

INSTALLATION OF STRAW BARRIERS
AND SILT FENCES

by

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(A Cooperative Organization Sponsored Jointly by the Virginia
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SUMMARY

The most common types of temporary sediment control structures used by the Virginia Department of Highways and Transportation are straw barriers and silt fences. Based on observations made in Virginia and other parts of the nation, filter barriers have not been as effective as many users had hoped they would be. Different researchers have found that the sediment trapping efficiency of straw barriers has generally ranged from 0 to 20 percent. The reasons for the low trapping efficiencies and high failure rates of straw barriers are described. The proper installation procedures for straw barriers in ditch lines where flows not over 1 cfs are expected are stressed. The proper installation of silt fences for critical areas where siltation control is needed is also described.

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INTRODUCTION

Early reestablishment of vegetation on areas denuded by construction is generally agreed to be the most effective method of controlling accelerated erosion and sedimentation. However, regardless of how conscientious revegetation efforts may be, there still will be a critical period between the onset of land disturbance and the final stabilization by vegetation. It is during this critical period that the use of temporary erosion and sediment control structures is required.

Through the years a large number of different types of erosion and sediment control structures have been developed by agencies concerned with soil conservation and water quality. On the basis of their function, these control measures -

1. protect bare soil surfaces from water impact and runoff;
2. divert storm waters into stabilized areas;
3. impede and filter runoff; and
4. impound storm waters.

Straw barriers and silt fences serve the functions in item three, and are the most common type of temporary sediment control structures in use by the Virginia Department of Highways and Transportation.

USE OF FILTER BARRIERS

Filter barriers are structures composed of permeable material and are placed so as to intercept sheet flow and low level channel flow from denuded areas. As indicated above the function of these barriers is (1) to decrease the velocity of moving water, and (2) to trap suspended sediment. In Virginia, the materials most commonly used to construct filter barriers are straw and hay.*

PROBLEMS WITH FILTER BARRIERS

Based on observations made in Virginia (Sherwood and Wyant 1973), Pennsylvania (Weber and Wilson 1976), Maryland (Benner 1976), and other parts of the nation (Thornton 1973), filter barriers have not been as effective as many users had hoped they would be. For example, Weber and Wilson found that the sediment trapping efficiency of straw barriers in Pennsylvania was 0 to 5 percent.

Improper use of filter barriers has been a major problem. For instance, straw barriers have been used in streams and drainage ways where high water velocities and volumes have destroyed or impaired their effectiveness. Another major problem has been that improper placement of the barriers, as illustrated in Figure 1, has allowed undercutting and end flow, which have actually resulted in additions to rather than removal of sediment from runoff waters (Poché and Sherwood 1976). Finally, inadequate maintenance and cleaning efforts have tended to greatly lower the effectiveness of the barriers.

Because of the problems noted above straw barriers placed by contractors in Virginia and elsewhere have shown low trapping efficiencies and high failure rates. On one project in Virginia, only 2 of 12 straw barriers installed in the side ditches were found to be effective in trapping silt. Observations statewide

*Barriers composed of straw and hay bales are commonly referred to collectively as "straw barriers".

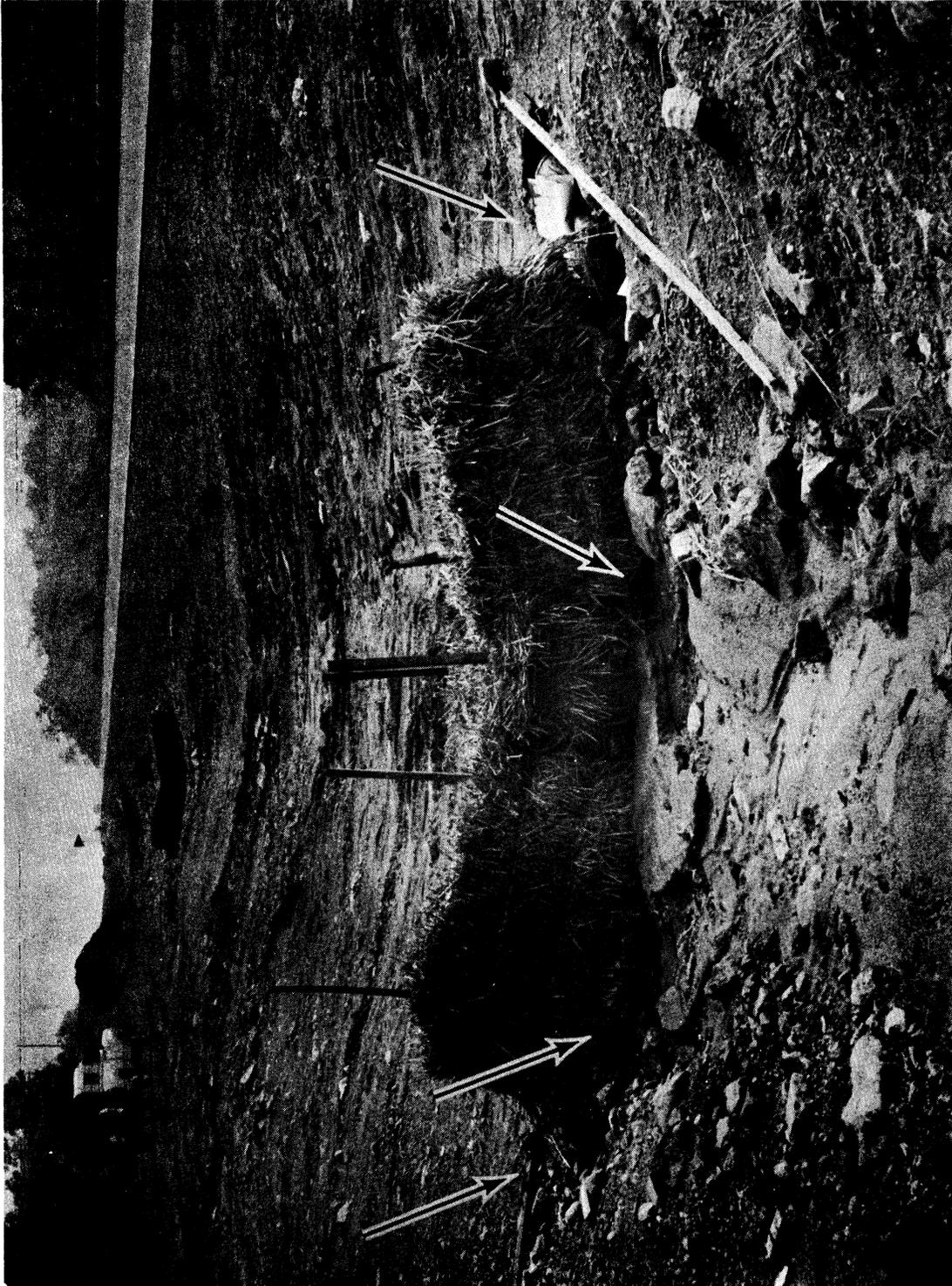


Figure 1. Straw barrier placed by a contractor. Arrows indicate failure by undercutting and end flow. A high percentage of straw barriers now in use in Virginia exhibit similar problems.

and in other states indicate that this poor performance may not be atypical. In fact, there are serious questions concerning the continued use of straw barriers as they are presently installed and maintained. At approximately \$2.50 per linear foot, the thousands of straw barriers used in Virginia annually represent sufficient expense that optimum installation procedures should be emphasized. Recent field experiments have strongly suggested that if such procedures are carefully followed straw barriers can be quite effective. A major objective of this report is to provide step-by-step installation procedures that can be utilized to significantly increase the efficiency of straw barriers.

In addition to the procedures relating to straw barriers, this report includes information on a second type of filter barrier, the filter fence, which is constructed of tough, durable, commercially available fabrics. Laboratory work at the Research Council has shown that filter fences can trap a much higher percentage of the suspended sediments than can straw bales, and preliminary results of field installations have corroborated this finding (Wyant 1976). Consequently, if critical areas are to be protected, silt fences may be preferable to straw barriers in many cases. Specific results of the research now under way on filter fences are being compiled and are expected to be available in report form by early 1977.

RECOMMENDED INSTALLATION PROCEDURES

Straw Barriers

The use of straw barriers must be limited to situations in which only low or moderate flows are to be intercepted. A recent Soil Conservation Service publication (July 1975), titled "Standards and Specifications for Soil Erosion and Sediment Control in Developing Areas", limits the use of straw bales in Maryland to situations in which no other practice is feasible and only sheet and rill erosion are expected. Also, a recent communication from Maryland authorities has brought to light plans in that state to increase entrenchment depth of straw barriers from 4 inches to 6 inches.* Use of these barriers is specifically excluded for situations in which water is to be concentrated in a channel or drainage way. Also, experience in Virginia has indicated that the installation methods now in use for straw barriers result in a high failure rate in ditch line channels. However, some straw barriers, correctly and carefully installed, have been successful. Based on these experiences, it is recommended that the use of straw barriers be continued in Virginia only if

* Michael Ports and Roy Benner 1976: Personal communication.

installation and maintenance procedures are significantly improved. Barrier installation should conform to one of the following guidelines depending on whether the barrier will be exposed to moderate or low flows.

Installation of Straw Barrier Where Moderate Flow is Expected

The term "moderate flow" is meant to cover flows from sheet flow through flow rates not to exceed 1 cfs (cubic feet per second). Using the rational method for flow prediction and assuming average surface conditions and a rainfall rate of 1 inch per hour. An area of 2.0 acres should provide approximately 1 cfs of flow (see Appendix).

The installation procedures for locations with moderate flow rates are given below and are illustrated in Figure 2.

1. Excavate a trench the width of a bale and the length of the proposed barrier to a minimum depth of four inches.
2. Place bales tightly together in the trench. Drive two sturdy wooden stakes or steel pins through each bale and into the ground to a depth sufficient to securely anchor the bales.
3. Wedge loose straw tightly between bales after staking.
4. Backfill and compact the excavated soil against the barrier. Backfilled soil should conform to ground level on the downstream side and should be built up to 4 inches against the upstream side of the barrier.

Installation of Straw Barrier Where Low Flow is Expected

The term "low flow" is used here to describe sheet flow or overland flow. Channel flows are specifically excluded.

The procedures for installing barriers in areas of low flow are listed below and are illustrated in Figure 3.

1. Prepare smooth ground surface by removing rocks and leveling humps and depressions.

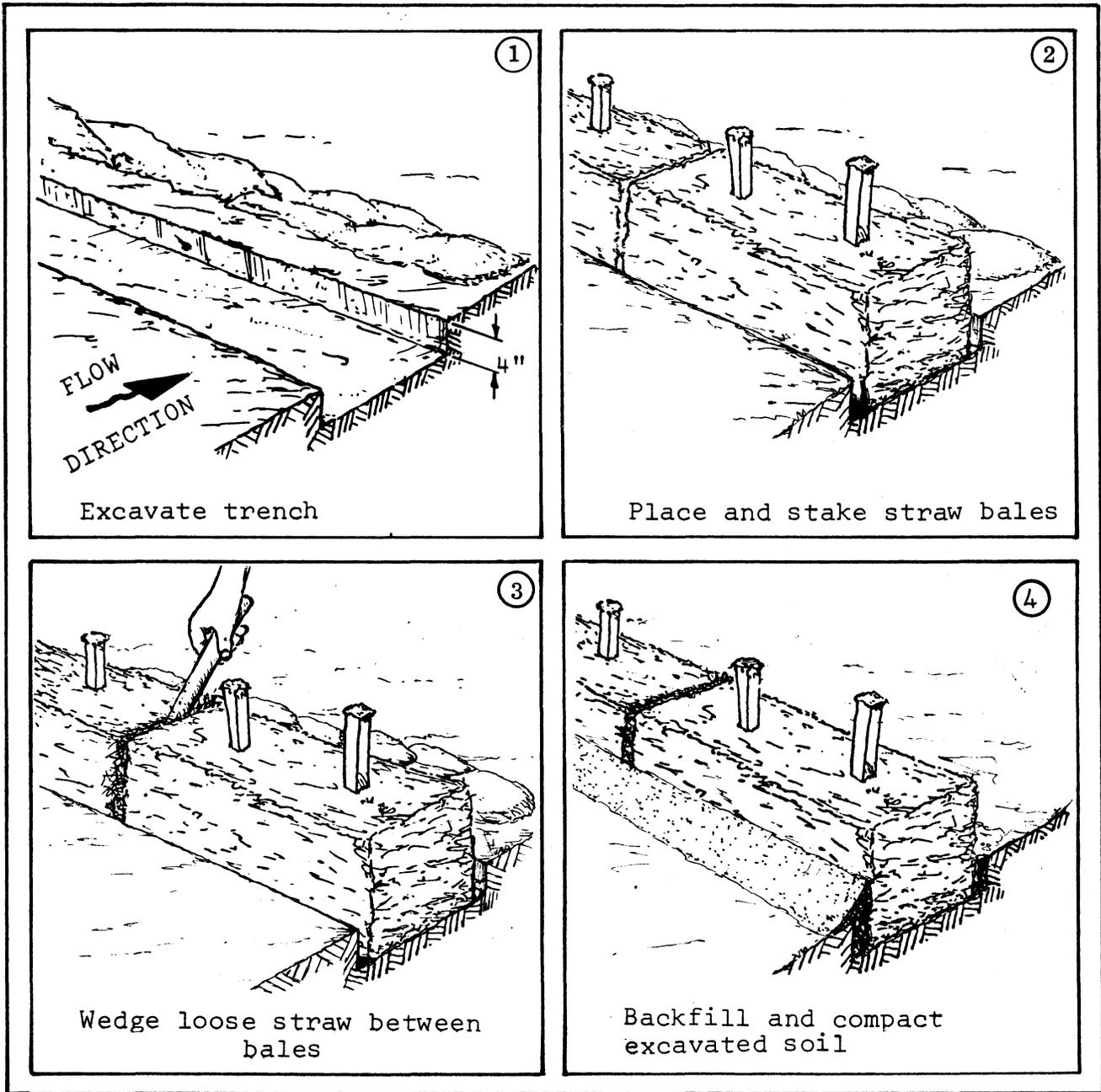


Figure 2. Placing a straw barrier at locations where moderate flows are expected.

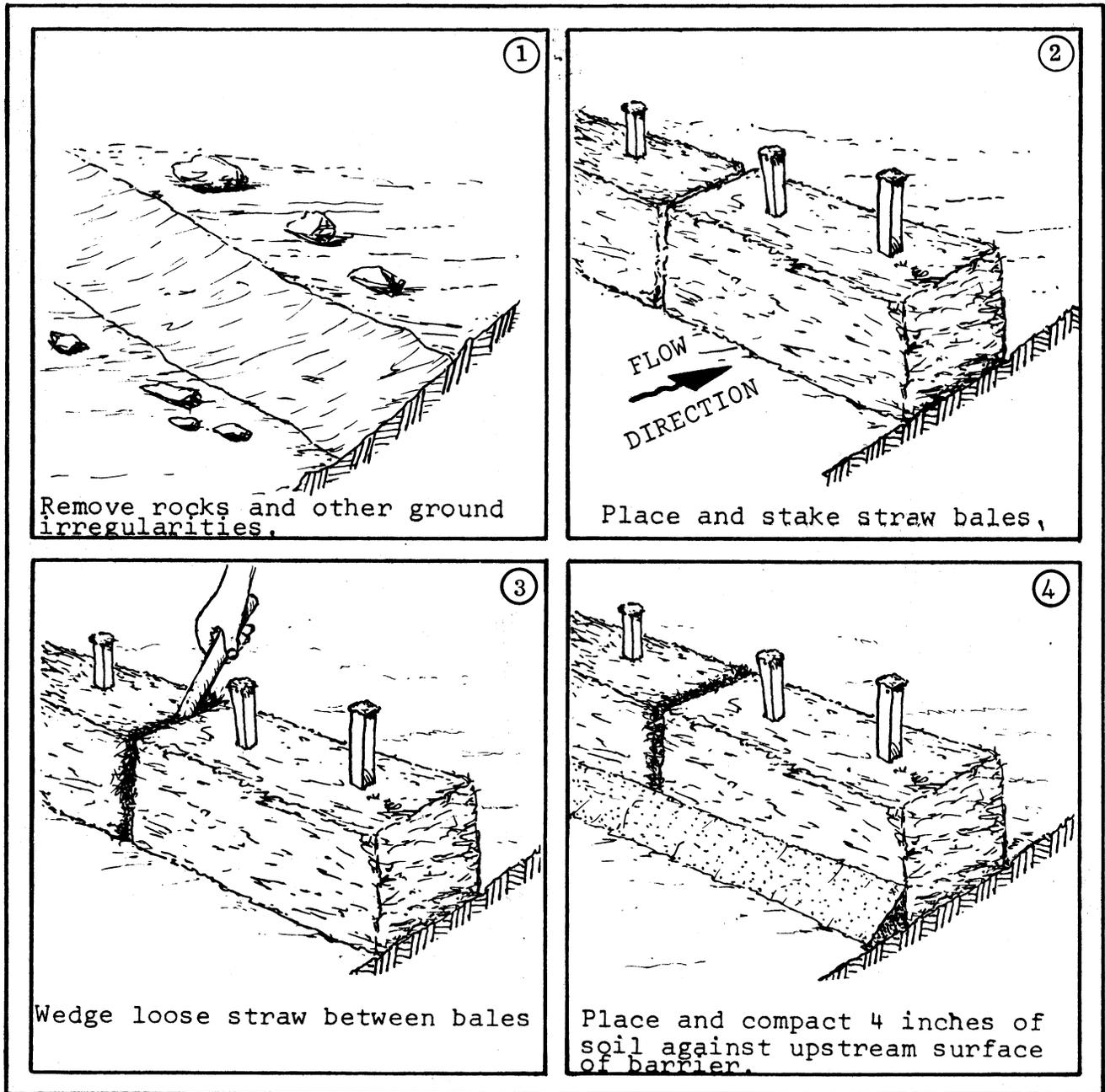


Figure 3. Placing a straw barrier at locations where low flows are expected.

2. Place bales tightly together and drive sturdy wooden stakes or steel pins through each bale and into the ground to a depth sufficient to securely anchor the bales.
3. Wedge loose straw tightly between bales.
4. Place and compact 4 inches of soil against the upstream surface of the barrier.

If a barrier is to be placed in a swale or a ditch line, where possible the structure should be extended to such a length that the bottoms of the end bales are higher in elevation than the top of the lowest middle bale (Figure 4).

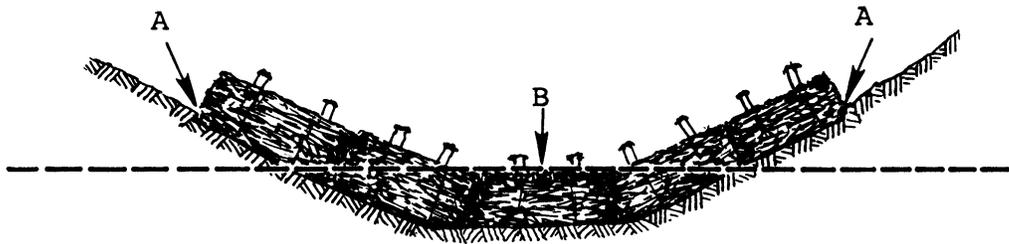


Figure 4. Proper straw barrier placement. Points A should be higher than point B.

Baled Straw Check Dams

Specifications for constructing baled straw check dams at locations where high flows (greater than 1 cfs) may be expected are detailed in Location and Design Instructional and Information Memorandum LD-76 (D) 11.8. This memo specifies that baled straw check dams are to be entrenched to a depth of 6 inches and are not recommended for use in live streams. In ditch lines where high flows may occur, use of the baled straw check dam will be preferable to use of the straw barriers detailed in Figures 2 and 3.

Silt Fences

The silt fence is a two-component barrier system composed of a support fence and an attached filter fabric.* The support fence is composed of minimum 14-gage woven wire** attached to

* Several companies manufacture porous fabrics suitable for silt fences. Brand names include Polyfilter X and Mirafi 140.

** Commonly referred to as "hog wire" fencing.

metal or wooden posts. The filter fabric is stapled or wired securely to the support fence. The filter fabrics used in silt fences have a lower permeability than do straw bales; consequently, the use of silt fences should be limited to situations in which only sheet or overland flows are expected. Silt fences normally cannot filter the volumes of water generated by channel flows.

The construction of silt fences should conform to the procedures illustrated in Figure 5 and listed below. For the case in which the filter fabric is to be used on a filter barrier made from materials such as brush or straw, the method of construction is shown in Figure 6.

In most cases the fabric should not extend to a height greater than 36 inches; higher heights may back up volumes of water sufficient to cause failure of the structure. If water is flowing over a 36 inch filter fence, the fence then acts as a dam and is trapping sediment by the ponding action of the inflowing sediment-laden waters.

The procedures for installing silt fences are given below.

1. Set wood or steel posts securely at intervals no greater than 10 feet apart. Wood posts should be at least 3 inches in diameter; with steel, only the T-shaped posts should be used.
2. Fasten fence wire securely to the upstream side of the posts. Wire should extend into the soil a minimum of 2 inches, and be a minimum of 36 inches in height.
3. Excavate a trench 6 inches wide by 6 inches deep along the upstream base of the fence.
4. Staple or wire the filter fabric to the fence, allowing the fabric to extend into the trench as shown in Figure 5. The fabric should not extend over 36 inches above the original ground on the wire fence.
5. Backfill and compact the soil over the fabric extending into the trench.
6. If a filter fence is to be constructed across a ditch line or drainage way of low flow, the barrier should be of sufficient length to eliminate end flow.
7. Both the strength and effectiveness of silt fences can be maximized by constructing the barrier in an arc or horseshoe shape, with the ends pointing upslope (see Figure 7).

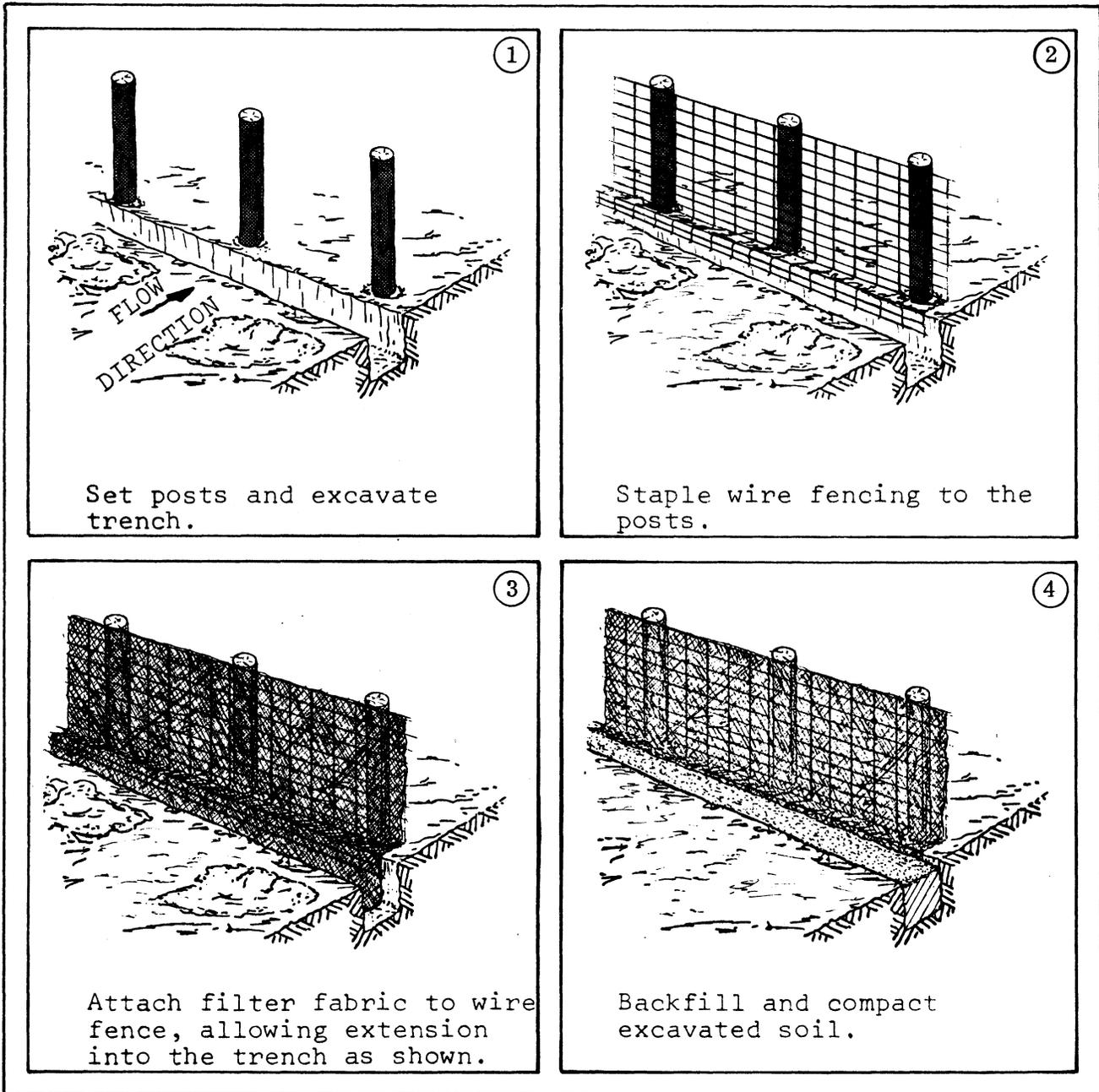


Figure 5. Building a silt fence.

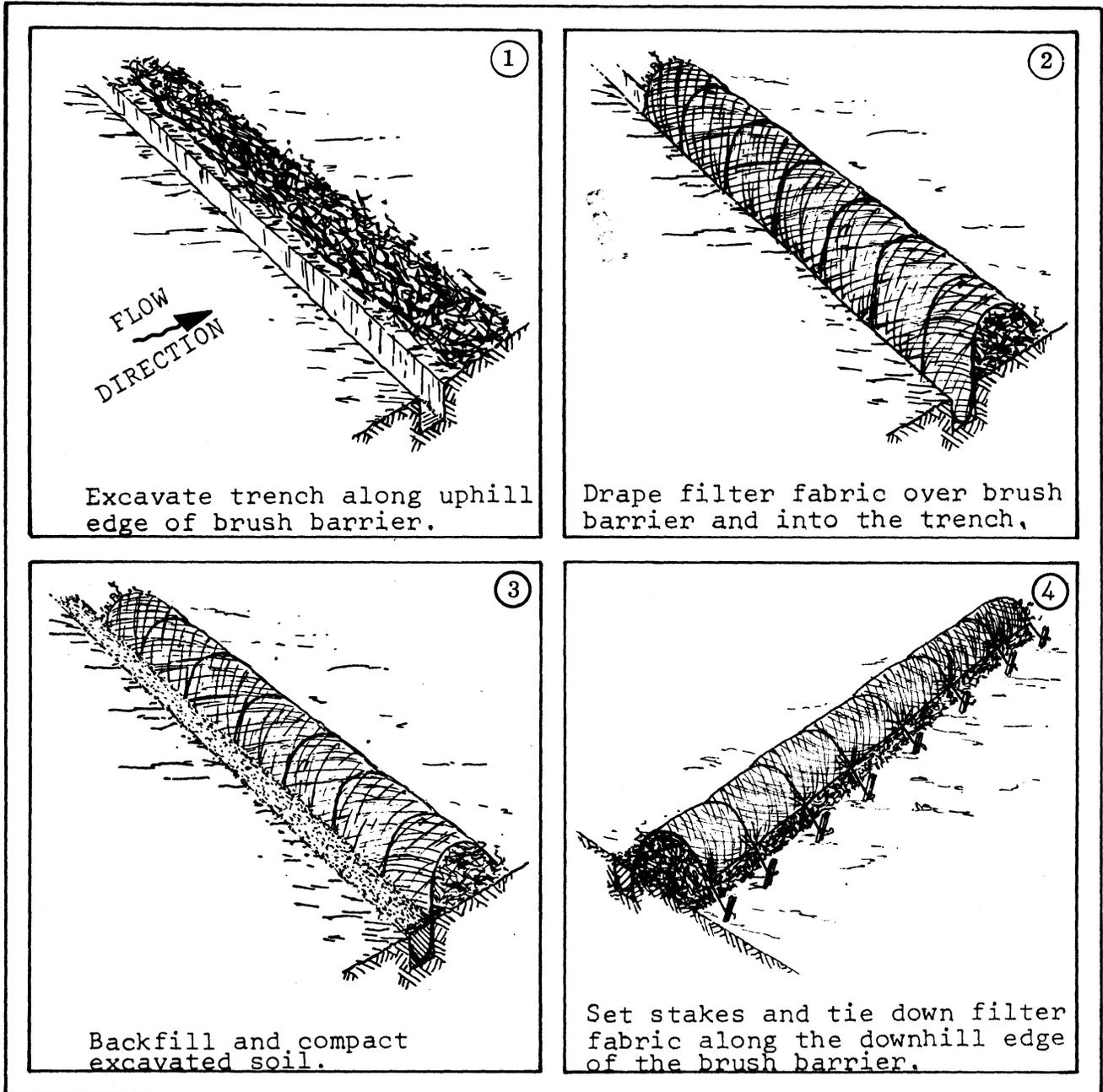


Figure 6. Building a silt fence with brush barrier support.

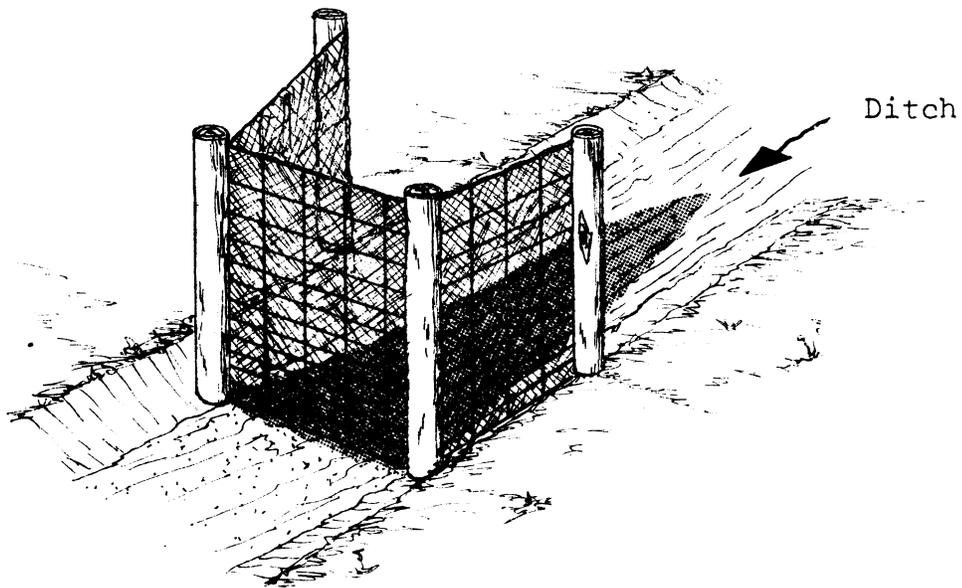
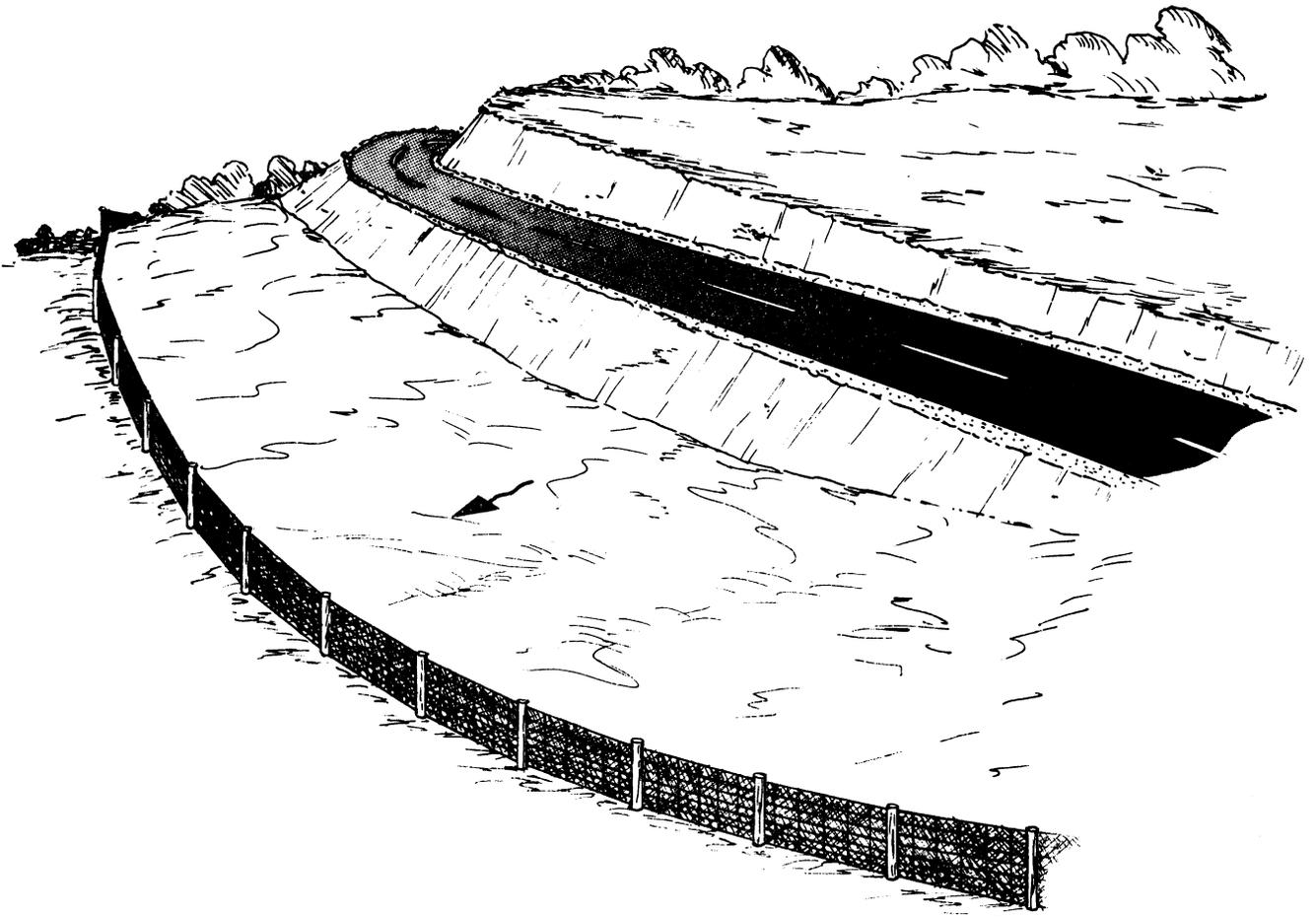


Figure 7. Silt fences illustrating arcuate and horseshoe shapes.

COST EFFECTIVENESS

While costs of constructing straw barriers vary widely, an average figure for Virginia is estimated to be \$2.50 per linear foot of barrier. This figure is for staked bales without entrenchment. Because very few straw barriers have been entrenched, costs of entrenched barriers are more difficult to obtain. However, \$3.00 per linear foot would appear to be a reasonable estimate for entrenched straw barriers, and an unchanged \$2.50 is estimated for barriers sealed by a 4 inch soil layer on the uphill side. Investigations now under way at the Research Council indicate that the success rate of entrenched or soil-sealed barriers should at least double that for bales installed under the presently used system. Based on these figures, the cost benefits of entrenchment or soil sealing are very positive. (For a 20 percent increase in costs [\$2.50 to \$3.00 per linear foot] a 100 percent increase in successful barriers should result.) Even allowing for some error in estimating costs, barrier entrenchment and soil sealing of barriers are decidedly cost effective.

At present, the cost per linear foot for silt fences appears to be approximately \$3.50. Work now under way at the Research Council is designed to yield accurate figures on costs and trapping efficiencies of silt fences.

MAINTENANCE

In addition to the proper construction of filter barriers, proper maintenance is absolutely necessary. Poché and Sherwood found that trapping efficiencies of carefully placed straw barriers on one project in Virginia dropped from 57 percent to 16 percent in one month because of lack of maintenance. It is necessary that filter barriers be checked after each storm event, and that required repairs and alterations be made promptly. Checking of the barriers during a storm event, while a wet and unattractive job at times, can also pay great dividends in helping to improve the effectiveness of the erosion and sediment control program.

Over the time required for any given construction project, the control of erosion and sedimentation will be no better than the quality of the maintenance effort. The value of careful and prompt attention to maintenance cannot be overemphasized.

RECOMMENDATIONS

1. It is recommended that the present practice of staking straw bales directly to the ground surface with no soil seal or entrenchment be discontinued.
2. It is recommended that all straw barriers and silt fences installed under the auspices of the Virginia Department of Highways and Transportation be constructed in accordance with the procedures and guidelines contained in this report.
3. It is recommended that baled straw check dams (Memo LD-76(D) 11.8) be used in place of straw barriers in those ditch lines where high flows (greater than 1 cfs) are likely to occur during storm events.
4. It is recommended that because of the low permeability of filter fabrics, silt fences should be used only for situations in which sheet or overland flows are expected.
5. It is recommended that where critical area protection from sedimentation is desired, silt fences be installed in preference to straw barriers.
6. It is recommended that all sediment barriers be checked by the inspector during storm events, when these events occur during normal working hours.

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APPENDIX

DEFINITION OF FLOW TERMS

When used to describe flow rates in this report, the terms "low", "moderate", and "high" are based on the following criteria and assumptions.

Low Flow

The term "low flow" is limited to overland or sheet flows. This type of flow occurs on slopes where no ditches or natural drainage ways are present. Small rills may be present.

Moderate Flow

Moderate flow is defined as channel flow of one cubic foot per second or less. Such a flow would be expected to occur in ditches, medians, and other drainage ways receiving water from areas of 2 acres or less.

High Flow

Channel flows in excess of one cfs would be considered high flows under the criteria used here. Flows of this magnitude would be expected in ditches, medians, and other drainage ways receiving runoff from areas in excess of 2 acres.

The rationale used to arrive at a limit of 2 acres for production of moderate flow rates of 1 cfs or less is based on use of the rational formula for runoff and some simple assumptions:

$$Q = CIA$$

where,

Q = flow in cfs,

C = coefficient of runoff,

I = rainfall intensity in inches per hour, and

A = area in acres.

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Assuming,

$Q = 1$ cfs,

$C = .5$ for the area drained,

$I =$ rainfall intensity of 1 in./hr., and

$l = (.5) (1) (A),$

then,

$A = 2$ acres, the maximum area expected to produce moderate flows.

Use of the three flow terms - low, moderate and high - is limited to situations where flow is due to a specific storm event. Live streams are specifically excluded and use of baled straw or silt fences in live streams is prohibited by Virginia Department of Highways and Transportation regulations.