within the laurel hill plan policies section: If, in the opinion of the responsible City official, an adverse geological condition exists upon a parcel of land proposed for a subdivision, or before any major hillside clearing, excavation, filling or construction is contemplated, the requirements of the Uniform Building Code, Chapter 70, Excavation and Grading, and those sections of the code relative to foundation design may be invoked.</p> <p>Generally - UBC referenced in several locations, but with no specific code mentioned. Primarily, "The UBC shall be conformed to".</p>
18	Fairview		<p>16.15.010 - The city of Fairview does here adopt the City of Gresham's "Erosion Prevention and Sediment Control Manual," revised January 2011* and attached to the ordinance codified in this chapter, to promote and encourage construction practices which minimize the amount of disturbed land area and avoid or minimize work on steep slopes.</p> <p>19.425.020.D - Site design review application must include a "Preliminary Grading Plan. A preliminary grading plan prepared by a registered engineer shall be required for developments which would result in the grading (cut or fill) of 1,000 cubic yards or greater. The preliminary grading plan shall show the location and extent to which grading will take place, indicating general changes to contour lines, slope ratios, slope stabilization proposals, and location and height of retaining walls, if proposed. Surface water detention and treatment plans may also be required."</p>	<p>19.430.140.B.2.d - Plat application must include site analysis that shows ground elevations shown by contour lines at five-foot vertical intervals for ground slopes exceeding 10 percent and at two-foot intervals for ground slopes of less than 10 percent.</p> <p>19.430.140.B.2.f - Application must also include potential natural hazard areas, including landslide areas, and areas having a high erosion potential;</p>	NA
19	Fairview	Pg.65,66 - Outlines primary soil types within Fairview and drainage characteristics for each soil.	Pg.62 - Development and earth disturbing activities shall follow the City Erosion Control Ordinance.	Not referenced	Not referenced
20	Forest Grove	Not referenced	9.810 - Erosion Control Plan. All development applications require a soil erosion control plan. This section outlines requirements of plan in detail.	Not referenced in relation to landslides, soils, or erosion.	Not referenced

Table 8.1. Landslide Code Review Details Table

	A	S	T	U	V
1	Community	What are the connections between the landslide code info and the other codes?	Are there any disconnections between codes and maps?	Other relevant codes/provisions	Other observations:
17	Eugene	9590.1.c.1 - Direct reference to chapter 70, excavation and grading, of UBC in regards to grading and excavation of hillsides.	NA	9.6710.3 - Maintenance, operation, reconstruction of existing streets, driveways, and utility lines, emergency actions which must be undertaken immediately or for which there is insufficient time for full compliance to prevent or abate threat to people, property, or environment, street and alley dedications that widen existing public right-of-way, residential building permits for lots that were subject to previous reports and assessments, new construction, building alterations and building additions that will not result in soil disturbance, and activities on land included on the city's acknowledged Goal 5 inventory, are EXEMPT from geotechnical report.	96710.4 and 5 - Geotech report requirements are divided into three categories based on site geologic conditions. Level one being the most basic report, and level three being the most detailed. Site slope less than 10% requires a level one, while slope greater than 10% requires a level 2. Level three report is required when Level One or Two Analysis reveals evidence of existing or potential stability problems or where site conditions such as springs or seeps, depth of soil to bedrock, variations in soil types, or a combination of these conditions, in the opinion of the professional, impact the design parameters of the structure. 9.6710.6 - Propositions for needed housing are exempt from geotechnical report given that they include certification from an Oregon licensed Engineering Geologist or Civil Engineer with "geologic experience" stating the development will not be impacted by site geology, or any impact will be mitigated.
18	Fairview	NA	NA		
19	Fairview	NA			
20	Forest Grove	NA			Forest Grove code does not specifically address landslides or dangerous slopes in any portion. This is most likely due to Forest Grove's generally flat topography.

Table 8.1. Landslide Code Review Details Table

	A	B	C	D	E	F	G	H
1	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
21	Gladstone	12,116	Gladstone Municipal Code	https://www.codepublishing.com/OR/Gladstone	city code	Not referenced		17.80.061.b.D - Application for design review must include areas of potential geologic hazards. 15.06.030.1.c - An engineering geology report is required when the application is for earthwork in excess of 5,000 cubic yards or affects one acre or more of land or is requested by the City Administrator.
22	Gold Beach	2,305	City of Gold Beach Comprehensive Plan	file:///C:/Users/justin.mccarley/Downloads/HT168_G64G64_1982_OCR.pdf , https://scholarsbank.uoregon.edu/xmlui/handle/1794/9341	Comprehensive Plan	Not reference	The Comp Plan describes four categories of slope: Class A is relatively flat <12%, Class B is moderate slope 12-30%, Class C is relatively steep slope 30-50%, and Class D is steep slopes.	Not referenced
23	Gold Beach	2,305	City of Gold Beach Zoning Ordinance	https://www.goldbeachoregon.gov/vertical/sites/%7B95824C9A-6BB0-47B3-83E2-3D2AE3179E09%7D/uploads/2018_full_GBZO.pdf	City Code	Not Referenced 1.030 - Definitions section "Geologic Hazard Area" describes physical traits of areas with evidence of recent mass movement or slope failure quite well. This definition is used as a trigger for sites requiring a geologic study in favor of a simple slope value.		2.1210 - When development is to take place within areas known to contain mapped geologic hazards, as per the cited maps or as identified by the engineer or geologist.
24	Gresham	111,523	City of Gresham Development Code Article 5 - Overlay Districts	file:///C:/Users/justin.mccarley/Downloads/Development%20Code%20Article%205.pdf	City Development Code	5.0202.A.1 - 15% or greater (before development)		5.0202.B.1 - Before any development (with exceptions; see notes) occurs within the Hillside Physical Constraint Overlay District, as defined by the Community Development Hillside Special Purpose District Map or where contiguous slope is 15% or greater with an area of 10,000 sq.ft.

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
21	Gladstone	15.06.010.2 - "Civil Engineer" shall mean a professional engineer registered in this state to practice in the field of civil works. 15.06.010.11 - "Soil Engineer" shall mean a civil engineer experienced and knowledgeable in the practice of soil engineering.	15.06.030.4 - the engineering geology report is approved by the City Administrator.	No		NA	NA
22	Gold Beach	Not referenced	Not referenced	There is a Natural Hazards Map as Appendix C (page 215 out of 266 in the PDF of the Comp Plan).	Comp Plan does not list overlays.	The 1982 Gold Beach Comp Plan includes quite a few maps, including those related land use, natural hazards, natural resources, and soil types. There is a bibliography that lists the sources of information.	1982
23	Gold Beach	2.1210.3 - Code only mentions that the assessment must be completed by a Geologist.	2.1210.3 - the city Planning Director 2.1230.9 - Appeals of the Planning Directors decision may, at the Planning Director's discretion, be submitted to an independent engineer or geologist for peer review, the cost of which is to be split evenly between the appellant and applicant.	2.1210 - the Natural Hazard Inventory map (including DOGAMI maps "Provisional Maps of Rapidly Moving Landslides" and "Further Review Areas" as well as maps from the DOGAMI Bulletin 90: Land Use Geology of Western City of Gold Beach, Oregon) NOTE: Bulletin 90 mislabeled; should read "Land-use Geology of Western Curry County, Oregon."	Natural Hazards overlay - http://www.goldbeachoregon.gov/vertical/sites/%7B95824C9A-6BB0-47B3-83E2-3D2AE3179E09%7D/uploads/Zoning_Ordinance-City_of_Gold_Beach-1.pdf	DOGAMI "Provisional Maps of Rapidly Moving Landslides" (Possibly referencing "Map of Potentially Rapidly Moving Landslide Hazards in Western Oregon" - http://www.oregongeology.org/sub/publications/ims/ims-022/ims-22_GoldBeach.pdf) and "Further Review Areas", and maps from the DOGAMI Bulletin 90 Land Use Geology of Western City of Gold Beach, Oregon (Most likely referencing "Geologic Hazard Map of the Gold Beach Quadrangle" http://www.oregongeology.org/pubs/B/B-090.pdf#page=163 from that publication)	Bulletin 90 - 1976 PMRML - 2002?
24	Gresham	5.0202.F - Certified Engineering Geologist – any State of Oregon Registered Geologist who is certified in the specialty of Engineering Geology under provisions of ORS 672.505 to 672.705. 5.0202.G - Geotechnical Engineer – a Professional Engineer, registered in the State of Oregon provided by ORS 672.002 to 672.325, who by training, education and experience is qualified in the practice of geotechnical or soils engineering practices.	The City Manager of the City of Gresham. While not explicitly stated as the responsible party for approving permits, the Manager is referenced in several codes (5.0210.C, 5.0210.C.1, 5.0222.C, 5.0223.B, 5.0226.G,) as the approving or discretionary body.	Yes. 5.020.A - The Community Development Hillside Special Purpose District Map. Hazardous areas are divided into three categories; Higher landslide risk, Transition area, and Further review area.	Hillside physical constraint overlay - file:///C:/Users/justin.mccarley/Downloads/Development%20Code%20Article%205.pdf	The Community Development Hillside Special Purpose District Map	Not Referenced

Table 8.1. Landslide Code Review Details Table

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
21	Gladstone	17.56.020 - Adequate provisions shall be made to ensure proper drainage of surface waters and to prevent soil erosion and flooding of neighboring properties or streets.	17.58.020.1 - Grading and fill of building sites shall conform to Chapter 70 of the Uniform Building Code.	17.32.020 - Subdivision plans require contour intervals, and locations of waterways, wetlands, large trees, and rock outcrops but no reference to landslides or geologic hazards.	Not referenced
22	Gold Beach	There are descriptions of soil types and there are maps showing the location of the soils, the estuary, etc.	Not specifically discussed.	Not specifically discussed.	NA to the Comp Plan.
23	Gold Beach	Not Referenced	2.1230.1 - The geologic hazard assessment shall also assess erosion and any increase in storm water runoff and any diversion or alteration of natural storm water runoff patterns resulting from the development activity.	2.1230.7.b - In the event that the development activity is a division of land, the mitigation plan shall specify mitigation measures or improvements that must be implemented on each parcel to assure the protection of the subject property and of other properties from the hazards identified in the geologic hazard mitigation report.	Not Referenced
24	Gresham	5.0210.C.3 - Geologic mapping and investigation of the parcel shall be completed in sufficient detail to describe the geology of the parcel, and evaluate and describe existing or potential geologic hazards associated with the parcel and shall address (Among other things): Soil and rock types and groundwater conditions	5.0210.C.5.c - The required geologic study must include recommendations for site grading and drainage. This must address specific requirements including: prediction of soil material and structures, soil stability, soil permeability, protection from gully and sheet erosion, bedrock and groundwater considerations, fill considerations, suitability of on site material as fill, recommendations for fill drainage, vegetation removal and erosion concerns, recommendation to minimize site disturbance, other considerations. 5.0210.D - Application must include Preliminary Site Grading Plan	5.0221 - The underlying land use district regulations shall apply to parcels within the HPCD, for areas of less than 15%. Minimum and maximum number of units is dependent upon amount of lot that is less than 15% slope. Maximum can be increased through a Planned Development (6.0300). 5.0221.D - Lots within the HPCD are exempt from certain design standards for specific land use districts.	5.0220.D - Exemption from the safe neighborhood design standard (4.0132)

Table 8.1. Landslide Code Review Details Table

	A	S	T	U	V
1	Community	What are the connections between the landslide code info and the other codes?	Are there any disconnections between codes and maps?	Other relevant codes/provisions	Other observations:
21	Gladstone	NA			
22	Gold Beach	NA to the Comp Plan.	There are quite a few maps in the Comp Plan.	Related policies are those for Goals 5, 6, 17, and 18.	The Comp Plan includes this: GOAL 7 - AREAS SUBJECT TO NATURAL DISASTERS AND HAZARDS Goal: To protect life and property from Natural Hazards and disasters. Policies: a) To insure that development in the floodplain conforms to the National Flood Insurance Act. b) To discourage development in natural drainage ways, on excessive slopes and in other hazardous areas by careful review of development proposals in those areas with such identified problems. c) To require site information prior to development in those identified hazardous areas through implementation of the Zoning Ordinance
23	Gold Beach	NA		2.750 - Describes requirements for a geologic study to address impact on beach and foredunes when development occurs in these areas. This section describes Geologist credential requirements, geologic study content requirements, and study approval process in greater detail than any other section. 2.1230.10 - Unmapped geologic hazards brought to the city's attention must be investigated by a city hired geologist prior to development. The cost of this is passed on to the applicant.	2.1210.4 - Code describes in detail the requirements for information contained in the geologic hazard mitigation report and the site technical analysis. Note: Gold Beach code does a fantastic job of laying out the application, geologic study, and approval process for areas with possible geologic hazards relative to other communities. Some things that could be improved are the maps used to denote the areas of possible geologic hazards, and a better definition of geologist or engineer qualifications. Was unable to find the maps cited in the code, and suspect that they are well out of date.
24	Gresham	5.0210.D - Code includes requirements for grading plans from section 9.0500. 5.0221.A.4 - References Planned Developments section 6.0300. 5.0221.D - References Safe Neighborhood Design Performance Standards section 4.0132.D.		5.0222 - Development of any kind other than public facilities and utilities is restricted on slopes greater than 35% except for specific instances where lot size does not allow any other development or is of a size larger than 10 acres.	The Hillside Physical Constraint Overlay District Regulations, Section 5.0200 are much more extensive in detail than can be reflected in this spreadsheet. Section includes information on applicability, submittal requirements, development and lot development standards, grading standards, specific regulations for slopes greater than 35%, trees and vegetation on site, Surface and groundwater drainage, and development in further review areas.

Table 8.1. Landslide Code Review Details Table

	A	B	C	D	E	F	G	H
1	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
25	Maywood Park	828	Maywood Park Ordinances	http://cityofmaywoodpark.com/city-ordinances/	City Code	Not Referenced		Not Referenced
26	Medford	81,636	Land Development Code	http://www.ci.medford.or.us/Page.asp?NavID=447	City Code	10.931: For parcels containing Slopes greater than fifteen percent (15%), as shown on the 2009 City of Medford Slope Map, a copy of which is maintained on file in the Planning Department, a Slope Analysis is required to be submitted with: (1) Class "C" applications (except for zone changes); and, (2) Building permit applications, if a Slope Analysis of the parcel was not previously submitted with a development application. Medford's zoning provision for slopes that are 15% or greater limits residential development to two units per acre (SFR-2).		The Medford City Council adopted a Hillside Ordinance in 2009 as an amendment to the Land Development Code (10.929-10.933). Requirements include submittal of a Constraints Analysis to the City Engineer of the Public Works Department, consisting of a Geology and Soils Report and a Hydrology and Grading Report. 10.929 Purpose; Applicability. Sections 10.929 to 10.933 establish procedural requirements for development on Slopes in excess of fifteen percent (15%) to decrease soil erosion and protect public safety. Sections 10.929 to 10.933 apply in addition to all other requirements set forth by ordinance. In the case of conflict between Sections 10.929 to 10.933 and other requirements set forth by ordinance, Sections 10.929 to 10.933 shall govern. [Added, Sec. 1, Ord. No. 2009-193, Aug. 20, 2009, effective Oct. 15, 2009.]

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
25	Maywood Park	Not Referenced	Not Referenced	Not Referenced		NA	NA
26	Medford	A "complete" Constraints Analysis is one that contains all items in Sections 10.933(A) (1)-(7) and 10.933(B) (1)-(4). Both a Geology and Soils Report, prepared by an Oregon licensed geologist or engineering geologist, and a Hydrology and Grading Report prepared by an Oregon registered civil engineer, must be provided.	The Slope Analysis shall be reviewed by the City Director of Public Works or designee.	Medford Slope Map approved in 2009.		DOGAMI's Open File Report 0-16-02, Landslide Susceptibility Overview Map of Oregon (Burns et al., 2016) has relevant landslide information. The 2017 Medford Natural Hazards Mitigation Plan includes Medford data related to landslides in susceptibility areas, steep slopes, and the Medford Slope Map.	

Table 8.1. Landslide Code Review Details Table

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
25	Maywood Park	Not Referenced	Not Referenced	Not Referenced	Not Referenced
26	Medford	The Constraints Analysis requires that there is a description of the nature, distribution, and strength of the existing soils on the site relative to their adequacy for the proposed development; and a determination of the suitability of the geology and soils on the site for the proposed development.	10.931: Issuance of an Excavation and Grading permit shall be required prior to any excavation or grading, except for the types of excavation or grading exempted in Appendix J of the 2007 Oregon Structural Specialty Code, a copy of which is maintained on file in the Planning Department. The permit application shall be reviewed and approved by the City Building Official or designee. An application for an Excavation and Grading Permit shall be subject to the requirements set forth in Sections 10.727 and 10.728.	There appear to be no specific references to landslides within the land division application requirements and the approval criteria.	Yes. There is a reference to the 2007 Oregon Structural Specialty Code in Section 10.931.

Table 8.1. Landslide Code Review Details Table

	A	S	T	U	V
1	Community	What are the connections between the landslide code info and the other codes?	Are there any disconnections between codes and maps?	Other relevant codes/provisions	Other observations:
25	Maywood Park	Not Referenced	Not Referenced	Article 9 - Adopts Multnomah County Zoning Ordinance 100.	There are no land use codes referenced within the City of Maywood Park Ordinances.
26	Medford	10.931: For parcels containing Slopes greater than fifteen percent (15%), as shown on the 2009 City of Medford Slope Map, a copy of which is maintained on file in the Planning Department, a Slope Analysis is required to be submitted with: (1) Class "C" applications (except for zone changes); and, (2) Building permit applications, if a Slope Analysis of the parcel was not previously submitted with a development application.	The Medford Slope Map is linked to the existing codes. The DOGAMI Landslide Susceptibility Overview Map , and the Landslide Hazard map in the Medford Natural Hazards Mitigation Plan are not otherwise linked to the Medford codes.		On steep slopes, water and sewer lines must be "keyed into" hillsides. This entails the burying of a concrete anchor into the subsurface rock, a structural technique that holds the lines in place. City not currently LiDAR mapped by DOGAMI

	A	B	C	D	E	F	G	H
1	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
27	Newport	10,393	Newport Municipal Code: Chapter 14.21 Geologic Hazards Overlay	http://www.newportoregon.gov/dept/cdd/documents/NMC_Chap14_Zonin_g.pdf	City Code	Chapter 14.21 does not specify a slope % threshold. In Newport, it's still ok to build on 25% slopes, if the proper studies and reviews are accomplished.		14.21.020 Applicability of Geologic Hazards Regulations: A. The following are areas of known geologic hazards or are potentially hazardous and are therefore subject to the requirements of Section 14.21: 1. Bluff or dune backed shoreline areas within high or active hazard zones identified in the Department of Geology and Mineral Industries (DOGAMI) Open File Report 0-04-09 Evaluation of Coastal Erosion Hazard Zones along Dune and Bluff Backed Shorelines in Lincoln County, Oregon: Cascade Head to Seal Rock, Technical Report to Lincoln County, dated 2004. 2. Active or potential landslide areas, prehistoric landslides, or other landslide risk areas identified in the DOGAMI Open File Report 0-04-09. 3. Any other documented geologic hazard area on file, at the time of inquiry, in the office of the City of Newport Community Development Department. A "documented geologic hazard area" means a unit of land that is shown by reasonable written evidence to contain geological characteristics/conditions which are hazardous or potentially hazardous for the improvement thereof. B. The DOGAMI Open File Report 0-04-09 is not intended as a site specific analysis tool. The City will use DOGAMI Open File Report 0-04-09 to identify when a Geologic Report is needed on property prior to development. A Geologic Report that applies to a specific property and that identifies a proposed development on the property as being in a different hazard zone than that identified in DOGAMI Open File Report 0-04-09, shall control over DOGAMI Open File Report 0-04-09 and shall establish the bluff or dune-backed shoreline hazard zone or landslide risk area that applies to that specific property. The time restriction set forth in subsection 14.21.030 shall not apply to such determinations. C. In circumstances where a property owner establishes or a Geologic Report identifies that development, construction, or site clearing (including tree removal) will occur outside of a bluff or dune-backed shoreline

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
27	Newport	<p>14.21.030. All persons proposing development, construction, or siteclearing (including tree removal) within a geologic hazard area as defined in 14.21 .010 shall obtain a Geologic Permit. The Geologic Permit may be applied for prior to or in conjunction with a building permit, grading permit, or any other permit required by the city. Unless otherwise provided by city ordinance or other provision of law, any Geologic Permit so issued shall be valid for the same period of time as a building permit issued under the Uniform Building Code then in effect. A Geologic Permit requires: C. Identification of the bluff or dune-backed hazard zone or landslide hazard zone for the parcel or lot upon which development is to occur. In cases where properties are mapped with more than one hazard zone, a certified engineering geologist shall identify the hazard zone(s) within which development is proposed; and D. A Geologic Report prepared by a certified engineering geologist, establishing that the site is suitable for the proposed development; and E. An engineering report, prepared by a licensed civil engineer, geotechnical engineer, or certified engineering geologist (to the extent qualified), must be provided if engineering remediation is anticipated to make the site suitable for the proposed development.</p>	<p>An application shall be processed and authorized using a Type I decision-making process. Any appeal from the issuance or denial of a Geologic Permit shall be filed within 15 calendar days of the date the city issues a final order as provided by Section 14.52.050. Appellants challenging substantive elements of a Geologic Report shall submit their own analysis prepared by a certified engineering geologist. Such report shall be provided within 30 days of the date the appeal is filed. A failure to submit a report within this timeframe is grounds for dismissal of the appeal. No development requiring a Geologic Report shall receive final approval (e.g. certificate of occupancy, final inspection, etc.) until the city receives a written statement by a certified engineering geologist indicating that all performance, mitigation, and monitoring measures contained in the report have been satisfied. If mitigation measures involve engineering solutions prepared by a licensed professional engineer, then the city must also receive an additional written statement of compliance by the design engineer.</p>	<p>The City will use DOGAMI Open File Report 0-04-09 to identify when a Geologic Report is needed on property prior to development. The City of Newport also has maps called the Natural Hazard Overlay Zones: North Newport and South Newport. The maps include geologic hazards, FEMA floodway, 100-yr floodplain, base flood elevation, and the SB 379 tsunami inundation line.</p>	<p>Natural hazards Overlay Zones: North Newport - http://www.newportoregon.gov/dep/cdd/documents/North_Newport_Hazards.pdf South Newport - http://www.newportoregon.gov/dep/cdd/documents/South_Newport_Hazards.pdf</p>	<p>When Derrick Tokos, the current Community Development Director, arrived in 2009, he quickly set out to revise the geologic hazard code. The code was from the 1970s. He used DOGAMI's Open File Report 0-04-09 as a basis to do the updates.</p>	

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
27	Newport	<p>Geologic Report Guidelines: Geologic Reports shall be prepared consistent with standard geologic practices employing generally accepted scientific and engineering principles and shall, at a minimum, contain the items outlined in the Oregon State Board of Geologist Examiners "Guidelines for Preparing Engineering Geologic Reports in Oregon," in use on the effective date of this section. Such reports shall address subsections 14.21.070 to 14.21.090, as applicable. For oceanfront property, reports shall also address the "Geological Report Guidelines for New Development on Oceanfront Properties," prepared by the Oregon Coastal Management Program of the Department of Land Conservation and Development, in use as of the effective date of this section. All Geologic Reports are valid as prima facie evidence of the information therein contained for a period of five (5) years. They are only valid for the development plan addressed in the report. The city assumes no responsibility for the quality or accuracy of such reports.</p>	<p>For structures, driveways, parking areas, or other impervious surfaces in areas of 12% slope or greater, the release rate and sedimentation of storm water shall be controlled by the use of retention facilities as specified by the City Engineer. The retention facilities shall be designed for storms having a 20- year recurrence frequency. Storm waters shall be directed into a drainage with adequate capacity so as not to flood adjacent or downstream property. There is a section on erosion control measures. Within that section there info requestion on vegetation removal, cut and fill, stormwater, etc.</p>	<p>These code provisions do not specifically mention land divisions.</p>	<p>These code provisions do not specifically mention the building code. There are provisions related to stormwater retention.</p>

	A	S	T	U	V
1	Community	What are the connections between the landslide code info and the other codes?	Are there any disconnections between codes and maps?	Other relevant codes/provisions	Other observations:
	Newport	There are links to the conforming and non-conforming structures and uses.	Chapter 14.21 does not specifically reference the Natural Hazards Overlays which are two maps, North Newport and South Newport. The maps are dated Junen 29, 2016 and located on the website at these two links: http://www.newportoregon.gov/dept/cdd/documents/North_Newport_Hazards.pdf and http://www.newportoregon.gov/dept/cdd/documents/South_Newport_Hazards.pdf . I looked through the chapters in the Municipal Code and did not see these Natural Hazards Overlays listed or described. These links are on the Newport website: Geologic Hazards Permit, -Report Guidelines - new oceanfront developments, - Guidelines for preparing Geologic Reports, -Exemption to Geologic Permit Requirements on this link: http://www.newportoregon.gov/dept/cdd/planningAppsChecks.asp .	There is a section, 14.21.150, about conforming and non-conforming uses and structures that are damaged.	Tricia: I included the City of Newport as an example in the presentation I made on October 27, 2016 at the Oregon-Washington APA conference, "Landslides in Oregon: Integrating Science and Policy." Contacts there include Derrick Tokos, Community Development Director. I will add some thoughts here. From the Newport code: "If the results of a Geologic Report are substantially different than the hazard designations contained in DOGAMI Open File Report 0-04-09 then the city shall provide notice to the Department of Geology and Mineral Industries (DOGAMI) and Department of Land Conservation and Development (DLCD). The agencies will have 14 days to provide comments and the city shall consider agency comments and determine whether or not it is appropriate to issue a Geologic Permit." To date, they have not had this issue come up. City not currently LiDAR mapped by DOGAMI

Table 8.1. Landslide Code Review Details Table

	A	B	C	D	E	F	G	H
	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
1	Oregon City	36,286	Oregon City Municipal Code	http://library.municode.com/index.aspx?clientId=16540	City Code	Chapter 17.44.060.H and I contain density/slope requirements.		17.44.025 - No development is allowed within the Geologic hazards overlay zone without prior approval. 17.04.515 - The geologic hazards overlay zone is defined thusly: The following areas identified on the city's slope and geology map which represents: a. Areas within fifty feet of the crest or toe of a slope that is twenty-five percent or greater, or within two hundred feet of the crest or toe of a landslide geologic units Q1s and Qf identified by DOGAMI and derived from LIDAR IMS-29 and IMS-26 publications in 2009, whichever is greater; b. Areas with a slope of twenty-five percent or more; c. Geologic Hazards areas identified by the State of Oregon Department of Geology and Mineral Industries (DOGAMI) as landslide or debris flow fan (Q1s and Qf geologic units derived from LIDAR IMS-29 and IMS-26 publications in 2009); d. Geologic Hazards areas identified in Bulletin 99, Geology and Geologic Hazards of Northwestern Clackamas County, Oregon (1979); and; 2. Any other area that is identified by a suitably qualified geotechnical engineer or engineering geologist who is licensed in Oregon and derives his or her livelihood principally from that profession as being subject to soil instability, slumping or earth flow, high groundwater level, and landslide.
28	Port Orford	1,159	Port Orford Municipal Code	http://www.portorford.org/municipalcode.html	City Code	17.16.080 - 15%		17.16.080 - Whenever development is to occur within the Geologic Hazards Overlay Zone or on slopes of greater than 15%
29								

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
28	Oregon City	<p>17.04.520 - "Geotechnical engineer" is a Professional Engineer, registered in the State of Oregon as provided by ORS 672.002 to 672.325, who by training, education and experience is qualified in the practice of geotechnical or soils engineering practices.</p> <p>17.04.510 - "a suitably qualified geotechnical engineer or engineering geologist who is licensed in Oregon and derives his or her livelihood principally from that profession as being subject to soil instability, slumping or earth flow, high groundwater level, landslide, or seismic activity".</p>	<p>17.50.030 - Decisions regarding land use applications involving geologic hazards go through a type II decision making process, which is defined thusly:</p> <p>17.050.030.2.B - Type II decisions involve the exercise of limited interpretation and discretion in evaluating approval criteria, similar to the limited land use decision-making process under state law. Applications evaluated through this process are assumed to be allowable in the underlying zone, and the inquiry typically focuses on what form the use will take or how it will look. Notice of application and an invitation to comment is mailed to the applicant, recognized active neighborhood association(s) and property owners within three hundred feet. The community development director accepts comments for a minimum of fourteen days and renders a decision. The community development director's decision is appealable to the city commission with notice to the planning commission, by any party with standing (i.e., applicant and any party who submitted comments during the comment period). The city commission decision is the city's final decision and is appealable to the land use board of appeals (LUBA) within twenty-one days of when it becomes final.</p>	<p>17.04.515.1 - Yes. The area is mapped as the 'geologic hazards overlay zone'. This is an amalgamation of several maps and reports, including: DOGAMI publications from 2009 and 1979. Based on "LIDAR IMS-29 and IMS-26 publications".</p>	<p>Oregon City Geologic Hazards Overlay Zone – https://www.orcity.org/publicworks/geologic-hazards</p>	<p>Oregon city online maps page down at time of writing. http://webmaps.orcity.org/</p>	<p>2009 and 1979</p>
29	Port Orford	<p>17.16.080.A - Engineering Geologist licensed by the State of Oregon as provided by ORS 672.505 to 672.705</p>	.	<p>Yes.</p> <p>17.16.080 - Port Orford Geologic Areas Map 3-A and Landslide Inventory Map of Coastal Curry County Oregon 2014</p>	<p>Port Orford – Mention of proposed Natural Hazards Overlay Zone in 2015 planning document, but nothing yet available online.</p>		<p>2014 (both)</p>

Table 8.1. Landslide Code Review Details Table

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
28	Oregon City	<p>13.12.080 - All development plans require engineered drainage plans, drainage reports, and design flow calculation reports in compliance with the submittal requirements of the Public Works Stormwater and Grading Design Standards and each project site shall have a separate valid city approved plan and report before proceeding with construction.</p> <p>17.44.050.A.2 - Geologic reports must include information and recommendations regarding existing local drainage, proposed permit activity impacts on local drainage, and mitigation to address adverse impacts.</p> <p>17.44.050.A.1 - Geologic reports must include information and data regarding the physical and chemical properties of existing soils and groundwater.</p>	<p>17.44.050.A.7/8 - Geologic site report must include conclusions regarding the effect of geologic conditions on the grading activity and specific requirements and recommendations for plan modification, corrective grading, and special techniques and systems to facilitate a safe and stable site.</p> <p>17.44.050.A.9 - Geologic report must include recommendations and considerations for erosion control techniques applicable to the site.</p>	<p>16.08.025 - Subdivision applications must include a Natural Features Plan and Topography, Preliminary Grading and Drainage Plan, including: All known geologic and flood hazards, landslides or faults, and areas with a water table within one foot of the surface.</p>	Not referenced
29	Port Orford	<p>17.16.080.4.a.iv.2.a - The results of all test performed on soils, material, and rock at the site must be included in the technical analysis from the geologist.</p>	<p>17.17.060.1 - Applications for development shall include an Erosion Prevention and Sediment Control Plan.</p>	<p>17.16.080.8.b - For development involving land divisions, a mitigation plan must be included that shows measures necessary to protect each parcel from geologic hazards.</p>	

Table 8.1. Landslide Code Review Details Table

	A	S	T	U	V
1	Community	What are the connections between the landslide code info and the other codes?	Are there any disconnections between codes and maps?	Other relevant codes/provisions	Other observations:
28	Oregon City			17.44.050.B.3 - All geologic assessments and geotechnical reports shall be reviewed by an engineer certified for expertise in geology or geologic engineering and geotechnical engineering, respectively, as determined by the city. The city will prepare a list of prequalified consultants for this purpose. The cost of review by independent review shall be paid by the applicant.	17.04.1145 - Oregon City specifically outlines the method to be used for calculating slope: 1. For lots or parcels individually or cumulatively greater than ten thousand square feet in size, between grade breaks, obtain the vertical distance, divide by the horizontal distance and multiply by one hundred. The horizontal distance to be used in determining the location of grade breaks shall be fifty feet; 2. For lots or parcels ten thousand square feet or smaller in size, obtain the vertical distance across the lot or parcel, divide by the horizontal distance and multiply by one hundred;
29	Port Orford				

Table 8.1. Landslide Code Review Details Table

	A	B	C	D	E	F	G	H
1	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
30	Portland	639,863	Portland Zoning Code (Title 33 of the City Code)	https://www.portlandoregon.gov/bps/31612?	City Codes	Related to 33.632.020, there is no percent slope identified. The trigger is a proposed land division with any portion of the land within the potential landslide hazard area. That area is mapped.		Chapter 33.632 Sites in Potential Landslide Hazard Areas. 33.632.020 Where This Approval Criterion Applies: The approval criterion of this chapter applies to all proposals for land divisions where any portion of the site is within a potential landslide hazard area.
31	Portland	639,863	Portland City Code, Title 24	https://www.portlandoregon.gov/citycode/28188	City Codes			
32	Portland	639,863	City of Portland Erosion Control Manual (March 2008)	https://www.portlandoregon.gov/bds/article/94539	City Codes			

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
30	Portland	The Landslide Hazard Study (LHS) must be prepared by a Certified Engineering Geologist (CEG) and Geotechnical Engineer (PE). Handout at: https://www.portlandoregon.gov/bds/article/403947 and additional related provisions in Section 33.730.060.D.1.f.	The Bureau of Development Services Site Development staff will review the LHS. The LHS will also be reviewed by the planner assigned to the land division application.	The potential landslide hazard area is mapped on Portland Maps at: https://www.portlandmaps.com/	Portland – Potential Landslide Hazards Area – https://www.portlandoregon.gov/bds/article/72539	Portland Maps includes categories of: Mapped Landslide Inventory Area; Title 33 Potential Landslide Hazard Area; and Steep Slope Area (25%).	On Portland Maps, the dates are generally showing the data is updated through April 2017.
31	Portland						
32	Portland						

Table 8.1. Landslide Code Review Details Table

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
30	Portland	Chapter 33.635 Clearing and Grading and Land Suitability. 33.635.020 Where This Approval Criterion Applies: The approval criteria of this chapter apply to proposals for land divisions in all zones. Nothing about soil types. Section 33.635.100: Existing contours and drainage patterns of the site must be left intact wherever practicable. Where alteration to existing drainage patterns is proposed, it must not adversely impact adjacent properties by significantly increasing volume of runoff or erosion;	33.635.100: Clearing and grading should be sufficient for construction of development shown on the Preliminary Clearing and Grading Plan; Clearing and grading should be limited to areas of the site that are reasonably necessary for construction of development shown on the Preliminary Clearing and Grading Plan; Topsoil must be preserved on site to the extent practicable for use on the site after grading is complete; Soil stockpiles must be kept on the site and located in areas designated for clearing and grading as much as is practicable; and The limits of disturbance and tree protection measures shown on the Preliminary Clearing and Grading Plan must be adequate to protect trees to be retained on the tree preservation plan.	The Landslide Hazard Study and the potential landslide hazard map are related to land divisions.	No.
31	Portland		24.70.10: The provisions of this Chapter shall regulate clearing, grading and earthwork construction on private property. Tree removal, whether associated with clearing, grading, earthwork construction or conducted separately shall be regulated pursuant to Title 11, Trees. Erosion control is regulated by Title 10. Section 24.70.30 specifically relates to hazards.		Title 24 is Building Regulations
32	Portland				Title 10 is Erosion and Sediment Control

Table 8.1. Landslide Code Review Details Table

	A	S	T	U	V
1	Community	What are the connections between the landslide code info and the other codes?	Are there any disconnections between codes and maps?	Other relevant codes/provisions	Other observations:
30	Portland	Portland Maps includes categories of: Mapped Landslide Inventory Area; Title 33 Potential Landslide Hazard Area; and Steep Slope Area (25%). What are the code links to the Steep Slopes Area (25%) and the Mapped Landslide Inventory Area?	At this point, yes, but perhaps it is a matter of more research.	Site development permits are reviewed by BDS geotechnical and join/or civil engineers and Planning and Zoning staff, and potentially other bureaus. There are several situations when a project would require a site development permit: 1.Clearing - For cutting or removal of vegetation which results in exposing any bare soil. 2.Grading - For earthwork, excavation or filling in excess of 10 cubic yards. 3.Tree Cutting - For tree cutting on slopes with gradients which exceed 25% when more than five trees of six-inch diameter are to be cut or the area to be cleared is greater than 2,500 square feet. 4.Private Right-of-ways - For construction of streets, alleys, common greens and pedestrian connections located within a private right-of-way.	City of Portland has a Landslide Hazard Area (LHA) map and code provisions. The map and code provisions are specifically linked to the Land Divisions. If a Land Division is proposed within the LHA, a Landslide Hazard Study (LHS) is required. There are specific requirements for the LHS. The requirements for the LHS include: The Landslide Hazard Study (LHS) must be prepared by a Certified Engineering Geologist (CEG) and Geotechnical Engineer (PE). A copy of the LHS handout can be found at: https://www.portlandoregon.gov/bds/article/403947 and additional related provisions in Section 33.730.060.D.1.f.
31	Portland				
32	Portland				When a Land Division is not proposed, but some other land use application is, there are no other Zoning Code (Title 33 of City Code) provisions that apply. The provisions that apply are part of City Code (but not Zoning Code) and are overseen by the Site Development staff. The Site Development staff can invoke City Code provisions (e.g. erosion control, steep slope, whatever) pursuant to Title 24 (building code regulations) and Title 10 (erosion and grading control regulations). They have the ability to ask for additional studies and reports as needed. They use two maps that are not related to the Zoning Code: Mapped Landslide Inventory Area and Areas with Steep Slopes (25%). All three maps: Steep slopes (25%); Mapped Landslide Inventory Area; and Landslide Hazard Area are found online on the City of Portland's site called Portland Maps.

Table 8.1. Landslide Code Review Details Table

	A	B	C	D	E	F	G	H
1	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
33	Salem	167,419	Salem Revised Code	http://www.cityofsalem.net/Pages/salem-revised-code.aspx	City Code	NA		810.020.a.1 - Prior to development in areas designated as moderate or high total landslide hazard risk as a determined by the landslide hazard risk assessment worksheet score in section 810.025. Scores are based off a matrix of site geology and development activity landslide susceptibility. A score of 5 or higher triggers a Geologic assessment requirement for the application process.
34	Sandy	11,005	Title 17 Development Code	http://www.ci.sandy.or.us/Development-Code/	City Code	17.56.10 - 25%		17.56.10 - Applies to all development that "require a building, grading, tree removal, and/or land use permit" within the Hillside Development Overlay District, or in areas with slope hazards as mapped by DOGAMI. With limited exceptions. 17.56.40 - Three different levels of study may be required based upon site factors including slope and location within DOGAMI mapped hazard areas.
35	Silverton	10,002	Silverton Municipal Code	http://www.codepublishing.com/OR/Silverton/	City Code	18.2.6.100 - 12%		18.2.6.130 - Prior to development on land that exceeds 12 percent average slope or contains areas classified as having moderate or high susceptibility to shallow-seated and deep-seated landslides by DOGAMI

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
33	Salem	810.010.a/c - Certified Engineering Geologist: Any Registered Geologist who is certified in the specialty of Engineering Geology under provisions of ORS 672.505 to 672.705. Geotechnical Engineer: A Professional Engineer, registered in the State of Oregon as provided by ORS 672.002 to 672.325, who by training, education and experience is qualified in the practice of geotechnical or soils engineering practices.	810.020.b - A landslide hazard construction permit is processed as a Type I procedure under SRC Chapter 300. Table 300-2 - Landslide hazard construction permits are approved by the Public Works Director.	810.015 - Areas subject to this Chapter shall be shown on Landslide Hazard Susceptibility Maps, which shall be adopted by administrative rule by the Director pursuant to SRC Chapter 20J. The Landslide Hazard Susceptibility Maps shall indicate the general location of areas of low, moderate, and high susceptibility to landslides, areas of known slide hazards, and slope contours. These maps shall be based on the best available information. (Ord No. 31-13)	Mention of updating landslide overlay maps in 2012 natural hazards mitigation plan. Nothing available online	810.010.g - Cumulatively, the Oregon Department of Geology and Mineral Industries (DOGAMI) Interpretive Map Series IMS-5, IMS-6, IMS-17, IMS-18, and IMS-22 maps, together with the slope contour map	IMS-5: 2000 IMS-6: 1998 IMS-17: 2000 IMS-18: 2000 IMS-22: 2002
34	Sandy	17.56.30.B - Certified Engineering Geologist or Geotechnical Engineer depending on the level of study required.	17.56.50 - The Planning and Development Director of the City of Sandy or designee	Yes. The Hillside Development Overlay District Map (Multnomah County?)	Sandy - Hillside Development Overlay District Map – Section 17.56 https://evogov.s3.amazonaws.com/media/88/media/20570.PDF		
35	Silverton	18.2.6.130 - geotechnical engineer and certified engineering geologist	18.4.1.300 - The community development director. Section 18, chapter 4.1 outlines review process in detail. Review process differs for different type of development.	18.2.6.110 - Map not reference directly, but code applies to "areas classified as having moderate or high susceptibility to shallow and deep seated landslides by the Department of Geology and Mineral Industries (DOGAMI)"	Silverton – Hillside protection overlay district – http://www.codepublishing.com/OR/Silverton/Silverton18/Silverton180206.html	NA	NA

Table 8.1. Landslide Code Review Details Table

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
33	Salem	A soils study or soils type report does not seem to be required as part of the code.	75.030 - Erosion is prohibited. No person shall cause or suffer visible and measurable erosion or sediment which enters or is likely to enter the public storm drainage system, drainage courses, or wetlands. (Ord No. 39-2001) 75.050.a - All development projects require an erosion control permit with exceptions. 82.030 - a Clearing and Grading Permit is required for any activity that involves ground disturbing activity exceeding two feet in depth or 25 cubic yards of volume with exceptions. A technical report is required as part of the application process if excavation requirements and standards cannot otherwise be met.	205.005 - All parcel division plans must include as part of the applications process, any special development standards and geological or geotechnical analysis.	
34	Sandy	17.56.Apendix A - Geologic assessments must include information on soil types, structure, development, and information on hydrologic conditions at the site, including spring, water table, and drainage. 17.60.50.A - Development applications must include a hydrology and soils report that outlines the current status and effect of changes to the hydrology, and erosion concerns of the development area and downstream. Report must include soil characteristics including strength, erosion and slumping susceptibility.	17.60.50.B - Development applications must include a grading plan completed by a licensed professional engineer registered in Oregon outlining effect of development on contours, water quality, dams, basins, and more. Report erosion control plan must be consistant with the provisions of section 15.44.	17.54.00.G - New construction and land divisions shall meet any development, land division and design standards of the applicable specific area plan.	Appendix B - The recommended techniques portion of the OBGE guidelines for preparing geologic reports includes the following: "Commonly accepted grading requirements are described in Chapter 70 of the Uniform Building Code."
35	Silverton	18.2.6.130 - Reports required with application include a description of project drainage and drainage control methods. 18.2.6.180.G.2 - Existing natural drainage systems shall be utilized, as much as possible, in their natural state, recognizing the erosion potential from increased storm drainage. 18.2.6.190 - In all slope areas, impervious surface drainage from roofs, driveways, and parking areas must be directed to a city storm drain or other city-approved drainage system. 18.2.6.130.E - Applications must include reports detailing soil depth and soil structure.	18.2.6.180 - Code has extensive rules regarding grading and erosion control. Requirements include grading plans, designed by a geotech engineer, prior to development, restriction of grading projects to summer (low rainfall) months, specific cut standards for hillsides, standards for fill, requirements for re-vegetation, enforcement for grading regulations, and general site grading review considerations.	18.2.6.140 - Code sets out minimum lot sizes based on slope grade. There are two options for developers to follow. Option A allows for a strick lot size based on slope grade. Option B allows the developer to transfer density to locations of less than 12%, retaining steeper areas as open space.	None referenced

Table 8.1. Landslide Code Review Details Table

	A	S	T	U	V
1	Community	What are the connections between the landslide code info and the other codes?	Are there any disconnections between codes and maps?	Other relevant codes/provisions	Other observations:
33	Salem	810.020 - Reference to SRC Chapter 20J regarding authority of the Director 810.020.c - Reference to SRC Chapter 300 regarding application type 1 procedure.			City not currently LiDAR mapped by DOGAMI Salem uses a landslide hazard susceptibility calculation method unlike any of the other entities in the review. This requires the applicant derive values from three matrices, the combined value of which is their total landslide susceptibility risk value. Based on this value, the development application process may require the inclusion of geologic assessment and/or a geotechnical report. The matrices include various values assigned for earthquake induced landslide susceptibility, water induced landslide susceptibility, and activity susceptibility (ie., required grading, vegetaion removal, etc.)
34	Sandy			17.56.40 - Sandy requires three different levels of site review based on site conditions. Determining factors are site slope percentage, and whether the site is located within a DOGAMI mapped hazard area.	Good outline of requirements for geologic assessment. Sandy includes the following disclaimer in their code: 17.60.110 - The degree of hazard protection afforded by adherence to the provisions of this chapter is considered reasonable for regulatory purposes, and is based on the best available engineering and scientific information available to the City. Larger floods than those anticipated by the chapter may occur. Landslides may occur on rare occasions in areas outside of the delineated steep slope and constrained slope boundaries. This chapter does not imply that areas outside FSH overlay district or land use permitted within FSH boundaries will be free from any significant flooding, mass movement, landslide damage, erosion or water pollution. This chapter shall not create liability on the part of the City of Sandy for any damage that results from reliance on the provisions of this chapter or any administrative decision lawfully made thereunder.
35	Silverton	NA	Code references areas classified as having moderate or high susceptibility to shallow and deep seated landslides by the Department of Geology and Mineral Industries (DOGAMI), but does not denote how to determine what these areas are.	18.2.6.130 - Reports required as part of the application process include a required Inspection schedule, and a discussion of off site geology that might present a hazard.	Silverton code is a good example of unambiguous hillside hazard regulation compared to some other localities.

Table 8.1. Landslide Code Review Details Table

	A	B	C	D	E	F	G	H
1	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
36	Springfield	61,893	Springfield Development Code	http://qcode.us/codes/springfield-development/	City Code	3.3-530 - 15% as defined by the formula in section 3.3-520		3.3-530 - Where the buildable portion of the property exceeds 15% as defined by the formula in section 3.3-520
37	Tigard	51,902	Community Development Code	http://www.tigard-or.gov/business/titl	City Code	18.775.010.G.4 - Slopes of 25% or greater;		18.775.020.F.1 - None required. The Director of Community development approves or denies development permit based on Type II Community outreach and input decision making process.
38	Vernonia	2,194	City of Vernonia Ordinances	http://www.vernonia-or.gov/Forms/Ordinances.asp	City Codes	Not referenced in code		Not referenced in code
39	West Linn	26,859	West Linn community Development Code	https://www.codepublishing.com/OR/WestLinn/#!/WestLinnCDC/WestLinnCDCNT.html	City Code	85.200.E.7.b - 12% 55.110.B.3 - 15%		55.110 - Site slope analysis must be completed for all development applications.
40								
41	COUNTIES							

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
36	Springfield	3.3-530 - A civil engineer, geologist, or geotechnical engineer.	2.1-120 - The Development Services Director or duly appointed representative.	3.3-510 - No. The code references the Hillside Development Overlay District, but does not reference maps of this area. The Overlay District is defined as any area above 670ft. elevation or below 670ft. With a greater than 15% grade.	Springfield – Hillside Development Overlay District – http://qcode.us/codes/springfield-development/view.php?topic=3-3_3_500&frames=on	Not referenced	NA
37	Tigard	NA	18.360.090 - The Director of Community Development for the City of Tigard, Oregon, or designee.	Not referenced		NA	NA
38	Vernonia	Not referenced in code	Not referenced in code	Not referenced in code		Not referenced in code	
39	West Linn	55.110.B.3 - Design review process requires a site analysis that includes a slope analysis. Slope is divided into four categories, Type 1, 2, 3, and 4, based on slope grade.	NA - Code does not reference landslide study requirements	Not referenced in code	West Linn – Natural Hazards Mitigation Map (Potential Landslides)- http://westlinnoregon.gov/sites/default/files/gis/natural_hazards/Map11_PotentialLandslides.pdf	Not referenced in code	
40							
41	COUNTIES						

Table 8.1. Landslide Code Review Details Table

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
36	Springfield	3.3-530.B.2 - Applications for development must include a grading plan report which outlines the current state of terrain and drainage at the site, drainage vectors and street grades, proposed alterations to drainage at site, and any currently existing drainage devices, dams, etc.	3.3-530.B.2 - Applications for development must include a grading plan report completed by a civil engineer which contains current site contours, location of buildings in relation to topography, and a schedule of work to be done.	3.3-520 - Lots which are above 670ft. elevation and/or above a certain slope grade are limited in density. The code includes a formula which determines the average slope. Based on the slope determined by this formula, the minimum allowable lot size, and therefore maximum allowable dwelling density for the lot can be determined by a table included in 3.3-520.B.1.c. For lots both below 670ft. elevation AND 15% grade, the lot size regulations are determined by section 3.2-215.	3.3-535.A - Yard setback restrictions may be reduced to zero by the Director as long as permitted by building code standards.
37	Tigard	18.360.090.B.1 - Buildings shall be located to preserve existing topography and natural drainage where possible based upon existing site conditions;	18.775.070.C.3 - Permits for development on steep slopes require that the development will not result in erosion, stream sedimentation, ground instability	Not referenced	Not Referenced
38	Vernonia	Not referenced in code	Not referenced in code	Not referenced in code	
39	West Linn	Not referenced in code	5.477.1 - No owner or person in charge of any project, building, structure, or parcel of land may intentionally or inadvertently allow any visible or measurable erosion. This includes due to earth slides, mud flows, land slumping, slope failure, or other earth movement that leaves, or is likely to leave, the property of origin. 85.200.E.7 - Grading on slopes greater than 12% may not remove the toe of any slope where a severe landslide or erosion hazard exists (as described in subsection (G)(5) of this section). 55.130.A - Site development plans must include a grading plan.	85.160.F.2.c - Earth slides, mud flows, land slumping, slope failure, or other earth movement that is likely to leave the property of origin must be shown on tentative plan included with subdivision application.	Not referenced in code
40					
41	COUNTIES				

Table 8.1. Landslide Code Review Details Table

	A	S	T	U	V
1	Community	What are the connections between the landslide code info and the other codes?	Are there any disconnections between codes and maps?	Other relevant codes/provisions	Other observations:
36	Springfield	3.3-350.C - Applications for development must include a site vegetation and re-vegetation report as outlined in section 5.19-120 if any trees are to be cut down on site. Additionally, a tree felling permit must be applied for as outlined in section 5.19-100. 3.3-530.E - A development plan report, included as a requirement for the application, shall be based on the lot standards set forth in section 3.2-215.			3.3-530 - The development applicant shall fund peer review of the geologic reports as deemed necessary by the City Engineer.
37	Tigard	Not Referenced			Tigard prohibits all development on slopes greater than 25%, and "unstable ground" with exceptions for yards, farmlands, community recreation areas, conservation areas, fencing, accessory buildings less than 120 sq.ft., or removal of noxious or invasive plants.
38	Vernonia				Unable to find any provisions on city website relating to landslides, slope, grading, or landslip.
39	West Linn				
40					
41	COUNTIES				

Table 8.1. Landslide Code Review Details Table

	A	B	C	D	E	F	G	H
1	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
42	Clackamas County	408,062	Clackamas County Zoning and Development Ordinance	http://www.clackamas.us/planning/zdo.html	County Zoning Code	1003.02.A - 20% or greater		1003.02.A - For any development proposed on slopes of 20% or greater.
43	Coos County	63,761	Coos County comprehensive Plan Volume 1 Part 1	http://www.co.coos.or.us/Portals/0/Planning/Vol%201%20Part%201%20CCP.pdf?ver=2015-05-19-132047-017	Comprehensive Plan	Not referenced		1.1.6 - Any new dwellings developed in in known areas potentially subject to mass movement.

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
42	Clackamas County	1003.02.B.i - Engineer or engineering geologist registered in the State of Oregon	1102.04.A - Either the Planning Director or a hearings officer depending on the development type and whether the application is for a type 1 or 2 permit. See table 1307-1 for approval body matrix. 1307.03.E - The planning director may forward the request to the Design Review Committee. The DRC is a seven member board appointed by the board of county commissioners and must include: one landscape architect, one architect, one registered engineer, one graphic designer, and one rep from finance or construction industry.	1003.02.E - The principal source of information for determining mass movement hazards is the State Department of Geology and Mineral Industries (DOGAMI) Bulletin 99 and accompanying maps.		http://www.oregongeology.org/pubs/B/B-099.pdf#page=86	1979
43	Coos County	1.1.6.ii - "a qualified geologist or civil engineer"	The Planning Director (referenced not in comprehensive plan but in planning ordinance 6.2.375.6)	Not referenced		Not referenced	

Table 8.1. Landslide Code Review Details Table

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
42	Clackamas County	<p>1003.02.B.c - Site study must include "description of bedrock and surficial materials including artificial fill".</p> <p>1003.02.B.g - Site study must include "seepage and drainage control, or other design criteria to mitigate geologic hazards".</p>	<p>1003.02.B - No grading or development is allowed without stabilization of hazardous areas, or geologic report stating site is stable for proposed use.</p> <p>1003.02.C - Vegetative cover shall be maintained or established for stability and erosion control purposes.</p> <p>1002.02.A.2.b - The additional lot coverage, grading, or stripping shall not decrease the stability of the slope, appreciably increase erosion, sedimentation, or drainage flow from the property.</p> <p>1002.02.A.2.c/d - Measures shall be employed to minimize grading or filling to accomplish the development, disturbed areas shall be compacted if necessary and re-vegetated as soon as practical and before the annual wet season.</p>	1002.02.A.1 - No partition or subdivision shall create any new lot or parcel which cannot be developed under the provisions of this code.	Not Referenced
43	Coos County	Not referenced	Not referenced	The Planning Director may impose special conditions upon the approval of a land division plan when it is deemed to cause danger from geologic hazards. (Planning ordinance 6.2.375.6)	Not referenced

Table 8.1. Landslide Code Review Details Table

	A	S	T	U	V
1	Community	What are the connections between the landslide code info and the other codes?	Are there any disconnections between codes and maps?	Other relevant codes/provisions	Other observations:
42	Clackamas County	Development Standards Section 1003 Hazards to Safety is closely tied to Section 1002 Protection of Natural Areas.		1102.02.I - Development applications must include a grading plan detailing adherence to sections 1002 and 1003.	1003.02.B.2 - Contains description of required contents of engineering geologic report. Not as detailed as entities like Sandy or Gold Beach. 1002.02.B - Slopes greater than 20% but less than 35% require a type 1 permit. Slopes above 35% require a type 2 permit. Type 2 permits include all the requirements of a type 1 permit with additional requirements.
43	Coos County				From Meg Reed of DLCD email 5/15/15 For Coos County "I'm going to hold off sending you what they've recently adopted since we are working through potentially updating/streamlining their process to review hazards, including landslides, now and so what they have in place may change. For context, right now they have one process for reviewing applications for development in mapped landslide, liquefaction, and erosion hazard areas. We are working with them to somewhat redo that process (which they call a "geologic assessment review") to be in compliance with the Oregon State Board of Geologist Examiners "Guidelines for Preparation of Engineering Geologic Reports.""

Table 8.1. Landslide Code Review Details Table

	A	B	C	D	E	F	G	H
1	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
44	Curry County	22,713	Curry County Zoning Ordinance	http://www.co.curry.or.us/Portals/0/Documents/public_services/Planning/2009%20zoning%20ord.pdf	County Code	No slope grade mentioned. Study trigger based solely on natural hazards overlay zone.		3.252 - For any development taking place in an area of "geologic hazards" as defined by the natural hazards overlay zone. Based on maps adapted into goal 7 of the county comprehensive plan OR by section 3.250 OR by the geologist performing the site study.
45	Lane County	369,519	Lane Code	https://www.lanecounty.org/cms/one.aspx?portalId=3585881&pageId=4119453	County Code			

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
44	Curry County	1.030.57 - A certified engineering geologist licensed by the State of Oregon as provided by ORS 672.505 to 672.705	3.252 - The planning director. Curry County does an excellent job of outlining the application process as it pertains to the geologic study, including following up on hazard mitigation recommendations after the work is completed.	yes. 3.250 - The maps include the Oregon Department of Geology and Mining Industries Bulletin 90 Land Use Geology of Western Curry County, Oregon the DOGAMI maps known variously as the "Provisional Maps of Rapidly Moving Landslides" and the "Further Review Areas" maps. NOTE: Curry county includes links to DOGAMI liquefaction and landslide inventory maps, 2014, on their community development webpage. No reference to these in code.	Curry County – Curry County DOGAMI Landslides Hazard Data Layer http://lcmmaps.lanecounty.org/LaneCountyMaps/CurryCountyApp/index.html	http://www.co.curry.or.us/Portals/0/Documents/public_services/Hazards/Landslide%20set%20reduced.pdf	
45	Lane County		10.340-50 - Applications for Site Reviews shall be reviewed by the Director pursuant to LC 14.100.	Not referenced			

Table 8.1. Landslide Code Review Details Table

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
44	Curry County	3.252.4.a.ii.2.a - Geologic study technical analysis narrative section must include the results of all geologic and/or engineering tests performed on soils, material, and rock type subsurface data from drill holes.	3.300 - Curry county has a section dedicated to erosion prevention and control separate from LS hazard code. Applications for development must be accompanied by an erosion control plan. Curry county does a great job of detailing the requirements for this plan.	3.252.7.b - In the event that the development activity is a division of land, the mitigation plan shall specify mitigation measures or improvements that must be implemented on each parcel to assure the protection of the subject property and of other properties from the hazards identified in the geologic hazard mitigation report.	Not referenced
45	Lane County		10.335-20.4 - Site review criteria requires that suitable planting of ground cover or other surfacing is provided to prevent erosion and reduce dust. 9.945 Applicable Erosion Control Prevention Regulations. Lane County has adopted the following erosion control regulations to be applied by Eugene on urbanizable land within the Eugene Urban Growth Boundary, as set forth in LC 10.600-20. (1) The Eugene Erosion Prevention regulations as adopted by the Lane County Board of Commissioners as part of Ordinance No. 2-04. (2) Copies of the applicable erosion prevention regulations shall be on file at the Lane County Land Management Division. (Revised by Ordinance 2-04, Effective 4.9.04)		

Table 8.1. Landslide Code Review Details Table

	A	S	T	U	V
1	Community	What are the connections between the landslide code info and the other codes?	Are there any disconnections between codes and maps?	Other relevant codes/provisions	Other observations:
44	Curry County		There appears to be a disconnection between the liquefaction and landslide susceptibility maps on the website and the code itself. Code does not reference these maps directly.	3.055.5. Citing fire fighting hazards, a new dwelling shall not be sited on a slope greater than 40 percent.	Meg Reed of DLCD email on 4/19/17 noted this "As I mentioned on the call, you can find the comp plan policies and code language we assisted Curry County with here: S:\MReed\Risk MAP Curry County All Hazards Project. These are for five hazards that were updated through a Risk MAP grant." Meg Reed email 5/15/17 "For Curry County – in the folder I shared with you below, I would recommend two documents to look at for landslides specifically: "Chapter 7 Update" for general comp plan policies, and "Section 3.255 Landslides Final" for code policies." County comprehensive plan notes inventory of geologic hazards but does not provide map or data.
45	Lane County				

Table 8.1. Landslide Code Review Details Table

	A	B	C	D	E	F	G	H
1	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
46	Multnomah County	799,766	Multnomah County Zoning Code	<p>The Multnomah County Zoning Code is divided into sections on their website: https://multco.us/landuse/zoning-codes. The rural zoning codes include</p> <ul style="list-style-type: none"> • Chapter 33: West Hills Rural Plan Area (1.99 MB) • Chapter 34: Sauvie Island/Multnomah Channel Rural Plan Area (1.6 MB) • Chapter 35: East of Sandy River Rural Plan Area (1.82 MB) • Chapter 36: West of Sandy River Rural Plan Area (1.93 MB) • Chapter 37: Administration and Procedures (167.97 KB) • Chapter 38 - Columbia River Gorge National Scenic Area (2.1 MB) <p>Development Code</p> <ul style="list-style-type: none"> • Chapter 29: Building Regulations (674.32 KB) <p>Urban Zoning Codes</p> <p>Multnomah County's urban planning areas are the Interlachen Urban Plan Area and the Pleasant Valley Urban Plan Area. Zoning in these areas is governed by MCC 11.15 and 11.45, the Multnomah County Zoning Ordinance.</p> <ul style="list-style-type: none"> • Chapter 11.45: Urban Land Division 	Zoning Code	25% or as shown on the Slope Hazard Map		<p>Hillside Development Permit: All persons proposing development, construction, or site clearing (including tree removal) on property located in hazard areas as identified on the "Slope Hazard Map", or on lands with average slopes of 25 percent or more shall obtain a Hillside Development Permit as prescribed by this subdistrict, unless specifically exempted by MCC 33.5510.</p>

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
46	Multnomah County	A geological report prepared by a Certified Engineering Geologist or Geotechnical Engineer certifying that the site is suitable for the proposed development; or,	Planner reviews the information. Consults with Multnomah County engineering staff as needed. Code states: (E) A Hillside Development permit may be approved by the Director only after the applicant provides: (1) Additional topographic information showing that the proposed development to be on land with average slopes less than 25 percent, and located more than 200 feet from a known landslide, and that no cuts or fills in excess of 6 feet in depth are planned. High groundwater conditions shall be assumed unless documentation is available, demonstrating otherwise; or (2) A geological report prepared by a Certified Engineering Geologist or Geotechnical Engineer certifying that the site is suitable for the proposed development; or, (3) An HDP Form– 1 completed, signed and certified by a Certified Engineering Geologist or Geotechnical Engineer with his/her stamp and signature affixed indicating that the site is suitable for the proposed development. (a) If the HDP Form– 1 indicates a need for further investigation, or if the Director requires further study based upon in-formation contained in the HDP Form– 1, a geotechnical report as specified by the Director shall be prepared and submitted.	Slope Hazard Map	Geologic Hazards data layer - https://pdx.maps.arcgis.com/apps/webappviewer/index.html?id=0aafd41ec7f845078162f0cfe4c33b6	There is a report related to the Slope Hazard Map.	I believe it was crafted in the 1970s.

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
46	Multnomah County	(D) Narrative, map or plan information necessary to demonstrate compliance with MCC 33.5520 (A). The application shall provide applicable supplemental reports, certifications, or plans relative to: engineering, soil characteristics, stormwater drainage, stream protection, erosion control, and/or replanting.	(D) Narrative, map or plan information necessary to demonstrate compliance with MCC 33.5520 (A). The application shall provide applicable supplemental reports, certifications, or plans relative to: engineering, soil characteristics, stormwater drainage, stream protection, erosion control, and/or replanting.	11:45.020 Intent: In the regulation of the division of land, it is intended that this Chapter shall minimize street congestion, secure safety from fire, flood, geologic hazards, pollution and other dangers, provide for adequate light and air, prevent the overcrowding of land and facilitate adequate provisions for transportation, water supply, sewage disposal, drainage, education, recreation and other public services and facilities, all in accord with Oregon Revised Statutes, Chapter 92.	Not in the Hillside Development portions of the Zoning Code.

	A	S	T	U	V
1	Community	<p>What are the connections between the landslide code info and the other codes?</p>	<p>Are there any disconnections between codes and maps?</p>	<p>Other relevant codes/provisions</p>	<p>Other observations:</p>
46	Multnomah County	<p>Good connections that link the landslide hazard to erosion control, watercourse, drainfields, drywells, vegetation, etc.</p>	<p>Codes and maps seem to be linked. Good question to ask the staff.</p>	<p>The website contains three HD related links: • Hillside Development Permit Brochure (70.86 KB) • Hillside Development Permit Application (52.59 KB) This includes the HDP Form-1 • Hillside Development Permit Worksheet (107.48 KB)</p>	<p>Tricia: I included Multnomah County as an example in the presentation I made on October 27, 2016 at the Oregon-Washington APA conference, "Landslides in Oregon: Integrating Science and Policy." Contacts there include Adam Barber, Senior Planner. I will add some thoughts here. Multnomah County has plan areas in rural and urban areas. The plan areas are similarly set up with regulations; for example each includes a reference to the Hillside Development and Erosion Control (HD) section. In Chapter 33 that would be Section 33.5500-33.5525. The purposes of the Hillside Development and Erosion Control subdistrict are to promote the public health, safety and general welfare, and minimize public and private losses due to earth movement hazards in specified areas and minimize erosion and related environmental damage in unincorporated Multnomah County, all in accordance with ORS 215, LCDC Statewide Planning Goal No. 7 and OAR 340-41-455 for the Tualatin River Basin, and the Multnomah County Comprehensive Framework Plan Policy No. 14. It should be noted there are exemptions to the HD provisions. OTHER: From the DOGAMI Landslide Susceptibility Overview Map of Oregon released in Feb. 2016: About 25% of Multnomah County is categorized as "high" risk and about 5% falls into "very high." More detailed maps for Mult Co will be published this year.</p> <p>Hillside Development Permit: All persons proposing development, construction, or site clearing (including tree removal) on property located in hazard areas as identified on the "Slope Hazard Map", or on lands with average slopes of 25 percent or more shall obtain a Hillside Development Permit as pre-scribed by this subdistrict, unless specifically exempted by MCC 33.5510.</p>

Table 8.1. Landslide Code Review Details Table

	A	B	C	D	E	F	G	H
1	Community	Estimated Population (as of 2016, Source: https://factfinder.census.gov/)	Document name	Document Web Address	Code type	Percent slope used as threshold for the applicable codes	Is there a method to calculate slope? What is it?	When does the requirement for a landslide study kick in?
47	Tillamook County	26,143	Tillamook County Development Standards	http://www.co.tillamook.or.us/gov/ComDev/documents/luo/05272015LUO/Final%20Article%204.pdf	County Code	4.130.3.b - 19%		4.130.3 - Prior to any development or land division in locations defined as geologic hazard areas by section 4.130.1. This includes: Active landslides identified in DOGMI Bulletins 74 and 79, Inactive landslides, landslide topography and mass movement topography identified in DOGMI bulletins 74 and 79 where slopes are greater than 19 percent, Areas prone to mudflows identified in DOGMI Bulletin 79, Brallier Peat soils identified in Soil Survey, Tillamook Area, Oregon (USDA, Soil Conservation Service, 1964) and the unpublished Soil Conservation Service soils survey for coastal Tillamook County, Ocean front lots on bluffs in areas where erosion and sliding are identified as problems in the Goal 18 element of the Comprehensive Plan, Other locally known areas of GEOLOGIC HAZARD based on evidence of past occurrences.
48	Tillamook County	26,143	Tillamook County Comprehensive Plan Goal 7 Hazards	http://www.co.tillamook.or.us/gov/ComDev/documents/compplan/07Hazards.pdf	Comprehensive Plan	Not Referenced		7.2.1.Policies.k - Proposed development in close proximity to active or inactive landslides shall require site investigation.

Table 8.1. Landslide Code Review Details Table

	A	I	J	K	L	M	N
1	Community	What certification do they require for the landslide study? E.g. CEG, registered geologist etc	What is the process for the landslide study? Who reviews it and who approves it?	Is the landslide hazard area mapped? If so, what is it called? Date made?	Associated Overlays	Associated maps	Map Dates
47	Tillamook County	4.130.5 - Either an Oregon Certified Engineering Geologist OR both an Oregon registered geologist and a qualified Oregon registered engineer.	4.130.5 - The planning director or a person designated by the planning director.	<p>Yes. Various maps listed in DOGAMI bulletin 74 and 79. All DOGAMI maps are dated 1972.</p> <p>Brallier Peat soils identified in Soil Survey, Tillamook Area, Oregon (USDA, Soil Conservation Service, 1964);</p> <p>Ocean front lots on bluffs in areas where erosion and sliding are identified as problems in the Goal 18 element of the Comprehensive Plan (Note, Comprehensive plan PDFs online reference maps but they are not included in the documents. Source and date unknown);</p>		<p>From DOGAMI Bulletin 74; Engineering Hazard Map of Cannon Beach Quadrangle, Oregon, Engineering Hazard Map of the Hebo Quadrangle, Oregon, Engineering Hazard Map of the Nehalem Quadrangle, Oregon, Engineering Hazard Map of the Tillamook Quadrangle, Oregon, All dated 1972</p> <p>From DOGAMI bulletin 79; Hazard Map of the Blaine Quadrangle, Oregon, Hazard Map of the Enright Quadrangle, Oregon, Hazard Maps of portions of the Grand Ronde and Timber Quadrangles, Oregon, Hazard Map of the Saddle Mountain Quadrangle, Oregon, All dated 1972</p>	1972
48	Tillamook County	Not Referenced	Not Referenced	<p>Pages 7, 8, 9 - Comprehensive plan includes three maps outlining landslide areas, but maps are poorly photocopied and practically illegible. Maps are also not titled other than "VII-8", "VII-9", and "VII-10"</p> <p>Dates not listed</p>		<p>Map data cited as derived from: Oregon Department of Geology and Mineral Industries. "Environmental Geology of Inland Tillamook and Clatsop Counties, Oregon". Portland, Oregon. 1972. 65 pp., Oregon Department of Geology and Mineral Industries. "Environmental Geology of the Coastal Region of Tillamook and Clatsop Counties, Oregon". Portland, Oregon. 1972. 164 pp., Oregon Department of Geology and Mineral Industries. "Geologic Hazards Inventory of the Oregon Coastal Zone". Portland, Oregon. 94 pp., Oregon State Soil and Water Conservation Commission. "Streambank Erosion in Oregon". Salem, Oregon. 151 pp.</p>	

Table 8.1. Landslide Code Review Details Table

	A	O	P	Q	R
1	Community	What do the provisions say about drainage and soils types?	What do the provisions say about grading and erosion control?	What do the provisions say about land division requirements?	Are there any building code related provisions referenced in the land use code?
47	Tillamook County	<p>4.130.6.a - The geologic report must include water drainage patterns, soil and bedrock types, soil depth, and other relevant soils engineering data.</p> <p>4.130.6.c - In brallier peat soils, report must include boring log, bearing capacity and drainage patterns.</p>	<p>4.130.7 - The geologic hazards report must include recommendations on standards for grading practices, vegetation removal and replacement, and management of stormwater runoff during and after construction.</p>	<p>4.130.2 - A geologic hazard report is required for both proposed development AND subdivisions and partitions.</p>	<p>Not referenced in code</p>
48	Tillamook County	<p>7.2.1.Policies.b - Zoning regulations should incorporate the grading requirements as stipulated under Chapter 70 of the Uniform Building Code.</p> <p>7.2.1.Policies.h - Projects which include plans for modifying the topography of sloping areas should be evaluated in terms of the effect these changes would have on drainage and slope stability.</p> <p>7.2.1.Policies.i - Projects or long-range plans involving urbanization of given areas should be evaluated in terms of the long-range influence the proposed land use would have on land stability; drainage is particularly critical.</p>	<p>7.2.1.Policies.d - All excavations, fills and drainage changes, and vegetation removal programs in areas of mass movement topography shall be engineered to minimize the possibility of sliding.</p> <p>7.2.1.Policies.f - Where strata slope toward cuts, slides are easily initiated, and excavation in areas with such unfavorable bedrock conditions should be properly excavated.</p>		<p>7.2.1.Policies.c - Standards of the Uniform Building Code and the density and nature of developments should be keyed to slide potential.</p>

Table 8.1. Landslide Code Review Details Table

	A	S	T	U	V
1	Community	What are the connections between the landslide code info and the other codes?	Are there any disconnections between codes and maps?	Other relevant codes/provisions	Other observations:
47	Tillamook County	NA	Tillamook county has a great webmap on their community development page which includes development zodes and SLIDO, but the development standards code does not reference any DOGAMI maps younger than 1972.		Tillamook county has a webmap showing zoning districts and SLIDO linked on their community development/County code page. Beautiful! http://tillamookcountymaps.co.tillamook.or.us/geomoose2/geomoose.html
48	Tillamook County	NA	Maps included but not referenced in CP	7.2.1.Policies.j - Closely spaced drainfields and septic tanks should be restricted from moderate to steeply sloping areas because of the potential for sliding.	Tillamook County comprehensive plan denotes State Planning requirements and specifications: