

A HOMEOWNER'S GUIDE TO LANDSLIDES

Overview

While we hear about devastating mudslides in California, Allegheny County and Southwestern Pennsylvania experience a far greater number of landslides each year. With rare exceptions, these slope problems never make the news. Although smaller than their California counterparts, each individual slide has the potential to cause excessive damage and financial loss. The purpose of this document is to help educate property owners about landslides.

Types of Landslides

A landslide is defined as any movement of a mass of rock, debris, or earth down a slope. They can be initiated by rainfall, earthquakes, mine subsidence, changes in groundwater, and/or a wide variety of human-induced activities. Typically, landslides fall into one of the following recognized categories:

- *Earth Flow (Mudslides)* – Materials move downslope as a viscous fluid. This material can travel a significant distance from the source if it is sufficiently wet or water driven.
- *Slump* – Soil or rock masses move downslope in one or more slippage events, leaving a series of scarps as evidence. This type of slide typically remains close to the point of origin, and can resemble a series of steps on the slope.
- *Debris Slide* – This is a combination of the prior two slide types described, where the slide material breaks apart during movement, leaving a major scarp face and a large debris pile of irregular shape. The material can move a moderate distance, depending upon the shape of the land below the slide.
- *Rock Fall or Topple* – A rockfall or topple involves material dropping and/or tumbling down a slope. Each of the pieces usually falls independently through the air, and can travel moderate distances depending upon the size, shape, and height of fall at a particular site.
- *Creep* – This is the slow, almost imperceptible movement of soil and rock material downslope. It is best identified by visual indicators, such as tilted trees, posts and poles that are no longer vertical, displaced retaining walls, and minor bulges and depressions that change the contour of the land.

Common Terms

Some common terms used to describe landslide events include:

- *Scarp* – A near vertical face that defines the upper edge of a landslide event. Can vary in size based on slide.
- *Head* – The upper limit of movement of the slide material.
- *Transverse or Tension Cracks* – Horizontal cracks in apparently unaffected land above the scarp or head. These are signs of potential new movements that could occur. Common in all landslides when a scarp remains.
- *Foot* – The bottom of the actual failure zone. This will typically be hidden by the slide debris.

- *Toe* – The bottom limit of movement of the slide material. This includes any landslide material that may travel overtop of stable materials.
- *Residual Material* – Soil that is in its derived location overlying the parent bedrock material.
- *Colluvial Material* – Soils that have been deposited in their present location by the effects of gravity. (i.e., historical landslide)
- *Alluvial Material* – Soils that have been deposited in their present location by water.
- *Fill* – Any material, earthen or artificial, placed by man to alter the topography.
- *Redbeds* – A unique rock formation in Southwestern Pennsylvania that is strong when dry but crumbles when exposed to weather. The soils derived from this rock are also strong when dry, but very weak when wet.

Causes of Landslides

The classic causes of slope failure (landslides) involve one or more of the following:

- *Excess Load* at or near the top of the slope. Human activity and/or natural events can cause additional load to be placed in locations where the ability of the slope to support the weight is exceeded, causing a landslide.
- *Removal of the Toe* – If human activity or natural events such as erosion remove the toe or bottom of a slope, this loss of support can trigger a landslide event. The landslide will start to develop when the internal strength of the slope can no longer compensate for the loss of support at the toe. A minor excavation activity at the toe of a slope could trigger a major landslide event.
- *Water* – The presence of water within or overtop of a slope can have a number of effects on a slope, each with the capability of triggering a landslide. Saturated soils can lose their strength, making them incapable of supporting existing loads. The weight of water can add additional pressure (load) to the slope. Ice lenses during the winter can physically separate soil and rock, leaving the soil weaker or creating enough movement to trigger a landslide. Water flowing over the surface can saturate the soil and cause erosion, including slope movements from multiple issues.

A slide will stop when all the forces involved return to a delicate balance. And it is truly a *delicate* balance. If one force is exceeded, additional movement may occur.

Indicators of Slope Instability

There are a number of signs to look for that can be indicative of slope stability issues:

- *Hummocky ground* – These are low mounds that are irregularly spaced around the toes of prehistoric and even recent landslide areas. This is an indicator that the upslope area (old landslide deposits) could move again if the right conditions develop.
- *Bulging earth* – This is another visual indicator of slope change, similar to the hummocky ground described above. However, this is indicative of new or ongoing movement.

- **Seeps** – When excess water is present in a slope, it will sometimes try to find its way to the surface. This can indicate that the slope area above the seep is saturated and ready to fail. The water can also cause the downslope area to become saturated and ready to fail.
- **Cracks in the ground** – Cracks, particularly running parallel to a slope, are indicators of stress relief and subtle movement of a slope. In winter, these cracks have also appeared in the overlying snow, if the movement is significant enough.
- **Tilted utility poles, and taut or sagging wires** – These poles are typically put in vertical and in line when new. Any changes to this can indicate ground movement.
- **Tilted or bowed trees** – Trees like to grow vertically towards the sun, when possible. Like telephone poles, tilted trees can indicate a displacement of the slope. Bowed trees indicate that the ground is moving very slowly, which gives the trees time to try to straighten up as they grow. *Note: in a heavily wooded area, this can be deceiving. Trees will grow toward a light source, which can cause irregularly-shaped trunks. Also, trees can be affected by the effects of wind, further distorting their growth.*
- **Distorted retaining walls** – Retaining walls that show signs of distress or distortion are indicative of their inability to properly support the slope. Upslope areas may continue to move until the wall completely fails.
- **Cracks in building walls and foundations** – Slope movements can first show up in homes as cracks through the foundation or the walls of buildings. Doors and windows that jam can also be indicators that the slope movement is placing stress on the structure. *Note: These signs should be considered in conjunction with other indicators. These problems can also be caused by poor construction, settlement, or mine subsidence. Doors and windows can jam due to moisture conditions, poor maintenance, and dry rot. This is the least reliable primary indicator of a slope problem on a property.*

What You Should Do:

Here are some common things you can do as a homeowner to help prevent landslides on your property:

- **Consult** with a geotechnical engineer or engineering geologist prior to construction near a slope. This professional should be able to advise you regarding the conditions of your slope, and what construction measures may be necessary for your project.
- **Beware** of working on slopes greater than 15%. The steeper the slope, the greater the possibility of a landslide. Many municipalities have “steep slope” ordinances controlling development on slopes 25% or greater, and prohibit construction on slopes 40% or greater.
- **Don’t** place fill or debris near the top of a slope, especially to try to enlarge a backyard. This includes, but is not limited to, dumping yard wastes “over the hill.” Over time, even this little bit of weekly or seasonal debris can build up weight, which could aid in the failure of a hillside. Likewise, build away from the

- top of slopes when possible. Structures (homes, garages, sheds, etc.) placed close to the top of the slope add to the load.
- **Don't** dig out the bottom of the slope to enlarge your yard. The loss of support could cause the hillside to come down on you and your property.
 - **Don't** discharge water over the slope. Many homes have their downspouts and yard drains, as well as runoff from driveways, directed over the hill. Over time, this both saturates the soils and causes surface erosion. All flows should be directed away from the slopes, or conveyed in a pipe over the slope to a good discharge point, such as a storm water system or a natural stream.
 - **Avoid** constructing swimming pools at the top of a slope. The filled pool can add a lot of weight – a 24 foot diameter, 4 foot deep pool can add over 56 tons of weight to a slope when filled. Also, even a minor leak can saturate the slope. A significant number of slope failures can be traced to swimming pool issues.
 - **Report** water line, storm sewer line, and sanitary sewer line leaks to the proper authorities when they are first observed. These water sources can saturate a slope, and have been the cause of a number of failures in slopes that were otherwise stable.
 - **Don't** remove vegetation from a slope. Trees and shrubs on a slope can absorb a large amount of water, and the root systems are good at stabilizing soils on a slope. Dead root systems, once they decay, can weaken the slope, in addition to allowing more water to reside in the soil.



Slate Street slump – note how it has covered a part of the road



Flowers Avenue Wall – building on a retaining wall can lead to the failure of the wall and the hillside, resulting in serious damage to buildings and properties above and below the hill.



Oakland Square – building too close to a steep slope can be dangerous if that slope fails, as it has in this case



Doerrville Road – building on an unstable slope can cause even lightweight structures (like a road) to fail