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TECHNICAL NOTES

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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ADMINISTRATIVE MATERIAL - FOR USE ONLY WITHIN THE SOIL CONSERVATION SERVICE

Agronomy #2

SUBJECT: Erosion, Runoff and Revegetation of Denuded Construction Sites

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TO: All Offices Palmer G. Skalland

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Recent studies by Agricultural Research Service, USDA, in cooperation with Purdue University have provided some much-needed facts and figures regarding erosion and runoff from construction sites. The studies also showed the effects of various treatments on the revegetation of such sites.

Erosion and Runoff Study

The study site was an eroded Miami silt loam with a loam subsoil. Only a few inches of topsoil remained, and the subsoil was relatively uniform in composition to a depth of several feet. The research plots were prepared by removing all topsoil and cutting the subsoil to a uniform slope of 12.0 percent. The following six treatments were then applied:

1. Scalped only (no further treatment)
2. Scarified to a depth of 2 to 4 in.
3. Mulched with 1 ton of straw per acre
4. Covered with 4 inches of topsoil
5. Loose subsoil fill, 2 ft. deep
6. Compacted subsoil fill, 2 ft. deep.

The last two conditions were included to simulate areas filled during topographic modifications.

Reshaping was done in June, topsoil was applied in early July, and tests were conducted in August. Nearly 10 in. of natural rain fell on the plots between the time of their initial preparation and the tests. The straw for the mulch treatment was applied just before the tests.

All operations involved in applying the treatments were up and down slope. Simulated rainstorms totaling 5 in. were applied at an intensity of approximately 2.5 in. per hour. The initial run (storm) lasted 60 minutes. Two 30-min. runs, separated by 15 min., were made the following day. Rainfall intensity, runoff, and soil loss were evaluated in the standard manner.

The soil loss, runoff, and infiltration resulting from the 5 in. of intense simulated rainfall are summarized in Table 1. Soil loss was greatest on the scalped-only and scarified treatments, less on the loose-fill and topsoil, and least on the mulched treatment.

TABLE 1. EROSION, RUNOFF, AND INFILTRATION FOR RAINULATOR STUDY OF CONSTRUCTION-SITE CONDITIONS*

Treatment	Soil loss tons per acre	Runoff, in.	Infiltration Total in.	Infiltration Rate, in. per hr.
Scarified	54.5	4.2	0.8	0.1
Scalped only	53.8	3.8	1.2	0.4
Compact fill	48.0	4.1	0.9	0.2
Loose fill	31.0	3.4	1.6	0.6
Topsoil	30.9	3.8	1.2	0.4
Mulched	9.7	4.0	1.0	0.3

*Plots were 12 by 35 ft. on a 12 percent slope. Data are averages of two replications.
Initial runs lasted 60 min.: wet and very wet runs, 30 min. each; application intensity, 2.5 iph; total applied, 5.0 in. Soil loss and runoff amounts are the total from all three runs.

Sediment loads and runoff from the denuded plots were much greater than usually occur from topsoil under similar conditions. For the scalped-only and scarified treatments, soil losses from the 5 in. of simulated rain on the 35-ft. slope lengths totaled about 54 tons per acre. More than 60 percent of the sediment came from the 2.5-in. initial storm. Using the Universal Erosion Equation to extrapolate these 54-ton losses to a 300-foot slope length indicates a sediment yield of more than 6,000 tons, or 8,000 cu. yards (assuming about 55 pounds per cu. ft. of deposited sediment) from a 40-acre tract under otherwise similar conditions.

The compacted-fill treatment lost slightly less soil than the scalped-only and scarified treatments during the first hour of applied rain. This was attributed to decreased detachability of the firmly packed soil. During the wet runs, the losses were very similar for all three treatments.

Soil losses from the applied-topsoil and loose-fill treatments averaged 31 tons per acre. This decrease, relative to the scalped-only and scarified treatments, was attributed to the meandering flow paths and slightly higher infiltration rates on the loosely filled plots and to less rilling and a less-erodible soil on the topsoil plots.

The treatment with 1-ton per acre of applied surface mulch lost less than 10 tons per acre, a major reduction relative to the other treatments. This 82-percent reduction in soil loss was the same percentage of reduction obtained from 1 ton of straw mulch on a 15-percent Fox loam surface soil in another study. In that study, 2 tons per acre reduced erosion by 96 percent, so a heavier rate likely would have reduced erosion considerably more in this study also.

Runoff was high for all six treatments, ranging from 70 percent of the simulated rain on the loose-fill treatment to more than 80 percent on the compacted-fill and scarified treatments. All plots were quite wet prior to all runs.

The dominant conclusions from the erosion and runoff phase of this study are that soil and water losses from denuded soils are very great and that disturbed areas with surface mulch are much less erodible than the other conditions tested. It also suggests that reduced compaction of filled areas and/or soil of a good physical condition applied over disturbed areas may be expected to reduce erosion and runoff appreciably.

Each of the 12- by 35-ft. plots used for runoff and erosion determination (except the straw mulch treatment) was divided into 24 subplots, each about 4 ft. square, to study establishment of vegetation on disturbed soil conditions. All combinations of the following treatments were applied on each plot:

1. Surface condition (2 levels): (a) no tillage after erosion tests, and (b) reworked for seeding.

2. Fertility (2 levels): (a) normal, 100-50-50 per acre, and (b) high, 200-100-100 per acre, in one application prior to seeding.

3. Seed mixture (2 levels): (a) blend of vigorous bluegrasses, and (b) 25 percent of same blend plus 75 percent tall fescue.

4. Surface mulch (3 levels): (a) none, (b) 1 ton, and (c) 2 tons of straw per acre with asphalt binding.

The revegetation treatments were applied in mid-September, using standard turf establishment practices. The lower half of each plot was reworked with a tiller rake; all other treatments were randomized. Sequence of treatments were randomized. Sequence of treatments was (a) spread fertilizer, (b) till for seeding, (c) seed, and (d) mulch. Subsequent stands were estimated visually by experienced turf technicians.

Results

The effectiveness of revegetation on the 240 subplots was first appraised on October 30, 1968, seven weeks after seeding. Seven subplots had as high as 90 percent establishment, but 88 had no vegetation whatsoever. The average stand for all plots was 14 percent. Of the seven subplots with 90 percent stand, six had topsoil and the seventh was scarified, all were reworked, four had the normal fertility level, five had the fescue-bluegrass seed mixture, and all had straw mulch. The 88 subplots that had no vegetation included 39 of the 40 subplots that were neither reworked nor mulched. Most of the remainder were either not reworked or had no mulch. Only two of the 80 subplots with no mulch had more than a 5 percent stand.

Stands were not significantly different for the two fertility levels.

Revegetation effectiveness was again evaluated on May 16, 1969, eight months after seeding. The average for all subplots had increased to 24 percent establishment, and eleven subplots had 90 percent cover or better. Of these, nine had topsoil, one was scarified, and one was loose-filled; eight were reworked; eight had the high fertility level; nine had the fescue-bluegrass mixture; and all were mulched. Sixty-seven plots still had no vegetation, and 60 of these had not been mulched.

The mean effectiveness of each factor on revegetation is given in Table 2. Each value is the average percentage of establishment (or stand) for all subplots having that factor at the specified level, but including all levels of the other factors. For example, the 14 percent stand for the scarified treatment in the fall was an average of all 48 subplots on the two scarified plots that included all combinations of both tillage levels, both seed mixtures, both fertility levels, and all mulch rates.

The best combination of revegetation treatments tested, as indicated by Table 2, was applied topsoil, reworked for seeding, seeded with a fescue-bluegrass mixture, and mulched. The subplots with this combination averaged 77 percent establishment in the fall (range, 50 to 90 percent) and 86 percent in the spring (range, 75 to 95 percent).

For the four treatments without topsoil, mulching was essential for a stand, and reworking for a seedbed plus use of a fescue-bluegrass mixture were especially beneficial. Subplots without topsoil that were mulched, reworked, and mixture-seeded averaged 36 percent stand (range, 1 to 90 percent) in the fall and 48 percent stand (range, 5 to 90 percent) in the spring, whereas the mulched, but not reworked, bluegrass-alone subplots averaged only 3 percent stand (range, 0 to 20 percent) in the fall and 17 percent stand (range, 0 to 60 percent) in the spring.

TABLE 2. REVEGETATION EFFECTIVENESS ON CONSTRUCTION-SITE CONDITIONS

Treatment	Percent establishment* Fall, 1968, percent	Spring, 1969, percent
Mean for all 240 subplots	14	24
Original Treatments: (48 subplots each)		
Scalped-only	10	23
Scarify	14	19
Topsoil	25	41
Loose fill	11	20
Compact fill	9	18
Tillage Conditions: (120 subplots each)		
No subsequent tillage	7	21
Reworked for seeding	21	27
Fertility levels: (120 subplots each)		
Normal	15	23
High	13	25
Seed Mixture: (120 subplots each)		
Bluegrass only	7	15
Bluegrass plus fescue	21	34
Surface mulch rates: (80 subplots each)		
None	1	3
1 ton per acre	15	28
2 tons per acre	26	42

*Values given are overall mean stands for the specified factor level, including all combinations of other factor levels.

The autumn of 1968 was very dry. Moisture after seeding was seriously deficient for both germination and growth, and stands were generally poor. However, most treatments that combined tillage for seeding, fescue in the seed mixture, surface mulching, and topsoil were relatively successful. Treatments that were not reworked and had no mulch were particularly unsuccessful.

Although the overall means given for each factor level in Table 2 combine all levels of all other factors, they indicate the general effect of each factor at different levels. Of the original treatments established for the runoff and erosion studies, the plots with 4 in. of topsoil over the subsoil averaged by far the best cover. At the fall determination, the scarified treatment was next best, probably because of the rough surface and its influence on seed coverage and shading. The compacted treatment was poorest both in the fall and the following spring.

The subplots that were reworked for seeding averaged a much better stand than those that were seeded after more than 15 inches of natural and simulated rain had sealed, compacted, and eroded the surface. However, increasing the fertilizer application from 100-50-50 to 200-100-100 per acre did not appreciably influence early stands.

Mixing tall fescue with bluegrass resulted in much better initial stands than bluegrass alone. This was attributed to the more rapid germination and faster growth of the fescue.

Of all factors, mulch rate had the greatest effect on establishment of vegetation, just as it did on erosion control. Either rate of mulch was greatly superior to no mulch, but the 2-ton rate was considerably better than the 1-ton rate.

These results suggest several procedures to improve the chances of re-establishing vegetation on denuded areas:

1. Returning the original topsoil or importing topsoil.
2. Reworking compacted areas before seeding.
3. Adding sufficient plant nutrients to develop fast vegetative cover.
4. Including fast-growing grasses in the seed mixture.
5. Mulching the soil surface of seeded areas.
6. Applying supplemental irrigation when needed.

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