

settling which might create depressions resulting in pockets of poor drainage or, in the event of higher finish grade, droughty areas. The best device to accomplish this is a power driven vertical compactor (modified jack-hammer) or, as a second choice, a water filled mechanical roller operated in several directions across the subgrade floor.

In order to form a uniform root zone depth throughout the green, contours of the subgrade should match those of the finish surface grade with a tolerance of  $\pm 1$  inch. Initial shaping of subgrade contours involves placement of fixed grade stakes that are referred to the permanent bench mark elevation. The bulldozer operator then follows these pre-marked stakes to the indicated depths that the architect intended. Once the operator is finished with the initial contours, they should be resurveyed to ensure that the settled contour elevations are as originally specified. Usually the architect then inspects the subgrade contours to ensure that they meet the original specifications and to allow for any slight modification to improve them.

### Tile Installation

Providing the desired drainage for golf courses includes proper tile drain line installation. Tile installation is imperative for water removal if the subgrade is a clay or if the soil has a impermeable layer, otherwise the green could remain excessively wet for several days after heavy rain.

The first phase of tile installation involves location of an adequate-sized outlet for drainage water. Typically, tile lines are drained into nearby ditches, ponds, large drainage lines, existing french drains in the fairways, or nearby out-of-play grass areas. Discharge lines should be nonperforated pipe and not be laid straight down a steep slope, but have a gradual slope to reduce the flow rate from the green. In some cases, a suitable discharge source may not be readily available. In this case a sump and pump may be required. The sump is a water gathering area (tank) such as that formed when several concrete rings are placed on top of each other enclosed with a lid. A low-lift pump is installed inside the sump with float-activated switching so that the water level may be controlled within specified limits. Once this predetermined level of water is drained into the sump, the discharge water is then pumped up to an appropriate discharge area. Sumps should be located away from the green and in areas receiving little traffic. Care must be taken not to direct the green's main

drainage lines into adjacent sandtraps as washouts will be common. Covering the main tile line outlet with a mesh wire is also advisable to prevent rodents from entering the lines and tunneling up into the green.

Drainage lines should be spaced so water will not have to travel more than 10 feet to reach any one line (e.g., tile lines 15 to 20 feet apart). If the golf green is situated on an area with a high water table, larger tile lines placed deeper into the subgrade soil profile may be necessary to lower the water table and to handle the increased internal amount of water.

Typically, a gridiron or herringbone arrangement is designed for the tile outlay in which they are diagonally to the grade (Fig. 6). However, any shaped tile arrangement is acceptable as long as each line has a continuous downward slope and water does not have to travel significantly more than 10 feet to a drain line. Greens with slopes greater than 2 percent or have surface water runoff from high surrounding ground should have an interceptor drain line that rings the inside diameter of the green, especially in the front or lowest area (Fig. 6). This helps prevent water accumulation in the front portion of the green where players typically enter.

In the past, drain line tiles consisted of agricultural clay tile, concrete, or flexible, corrugated

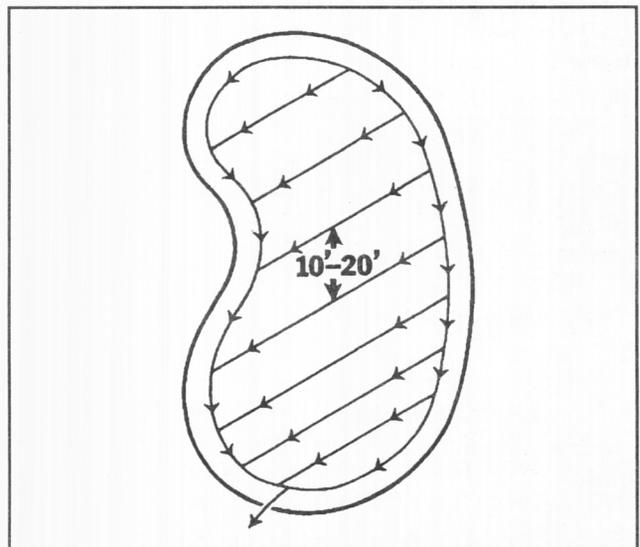


Figure 6. Typical pattern for drainage tile installation in golf greens so that water will not have to travel in excess of 10 feet and the recommended "ringing" a green with drainage line when slopes are greater than 2 percent or surface water runoff from higher surrounding ground occurs across the green's surface.