Chapter 14

Stabilization of Gullies

"A gram of erosion control and gully stabilization can prevent a kilogram of sediment loss."

GULLIES ARE A SPECIFIC FORM OF SEVERE EROSION typically caused by concentrated water flow on erosive soils. *Figure 14.1* shows a typical gully on a hillside and how it can impact a road and land use. Concentrated water flow may begin as minor sheet flow, produce rills, and eventually result in major gully formation. Gullies can have major impacts on an area by taking land out of production and by lowering the groundwater table, as well as being a major source of sediment (*Photo 14.1*). They can be caused by concentrated water flowing off roads, or they can impact roads by necessitating extra drainage crossings and more frequent maintenance.

Once formed, gullies typically grow with time and will continue down-cutting until resistant material is reached. They also expand laterally as they deepen. Gullies often form at the outlet of culverts or cross-drains due to the concentrated flows and relatively fast water velocities. Also, gullies can form

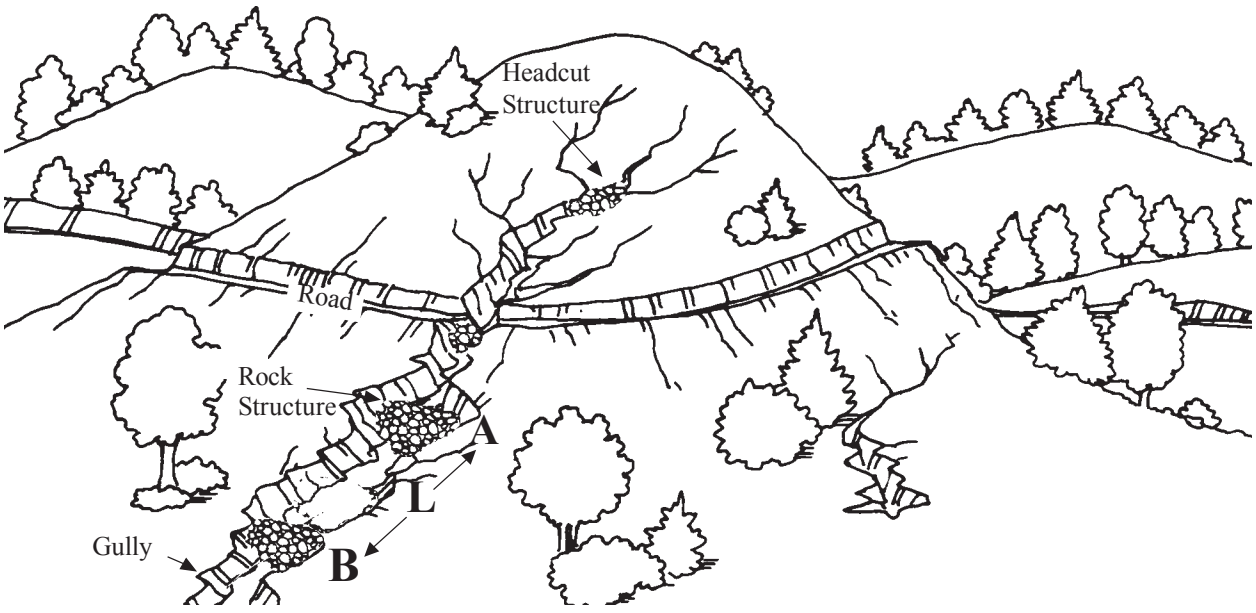


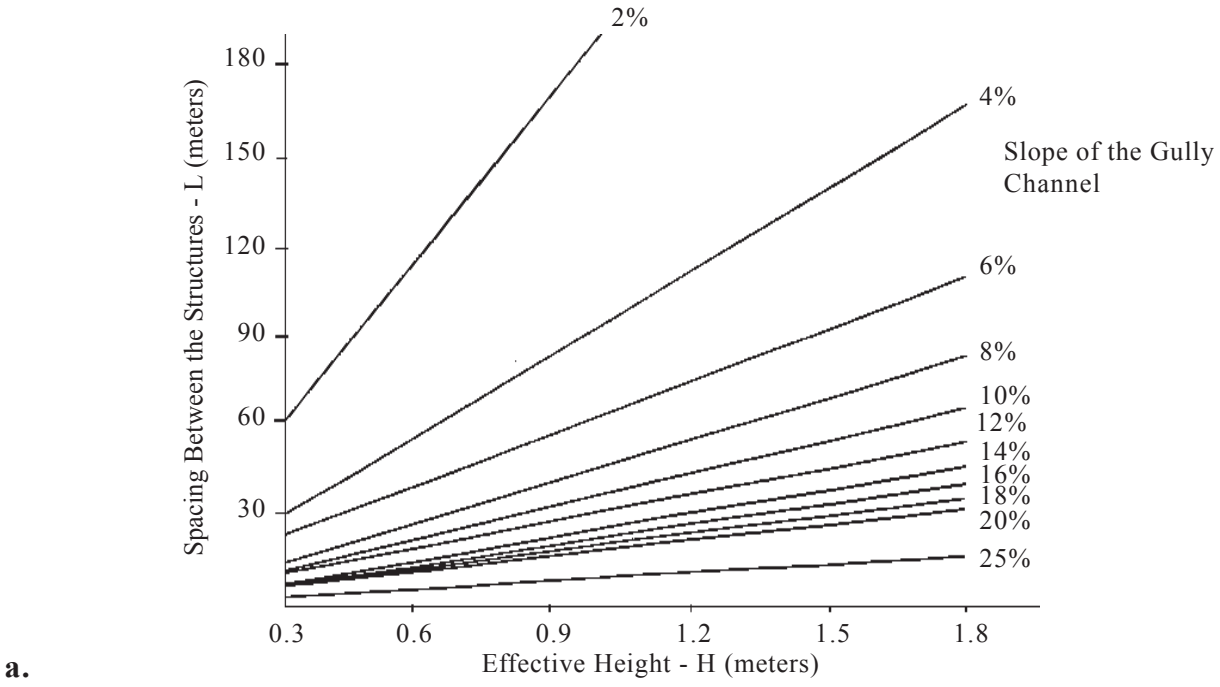
Figure 14.1 A gully caused by or impacting a road.

Photo 14.1 A typical gully caused by concentrated water on erosive soils and/or poor land use practices.

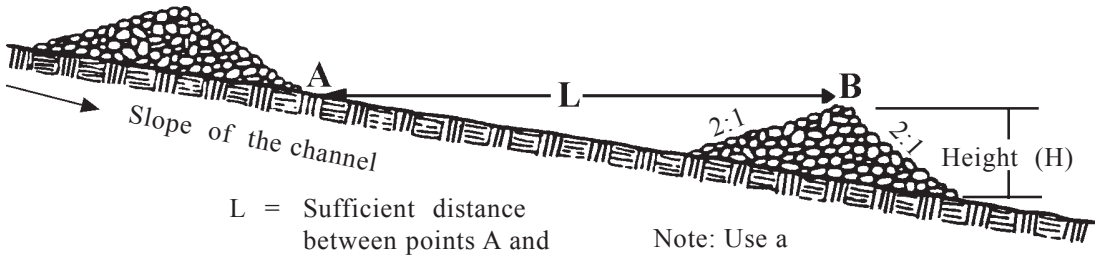
upslope of culvert pipes, especially in meadows, if the pipe is set below the meadow elevation. This causes a drop in the meadow or channel elevation and subsequent headward migration of the gully. Gullies formed through meadows often lower the local water table and may dry up the meadow.

Stabilization of gullies typically requires **removing or reducing the source of water** flowing through the gully and refilling the gully with dikes, or small dams, built at specific inter-

Figure 14.2 Spacing details of gully control structures. *(Adapted from D. Gray and A. Leiser, 1982)*



a.



L = Sufficient distance between points A and B so that the two dams have the same elevation (toe to top).

Note: Use a slope of 2:1 or flatter for rock dams structures.

b.

vals along the gully. Reshaping and stabilizing over-steep banks may also be needed. Typical gully stabilization structures are constructed of rock, gabions, logs (*Photo 14.2*), wood stakes with wire or brush, bamboo, or vegetative barriers. Biotechnical methods offer a combination of physical structure along with vegetative measures for physical protection as well as additional long-term root support and aesthetics. A headcut structure also typically is needed to stabilize the upslope, or top-most portion of the gully, and prevent additional headward movement (see *Figure 14.1*).

The recommended spacing for structures depends on the slope of the terrain or gully channel and the height of each structure, as presented in *Figure 14.2*. *Figure 14.2a* shows the ideal spacing needed between structures for varying channel slope and structure height. *Figure 14.2b* shows the physical relationship between structure height and spacing in a sloped channel so that water and material stored behind the lower structure is level with the toe of the upper structure. Thus, water will spill over the crest of the upper structure into the pool behind the lower structure.

In gully prevention, **a "gram" of erosion control measures can prevent a "kilogram" of sediment loss** and damge caused by erosion. Take action to prevent the formation of gullies and to stabilize existing gullies before they grow larger! Once large, gully stabilization measures can be very difficult and expensive.

Photo 14.2 Logs being used to build gully stabilization structures in a fire damaged area. Physical or vegetative dams (dikes or debris retention structures) may be used to control sedmient and stabilize gullies. Prevent water concentration before gullies form.

SUCCESSFUL GULLY STABILIZATION

Design details important for successful gully stabilization structures begin with removing the source of water and, as shown on *Figures 14.2* and *14.3*, include:

- Having a weir, notched, or "U" shaped top on the structures to keep the water flow concentrated in the middle of the channel;
- Keying the structures into the adjacent banks tightly and far enough to prevent erosion around the ends of the structures (*Photo 14.3*);
- Burying the structures deep enough in the channel to prevent flow **under** the structure;
- Spilling the water over the structures onto a splash apron, protective layer of rock, or into a pool of water to prevent scour and undermining of the structure; and
- Spacing the structures close enough so that the flow over the structure spills into backwater caused by the next structure downstream (*Figure 14.2*).

Note: Rock commonly used in loose rock check dams should be hard, durable, well-graded with fines, and large enough to resist movement. A commonly used gradation is shown below.

Size (cm)	Percent Passing
60cm	100
30cm	50
15cm	20
6 cm	10

RECOMMENDED PRACTICES

- Remove the source of water. Control water flow as needed with ditches, berms, outsloping, and so on. to divert water away from the top of gullies.
- Use gully control check dam structures constructed of materials such as stakes, logs, gabions, or loose rock, live vegetative barriers or brush layering planted on contour in disturbed areas to control gully erosion (see *Figure 13.4b* and *Figure 14.3*).
- Install gully control structures as soon as possible after the initial formation of a gully. Gullies only get bigger with time!
- Ensure that gully control structures are installed with needed design details. Such structures should be properly spaced, well keyed into the banks and channel bottom, notched to keep flows over the middle of the structure, and protected from down slope scour (*Photo 14.4*).
- Install headcut structures at the top of the gully to prevent up-channel migration of gullies in meadows.
- Develop local plant sources and nurseries for native vegetation that can be used in gully control measures.

PRACTICES TO AVOID

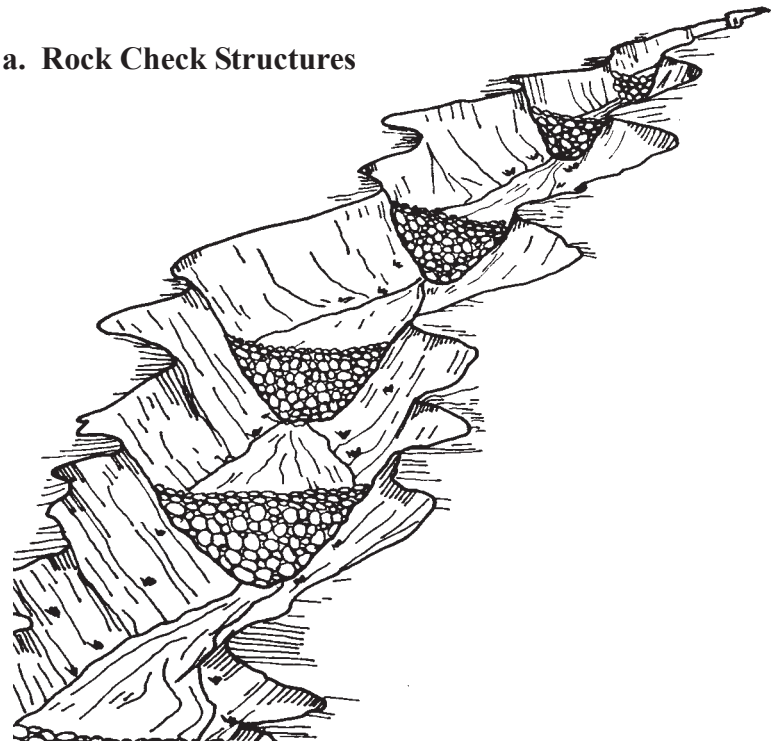
- Leaving gullies unprotected against continued erosion.
- Installing check dam structures with a straight, flat top, without scour protection, and without being well keyed into the banks.

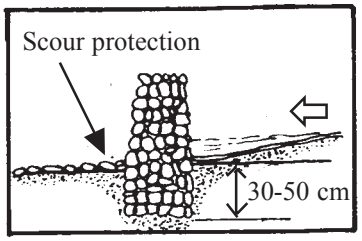
Photo 14.3 An expensive but failed gabion gully control structure that was not properly keyed into the banks of the gully. Further, the flow was not kept over the protected middle of the structure.

Photo 14.4 Construct debris retention and gully control structures with a notched wier to keep flow over the middle of the structure, add scour protection at the outlet of each structure, and key the structures into the firm soil banks.

Figure 14.3 Stabilization of gullies and severe erosion areas with check structures.

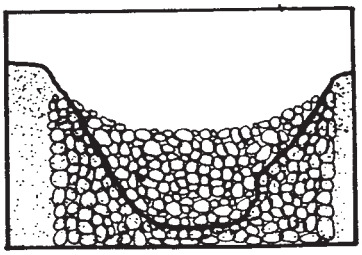
a. Rock Check Structures





Side View

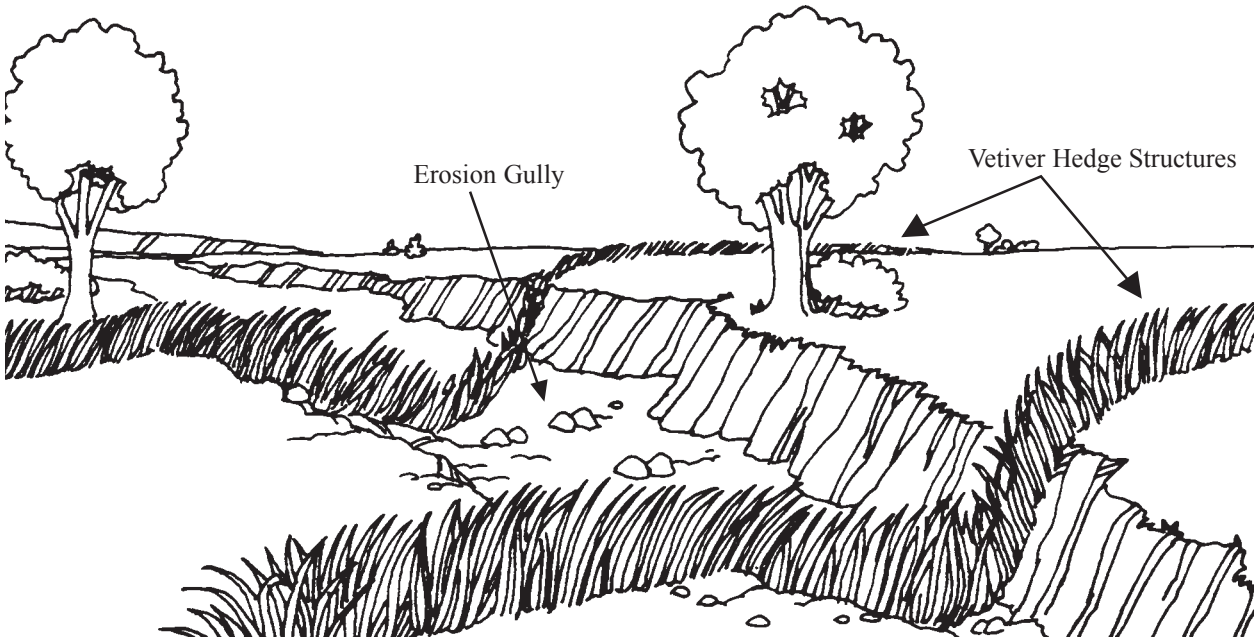
Key check structure into the native soil at the base of the gully. Add scour protection below each structure.



Front View

Key into native soil banks. Maintain a "U" or "V" shape over the top of the check structure.

b. Vegetative Check Structures (Adapted from Vetiver Grass. "The Hedge Against Erosion," World Bank, 1993.)



Depicted above is a loose rock gully control structure being used to stop headcutting up into the meadow. Note that the rock structure is well keyed into the banks and channel bottom.