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FINAL REPORT

EVALUATION OF EROSION AND SILTATION CONTROL FABRICS

by

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Virginia Highway & Transportation Research Council
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SUMMARY

New proprietary products in three areas of siltation and erosion control were evaluated. Hold/Gro and Griffnet materials were evaluated for use as slope stabilizers and were compared with the Department's present method of straw tacked with an asphalt emulsion. Griffolyn T-55 was evaluated for use in the construction of downdrains, and was compared with polyethylene, the material commonly used by the Department for that purpose. Poly-filter X was evaluated against the system of straw bales or brush barriers presently used to retain silt on a construction project. The report presents recommendations concerning the Department's possible use of the proprietary materials.

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INTRODUCTION

In early 1975 several manufacturers of new proprietary products for erosion and siltation control approached engineers in the Environmental Quality Division of the Virginia Department of Highways and Transportation about the possibility of using their products in construction projects. In keeping with practices within the Department, the Division requested that the Research Council evaluate the manufacturer's claims for the products prior to their use in ordinary construction. As a consequence, the study reported here was initiated in September 1975.[1]

PRODUCTS EVALUATED

The proprietary products evaluated in this study were claimed to be effective in three different facets of erosion and siltation control on construction projects. The products and their uses are discussed under the subheads below.

Slope Stabilizers

Two of the products evaluated are claimed to be effective in the stabilization of slopes. These are synthetic materials that purportedly decompose to provide a mulch for the seed and hold the soil in place.

Griffnet — Produced by Griffolyn Company, Inc.

Griffnet is a tough, flexible netting supplied in different mesh sizes, depending upon the application. In the present study Griffnet type GN-5 was used. It is a black netting with 3/16-inch (0.5 cm) square openings and weighs 7 pounds per million square feet (0.03 gram per square meter). The manufacturer claims that this netting does not deteriorate very easily under direct exposure to sunlight.

It is supplied in 11 feet by 100 feet (3.4 meters by 30.5 meters) rolls. If the material is torn, it can be patched with Griff-Tape, which is available in 4 inch by 180 feet (0.1 meters by 54.9 meters) rolls.

Hold/Gro — Produced by Gulf States Paper Corporation

Hold/Gro consists of plastic netting interwoven with strips of paper. The plastic netting is a rugged, flexible knit of polypropylene yarn that deteriorates very slowly in direct sunlight. The netting provides strength and allows the fabric to conform to uneven surfaces. The interwoven paper can be had in different compositions so as to allow control of the time required for it to deteriorate after contact with the soil.

In the evaluation three types of Hold/Gro were used. Two have a reported life expectancy of 4 to 6 months, depending upon the soil type; the third reportedly is more permanent, having a life expectancy greater than 6 months.

Hold/Gro is supplied in 300 feet (91 meters) rolls in a width of either 4.5 feet (1.4 meters) or 10 feet (3.1 meters). The narrower roll covers 150 square yards (125.4 square meters) and weighs 35 pounds (15.9 kilograms) per roll. The 10-foot roll weighs 72 pounds (32.7 kilograms) and covers 333 square yards (278.4 square meters).

Temporary Downdrains

The second type of material evaluated is used to construct temporary downdrains to carry water from the construction zone to undisturbed areas. The presently used polyethylene sheeting has presented problems since it is torn easily by the force of the water flowing against underlying rocks, and the water escaping through the holes carries off large amounts of silt and thus undermines large sections of the sheeting.

In the evaluations, Griffolyn T-55, manufactured by the Griffolyn Company, was used in temporary downdrains. Griffolyn T-55 is a reinforced plastic fabric with a high tear strength, and weighs approximately 25 pounds (11.3 kilograms) per million square feet of material. It is available in rolls from 4 feet (1.2 meters) to 40 feet (12.2 meters) wide and either 100 feet (30.5 meters) or 250 feet (76.2 meters) long.

Silt Fences

At the present, the Department's standards specify that straw bale and brush barriers be used to prevent silt from being washed onto adjoining property. However, other means of containing silt are also sometimes needed, either because of a lack of straw or brush or because a critical or sensitive area is located below the construction site.

Several companies have developed fabrics during the last several years that can be used to construct a fence for silt retention. One of these fabrics, Poly-filter X, manufactured by Carthage Mills, Inc., was evaluated in this study.

It is a pervious sheet woven of polypropylene monofilament yarns that is resistant to the deteriorative effects of ultraviolet rays and heat. This product was demonstrated by Region 15 of the Federal Highway Administration prior to 1975. L. M. Darby, Chief of Region 15's Field Operations Office, reported the demonstration projects in the FHWA's June 1975 bulletin.(2)

EXPERIMENTAL INSTALLATIONS

A section of state Route 600 in Bath County that was being relocated in 1975 was selected for the evaluation. The project included a 15 feet (4.6 meters) fill with a 2:1 slope for the evaluation of the slope stabilizers; several fills and drainage ditches in critical areas to accommodate usage of the material for temporary downdrains; and the necessity for protection above these critical areas that offered the opportunity for use of the silt fence fabric.

Slope Stabilizers

The Griffnet and Hold/Gro fabrics were installed according to the manufacturer's instructions on the selected 2:1 fill slope on September 11. Plots 30 feet (9.1 meters) in width were laid off along the slope. A 4-foot (1.2 meters) wide walkway was left between the plots to provide work space and to prevent any influence of one plot upon another (Figure 1).

Each fabric was installed on three plots. On the first plot, the fabrics were installed immediately after the slope was dressed up but prior to any fertilizing, liming, or seeding. On the second plot, the slope was dressed up, limed, fertilized, and seeded before the fabric was installed. On the final plot, the slope was treated as for the second plot with the addition of straw prior to installation of the fabric.

Two control plots with seed, lime, fertilizer, and straw tacked with an asphalt emulsion were installed. This type of treatment is the Department's customary procedure(3) for establishing vegetation on bare slopes was included to provide a basis on which to evaluate the effectiveness of the fabrics.

The soil on the slopes on both sides of the roadway is a clayey silt that is present on most of the construction project. The west slope was cooler and more moist than the east slope.

The Hold/Gro was applied to the fill slope vertically as specified for the 2:1 grade. Prior to installation of the fabric, all roots and large rocks were removed from the slope to provide a relatively smooth surface. Gullies and other irregularities were raked smooth because they reduce the effectiveness of Hold/Gro. Close contact between the ground and the interwoven paper is necessary for the decomposition of the fabric.

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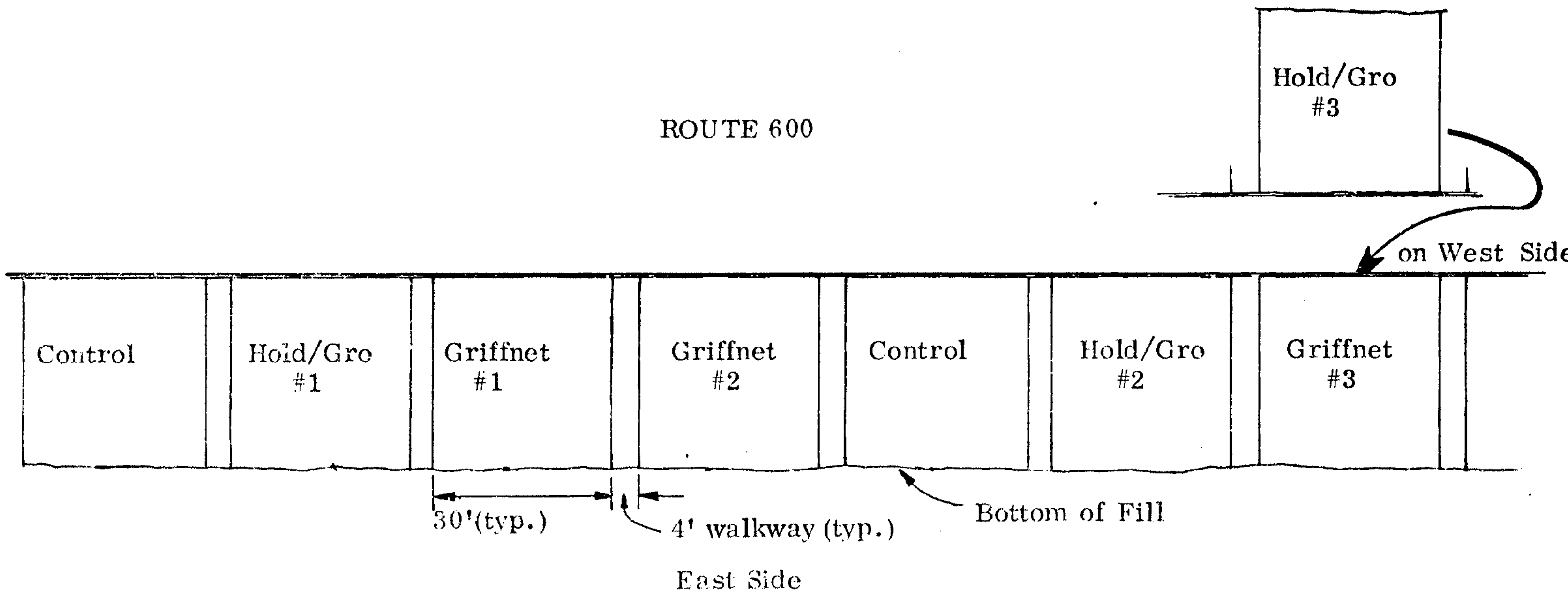

Plot	Treatment
Control	Seed, lime, fertilizer, straw, and asphalt
Hold/Gro #1	Hold/Gro
Hold/Gro #2	Seed, lime, fertilizer, straw, and Hold/Gro
Hold/Gro #3	Seed, lime, fertilizer, and Hold/Gro
Griffnet #1	Seed, lime, fertilizer, and Griffnet
Griffnet #2	Griffnet
Griffnet #3	Seed, lime, fertilizer, straw, and Griffnet

Figure 1. Layout of plots for slope stabilizing materials.

A 4 inch (10.1 cm) deep trench was dug one foot (0.3 meters) back from the top of the slope, and the upper end of the fabric was secured in the trench with six inch (15.2 cm) long metal staples (which were provided with the fabric) spaced 9 inches (22.9 cm) apart. After stapling, the fabric and staples were covered with soil for further anchorage (Figure 2). The fabric was then rolled down the slope and anchored at the bottom in the same manner as at the top. Staples were placed 3 feet (0.9 meter) on center in both the horizontal and vertical directions over the entire area covered.

On each plot of Hold/Gro three types of fabrics were installed. Figure 3 shows a finished plot of Hold/Gro with the fabric incorporating the more permanent paper (greater than 6 months' life expectancy) in the middle. The fabrics with less permanent paper (4-6 months life expectancy) are on the sides of the plot. The material on the left is 100% fill Hold/Gro, which has the degradable paper in all rows of the polypropylene netting; that on right is 75% fill fabric, which means that it has the degradable paper in 3 out of every 4 rows. Figure 4 shows the difference between the two types of fill fabric. In addition, Figure 4 shows the 4-inch (10.2 cm) overlap and the staples spaced 9 inches (22.9 cm) on center as specified by the manufacturer.

The Griffnet was installed in the same manner as the Hold/Gro with one exception; no trenches were dug at the top and bottom of the slope to anchor the fabric.

Figure 2. Anchoring Hold/Gro in the trench.

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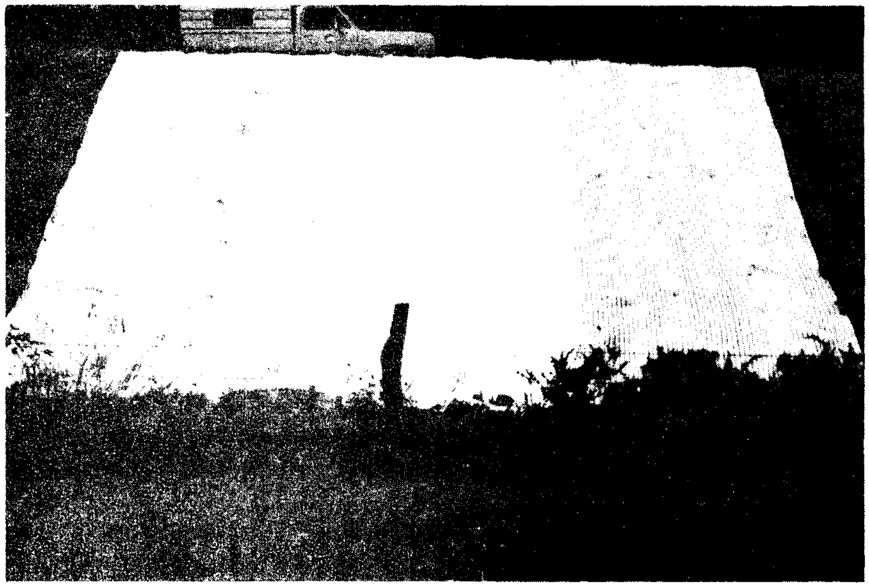

Figure 3. Typical Hold/Gro plot.

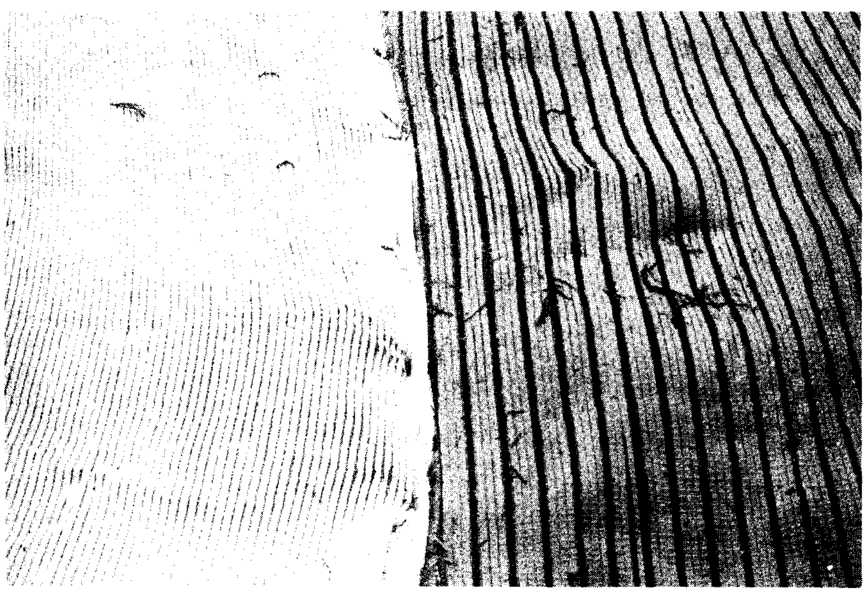

Figure 4. Overlap, 100% fill, and 75% fill Hold/Gro.

Temporary Downdrains

Two temporary downdrains and one ditch line of Griffolyn T-55 material were also installed on September 11. The drains were so designed as to carry rainwater, collecting between the earth berms on the roadway down a 2:1 slope into a straw bale barrier. Before the fabric was installed each of the temporary downdrains was shaped to help keep the runoff in the lined channel (Figure 5). The inlet end of the downdrain was buried and anchored at the top of the fill to prevent undermining (Figure 6), and the sides were secured with staples every 3 feet (0.9 meter) to prevent wind from blowing the fabric out of the channel.

Approximately 50 feet (15.2 meters) of the Griffolyn T-55 material were also placed in a side ditch that drained a 25-foot (7.6 meter) cut on one side and the roadway on the other side. The T-55 liner carried the runoff to a wet weather channel for disposal. The fabric was installed in a method similar to that used for the downdrains.

In this phase of the evaluation, polyethylene sheeting was also used in downdrains and ditch liners to provide a basis for evaluating the performance of the experimental fabrics. Several of the polyethylene downdrains were placed on the same fill as was the Griffolyn T-55 fabric as well as on other fills on the project.

Figure 5. Temporary downdrain channel.

Figure 6. Inlet end of temporary downdrain.

Silt Fences

Two Poly-filter X silt fences were installed above a critical area of a natural stream (see Figure 7). The first was placed in a wet weather channel fed by the ditch with the T-55 liner and a fill slope on Route 600 (Figure 8). The second fence was constructed on the opposite side of Route 600, and is subjected to water filtered through the first and carried under the roadway by a steel pipe. In addition to the filtered water, a small channel from adjoining private property empties into the steel pipe when it rains. The filtered water from the second fence discharges onto private property and into a stream.

Figures 9 through 11 show the method of constructing the silt fences. First, metal posts were placed in a U-shape,and no more than 10 feet (3.1 meters) apart. After the posts were set, a trench approximately 6 inches (15.2 cm) deep and 6 inches (15.2 cm) wide was dug along the inside of the posts. Hog wire (14 gage) 3 feet (0.9 meter) wide or greater was secured to the inside of the posts and down in the trench. (The mesh openings in this wire should be 6 inches (15.2 cm) or less in each dimension.) The Poly-filter X was secured to the inside of the wire. The bottom of the fabric was laid in the trench and buried to prevent undermining. Figure 11 is a photo of a finished installation.

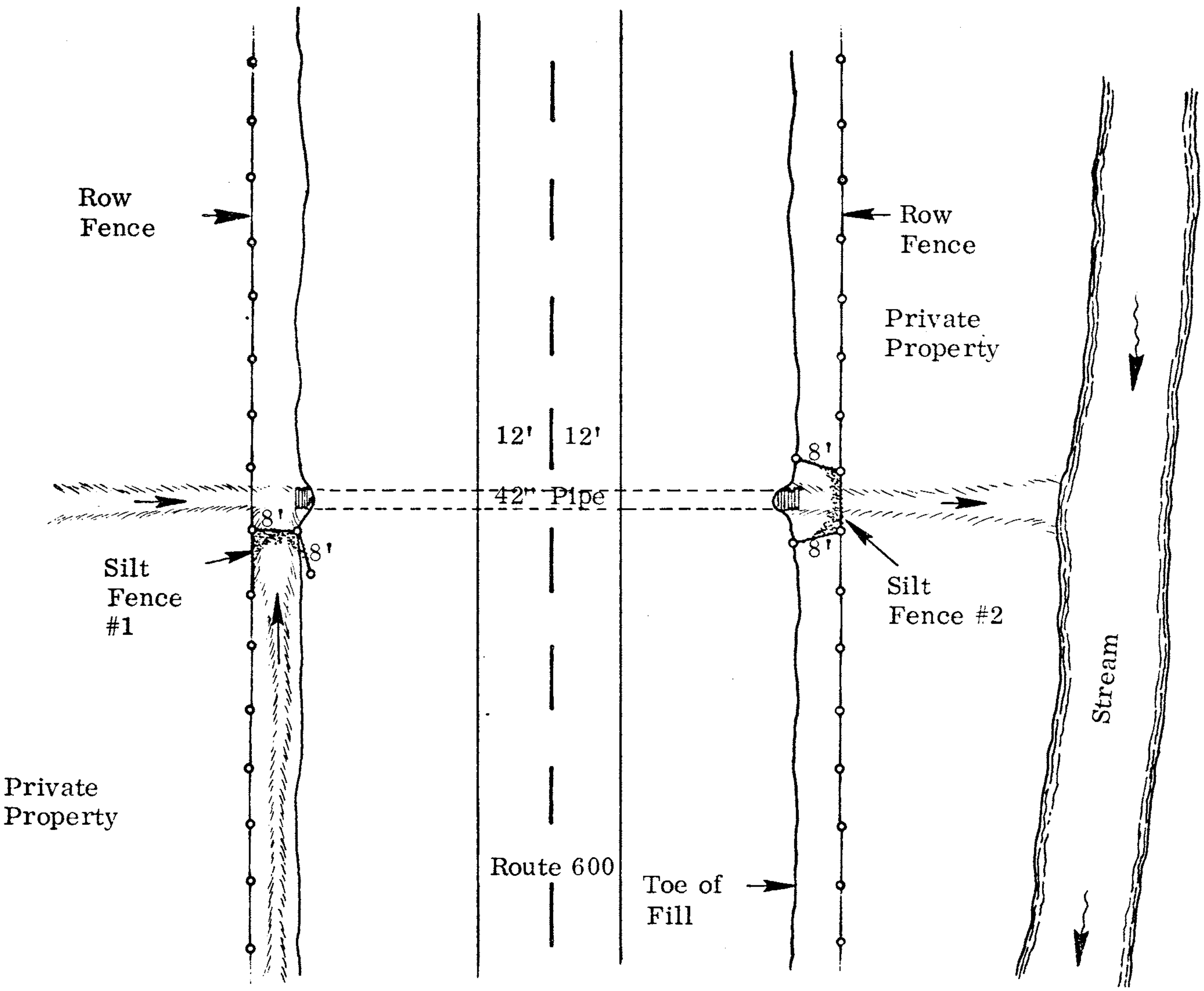

Figure 7. Silt fence locations.

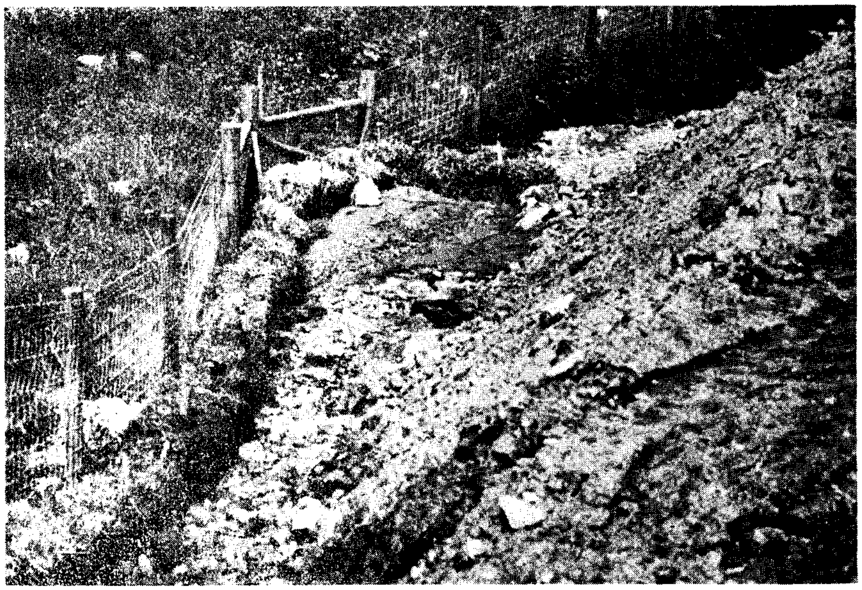

Figure 8. Construction area before installation of first silt fence.

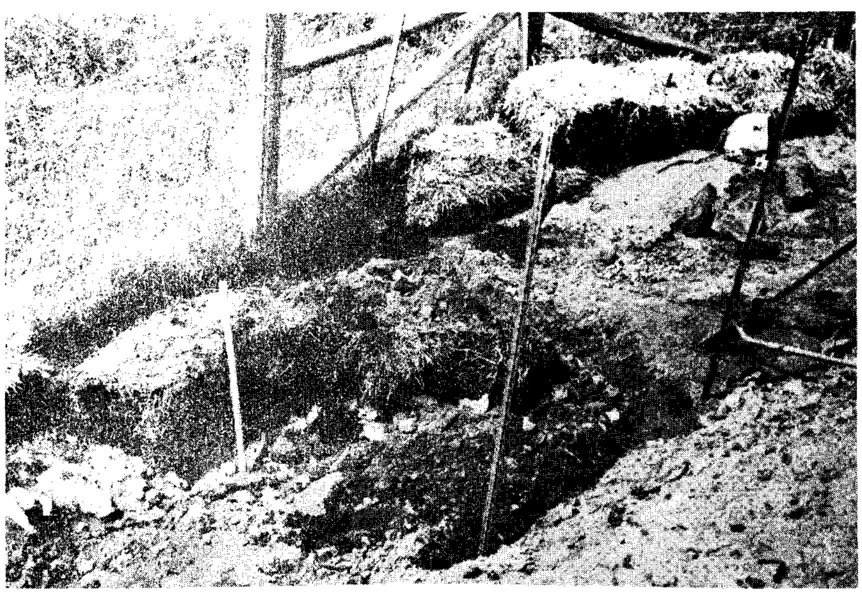

Figure 9. Posts and trench for silt fence.

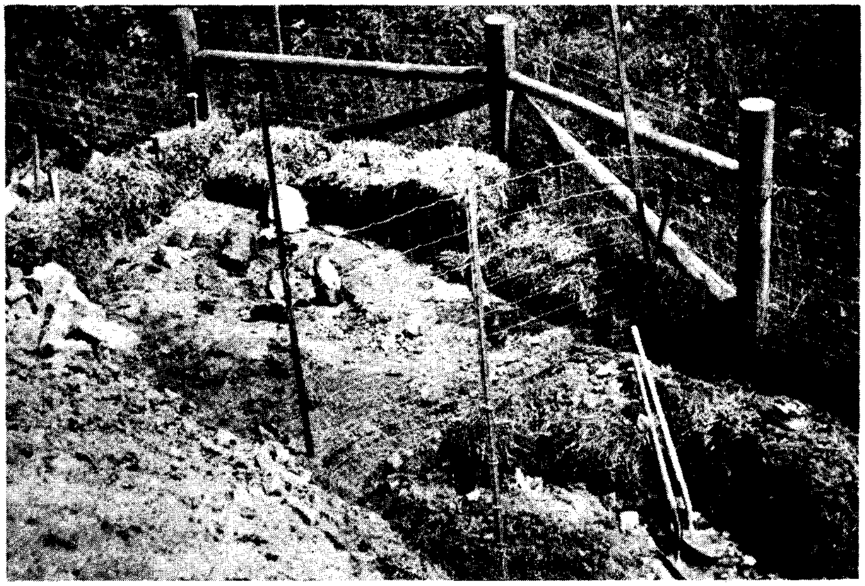

Figure 10. Hog wire secured to posts.

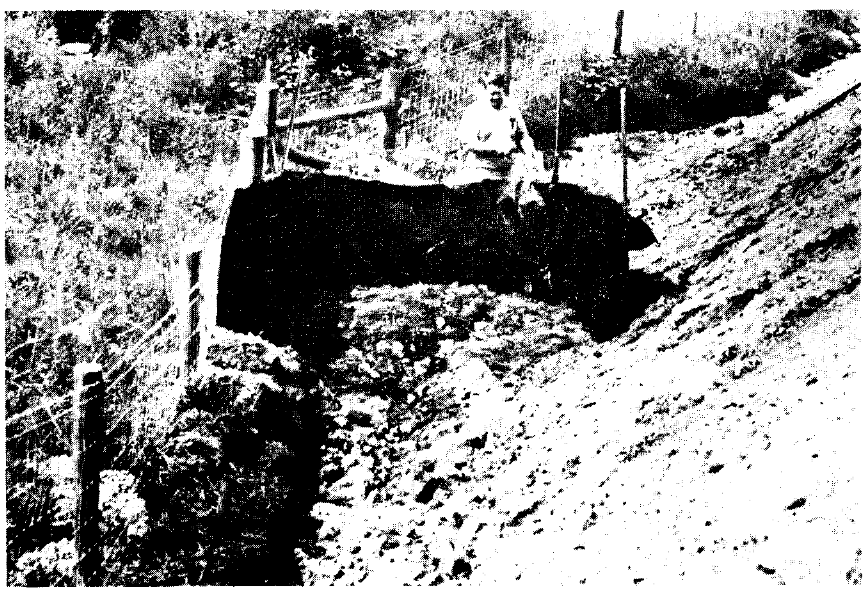

Figure 11. Poly-filter X placed on hog wire.

RESULTS

Slope Stabilizers

Observations were made of the slope stabilizing fabrics at least once a week during the first several months and at monthly intervals thereafter.

Within one week after installation of the Hold/Gro, Griffnet, and control plots, grass appeared. During this week 0.84 inch (2.1 cm) of rain fell on the project.

Approximately one month after installation, a fill failure occurred on the east slope of Route 600. The uppermost point of the failure was approximately 3 feet (0.9 meter) below the top of the slope. It was concluded that the failure was not initiated from the trench used to anchor the Hold/Gro at the top of the fill because the breaking point was below the top of the slope and the failure occurred for several hundred feet around the roadway. In the plots of Hold/Gro, the failed section did not move as much as it did throughout the rest of the fill. The slide shifted approximately 3 feet (0.9 meter) downhill in all the areas effected except the areas under the Hold/Gro, where the shifts were only one-third as far.

The grass stands established in the Griffnet and Hold/Gro plots were not as full as that in the plot in which the Department's current method of straw tacked with an asphalt emulsion was used. Of the three types of Hold/Gro evaluated, the 75% fill of 4-6 months permanency provided a better stand than did the other two types. All three yielded better results on the cooler, damper west slope, because the paper deteriorated faster than the warmer east slope.

The Griffnet plots did not compare as favorably with the straw tacked with an asphalt emulsion as did the Hold/Gro plot on the west slope. The grass stands in the Griffnet plots were equivalent to those in the Hold/Gro plots on the east slope, except more rills were present under the Griffnet.

The small rills occurring under the Griffnet were mainly due to its 3/16 inch (0.5 cm) mesh openings allowing direct exposure of the soil to the raindrops. Although rills were not found under Hold/Gro, some soil was washed down the slope and deposited above the metal staples in pockets of the fabric. In the control plots, very little washing or rills were noticed.

Temporary Downdrains

The temporary downdrains were evaluated at the same frequency as were the slope stabilizers. During the course of the evaluation, several of the Criffolyn T-55 temporary downdrains were removed by the contractor's grading operations. However, because of the durability of the T-55 fabric, the material was reinstalled in another location. In many cases where the polyethylene sheeting was used as a downdrain and torn out by construction activities, rips in the sheeting made it unsuitable for further use.

Several of the polyethylene downdrains installed by the contractor were undermined and did not carry the runoff because they were improperly installed. Figure 12 shows what typically happens to the polyethylene sheeting when rocks or large voids beneath the sheeting create tears. As more runoff flows down the temporary downdrain, the tears become progressively larger, and large volumes of soil are washed down the slope from underneath the sheeting (Figure 13).

Figure 12. Tear in polyethylene downdrain.

Figure 13. Undermining of torn polyethylene downdrain.

The Griffolyn T-55 material has a higher strength than the polyethylene sheeting, and in no instances was it torn by the force of the flowing water. Figure 14 shows the condition of Griffolyn T-55 after several weeks. No tears were created and the silt was carried down the slope into the straw bale barrier. This photograph is indicative of the results which are possible if the temporary downdrain is properly installed in a preshaped channel with accompanying anchored inlet end and sides.

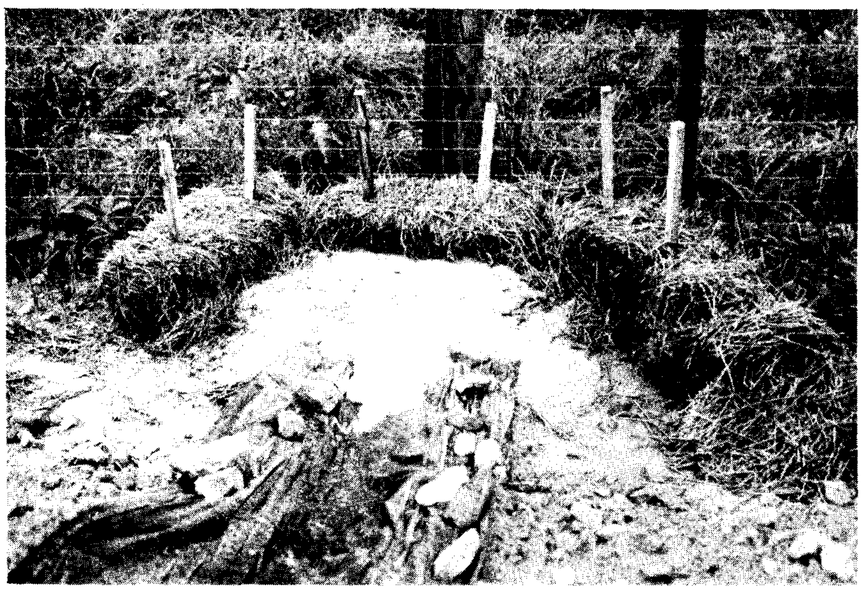

Figure 14. Silt transported by T-55 downdrain.

Silt Fences

The Poly-filter X silt fences were periodically inspected for approximately 3 1/2 months. During this time 11.2 inches (28.5 cm) of rain fell on the construction project. The first silt fence in the wet weather channel retained 12.5 cubic yards (9.6 cubic meters) of material during the 3 1/2 month period. During this same period, 4.4 cubic yards (3.4 cubic meters) of material was trapped above the second Poly-filter X fence. Most of this silt was contributed by the small area on the fill slope of Route 600 not draining into the first fence and from the intermittent stream draining from the private property (Figure 7).

Because of the distance from the Research Council to Route 600, water samples were obtained on only two days. Table 1 shows the suspended solids results determined from the samples. The efficiency of each silt fence is defined as the percentage increase or decrease of suspended solids in the samples. The difference values between the two samples was divided by the suspended solids above the fence and multiplied by 100 to convert to percentage.

Table 1

Suspended Solids Results

Fence No.	Sampling Location	Suspended Solids, ppm	Efficiency
1	Above Fence	39.0	
	Below Fence	70.2	+80 %
2	Above Fence	29,890.1	
	Below Fence	17,442.1	-41.6%
1	Above Fence	394.9	
	Below Fence	427.1	+ 8.2%
2	Above Fence	209.7	
	Below Fence	158.5	-24.4%

The increase in suspended solids below the first fence on both sampling days could not be attributed to the fence having been improperly installed. However, it should be noted that for low suspended solid loads, the efficiency results varied from +80% to -24.4%. The extremely high load showed a decrease in efficiency of 41.6%. Although there was a decrease in the case of the high suspended solids load, 17,442.1 ppm of the suspended solids were still being transported through the fabric.

In subsequent laboratory evaluations conducted on the Poly-filter X fabric, suspended solids loads of 5,000 ppm of a highly erosive soil were used. Table 2 shows the flow rate and efficiency of this material versus those for straw bales.

Table 2

Laboratory Results

Material	Efficiency	Flow Rate (cfs)
Straw	68.1%	122.6×10^{-4}
Poly-filter X	95.2%	3.0×10^{-4}

As shown in Table 2, under almost ideal conditions in the laboratory, Poly-filter X will retain better than 95% of the water-borne silt. The fabric shows an efficiency increase of 27% over that of the presently used straw bales. However, the flow rate was only 2.4% that of straw.

Judging from both the low flow rates of the fabric and straw, and from field observations and tests, it appears that neither of these control measures should be used in a live stream. Both measures, however, serve as adequate protective barriers when properly installed in side ditches and intermittent streams.

COST ANALYSIS

Slope Stabilizers

In Table 3, the costs of using Hold/Gro and Griffnet are compared with those of the Department's presently used method of applying a straw mulch and tacking it with an asphalt emulsion. The comparison is on a per acre basis and shows the latest prices provided by the manufacturers.

Table 3

Cost of Slope Stabilizers

Cost Per Acre

Mulch	Seed	Fertilizer	Lime	Mulch	Total
Straw tacked with asphalt	$500	$210	$180	Included in seed	$ 890[a]
Hold/Gro (4-6 months permanence)	$ 24	$210	$180	$1,988[b]	$2,402[c]
Hold/Gro (> months permanence)	$ 24	$210	$180	$2,133[b]	$2,547[c]
Griffnet	$ 24	$210	$180	$ 566	$ 980[c]

(a) Cost of materials and installation.

(b) Includes the cost of staples.

(c) Installation cost is not included.

Table 3 indicates that the Hold/Gro and Griffnet materials cost more than straw tacked with an asphalt emulsion. Hold/Gro costs approximately three times the Department's present method, with the cost of installation for the former excluded. The Griffnet costs $90 per acre more than the straw tacked asphalt, again with the installation cost excluded.

Temporary Downdrains

Since on present construction projects temporary downdrains are not a separate bid item, contractor prices on polyethylene downdrains were not available. However, the cost of 400 square feet (37.2 square meters) of Griffolyn T-55 is $14.00 as compared to $5.40 for the same amount of polyethylene sheeting.

Silt Fences

The per linear foot (0.3 meter) cost of Poly-filter X is $0.90 while that of the Department's most frequently used siltation control measure, the straw bale barrier, is $0.54. These costs do not include installation, posts and hog wire for the Poly-filter X, or stakes for the straw bales.

CONCLUSIONS AND RECOMMENDATIONS

1. Slope Stabilizers -- The two fabrics evaluated as slope stabilizers were neither more effective nor less costly than straw tacked with an asphalt emulsion. The Hold/Gro fabric is as effective as the straw-asphalt method on cool, moist slopes, but it costs more. Therefore, it is recommended that the Hold/Gro fabric be used as a slope stabilizer only if straw or asphalt emulsion is unavailable or undesirable for any reason.

2. Temporary Downdrains -- Although the Griffolyn T-55 material costs more than twice as much as polyethylene sheeting, it is strong and durable enough to be used several times on a construction project. If the T-55 material is properly installed, no tears are created by the flowing water to cause undermining of the fabric as is the case with polyethylene. The cost of repairing the undermining by the contractor could well justify the initial higher cost for the T-55 material. Therefore, it is recommended that Griffolyn T-55 material be used as temporary downdrains and ditch liners.

3. Silt Fences -- Poly-filter X was determined to have an efficiency 1 1/2 times as great as that of a straw bale. Although the filtering efficiency was greater for the fabric, the flow rate decreased by 97.6%. In addition, Poly-filter X cost almost twice as much as the straw per linear foot. Therefore, it is recommended that Poly-filter X fabric be used as a silt fence in ditches and intermittent stream channels.

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3. Wyant, David C., W. Cullen Sherwood, and Hollis N. Walker, "Erosion Prevention During Highway Construction by the Use of Sprayed on Chemicals", Virginia Highway Research Council, VHTRC 72-R1, July 1972.