Forestry Note:

SIDE-GULLY CONTROL

Using Trees, Hand Labor, Rock and Other Materials

Introduction

This Forestry Note describes low-cost structures and practices for controlling side-gullies and headcuts in large gully systems. Forestry Services applied and tested these practices on large gully systems in Tillman and McClain counties in Oklahoma.

On large gully systems in deep sandy soils (Figures 1 and 2), lateral or side headcuts or overfalls frequently develop where small side drainages flow over the rim of the main gully. Where considerable runoff occurs, side gullies soon develop from these headcuts or overfalls. In such cases, control of the upper side gully as well as the headcut is needed.

Figure 1. Large gully near Grandfield in Tillman County. This gully system is about 2 miles long, 70 feet wide and 18 feet deep at this location.

Because they are deep, these side gullies will continue to grow by sloughing and by headcut erosion (Figure 3), resulting in loss of soil and damage to streams and water quality. The main factor affecting growth is the size of the drainage area. Drainage areas for the side headcuts on the two gully systems vary from less than one to about 15 acres.

Figure 2. Large gully in McClain County caused by advance of a deep headcut in Stinson Creek channel

Figure 3. Side gully with sloughing sides and deep headcut on the Tillman County gully. This gully drains about three acres of the field in the background.

Side gullies with small drainage areas and shallow headcuts can be controlled by a number of practices or practice combinations, including tree planting, livestock exclusion, diversion of runoff water, shaping and applying fiber mat and single cattle panel structures (Figures 4 and 5). (For information on these practices, see the video entitled *Gully Control Using Fiber Mat and Trees* and Forestry Notes on these techniques.)

Figure 4. Small gully with shallow headcut in Tillman County controlled by applying fiber mat and planting black locust trees

Figure 5. Lower part of a small gully on the Tillman County system, controlled by installing a curved cattle panel with T-posts and planting black locust trees

However, controlling deep side headcuts and gullies having larger drainage areas presents substantial costs to landowners. Commonly used treatments that involve extensive shaping with heavy equipment or installation of drop structures are expensive.

This Forestry Note describes three examples of alternative experimental control treatments using trees, hand labor, rock and other materials with minimal use of heavy equipment. Depending on availability of hand labor and cost of rock, these alternatives may be less expensive. These treatments can be effective on drainage areas that are relatively flat and up to about 15 acres in size.

Example 1: Rock Gabion Drop-Structure

This practice, consisting of two rock-gabion drop-structures, a rock-lined chute and tree planting, was applied on a side headcut and gully on the Tillman County large gully system. A gabion is a rock-filled fence-like structure intended to absorb the force of flowing water, allowing sediment to settle out, stabilize cut-banks and reduce soil erosion.

This gully represents a typical condition, having a lower, deep headcut and shallow headcuts in the upper arms of the side gully (Figures 6a and 6b). The watershed area is about five acres in size.

Figure 6a. Lower headcut of Example 1 side gully

Figure 6b. Upper part of Example 1 side gully, looking toward the main gully

Figure 7 presents the treatment design and the locations of the structures and upper and lower headcuts. The structures control the flow of water and eliminate erosion in the main part of the side gully. The chute and the lower drop structure eliminated the lower headcut and should prevent any further down cutting in the lower part of the gully.

The upper gabion drop-structure prevents further down cutting and promotes accumulation of sediment and vegetative growth in the upper part of the gully.

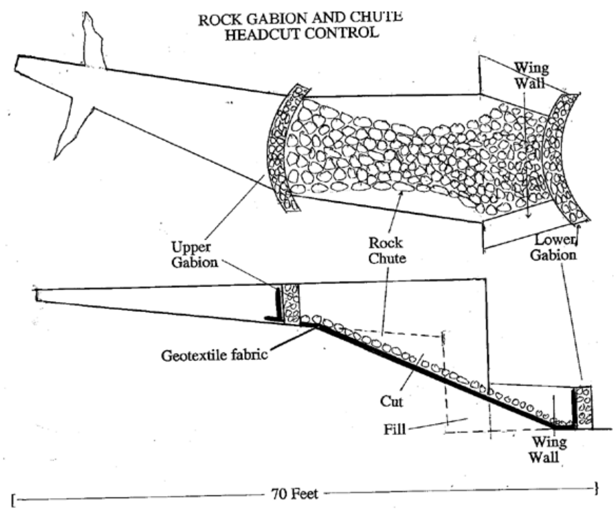

Figure 7. Example 1 control design showing upper and lower headcuts and structures

Constructing the Lower Drop Structure

This gabion was constructed by placing two 4 by 16 foot cattle panels parallel and about 18 inches apart in a bowed or curved shape. The outside of the curve was positioned to face uphill. The panels were held in place by steel T-posts and tied together with wire to prevent them from separating (Figure 8a).

The space between the panels was filled with rock by hand labor. The rock purchased for the treatment was non-select riprap, 18 inches maximum diameter. Smaller rock in the range of about 6 to 8 inches maximum diameter were picked and placed by hand in the gabion.

The rock fill is lower in the middle of the gabion to provide a spillway for high flows. An apron of larger rock was placed below the gabion (Figure 8b). The upper side of the gabion is lined with geotextile fabric.

Figure 8a. Constructing the lower gabion drop structure

Figure 8b. Completed lower gabion with apron

Wing Wall Construction

Wing walls from the ends of the gabion to the main gully wall were constructed with soil, using shovels.

The wing walls were covered with burlap anchored by sandbags. The wing walls and surrounding area were planted with black locust seedlings at a close spacing (Figure 8c).

Figure 8c. Lower gabion with wing walls completed and black locust seedlings planted

Chute Construction

The chute was constructed by first cutting down the lower headcut and gully sides, using shovels, to form a flat-sloping bottom. The slope of a chute structure should not exceed 1.5 to 1 (that is 1.5 feet of horizontal distance to a one-foot rise). The slope of the chute is 1.5 to 1 in the steepest part.

The entire chute area was lined with geotextile fabric before placing the rock. The fabric is necessary to prevent channeling of runoff water between and under the rocks causing failure of the chute. A six-inch layer of smaller rock was placed on the fabric with shovels (Figure 9a).

Figure 9a. Chute with geotextile fabric and small rock placed

Larger rocks ranging from about 8 to 18 inches maximum diameter were placed by hand to complete the chute (Figure 9b).

Figure 9b. Completed chute with large rock placed

Upper Gabion Construction

The upper gabion was constructed in the same way as the lower gabion. Notches were cut to tie the ends of the gabion into the gully walls (Figure 10a and 10b). Geotextile fabric was applied to the upper side of the gabion and gully bottom, and then was covered with soil (Figure 10c).

Figure 10a. Constructing the upper gabion

Figure 10b. Completed upper gabion and upper part of chute

Figure 10c. Upper gully area and completed upper gabion. Note geotextile fabric and soil cover on the upper side of the gabion.

Tree Planting

The treatment included the planting of black locust trees next to the structures and on the areas adjacent to the gully (Figures 11 a-11d). Figure 11a is a view of the black locust trees and other vegetation in the vicinity of the lower gabion in the summer following planting. Figure 11b is a view of the trees next to the lower gabion in the first winter following treatment. The growing season was favorable and almost all the seedlings survived.

Figure 11a. Black locust tree growth around lower gabion, in the summer following planting

Figure 11b. Tree and other growth around lower gabion in the first winter

Figure 11c. Tree growth below upper gabion, in the first winter following treatment. The larger trees are 5 years old.

Figure 11d shows vegetative development and sediment build-up in the upper gully, in the winter following treatment. In Figure 11c, the tree plantings are 1 and 5 years of age. The upper, shallow headcuts will heal through continued sediment accumulation, vegetative growth and livestock exclusion.

Figures 11d. Tree growth above upper gabion in the first winter following treatment. The larger trees are 5 years old.

Gully Control Costs

Costs of installation are shown below.

Cost Item	Quantity	Per Unit	Cost Total
Rock (tons)	12	$20	$240
Geotextile fabric (square yards)	100	0.70	70
Cattle panels	4	12	48
Coconut fiber mat (square yards)	39	0.90	35
T-posts	16	2.75	44
Tie-wire	300	-	4
Tree seedlings	300	0.19	57
	Total cost other than labor		$498

Total cost other than labor was about $500. One hundred ten (110) hours of labor were required for the entire treatment. About the same hours were required for the chute, both wing walls and each gabion.

Example 2: Single Gabion Drop-Structure

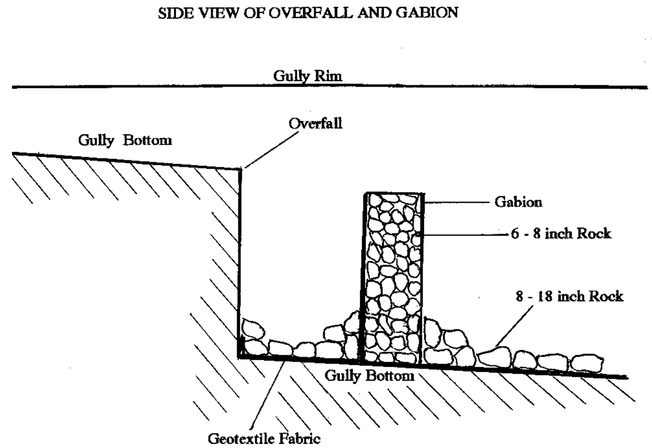

Figure 12. Example 2 control design

Using the design shown in Figure 12, a gabion drop-structure was installed below the headcut of a small branch of the Tillman County gully system (Figure 13a). The treatment consisted of shaping the gully bottom below the overfall with shovels, covering the shaped area with geotextile fabric and constructing a rock gabion and apron (Figure 13b). The gully is similar to the other two examples in general conditions of the overfall and the normal drainage. The overfall was about 5 feet in height. The normal drainage area was about 10 acres. However, the site differed from the other two examples in being subject to overflow through the emergency spillway of the main gully drop-structure.

This structure was installed along with an additional gully bottom control and tree planting to stabilize this part of the gully system in order to handle occasional emergency spillway flows within the main structure design limits (Figure 13c).

Black locust trees were planted along the gully rim and on the gully walls and bottom above and below both structures.

Figure 13a. Beginning construction on the Example 2 drop-structure

Figure 13b. Completed gabion drop-structure and apron

Figure 13c. Gully bottom control below the Example 2 drop-structure, constructed by placing cattle panels next to the gully sides and across the bottom. Photo was taken in the first growing season.

Headcut Control Costs

The estimated installation costs for Example 2 are shown below.

		Costs ($)	
Cost Item	Quantity	Per Unit	Total
Rock (tons)	3	$20	$60
Geotextile Fabric (square yards)	30	0.70	21
Cattle Panels	2	12	24
T-posts	12	2.75	33
Tie wire (feet)	150	-	2
Tree Seedlings	250	0.19	47.50
	Total cost other than labor		$187.50

The principal cost of the types of treatment in examples 1 and 2 would be labor. Twenty-five (25) hours of labor were required for this treatment. Pre-parolees of the Oklahoma Department of Corrections provided most of the labor. Hired or contract labor hours would likely be lower.

The effectiveness of this treatment could not be evaluated because both structures were washed out and the gully greatly enlarged at this location by an extreme storm runoff event through the emergency spillway of the main gully drop-structure. This storm, which had a return frequency of 2,000 years, greatly exceeded reasonable design limits.

Example 3: Rock Chute Headcut Control

This example is located on the Stinson Creek gully system in McClain County (Figure 2). The side-gully outlet is in the right background of Figure 14a. This side gully is about 70 feet long and 15 feet deep at the outlet. The gully drains about 10 acres.

This control treatment consisted of (1) shaping and sloping the upper gully area to remove the headcut steps, (2) building a chute with geotextile fabric, tires and rock to carry runoff water, (3) installing an apron of large tires to stabilize the bottom end of the chute, and (4) planting the gully area with black locust seedlings.

Figure 14a. Lower part of Example 3 side-gully on Stinson Creek system (at right side of photo). The plantings are first-year seedlings and trees in the third year of growth.

The gully tapered to a two-step headcut (Figure 14b). The upper step was about 3 feet in height. The lower step was located about 20 feet from the upper step and was about 5 feet in height.

Figure 14b. Upper end of Example 3 side-gully showing headcuts in 2 steps. Note rooting characteristics of black locust in the gully wall.

Shaping and Geotextile Application

The chute area was shaped with a backhoe to a flat bottom with a slope of about 3 to 1 (Figures 15a and 15b). The shaped bottom was then covered with geotextile fabric (Figure 15c). The fabric is necessary to prevent channeling of runoff water underneath the rock surface. To prevent water from undercutting the chute, the edges of the fabric were buried to a depth of one foot on all sides.

Figure 15a. First steps in construction on Example 3 were to shape and slope the upper gully area (note black locust saplings)

Figure 15b. The backhoe was used for final shaping

Figure 15c. Applying the geotextile fabric

Placement of Tires and Rock

Used tires were then laid on the fabric and wired together (Figure 15d). A rock surface was applied over the tires by the bucket loader (Figure 15e). The rock material is non-select riprap with a maximum diameter of 12 inches. Figure 15f is the same view after rock application.

Figure 15d. Placing and wiring the tires

Figure 15e. Completed placement of rock

Construction of Apron

Old tractor and truck tires were placed to prevent undercutting of the toe of the chute (Figure 15f). The tires will soon be covered with soil. The gully and adjacent areas were planted with black locust trees.

Figure 15f. Completed cattle panel structure and apron of tires

The apron treatment includes a 4-foot by 16-foot cattle panel structure that was installed as part of a previous treatment design. The panel is not essential to this design, but will help hold the tires in place, promote soil accumulation and stabilize the gully bottom. The panel is curved upstream for added strength. It is held in place with T-posts. The panel is lined with geotextile fabric to trap sediment and promote vegetation. The tires were tied together and to the T-posts with wire.

Control Costs

Costs of installation are presented below.

		Costs ($)	
Cost Item	**Quantity**	**Per Unit**	**Total**
Rock (tons)	3	$20	$60
Geotextile Fabric (square yards)	65	0.70	45.50
Cattle Panels	1	12	12
T-posts	4	3	12
Tie Wire (feet)	600	-	8
Tree seedlings	250	0.19	47.50
Tires	110	-	-
Labor (hours)	18	6	108
Backhoe (hours)	3	40	120
	Total Costs		$413

For this treatment design the largest single cost item will be for the backhoe, with hand labor next. The unit cost for rock would vary considerably by haul distance. Backhoe unit cost would vary by the distance and the amount of work on site.

Maintenance of Structures

The main concern in structure maintenance is to insure that runoff water does not cut around the structures where they are tied into the wing walls or gully side, particularly before disturbed soil has settled. Animal burrows can also cause failure. Examine the treatment annually for repair needs.

Management of Trees and Other Vegetation

The primary objectives in the use of trees with other practices in gully control are to accelerate and maximize stabilization and erosion control. Proper tree species, tree spacing and management of the tree stands and other vegetation are essential for long-term success. For these objectives, the use of black locust as the principal tree species is essential, because of its special characteristics.

Black locust is particularly effective in erosion control because of its hardiness, drought resistance, high seedling survival rates, rapid growth and rooting characteristics. The rapid growth improves the microclimate for early development of grasses and other surface vegetation. Black locust, a legume, also benefits other plants by fixing nitrogen in the soil. Its strong branching root system is very effective in stabilizing banks and limiting erosion (Figures 16a and 16b). The trees typically develop large lateral and downward branch roots that are several times longer than tree height, and form a network of branch roots.

While gullies are often part of a drainage system in which other tree species are desirable for other riparian area management objectives, the selection of species should be based on the primary objective. Other species can be intermixed with black locust, particularly on sites with good tree survival and growth potential. In such cases, more space is needed for the other species, and early thinning may be necessary because of the more rapid growth of black locust.

Figure 16a. Sprouting of exposed black locust roots

Figure 16b. Branching roots of a 5-year old black locust

Black locust stands may need thinning to promote and maintain ground cover vegetation. The stands typically deteriorate, often rapidly, beginning at about age 20, because of borers and *Phellinus* heart rot. When this occurs, cutting the diseased trees will promote sprouting and new root development, and rejuvenate the stand. Grazing control is essential for early development and maintenance of ground cover vegetation.

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(Above) Lower gabion on Tillman County gully during construction in 1999

(Below) Same gabion in 2006

(Above) Upper gabion on Tillman County gully during construction in 1999

(Below) Same gabion in 2006

Other Information Sources

Additional information on these gully control treatments and other gully erosion control using trees in combination with other practices can be obtained from the local offices of Forestry Services and the Conservation Districts or by calling Forestry Services at 405-522-6158. *Side-Gully Control Using Trees, Hand Labor, Rock and Other Materials* is one of a series of Forestry Notes produced by the Oklahoma Department of Agriculture, Food, & Forestry - Forestry Services Division on low-cost practices to control soil erosion. Additional Forestry Notes in this series include:

- Low-Cost Gully Control Using Fiber Mat and Trees
- Stabilizing Gully Walls and Bottoms With Deflectors and Trees

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