

Problems described in the first paragraph above usually require rebuilding, those in the second are primarily renovation projects.

Pride in membership. Most club members desire to make their course one of the best; they wish to modernize it; they wish at all times to have a good golf course in top playing condition; they wish to have it a tough, yet fair test of golf. What constitutes a tough yet fair test of golf depends largely on the handicap of the golfer who is asked this question. The direction in rebuilding, therefore, generally favors the "average" golfer, for after all the purpose of the golf course is to afford pleasure to the greatest number of golfers. Yet all through this desire for improvement is the underlying wish on the part of the members that the course not be touched. No golfer wants to play 17 holes—they don't like to play temporary greens—they don't like to see fairways torn up—they hope for a "magic-wand" type reformation.

Fortunately, clubs have the organizational framework for easing this situation—they get their direction from the Green Committee and the superintendent. The obvious solution is to set up a program of projects with priority of assignment so that the course is not torn up year after year during the height of the golfing season. Here, the superintendent's counsel strongly enters the picture as he

can schedule projects for best results with least interference with play.

Because of the usual quick turnover of Green Committee personnel, it is most important to set up a long-range program of improvement projects, approved by the membership, so that the superintendent can set his course of action. Only then is it possible to keep members informed and only then is the road to harmony open.

In summary, we wish to re-emphasize the following points:

1. The desire on the part of the superintendent and the membership for improvement makes renovation and in some cases rebuilding necessary.

2. Plan each improvement project thoroughly, do it at the right time for best results, and keep the length of time required to complete the project to a minimum.

3. Do not take on more work than you can handle comfortably in any one season.

4. Prepare the membership for improvement projects by informing them well in advance of what is to take place.

5. Pursue the improvement plan vigorously—leave nothing undone that should be done. Success with one project eases the way for the next.

6. Alter as necessary the maintenance and management program to derive full benefit of the renovation or rebuilding programs.

Good Drainage For Greens

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Drainage is one of the major building blocks in successful green construction. Without good drainage the task of turfgrass maintenance will always be more difficult and expensive. Excessive wetness increases soil compaction. Wet and compact soils lower the oxygen levels. This reduces the efficiency of the soil organisms, inactivates the root system, and gives shallow rooting. All these are factors which increase susceptibility of the turf to drought and heat. Often the extra stress produced by these conditions may bring disaster during critical summer periods. Even short periods of excessive wetness may cause drowning of

the root system or a slow down of water intake by the plant.

Good drainage is always a first class investment. Without it the area may be unfit for use on occasions. With good drainage, watering is easier, and overwatering or excessive rainfall is less likely to cause trouble. If a green has correct drainage, more watering can be done with sprinklers, and hand watering can be restricted largely to watering of the ridges and to syringing during periods of severe heat.

Good drainage can be characterized by prompt water movement off the surface and through the soil. Also, the system

must have an adequate outlet which will permit drainage to continue even with the most extreme total quantities of water. Occasionally, drainage is made into stone or coarse soil set in basins of clay, "french" drains or other limited reservoirs. When these fill, days may elapse before excess water moves from the soil.

Some ask if over-drainage is possible. Rapid and complete drainage will not harm the grass. However, soils are frequently made shallow and droughty by placing coarse materials too near the surface.

The precise quantity of drainage, probably is not as critical as the free movement of water at all times. Grass roots are living structures which require oxygen. The amount of oxygen needed varies with temperature, the soil organism activities, and the grass species. The oxygen requirements of bentgrass are lower than for many plants, and it has been shown that bent grass can remain healthy with the amount of oxygen present in fresh water. Thus, fresh water moving through the soil never harms bent; it is an important carrier of oxygen.

Good surface drainage of the green eases the problem where internal drainage is slow and it shortens the period of wetness that follows heavy deluges of water. Even though the surface must be relatively flat, a slope of 1/2 to 1 per cent, if carefully graded, can give excellent surface drainage. In addition to slope, the pattern of surface drainage is important. As far as possible, avoid concentrating all of the run-off in one waterway. If this is necessary, try to place this construction in a minimum traffic area.

Underground drainage can be obtained by a naturally occurring or an installed layer of coarse material. On occasion, a coarse sand subsoil may exist which would prove adequate. A layer of gravel, cinders or trap rock can be used. If a coarse base is effective under all conditions, it must have an outlet at the bottom or side.

In the more clayey soils where a coarse base does not exist to serve as an outlet for the water from the topsoil region, tile drains may be necessary. If the green is being rebuilt, past behavior may have demonstrated the need. Before embarking

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on establishment of drainage for a wet green, be sure to locate the source of trouble in advance. Greens built near embankments or slopes may have especially tricky problems. Test diggings are helpful in establishing the drainage techniques.

Tile must be carefully installed at a depth of 24 to 36 inches. In some cases, one line in a green is adequate, while in others, they should be spaced at intervals as close as 10 to 15 feet. The grade of the tile may range from 0.5 to 5 feet per 100 linear feet. The grade and line must be established by instrument.

The tile should be laid on a true-line on a firm base of stone or trap rock. The joints should allow a space of 1/16 to 1/8 inch and they should be covered on the top with tar paper. The tile should then be covered with coarse stone or trap rock. The contour of the base soil after installation of the tile drains should have slight crowns that will lead water toward the drain opening.

In covering a coarse base or a tile drain covered with coarse material, add similar materials of slightly but increasingly finer texture up to the finest grades of gravel or trap rock to reach the level for start of topsoil installation. Twelve inches of loose topsoil material and the base soil above the coarse base or tile drain should total a minimum depth of two feet. When adding soil base before adding topsoil, make sure this material does not contain more clay than the topsoil. A material of this type could destroy all or part of the value of previous drainage work.

The soil that is used above the coarse base or tile drain should be very carefully selected. Details will not be given on the quantities of clay and sand as this will be covered in a subsequent paper. As the layers of topsoil and base soil are placed above the coarse base material or drains, use care to blend all layers. Also, all ingredients of the individual layers should be thoroughly mixed off the site before placement.

Quite often, use of drainage procedures as described will raise the level of the green above the natural surface soil. This is commonly very helpful in enabling soil water to move out of the drainage system. This more exposed elevation permits the wind and air to circulate more freely over the surface of the green. Usually this feature is considered very desirable.

The drainage system should not be developed without the sound guidance of someone who has thorough knowledge and actual experience. This applies especially with tile drainage. Also, actual attainment of the proper soil materials and the desired blending is far more likely to occur with experienced guidance.

Some of the details suggested to insure drainage give the task an appearance of being too much trouble. Every effort required for soundness of the drainage system will be repaid. A lack of drainage cannot be corrected easily after the green is finished, and without good drainage, putting green maintenance becomes undesirable business. In some cases, the quality of the greens will always be inferior regardless of the amount of maintenance effort.

Soils

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Soils upon which turf is to be established deserve considerable attention whenever rebuilding or remodeling is contemplated. Putting green soils are so often the source of turf trouble that the USGA Green Section began about 10 years ago to sponsor research dealing with the physical relationship of soils. This work has been done at Beltsville, at Oklahoma State University, at UCLA, and more recently at Texas A. & M. College.

There are four primary functions of a soil. It provides support, nutrients, water, and air (oxygen). In addition to these primary functions, the soil used in a putting green must fulfill other peculiar requirements. (1) It must resist compaction under traffic and during all kinds of weather conditions. (2) It must hold a properly played golf shot, yet be firm enough to resist the pitting caused by golf balls played with a high trajectory.