After Five Years: The Green Section Specifications for a Putting Green

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In 1960, the USGA Green Section staff published an article in the USGA JOURNAL AND TURF MANAGEMENT entitled "Specifications for A Method of Putting Green Construction." The article sparked a considerable amount of controversy about the concept even though the various principles embodied in the method are rather widely accepted, and readily demonstrable.

After a period of five years, there are presently some 1,200 greens in existence that have been built by this method. There is no question that the method is both practical and successful.

There are, however, some questions which continue to arise. There are some who have failed to grasp the significance and the importance of each single step in the process. There are some who have experienced partial failure because they only *partially* followed the specifications.

It is the purpose of this article to restate the steps involved in the construction procedure, to reemphasize the significance and the importance of each step, and to point out again the danger of following the method just partially.

The following seven steps in the construction procedure are reprinted from the September 1960 article:

1. SUBGRADE

The contours of the subgrade should conform to those of the proposed finished grade, with a tolerance of plus or minus 1". The subgrade should be constructed at an elevation 14 inches below the proposed finished grade. The subgrade should be compacted sufficiently to prevent future settling which might create water-holding depressions in the subgrade surface and corresponding depressions in the putting surface.

Where terrain permits, it is possible to build the subgrade into the existing grade or to cut it into the subsoil. It is not necessary to elevate or "build up" the green unless design considerations dictate the desirability of doing so.

It will be noted that courses of materials above the subgrade consist of 4 inches of gravel, 1½ to 2 inches of coarse sand, and 12 inches of topsoil. Thus the total depth will be 17½ to 18 inches. However, this fill material will settle appreciably, and experience indicates that 14 inches will be the approximate depth of these combined materials after settling.

2. DRAINAGE

Tile lines of at least 4-inch diameter should be so spaced that water will not have to travel more than 10 feet to reach a tile drain. Any suitable pattern or tile line arrangement may be used, but the herringbone or the gridiron arrangements will fit most situations.

Cut ditches or trenches into the subgrade so tile slopes uniformly. Do not place tile deeper than is necessary to obtain the desired amount of slope.

Tile lines should have a minimum fall of .5%. Steeper grades can be used but there will seldom be a need for tile line grades steeper than 3% to 4% on a putting green.

Tile may be agricultural clay tile, concrete, plastic, or perforated asphalt-paper composition. Agricultural tile joints should be butted together with no more than ¼" of space between joints. The tops of tile should be covered with asphalt paper, fiberglass composition, or with plastic spacers and covers designed for this purpose. The covering prevents gravel from falling into the tile.

Tile should be laid on a firm bed of ½" to 1" of gravel to reduce possible wash of subgrade soil up into tile line by fast water flow. If the subgrade consists of undisturbed soil, so that washing is unlikely, it is permissible to lay tile directly on the bottom of the trench.

After the tile is laid, the trenches should be backfilled with gravel, and care should be taken not to displace the covering over the joints.

3. Gravel and Sand Base

a. The entire subgrade should be covered with a course of clean washed gravel or crushed stone placed to a minimum thickness of 4 inches.

The preferred material for this purpose is washed pea gravel of about ¼" diameter particle size. Larger gravel or stone may be used, but it is important that changes in size between this course of material and the succeeding one overlying it not be too great. Otherwise, smaller particles from overlying material will wash into the gravel, clog the pores or drainage ways and thereby reduce the effectiveness of the gravel.

The maximum allowable discrepancy appears to be 5 to 7 diameters. In other words, if ¼" pea gravel

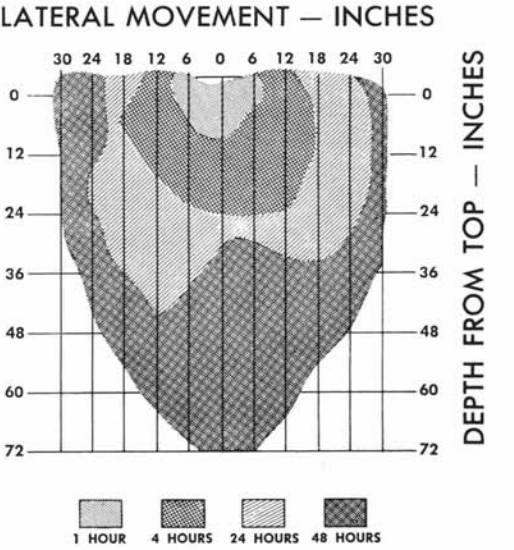


Figure 2. Infiltration of water into Yolo loam from an irrigation furrow kept fiilled for various lengths of time. Note that vertical movement exceeds lateral movement. (Adapted from Hendrickson and Veihmeyer, 1933.)

(about 6 mm.) is used, then the particles of the overlying course of sand should not be less than 1 mm. in diameter. If stone of 1 inch diameter were used, it would be necessary to include a course of pea gravel to prevent the movement of smaller soil aggregates into the stone.

b. When the gravel is in place, assuming that pea gravel has been used, a 1½" layer of coarse washed sand (commercial concrete sand is satisfactory) should be placed to a uniform thickness over the gravel.

The tolerance for error in the thickness of gravel and sand courses should be limited to plus or minus .5 inch.

A profile of a properly constructed putting green is illustrated in Figure 1.

4. "Ringing" the Green

When the courses of gravel and sand are in place and outlets have

been established for subsurface water (through tile lines), the green should be "ringed" with the soil which is to be used for aprons and collars. This soil should be placed around the green and any contours established in such a way that they will blend into the putting surface.

The next step is to fill the depression, which represents the putting surface, with the prepared topsoil mixture described in the following paragraphs.

5. Soil Mixture

A covering of topsoil mixture at least 12 inches in thickness should be placed over the sand and gravel layers.

The soil mixture should meet certain physical requirements.

Permeability—After compaction at a moisture content approximately field capacity as described by Ferguson, Howard and Bloodworth, a core of the soil mixture should permit the passage of not less than ½ inch of water per hour nor more than 1½ inches per hour when subjected to a hydraulic head of .25 inches.

Porosity—*After compaction*, a sample of the soil mixture should have a minimum total pore space of 33%. Of this pore space, the large (noncapillary) pores should comprise from 12 to 18% and capillary pore space from 15 to 21%.

Information with respect to bulk density, moisture retention capacity, mechanical analysis, and degree of aggregation in the hands of a soil physicist may be helpful in further evaluating the potential behavior of a putting green soil.

Few natural soils meet the requirements stated above. It will be necessary to use mixtures of sand, soil, and organic matter. Because of differences in behavior induced by such factors as sand particle size and gradation, the mineral derivation and degree of aggregation of the clay component, the degree of decomposition of the organic matter, and the silt content of the soil, it is impossible to make satisfactory recommendations for soil mixtures without appropriate laboratory analyses.

The success of the method of construction herein described is dependent upon the proper physical characteristics of the soil and the relationship of that soil to the drainage bed underlying the green. Therefore a physical analysis of soil should be made before the soil components are procured. When the proper proportions of the soil components have been determined, it becomes extremely important that they be mixed in the proportions indicated. A small error in percentages in the case of a plastic clay soil can lead to serious consequences. To insure thorough mixing and the accurate measurement of the soil components, "off site" mixing is advocated.

6. Soil Covering, Placement, Smoothing and Firming.

When soil has been thoroughly mixed off site it should be transported to the green site and dumped at the edge of the green. Padding the edge of the green with boards may be necessary to prevent disturbance by wheeled vehicles of the soil previously placed around the outside of the putting surface. A small crawler-type tractor suitably equipped with a blade is useful for pushing the soil mixture out onto the prepared base. If the tractor is always operated with its weight on the soil mixture that has been hauled onto the site, the base will not be disturbed.

Grade stakes spaced at frequent intervals on the putting surface will

be helpful in indicating the depth of the soil mixture. Finishing the grade will likely require the use of a level or transit.

When the soil has been spread uniformly over the surface of the putting green it should be compacted or firmed uniformly. A roller usually is not satisfactory because it "bridges" the soft spots.

"Footing" or trampling the surface will tend to eliminate the soft spots. Raking the surface and repeating the footing operation will result in having the seed or stolon bed uniformly firm. It should be emphasized that the raking and footing should be repeated until uniform firmness is obtained.

Whenever possible after construction, saturation of the soil by extensive irrigation is suggested. Water is useful in settling and firming the surface. This practice will also reveal any water-holding depressions which might interfere with surface drainage.

7. STERILIZATION OF SOIL AND ESTABLISHMENT OF TURF

These steps may be accomplished by following well-known conventional procedures.

With the restatement of these procedures, let us reexamine the recommendations step by step and point out some of the opportunities for error.

THE SUBGRADE

When a new green is built and the subgrade is contoured, it frequently happens that there is a rather large amount of fill. It is very difficult to compact filled areas sufficiently to preclude further settling. However, the builder must strive to prevent further settling if at all possible. If uniform layers of gravel, sand, and soil overlay the subgrade, it is obvious that any settling of the subgrade will result in a corresponding settling of the top. Therefore the thorough compaction of filled areas is necessary if the green is to maintain the contours built into it.

TILE DRAINAGE

It is commonly believed that the use of a gravel layer provides adequate drainage and that the installation of tile is a needless expense. No doubt there is good reason for this belief in many cases. However, when large amounts of water are moving through soil under conditions of heavy rain or rapid irrigation, and where the water must move a considerable distance to reach an outlet, tile lines aid in the removal of excess water. It is also true that despite the best efforts to compact the subgrade, it sometimes settles after construction and "pockets" appear. Tile lines help to remove such trapped water. A putting green is expensive to build and the relatively small additional cost of adding tile drainage appears to be a small price for the insurance it provides.

GRAVEL AND SAND BASE

In a few cases builders have used tile and have then assumed that there is no need for a gravel base. This assumption is the result of a failure to understand how water moves in the soil. Lateral movement of water is relatively small unless there is a barrier which impedes its downward movement. See Figure 2. Therefore when tile is placed near the surface it must be very closely spaced if it is to remove much of the excess water. Conversely, if it is spaced at intervals of more than 4 or 5 feet it must be placed very deeply.

When the gravel layer is used beneath the putting green, it provides a medium whereby water can move laterally very easily. Thus tile can be

placed just at the bottom of the gravel layer and spaced at intervals of ten to twenty feet, depending upon the degree and direction of slope.

The layer of coarse sand used over the gravel base is for the sole purpose of preventing the soil particles from migrating downward into the gravel. This principle can be most easily pictured by an overly simplified illustration. Suppose one filled a room half full of basketballs and then poured a sack of marbles on top of them. The marbles wll move down through the voids to the floor. So will small soil particles move down through gravel. In contrast suppose the room half full of basketballs were covered with a layer of baseballs. They would remain in a layer. Then a layer of golf balls would stay on top of the baseballs. Then if you poured the sack of marbles on top they would stay in place. Thus, if you wish to keep fine soil on top of coarse materials, it is necessary to build up with successively finer layers of material.

RINGING THE GREEN

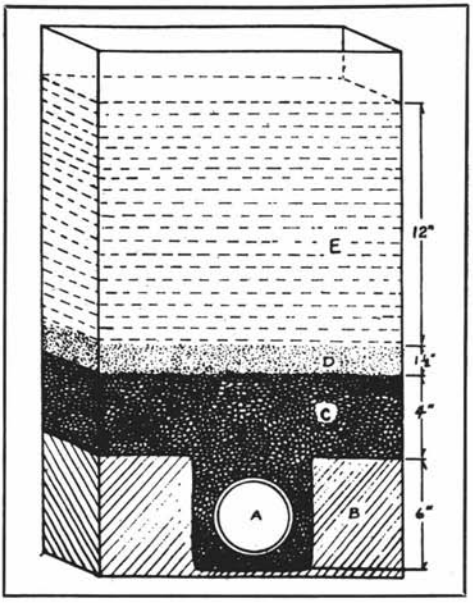
Some builders place topsoil around the edges of the green after the sand and gravel are in place. They will then proceed to place the putting green soil mixture on top of the gravel and bring it to the finished grade.

There is one disadvantage to placing a heavier topsoil contiguous to the porous putting green soil mixture. Moisture is sometimes drawn out of the putting green edge because of the greater tension exerted by fine textured soil. This disadvantage can be overcome by using something like polyethylene plastic sheeting as a vertically placed moisture barrier between the "ring" of topsoil and the soil mixture on the putting surface.

Without the use of such a moisture barrier, the edge of the putting green may dry out faster than the remainder of the green.

Figure 2

PROFILE OF PUTTING GREEN WITH TRENCH AND TILE LINE, IN CROSS-SECTION



A. 4-inch diameter tile.

B. Subgrade of native soil or fill material.

C. Gravel—preferably pea gravel of approximately ¼" diameter. Minimum thickness 4 inches.

D. Coarse sand—this sand should be of a size of 1 mm. or greater, 1½ to 2 inches in thickness.

E. Topsoil mixture. Minimum thickness of 12 inches.

THE INTERFACE

Apparently one of the most puzzling of the principles involved in the Green Section Specifications is the function of the textural barrier. Figure 3 is a photograph showing that water does not move from a layer of fine soil into a lower layer of a

coarser textured soil until the fine textured soil becomes saturated. The reason for this failure of water to readily cross the "textural barrier" is a matter of surface tension. When sufficient gravitational force (weight) accumulates, the tension force is overcome and water then drains out through the sand and gravel.

The "textural barrier" then can be used to increase the water holding capacity of an open textured soil. If irrigation is stopped just before the soil reaches the saturation point, no drainage occurs. On the other hand, in the case of a heavy rain, the soil will not hold too much water. It is paradoxical that the soil overlying such a "textural barrier" can be made to hold more water than it would without the gravel layer, but it cannot be made to hold enough water to be harmful to plants.

THE SOIL MIXTURE

The compounding of a soil mixture based on laboratory tests is one of the essential elements of the Green Section Specifications.

In some cases greens have been built and called "Green Section Specification" greens where the builder has borrowed a formula based on his neighbor's laboratory tests. This is a dangerous practice because soils, sands, and organic matter are likely to vary widely within a community. In some experimental plots where the same sand and the same organic matter were used but where two different high clay content soils were used, a suitable mixture required 40 percent of one soil and less than 10 percent of the other.

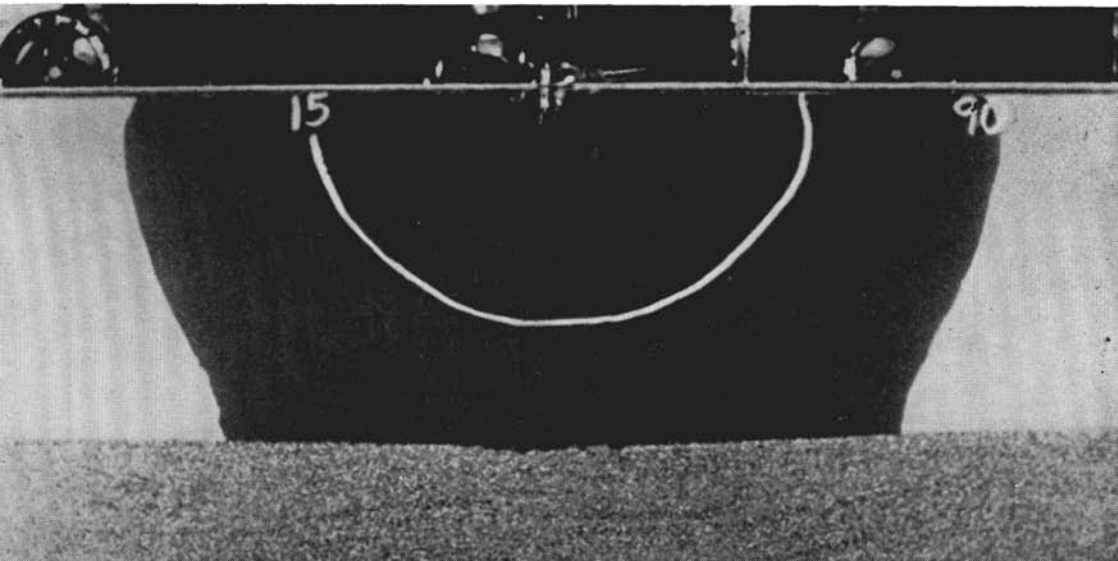
The Green Section can provide laboratory tests at a nominal cost. Such a test is of utmost importance.

Some critics of the use of laboratory methods have argued that one cannot substitute laboratory measurements for good judgment. How true! *But how much better is a judgment based upon measurable physical facts rather than on instinct, "feel," or visual estimation!*

SOIL COVERING, PLACEMENT, SMOOTHING, AND FIRMING

In our experience we have found no difficulty in following this step in the method we have advocated. It may be well to reiterate that soil should be mixed "off site." It is virtually impossible to do a satisfactory job of

Figure 3. Water does not move from a loam soil until the soil becomes saturated. (From W. H. Gardner — 1953)



mixing soil materials in place on the green site.

ESTABLISHMENT OF TURF

Because of the fact that soil mixtures prescribed are quite porous, there have been a number of cases where greens have been rather slow to become established. Frequent, light fertilization of newly seeded or vegetatively planted greens appears to be one method of speeding establishment.

In several cases these greens have been sodded. This is a satisfactory procedure *provided the sod is grown on the same soil mixture as is used in the green.* Growing sod on a heavier soil and then moving it to a porous putting green soil is an almost certain invitation to failure.

USE THE "WHOLE PACKAGE"

The steps outlined for constructing putting greens will provide excellent results if they are followed exactly and completely. This fact has been amply demonstrated.

Equally demonstrable is the fact that going just part of the way with these procedures is an invitation to failure. A great many years of research have gone into the study of each phase of this method of construction. If one uses a heavy soil, he must either use a much deeper seedbed or he must leave out the gravel layer. If one mixes a soil that is too sandy and too deep, it will be droughty.

These are negative ways of saying that if you undertake to construct a putting green by this method, follow the instructions completely.

HOW EXPENSIVE?

Some clubs have been deterred from building putting greens by this method because they have thought that the construction costs will be excessive. It is obviously impossible to predict the cost in any given area because of variations in the cost of soil materials, gravel, and labor. Some ideas of quantities of materials may help in cost estimations. The following quantities of materials are required per 1,000 square feet of putting surface:

Gravel	4	inch depth—12.3 cubic yards
Sand	1½	inch depth— 4.6 cubic yards
Soil Mixt.	12	inch depth—37.0 cubic yards
Tile		approximately 100 lineal feet

Finally, the reader again is referred to the original article published in the USGA JOURNAL of September 1960. The same procedures are still recommended, and the same criteria for determining soil mixtures are still being used. The original publication contains a list of references which will provide informative background reading. In the same issue, there is an article describing laboratory methods used in soil mixture evaluation. Five years of field experience in widely separated geographical areas provide abundant evidence of the merits of this method.

COMING EVENTS

Nov. 17-18 .....Minnesota Turfgrass Conference
Normandy Hotel
Minneapolis, Minn.

Dec. 1-3 .....Oklahoma Turfgrass Conference
Oklahoma State University
Stillwater, Oklahoma

Dec. 2-3 .....Illinois Turfgrass Conference
University of Illinois
Urbana, Illinois

Dec. 6-8 .....Texas Turfgrass Conference
Texas A&M University
College Station, Texas

Dec. 8-9 .....Louisiana Turfgrass Conference
Univ. of Southwestern Louisiana
Lafayette, La.

Jan. 4-March 11 ....Winter Turf Course
Rutgers University
New Brunswick, N. J.

Jan. 12-14 .....Nebraska Turfgrass Conference
Lincoln, Nebraska

Jan. 20-21 .....Golf & Fine Turf Short Course
Rutgers University
New Brunswick, N. J.

Jan. 25-26 .....Virginia Turfgrass Conference
John Marshall Hotel
Richmond, Va.

Jan. 28 .....USGA Green Section Conference
New York, N. Y.