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Drainage

An Essential Element of Golf Course Maintenance

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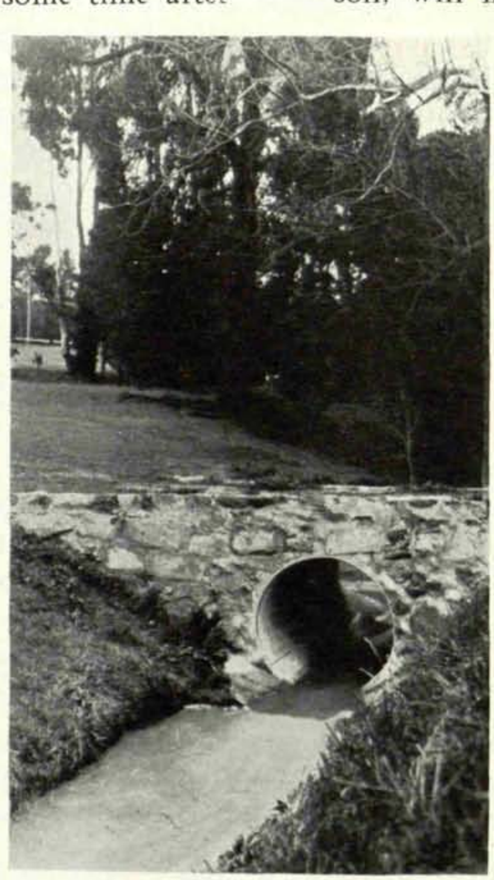
HOW early in the spring or how soon after a rain can play be resumed? Excessive moisture in the ground as a result of spring thaws or rains, generally leaves conditions underfoot unsatisfactory for some time after they become favorable overhead. To shorten this time interval is the aim of every golf club official and greenkeeper, for it affects finances—in two ways. It decreases income, especially on "daily fee" courses, delays maintenance and makes it more costly.

The problem of acquiring and maintaining a good playing surface at all times during the playing season and especially early in the spring or soon after heavy rains, generally involves either the removal of surface water or the removal of ground water or both. Local conditions will usually indicate the kind of drainage needed. Eroded surfaces or water standing in low places for long periods are conditions which indicate the need for surface water removal. Soggy or springy areas or water appearing on hillsides are evidences of the need of subdrainage. These places have the distinct habit of making themselves known. Tractor wheels or treads sink in and mar the turf, and mowing operations and playing are hindered for a long time after the remainder of the course has dried out.



THIS SMALL STREAM ON THE CLAREMONT COUNTRY CLUB OF OAKLAND, CALIFORNIA, IS CROSSED BY A CORRUGATED IRON CULVERT BRIDGE

Stone masonry head walls give a rustic appearance that harmonizes with the immediate surroundings

Surface Drainage

RAINFALL which is not absorbed by the soil, will flow over surface slopes to a natural outlet if such slopes and outlet exist. Surface water that remains spread out is more likely to be absorbed than if it were concentrated. And there is less danger of gulleying when the water is not concentrated. A greenkeeper knows that a smooth surface will remain smooth, whereas a rough one will become more gulleyed.

When surface water is concentrated in a draw or a gulley, erosion may occur. A good stand of sod in the bottom of the draw is a possible remedy for erosion. However, when the grade of the draw is too steep to permit seed or sod to become established between rains, the removal of surface water in an underground pipe line is necessary. Catchbasins at frequent intervals prevent the accumulation of enough water to damage the draw. After such a pipe has been in operation long enough, the sod will become established firmly enough so that it will absorb more and more of the water passing over it, especially if the pipe acts also as a subdrain.

Water standing in low places may be removed by either catchbasins or subdrains. The latter is feasible only when the character of the soil is such that water will pass through it with the required rapidity.

After the water has reached a stream or open channel of some kind, it needs further attention. If the stream is of any consequence, it may require the removal of silt, gravel and debris at some points, and protection against erosion at the other points. Brush mats, posts backed up with branches, and rock rip-rap are three methods of protecting the banks. If the stream is not too large it may economically be enclosed, thereby practically eliminating maintenance work.

Wherever it is necessary to cross a ditch or an open stream, either with a driveway or a fairway, a culvert pipe or bridge will afford a dry crossing.

Subdrainage

IF PROPERLY designed and constructed, subdrains are very effective in removing water from most soils. The layout of the drains and their depth and spacing must be governed by local conditions.

For nearly level ground, the mains and submains will follow the natural drainage traces while the laterals, except those which are placed for the purpose of intercepting seepage water, will branch out in the direction of greatest slope. The layout should be arranged so that the areas of double drainage are reduced, as far as possible, to a minimum.

The depth and spacing of the laterals (subdrains) should be such that the ground water level is lowered to a point that the top soil will become stable and yet sufficient moisture will be available for the growth of grass during the dry season. In other words, the course can be over-drained as well as under-drained.

During times of drought, plant roots receive their moisture from a source below the root zone. This moisture which rises in the soil is known as capillary moisture. In extreme cases, not often encountered, it may be possible to drop the ground water table below the reach of capillary action and thus endanger the health of the grass. Capillary action is illustrated by the drawing up of oil in a lamp wick or by the action of a liquid when the edge of a blotter is dipped into it. Table No. 1, from the Department of Soil Technology, Cornell University, shows how soil texture affects capillarity.

TABLE 1

Effect of Texture on Rate and Height of Capillary Rise from a Water Table Through Dry Soil

Soil	1 hour Inches Rise	1 day Inches Rise	2 days Inches Rise	3 days Inches Rise	4 days Inches Rise	5 days Inches Rise
Sand	3.5	5.0	5.9	6.8	6.8	6.9
Ciay	0.5	5.7	8.9	10.9	12.2	13.3
Silt	2.5	14.5	20.6	24.2	26.2	27.4

The quantity of water raised above the water table varies as to the character of the soil and as to the distance above that source, as indicated in Table 2. Capillary lift approaches zero in loose organic soils like peat, on account of the insulating action of large air spaces. Such soils are rather easily over-drained.

TABLE 2*

Quantity of Capillary Water Raised per Day, Pounds per Square Foot of Soil

Soil	Height above sources 1 ft.	2 ft.	3 ft.	4 ft.
Medium fine sand	2.37	2.07	1.23	0.91
Medium clay loam	2.05	1.62	1.00	0.90

Due to the varied conditions which may exist relative to the water table, the amount and extent of capillary rise and the permeability factor of the soil, all of which may vary for each soil class, it is impossible to outline a rule of thumb method for depth and spacing of subdrains. It is advisable to employ the services of a competent drainage engineer who has had experience with golf course drainage.

Depth of Subdrains

FOR golf course drainage, engineers are generally recommending a depth varying from 2 to 4 feet. The depth of the drain refers always to the distance the bottom of the trench is below the surface of the ground. For dense clay soils a depth of 2 to 2½ is commonly used. For the medium soils such as a sandy clay loam, a depth of 2½ to 3 feet is considered advisable. For the more open soils such as the sandy loam soils, the depth should be 3 to 4 feet.

* 19th Annual Report of U. S. Geological Survey.

Drains should not be placed below the surface of a layer of hard pan or other impervious material unless their trenches be backfilled with some pervious material, such as crushed rock, cinders or gravel, up to the top of the impervious layer.

Spacing of Subdrains

C. G. Elliott, in "Engineering for Land Drainage," gives the following recommendations for spacing of subdrains:

"In close, dense soils, largely clay, 30 to 40 feet; coastal plain lands composed of mixed clays with fine sand and uniform structure, 60 feet; alluvial gumbo or heavy soils but with granular structures, 70 to 80 feet; alluvial, glacial drift and sandy loam soils, with clay subsoils, 100 feet; sandy lands and soils containing considerable quantities of vegetable matter and those without subsoils having a liberal supply of sandy or gravelly material, 150 to 200 feet."

Seepage Water on Hillsides

TO ELIMINATE soft spots appearing on hillsides caused by seepage water, the subdrains should be placed in a direction as nearly perpendicular as possible to the underground flow. Their trenches should be backfilled with gravel or crushed rock up to within about 6 inches of the surface. Their depth should be such that the seepage flow will be intercepted but usually need not be more than 4 feet.

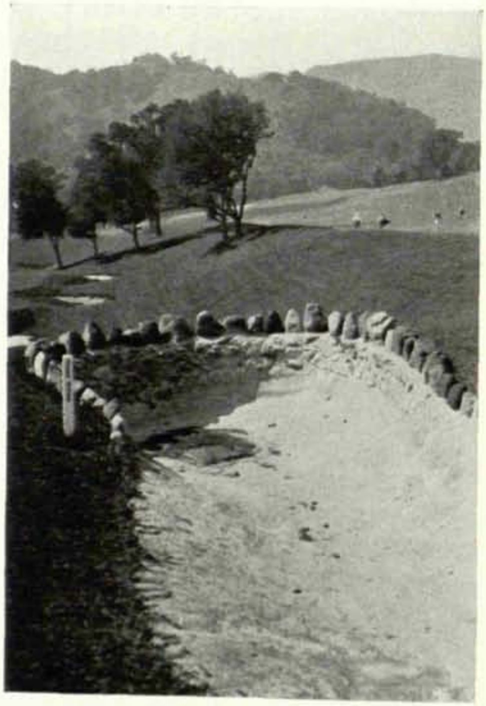
Economies

NATURALLY the question is, can subdrainage be afforded; will it be economical? For a subdrain to answer the question of economy affirmatively it must meet the following requirements: strength, durability, and continuous drainage efficiency. A drain pipe must be strong, otherwise the weight of mowing and other maintenance machinery will crush the pipe where it is necessary to lay it close to the surface. Immunity to the damaging action of frost is also necessary for shallow installations.

Durability is essential along with strength if the pipe is to have a long life, and consequently a low yearly cost of service. Replacement and repairs should be kept down to a minimum. Of equal importance with the above two requirements is continuous drainage efficiency . A pipe which is easily crushed, which separates at the joints and admits soil or gets out of alignment, will decrease in drainage efficiency until after a few years it becomes entirely clogged up and useless. The selection of a drain meeting the above requirements, will insure in the long run economical drainage that will pay dividends in increased playing hours and less maintenance expense.

Flood Prevention

FLOOD prevention on low areas is a special drainage problem sometimes encountered on low land which is subject to flood water



A CATCHBASIN THAT INTERCEPTS THE SURFACE WATER IN THE DRAW ABOVE FAIRWAY NO. 8 ON THE ORINDA GOLF COURSE AT OAKLAND, CALIFORNIA

A corrugated iron pipe conducts the water safely to a ravine below

flowing across or backing up on it. Such land can often be made an asset instead of a liability. By building an earth levee, the flood water may be kept off. A simple yet efficient means of providing natural drainage for surface water that collects back of the levee is to pierce the levee by means of a drainpipe and attach an automatic drainage gate to the stream end. Such gates prevent any backflow of flood waters. When the water behind the levee is the least bit higher than on the stream side it flows out automatically or naturally.