

## 2013

**IMS-55**  
INTERPRETIVE MAP SERIES

**Landslide Inventory Maps of the Southern Half of the Pittsburg Quadrangle,  
Columbia County, Oregon**

by William J. Burns, Katherine A. Mickelson, and Evan C. Saint-Pierre

Partial funding provided by the Oregon Geospatial Enterprise Office (Grant 00320340)

## PLATE 1

**EXPLANATION**

This map is an inventory of existing landslides in this area. The landslide inventory is one of the essential data layers used to delineate regional landslide susceptibility. This landslide inventory is not regulatory, and revisions can happen when new information regarding landslides is found or when future (new) landslides occur. Therefore, it is possible that landslides within the mapped area were not identified or occurred after the map was prepared.

The inventory map was prepared following the Protocol for Inventory Mapping of Landslide Prone Areas from Light Detection and Ranging (LiDAR) Imagery developed by Burns and Madin (2009). The three primary tasks included compilation of previously mapped landslide inventories, review of the existing inventory maps for Oregon, release data (Burns and Madin, 2011) and digitization of these maps. [In preprint], digitized compilation of Landslide database. The digitized maps were then digitized into a GIS database at varying scales. Each landslide was also attributed with classifications for landslide type and size. The digitized maps are displayed on an open web map that consists of an aerial photograph (orthorectified) overlaid on the lidar-derived hillshade image.

This landslide inventory map is intended to provide users with basic information regarding landslides within the area. The geologic terrain, and climatic conditions that led to landslides in the past may provide clues as 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, and to provide information to the public.


## LANDSLIDE CLASSIFICATION

Each landslide shown on this map has been classified according to a number of specific characteristics identified at the time 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, type of landslide movement, and confidence of landslide interpretation. These landslide characteristics are determined primarily on the basis of geomorphic features, or landforms, observed for each landslide. The symbology used to display these characteristics is explained below.

**LANDSLIDE ACTIVITY:** Each landslide has been classified according to the relative age of last movement. This map display uses color to show the 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).
-  **PREHISTORIC 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 result in smoothed and subdued morphology.

**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(S):** The head scarp or uppermost scarp, which in many cases exposes the primary failure plane (surface of rupture), and flanks or shear zones.
-  **HEAD SCARP LINE and INTERNAL SCARP LINE:** Uppermost extent of the head scarp and internal scarps within the body of the landslide. Hatching line 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 seated and failures greater than 4.5 m (15 ft) deep are classified as deep seated.

- ☐ **SHALLOW-SEATED LANDSLIDE:** Estimated failure plane depth is less than 4.5 m (15 ft).
- ☒ **DEEP-SEATED LANDSLIDE:** Estimated failure plane depth is greater than 4.5 m (15 ft).

**CONFIDENCE OF INTERPRETATION:** Each landslide was classified according to the confidence that the mapper assigns based on the likelihood that the landslide actually exists. Landslides are mapped on the basis of characteristic morphology, and the confidence of the interpretation is based on how clearly visible that morphology is. As a landslide ages, weathering (primarily through erosion) degrades the characteristic morphologies 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 morphologies associated with them, and we define confidence through a simple point system (see table below) associated with these features. The point system is based on a ranking of four primary landslide features with a ranking of 0 to 10 points per feature. 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.

The visual display of this landslide characteristic is through the use of different line styles as shown below

- |  | <b>HIGH CONFIDENCE</b> (≥30 points)       | <table border="1"> <thead> <tr> <th>Landslide Feature</th><th>Points</th></tr> </thead> <tbody> <tr> <td>Head scarp</td><td>0-10</td></tr> <tr> <td>Flanks</td><td>0-10</td></tr> <tr> <td>Toe</td><td>0-10</td></tr> <tr> <td>Internal scarps, sag ponds, compression ridges, etc.</td><td>0-10*</td></tr> </tbody> </table> | Landslide Feature | Points | Head scarp | 0-10 | Flanks | 0-10 | Toe | 0-10 | Internal scarps, sag ponds, compression ridges, etc. | 0-10* |
|---|---|---|-------------------|--------|------------|------|--------|------|-----|------|--|-------|
| Landslide Feature   | Points                                    |   |                   |        |            |      |        |      |     |      |  |       |
| Head scarp  | 0-10                                      |   |                   |        |            |      |        |      |     |      |  |       |
| Flanks  | 0-10                                      |   |                   |        |            |      |        |      |     |      |  |       |
| Toe   | 0-10                                      |   |                   |        |            |      |        |      |     |      |  |       |
| Internal scarps, sag ponds, compression ridges, etc.                                  | 0-10*                                     |   |                   |        |            |      |        |      |     |      |  |       |
|  | <b>MODERATE CONFIDENCE</b> (11-29 points) |   |                   |        |            |      |        |      |     |      |  |       |
|  | <b>LOW CONFIDENCE</b> (≤10 points)        |   |                   |        |            |      |        |      |     |      |  |       |

**CLASSIFICATION OF MOVEMENT:** Each landslide was classified with the type of landslide movement. There are five types of landslide movement: slide, flow, fall, topple, and spread. 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 quadrangle.

EFL	EFL – Earth Flow – Abbreviation for class of slope movement. The table below displays the types (Varves, 1978) (unclassified diagrams) (some modified from Highland, 2014) showing types of movement as depicted below. Earth Flow					
	Type of Movement	Rock		Type of Material		
				Debris		Soil
Roll	RF	rock roll		DF debris roll		EF earth roll
Toppie	RT	rock topple		DT debris topple		ET earth topple
Side-rotational	RS-R	rock side-rotational	DS-R	debris side-rotational	ES-R	earth side-rotational
Side-translational	RS-T	rock side-translational	DS-T	debris side-translational	ES-T	earth side-translational
Lateral spread	RS	rock spread	DS	debris spread	ES	earth spread
Flow	RF	rock flow	DF	debris flow	EF	earth flow
Complex	C = complex or combinations of two or more types (for example, ES-R + EFL)					

- 
- The diagram illustrates six types of mass wasting, each with a cross-sectional view and a plan view:
- Falls:** A vertical rock face with a rock falling from the top. The plan view shows a vertical cliff face.
  - Topples:** A block of material rotating forward around a pivot point. The plan view shows a block rotating around a central point.
  - Slides:** A block of material moving down a curved surface. The plan view shows a block moving along a curved path.
  - Spreads:** A block of material moving down a flat surface. The plan view shows a block moving in a straight line.
  - Channelized Debris Flows:** A flow of material moving down a channel. The plan view shows a flow moving down a channel.
  - Earth Flows:** A flow of material moving down a slope. The plan view shows a flow moving down a slope.
- 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 diplose 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 the 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 end 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 slump-earth flow, which usually exhibits slump features in the upper region and earth flow features near the toe.

## LIMITATIONS

This landslide inventory was developed with the best available data, 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.

3. Every effort has been made to ensure the accuracy of the GIS and tabular databases, but it is not possible to completely verify all original input data.
4. Burns and Madin (2009) recommended a protocol to develop landscape inventories that is based on four primary tasks: (a) develop a landscape inventory, (b) conduct a landscape inventory, (c) evaluate the landscape inventory, and (d) limited field checking. These tasks can affect the level of detail and accuracy of the landscape inventory. We expect that the accuracy of the landscape inventory will be affected by the number of field checks, the number of landscape inventories, and the time of day. Due to time limitations some landscapes have likely been missed. In some locations, historic air photo may be available. However, field work is time consuming and therefore expensive, field checking may be extensive in some locations and very limited in others.
5. The landscape mapping is a "snapshot" view of the current landscape that may change as new information regarding landscapes becomes available and as new landscapes occur.
6. Because of the resolution of the lidar data and air photo, landscapes that are smaller than 100 square meters (1/925 acres) could not be identified. Some of the smaller landscapes were included if they were reported by a local governmental agency, a site-specific study, or a local landowner.
7. Even with high-quality lidar-derived topographic data, it is possible that some existing landscapes will be missed, overlooked, or misinterpreted by the map author. This database and map were prepared in accordance with a published protocol (Burns and Madin, 2009) and were reviewed to minimize these problems.
8. Earthwork related to development on hillsides can remove the geomorphic expressions of past landholding. This can result in loss of landscape information. The current work on hillsides can also create geomorphic expressions that mimic past landholding. For example, a cut and fill can look like a landslide scar and so on. This limitation can sometimes be addressed by viewing aerial imagery, but this is not always possible. The current work on hillsides can also create geomorphic expressions that mimic past landholding. For example, a fill can be identified on the predevelopment air photo. It was included in the landscape inventory, whether or not surface erosion was located in the lidar-derived mapping.
9. Some lands have been misclassified. Because it is not feasible to collect detailed site-specific information on every landscape, some misclassification is inevitable. The current work was implemented, mitigation was not omitted. Areas of the landscape that are misclassified may be identified by the user. The current work is intended for regional purposes only and cannot replace site-specific investigations. However, the map can serve as a useful tool for the user to identify the regional landscape and to select the appropriate place for detailed landscape site-specific maps.

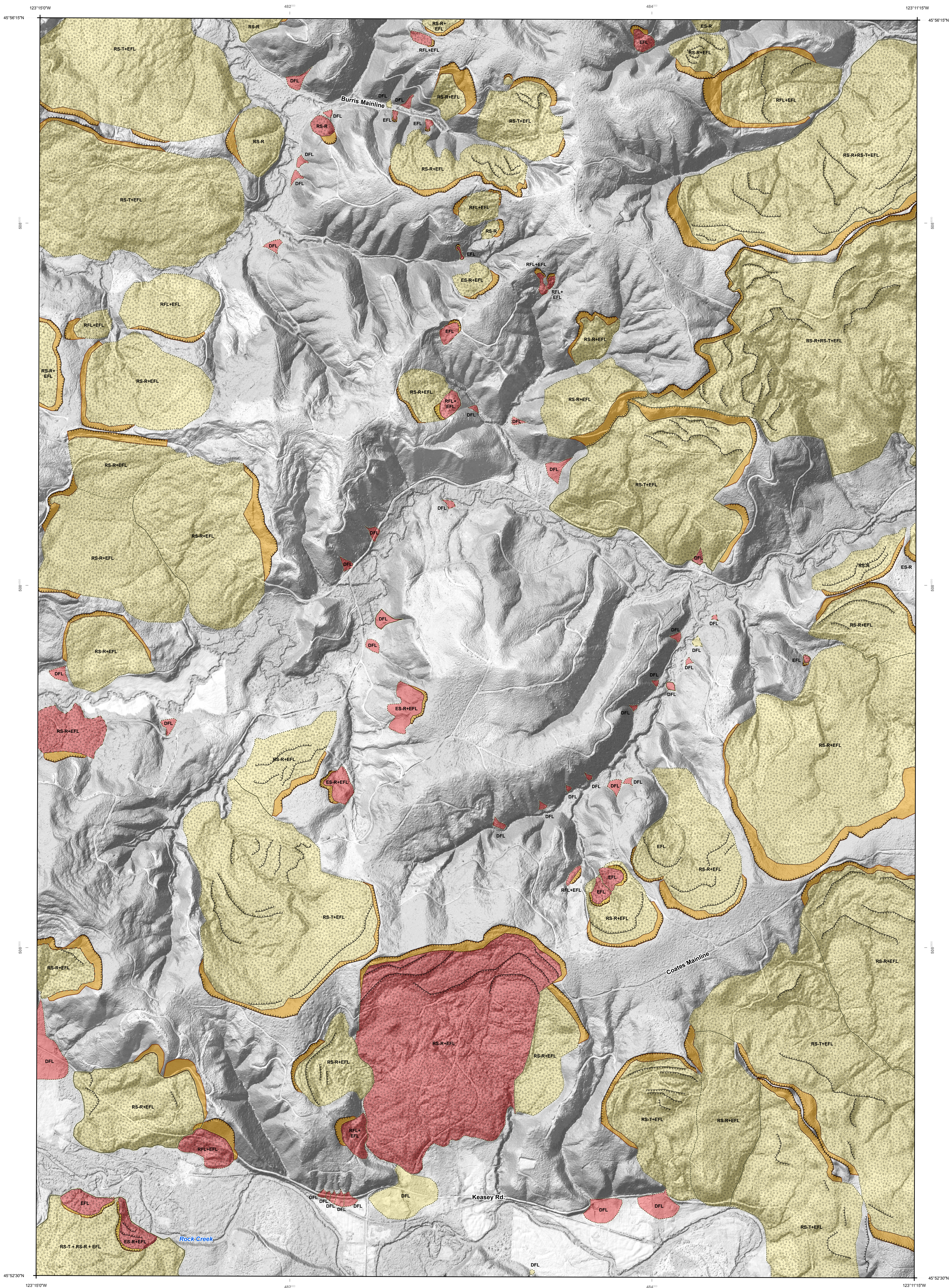
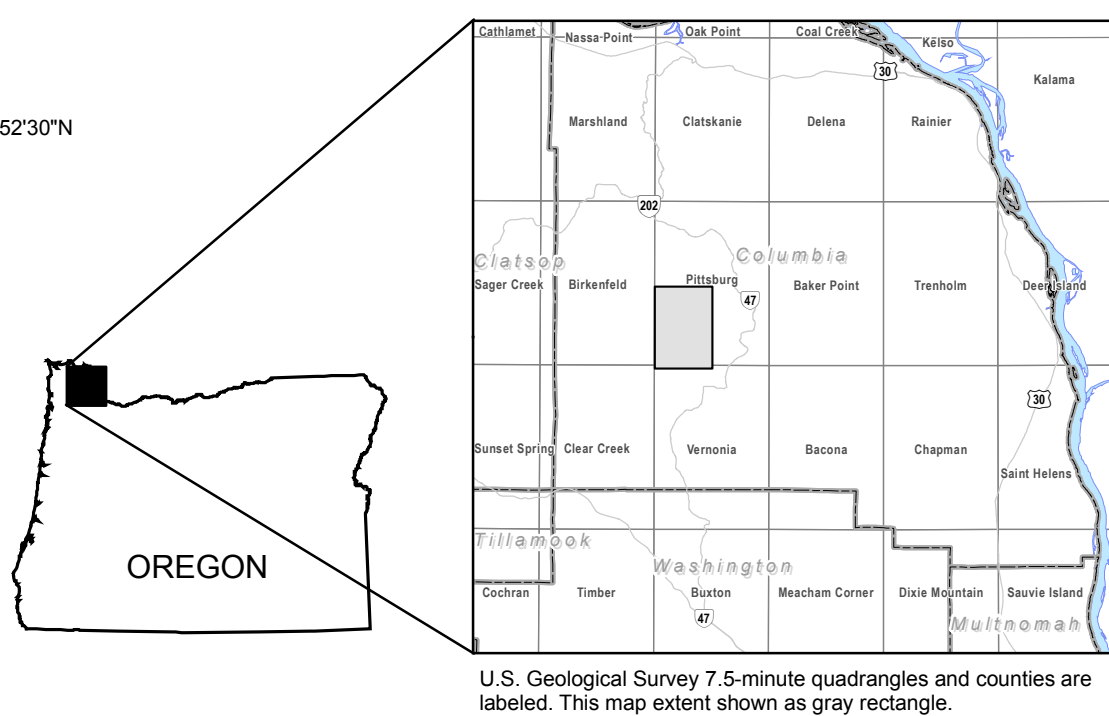
## ACKNOWLEDGMENTS

We thank U.S. Geological Survey Landslide Hazard Program staff, especially Jeff Coe, and DOGAMI staff Rob Witter, Yumei Wang, and Deb Schueller, who provided detailed reviews that significantly improved the protocol and the map template for this series.

## REFERENCES

- Burns, W. J., and Madin, I. P., 2000. Protocol for inventory mapping of landslide deposits from light detection and ranging (lidar) imagery. Portland, Ore.: Oregon Department of Geology and Mineral Industries Special Paper 42, 30 p.
- Burns, W. J., Mickelson, K. A., and Saint-Pierre, E. C., 2011. Statewide landslide information layer for Oregon (SLIIO). *Research in Geology*, Oregon Department of Geology and Mineral Industries Digital Data Series SLIIO-2, 01, 1 p., scale: 1:750,000.
- Highland, L., compiler, 2004. Landslide types and processes: US Geological Survey Fact Sheet 2004-3072 (ver. 1.1). 4 p.
- Nielsen, A. N., Hanson, W. B., McKnight, R. K., Niemi, A. A., and Houston, R. A., in prep. Geologic map of the Vermont 7.5-minute quadrangle, northwest Oregon. US Geological Survey, scale 1:24,000.
- Varnes, D. J., 1978. Slope movement types and processes. In Schuster, R. L., and Krizek, R. J., eds., *Landslide—Inception, Development, and Countermeasures*. U.S. Transportation Research Board, Washington, D. C., 371 p., 1:183.

### LOCATION MAP



**Base Map:**

Lidar data from DOGAMI Lidar Data Quadrangle LDQ-2011-45123H-Pittsburg Digital elevation model (DEM) consists of a 3-foot-square elevation grid that was into a hillshade image with sun angle at 315 degrees at a 60-degree angle from horizon. The DEM was multiplied by 5 (vertical exaggeration) to enhance slope areas.

2005 orthophoto imagery is from Oregon Geospatial Enterprise Office and is draped over the hillshade image with transparency.

Projection: North American Datum 1983, UTM zone 10 North.

Software: Esri ArcMap 10, Adobe Illustrator CS2

Source File: Project\Pittsburg.mxd

Cartography by William J. Burns and Katherine A. Mickelson,  
Oregon Department of Geology and Mineral Industries

This map benefited from comments by Alan Niem, Research Geologist, Oregon State University; Glenn Higgins, Planning Manager, Columbia County and other Columbia County staff; and Fred Gullixson, Geo Team Leader, ODOT. This map also benefited from internal review and comments by Ian Madin, DOGAMI Chief Scientist.

## IMPORTANT NOTICE

This map depicts an inventory of existing landslides based on published and unpublished reports and interpretation of topography derived from lidar data and air photos. The inventory was created following the protocol defined by Burns and Madin (2009). This map cannot serve as a substitute for site-specific investigations by qualified practitioners. Site-specific data may give results that differ from those shown on this map.



Nature of the Northwest

Nature of the Northwest Information Center  
800 NE Oregon Street, #28, Ste. 965  
Portland, Oregon 97232  
telephone (971) 673-2331  
<http://www.naturenw.org>