

Section 9: Landslide

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Why are Landslides a Threat to Douglas County?

Landslides are a serious geologic hazard in many states, including Oregon. Nationally, landslides cause 25 to 50 deaths each year. The best estimate of direct and indirect costs of landslide damage in the United States range between \$1 and \$2 billion annually. In Oregon, a significant number of locations are in danger of being impacted by landslides. While not all landslides result in private property damage, many landslides impact transportation corridors, fuel and energy conduits, and communication facilities. Landslides can also pose a serious threat to human life.

Landslides can be broken down into two categories: (1) rapidly moving, and (2) slow moving. Rapidly moving landslides present the greatest risk to human life, and people living in or traveling through areas prone to rapidly moving landslides are at increased risk of serious injury. Rapidly moving landslides have also caused most of the recent landslide related injuries and deaths in Oregon. During the winter storms of 1996, a rapidly moving landslide debris flow killed four people in Douglas County. Slow moving landslides can cause significant property damage, but are less likely to result in serious human injuries.

History of Landslide Events and Impacts

Landslides are a common hazard in Oregon. In fact, a prominent theme of the 1996 flood disaster was that a significant amount of building damage affected structures outside of identified flood hazard areas, which were in debris flow channels.

In many parts of Douglas County, weathering and the decomposition of geologic materials produces conditions conducive to landslides. Human activity is believed to further exacerbate the landslide problem. A study conducted by Dr. Scott Burns at Portland State University found that changes to the slope through cutting or filling increased the risk of landslides in 76% of the 701 inventoried landslides in the Metro region. The study documented 48 landslides that occurred in Oregon City in February 1996, and found that about half the slides were considered natural.

Landslides are difficult to mitigate, particularly in areas of large historic movement with weak underlying geologic materials. As communities continue to modify the terrain and influence natural processes, it is important to be aware of the physical properties of the underlying bedrock as it, along with climate, dictates hazardous terrain. Without proper planning, landslides will continue to threaten the safety of people, property, and infrastructure.

Landslide Characteristics

What is a Landslide?

Landslides are downhill movements of rock, debris, or soil mass. The size of a landslide usually depends on the geology and the initial cause of the landslide. Landslides vary greatly in their volume of rock and soil, the length, width, and depth of the area affected, frequency of occurrence, and speed of movement. Some characteristics that determine the type of landslide are slope of the hillside, moisture content, and the nature of the underlying materials. Landslides are given different names, depending on the type of failure and their composition and characteristics.

Slides move in contact with the underlying surface. These movements include rotational slides where sliding material moves along a curved surface, and translational slides where movement occurs along a flat surface. These slides are generally slow moving and can be deep. Slumps are small rotational slides that are generally shallow (See Figure 9.1).

Slow moving landslides can occur on relatively gentle slopes and can cause significant property damage, but are far less likely to result in serious injuries than rapidly moving landslides.

Washouts caused by **erosion** can occur in Douglas County. These occur when ditches or culverts beneath hillside roads become blocked with debris. If the ditches are blocked, run-off from slopes is inhibited during periods of precipitation. This causes the run-off water to collect in soil, and in some cases, cause a slide.

Figure 9.1 Rotational Slide

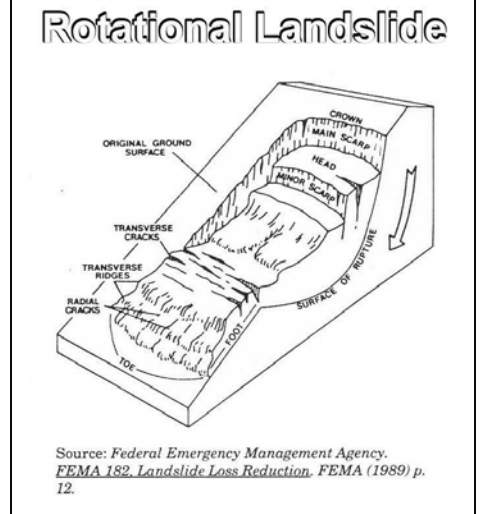
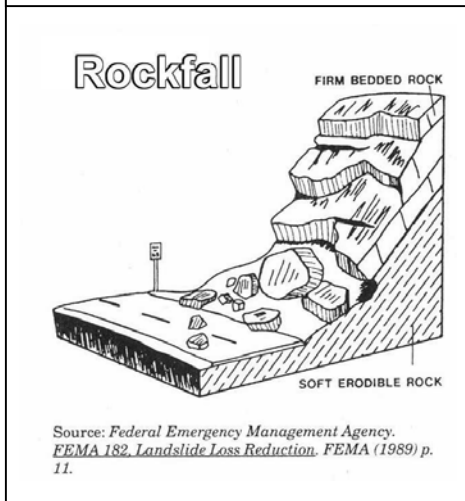


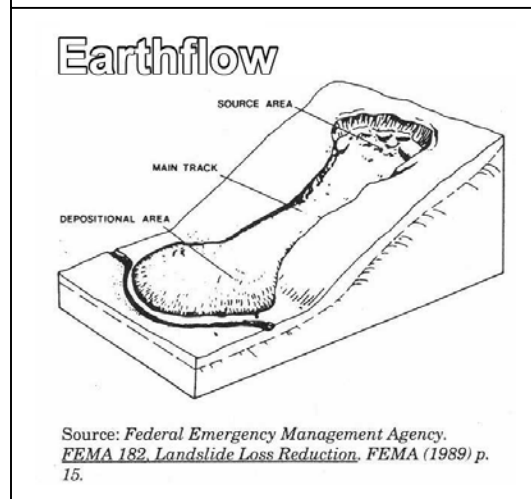
Figure 9.2 Rock fall



Rock falls (see Figure 9.2) occur when blocks of material come loose on steep slopes.

Weathering, erosion, or excavations, such as those along highways, can cause falls where the road has been cut through bedrock. They are fast moving with the materials free detached from a steep slope or cliff. The volume of material involved is generally small, but large boulders or blocks of rock can cause significant damage. A motorist was killed from a rock fall in 1993. The 1993 rock fall occurred near Klamath Falls during the 1993 Earthquakes.

Figure 9.3 Earthflows



Earthflows (see Figure 9.3) are liquid movements of landmass (e.g. soil and rock), which breaks up and flows during movement. Earthquakes are often the mechanism, which trigger flows. Debris flows normally occur when a landslide moves downslope as a semi-fluid mass scouring, or partially scouring soils from the slope along its path. Flows are typically rapidly moving and also tend to increase in volume as they scour out the channel.

Flows often occur during heavy rainfall, can occur on gentle slopes, and can move rapidly for large distances. One example of a flow in Oregon is the Dodson debris flow that occurred in 1996. This debris flow started high on the Columbia Gorge cliffs, and traveled far down steep canyons to form debris fans at Dodson.

Landslide Conditions

Landslides are typically triggered by periods of heavy rainfall or rapid snowmelt. Earthquakes, volcanic activity, and excavations may also trigger landslides. Certain geologic formations are more susceptible to landslides than others. Human activities, including locating development near steep slopes, can increase susceptibility to landslide events. Landslides on steep slopes are more dangerous because movements can be rapid. Although landslides are a natural geologic process, the incidence of landslides and their impacts on people can be exacerbated by human activities. Grading for road construction and development can increase slope steepness. Grading and construction can decrease the stability of a hillslope by adding weight to the top of the slope, removing support at the base of the slope, and increasing water content. Other human activities effecting landslides include: excavation, drainage and groundwater alterations, and changes in vegetation.

Natural Conditions

Natural processes can cause landslides or re-activate historical landslide sites. The removal or undercutting of shoreline-supporting material along bodies of water by currents and waves produces countless small slides each year. Seismic tremors can trigger landslides on slopes historically known to have landslide movement. Earthquakes can also cause additional failure (lateral spreading) that can occur on gentle slopes above steep streams and riverbanks. Landslides are particularly common along stream banks, reservoir shorelines, large lakes, and seacoasts. Steep, concave-shaped slopes with larger drainage areas appear to be more susceptible to landslides than other landforms. Landslides associated with volcanic eruptions can include volumes of over one cubic mile of material. All soil types can be affected by natural landslide triggering conditions.

Particularly Hazardous Landslide Areas

Locations at risk from landslides or debris flows include areas with one or more of the following conditions:

- On or close to steep hills;
- Steep road-cuts or excavations;
- Existing landslides or places of known historic landslides (such sites often have tilted power lines, trees tilted in various directions, cracks in the ground, and irregular-surfaced ground);
- Steep areas where surface runoff is channeled, such as below culverts, V-shaped valleys, canyon bottoms, and steep stream channels; and
- Fan-shaped areas of sediment and boulder accumulation at the outlets of canyons.

Impacts of Development

Although landslides are a natural occurrence, human impacts can affect the potential for landslide failures in Douglas County. Proper planning can protect people,

property, and infrastructure.

Excavation and Grading

Slope excavation is common in the development of home sites or roads on sloping terrain. Grading these slopes can result in some slopes that are steeper than the pre-existing natural slopes. Since slope steepness is a major factor in landslides, these steeper slopes can be at an increased risk for landslides. The added weight of fill placed on slopes can also result in an increased landslide hazard. Small landslides can be fairly common along roads, in either the road cut or the road fill.

Drainage and Groundwater Alterations

Water flowing through or above ground is often the trigger for landslides. Any activity that increases the amount of water flowing into landslide-prone slopes can increase landslide hazards. Broken or leaking water or sewer lines can be especially problematic, as can water retention facilities that direct water onto slopes. However, even lawn irrigation and minor alterations to small streams in landslide prone locations can result in damaging landslides. Ineffective storm water management and excess runoff can also cause erosion and increase the risk of landslide hazards. Drainage can be affected naturally by the geology and topography of an area. Development that results in an increase in impervious surface impairs the ability of the land to absorb water and may redirect water to other areas. Channels, streams, ponding, and erosion on slopes all indicate potential slope problems. Road and driveway drains, gutters, downspouts, and other constructed drainage facilities can concentrate and accelerate flow. Ground saturation and concentrated velocity flow are major causes of slope problems and may trigger landslides.

Changes in Vegetation

Removing vegetation from very steep slopes can increase landslide hazards. The *Storm Impacts Study* conducted by the Oregon Department of Forestry found that landslide hazards in three out of four steeply sloped areas were highest for a period of roughly 10 years after timber harvesting. Areas that have experienced wildfire and land clearing for development may have long periods of increased landslide hazard. In addition, woody debris in stream channels (both natural and man-made from logging) may cause the impacts from debris flows to be more severe.

Landslide Hazard Assessment

Hazard Identification

Identifying hazardous locations is an essential step towards implementing more informed mitigation activities. The Oregon Department of Forestry (ODF) and the Department of Geology and Mineral Industries (DOGAMI) are active in developing maps and collecting data on hazard risk. The final products might be useful for local geologists, engineers, planners, and policy makers interested in addressing landslide hazards.

Vulnerability and Risk

Vulnerability assessment for landslides will assist in predicting how different types of property and population groups will be affected by a hazard. Data that includes specific landslide-prone and debris flow locations in the county can be used to

assess the population and total value of property at risk from future landslide occurrences. While a quantitative vulnerability assessment (an assessment that describes number of lives or amount of property exposed to the hazard) has not yet been conducted for Douglas County landslide hazard areas, there are indicators such as steepness of slope which indicate potential vulnerability. Landslides have impacted major transportation routes causing residents to temporarily be without essential services and businesses. Past landslide events have caused property damage and loss of life. Mapping county landslide and debris flow areas might help in preventing future loss.

Factors included in assessing landslide risk include population and property distribution in the hazard area, the frequency of landslide or debris flow occurrences, slope steepness, soil characteristics, and precipitation intensity. This type of analysis could generate estimates of the damages to the county due to a specific landslide or debris flow event. At the time of publication of this plan, data was insufficient to conduct a risk analysis.

Community Landslide Issues

What is Susceptible to Landslides?

Landslides can affect utility services, transportation systems, and critical lifelines. Communities may suffer immediate damages and loss of service. Disruption of infrastructure, roads, and critical facilities may also have a long term effect on the economy. Utilities, including potable water, wastewater, telecommunications, natural gas, and electric power are all essential to service community needs. Loss of electricity has the most widespread impact on other utilities and on the whole community. Natural gas pipes may also be at risk of breakage from landslide movements as small as an inch or two.

Roads and Bridges

The largest losses incurred from landslide hazards in Douglas County have been associated with roads. The Douglas County Public Works Department and the Oregon Department of Transportation (ODOT) are responsible for responding to slides that inhibit the flow of traffic and/or damage a road or bridge.

It is not cost effective to mitigate for all slides, due to the fact that some historical slides are likely to become active again even after mitigation measures have been implemented. The County Public Works Department alleviates problem areas by grading slides, and by installing new drainage systems on the slopes to divert water from the landslides. This type of response activity is often the most cost-effective in the short-term.

Lifelines and critical facilities

Lifelines and critical facilities should remain accessible during a natural hazard event. The impact of closed transportation arteries is increased if the closed road or bridge is the access to a hospital or other emergency facility. Therefore, inspection and repair of critical transportation facilities and routes is essential and should be a high priority. Loss of power and/or phone service is also potentially a consequence of landslide events. In hillside areas, soil erosion can be accelerated by heavy rains, resulting in loss of soil support beneath high voltage transmission towers.

Landslide Mitigation Activities

Landslide mitigation activities include current mitigation programs and activities that are being implemented by local or county organizations.

County

Douglas County Land Use and Development Ordinance

Douglas County addresses development on steep slopes in Section 3.35.500 of the Land Use and Development Ordinance (LUDO). This section outlines standards for steep slope hazard areas, which are slopes greater than 25 percent. The ordinance requires an engineering geologist or (qualified) engineer to certify that the proposed development may be completed without threat to public safety or welfare.

Community Issues Summary

Communities in Douglas County face problems in identifying the location of landslides, because calculating where a landslide hazard area is located, involves numerous variables. Some of the variables are steepness of slope, soil type, age of trees and bushes, amount of rain fall, etc. Landslides are more prevalent in some parts of the county than others. It is not feasible to identify all hazard areas. In addition, historically, there are no landslide records. The County Public Works Department and Planning Department's however, do deal with landslides and their repercussions.

Landslide Mitigation Goals

GOAL A

Prevent Loss of Life from Landslides

GOAL B

Reduce Property Damages

GOAL C

Enhance Education and Public Awareness of Landslide Danger

GOAL D

Increase Preparedness of Communities and Agencies To Deal With Landslides

Landslide Mitigation Action Items

The landslide mitigation action items provide direction on specific activities that cities, organizations, and residents in Douglas County can undertake to reduce risk and prevent loss from landslide events. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation.

Action Item #1: Encourage construction, site location and design that can be applied to steep slopes to reduce the potential threat of landslides.

Ideas for Implementation

- Develop a “How-To” development and construction guide for homeowners in potential landslide hazard areas
- Develop public information to emphasize economic risk when building on potential or historical landslide areas.

Coordinating Organization: Douglas County Planning Department, Douglas County Building Department

Timeline: 3 years

Plan Goals Addressed: A, B, C, D

Action Item #2: Mitigate activities in identified potential and historical landslide areas through public outreach.

Ideas for Implementation

- Identify and use existing mechanisms for public outreach (e.g., SWCD, NRCS, watershed councils, etc.).
- Distribution of landslide educational materials to public

Coordinating Organization: Douglas County Planning Department, Douglas County Emergency Management

Timeline: Ongoing

Plan Goals Addressed: A, B, C

Action Item #3: Increase coordination between local jurisdictions, Emergency Responders, homeowners and ODF for landslide warning systems.

Ideas for Implementation

- Educate at risk home sites about climatic and soil conditions that are conducive to landslides.
- Develop mitigation and evacuation information and procedures for at risk home sites

Coordinating Organization: Douglas County Emergency Management

Timeline: 3-5 years

Plan Goals Addressed: A, B, C, D,