3.3 Landslide

Much of the northwest portion of Multnomah County is prone to very large and deep landslides. These types of slides tend to move slowly and rip apart infrastructure.

The cities of Gresham and Wood Village consider themselves to have moderate risk to landslides because of slide hazard zones in developed areas.

As more areas susceptible to landslides are developed, greater losses and damages to people and property are likely to result from landslides.

The area's landslide risk is strongly correlated with rainfall, particularly in extreme rain events. Projected increases in extreme precipitation caused by climate change likely will trigger increased landslides in the future.

Level of Risk* to Landslide Hazards

High

- None

Moderate

- Gresham
- Wood Village

Low

- Fairview
- Troutdale
- Unicorpoated Multnomah County

Level of risk is based on the local OEM Hazard Analysis scores determined by each jurisdiction in the Planning Area. See **Appendix C for more information on the methodology and scoring.*

3.3.1 Overview

The term "landslide" refers to a variety of slope instabilities that result in the downward and outward movement of slope-forming materials, including rocks, soils and artificial fill. There are three main factors that trigger potential for landslides: slope, soil and rock characteristics, and water content.

In general, landslide-prone locations are:

- on or close to steep slopes
- steepened roadcuts or excavations into steep slopes
- on fill slopes
- existing landslides or places of known historic landslides
- steep areas where surface runoff is concentrated
- steep canyon bottoms, and outlets stream channels

Areas with steeper slopes, weaker geology and higher annual precipitation tend to have more landslides. Most landslides in Multnomah County happen during rainy months when soils are saturated with water. However, landslides may happen at any time of year. Other contributing causes of landslides include: placing fill (weight) on steep slopes, vegetation removal, undercutting of a slope by erosion or excavation, and intense prolonged rainfall or rapid snow melt that cause sharp changes in groundwater levels.

Earthquakes will trigger landslides. Areas prone to seismically triggered landslides are the same as those prone to ordinary (i.e., non-seismic) landslides. As with ordinary landslides, seismically triggered landslides are more likely with earthquakes that occur when soils are saturated with water.

Types

Four types of landslides — slides, flows, spreads and topples/falls — are distinguished based on the types of materials involved, the mode of movement, and how they are triggered. All communities in the Planning Area are impacted by these types of landslides (**Table 3.3-1**). These four types of landslides are characterized in **Figure 3.3-1.**

Table 3.3-1 Types of Landslide Hazards that Impact Each Jurisdiction

Jurisdiction	Slides	Flows	Spreads	Topples/Falls
Unincorporated Multnomah County	✓	✓	✓	✓
Fairview	✓	✓	✓	✓
Gresham	✓	✓	✓	✓
Troutdale	✓	✓	✓	✓
Wood Village	✓	✓	✓	✓

Source: DOGAMI, 2016; NHMP Steering Committee, 2016

Location and Extent

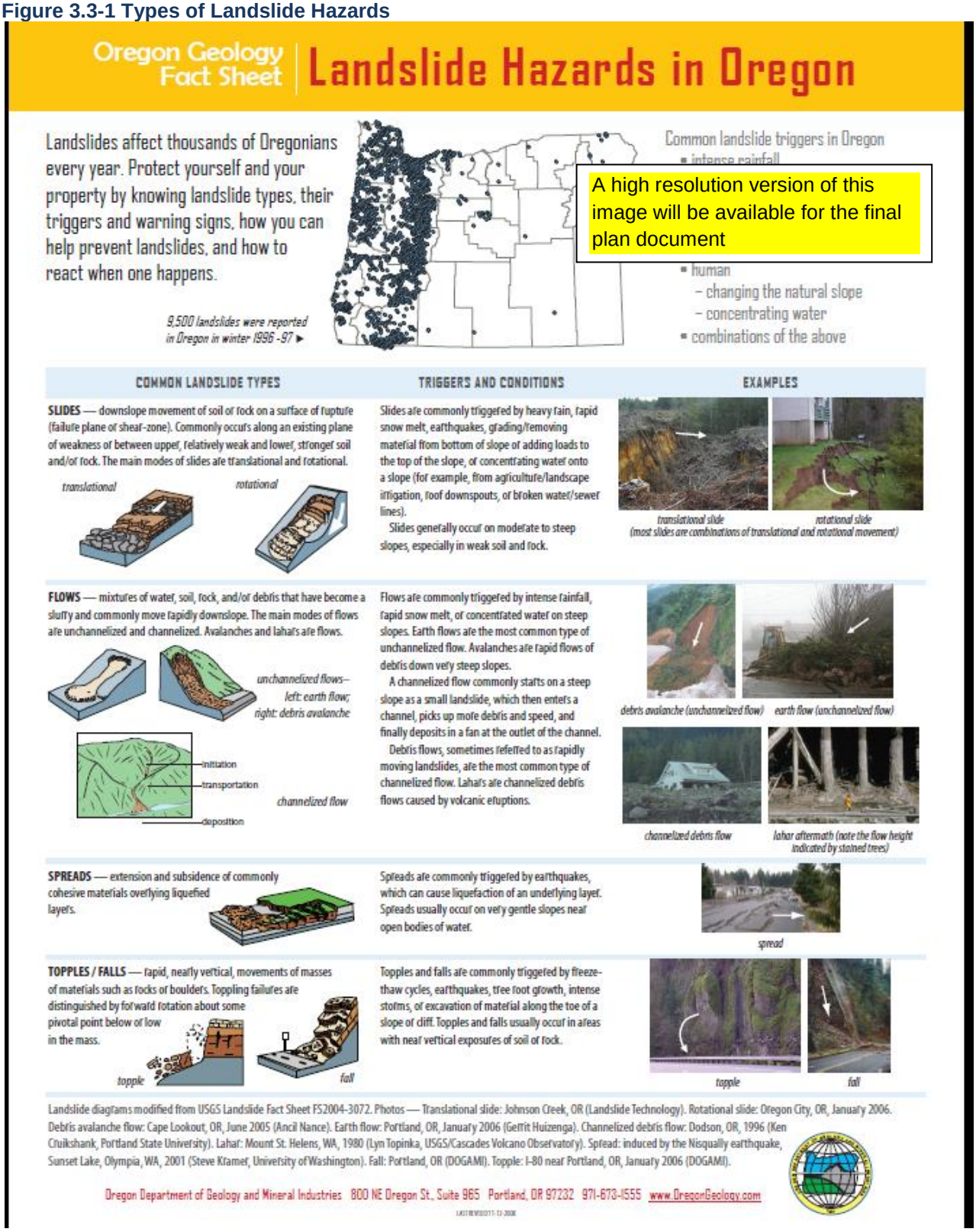
The Oregon Department of Geology and Mineral Industries (DOGAMI) found that to more fully understand the landslide hazard in Oregon, lidar (light detection and ranging) topographic data must be collected and used during the mapping of existing landslides and modeling of future susceptibility (Oregon Department of Land Conservation and Development [DLCD], 2015). Collaborative landslide research in 2005 conducted by DOGAMI and the U.S. Geological Survey Landslide Hazards Program resulted in two key findings. First, the use of the lidar data resulted in the identification of 3 to 200 times the number of landslides than the number identified using other data. Second, the ease and accuracy of mapping the spatial extent of landslides…[was] greatly improved [by lidar]… (DLCD, 2015).

DOGAMI has since updated its State Landslide Information Database for Oregon (SLIDO) through December 29, 2014 (version 3.2). SLIDO data and an interactive web-based map can be found at the website: http://www.oregongeology.org/sub/slido/index.htm.

This version of SLIDO includes past landslides for most of Multnomah County, as shown in **Figure 3.3-2**. There are 2,574 lidar-based landslide deposits and 977 historic point locations of landslides in the county[1]. Data for the northeastern portion of the county was completed recently and will be available in 2017.

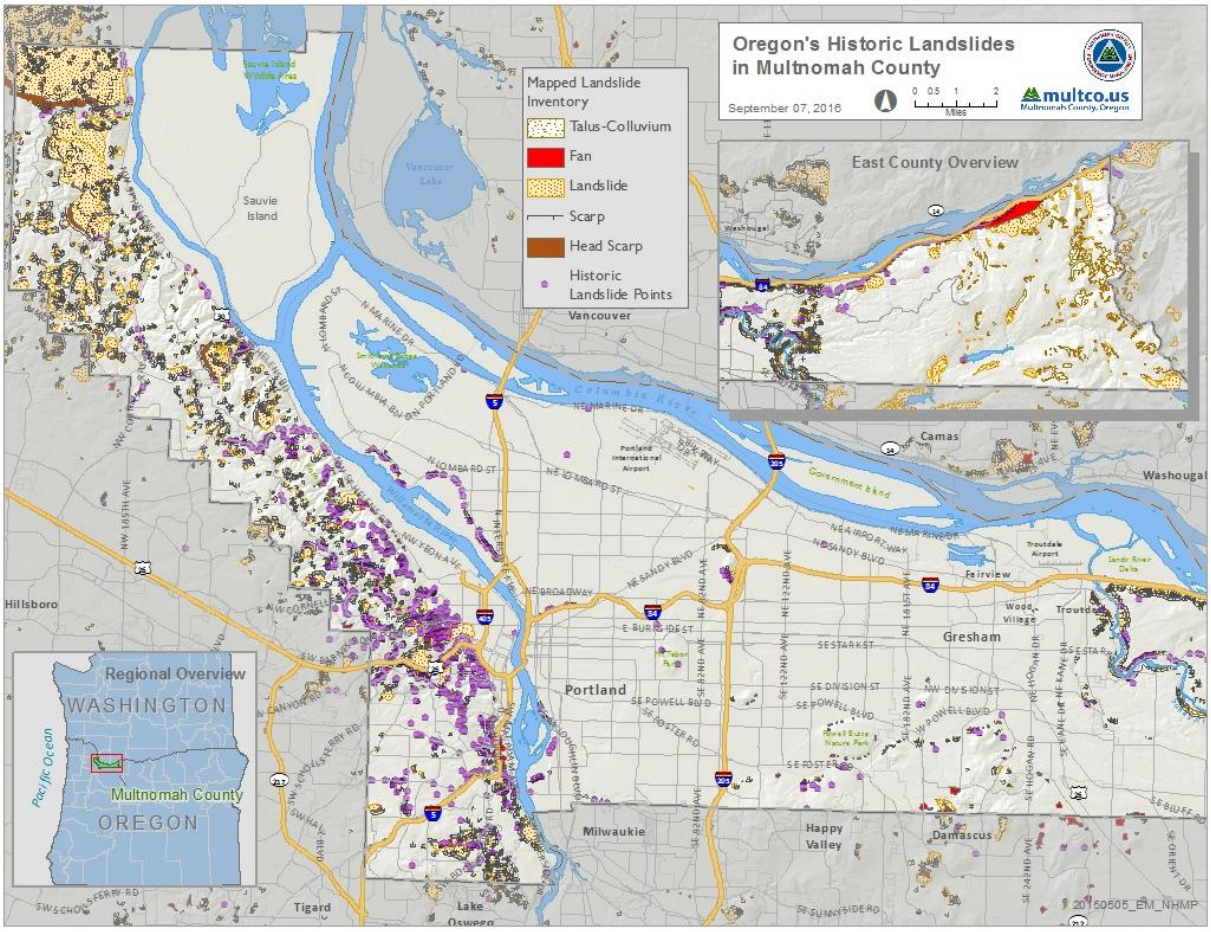
[1] DOGAMI's lidar-based data of past landslides in Multnomah County includes landslides within the City of Portland.

Figure 3.3-1 Types of Landslide Hazards



Source: DOGAMI, 2008

Figure 3.3-2 Landslide Inventory Map



Source: DOGAMI, SLIDO 3.2, 2014

3.3.2 History

In 1996, one of the most notable winter storms in the Planning Area triggered more than 700 landslides in the Portland metropolitan area. More than 100 homes were moderately to completely damaged (Burns et al., 1998). Significant landslides occurred in areas west of the Sandy River, including Wilson Road south of Kerslake Road and SE Stark Road about ½ mile west of the Sandy River. Rockfalls from steep slopes fell along the Historic Columbia River Highway. An approximately three-mile long debris flow closed Interstate 84 and the Union Pacific Railroad for several days. Mandatory evacuations took place in the Dodson-Warrendale area near Gresham in east Multnomah County. In some situations, houses and other buildings were partially and fully destroyed, such as the house in **Figure 3.3-3** (which remained in place after 1996 and was subsequently adjacent to a 2001 landslide). A few properties were acquired by agencies through post-disaster funds and no new structures can be constructed on them. In addition, many landslides in forest areas that had been clear-cut had damaged logging roads. **Table 3.3-2** lists this and other significant historic landslides that have occurred in the Planning Area.

Figure 3.3-3 Landslide along Interstate 84 in the Dodson-Warrendale Area, December 2, 2001

Sources: Aerial photo from Oregon Department of Transportation (ODOT), December 2, 2001; house photo from Tricia Sears, 2003.

Table 3.3-2 Significant Historic Landslides

Date	Location	Description
Feb. 1918	Dodson-Warrendale, Oregon	Massive debris flow that initiated in canyon east of St. Peters Dome and flowed northward; covered the highway in 10–12 feet of debris. Estimated 500,000 to 1 million cubic yards of material deposited.
Dec. 1964	Statewide	DR-184. Heavy rains and flooding, with landslides, on December 24, 1964.
Mar. 1972	Near Portland, Oregon	Mud and rockslide on I-5; three motorists injured.
1964, 1972, and 1975	Columbia Gorge, Oregon	Flooding and debris flow events described in a report as coming from a verbal source for the noted years, but no supporting documents.
Oct. 1984	I-84 near Cascade Locks, Oregon	Rockslide; fatalities: two children; cost of stabilizing the slide area: $4 million.
Dec. 1987	John B. Yeon State Park	A debris flow event removed a footbridge over McCord Creek.
Sep. 1990	Near Troutdale, Oregon	Landslide injured four highway workers.
Feb. 1996	Dodson-Warrendale, Portland Metro area, Oregon	DR-1099. Heavy rains and rapidly melting snow contributed to thousands of landslides and debris flows across the state; many occurred on clear-cuts that damaged logging roads; I-84 closed at Dodson-Warrendale; 700 landslides in the Portland metro area.
Apr. 1997	I-84 at Milepost 35	A debris flow event on April 20, 1997, covered both lanes of eastbound I-84 for approximately nine hours.
Jan.- Feb. 1999	Northwest Oregon	Widespread flooding on smaller rivers and streams; numerous landslides and mudslides. Historic Columbia River Highway east of the Sandy River Bridge covered with slides coming from the cliffs above.
Nov. 2001	I-84 near Milepost 35	Multiple debris flows on November 28, 2001; they occurred in the drainage basin after five days of heavy rainfall. These flows originated in the steep cliffs south of the drainage basin. Approximately 200,000 cubic yards of debris was deposited.
Dec. 2003-Jan. 2004	Statewide	DR-1510. Winter storms with landslides. Much of the Portland area shut down.
May 2006	Statewide	DR-1632. Statewide impacts from storms, floods, landslides and mudslides.
Dec. 2007-Jan. 2008	Western Oregon	DR-1824. Severe winter storms, record and near-record snow, landslides and mudslides.
Jan. 2011	Statewide	DR-1956. Severe winter storm, flooding, mudslides, landslides and debris flows.
Jun. 2014	Historic Columbia River Highway	A landslide closed the Historic Columbia River Highway just west of the Stark Street bridge. ODOT estimated the slide to be about 1,000 cubic yards of rock.
Dec. 2015	Western Oregon	DR-4258. Severe winter storms, straight-line winds, flooding, landslides and mudslides.

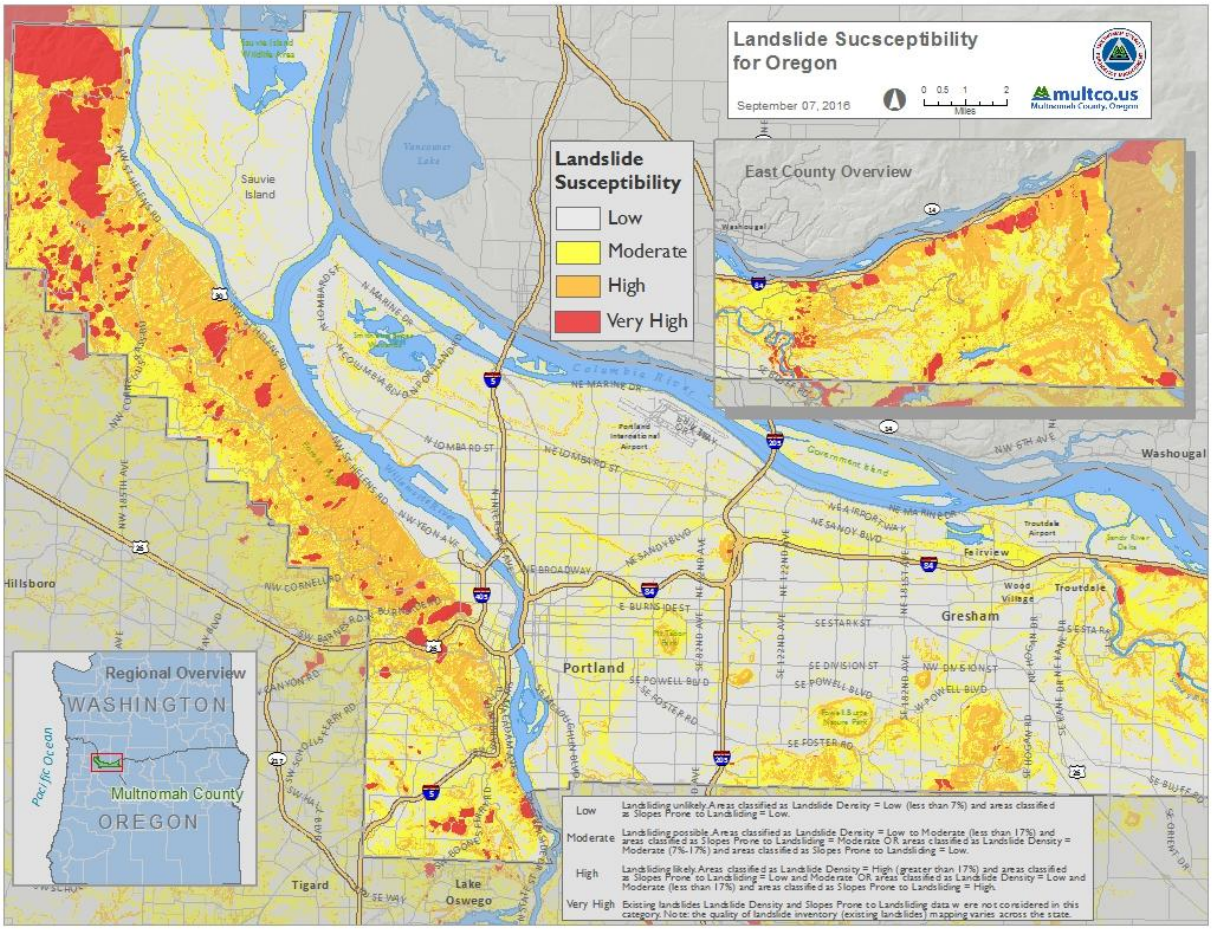
Sources: DLCD, 2015; ODOT Emergency Operations Plan, May, 2002; Interagency Hazard Mitigation Team Report, Federal Emergency Management Agency (FEMA)-1099-DR-OR, June, 1997; Interagency Hazard Mitigation Team Report, FEMA-1149-DR-OR, March, 1997; Taylor and Hatton, 1999; Hazards and Vulnerability Research Institute, 2007; The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]; Columbia, SC: University of South Carolina; FEMA, 2016; Powell et al, 1996; Denning, 1987; Watanbe, 1997; BikePortland.org, 2014.

3.3.3 Probability

Landslides tend to move repeatedly over time. As such, the location of existing landslides is critical for predicting the locations of future landslides. However, the location of existing landslides alone is not enough to predict the future. The geology, slope and triggering factors such as water, earthquakes, volcanic eruptions and man also must be considered. All of these factors combined result in landslide susceptibility, or the more- or less-likely locations of future landslides. Inventory and susceptibility maps can be used to guide assessments for future developments, and can be used to assist in planning and mitigation of existing landslides (DLCD, 2015).

As of today, the best data to predict locations of future landslide events is Multnomah County's current inventory of past landslides and the statewide landslide susceptibility overview map (**Figure 3.3-4).** Landslide inventory maps reveal areas that may require additional site evaluation prior to development.

Figure 3.3-4 Landslide Susceptibility in Multnomah County



Source: DOGAMI, 2016

In February 2016, DOGAMI published a Landslide Susceptibility Overview Map of Oregon and a related report called Open File Report 0-16-02 Landslide Susceptibility Overview Map of Oregon. The maps and report provide a general level of data for the entire state, with some specific data for the county and city level. The map is designed to provide landslide hazard information for regional planning, and specifically to identify areas where more detailed landslide mapping is needed (DOGAMI, 2016). **Table 3.3-3** uses

data from the report to show the percentage of low to very high landslide susceptibility in the Planning Area. Portions of the Planning Area not identified as susceptible to landslides are not included in the calculations.

Table 3.3-3 Landslide Susceptibility Exposure for Fairview, Gresham, Troutdale and Wood Village

Jurisdiction	Landslide Susceptibility Exposure %			
	Low	Moderate	High	Very High
Fairview	63.2	31.5	5.2	0.0
Gresham	66.6	23.4	9.8	0.3
Troutdale	65.7	25.6	7.4	1.3
Wood Village	53.3	40.8	5.9	0.0

Source: DOGAMI, 2016

Future Data

DOGAMI is in the process of developing new lidar-based landslide inventory data for eastern Multnomah County and detailed landslide susceptibility maps for central and western Multnomah County. This study is scheduled to be completed in early 2017. When complete, this study will result in more robust countywide inventory (history) maps and the first landslide susceptibility (probability) maps for the Natural Hazards Mitigation Plan (NHMP) Planning Area. These maps will include data and related analysis that will inform future land use and hazard mitigation planning efforts.

- **Landslide Inventory Maps:** A countywide inventory map of past landslides. Portions of Multnomah County have been inventoried in the past several years, but as of July 2016, the entirety of Multnomah County has been inventoried. A map of the entire county will be produced showing this information. This will be the first lidar-based countywide inventory map of its kind in the United States.

- **Landslide Susceptibility Map:** This map will identify locations that are identified as susceptible to future landslides, based on the inventory of past landslides and related information. This map will be produced by the end of 2016. The detailed information in this map for Multnomah County is at a level of specificity that is greater than the previously mentioned Landslide Susceptibility Overview Map of Oregon. The level of detail is ideal for use in local risk reduction actions such as planning, regulation and zoning.

Climate Change

According to the Multnomah County and City of Portland Climate Change Preparation Strategy (2014) and the Oregon NHMP (2015), climate models project an increased incidence of flooding and an increased magnitude of extreme flooding events to occur in western Oregon, including Multnomah County. Increased rainfall, particularly extreme events, likely will trigger an increase in the number of landslides (DLCD, 2015). With warmer winters, there will be an increased incidence of landslides (Multnomah County and City of Portland, 2014).

3.3.4 Vulnerability

Landslides can move very fast, impacting people and property in many ways and posing risk to life safety. Landslides can block and damage roadways as they dump debris on roadways or as roadways themselves slide downhill. Even ground displacements of a few inches can result in pipe failures and building or road damages. The less common larger landslides can affect several buildings and homes, or entire neighborhoods; major roads or highways, including bridges, overpasses and viaducts; or major

utility lines. Large landslides can have significant economic impact, in the range of tens of millions of dollars. Occupants of buildings or vehicles may be injured or killed by landslides of any size. **Table 3.3-4** summarizes the potential impacts of landslides to the jurisdictions in this NHMP.

Table 3.3-4 Potential Impacts of Landslides on Communities in Multnomah County

Inventory	Probable Impacts
Portion of Multnomah County Affected	Landslides are possible in any of the landslide hazard areas shown in the landslide inventory map in Figure 3.3-1.
Buildings	Landslides may affect a small number of buildings. In unincorporated parts of the county, most buildings at risk are residential buildings.
Streets within Communities	Street closures possible, but impacts generally limited because of short detour routes.
Roads within and to/from Multnomah County	Potential closures of major highways due to landslides, including Highway 30, Interstate 84, and many secondary roads. Road closures can pose economic hardship to businesses and residents.
Rail Transportation	Disruption of rail service possible along the Highway 30 and Interstate 84 corridors.
Electric Power	Potential for localized loss of electric power due to landslides affecting power lines in or near Multnomah County.
Other Utilities	Potential outages of water, wastewater and natural gas from pipe breaks from landslides. Probable impacts are localized.
Casualties	Landslides that impact buildings or roads could result in casualties (death or injuries)

Source: Unknown

There are 839 buildings within the mapped landslide hazard zones in the Planning Area, most of which are in unincorporated areas of the county (**Table 3.3-5)**. It is important that the current data does not indicate the use of these buildings.

Table 3.3-5 Total Buildings in Landslide Zones by Jurisdiction

Jurisdiction	Count
Unincorporated Area of Multnomah County	778
Gresham	33
Troutdale	28

Source: DOGAMI, SLIDO 3.2, 2014

Following is a list of areas in the Planning Area that are particularly vulnerable to landslides.

Multnomah County

- Developed areas in the West Hills, including U.S. Highway 30 and the adjacent rail line
- Interstate 84 and the Historic Columbia River Highway from Troutdale east to the Multnomah County border
- East-west Union Pacific Railroad tracks in the Columbia River Gorge
- Dodson-Warrendale area (including the area of the 1996 three-mile long debris flow)
- Hilly eastern portion of Multnomah County
- Steep slopes along portion of Stark Street outside Troutdale city limits

Gresham

- Springwater and Pleasant Valley communities
- Areas in the south-central part of the city
- Along the city's buttes at
- Gresham Butte, north and east face and Walter's Road
- Hogan Butte, east face
- Along Miller Avenue, Lovar Street and 14th Street

Fairview

- Small areas near Sandy Boulevard and Interstate 84 with slopes between 15 and 30 degrees
- Areas in Interlachen with slopes between 15 and 30 degrees

Troutdale

- Canyons along Beaver Creek
- Canyons along the Sandy River
- Steep slopes along Historic Columbia River Highway east of the Sandy River area north of Tad's restaurant

Wood Village

- Hilly area in the southern part of the city
- Slide upslope possibility south and west from NE 238th Drive that could cause damage to NE 238th Drive and to the condominiums on the east side of the street

3.3.5 References

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