STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
BRAD AVY, STATE GEOLOGIST
www.oregongeology.org

Deep Landslide Susceptibility Map of Central and Western Multnomah County, Oregon

2018

IMS-57
INTERPRETIVE MAP SERIES

Landslide Hazard and Risk Study of Central and Western Multnomah County, Oregon

by William J. Burns, Nancy C. Calhoun, Jon J. Franczyk, Kassandra O. Lindsey, and Lina Ma

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PLATE 3

EXPLANATION

This map depicts susceptibility to deep landslides in this area. For the purpose of this map, deep landslides are defined as those with a depth to the failure plane of greater than 15 ft (4.5 m) (Burns and Madin, 2009).

This susceptibility map was prepared by combining three factors: 1) landslide inventory data taken from the corresponding inventory map (see Plate 1) and head scarp buffers, 2) minimal zone buffer, and 3) geologic factors (susceptible geologic units and contacts, slope angles, and preferred direction of movement). The combinations of these factors comprise the relative susceptibility hazard zones: high, moderate, and low, as shown in the Hazard Zone Matrix below. The deep landslide susceptibility data are displayed on top of a base map that consists of the lidar-derived digital elevation model. For additional detail on how this map was developed see the accompanying text report.

DEEP LANDSLIDE SUSCEPTIBILITY CLASSIFICATION

Each landslide susceptibility hazard zone shown on this map has been developed according to a classification scheme using a number of specific factors. The classification scheme was developed by the Oregon Department of Geology and Mineral Industries. The symbology used to display these hazard zones is explained below.

Deep Landslide Susceptibility Zones: This map uses color to show the relative degree of hazard. Each zone is a combination of several factors (see Hazard Zone Matrix, below).

HIGH: High susceptibility to deep landslides.
Deposits mapped as historical and/or active are outlined in black.

MODERATE: Moderate susceptibility to deep landslides.

LOW: Low susceptibility to deep landslides.

Deep Landslide Susceptibility Hazard Zone Matrix

Contributing Factors	Final Hazard Zone		
	High	Moderate	Low
Landslides, Head Scarp-Flanks, Buffers	included	——	——
Geologic Factors and Minimal Zone Buffer	——	included	——
Minimal Geologic Factors	——	——	included

❶ Landslide Inventory

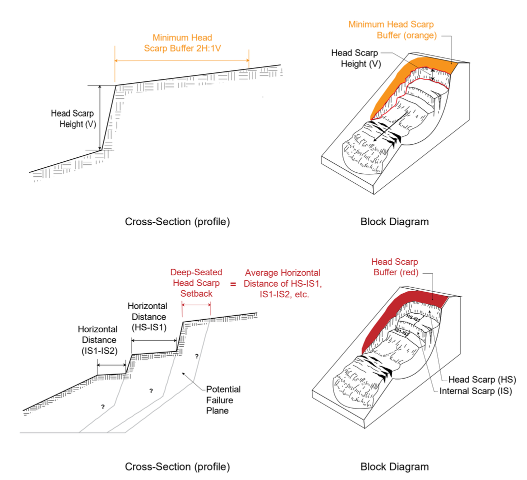
An inventory of all existing landslides in this area is shown on Plate 1. We prepared this inventory map by compiling all previously mapped landslides from published and unpublished geologic and landslide mapping, analyzing lidar-based geomorphology, and reviewing aerial photographs. We also attributed each landslide with classifications for activity, depth of failure, movement type, and confidence of interpretation. We created the inventory by using the protocol developed by Burns and Madin (2009). We extracted the deep landslides from the inventory and used them to create this deep landslide susceptibility map.

❷ Head Scarp Buffers

Buffers were applied to all head scarps from the landslide inventory (Plate 1). In most cases the first buffer results in a minimum buffer distance and the second buffer (described below) results in the maximum buffer distance. In all cases the greater of the two was used.

The first buffer (orange on diagram) consists of a 2:1 horizontal to vertical distance (2H:1V). This buffer is different for each head scarp and is dependent on head scarp height. For example, a head scarp height of 18 ft (5.5 m) has a 2H:1V buffer equal to 36 ft (11.0 m).

The second buffer (red on diagram) is different for each head scarp and is dependent on the average of the horizontal distance between internal scarps. For example, an average horizontal distance of 150 ft (50 m) has a 2H:1V buffer equal to 300 ft (100 m).



(Modified from Burns and Mickelson, 2016)

❸ Geologic Factors and Buffers

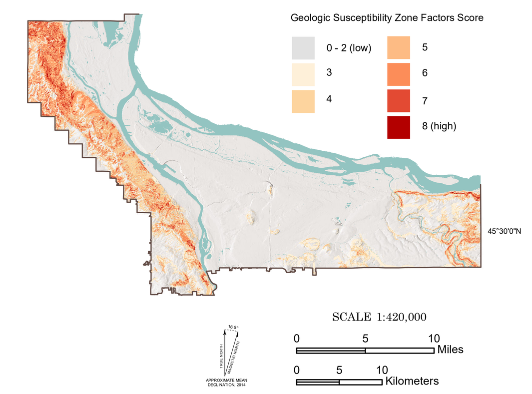
The small map below displays the scores of the relative geologic susceptibility zone factors, a minimal zone buffer applied around the high susceptibility zone, and the mapped deep landslide deposits in this area. The geologic zone factors are:

1) Susceptible geologic units
2) Susceptible geologic contacts
3) Susceptible slope angles for each engineering geology unit polygon
4) Susceptible direction of movement for each engineering geologic unit polygon

The geologic susceptibility zone factors and the minimal zone buffer datasets along with professional judgment were used to create the boundary between the moderate and low deep landslide susceptibility zones.

A minimal zone buffer was applied around the high susceptibility zone of each landslide deposit. This buffer is different for each landslide deposit and is dependent on head scarp height.

Each geologic zone factor was given a score of 0, 1, or 2. Thus, if all factors have the highest score at some particular location, the final factor score is 8. A minimal combined factor score threshold between 3 and 5 along with professional judgment was used to delineate the boundary between the low and moderate zones.



LIMITATIONS

The deep landslide susceptibility map was developed by following an established protocol (Burns and others, 2013) that incorporates several types of data. Several limitations are worth noting and underscore that any regional hazard map can be useful for regional applications but should not be used as an alternative to site-specific studies in critical areas. Limitations include the following:

1) Every effort has been made to ensure the accuracy of the GIS and tabular database, but it is not feasible to completely verify all of the original input data.

2) As discussed in the above, the protocol to develop deep landslide susceptibility maps is based on three factors: 1) landslide inventory data taken from the corresponding inventory map and head scarp buffers, 2) minmal zone buffer, and 3) geologic factors (susceptible geologic units and contacts, slope angles, and preferred direction of movement). All of these parameters can affect the level of detail and accuracy of the final susceptibility map. Because the maps are based on a combination of factors, all of which have inherent uncertainty, the resultant hazard zones also have uncertainty.

a. Limitations of the landslide inventory, as discussed by Burns and Madin (2009).

b. Calculation of head scarp buffers is limited based on the head scarp height (first buffer) and an average of the horizontal widths of previous or downslope blocks (second buffer). It is assumed that most large deep landslides have the potential to fail retrogressively upslope; however, this is not always the case.

c. The additional factors used to delineate the moderate susceptibility zone include susceptible geologic units, susceptible geologic contacts, susceptible slope angles for each engineering geologic unit polygon, and susceptible direction of movement for each engineering geologic unit polygon. These factors are combined and a final score is produced, but the delineation of the final moderate zone is based on visual overlap of these four factors; therefore, the accuracy and resolution of the output data can be overestimated or underestimated.

3) The susceptibility maps are based on the topographic and landslide inventory data available as of the date of publication. Future landslides may render this map locally inaccurate.

4) The lidar-based digital elevation model does not distinguish elevation changes that may be due to the construction of structures like retaining walls. Because it would require extensive GIS and field work to locate all of these existing structures and remove them or adjust the material properties in the model, such features have been included as a conservative approach and therefore must be examined on a site-specific basis.

5) Some landslides in the inventory may have been mitigated, thereby reducing their level of susceptibility. Because it is not feasible to collect detailed site-specific information on every landslide, potential mitigation has been ignored.

REFERENCES

Burns, W.J., and Madin, I.P., 2009, Protocol for inventory mapping of landslide deposits from light detection and ranging (lidar) imagery: Oregon Department of Geology and Mineral Industries Special Paper 42, 30 p., geodatabase template.

Burns, W.J., and Mickelson, K.A., 2016, Protocol for deep landslide susceptibility mapping: Oregon Department of Geology and Mineral Industries Special Paper 48, 69 p.

Burns, W.J., Mickelson, K.A., Jones, C.B., Pickner, S.G., Hughes, K.L., and Sleeter, R., 2013, Landslide hazard and risk study of northwestern Clackamas County, Oregon: Oregon Department of Geology and Mineral Industries Open-File Report O-13-08, 38 p., 74 pl., scales 1:50,000, 1:8,000. http://www.oregongeology.org/pubs/ofr/p-O-13-08.htm

NOTICE

ABOUT THIS PUBLICATION

The central and western portion of Multnomah County contains the Cities of Portland, Gresham, Troutdale, Fairview, and Wood Village. The study area is one of the most densely populated areas in Oregon. Because landslides are one of the most widespread and damaging natural hazards in the state, it is important to map and assess the risk in the study area. The purpose of this study is to assist the cities and county in understanding the landslide hazard better and thus increase their ability to reduce future risk. The study publication consists of a text report, three map plates, and GIS data.

Generalized Bedrock Engineering Geology Map

Generally Quaternary alluvial rocks

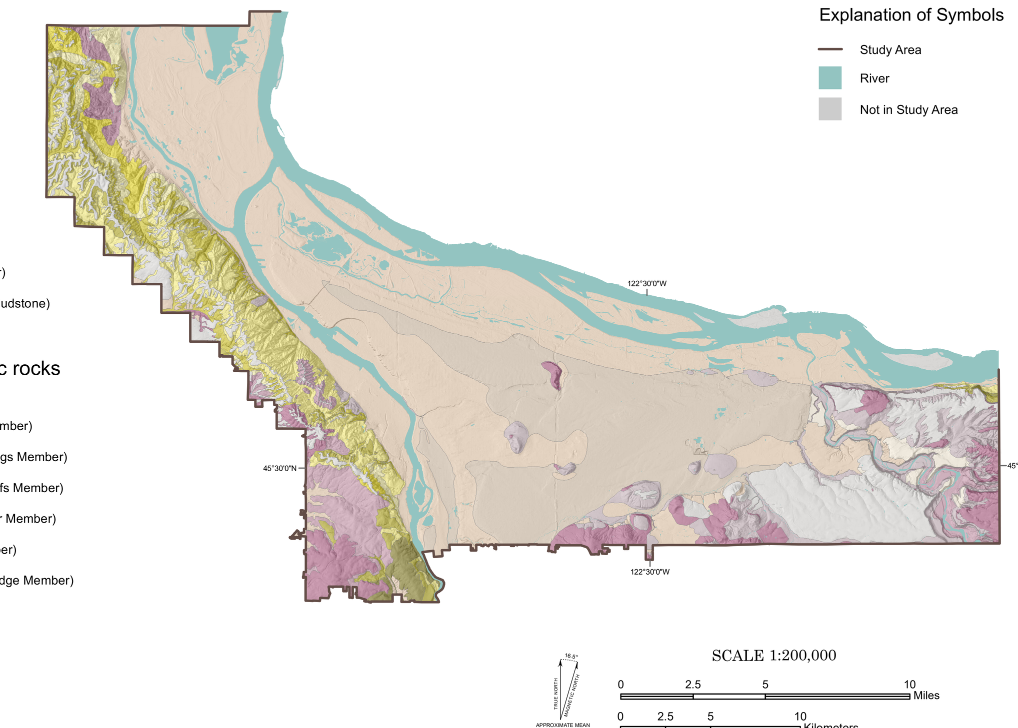
- Coarse-Grained Alluvial Deposits (recent alluvium)
- Coarse-Grained Alluvial Deposits (Missoula coarse)
- Fine-Grained Older Alluvial Deposits (Missoula fine)
- Soft Loess (loess)

Generally Pliocene to Quaternary volcanic and sedimentary rocks

- Weak Severely Weathered Basalt (Boring Lavas)
- Weak Coarse-Grained Sedimentary Rock (Troutdale/Springwater)
- Weak Fine-Grained Sedimentary Rock (Troutdale/Sandy River Mudstone)
- Weak Sandstone (Troutdale, includes Scappoose)

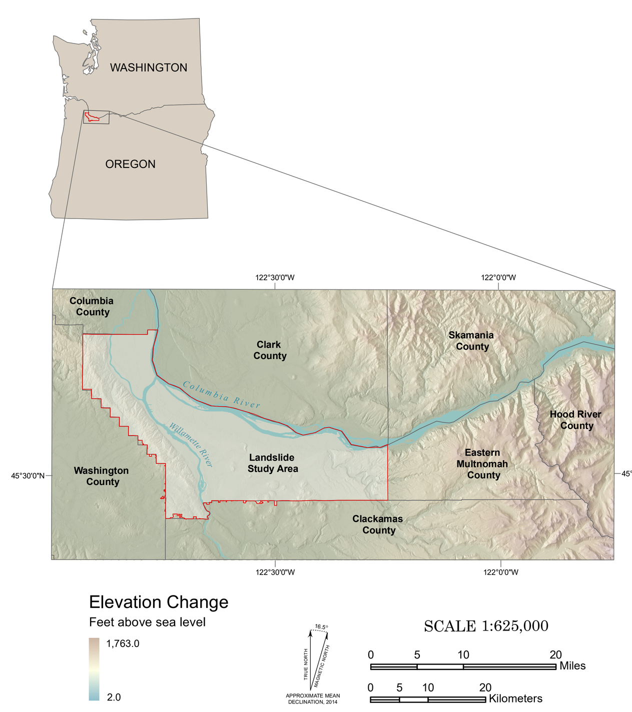
Generally Eocene to Middle Miocene volcanic rocks (CRBG-Columbia River Basalt Group)

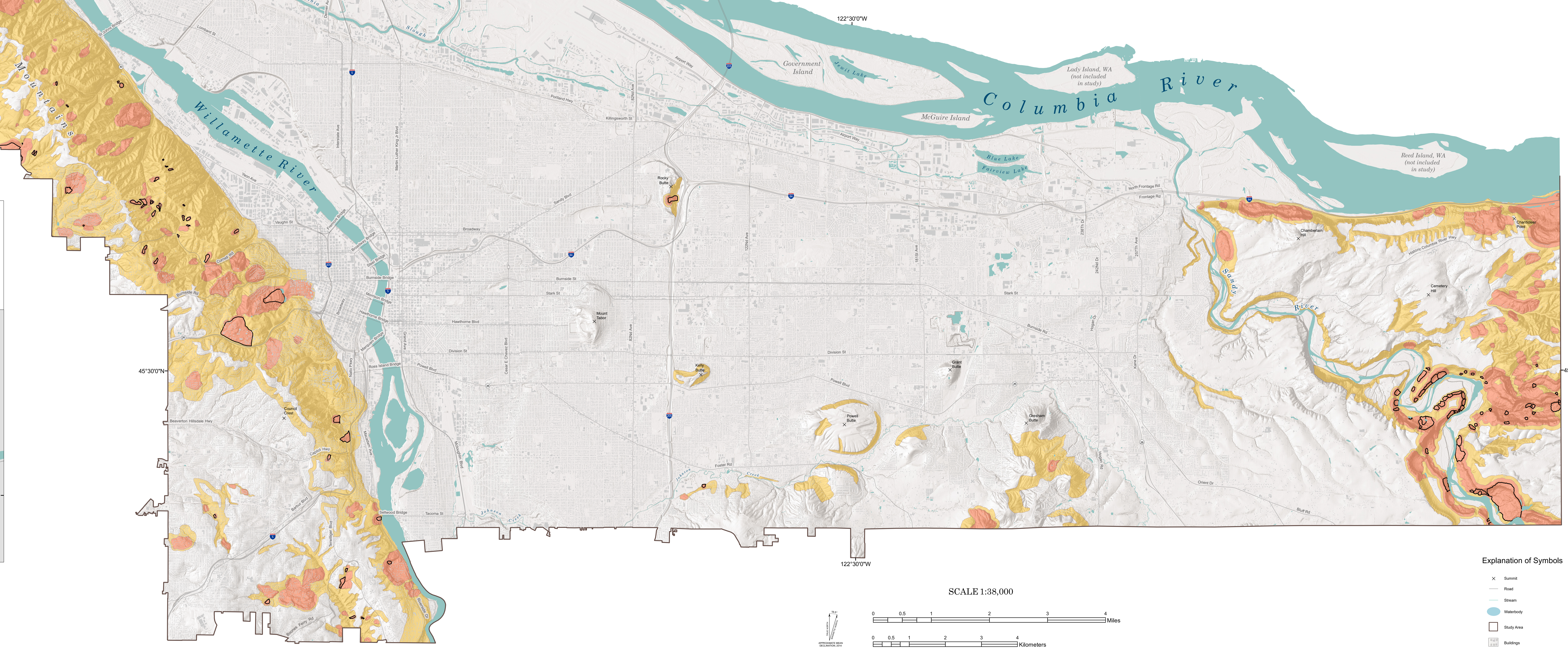
- Medium Weathered Basalt (CRBG - Wanapum-Priest Rapids Member)
- Medium Weathered Basalt (CRBG - Wanapum-Frenchman Springs Member)
- Medium Weathered Basalt (CRBG - Grande Ronde-Sentinel Bluffs Member)
- Medium Weathered Basalt (CRBG - Grande Ronde-Winter Water Member)
- Medium Weathered Basalt (CRBG - Grande Ronde-Ortley Member)
- Medium Weathered Basalt (CRBG - Grande Ronde-Wapshilla Ridge Member)
- Medium Weathered Waverly Basalt (Basalt of Waverly Heights)



Study Area Location Map

(See Study Area Communities Map for more detail)





SCALE 1:38,000

0 0.5 1 2 3 4 Miles

0 0.5 1 2 3 4 Kilometers

Explanation of Symbols

- Summit
- Road
- Stream
- Waterbody
- Study Area
- Buildings

Study Area Communities Map

General Features

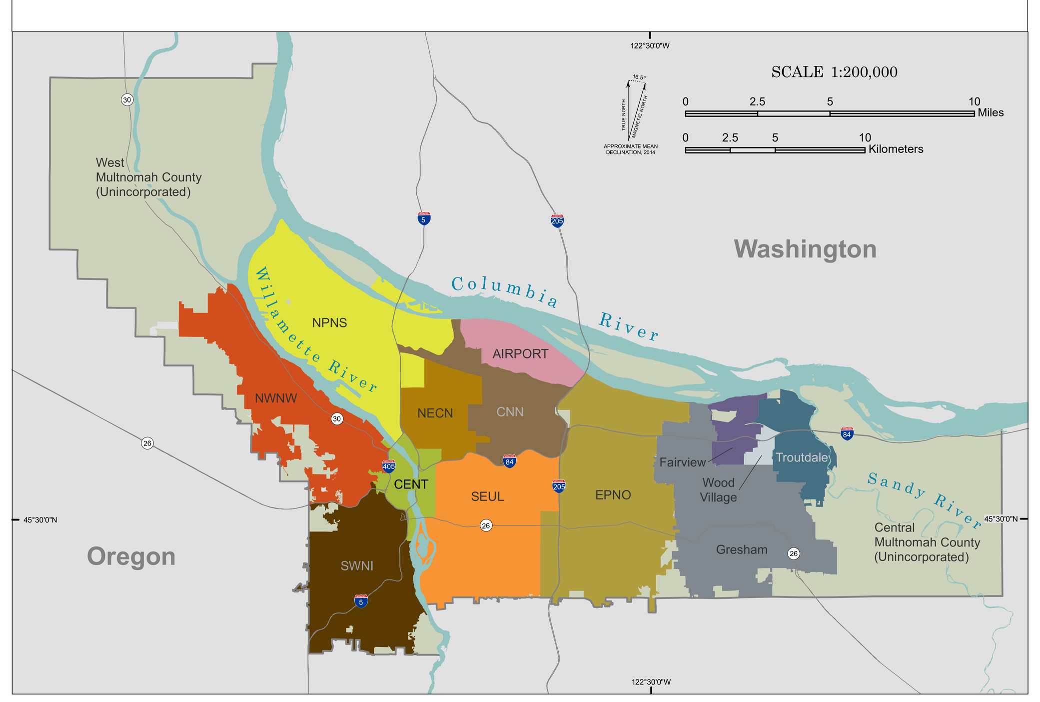
- Highway
- Study Area
- River

Community Boundaries

- West/Central Multnomah County (Unincorporated) & Maywood Park
- City of Fairview
- City of Gresham
- City of Troutdale
- City of Wood Village

City of Portland, NHMP Risk Reporting Areas

- CENT - Central City
- AIRPORT
- NWNW - Neighbors West/Northwest
- SEUL - Southeast Uplift Neighborhood Program
- NPNS - North Portland Neighborhood Services
- EPNO - East Portland Neighborhood Office
- NECN - Northeast Coalition
- CNN - Central Northeast Neighborhoods
- SWNI - Southwest Neighborhoods, Inc.



Source Data:
Lidar data from DOGAMI Lidar Data Quadrangles LDQ-2009-45122F8-Dixie Mountain, LDQ-2009-45122F7-Sauvie Island, LDQ-DATE-45122-F6-Vancouver, LDQ-2009-45122E8-Hillsboro, LDQ-2009-45122E7-Linnton, LDQ-2009-45122E6-Portland, LDQ-2009-45122E5-Mount Tabor, LDQ-2009-45122E4-Camas, LDQ-2010-45122E3-Washougal, LDQ-2009-45122D8-Scholls, LDQ-2009-45122D7-Beaverton, LDQ-2009-45122D6-Lake Oswego, LDQ-2009-45122D5-Gladstone, LDQ-2009-45122D4-Damascus, LDQ-2009-45122D3-Sandy.

Roads, streams, waterbodies, county boundary, and community boundary datasets are from the Regional Land Information System (RLIS), Oregon Metro, 2016. Additional physical and cultural locations are from the Geographic Names Information System (GNIS), U.S. Geological Survey, 2013. Natural Hazard Mitigation Plan (NHMP) risk reporting areas are from the City of Portland, Bureau of Emergency Management (2016).

Projection:
Oregon Statewide Lambert Conformal Conic, Unit: International Feet, Horizontal Datum: NAD 1983 HARN.

Software:
Esri® ArcMap® 10.5.1

Cartography:
Jon J. Franczyk