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Landslide Inventory Map of Eugene and Springfield, Lane County, Oregon

2018

IMS-60
INTERPRETIVE MAP SERIES

Landslide Hazard and Risk Study of Eugene-Springfield and Lane County, Oregon

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PLATE 1

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 eastern portion of Lane County contains the cities of Eugene, Springfield, and Coburg. 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 map is an inventory of existing landslides in the study area. The landslide inventory is one of the essential data layers used to delineate regional landslide susceptibility. This landslide inventory is not regulatory, and we may make revisions to the inventory of this area when new information regarding landslides is found or when new landslides occur. Therefore, it is possible that landslides within the mapped area were not identified on this map or occurred after the map was prepared.

We prepared this inventory map by following the protocol for inventory mapping of landslide deposits developed by Burns and Madin (2009). The three primary tasks included compilation of previously mapped landslides (including review of the Statewide Landslide Information Layer for Oregon, release 2 [Burns and others, 2011]), lidar-based morphologic mapping of landslide features, and review of aerial photographs. We digitally compiled landslides identified by these methods into a GIS database at varying scales. While the protocol recommends data use at a map scale of 1:8,000, and the geodatabase contains data at 1:8,000 or better, for representation purposes we have visualized the data on the map plate at 1:38,000 scale. We also attributed each landslide with classifications for relative age of activity, depth of failure, movement type, and confidence of interpretation. The landslide data are displayed on top of a base map that consists of a lidar-derived hillshade image.

This landslide inventory map is intended to provide users with basic information regarding landslides within the study area. The geologic, terrain, and climatic conditions that led to landslides in the past may provide clues to the locations and conditions of future landslides, and it is intended that this map will provide useful information to develop regional landslide susceptibility maps, to guide site-specific investigations for future developments, and to assist in regional planning and mitigation of existing

LANDSLIDE CLASSIFICATION

We have classified each landslide shown on this map according to a number of specific characteristics identified at the time the data were recorded in the GIS database. The classification scheme was developed by the Oregon Department of Geology and Mineral Industries (Burns and Madin, 2009). Several significant landslide characteristics recorded in the database are portrayed with symbology on this map. The specific characteristics shown for each landslide are the activity of landsliding, landslide features, deep or shallow failure, confidence of landslide interpretation, and type of landslide movement. These landslide characteristics are determined primarily on the basis of geomorphic features, or landforms, observed for each landslide. The symbology we use to display these characteristics on the map is explained below.

LANDSLIDE ACTIVITY: Each landslide has been classified according to the relative age of most recent movement. This map display uses color to show the relative age of activity.

HISTORIC and/or ACTIVE (movement less than 150 years ago): The landslide appears to have moved within historic time or is currently moving (active).

PRE-HISTORIC or ANCIENT (movement greater than 150 years ago): Landslide features are slightly eroded and there is no evidence of historic movement. In some cases, the observed landslide features have been greatly eroded and/or covered with deposits that

LANDSLIDE FEATURES: Because of the high resolution of the lidar-derived topographic data, some additional landslide features were identified. These include:

HEAD SCARP ZONE and FLANK ZONE: The head scarp or upper most scarp, which in many cases exposes the primary failure plane (surface of rupture), and flanks or shear zones.

HEAD SCARP LINE and INTERNAL SCARP LINES: Upper most extent of the head scarp and internal scarps within the body of the landslide. Hatching is in the down-dropped direction.

DEPTH OF FAILURE: The depth of landslide failure was estimated from scarp height. Failures less than 4.5 m (15 ft) deep are classified as shallow, and failures greater than 4.5 m (15 ft) deep are classified as deep.

SHALLOW LANDSLIDE: Estimated failure plane depth is less than 4.5 m (15 ft).

DEEP LANDSLIDE: Estimated failure plane depth is greater than 4.5 m (15 ft).

CONFIDENCE OF INTERPRETATION: We classified each landslide at the time of mapping according to our "confidence" that the landslide actually exists. We mapped landslides on the basis of characteristic morphology, and the confidence of the interpretation was based on how clearly visible that morphology is. As a landslide ages, after its most recent movement, weathering (primarily through erosion) degrades the morphology produced by landsliding. With time, landslide morphologies may become so subtle that they resemble morphologies produced by geologic processes and conditions unrelated to landsliding.

Landslides may have several different types of associated morphologies, and we define confidence through a simple point system (see table below). The point system is based on a 0 to 10 point ranking of each of four primary landslide features. For example, if, during mapping, the head scarp and toe of a landslide were identifiable and clearly visible, the mapper would apply 10 points for the head scarp and 10 points for the toe, equaling 20 points, which would be associated with a moderate confidence of identification.

HIGH CONFIDENCE (≥ 30 points)

MODERATE CONFIDENCE (20 – 30 points)

LOW CONFIDENCE (≤ 20 points)

Landslide Feature	Points
Head scarp	0-10
Flanks	0-10
Toe	0-10
Internal scarps, sag ponds, compression ridges, etc.	0-10*

* Applied only once so that total points do not exceed 40.

CLASSIFICATION OF MOVEMENT: We classified each landslide with the type of landslide movement. There are five types of landslide movement: slide, flow, fall, topple, and spread (Varnes, 1978). These movement types are combined with material type to form the landslide classification. Not all combinations are common in nature, and not all are present in this study area.

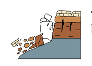
EFL EFL - Earth Flow - Abbreviation for type of slope movement. The table below displays movement types (Varnes, 1978). Generalized diagrams (some modeled from Highland, 2004) showing types of movement are shown in the next column.

Type of Movement	Type of Material		
	Rock	Debris	Soil
Fall	**RF** rock fall	**DF** debris fall	**EF** earth fall
Topple	**RT** rock topple	**DT** debris topple	**ET** earth topple
Slide-rotational	**RS-R** rock slide-rotational	**DS-R** debris slide-rotational	**ES-R** earth slide-rotational
Slide-translational	**RS-T** rock slide-translational	**DS-T** debris slide-translational	**ES-T** earth slide-translational
Lateral spread	**RSP** rock spread	**DSP** debris spread	**ESP** earth spread
Flow	**RFL** rock flow	**DFL** debris flow	**EFL** earth flow
Complex	**C** complex or combinations of two or more types (for example, **ES-R + EFL**)		

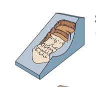
LANDSLIDE CLASSIFICATION (Cont.)

Types of Landslide Movement:

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.

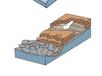


Topples are distinguished by forward rotation about some pivotal point, below or low in the mass.



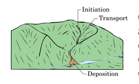
Slides are downslope movements of soil or rock on a surface of rupture (failure plane or shear zone).

- Rotational slides move along a surface of rupture that is curved and concave.



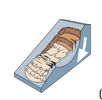
- Translational slides displace along a planar or undulating surface of rupture, sliding out over the original ground surface.

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, the mixture 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 are combinations of two or more types. An example of a common complex landslide is a rotational slide + earth flow, which usually exhibits rotational slide features in the upper region and earth flow features near the toe.

(Block Diagram from Highland, 2004)

LIMITATIONS

We developed this landslide inventory with the best available data by using the protocol of Burns and Madin (2009). However, there are inherent limitations as discussed below. These limitations underscore that this map is designed for regional applications and should not be used as an alternative to site-specific studies in critical areas.

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 original input data.
2. Burns and Madin (2009) recommended a protocol to develop landslide inventories that is based on four primary tasks: 1) interpretation of lidar-derived topographic data, 2) compilation and review of previously mapped landslides, 3) review of historic air photos, and 4) limited field checking. These tasks can affect the level of detail and accuracy of the landslide inventory. We expect the lidar data quality to improve in the future, and this improvement will likely result in the identification of more landslides with greater accuracy and confidence. Because of time limitations it is likely that we have missed some previously mapped landslides. In some locations, historic air photos may not be available. Because field work is time consuming and therefore expensive, field checking may be extensive in some locations but very limited in other locations.
3. The lidar-based mapping is a "snapshot" view of the current landscape that may change as new information regarding landslides becomes available or new landslides occur.
4. Because of the resolution of the lidar data and air photos, landslides that are smaller than 100 square meters (1,075 square feet) may not be identified. Generally, small landslides are included if they are reported by a local governmental agency, a site-specific study, regional study report, or a local area landslide expert, and are found to be accurately located by the mapper.
5. Even with high-quality lidar-derived topographic data, it is possible that some existing landslides are misinterpreted by the map authors. We prepared and reviewed this database and map in accordance with a published protocol (Burns and Madin, 2009) to minimize these problems.
6. Earthwork related to development on hillsides can remove the geomorphic expressions of past landsliding. This can result in landslides being missed in the inventory. Earthwork on hillsides can also create geomorphic expressions that mimic past landsliding; for example, a cut and fill can look like a landslide scarp and toe. This limitation can sometimes be addressed by viewing aerial photographs that predate development in the area being mapped. Therefore, to ensure that past landslides have been adequately identified, if a landslide was identified on the predevelopment air photos, we included the landslide in the landslide inventory, whether or not surface expression was located in the lidar-derived mapping.
7. Some landslides have been mitigated. Because it is not feasible to collect detailed site-specific information on every landslide, for example if it has been mitigated and what level of mitigation was implemented, we have omitted mitigation. Again, because of these limitations this map is intended for regional purposes only and cannot replace site-specific investigations. However, the map can serve as a useful tool for estimating the regional landslide hazard and as a starting place for future detailed landslide site-specific maps.

REFERENCES

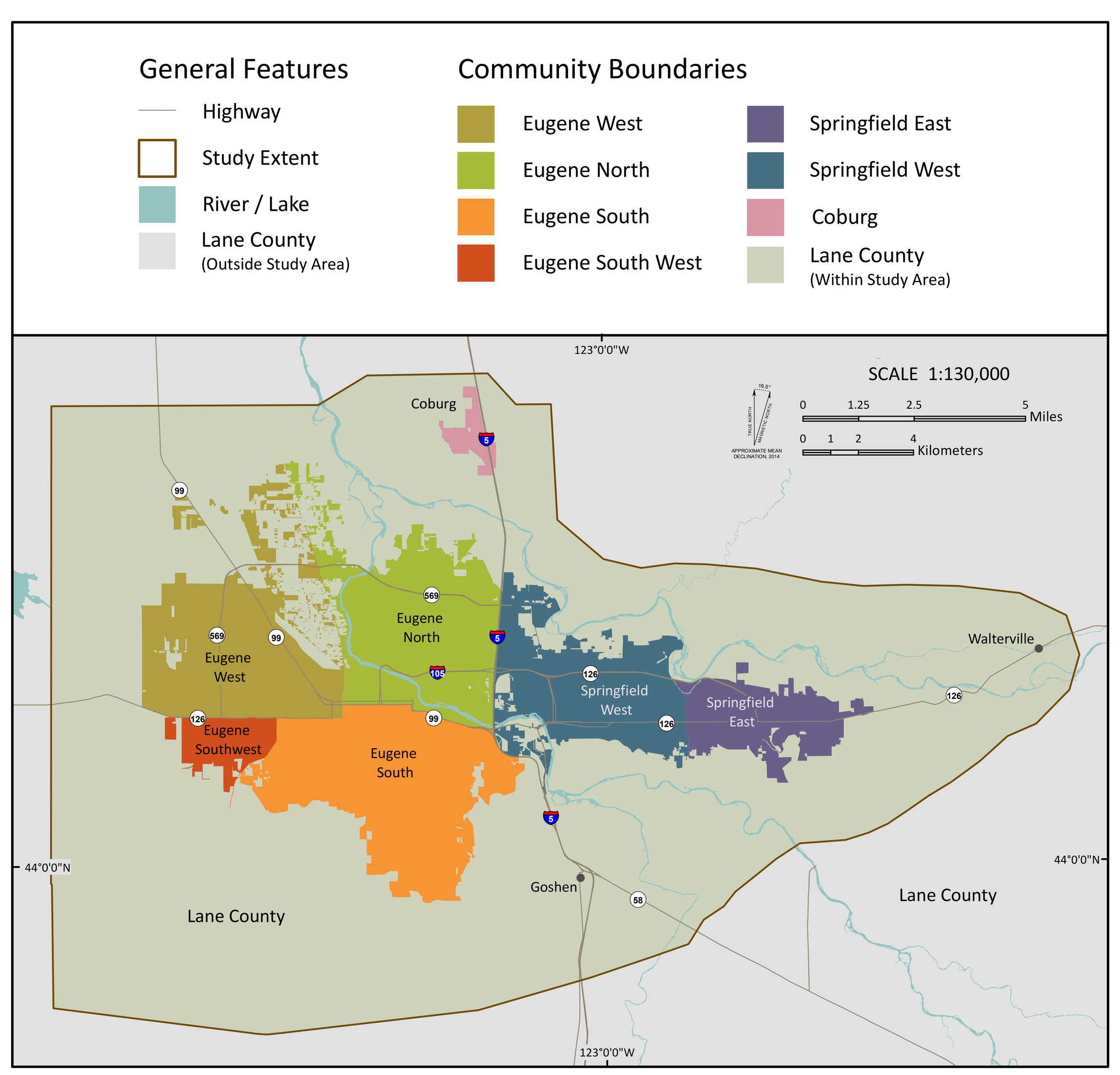
Burns, W.J., and Madin, I.P., 2009, Protocol for inventory mapping of landslide deposits from light detection and ranging (lidar) imagery: Oregon Department of Geology and Mineral Industries Special Paper 42, 30 p., geodatabase template.

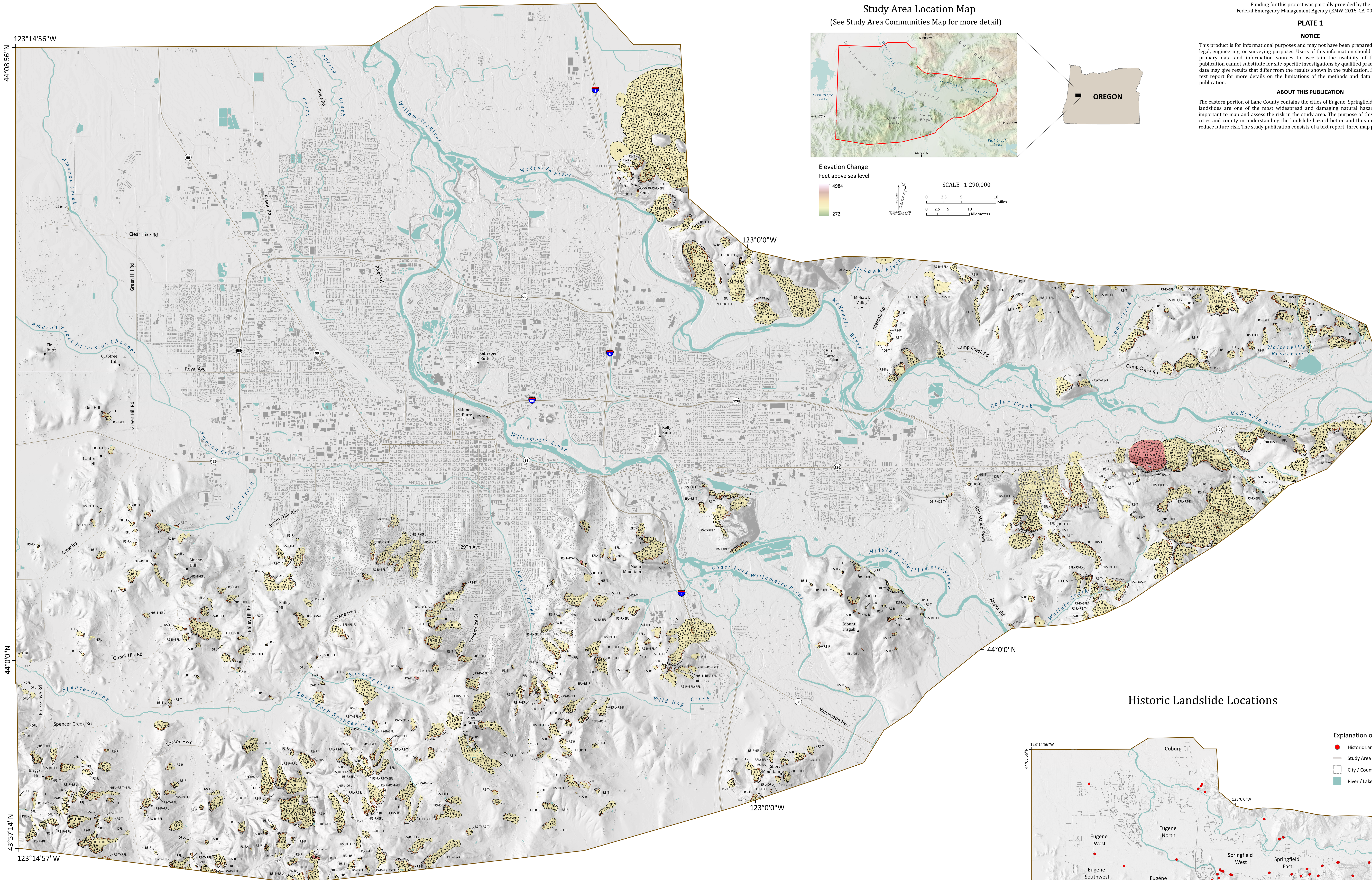
Burns, W.J., Mickelson, K.A., and Saint-Pierre, E.C., 2011, Statewide landslide information database for Oregon (SLIDO), release 3.2: Oregon Department of Geology and Mineral Industries, Digital Data Series SLIDO-3.2, 41 p., 1 pl., scale 1:750,000, GIS data.

Highland, L., compiler, 2004, Landslide types and processes: U.S. Geological Survey Fact Sheet 2004-3072 (ver. 1.1), 4 p.

Varnes, D.J., 1978, Slope movement types and processes, *in* Schuster, R.L., and Krizek, R.J., eds., Landslides—analysis and control: Washington, D.C., Transportation Research Board Special Report 176, p. 11–33.

Study Area Communities Map



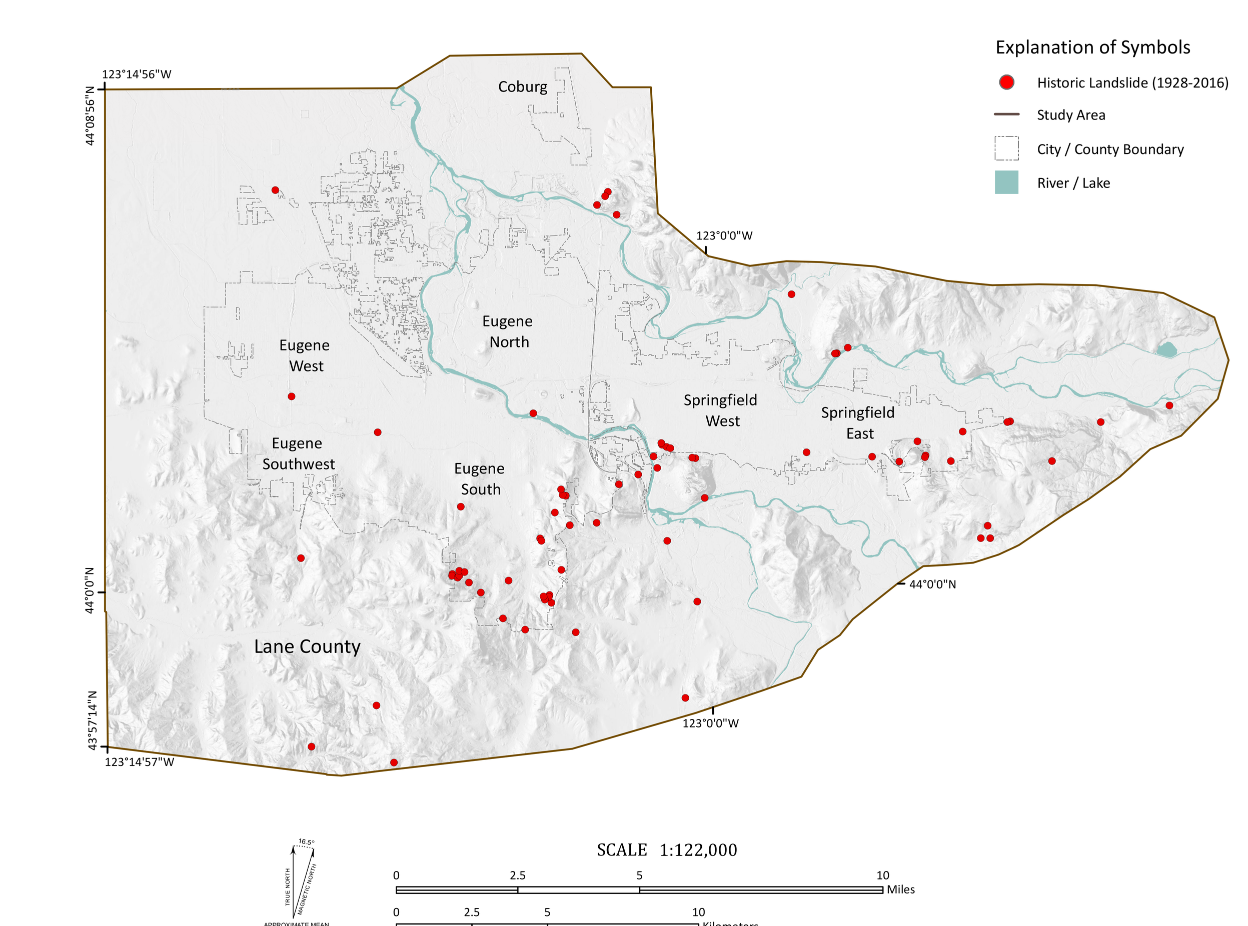


Study Area Location Map

(See Study Area Communities Map for more detail)

Elevation Change
Feet above sea level
4984
272
SCALE 1:290,000

Historic Landslide Locations



Source Data:
Oregon Lidar Consortium, 2008-2009 and 2013-2015, 3-foot bare earth lidar digital elevation model for Coburg (44123-B1), Creswell (43123-H1), Crow (43123-H3), Eugene East (44123-A1), Eugene West (44123-A2), Fox Hollow (43123-H2), Jasper (43122-H8), Junction City (44123-B2), Springfield (44122-A8), Walterville (44122-A7).

Water features are from the USGS National Hydrography Dataset (2015). Highways and signed routes are from the Oregon Department of Transportation (2013). Additional physical and cultural locations are from the Geographic Names Information System (GNIS), U.S. Geological Survey (2013). Eugene and Springfield community boundaries and building footprints are from Lane Council of Governments (2017).

Projection:
Oregon Statewide Lambert Conformal Conic, Unit: International Feet. Horizontal Datum: NAD 1983 HARN. UTM Coordinates: Zone 10N, NAD83.

Software:
Esri® ArcMap® 10.6

Cartography:
Jon J. Franczyk