This doesn't mean that renovation attempts are never justified, because that depends entirely on the particular problem that must be solved.

Another reason that rebuilding could be better and more economical in the long run is that it is impossible to obtain as good a soil mix by blending on the site with a tiller or disc as it is by mixing the components away from the site and placing them on the green.

Maybe some day someone will devise a foolproof method of renovation, but until then the process will be strictly guesswork and should be considered in its proper place as second best to a good rebuilding job when significant problems are involved.

Any of our present methods of renovation which attempt to modify a green below depths of one inch should be taken under advisement. Be sure that members will get the most for their money and that any changes fit into the long range plan of improvements.

Putting Green Construction

by JAMES L. HOLMES, Agronomist, USGA Green Section

In 1960 the USGA Green Section published the article: "Specifications for a Method of Putting Green Construction." This is a laboratory-proven method of construction that is known to have the following characteristics even after soil compaction:

1. A known and relatively constant water infiltration rate.
2. A known and relatively constant water permeability rate.
3. A predetermined amount of air or void in the soil mix.
4. That amount of void which will contain air balanced against that amount of void which will contain water when the soil mix is at field capacity.

A perched water table phenomenon described in the specifications becomes of paramount importance when greens are built in this manner. Thus, if attempts are made to build greens following this method, instructions must be followed **exactly.** In order to keep infiltration and percolation rates within prescribed limits and to arrive at a suitable air-water relationship at field capacity, it has been proven necessary to use a relatively large percentage of coarse material such as sand in preparing the putting green soil mix. This is especially true in dealing with soil high in content of silt, clay, or organic matter.

One or more greens built according to Green Section specifications have been installed at many golf courses. Usually when a club decides to build one green according to these specifications, it is built in the poorest possible location and where a history of failures exists. Invariably this new green holds up better and then clubs frequently rebuild all their greens to these specifications.

Of foremost consideration is the fact that greens built by this method can be played immediately after a heavy rain or even after a green has been mistakenly watered to excess. With increasing traffic on putting greens, this characteristic becomes ever more important. Greens which do not contain adequate internal drainage are seriously damaged if play is allowed when soil is saturated. If for nothing else, a method of putting green construction which allows play immediately after saturation is of considerable help.

Previous Methods

The traditional method of building greens was to form general contours with existing soil, then spread sufficient sand and organic matter (humus or peat moss) so that a mixture of approximately ⅓ native soil—⅓ sand—⅓ organic matter (or 1-1-1 ratio) is present to a depth of eight to 10 inches after mixing. Numerous mixing procedures are followed, such as plowing, discing, rototilling and shoveling. Such greens have presented suitable putting surfaces for 60 years or more, especially where surface drainage has been adequate.

No doubt a majority of greens in the United States were constructed in this manner. However, the demand on greens is increasing steadily. Golfers insist on playing at any and

all times, following heavy rains or at times when greens built to the 1-1-1 ratio are completely saturated. Often permanent damage results.

Not only has the 1-1-1 ratio been in use for a number of years, but many courses have used only native soil in making greens. Greens made from native soil have held up quite well, but the most satisfactory results are obtained only if rapid surface drainage is assured.

Using these methods today it would be necessary to construct very large greens simply to assure adequate space to place cups. If large and numerous cup placement areas are not available, turf is worn out, especially when play is heavy and soil is saturated. With greens in excess of 15,000 square feet it is not always possible to obtain adequate surface drainage; at least this requirement is not always built in.

In addition to the 1-1-1 consistency and native soil construction, a few are constructed on almost pure sand, and occasionally simply by mixing sand with organic matter. Greens built this way have held up well, resulting in years of trouble-free play. All this emphasizes that greens have a better chance to survive if excess moisture can be removed from the soil.

What's Happening Now

Controversy exists and misinformation abounds in the green construction field today. Many builders and architects have given the Green Section's specifications a cursory reading and have decided that certain steps are not really necessary, or that such construction is too costly or too troublesome.

Quite often soil tests are not made and other short cuts are attempted. Tile is not installed as specified, the amount of gravel is reduced, or the builder decides that 10 to 12 inches of topsoil mix after settling is not required. Others have decided that too much sand is being used in the topsoil mix. They guess that a mixture which contains between 50 percent and 65 per cent is suitable.

It has been found repeatedly that when this amount of sand is mixed primarily with a silt-clay loam, a superb grade of concrete or adobe results. It seems impossible to arrive at a poorer soil mix. After this mix has been in place for less than a year, frequently it is impossible to probe to a depth of two inches. Within the first year, superintendents are either rebuilding these greens or are involved in major renovation to improve drainage.

For some reason it is difficult to get across the idea of the perched water table phenomenon. This is of absolute importance if greens are to be built according to Green Section specifications. Most people believe that if gravel is placed under a soil of any type, drainage will be assured. It won't.

To explain, it is necessary to understand the principle of capillary attraction. Water is attracted to itself as well as to many other things. Water will envelope and be attracted to soil particle surfaces and interfaces. Thus, the smaller the pore spaces in a soil, the greater the adhesive force exerted and the more tenaciously water is held.

Not only is the size of the individual pore important, but so is the total pore space contained in a given soil mixture. Pure sand contains relatively large pore spaces and, therefore, will drain readily. As fine soils (silt and clay) are mixed with sand, they fill the larger pore spaces between sand particles. When this occurs, extremely fine pore spaces develop and a highly effective natural sponge results.

If gravel or any material which has larger pore spaces is placed beneath this fine soil mixture, capillary attraction is much greater in the fine soils above. Consequently, it is impossible for water to drain naturally from the fine soils into the gravel. The perched water table that develops from this mixture is more or less permanent, and this can be disasterous to growing turf.

However, if soil components are properly tested, a mixture can be prepared whereby the perched water table phenomenon would exert a sufficient water-holding force so that half the water held in the mixture is contained in larger voids. This will drain by gravitational pull coupled with column tension when the mixture approaches saturation.

Controversy continues over the necessity of drain tile. Here again, if those involved would simply develop an understanding of water-holding capacity of the soil mix with which they are dealing, it is a simple matter to determine whether tile will work. If many fine pore spaces are present, this soil has a great attraction for water. A tile is simply a large void with absolutely no attraction for water other than through gravity. Thus, if the soil surrounding the tile is a strong enough sponge and has a great enough attraction for water, it is impossible for water to enter the tile, especially a shallowly placed tile.

On the other hand, if the soil mixture surrounding the tile does not have a great attraction for water, and if a sufficient quantity of water is present, water will move by force of gravity into the tile.

Once water starts into the tile, column tension comes into play. A quantity of water which exceeds the amount which would normally drain due to gravitational pull, then enters the tile. This leads to the theory that tile pulls water. However, it is really water pulling water. The question of whether tile is necessary depends entirely upon the soil with which you are dealing.

It is of absolute, prime and controlling importance that adequate surface drainage be built into any green. It is especially necessary in those where guess-work, and not specified procedures, is being followed.

Checking into other methods of construction for putting greens is continuing with emphasis on hydroponics or sub-surface irrigation, as well as on incorporating synthetic materials. It would seem, as our current knowledge indicates, that water and air relationships with regard to turf and the demands of the golfer are key factors. These are being explored to the greatest extent. We should not overlook the possibility to employ complete synthetic materials such as those used in the Astrodome in Houston, Texas, in areas of heavy use.

Even though significant break-throughs have been made with regard to green construction, it goes without saying that improvement will be made in this area and that new ideas and practices will be forthcoming in time.

Green Section Award

Elmer J. Michael of Pittsford, N.Y., was named recipient of the United States Golf Association Green Section Award, presented for distinguished service to golf through work with turfgrass. Mr. Michael was Golf Course Superintendent at the Oak Hill Country Club, Rochester, N.Y., from 1929 until his retirement in 1965.

The award was presented by Wm. Ward Foshay, of New York, USGA President, and Henry H. Russell, of Miami Beach, Chairman of the Green Section Committee.

Mr. Michael began his career in 1918 as an assistant to his father at the Park Club of Buffalo, N.Y., which was built on the site of the Pan-American Exposition. A few years later Walter J. Travis redesigned the city course and, at the age of 22, Mr. Michael was put in charge of construction. He supervised the work of 40 men. He remained at this course until 1925, and from there went to Transit Valley Country Club, East Amherst, N.Y., until he moved to Oak Hill.

Mr. Michael was among the earliest superintendents to recognize the value of creeping bentgrasses for putting greens. He planted the East Course at Oak Hill to a strain of bentgrass that he discovered on grass plots that were abandoned after the Pan-American Exposition.

He also designed and installed an irrigation system for both the East and the West Courses at Oak Hill.

Mr. Michael trained numerous men who are now working as golf course superintendents throughout the country.

He is a member of the USGA Green Section Committee and of several turfgrass organizations, including the Finger Lakes Golf Course Superintendents Association and the Golf Course Superintendents Association of America. He served as Mayor of Pittsford from 1956 until 1960 with no interruption to his duties at Oak Hill. He is a past President of the Pittsford Rotary Club and an Elder in the Pittsford Presbyterian Church.

Mr. Michael is the seventh recipient of the Green Section Award. Previous winners were Dr. John Monteith, Jr., of Colorado Springs, Colo.; Professor Lawrence S. Dickinson, of Amherst, Mass.; O. J. Noer, Milwaukee, Wis.; Joseph Valentine, Ardmore, Pa.; Dr. Glenn W. Burton, of Tifton, Ga., and Professor H. Burton Musser, of State College, Pa.