



Prepare for Landslide Season in Seattle



Seattle Landslides: What You Need to Know

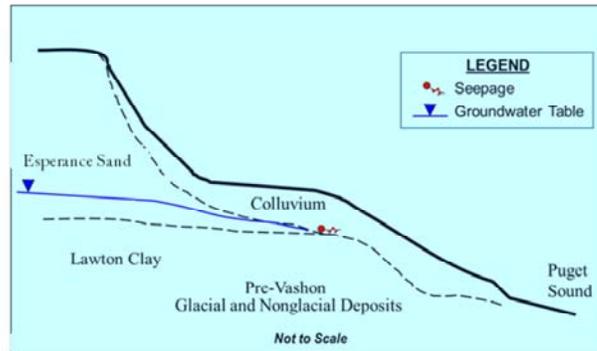
www.seattle.gov/dpd/emergencymanagement/

It's time to prepare for landslide season in Seattle. This presentation explains the major causes of landslides in Seattle, how to reduce landslide risks, and what to do if a landslide happens on your property.

Reasons For Landslides

- Topography
- Geology
- Water
- Water
- Water
- Human Activities

Typical Seattle Geology



In places where sand overlies clay (which is relatively impermeable), the upper materials quickly become saturated. Saturation of the soil and groundwater forces lead to increased landsliding near the contact of the sand and clay.

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Landslides occur for many reasons. The steeper the slope (or topography) at your site, the more likely you are to have a landslide. In Seattle, our geology was shaped by the advance and retreat of glaciers, and this makes some areas more prone to landslides. As you can see in this figure, places where we have permeable soils, such as sand, over impermeable soils, such as Lawton Clay, are more prone to sliding because water collects where the two soils meet. Heavy rain, uncontrolled stormwater, and human activity are also major factors that contribute to a landslide on a sloping site.

Seattle Landslide Study

- Published in 2000 and updated in 2003
- Led by Seattle Public Utilities (SPU), with substantial contributions from the Department of Planning and Development (DPD) and Seattle Department of Transportation (SDOT)
- Compiled detailed database of historic landslides in Seattle from 1890's
- Refined definition of landslide hazard zones within the City
- <http://bit.ly/landslidestudy>

Source: Seattle Landslide Study, SPU, Shannon & Wilson, Inc.



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In Seattle, we know quite a bit about our landslide risk because of records we have kept since the 1890's. In addition, the City of Seattle commissioned a comprehensive Seattle Landslide Study in 2000 and 2003. Using the information in our historical records and numerous site visits, the study developed maps of landslide-prone areas. We now have a better understanding of the types and causes of landslides in Seattle.

Shallow Colluvial Slide (Skin Slide)

The diagram illustrates a cross-section of a hillside. A dashed line represents the 'Ground Surface Before Slide', and a solid line represents the 'Ground Surface After Slide'. A green arrow indicates the direction of 'Slide Movement' down the slope. The soil layers are labeled as 'Sand' at the top, followed by 'Clay or Low Permeability Layer', and 'Colluvium' at the bottom. A 'Slide Runout' is shown where the material has traveled down the slope. A legend in the top right corner shows a green arrow for 'Slide Movement'. The text 'SHANNON & WILSON, INC.' and 'Not to Scale' is at the bottom left of the diagram.

December 2, 1999

A photograph showing a paved road curving to the right. Two orange traffic cones are placed on the road. The background shows a steep, vegetated hillside that has experienced a landslide, with some trees and shrubs visible.

Most landslides in Seattle (68%) are shallow slides and influenced by human activity.

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According to the Seattle Landslide Study, 68% of the landslides in Seattle are shallow and influenced by some sort of human activity.

This is an example of a shallow colluvial slide. It's also sometimes called a "skin slide" because a relatively thin layer of soil is involved. Shallow slides are usually rapid movements of saturated soil acting like a thick fluid, and they can run out over a long distance. These slides are usually caused by water that may come from rain, groundwater, runoff, or discharge from pipes.

Deep-Seated Slide

The diagram illustrates a cross-section of a deep-seated landslide. It shows the ground surface before and after the slide, with a dashed line for 'Ground Surface Before Slide' and a solid line for 'Ground Surface After Slide'. A green arrow indicates 'Slide Movement' along a 'Slide Plane' (yellow line). A blue line with downward-pointing triangles represents the 'Groundwater Table'. The soil layers consist of 'Sand' at the top and a 'Clay or Low Permeability Layer' below. A 'Scarp' is shown at the top left. A note states 'Typically More than 6 to 10 ft' deep. The diagram is credited to 'SHANNON & WILSON, INC.' and is 'Not to Scale'. To the right, a photograph shows a residential area with a landslide in January 1997, with white plastic sheeting covering the exposed earth.

January 1997

SHANNON & WILSON, INC. Not to Scale

LEGEND
 Slide Movement
 Groundwater Table

Scarp
 Sand
 Clay or Low Permeability Layer
 Slide Plane
 Ground Surface Before Slide
 Ground Surface After Slide
 Typically More than 6 to 10 ft

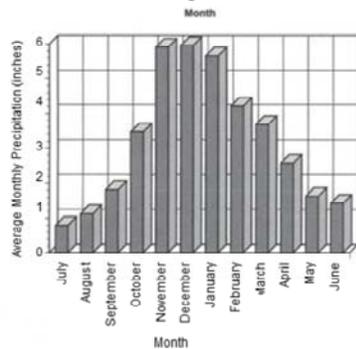
About 20% of landslides in the historical record are deep-seated slides.

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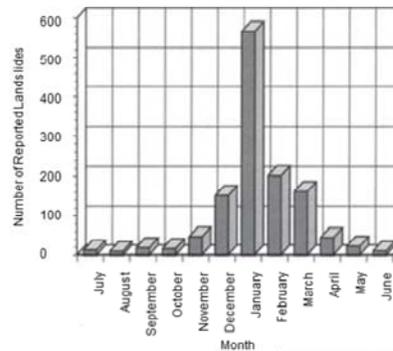
The photo on the right shows a local example of a deep-seated landslide that occurred during the 1996/97 landslide season after heavy snow and rain. In the Seattle Landslide Study, slides that involved moving soil more than 6 to 10 feet deep were categorized as deep-seated. These slides can happen quickly or they can occur gradually over days to weeks. About 20% of landslides in our historical record are deep-seated slides.

Monthly Distribution Of Landslides

Rainfall by Month



Landslides by Month



Reported average monthly precipitation is from the SeaTac station for the years 1948 through 1997. Most landslides occur in January, after soils are saturated.

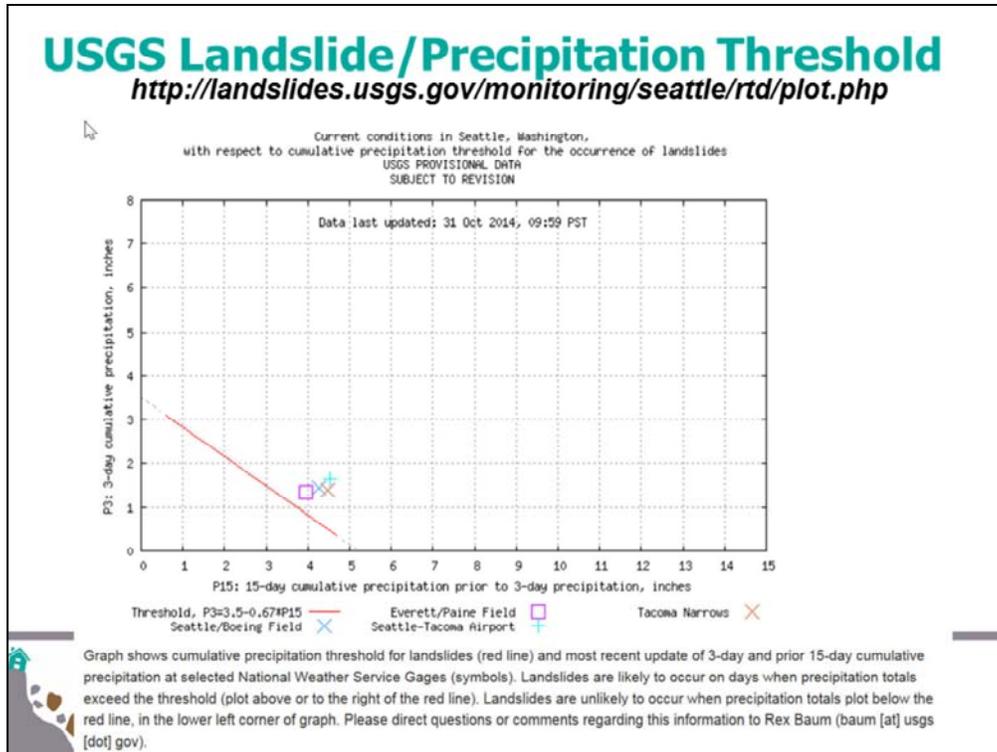
Seattle Landslide Study Seattle Public Utilities Seattle, Washington	
MONTHLY DISTRIBUTION OF LANDSLIDES	
October 1998	W-7992-04
SHANNON & WILSON, INC. Environmental and Engineering Consultants	FIG. 1-8 Sheet 1 of 2



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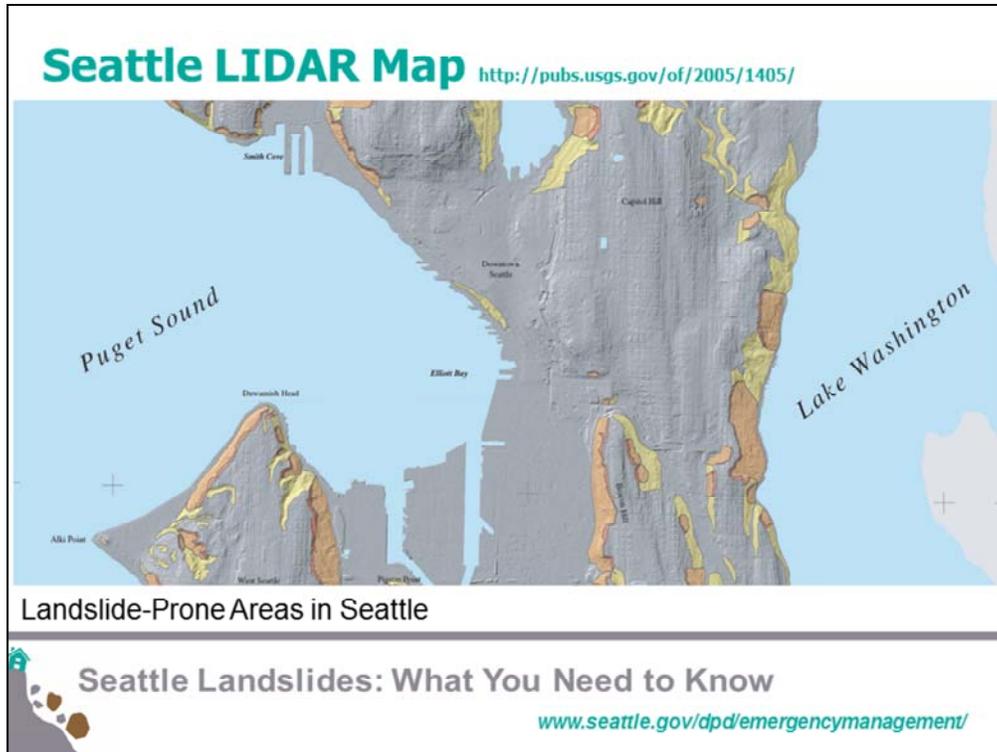
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When landslides occur is closely related to when we have significant rainfall. Our rainy season typically starts in September or October, with peak rainfall in November, December, and January. The largest number of landslides occurs in January when the soils have been saturated by rainfall in the preceding months.



Here's a tool that we use to estimate when landslides are more likely to happen. This US Geological Survey chart plots the total rainfall measured at local rain gages in the last three days versus the total rainfall in the past 15 days. Landslides are more likely to occur when the data plots above the red line.

You can access this tool at the webpage shown at the top of this figure so that you know when landslides are more likely to happen. You can also find a link to this tool on DPD's Emergency Management webpage.



Here's a map of landslide-prone areas in Seattle developed by the US Geological Survey. This map is based on LIDAR technology that maps the ground surface using laser imagery.

This map is similar to the City's Landslide Prone Area map and is also posted on our emergency management webpage.

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DEPARTMENT OF PLANNING AND DEVELOPMENT
Building a Dynamic and Sustainable Seattle
Diane Sugimura, Director

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Emergency Management - Landslides & Earthquakes

Our emergency preparedness effort has two goals:

- Protect lives during earthquakes, landslides, and other emergencies
- Restore essential services after earthquakes, landslides, and other emergencies

We count on you to be prepared. We also work with regional, state, and emergency partners to help you prepare for an emergency and to respond to an emergency.

How Are We Involved?

We ensure building safety by:

- Making sure your building meets our codes and regulations when you get a permit
- Inspecting your work during construction
- Developing a program for retrofitting unreinforced masonry (URM) buildings
- Promoting home retrofits of wood frame structures

Landslides

If your home was damaged by a landslide, you should apply for an [emergency repair permit](#).

Protect Your Home
If you think your property might be at risk from a landslide, check out our [GIS Map](#) to see if you are in a landslide-prone area and then contact a geotechnical engineering professional for an evaluation.

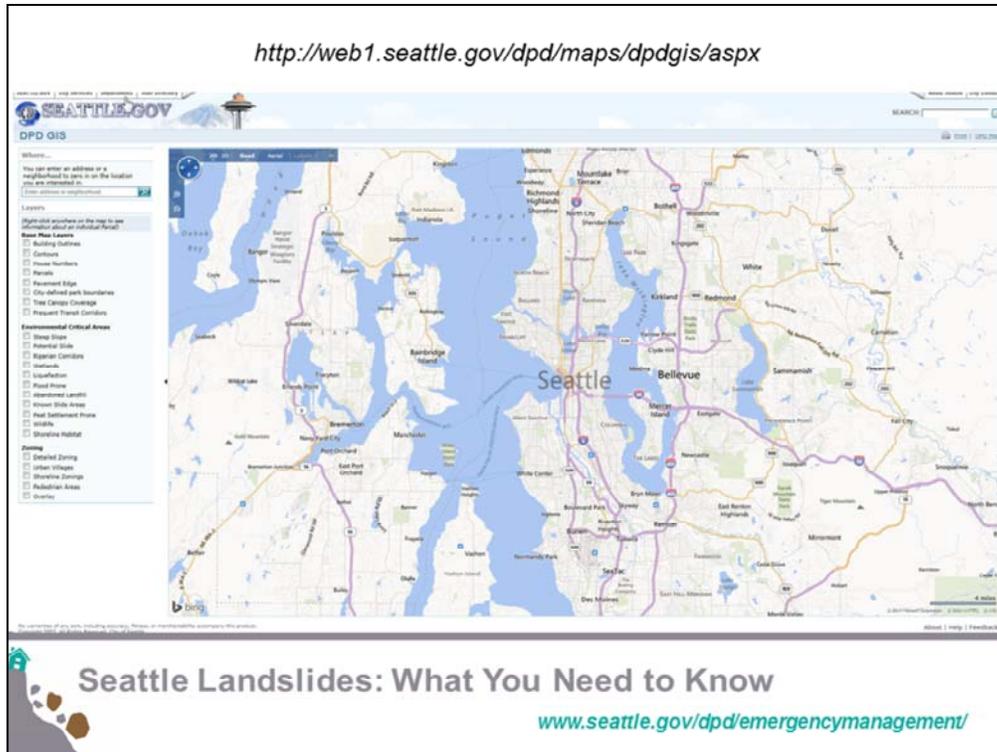
- [Landslide Dos and Don'ts](#)
- [Seattle Landslide Prone-Area Map](#)
- [FEMA Landslide Factsheet](#)
- [Tip 324, Reducing Landslide and Stormwater Erosion Damage: What You Can Do](#)

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If you want a customizable map for your property, use our interactive GIS mapping tool. Go to www.seattle.gov/dpd/emergencymanagement, then scroll down to the link for our GIS map.

<http://web1.seattle.gov/dpd/maps/dpdgis.aspx>



Type in your address on our GIS map. Under the Environmental Critical Areas category, click steep slope, potential slide, and known slide or other critical areas you're interested in. It's also helpful to click "contours" under the Base Map Layers category. Play around with the map a little and you'll get the feel for all the information available.

Do List

- Maintain drainage system (pipes, ditches, etc., on your property and keep street drains free of leaves and debris).



- Keep fill and yard waste off slopes.
- Leave stumps in the ground on slopes.
- If you have an irrigation system, shut it off and check it out seasonally.



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Real estate located atop hillsides have long been attractive to buyers for their spectacular views. But living in a landslide-prone area comes with an added level of maintenance and responsibility to help reduce the risk of landslides. If you're a resident on a site located within a steep slope or landslide prone area, there are several things you should do.

- Maintain the drainage system on your property to allow the water to flow to an appropriate discharge point. Keep your street drains free of leaves and debris.
- Keep yard waste or fill off the hillside. The yard waste or fill collects water and adds weight to the slope, increasing the risk of a landslide.
- Leave tree stumps in the ground on slopes. These stumps help hold the top soil in place, preventing erosion of the hillside.
- Turn off sprinkler systems. If there are any leaks in the system, the additional water can cause landslides.

Do List

- Direct stormwater away from steep slopes
- Check weep holes on walls and keep them open.



- Be alert during and following storms.
- Call a professional if you have questions or see a problem.



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Most important during the wetter months, make sure that stormwater is being routed to an appropriate location. As an example, inspect downspouts to verify they are functioning and directing water away from the slope. Don't direct the stormwater on the slope or near the top of a slope.

If you have a retaining wall, check that the drainage system for the wall is working. If you have weep holes—the holes at the base of the wall through which water flows--clean out the weep holes so water behind the wall can drain properly. Failure to maintain drainage systems can increase your risk of a landslide. If you notice a problem on your property, call a private geotechnical professional to evaluate the issue and find a solution to the problem.

Do List

- Perform periodic inspections of property before winter and during storms keeping safety as the #1 concern.



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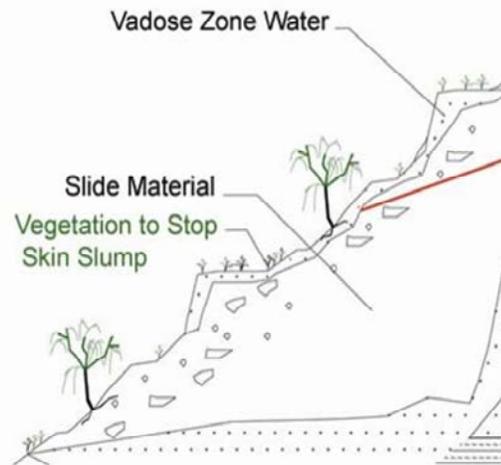
Before and during the wet season, conduct a periodic inspection of your property for signs of soil movement. Look for bulging soils at the base of slopes, cracks in the ground, and leaning trees.

Trees Are Important

Trees reduce surface erosion:

- Web of roots holds soil
- Pump water out of slope
- Reduce rate of rainwater on slope
- Reduce volume of rainwater on slope

However, trees don't prevent deep-seated slides.



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Trees and vegetation are an important part of preserving slope integrity. While they don't prevent a deep-seated slide, they do prevent surface erosion by holding the soil together and slowing the flow of rain water on slopes.

Other Question About Trees and Vegetation

- DPD Tip 331: Environmentally Critical Areas-Tree and Vegetation Overview
- DPD Tip 331a: ECA: Vegetation Restoration
- DPD Tip 331b: Hazard Trees
- <http://web1.seattle.gov/dpd/cams/CamList.aspx>

Contact Seth Amrhein (seth.amrhein@seattle.gov) with questions regarding revegetation and tree removal.



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For more information about dealing with trees and vegetation in landslide-prone areas, see DPD Tips 331, 331a, and 331b. These Tips provide a shorthand explanation of our rules and processes. For example, removing trees in landslide-prone areas is generally not allowed, but there are certain instances where it may be necessary.

You can also contact Seth Amrhein with questions at seth.amrhein@seattle.gov.

Don't List

- Don't direct storm or other water onto a slope.



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Now these are some things you should NOT do. Do not direct water onto a slope as shown in the picture on the left. Tarps like the ones in the other photo can concentrate stormwater at the edge of the tarp. Make sure that if you use a tarp that the edge of the tarp does not end at the top of or on a steep slope.

Don't List

- Don't remove vegetation on slope without a re-vegetation plan.
- Don't cut into the toe (or bottom) of a slope.
- Don't put fill or yard debris on a steep slope.
- Don't remove tree stumps from slopes.
- Don't install a permanent irrigation system in landslide-prone areas.



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You cannot remove vegetation from a landslide-prone area without a re-planting plan because exposed soil on hillsides causes soil erosion and increased landslide risk. Depending on the size of the area where you want to remove vegetation, you may have to hire a geotechnical professional.

In general, don't add water to a steep slope, don't do any digging on the slope or remove vegetation or tree stumps...items that help keep soil in place.

If you have concerns about your property

Contact a private geotechnical engineer to evaluate slope stability and drainage issues.

Firms associated with the American Society of Civil Engineers
Seattle Section Geotechnical Group

<http://www.seattlegeotech.org/firms.html>



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If you have concerns about your property and want to help prevent a slide, contact a private geotechnical engineer to evaluate the slope and drainage condition. You can find firms associated with the American Society of Civil Engineers Seattle Section Geotechnical Group at the link shown on this page.

Development Regulations for Landslide-Prone Property in Seattle

A permit is required for construction in landslide prone areas, including retaining walls and drainage systems.

More information:

<http://web1.seattle.gov/dpd/cams/CamList.aspx>



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If you need to stabilize a slope or if you want to develop near or in a landslide prone area, you need to review our codes and rules. In many cases, you will need a permit, a soils report from a private geotechnical engineer, and a topographic survey from a licensed surveyor. For more information, please refer to DPD's website.

Development Regulations for Landslide-Prone Property in Seattle

Getting a Building Permit

- Visit the Applicant Services Center on the 20th Floor of 700 5th Avenue, Seattle to get started
 - Free permit coaching offered by staff
- Call 206-684-8850 to get more information or to schedule a permit application appointment
- www.seattle.gov/dpd



Seattle Landslides: What You Need to Know

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In order to get a permit, you should first visit our website and then speak with DPD staff. We provide free advice on our regulations and permit processes at the Applicant Services Center located on the 20th floor at 700 5th Avenue.

For more information about getting a permit, visit www.seattle.gov/dpd.

Who Do You Call If a Landslide Occurs?

- If a slide occurs, **call 911** if there is a threat to life or safety
- Call SPU if a utility is impacted: 206-386-1800 (staffed 24/7)
- Call SDOT if a road is impacted: 206-386-1218 (staffed 24/7)
- Call DPD if a building is impacted 206-615-0808 (complaint line)
 - DPD building inspector responds during daylight hours
 - Provides **red/yellow/green** tag
 - Suggests next course of action-do you need a permit or private engineer?
 - Emergency stabilization (what qualifies?)
- Call Parks if the slide is in a park: 206-684-4075



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Through preventative maintenance, we hope you never have to experience a landslide. But if you do and you don't feel safe, please leave the property and call 9-1-1. You can call SPU if a utility is impacted, SDOT if a roadway is involved, DPD if a structure is involved, and Parks if it is within a park.

DPD's role is to inspect the exterior of occupied buildings on the property to determine if there is a life-safety threat. This requires an inspection during daylight hours. A DPD structural inspector may label the building if it's hazardous. You may need to hire a private geotechnical engineer to evaluate the slope or obtain permits to stabilize and repair the building.