

# Streambank Erosion

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## What is Streambank Erosion?

Streambank erosion refers to the removal of soil and other material, such as rock and vegetation, from the streambank (Figure 1). Streambank erosion is a naturally occurring process, but the rate at which it occurs is often increased by anthropogenic or human activities such as urbanization and agriculture. Changes in land use can cause streambanks to erode at rates much faster than those seen in natural, undisturbed systems.

## What Causes Streambank Erosion?

Streambank erosion occurs when the driving forces of water (hydraulic) and gravity (geologic) are greater than the ability of the streambank to resist them, thus resulting in a failure. A hydraulic failure occurs when the flowing water from the stream directly hits the streambank (Figure 2). A geologic failure occurs when an overhanging bank collapses due to gravity (Figure 3).

Activities both at the watershed (large-scale) as well as the stream or reach scale (small-scale) can cause streambank erosion to occur. Urbanization is a large-scale activity that results in an increase in the amount of impervious surfaces such as parking lots, buildings and roads within a watershed. Impervious surfaces prevent water from infiltrating or soaking into the soil so more rainfall during storm events becomes runoff, which in turn flows to streams. Consequently, streams in urbanized watersheds transport a



Photo: Carmen Agouridis

**Figure 1.** Streambank erosion occurs when soil is removed from the banks.



Photo: David Collett, University of Kentucky, Robinson Center for Appalachian Resource Sustainability

**Figure 2.** Hydraulic failures occur when flowing water erodes streambanks.



Photo: Matthew Peake, University of Kentucky, Animal Research Center

**Figure 3.** The collapse of overhanging banks is an example of a geologic failure.

much larger volume of stormwater than streams in undeveloped watersheds. Larger volumes of stream flow mean that the waters in these streams are deeper. Deeper waters mean increased levels of stress on the bed and banks, which in turn means higher stream-bank erosion rates.

At the reach scale, streambank erosion is increased largely by activities that impact riparian vegetation, soil stability, and channel sinuosity. Riparian vegetation with dense roots that extend the full length of the stream bank offers the greatest protection against streambank erosion. Mowed grasses offer little protection as their roots are typically short. Livestock and vehicles entering and exiting streams can accelerate streambank erosion (Figure 4), so stream crossings should



Photo: Carmen Agouridis

**Figure 4.** Livestock trample streambanks, so their access to streams should be controlled.

be constructed. Changes in channel sinuosity or curviness can occur naturally or may be human induced. For example, the practice of straightening streams increases streambank erosion. Streams may be straightened to increase the accessibility of lands (such as moving a stream to the side of a hill or removing meanders or bends), but the practice often results in a shorter stream. Since the same drop in elevation must occur over a shorter distance, the stream becomes steeper, which in turn increases stress on the stream's banks and bed and thus streambank erosion.

### Why Is Streambank Erosion Problematic?

Streambank erosion is problematic for a number of reasons. When streambanks erode, valuable land, such as crop or livestock fields, is lost. Critical infrastructure such as bridges, roads, and underground utilities may be damaged (Figure 5). Eroding streambanks are often a safety concern for humans, livestock and wildlife (Figure 6). Overhanging banks can collapse from the weight of a person or animal. Streambank erosion also negatively impacts water quality largely by increasing the amount of suspended sediment in the stream water. When suspended sediment levels in streams are high, aquatic life suffers as the amount of suitable habitat is reduced. Suspended sediments cause the water to become turbid or cloudy making it difficult for aquatic life such as fish to breathe and find food. When sediments begin to settle out, they can cover and fill in the spaces around rocks, reducing the places aquatic life can live and reproduce. Studies have shown that streambank erosion accounts for a large portion of the suspended sediment load in streams, in some cases as much as 90 percent.



Photo: Jim Hanssen, EcoGro

**Figure 5.** Streambank erosion threatens infrastructure.



Photo: Eric Dawalt, Ridgewater, LLC

**Figure 6.** Streambank erosion can pose a safety hazard.

## How Are Streambanks Stabilized?

Streambanks are stabilized largely through one or a combination of the following methods: 1) providing floodplain access, 2) establishing a dense cover of deep-rooting riparian vegetation, and/or 3) redirecting stream flows away from the streambanks and towards the center of the channel.

### Floodplain Access

One of the main reasons streambank erosion occurs is a lack of floodplain access. Streams with low levels of streambank erosion often have good access to their floodplains (Figure 7). This means that the waters in the channel regularly, typically once per year on average, spill out onto the adjacent lands or floodplain. Such streams have low bank heights, meaning that water depths and hence stress remains low. For streams with high banks, floodwaters rarely escape the confines of the channel. Such streams are considered incised (Figure 8). Because waters become deep with incised channels, stresses and erosion potential are high.

One way to reduce streambank erosion is to create floodplain access. For streambank stabilization projects, floodplain access is often created by excavating a small floodplain (Figure 9). In some instances, large-scale efforts such as stream restoration are needed. Stream restoration involves the re-establishment of the structure and function of a stream as closely as possible to pre-disturbance conditions (Figure 10).



Photo: Carmen Agouridis

**Figure 7.** Streams with good floodplain access have less potential for erosion.



Photo: Carmen Agouridis

**Figure 8.** Streams with poor floodplain access have a high potential for erosion.



Photo: Carmen Agouridis

**Figure 9.** Excavating a new floodplain is one way to create floodplain access along the stream.

**Figure 10.** A stream before (a) and after (b) restoration.



Photo: Eric Dawalt, Ridgewater, LLC

(a)

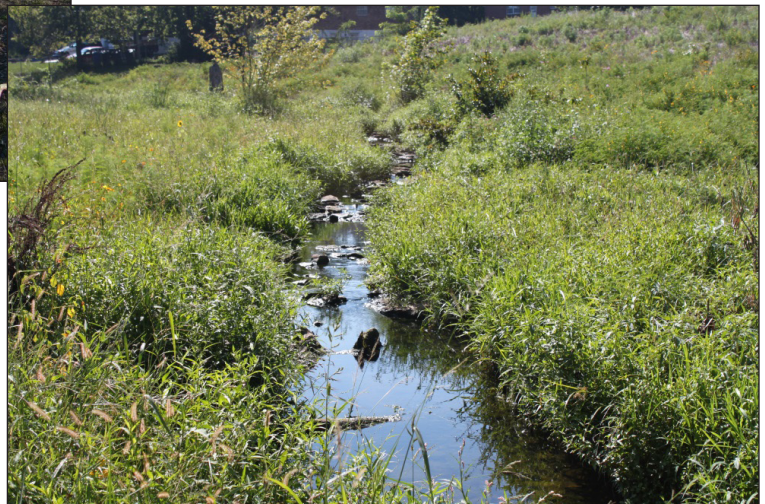


Photo: Carmen Agouridis

(b)

## Riparian Vegetation

Riparian zones or buffers are sections of land that border water bodies such as streams, rivers and ponds. These zones serve as the transition from the aquatic environment to the uplands or terrestrial environment. While riparian buffers can consist of one vegetation community, often riparian buffers include a zone of fast-growing and water tolerant trees (Zone 1), a zone of shrubs (Zone 2), and a zone of grasses and forbs (Zone 3).

A common and cost-effective method for reducing streambank erosion is to plant vegetation with deep, thick root systems such as trees in riparian zones, especially along the streambanks. Some vegetation, such as dogwoods and willows, can be planted using live stakes. Live stakes are dormant, unrooted plant cuttings that can be driven into the streambank. Once planted, they will begin to develop roots. Due to their low cost and ease of implementation, live stakes are an attractive option for landowners seeking to reduce streambank erosion. Another option is to use containerized plants, though the cost is higher.

## Live Stake Planting

A live stake is a piece of live hardwood material from a woody species of plant. Live stakes are cut to specific lengths depending on soil and site conditions but should be at least 0.5 in. (1.3 cm) in diameter and 18 in. (46 cm) in length. When harvested, the plant material is usually in a dormant state. When selecting live stake species, a quick growth rate and a dense root mat are essential. Commonly used species include black willow (*Salix nigra*) and silky dogwood (*Cornus amomum*). Live stakes are often planted on the outside of meander bends where shear stress is highest.



Photo: Christopher Barton, University of Kentucky, Department of Forestry

## Streambank Soil Bioengineering

Streambank soil bioengineering is the practice of using plant material (living and nonliving) to stabilize streambanks (Figure 11). Both engineering practices and ecological principles are used as the plant material provides structural support as well as habitat benefits. Because of the use of plant material, streambank soil bioengineering is often referred to as “soft” engineering. The *National Engineering Handbook* contains detailed information on a variety of streambank soil bioengineering techniques. For additional information on streambank soil bioengineering, contact your local University of Kentucky Cooperative Extension Service office or Natural Resources Conservation Service (NRCS) office.

## Hard Engineering

“Hard” engineering, often termed armoring, refers to the practice of stabilizing streambanks using hard structures made of rock, concrete or metal. Examples of hard engineering techniques include rip-rap and gabion baskets. Rip-rap is large rock that is placed on the streambanks to prevent bank erosion (Figure 12). Gabion baskets are wire baskets that are filled with rock (Figure 13). Because gabion baskets hold the rock in place, they are used when the available rock material is too small to withstand the erosive power of the stream. Because of the amount of rock, concrete and/or metal required, hard engineering techniques are often costly to install and maintain. Unlike soft engineering, hard engineer-

ing techniques offer little in the way of habitat improvement.

## Instream Structures

Instream structures help reduce streambank erosion by redirecting the flowing water away from the streambanks and toward the center of the channel. Examples of instream structures include vanes such as cross-vanes, single vane arms, and J-hooks (Figure 14). Such structures are often constructed using large rock, although logs can be used. The *National Engineering Handbook* contains detailed information on instream structures. For additional information on instream structures, contact your local University of Kentucky Cooperative Extension Service office or Natural Resources Conservation Service (NRCS) office.

## What Technical Expertise Is Needed?

Reducing streambank erosion can be a complex process requiring an understanding of engineering, hydrology, hydraulics, soils, vegetation and construction management. Therefore, landowners should consult their local University of Kentucky Cooperative Extension Service office or Natural Resources Conservation Service (NRCS) office for assistance.

## Are Permits Required?

Prior to grading streambanks or installing instream structures, it is important to determine if any federal, state or local permits are required. Contact the U.S. Army Corps of Engineers to inquire about any necessary federal permits. Contact the Kentucky Division of Water regarding state-level permits in Kentucky. Consult local agencies such as city and/or county governments regarding local permit requirements. Note that the permitting process can take several months to complete.



Photo: Jim Hanssen, EcoGro

**Figure 11.** Streambank soil bioengineering uses living and nonliving plant material to stabilize streambanks.



Photo: Carmen Agouridis

**Figure 12.** Rip-rap is a common form of "hard" engineering to reduce streambank erosion.



Photo: Matthew Burnette

**Figure 13.** Gabion baskets are wire mesh baskets filled with rock.



Photo: Carmen Agouridis

**Figure 14.** Instream structures such as this cross vane help reduce streambank erosion by redirecting flows to the center of the channel.

## Further Reading

*Stream Crossings for Cattle* (AEN-101)

*Restoring Streams* (AEN-122)

*Living Along a Kentucky Stream* (IP-73)

*Planting a Riparian Buffer* (ID-185)

*Planting Along Your Stream, Pond, or Lake* (HENV-202)

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