REPORT OF DIVISION II
ON
CONSTRUCTION AND MAINTENANCE

John L. Wright, Head

* * *

Division II includes Project Committees on Drainage and Drainage Structures, Erosion Control and Plant Ecology, and Turf Culture. One year of operation under the reorganization of the committee into three divisions has proven its value in eliminating duplication of effort. This has enabled division heads to more clearly correlate project committee activities, as evidenced by the reports and discussions.

The Division holds that landscape principles and roadside development practices, to be fully effective, should be integrated with the construction and maintenance of the COMPLETE HIGHWAY.

The Project Committees on Erosion Control and Plant Ecology and on Cooperative Agreement Project Analyses submit a joint report, containing the principles and practices which they consider should be included in the initial construction of the COMPLETE HIGHWAY. Where landscape principles and roadside development practices have been integrated with the initial construction of the COMPLETE HIGHWAY, maintenance operations have been facilitated and unit costs reduced.

The Project Committee on Drainage and Drainage Structures has submitted an outline of general principles of highway drainage with recommended practices for humid regions and for regions of deficient rainfall, which may well be considered in the construction of the COMPLETE HIGHWAY.

The report of the Project Committee on Turf Culture covers recommendations and specifications on Turf for Airfields and Roadsides, based on experience acquired in the development and maintenance of airfields and flight strips since the early days of the war.

In addition to the above reports centering on the COMPLETE HIGHWAY, the Project Committee on Cooperative Agreement Project Analyses has submitted a wartime summary of its findings on the status of the proposed Inspection and Evaluation of Cooperative Highway Erosion Control Demonstration Projects.

The joint report covers progress also on the "Technical Motion Picture of Highway Erosion Control".

Several research topics are listed in the joint report as a basis for selection and possible assignment of subjects during 1944 to the respective project committees.

A tentative outline of proposed Climatic Groups of Raw Soils prepared by the joint project committees is included in the Appendix for further study.

REPORT OF THE
PROJECT COMMITTEE ON EROSION CONTROL AND PLANT ECOLOGY
AND THE
PROJECT COMMITTEE ON COOPERATIVE AGREEMENT PROJECT ANALYSES

* * *

A. Landscape Principles and Roadside Development Practices which Should be Integrated with the Initial Construction of the Complete Highway, and the Effect of Such Integration upon Maintenance.

These operations are easily adaptable to contract work and most of them can be done by modern road construction machinery at a cost much lower than if they are attempted after construction has been completed. Collaboration between the design or plan engineer and the landscape or roadside development engineer from the time plans are first started can easily accomplish the desired integration of these principles and practices. Carried out on this integrated basis, the work of the maintenance engineer will be strictly maintenance, and he will not have to assume the job of finishing up work that is definitely a part of the construction of the COMPLETE HIGHWAY.

Streamlined Cross-Section and Adequate Drainage. A "streamlined" cross-section with adequately designed and protected roadside gutters and supplementary drainage channels will pay for itself by preventing dangerous gullying or expensive silting of roadside gutters, by reducing snowdrifting, by simplifying snow removal, and by facilitating roadside mowing and clean-up.

Roadside Gutters should be designed according to need, rather than completely standardized throughout a State, or even throughout a single project. The design of an ample basic drainage channel section would be governed by the watershed drainage conditions for the particular project. Special variations from this basic section would provide less or additional capacity as necessary at certain drainage points. By experimental work in hydrology and by experience in actual construction, a flat-bottom, rounded, or wide flat-sided gutter has been found far superior to the narrow steep-sided V-type section so frequently used. Roadside gutters of adequate design prevent flooding of pavement and deposition of silt, undermining of shoulders and backslopes, and deep scouring of the flow line into a gully dangerous to traffic. In the snow belt, adequate roadside gutters provide snow storage.

Intercepting channels should be installed where necessary at the top of cut slopes to keep runoff water on land above the cut from flowing over the slope, particularly farm terrace water which cannot be diverted from the highway. These intercepting channels themselves must be protected against erosion and carried to a natural drainageway on the contour or by a protected spillway or flume. Intercepting channels prevent serious sheet or gully erosion of cut slopes and therefore keep such erosion from filling up roadside drainage channels and structures. If surface runoff is handled properly, the vegetative stabilization of almost any reasonable slope is possible, although more expensive on steep slopes than on flat slopes. On the other hand, if drainage is not properly controlled, it can easily destroy excellent vegetative treatment regardless of degree of slope.

Cut and fill slopes should be as flat as economically feasible, varying according to topography, with slope intersections well-rounded and with ground surfaces between cuts and fills warped to get a truly "streamlined" section. The initial cost must, of course, be considered; but full consideration must also be given to the values of flatter, rounded slopes for safety of travel, full utilization of the entire highway, attractiveness and economy of maintenance. Modern construction equipment is well-adapted to a cross-section with flat and rounded slopes. The grading of a "streamlined" design can be done with machinery without involving costly hand labor. Streamlined cross-sections with flat slopes have larger mowing areas, but this increase in area is offset by the ease, speed and economy of machine mowing as compared to mowing by hand on steep slopes. There is less drifting of snow on a streamlined section than on a section having sharp steep cuts to trap snow. Flatter fill slopes in many locations can eliminate the need for guard rail, which not only is costly to maintain but also interferes with mowing and snow removal.

Culvert outlet channels designed to obtain full capacity of the culvert, and care in planning the outlet channel to avoid damage to bordering cultivated land will return big dividends by reducing complaints and damage suits from owners of bordering property.

Drop inlets and catch basins at culvert inverts maintain flow lines of roadside gutters and prevent holes and gullies from forming and "trapping" the highway traveler who has wandered or been forced from the pavement. Such structures prevent progressive "scouring" of roadside gutters back from culvert inverts, and also prevent similar "scouring" back into adjacent fields. Sufficient hydraulic capacity must be provided with size of openings large enough to pass leaves and grass.

Berms or dykes on shoulders of high fills should be installed, particularly on the inside of superelevated curves, with flumes or spillways to carry accumulated water to the bottom of the fills. By thus controlling drainage, it is possible to eliminate the repair of washes on fill slopes, which are particularly vulnerable areas on new construction until they can be protected with vegetative cover. Berms or dykes cause some interference with shoulder maintenance and snow removal, so must not be used indiscriminately, and in many locations should be considered a temporary measure only, to be removed when vegetation has become established on the slopes.

Paving of roadside gutters. Only slightly less important than the adequate design of roadside gutters is their proper protection. Sod cover has proved its value as a protection in most drainage channels, but vegetation cannot be considered a "cure-all". For extreme conditions of grade, size and velocity at peak flow, provision can be made in initial construction for paving of such drainage channels with concrete, soil-cement, rubble masonry, bituminous treatment, or other protective treatment. Paving of roadside gutters can be recommended on steep grades as a valuable preventative measure against scouring and gullying. Paving is also valuable on very flat grades where a smooth gutter surface is needed to avoid siltation.

Underground drainage is recommended where it is obviously necessary without extensive and costly operations of taking many borings and other investigations in the initial surveys. Underground drainage may prevent sudden slides, and may also avoid the need for the expensive operation of cleaning up slide debris and the possible replacement of the pavement itself. The need for underground drainage some-

times does not develop or cannot be determined until after construction, and it then becomes of necessity a maintenance operation.

B. Salvaging of topsoil, obliterating abandoned roadways and borrow pits, seeding or sodding, and mulching done during initial construction will check costly erosion before it starts.

Salvaging of topsoil during initial grading. The term "topsoil" in this report applies to a loamy soil capable of introducing and supporting vegetation on roadside areas. Experience has shown that a little good topsoil salvaged is much better than large quantities of "alleged" topsoil hauled in from borrow pits at high cost. There can be little question as to the economy of salvaging topsoil during initial grading. However, the question of whether or not to salvage topsoil is one that must be considered for each individual project. The depth and distribution of topsoil available within construction limits, the quality and availability of topsoil from borrow pits, and the relative cost of each, must be considered. The important point is that the possibility of salvaging topsoil during original highway construction be carefully considered and not ignored. When there is sufficient depth and area of good topsoil within construction limits, modern machinery can easily stockpile or windrow topsoil, and later spread it back on new slopes with a minimum of hand labor. Salvaging of topsoil during initial grading has an indirect but important effect on maintenance, because topsoil aids in better and more rapid vegetative ground cover. Experience has shown that where topsoil is not used, seeding failures are most numerous, and failures mean more maintenance in patching and reseeding.

Obliteration of abandoned roadways and borrow pits can be most economically handled by inclusion in the initial grading. If this is not done, these areas will not only be an eyesore, but also a continuing source of erosion, drainage difficulties, and complaints. Restoration of abandoned roadways is an excellent practice of cooperative soil conservation since the property owners can again use the land for agricultural purposes.

Mulching. Mulching during initial construction is of prime importance, because of the immediate protection it gives against erosion, regardless of season. Thus maintenance is aided because erosion is checked before it starts. Mulching alone is of great value for erosion control since it is not as seasonal as seeding and planting. Seeding can be done later through the mulch, if necessary.

Seeding and Sodding. Although these items are seasonal, selective adjustments in seed mixtures*, coupled with proper mulching, have "stretched" the seasons considerably beyond what were originally considered safe seasons for seeding. With flat rounded cross-sections, several methods -- particularly seeding with farm equipment, broadcast sprigging, and topsoil planting (also known as mulch sodding or broadcast sodding) -- are readily adaptable to mechanization and inclusion in initial construction. The inclusion of this work in initial construction prevents erosion, instead of placing on the maintenance engineer the duty of curing erosion. Even if erosion of bare slopes is not of the spectacular gullying type, year after year of frost heaving, sloughing, and sheet erosion will be an ever present cause of silted drainage channels.

* See 1942 Report of the Committee on Roadside Development, pp. 31-41.

It is considered advisable to include these items of mulching, seeding and sodding in initial construction, but in any case provision should be made to leave slope surfaces rough in preparation for subsequent mulching, seeding and sodding, rather than requiring the labor-wasting "sandpapering" of slopes which is all too frequently done.

C. Salvaging and protecting existing vegetation, particularly specimen trees, adds beauty to the "Complete Highway" without extensive operations of planting and subsequent plant maintenance.

Salvaging of specimen trees from within construction limits under favorable conditions may reduce right-of-way acquisition costs and provide an immediate landscape effect on the newly graded highway. In some cases such trees can be saved by being moved directly to a new permanent location at the outer edges of the right-of-way. Although transplanting requires hand labor for digging, the heavy road machinery such as tractors, bull-dozers and even light shovels can be utilized economically for lifting, skidding or hauling trees. Excepting special situations, public policy does not usually justify the cost of such salvage operations over about a 6-inch caliper size. Successful salvaging of specimen trees requires competent landscape supervision and trained crews during transplanting operations and during maintenance for a period of two or three seasons.

Protection of existing specimen trees at edges of cut and fill slopes can be accomplished by aeration courses under fill material and by tree "wells" and retaining walls. Walls for protection of tree roots in cuts can be built after initial construction, but in fills it is only before any fill is made that the tree roots can be protected with an aeration layer of coarse material. Protection during initial construction will reduce materially the subsequent maintenance that would be needed to rejuvenate "smothered" plants.

Planting. Under satisfactory seasonal conditions, planting of trees, flowering trees, shrubs and vine ground cover for erosion control and landscape effect can be satisfactorily integrated with initial construction. Otherwise, it may be best to have the planting done under a separate contract from the actual roadway construction. In any case, planting items should be planned and made a part of the plans specifications and estimates of the initial construction project. As in the case of mulching, seeding and sodding, planting for erosion control during construction gives a head start in preventing erosion, rather than necessitating curing of erosion by maintenance.

Selective clearing and special roadside clean-up outside of construction limits is somewhat difficult to describe in written specifications. It would be advantageous, however, to include selective cutting and clean-up work in initial construction. When not so included, it may at some later date disturb other roadside development -- such as seeding, sodding, mulching or planting -- that was included in initial construction. A good clean-up of rocks, logs, stumps and other debris during initial construction increases the percentage of right-of-way area that can be maintained by machinery, and makes all subsequent right-of-way clean-up quicker and easier.

These two items of planting and selective clearing and special clean-up will require careful specifications and then adequate specialized inspection during construction.

The integration of landscape principles and roadside development practices with initial highway location and construction will be beneficial to subsequent maintenance in two ways:

1. It will make the work of the maintenance engineer strictly maintenance. He should not be required to assume the duties of finishing up work that is definitely a part of the construction of the COMPLETE HIGHWAY.

2. It will turn over to the maintenance engineer a highway which is so designed and protected that the actual maintenance operations which are his responsibility can be done more quickly, more easily, and more economically.

PRINCIPLES OF HIGHWAY DRAINAGE/1

The report recognizes the fact that drainage practices are distinctly different in the humid regions where vegetation can be relied upon to control erosion, as compared with the dry regions where vegetation can only be established with difficulty.

In regions of deficient rainfall, the emphasis is on keeping water away from the highway. In both humid and dry regions, water should be discharged from the highway as soon as possible in a manner which will not cause damage to property below the highway.

The outline is limited to conditions normally occurring on rural highways without storm sewers and similar elaborate installations.

TURF FOR AIRFIELDS AND ROADSIDE DEVELOPMENT

The development of turf on airfields presents many problems that are common also to roadside development work. For convenience the different types of turfed areas are grouped according to probable use as areas of intensive traffic, occasional traffic and non-traffic. The areas that are used frequently for landing or taxiing of planes are comparable to many of the shoulder strips along highways. The areas of non-traffic on an airfield, like on roadside embankments, are planted only as needed to provide protection against dust and erosion, using native material where practical. Between these two extremes of use are plantings of different types to control dust and erosion, or to provide a camouflaging tonedown. The planting of airfields and roadsides should have in common the objectives of maximum durability and lowest maintenance costs consistent with the use requirements.

Grass-seeding and planting programs on airfields and roadsides, unfortunately, come at the end of major paving or other construction programs. The tendency,

---

1/ - The complete report by Carl F. Izzard, Chairman on Drainage and Drainage Structures, is published in the Highway Research Board Proceedings, Vol. 23, p. 264. Reprints are also available.

therefore, is to plan and execute them as "after thoughts." Such an attitude has resulted in much waste of effort and has led to false conclusions as to the effectiveness of the programs.

SPECIFICATIONS.* - A study of specifications for the seeding or planting of grass on Army installations, as on roadsides and other Federal projects, reveals a great variation in requirements and many indefinite clauses that clearly indicate the need for a more careful consideration of this phase of the program.

Any development of living things presents problems that cannot be solved by slide-rule methods. The specifications for turfing must necessarily be more flexible than are the specifications for most of the other items in highway or airfield construction. On the other hand it is not desirable or necessary to go to the extreme of making specifications so loose that they are subject to almost limitless interpretations. Extremes of rigid exactness or of loose indefiniteness in specifications lead to misunderstandings and delays and tend to add to the costs of establishing turf.

There are many examples in government specifications for turfing of extreme looseness in stating requirements which make it almost impossible to enforce definite standards. As an example, it is common in planting specifications to find that the seed requirements are covered by some such general clause as "the seed shall meet the requirements of the State and Federal Seed Laws." Actually such a requirement does not assure the delivery of any particular quality of seed since the laws referred to are essentially labelling laws. For example, a very low quality seed could conform to the above requirement provided it is correctly labelled. Also such a common statement of requirement as "seed shall be of good quality and high germination and obtained from reliable sources" is actually nothing that can be enforced as intended.**

In other cases cases seed mixtures are stated very precisely in terms of percentage of the total weight of each ingredient together with purity and germination figures for each. This type of specification is unsatisfactory because it is impractical to determine by seed tests whether the mixture was actually prepared in the specified manner.

A review of the several methods used in the specification of seed mixtures has indicated the need for a standardized, simple method for defining requirements in terms that can be enforced and at the same time encourage maximum competitive bidding. The requirements of seed have frequently been expressed in terms of pure live seed, which method was recommended in the report of this committee in 1941. The new "Corps of Engineers Guide Specification for Seeding" uses this designation of pure live seed, but goes a step farther than has been commonly used in the past in stating requirements for mixtures. The new specification states minimum requirements in terms of the percentage by weight of pure live seed in the total mixture as in the specification method "D".

---

* See Appendix IX, p.107 for Guide Specifications prepared by the Army Corps of Engineers.

**See Appendix IX, Sect. 1, for "Tentative Specifications for Purchase of Grass Seed."

Four methods of specifying seed requirements are as follows:

SPECIFICATION METHOD A

	Percentages		
	Weight Mixture	Purity	Germination
Kentucky Bluegrass	50	80	80
Domestic Ryegrass	30	95	90
Redtop	20	90	90

By multiplying the percentages of purity and germination, this requirement can be expressed by:

SPECIFICATION METHOD B

	Percentages	
	Weight Mixture	Pure Live Seed
Kentucky Bluegrass	50	64.0
Domestic Ryegrass	30	85.5
Redtop	20	81.0

By multiplying the percentages of weight of mixture and purity in SPECIFICATION METHOD "A", the requirement can also be expressed by:

SPECIFICATION METHOD C

	Percentages	
	Weight of Pure Seed	Germination
Kentucky Bluegrass	40.0	80
Domestic Ryegrass	28.5	90
Redtop	18.0	90

By multiplying the percentages of weight of mixture, purity and germination in SPECIFICATION METHOD "A", the requirement can be expressed in another manner by:

SPECIFICATION METHOD D

	Percentage Pure Live Seed
Kentucky Bluegrass	32.00
Domestic Ryegrass	25.65
Redtop	16.20

In 100 pounds of the mixture as stated in specification Method A, 50 per cent or 50 pounds comes from Kentucky Bluegrass seed stock. Since this stock is only 80 per cent pure, there are only 40 pounds (40 per cent) of pure bluegrass seed in the mixture (as shown in Specification Method C). However, only 80 per cent of this pure bluegrass seed germinates, so the mixture contains only 32 pounds (32 per cent) of pure bluegrass seed that may be expected to germinate and produce bluegrass plants, as in specification method D. It will be noted that by multiplying the figures in the several columns, in methods A, B and C, the same figure of 32 per cent is obtained for bluegrass, and similarly the percentages of 25.65 and 16.20 for the other grasses in the mixture.

The percentage of the pure seed which will germinate is called the percentage of pure live seed. Since, the plantings such as roadsides and airfields, the value of any lot of seed is dependent on the amount of the required seed that may be expected to germinate and produce plants, the requirements are stated most simply in terms of specification method D.

In addition to its simplicity, specification method D has the advantage of permitting seedsmen some leeway in the mixing of the ingredients to meet the specification requirements. A case is cited below of a mixture of seed which more than meets the requirements as expressed in specification method D on page 23, but which is below the specified minimum requirements, in the underscored items, when stated by specification methods A, B or C respectively.

CASE METHOD A

	Percentages		
	Weight of Mixture	Purity	Germination
Kentucky Bluegrass	40	90	90
Domestic Ryegrass	35	90	85
Redtop	25	90	85

CASE METHOD B

	Percentages	
	Weight of Mixture	Pure Live Seed
Kentucky Bluegrass	40	81.0
Domestic Ryegrass	35	76.5
Redtop	25	76.5

CASE METHOD C

	Percentages	
	Weight of Pure Seed	Germination
Kentucky Bluegrass	36	90
Domestic Ryegrass	31.5	85
Redtop	22.5	85

CASE METHOD D

	Percentage of Pure Live Seed
Kentucky Bluegrass	32.40
Domestic Ryegrass	26.77
Redtop	19.12

With requirements specified as in method D in terms of the percentages of pure live seed, the seedsman can change the proportions of the ingredients to conform with stocks on hand to get the mixture called for. For instance in case method A the percentage of the weight of Kentucky bluegrass is 40 which is below the minimum requirement of 50 called for in specification method A. This smaller weight of bluegrass seed is more than compensated by the higher percentages of purity and germination 40(90x90) = PLS 32.40 as compared with the requirement 50 (80x80)= PLS 32.00. Thus this smaller weight of higher grade bluegrass seed which will produce more plants than anticipated in the specification requirements is not acceptable when specification method A is used but is acceptable under the more flexible specification method D.

The actual percentage of pure live seed of each of the ingredients is the criterion of value regardless of how the seedsman combines them. Greater flexibility in the seed supply without reducing the quality of the final mixture tends not only to encourage more and lower bids but also helps avoid delays due to inadequate stocks of one or more of the ingredients of rigidly prescribed standards.

The remaining materials in the mixture are specified as a maximum of "other materials". These include chaff, dead seed, hulls, crop seed other than those specified, harmless inert matter and a prescribed maximum of weed seeds.

Another clause in grass seeding or planting specifications which has served to give a false sense of security is the guarantee clause. This clause has recently been eliminated from most types of contracts in Army projects. It is admitted that there are many sound arguments in favor of the guarantee clause in planting work. It serves to place the responsibility on the contractor and thereby has the effect of appearing to relieve representatives of the Government from responsibility for proper inspection. It has the added disadvantage of tending to encourage the Contracting Officer to make unreasonable demands of the contractor.

CONSTRUCTION: Unless the actual grass seeding and planting operations of airfields, as well as highways, are more closely supervised than they have frequently been in the past, any discussion of details of specifications becomes merely academic. In the interest of the Government, as well as the most reliable contractors, more sincere efforts should be made to properly supervise planting projects.

There has been a general tendency to interpret planting specification requirements rather loosely. The urge for speeding the completion of the project has apparently been considered as a justification for much poor work. The so-called saving in time enables accounts to be closed but too often necessitates complete reseeding or replanting. Another reason for the loose interpretation of specifications is the assignment to these projects of inspectors who have little or no interest in or prior experience with this type of work.

One of the common faults in planting is inadequate preparation of the seedbed. With the type of soil and the compaction that often are encountered on airfields and roadsides, it is difficult to produce a satisfactory seedbed. When specifications are written it is impossible to predict exactly what detailed methods will be needed to provide a suitable seedbed on all areas. The method that will be needed to properly loosen soil in temporary roadways for instance may represent wasted effort in over 90 per cent of the area to be planted. Nevertheless, specifications often require plowing to a stated depth when a much faster and cheaper method of loosening the surface by light disking would be adequate except on comparatively small compacted areas.

Grading is often badly neglected in spite of the requirements of the specification. The most troublesome irregularity on the comparatively flat grades of airfields is the long narrow depression or ridge parallel to the pavement. These strips where water collects are a constant menance to vehicles moving along the shoulders and discourage or prevent the development of a satisfactory protective turf. They are usually caused by careless grading practices that are commonly carried on in only one direction, parallel to the pavement. Other irregularities in the surface, caused by the interference to grading from large stones or other obstructions, are all too common. Often these irregularities are not important from the standpoint of traffic but they will cause serious delays in mowing operations. Decided improvements in final grading operations are needed on highways and airfields if full advantage is to be taken of improvements in high speed mowing equipment. It must be remembered that good grading can be accomplished before planting at a cost that is trivial as compared with the cost of regrading after a sod is provided.

The question as to the best use of topsoil on airfields as on roadsides is still unsolved. There has been an increasing tendency to dispense with topsoil on Army Airfields. There are many cases where funds and manpower have no doubt been wasted in spreading topsoil. On the other hand there are many other cases where topsoiling has been omitted to the distinct detriment of the projects. Every success of plantings on subsoil is likely to be misinterpreted as proof that topsoil is never needed. A more critical study of subsoils and topsoils is needed to determine the most effective use of topsoil for all turfing projects. Further study is needed of the relative efficiency of topsoil as compared with fertilizers on different types of subsoil.

The recent need for rapid planting of turf grasses on large areas with a minimum of labor has led to some decided improvements in machine planting methods. The sprigging machines are the best examples of this development. Doubtless these machines will be found to have extensive application to future highway as well as airfield planting programs. These more rapid planting methods make it possible to have large planting programs completed during the most favorable planting seasons.

A common weakness in any turf program is hasty judgment as to accomplishment. Frequently uniformed individuals will decide on the success or failure of a program based on the appearance of some green covering over the area. There continues to be many instances where jobs are accepted as completely successful when as a matter of fact the resulting growth is nothing but weeds or temporary grasses. Such conclusions are dangerous in that they are interpreted as proof that fundamental principles

as to time and methods of planting are of no importance. If a covering of weeds is to be considered adequate for any area, there seems no justification for waste of public funds in seeding or grass planting work.

MAINTENANCE: The relationship between the construction and maintenance work on turf is still not fully appreciated. When engineers build bridges or pavements their work is not ruined in a few months by neglect or faulty maintenance. On the other hand, they can write up ideal specifications for planting turf and have them executed perfectly only to find that in a few weeks the program has failed due to neglect of maintenance. Excellent plantings of Bermuda grass in soil heavily infested with Johnson grass, for instance, frequently fails completely on highways and airfields merely because the Johnson grass is permitted to grow up and smother out the newly planted Bermuda grass. Unless there is a more general understanding of this relationship and a greater effort is made to coordinate the two phases of turf establishment on both highways and airfield, public funds will be wasted.

Unfortunately the most important period from the standpoint of maintenance is in the early stages of the development of turf. The average cost of maintenance of pavements increases as they age, but in the case of turf the greatest cost is in the early stages. The problem must therefore be recognized as quite different from pavement maintenance.

Since the stand of grass that is ultimately obtained is dependent on maintenance, as well as the original planting, it is important for those who make and execute the plans to know the future needs and probable maintenance of the turf in the areas to be planted. It is obviously a waste of public funds, for instance, to sprig Bermuda grass along roadsides and on areas to be unused on airfields, where no provision is to be made for proper mowing and where weeds or native vegetation will develop quickly to give a satisfactory cover and to smother out the planted species.

The large turfed areas that have been developed on airfields and the constantly increasing acreage of turf along highway present mowing problems that are certain to receive more careful attention in the future. The old type of farm mower so generally used along highways and airfields in the past is too slow and expensive for large areas. Recent developments in mowing equipment for airfield use have already greatly speeded up mowing operations. Further improvements no doubt will soon follow. The new types of mowing equipment will be useful for road shoulders as well as airfields. In order to use high speed mowers to best advantage, it will be necessary to plan for roadsides that are more streamlined and more free from obstructions than are commonly seen today. Such provisions in addition to reducing maintenance costs will have the added advantage of added safety features.

DUST PALLIATIVES OTHER THAN TURF: In many areas it is impractical to grow turf, so some other method for the control of dust must be used on airfields. The common highway practice of using mulches of straw, hay or similar materials has been modified to make it serve airfield needs. The mulch is spread on tilled soil and then anchored down by pressing it into the soil by means of land packers or disks. Mulch alone greatly reduces the movement of dust but it has also been very effective on airfields, as on highways, as a protecting medium to aid in the establishment of grass. Gravel blankets, various bitumens and chemicals, rough tillage and other methods used in highway work have also been useful in the airfield program.

SUMMARY: There are many problems in common in the development of turf for airfields and roadsides. There is need for improvements in writing turfing specifications to state requirements more definitely and at the same time make allowance for needed flexibility. Details of writing specifications, however, are merely academic unless improvements are made in supervising the actual planting programs. Greater efforts must be made to work out better coordination between construction and maintenance since seeding and planting efforts may be wasted quickly by failure to follow up promptly with appropriate maintenance practices.

INSPECTION AND EVALUATION OF COOPERATIVE HIGHWAY EROSION CONTROL DEMONSTRATION PROJECTS

The Project Committee on Cooperative Agreement Project Analyses had tentatively planned for 1943 (jointly with the Project Committee on Erosion Control and Plant Ecology) a series of field inspections, evaluations and comparisons of a considerable number of the 109 Cooperative Highway Erosion Control Demonstration Projects which were handled cooperatively (beginning in 1937) by the Soil Conservation Service, the Public Roads Administration, the various State highway organizations, and the Highway Research Board. The postponement of the proposed inspections was made necessary, however, due to the restrictions of wartime conditions on personnel and travel.

The general program of the cooperative projects was originally outlined by the Project Committee on Erosion, Committee on Roadside Development of the Highway Research Board. The details of each project varied considerably, but in general the Soil Conservation Service furnished plans, labor, supervision, and a portion of the materials; and the State highway departments supplied equipment, equipment operators and the remaining materials. In some cases, the States used Federal Aid roadside improvement funds as a part of their contribution to the projects.

Complete reports of results are available only on a portion of the projects, and apparently any further reports, inspections, and evaluation will be severely limited until after the war; but it is only proper at this time to acknowledge the value of these projects in the progress of highway construction, maintenance, and erosion control in particular, and in all soil conservation work in general. The value can be summarized into three points:

1. They effected, in general, an immediate saving in maintenance cost. When official final reports of projects make statements such as "except for cost of mowing vegetation, the project apparently has required little maintenance," or "no repair work due to erosion since completion of project; whereas previously it was necessary to clean out ditches, remove silt from pavement, and repair shoulder washes after every heavy storm," it is obvious that substantial savings were made in maintenance cost even though no exact cost records are available.

2. They increased interest in highway erosion control on the part of State highway department engineers, and in a few States were the first serious efforts in erosion control work.

They had the effect of spurring on State highway landscape and roadside development personnel to improve erosion control techniques. Some parts of projects were failures; some immediate good results proved to be temporary and failed after several years; some methods of treatment were very costly. These failures and high costs were inevitable in a relatively new field of endeavor, but even the failures and high costs had a value because many of the effective and inexpensive erosion control techniques of today are traceable to the quickening of interest brought about by the cooperative projects.

It obviously is impossible to quote exact dollar and cent figures, but it can be fairly stated that the funds expended on these cooperative projects have been repaid many fold in highway erosion control. Advance data on these projects will be found on pages 79a to 83a of the 1941 Report, and on pages 42 to 47 of the 1942 Report of the Committee on Roadside Development.

TECHNICAL MOTION PICTURE ON HIGHWAY EROSION CONTROL

During 1943 the Project Committee on Erosion Control and Plant Ecology, with the material assistance of the Soil Conservation Service, distributed film and arranged for the filming of technical information on erosion control by a large number of States. Final editing of the film is being done in collaboration with Division III; Education, Evaluation, and Public Relations.