

Shallow 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

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Funding for this project was partially provided by the
Federal Emergency Management Agency (EWM-2014-CA-00280).

PLATE 2

NOTICE

This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information. This publication cannot substitute for site-specific investigations by qualified practitioners. Site-specific data may give results that differ from the results shown in the publication. See the accompanying text report for more details on the limitations of the methods and data used to prepare this publication.

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.

EXPLANATION

This shallow landslide susceptibility map identifies landslide-prone areas that are defined following the protocol of Burns and others (2012).

On the basis of several factors and just another described in detail by Burns and Matin (2009), a depth of 15 ft (4.5 m) is used to derive shallow free-face landslides. We prepared this shallow susceptibility map by estimating from factors: 1) calculated factor of safety (FOS); 2) landslide inventory data; and 3) buffers, as described below. We calculated the FOS by using conservative values such as having the water table at the ground surface. We used landslide inventory data from the corresponding inventory map (Plate 1). The combination of these factors comprise the relative susceptibility hazard zones: high, moderate, and low, as shown by the Susceptibility Hazard Zone Matrix below. The landslide susceptibility data are displayed as top of a base map that contains the lidar-derived digital elevation model.

SHALLOW LANDSLIDE SUSCEPTIBILITY CLASSIFICATION

Each landslide susceptibility hazard zone shown on this map has been developed according to a number of specific factors. The classification scheme, as described by the Oregon Department of Geology and Mineral Industries (Burns and others, 2012). The symbols used to display these hazard zones is explained below.

Shallow 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 shallow landslides.
- MODERATE: Moderate susceptibility to shallow landslides.
- LOW: Low susceptibility to shallow landslides.

Shallow Landslide Susceptibility Hazard Zone Matrix	
Contributing Factors	Final Hazard Zone
Factor of Safety (FOS)	High Moderate Low
Landslide Deposits and Head Scarps	Included Excluded Excluded
Buffer	2H IV (head scarps) 2H IV (FOS < 1.5) —

Factor of Safety (FOS)

The mechanics of slope stability can be divided into two forms: driving forces and resisting forces. These forces are a function of the material properties and the geometry of the slope. These two forces oppose each other and slope stability can be thought of as their ratio.

A slope with a FOS < 1 is theoretically a stable slope because the shear strength is greater than the shear stress. A slope with a FOS > 1 is theoretically an unstable slope because the shear stress is greater than the shear strength. A critically stable slope has a FOS = 1. Because of the inability to know the conditions present with a slope, most geotechnical engineers and engineering geologists recommend that slopes with a FOS < 1.5 be considered potentially unstable (Terzaghi and Schuster, 1996; Coe et al., 2000).

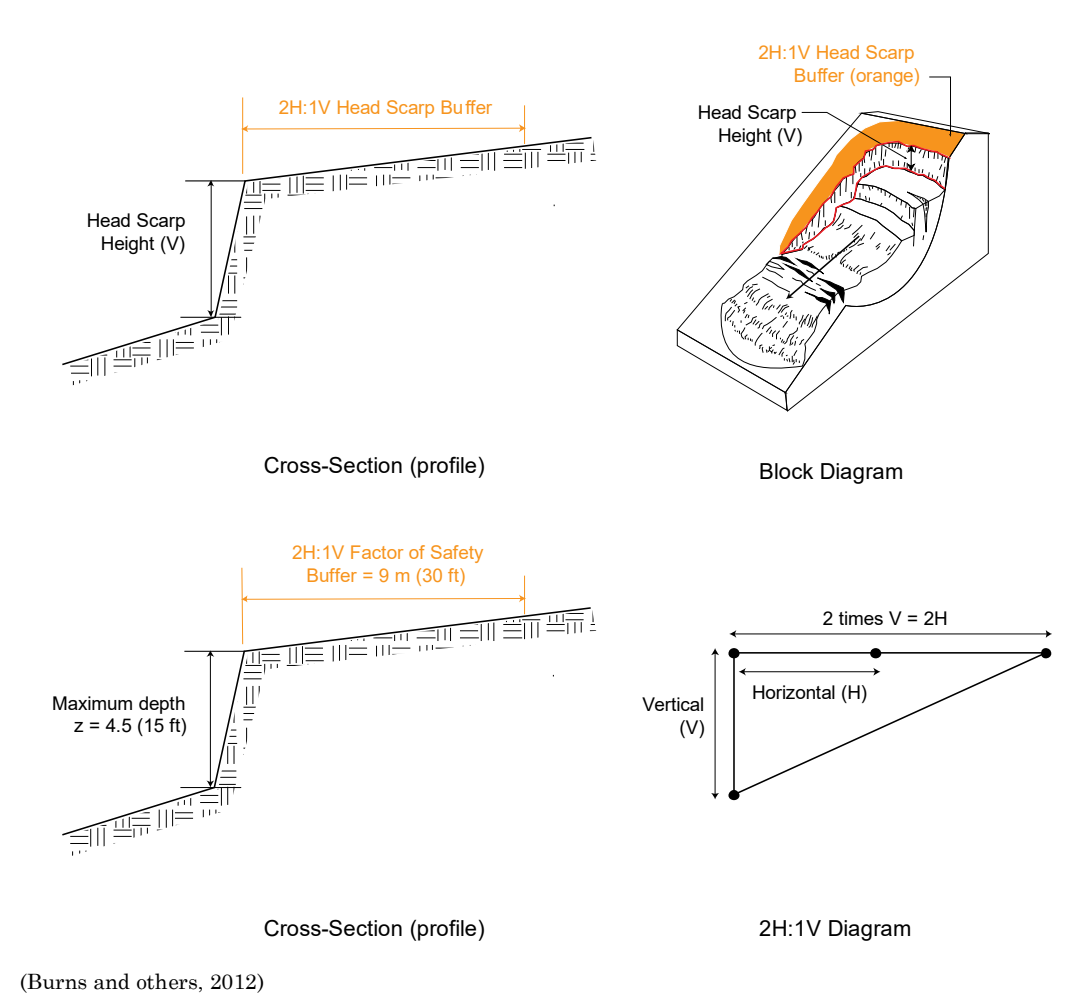
Landslide Inventory

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 field-based geomorphology, and reviewing aerial photography. We also identified each landslide with classifications for activity, depth of failure, movement type, and conditions of occurrence. We created the inventory by using the protocol developed by Burns and Matin (2009). We retained the specific landslide from the inventory and used them to create this shallow landslide susceptibility map.

Buffers for Head Scarps and Factor of Safety Less Than 1.5

Buffer for Head Scarps: This buffer was applied to all head scarps from the landslide inventory. The buffer consists of a 2-ft 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 4.5 ft on a 2H:1V buffer equal to 10 ft (3.0 m).

Buffer for Factor of Safety Less Than 1.5: This buffer was applied to all areas with a calculated FOS less than 1.5. The buffer consists of a 2-ft horizontal to vertical distance (2H:1V). For example, if the maximum depth for shallow landslides is 15 ft (4.5 m), then the 2H:1V buffer would equal 30 ft (9.0 m).



LIMITATIONS

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) The shallow landslide susceptibility map is based on three primary components: a calculated factor of safety, a landslide inventory, and 3) buffers. Factors that can affect the level of detail and accuracy of the final susceptibility map include the following:

- 1) Factor of safety calculations are strongly influenced by the accuracy and resolution of the input data for material properties, depth to failure surface, depth to groundwater, and slope angle. The first three of these inputs are mostly estimates (material properties or estimates limiting some depths to failure surface and groundwater), and local conditions may vary substantially from the estimated values used to make these maps.
- 2) Limitations of the landslide inventory are discussed by Burns and Matin (2009).
- 3) Infinite slope factor of safety calculations are done on one grid cell at a time without regard to adjacent grids. The results may underestimate or overestimate the level of stability for a certain area. We developed buffers to areas with the factor of safety to ensure the tendency to underestimate susceptibility. We developed the factor of safety method to ensure the tendency to overestimate susceptibility due to using slope with too few buffers. Overestimation and underestimation of susceptible areas are still likely to occur in some areas.
- 4) This susceptibility map is based on the topographic and landslide inventory data available as of the date of publication. Future new landslides may render this map locally inaccurate.
- 5) 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 know all existing structures and remove them to adjust the natural properties in the model, such features have been included as a conservative approach and may be retained in a non-specific block.
- 6) Some landslides in the inventory may have been reactivated, thereby reducing their level of susceptibility. Because it is not feasible to collect detailed site-specific information on every landslide, potential reactivation has been ignored.

REFERENCES

- Burns, W.J., and Matin, L.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 45, 30 p, pdf+dataset available.
- Burns, W.J., Matin, L.P., and Matin, K.A., 2012. Protocol for shallow landslide susceptibility mapping. Oregon Department of Geology and Mineral Industries Special Paper 45, 32 p.
- Coe, G.L., 1998. Landslide as process: investigation, analysis, and remedial/protective options in soils. Hoboken, N.J.: John Wiley and Sons, Inc., 198 p.
- Turner, A.R., and Schuster, R.L., eds., 1996. Landslide investigation and mitigation. Washington, D.C.: National Research Council, Transportation Research Board Special Report 357, 271 p.

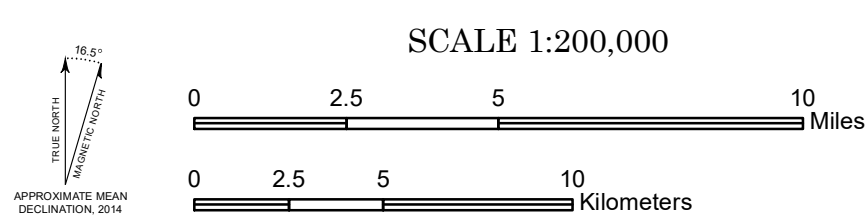
Generalized Surficial Engineering Geology Map

The units are listed below in generally increasing strength (weaker to stronger)

- Man-Made Mixed-Grained Fill
- Landslide (Deep) Deposits
- Talus Deposits
- Fine-Grained Older Alluvial Deposits and Colluvium
- Basalt Fragments and Loose Colluvium
- Loess and Loess-Basalt Colluvium
- Loess
- Fine-Grained Alluvial Deposits
- Coarse-Grained Alluvial Deposits
- Fine-Grained Older Alluvial Deposits
- Coarse-Grained Older Alluvial Deposits
- Residual Soil on Coarse-Grained Sedimentary Rock
- Residual Soil on Quaternary-Tertiary Basalt
- Residual Soil on Miocene Basalt

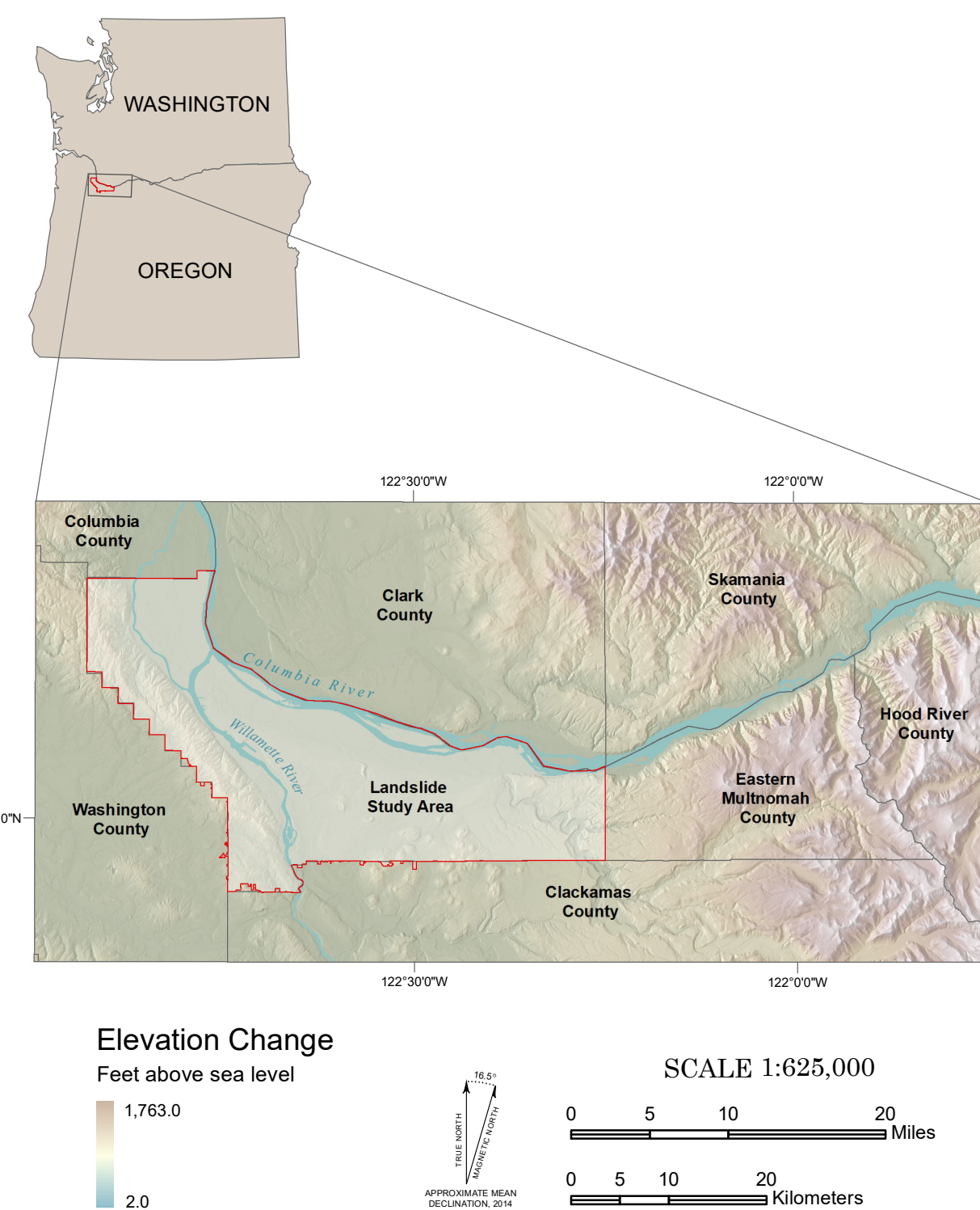
Explanation of Symbols

- Study Area
- River
- Not in Study Area

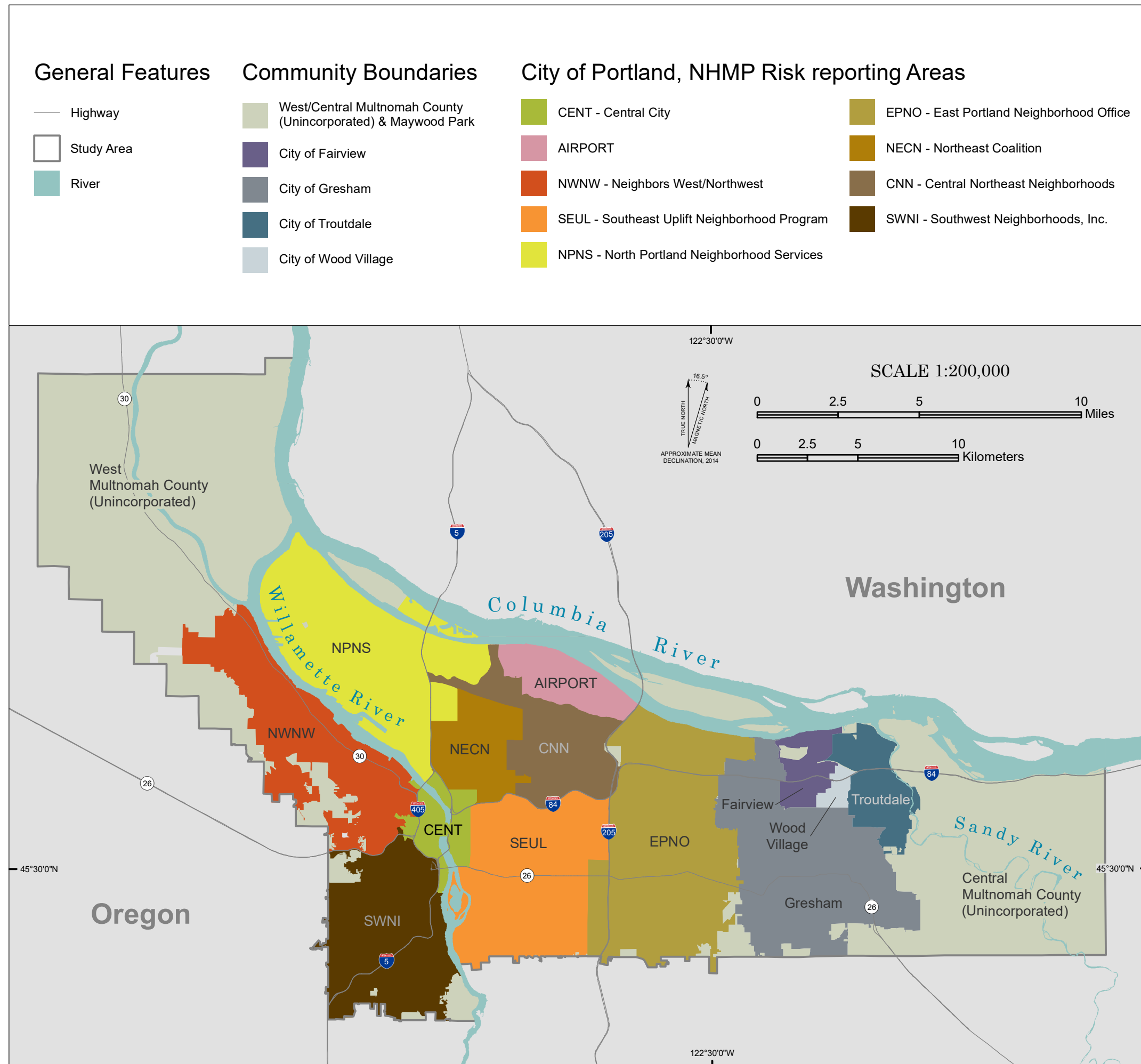


Study Area Location Map

(See Study Area Communities Map for more detail)



Study Area Communities Map



Source Data:
Lidar data from ODM: Lidar Data Quadangles LQ-2009-451228-Clatsop Mountain, LQ-2009-451227-Sauvie Island, LQ-2009-451226-Portland, LQ-2009-451225-Hillsboro, LQ-2009-451224-Beaverton, LQ-2009-451223-Clatsop, LQ-2009-451222-Portland, LQ-2009-451221-Beaverton, LQ-2009-451220-Clatsop, LQ-2009-451219-Beaverton, LQ-2009-451218-Clatsop, LQ-2009-451217-Beaverton, LQ-2009-451216-Clatsop, LQ-2009-451215-Beaverton, LQ-2009-451214-Clatsop, LQ-2009-451213-Beaverton, LQ-2009-451212-Clatsop, LQ-2009-451211-Beaverton, LQ-2009-451210-Clatsop, LQ-2009-451209-Beaverton, LQ-2009-451208-Clatsop, LQ-2009-451207-Beaverton, LQ-2009-451206-Clatsop, LQ-2009-451205-Beaverton, LQ-2009-451204-Clatsop, LQ-2009-451203-Beaverton, LQ-2009-451202-Clatsop, LQ-2009-451201-Beaverton, LQ-2009-451199-Clatsop, LQ-2009-451198-Beaverton, LQ-2009-451197-Clatsop, LQ-2009-451196-Beaverton, LQ-2009-451195-Clatsop, LQ-2009-451194-Beaverton, LQ-2009-451193-Clatsop, LQ-2009-451192-Beaverton, LQ-2009-451191-Clatsop, 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