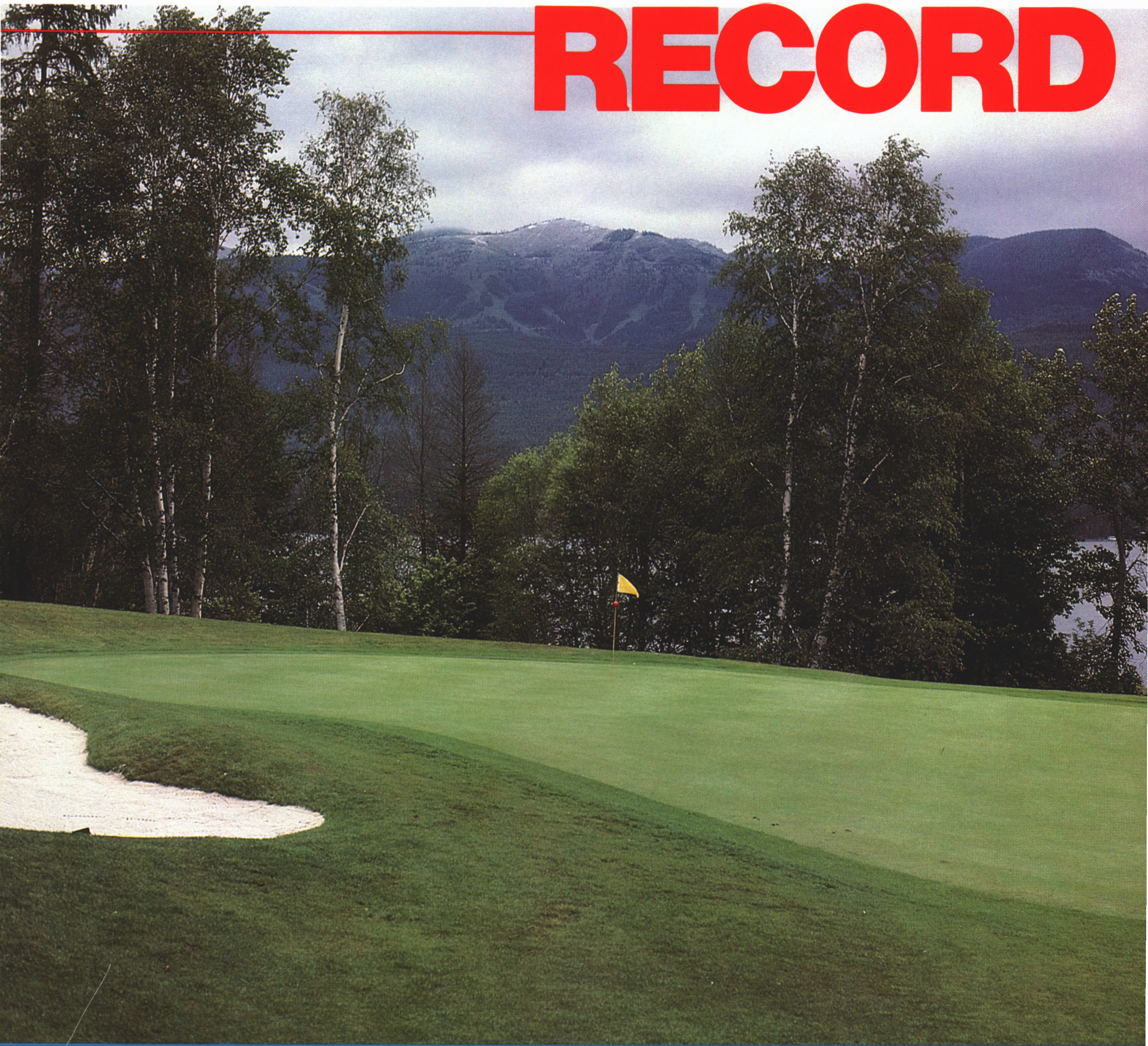
A Publication on
Turfgrass Management by the
United States Golf Association®

September/October 1987

USGA® Green Section RECORD



The Agronomics of Sand in Construction and Topdressing

USGA®

Green Section RECORD

EDITOR:
William H. Bengeyfield
MANAGING EDITOR:
Robert Sommers
ART EDITOR:
Diane Chrenko

Vol. 25, No. 5
SEPTEMBER/OCTOBER 1987

1 **The Agronomics of Sand in Construction and Topdressing**
by James M. Latham

5 **Peat in Greens: Knowns, Unknowns and Speculations**
by Wayne R. Kussow

8 **Getting Your House in Order — An Equipment List Update**
by Larry W. Gilhuly

10 **Answering the Most-Asked Questions About the Golf Course Pump Station**
by Keith McLain Inc.

Back Cover **Turf Twisters**

Cover Photo:

Springtime in the Rockies. Scene at Whitefish Lake Golf Club, Montana. New sand-based greens provide better playing quality under heavy traffic than earlier models.

GREEN SECTION RECORD (ISSN 0041-5502) is published six times a year in January, March, May, July, September and November by the UNITED STATES GOLF ASSOCIATION®, Golf House, Far Hills, N.J. 07931. Subscriptions and address changes should be sent to the above address. Articles, photographs, and correspondence relevant to published material should be addressed to: United States Golf Association Green Section, Golf House, Far Hills, N.J. 07931. Second class postage paid at Far Hills, N.J., and other locations. Office of Publication, Golf House, Far Hills, N.J. 07931. **Subscriptions $9 a year. Foreign subscriptions $11 a year.**

The Agronomics of Sand in Construction and Topdressing

by JAMES M. LATHAM
Director, Great Lakes Region, USGA Green Section

THE GREEN SECTION adopted a green construction method some 35 years ago that involved the principle of perched water tables. Since then we have seen a major evolution in the choice of components for the root zone mixture. Shortcuts in construction, however, have been tried and failed. The most important change has been the recognition that despite the agronomic benefits of some early mixtures, the playing surfaces were hard and required several years to mature. The automatic drainage system provided by the perched water table procedure remains the same.

As their basic concept, Green Section greens were to provide an alternative to the historic construction method of blending equal parts of sand, topsoil, and organic matter, with or without drainage, and set it atop any kind of base material. First, good topsoil had become hard to find. Second, the manures that keyed the composting operation weren't available in most regions. Finally, time became a limiting factor, because the demand for new courses forced builders to speed construction, eliminating any possibility of composting.

Simple mechanical mixtures, such as the 1-1-1, created easily compacted greens that could not withstand heavy play. When the greens became hard, they were softened by irrigation. That led to further compaction, so that any remaining voids in the soil became filled with water. This lack of soil oxygen severely restricted root growth, weakening and thinning the turfgrasses and almost inviting invasion by *Poa annua* and other weeds. *Poa annua* encroached because its root system could support its growth in shallow soils.

Because of the poor performance of bentgrasses in these soils, summer mowing heights were raised from a standard 1/4 inch to 5/16 inch, or even higher. Championships were then played at 3/16 inch. That often required a major maintenance effort by the golf course superintendents. Motorized aeration tools were invented to relieve compaction and allow better oxygen exchange. New agricultural chemicals were applied to greens just to keep the grass alive, much less flawless.

To keep greens affordable by all, laboratory standards were developed by which the agronomic requisites of root growth could be met by proper blends of

Figure 1: A potential black layer? Excellent root growth in this new green shows strong early turf development. Note the layer of original top growth that was buried by topdressing. This will require spiking or aeration to break up the layer of organic matter before it has the chance to inhibit water movement and become a black layer.

almost any sand, soil, or organic matter source. There was only one hitch. The greens were hard. They produced a satisfactory turf cover, but the golfer often had to play pitch-and-run shots, until a cushion of 1/2 inch or more of organic material built up on the surface.

Through the ensuing years, many concrete sands and most mortar sands have been eliminated from green construction, because the particles of fine gravel in them have usually produced surfaces unreceptive to even well-hit golf shots. Broad ranges of particle sizes are not desirable either, since they can fit together so tightly they leave no room for movement, and greens built with these materials can also become hard. In either case, it is distressing to have to grow a deep layer of thatch on a new green surface before it becomes receptive to a well-hit golf shot.

THE FINE-GRAINED sands at the other end of the scale also produce hard greens. The small pore spaces between the fine particles are easily clogged by silt, clay, or organic matter so that water percolation is slow, and the soil oxygen supply is restricted. Capillarity in fine sand profiles helps retain large quantities of water against the pull of gravity, and pores filled with water preclude air space.

During these years of evolution, the Green Section staff and consulting soil scientists developed a short, concise paper, "Sand for Golf Courses," printed in GOLF JOURNAL, May 1974. In it, the recommendation was made that sands used in green construction and in topdressing should have round particles ranging in diameter from 0.25mm to 1.00mm. Round medium to coarse sands, therefore, provide the narrow window needed for some water retention, adequate space for air, resistance to compaction, and the resiliency needed for golf play. The uniform sand grains seem to move about to become an excellent shock absorber, much like B-Bs in a bean bag. This gives the long-awaited receptivity to the surfaces of greens built with sand as the major component of the growing medium. Sand in this context is not just *any* sand (see Table 1).

In years gone by, we were looking in the wrong places. Industrial, not construction sand is a ready-made source. Casting sand, frac sand, and those known by other names are available in most areas. Some are even decalcified to achieve near neutral pH.

Using soil in green mixtures has become rare in recent years because of the relatively high amount of silt in some soils that in time interferes with the water and air movement into and through the root zone. The lack of soil in the growing medium, however, has a negative effect on its nutrient retention and buffering capacity. Having lost the forgiveness of soil, fertilization and chemical application must be carefully planned and executed. Nutrition management is, of necessity, not unlike hydroponic gardening. Even phosphorus is leachable in soilless greens.

Peat has become the substitute for soil and manure almost everywhere. Other regionally available products are in use as well, such as composted rice hulls and forest by-products. Their obvious use is for water retention, but they also provide some nutrient retention.

In some areas of the country, sand sources are highly calcareous, with a pH in the neighborhood of 8. This substantially reduces the availability of secondary or minor nutrients for uptake by grass roots. We know very little about the gross effect of a deficiency of these minerals on turfgrasses. Except for iron and perhaps magnesium, few, if any, have been visually identified in the field. The only substantive work on visible nutrient deficiency symptoms was done under laboratory conditions by Dr. J. R. Love, Roger Larsen, *et al* at the University of Wisconsin, in the early 1960s. Soil test results on available quantities of these nutrients are subject to question without accurate tissue analyses.

In practice, then, it appears that providing for the total nutrient needs of putting green turf remains a great guessing game. Nutrient retention is low in mixtures with low cation exchange capacity and high permeability. New sand greens require much higher nutritional levels until a cushion of turf has developed to withstand traffic and close mowing. Under alkaline conditions, it

Figure 2: The dark layer in sand topdressing is organic matter generated from plant growth and failure to begin topdressing.

Table 1.

Sand Particle Size Classification Table*

ASTM (Designation E-11) Sieve No.	Tyler Equivalent Mesh	Millimeter	Descriptive Size
10	9	2.00	
18	16	1.00	Coarse
35	32	0.500	
60	60	0.250	Medium
100	100	0.150	Fine
140	140	0.106	

The ideal particle size range for a USGA green is between 0.75mm and 0.25mm

*Meaningful measurements for use in determining sand quality for construction and topdressing. Note that these sieve numbers vary from those published in GOLF JOURNAL, May 1974. The other data remain the same. A desirable sand, then, will pass through number 18 sieve (or 16 mesh) and be retained on a number 60 sieve (or 60 mesh), giving particles ranging *from* 0.25mm up *to* 1.00mm diameter.

Figure 4: *The more aeration holes containing topdressing, the better will be the root penetration into the profile of previous soil mixtures.*

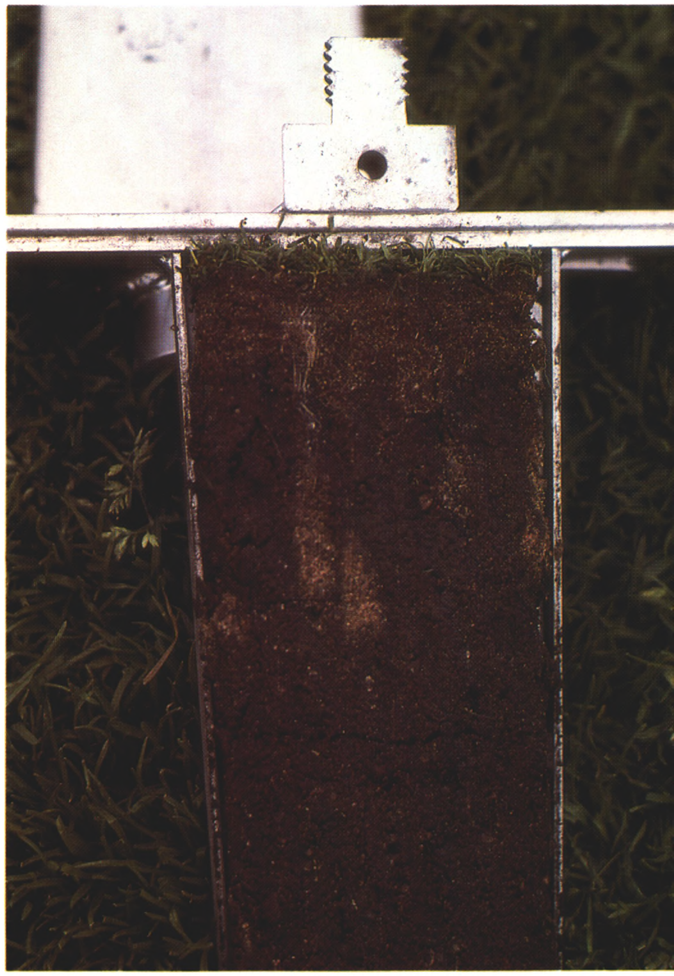
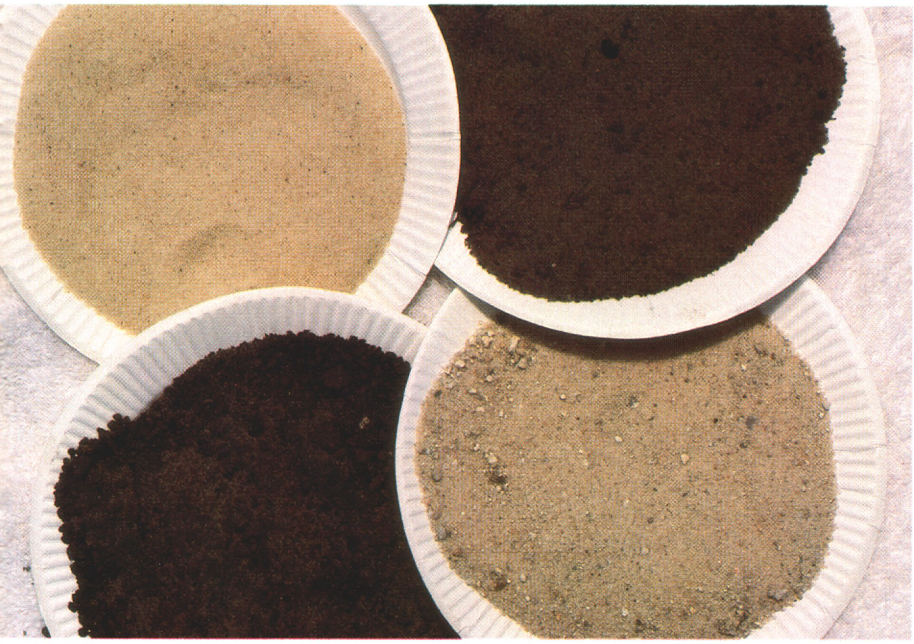


Figure 3: *These are four topdressing materials used in 1987, showing a variety of opinions and products: Upper left, well-graded industrial sand, about 76 percent in medium ranges and the rest above 0.15mm. Upper right, same sand with 20 percent peat added. Lower left, same sand with 40 percent soil added. Lower right, a masonry sand. Imagine the quantity of the larger particles that will be removed in dragging and cleanup procedures.*



may be necessary to rely principally on leaf feeding some nutrients unless trials *on turf* indicate that chelates or natural organics do, in fact, make them available to grass roots. Data extrapolated from horticultural plants growing on artificial rooting media may be misleading.

Sand on golf courses has had its most far-reaching effect in topdressing. Since the treatise on the subject by Madison *et al* in 1974, sand topdressing has been looked on as the potential remedy for most known putting surface ailments. It has, in fact, permitted the closely mown, high-speed, compaction-resistant, and shot-holding greens golfers expect today. There are exceptions to this, of course, but not many.

First, light and frequent topdressing provides a true putting surface. The topdressing material is the primary ball support, and the protruding grass blades create a live surface for ball control. Every application, in effect, raises the height of cut and permits more leaf growth while covering the stem stubble and dampening its tendency to cause the ball to roll erratically. Thus, putting trueness can be developed at most normal mowing heights independent of surface speed.

Straight 100 percent sand is widely used because it is easily applied and leaves no trash on the surface. It allows a dressing to be applied anytime during the day, with minimal displeasure to the golfer. If the sand is properly sized, brushes or upside-down carpeting can quickly and easily rub it into the turf surface. Sand is easily broadcast by spinner or oscillating spreaders for greater speed, so that frequent applications are feasible.

Frequency is a relative term, but in order to prevent stratification, keep the applications equivalent to the rate of grass growth. Layers of any kind restrict the downward growth of roots and percolation of water. Many years ago sand and/or soil layers were identified as major problems in greens. Even grass growth between infrequent topdressings can become troublesome when it is buried by subsequent applications. This is one cause of black layer problems that became famous in 1986 (Figure 1). Black layers have finally become visible in sands, even though they were described by O. J. Noer in poorly drained, dark-colored soil greens in 1934.

Since stratification affects both root growth and water percolation, it should be avoided in the root zone. Therefore, if topdressing is applied to match the rate of grass growth, layers are not likely to be formed. Madison felt that once a month was enough under the fertilizer regimes at the time, but by allowing five weeks between applications, an organic layer formed. To overcome interruptions in the program from weather and golf events, he suggested planning for three-week intervals, with the fourth as insurance.

HIS SUGGESTED rate of three cubic feet per 1,000 square feet has not been challenged, but it may be a bit heavy. It has been modified by those superintendents who use lighter applications at two-week intervals. Some rate-frequency modification may be necessary in cases where the turf growth is slowed by minimum nitrogen application. In this situation, turf damage is possible if the grass does not grow through the topdressing, particularly during hot weather. The goal is to match topdressing with growth, and to produce a layerless blend of topdressing and living turf.

Organic layers are most likely to develop in the early spring or late fall (Figure 2). The grass grows well during these times, but topdressing is often withheld until the first aeration in the spring. Then it is discontinued after the last treatment in the fall. It seems reasonable, then, that applications of topdressing should be made whenever there is a need for regular mowing.

There are several schools of thought on the use of additives to sands used for topdressing. Peat and/or sandy loam soil additives are prevalent in the Midwest (Figure 3). Some people just don't like the looks of straight sand. Others feel that sand alone tends to add to the wilt potential of the greens. As long as the additives provide the conditions necessary for good growth and optimum playing conditions, there is no cause for doubting their usefulness. It seems, however, that the grass itself can produce an adequate amount of organic matter by simply growing.

A popular mixture throughout the Great Lakes Region is a blend of 80 percent sand and 20 percent peat. In general, the quality of this peat is not well documented, and it often contains substantial amounts of silt, clay, and very fine sands that tend to clog the non-capillary pores in medium and fine sands. Further, the quantity of peat remaining after the dressing has been dragged and mowed is usually less than what had been applied. Larger particles do not fit into dense turf and are dragged, mowed, or washed off during the clean-up operations. The true percentage is never known and may, in fact, vary from one source to another, or from application to application, and could depend on whether the mixture was dry or moist.

There is, perhaps, a positive side to organic additives if they are active chemically or microbiologically. They may help to retain added nutrients or to make available some nutrients in the rooting medium. They may help sustain the activity of microorganisms needed to decompose raw organic matter (thatch). And they *may* help to neutralize, break down, absorb, or otherwise buffer the activity of the many complex pesticides applied to greens.

The generally low microbiological activity in sand profiles may well be a reason why localized dry spots frequently appear where sand is the principal component of the growing medium. If saprophytic fungi cause the condition and are feeding on the undecomposed plant tissue, then the normal population of soil microorganisms is evidently out of balance. The waxy coating on sand particles does not self-generate suddenly, and if it is not found in soil greens, soil microbiologists must answer a number of questions of more importance than what causes black layers. Sand and new pesticides are not solely responsible, however, because LDS was known and photographed on soil greens over 40 years ago.

FINALLY, there is some consternation from time to time about water movement through a sand profile built up by topdressing over the dense soil of old greens. The argument is that surface drainage took care of excess water from rainfall or irrigation on the dense soil mixtures. The sand layer over this old soil would hold the excess to give rise to anaerobic conditions, root loss, and devastation of the turf. If this hypothesis held any water, there would be more dead greens than live ones today.

Whenever core, cupcutter, or profile samples taken from greens are examined, the majority of the grass roots penetrating the lower soil are in the aeration holes, whether sand or a mixture is used for topdressing. It is apparent, then, that a change of topdressing materials should be accompanied by a rather intensive coring program (Figure 4). The holes, filled with the new dressing material, will provide some of the new roots with a uniform rooting medium even if it is only half an inch in diameter and a couple of inches deep. Roots grow into empty holes as well, but that seems only to concentrate organic matter, and if it is not adequately decomposed, it will lead to accelerated thatch development.

Any change in the texture of topdressing materials forms a layer that severely restricts the downward growth of roots and interferes with water and air penetration. For this reason a gradual change of texture between old and new materials is desirable. The simplest method to achieve a gradual transition is to begin with intensive early fall aeration when the cores can be shredded and blended with a relatively heavy topdressing with the new material. Repeating this procedure late the following spring should develop a transition zone between the different dressings and should minimize the impact of an abrupt change. Thereafter, light frequent topdressing can proceed on schedule, and plugs should be removed after future coring.

Greater problems are created when a change is made from coarse to a finer material, for example when sand is covered by a mixture containing peat and/or soil. This creates a perched water table just like a well-built green, where water does not move into the coarser material until the pull of gravity exceeds the capillary attraction in the small pores of the new layer. Since this layer is thin, the surface may remain wet for an extended time. When sand is laid over soil, however, water is absorbed, but at a slower pace.

Where infrequent sand topdressing has created alternating layers of sand and organic matter, future maintenance operations should be keyed to eliminating these layers. The old practice of spiking the greens could be revived. These machines put many small holes in the surface that will breach any shallow layers and give new root growth a better opportunity to penetrate. If spiking precedes topdressing, there is a better than even chance that some of it will be dragged into the small holes to maintain their integrity. Any shallow compaction by the spike tips will be minimized by the sand. Spikers are fast, easy to operate, easily fit into a sanding program, and do not disturb putting surfaces to any extent.

Greens that have been retained in the sand/soil/peat mode are certainly as up to date as any. They have performed up to the requirements of the golfers playing on them, or else the maintenance operations would have been changed by someone long ago. Credit must be given to the superintendents who have accomplished this in spite of the changes in the criteria for putting speed within the last 10 years, not to mention peer and publication pressure.

The evolution of sand quality and its use in construction is paying dividends today. Properly graded sand and high-quality organic matter, blended according to specific laboratory-derived recommendations, are producing very playable greens from the outset. These greens are receptive to well-played shots, and they respond positively to good maintenance operations. They are not an automatic success, but they produce the best playing quality attainable under present conditions. And light, frequent topdressing with the same mixture or with sand alone keeps them that way.

Peat in Greens: Knowns, Unknowns and Speculations

by WAYNE R. KUSSOW
Soil Science, University of Wisconsin — Madison

USGA SPECIFICATIONS define acceptable limits in the screen analysis of sand used in golf green construction and topdressing mixtures, and in key physical properties of sand-peat mixtures. Appropriate peat characteristics are not defined. In the material that follows, we will examine peat, not only from its physical side, but from the perspective of its chemical and biological properties as well.

Figure 1: Demonstration of the mobility of potassium in sand, an 8:2 sand-peat mix and an 8:1:1 sand-peat-silt loam mix.

Physical Properties of Peat

Peat is blended with sand primarily to reduce the bulk density of the sand and to add water-holding capacity. Thus, physical properties head the list of desirable peat characteristics.

The bulk densities of peats commonly range from 3 to 30 percent of those of sands (Table 1). Consequently, 8:2 volume blends of the two materials generally provide bulk densities in the range of 1.17 to 1.42 g/cc. These extremes are very near or outside the limits of 1.25 to 1.45 g/cc set by the USGA. Laboratory testing can readily define a blend that will provide the proper bulk density for any particular combination of sand and peat, but often testing is not performed. In this case, we need to be sure to select a peat with a bulk density in the range of 0.10 to 0.25 g/cc.

Everyone is aware of the high water-holding capacities of peats. By using the data in Table 1 and assuming use of the popular 8:2 blend, we can calculate that the moisture-holding capacity of sand-peat mixtures may range anywhere from 15 to 26 percent. That is, providing the peat is not allowed to air-dry before it is used. Air-drying reduces peat's moisture-holding capacities some 30 to 80 percent and can result in a blend that holds no more moisture than pure sand.

Moisture-holding capacity *per se* is not critical for USGA greens. The real concern is the contribution of peat to the plant-available water content of the greens mix. A large portion of the water in peat is bound so tightly that plants cannot use it. By definition, plant-avail-

Table 1.

Common Ranges in the Physical Properties of Peats[1]
(Sand properties shown for comparison)

Property	Peats	Sands
Bulk density, g/cc	0.05-0.50	1.45-1.65
Water-holding capacity[2]		
Continuously moist, %	28-66	12-16
Air-dried, %	6-46	12-16
Available water, %[3]	18-42	6-8
1/3 Available water, %	6-14	2-3

[1]Adapted from Boelter (1974), Dyal (1960), Puustjarvi and Robertson (1975), and Taylor and Blake (1984).
[2]Volume basis at 0.2 bar pressure.
[3]Difference in volumes of water retained at 0.2 bar and 15 bar pressures.

able water is that water held by soil at tensions (also known as suctions or pressures) between 1/3 and 15 atmospheres. In applying this concept of available water, we need to recognize that on a warm, sunny day, plants typically begin to show signs of wilt when they have used up only one quarter to one third of the available water in the soil. By this standard, the contribution of peat to the plant-available water supply in six inches of an 8:2 sand-peat blend with a bulk density of 1.3 g/cc ranges from approximately 0.2 to 0.5 inches of water. Even at a moderate to high transpiration rate of 0.3 inches of water per day, this is a significant contribution, because it represents 0.7 to 1.7 days of additional readily available water.

Chemical Properties of Peat

Laboratory testing of sands and peats for green construction focuses entirely on physical properties and conveys the idea that peat is chemically inert. Peat, in fact, imparts certain chemical properties that have a strong bearing on the performance and management of USGA greens. Peat has very high pH buffering action, retains calcium, magnesium, and potassium in exchangeable forms, and has the capacity to form chemical complexes with certain micronutrients. Because of the very high pH buffering capacity of peat, the pH of the peat determines the initial pH of sand-peat mixtures. As shown in Table 2, this means that such mixtures may initially have pH values anywhere from 3.1 to about 7.6. To put this in perspective, a pH range of 6 to 7 is generally considered optimum for most grass species.

Sands are noted for having very low cation exchange capacities. Thus, they contain relatively small amounts of calcium, magnesium, and potassium ions, and allow for rather high leaching rates of these nutrients. Peat is very effective in increasing soil retention of calcium and magnesium, but considerably less so for potassium.

To illustrate this point, we leached fertilizer potassium from three columns, one containing pure sand, one with an 8:2 sand-peat mix, and the third with an 8:1:1 sand-peat-silt loam mix. We first leached with the equivalent of four inches of distilled water and then with four inches of tap water containing substantial amounts of calcium and magnesium. The results are shown in Figure 1.

Potassium readily leached from pure sand, regardless of the type of water applied. Tap water removed more than one-half the potassium from the sand-peat column, but only about one-third of the potassium from the sand-peat-silt loam column.

These observations reflect that ion exchange sites on soil minerals show less preference for calcium and magnesium than do the sites on organic matter. Thus, from the perspective of potassium leaching, peat alone is not an ideal amendment for sand-based greens.

Peat further affects turfgrass nutrition through formation of chemical complexes with copper, iron, manganese, and zinc. Complexation of these nutrients generally reduces their plant availability, and becomes more extensive as soil pH rises to 7.0 or above.

Peat may be up to 99 percent organic matter, but it generally contains variable amounts of mineral matter in the form of sand, silt, and clay (Table 2). Ash content of peat indicates mineral content, but the two are not the same. Ash contains substantial amounts of carbonates formed with metallic ions in the peat during combustion. Our experience is that about 20 percent of ash consists of carbonates and the remainder is sand, silt, or clay particles. The significance of a high mineral content in peat is tied to its biological properties.

Biological Properties of Peat

In terms of the numbers and kinds of microorganisms present, peat is biologically as active as many mineral soils. The biological stability of the peat itself is of much greater concern. Like any other organic material, peat is a food and energy source for microorganisms, and it decomposes, but we don't know how fast in USGA greens. Under laboratory conditions it takes anywhere from one to five years for one-half of the peat to decompose. Assuming similar biological half-lives of peat in USGA greens, the consequences are illustrated in Figure 2. For peat with a half-life of one year, only about 4 percent of the peat added remains five years after green construction. With a five-year half-life, one-half the peat remains after five years.

Figure 2.

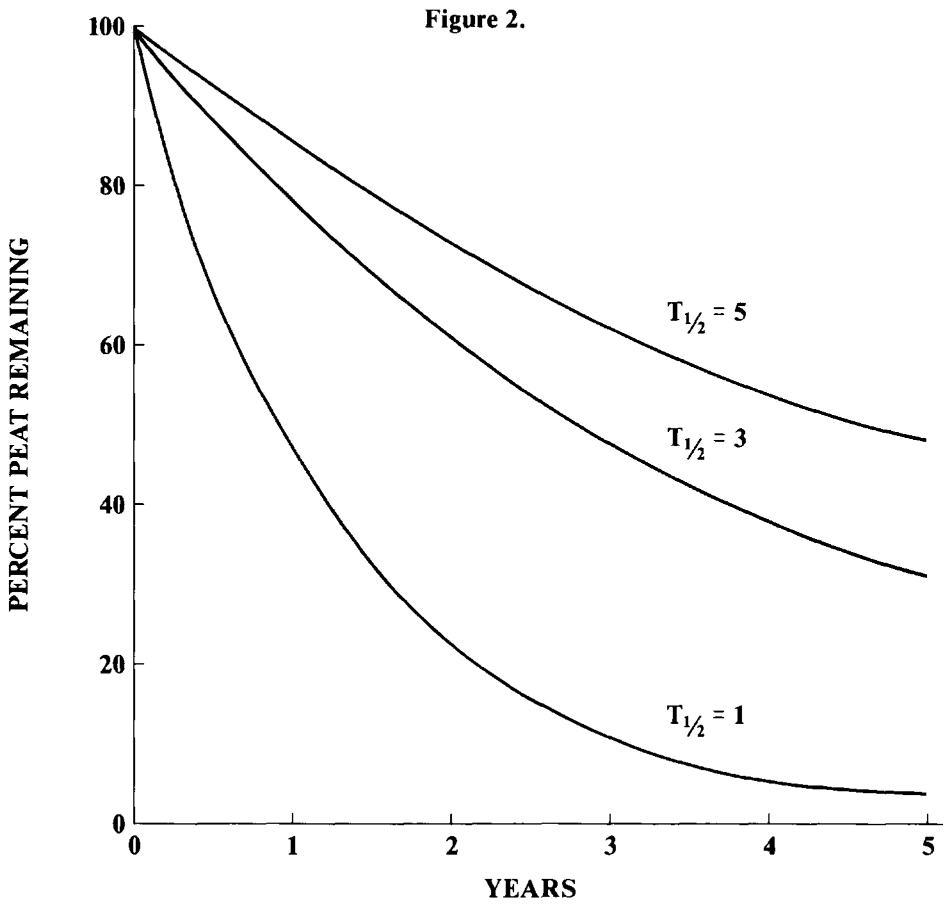


Figure 2: Laboratory incubation decomposition curves for peats with half-lives ($T_{1/2}$) of 1, 3, or 5 years.

Table 2.

Common Ranges in Selected Chemical Properties of Peats[1]

Property	Range
pH	3.1 - 7.6
Cation exchange capacity, me/100g	40 - 240
Organic matter content, %	40 - 99
Ash content, %	2 - 70

[1]Adapted from Dyal (1960) and Lucas (1982).

Table 3.

General Effects of the Degree of Decomposition on the Properties of Peat

	Degree of Peat Decomposition		
Property	Low	Medium	High
Bulk density	Low	Medium	High
Available water	Low	High	High
Cation exchange capacity	Low	Medium	High
Ash content	Low	Medium	High
Biological stability	Low	Medium	High
pH		Variable	

The question often arises concerning what dead turfgrass roots and stems contribute to the organic content of greens. Root tissues initially decompose very rapidly in soil, but some 20 percent of the carbon originally present remains after five years. In the case of stems with their higher lignin contents, perhaps as much as 30 or 35 percent of the original carbon remains after five years. Hence, plant tissues likely do contribute substantial amounts of organic matter to greens. This contribution, however, is principally in the top five inches or so of the green.

The impact of peat decomposition on the long-term performance of USGA greens is very speculative. We can anticipate progressive increases in bulk density and reductions in readily available water content and cation exchange capacities. Perhaps we should be more concerned about what might happen if we start out with a peat with a high silt and clay content. We know from studying mineral soils that silt and clay particles migrate downward for some depth, and then begin to accumulate. The silt and clay particles fill the spaces between sand grains in the zone of accumulation, and eventually form a barrier to water movement. Is this one of several processes that can lead to black layer formation? Who knows?

Selecting a Peat for USGA Greens

We can see many ways that the peat we select influences both the short-term and long-term performances of our greens. Making a good selection begins with understanding that the physical, chemical, and biological properties of peat relate more to its degree of decomposition than to its origin.

Table 3 shows the general relationship of various peat properties to its degree of decomposition. For example, a peat with very low bulk density typically has low mineral content, but it also has relatively low retention capacity for readily available water and low biological stability. Similarly, peats with high biological stability are highly decomposed to begin with, and have high bulk densities and mineral content.

Degree of peat decomposition is judged by its so-called rubbed fiber content. Highly decomposed peat contains virtually no discernible plant fibers, just black amorphous organic matter. Peat with little or no decomposition is generally brown to tan in color and consists primarily of plant fibers matted together. We need to be looking for peats that are intermediate to these extremes, and contain 50 to 75 percent rubbed fiber content.

Non-quantitative assessments of the rubbed fiber content of peats are quite simple to perform. A ball of moist peat approximately one inch in diameter is formed and held under flowing tap water above a fine mesh metal or plastic screen. The ball of peat slowly disintegrates in the stream of water by rubbing it gently between the thumb and forefinger. The amount of fibrous material that remains on the screen after disintegration allows us to judge the rubbed fiber content of the peat.

Obviously, selection of a peat for USGA greens involves compromises. Until matters of peat biological stability and mineral content are related to the long-term performance of USGA greens, emphasis should be placed primarily on peat bulk density and available water retention capacity. Taken together, these criteria preclude a material such as undecomposed peat moss, and favor a peat with an intermediate degree of decomposition.

Getting Your House in Order — An Equipment List Update

by LARRY W. GILHULY
Western Director, USGA Green Section

HAVE YOU ever entered your maintenance facility and wished for a certain piece of equipment that would make a major difference in your club's maintenance program? It may be as large as a fairway mower or as small as an edger for the bunkers, but it isn't on the equipment list, and the whole golf course suffers. More often than one might think, Green Section agronomists find equipment inventories one or two pieces short of enabling clubs to make dramatic improvements in their course conditioning.

It is not the intent here to claim that every piece of equipment listed is absolutely essential for every golf course. Rather, the following list should provide a broad overview of the backbone of every golf course maintenance operation; *i.e.*, the equipment inventory. If you lack one or more of these keys to turf management success, it may be time to take (or attempt to take) corrective action.

Putting Green Mowing Equipment

Five triplex putting green mowers, or five putting green walking mowers, plus three triplex riding mowers. (For a nine-hole course, three triplex green mowers, or three walking putting green mowers, plus two triplex putting green mowers.)

If walking mowers are used on greens, the triplex machines should be used for mowing tees, green aprons, and collars, greens on weekends, green vertical mowing, and following topdressing.

Vertical Mowing Units

Both verticutting and grooming units are needed. For thatch removal and verticutting, individual, replaceable units are needed for green maintenance. Smaller units are needed for dethatching of bermudagrass. Other types of grooming attachments are available for lighter grooming purposes.

Which direction is your equipment heading?

Putting Green Aerifiers

Two putting green aerifiers are needed for the least popular and most disruptive job on the golf course. It is important to complete this operation as fast as possible on greens and teeing surfaces. Because of the abuse aerifiers receive, two putting green aerifiers are needed for greens and tees, and for areas around greens and fairways that require special attention. This also provides insurance against breakdown during an important putting green aerification operation.

Heavy-Duty Topdressers

Two heavy-duty topdressers (one for a nine-hole course) to use after aerifying. This machine can also be used to topdress fairways, if necessary.

Light Topdressers

One light topdressing machine if your program calls for light and frequent topdressing for greens.

Spiker

One spiking machine to promote oxygen diffusion, or establish a seedbed for overseeding, etc. A spiking attachment used with other equipment may serve this purpose.

Dragmats, Brooms or Brushes

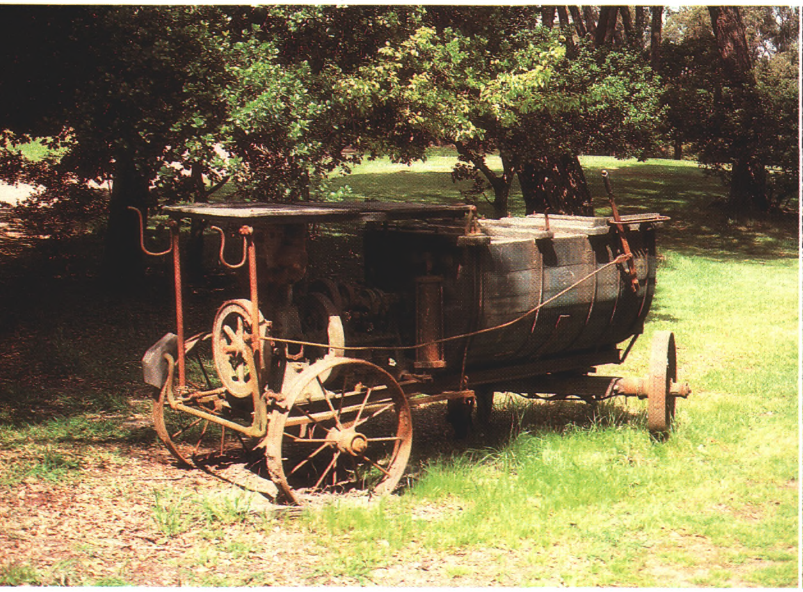
For use in filling the aerification holes, and following light putting green topdressing.

Plug Pushers

To remove aerification plugs.

Spray Rigs

One small sprayer (100 gallons) for putting green applications, and one large sprayer (250 to 300 gallons) for



Is your equipment inventory up to date?

Use the right equipment for the job.

fairway, rough, and pesticide applications.

Utility Vehicles

The number of utility vehicles will vary, depending on operations. Four to five utility vehicles are generally needed for an 18-hole course, while two or three are needed for a nine-hole course. These vehicles are used for heavier work, such as moving sand into or out of bunkers, installing drain lines, and carrying loads ranging from 200 to 1,500 pounds.

"People Movers"

Depending on the size of the maintenance crew, there is the need to provide transportation for them at all times. Generally four to five people movers are needed on an 18-hole course, while two or three are required for a nine-hole operation. Many jobs do not require a heavy-duty utility vehicle, and lighter-weight units are ideal for changing cups, hand watering greens, repairing minor irrigation problems, and hand raking bunkers.

A Bunker Rake

If bunker contours permit, one motorized bunker rake should be in the inventory.

Fairway Mowing Units

Two fairway mowing units are recommended (one for a nine-hole course). If pull-gang units are used, a utility tractor will also be necessary. If the fairway units are self-driven, they should be purchased with the type of grass, terrain, and soil found on the golf course taken into account. In recent years, the trend has been toward triplex-type mowing units for fairways. However, this is more labor intensive than the larger mowing units.

Rough Mowing Equipment

One five-gang rough mower (or one three-gang unit for a nine-hole course) is usually adequate. As with fairway mowing, this unit can be self-contained or pulled behind a tractor.

Rotary Mowers

Rotary mowers should be used on banks and around trees and tight areas that cannot be reached with regular rough mowing equipment.

Triplex Trim Mowers

Two triplex trim mowers (one for a nine-hole course) for cutting areas adjacent to tees, bunkers, greens, and other inaccessible areas.

Utility PTO Tractors

Two or three utility PTO tractors are recommended for an 18-hole course and at least two for a nine-hole course. These units are used for mowing fairways, roughs, spraying herbicides, fertilization, sweeping, and other tasks. If fairway mowing units are self-contained, or triplex units are used on fairways, two tractors may be adequate for an 18-hole course.

Large Area Sweepers or Vacuums

One or two sweepers (one for a nine-hole course) for general course cleanup after mowing, dethatching, aerification, tree debris, leaves, etc.

PTO Tractor — Blower

When a PTO tractor-mounted blower is combined with a sweeping operation, it provides an efficient means of course cleanup. This may not be needed if trees don't cause litter problems.

Front-end Loader/Backhoe

A front-end loader/backhoe is an essential piece of equipment for the modern 18-hole or nine-hole golf course.

Large-Volume Fertilizer Spreader

One large-volume fertilizer spreader is needed for fairways, roughs, tees, and greens.

Lightweight Fertilizer Spreaders (Small Volume)

At least two or three such spreaders are needed for putting green and tee applications.

Fairway Aerifier

One fairway aerifier will be needed on most golf courses. Buy one that does not tear the turf excessively.

Dump Truck (2½-Ton Minimum)

A dump truck is almost indispensable for drainage, topdressing, and construction projects.

Pickup Truck

One pickup truck is needed on almost every golf course for transportation and moving purposes.

Power Sod Cutter

At least one power sod cutter is recommended.

Heavy-Duty Wood Chipper

A heavy-duty wood chipper will prove exceptionally helpful at every golf course that has a reasonable number of trees.

Trencher

One trencher is needed for drainage and other installations.

Small Equipment

Three or four hand rotary mowers, three or four weedeaters, two power bunker edgers, one clubhouse reel mower, etc., are minimum requirements.

Slicer/Seeder

For use on heavy wear areas.

Fairway Vertical Mower

Depending on area and grass type, a self-propelled vertical mower or interchangeable attachment is needed for overseeding purposes, especially on those golf courses with fairway thatch problems.

Tree-Pruning Equipment

This to include one or two chain saws, extendable pole saws, and regular pruning equipment.

Shop Equipment

To include bedknife and reel grinders, table saws, a steam cleaner, air compressors, a small hydraulic hoist, a welder, paint sprayers, drill press, and many other pieces of equipment vital to golf course operations.

Irrigation Equipment

Equipment needed for irrigation and pumping stations will vary according to the type of system in operation. If any tools are needed to operate the irrigation system, include them in this list.

Miscellaneous Hand Equipment

This area covers shovels, picks, cup cutters, rakes, and all other small items needed for regular golf course maintenance.

Because of regional variations, this list may not include all the equipment your club might require, or it may exceed the necessities of your area, but it is suggested as a basic list of equipment required for maintaining a nine-hole or 18-hole golf course.

If you wish to streamline your maintenance operation and derive maximum benefit from your maintenance staff, equip them with the necessary tools to provide the maintenance results expected by the membership.

Answering the Most-Asked Questions About the Golf Course Pump Station

by KEITH McLAIN INC.
Houston, Texas

THE SPRINKLER heads pop up and water rushes forth. The water is projected across the greens, tees, and fairways, sustaining the life of the turf. The value of water to golf course maintenance cannot be overstated. Without functioning irrigation systems, most courses would cease to exist. Water is the life's blood of a golf course. The irrigation lines to the sprinkler heads act as the circulatory veins and the pump station as the heart of the system.

What comprises a typical pump station?

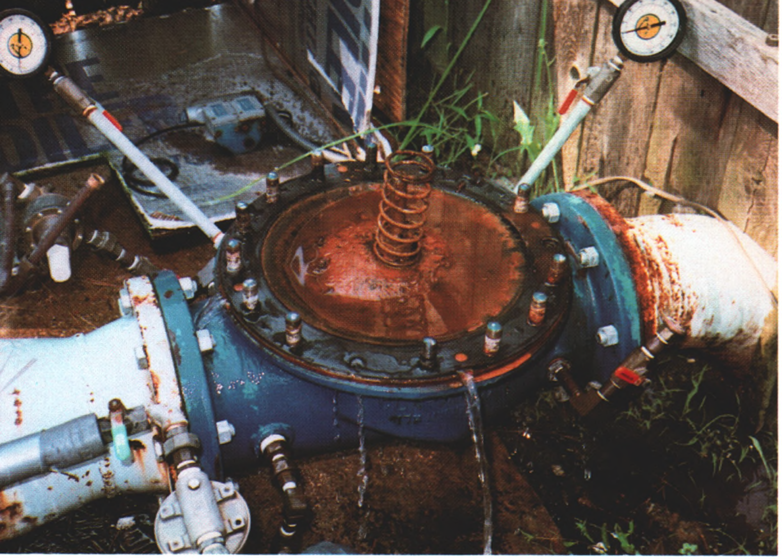
The irrigation needs of each golf course are as individual as the courses themselves, but the average station consists of a jockey pump, two booster or main pumps, a hydropneumatic tank, a control valve, and a controller. The jockey and booster pumps can be vertical turbine or centrifugal pumps. The simplest explanation describing the two types of pumps would be: A vertical turbine pump sits below water level with the motor above water level. The bell-shaped pump is at the end of a standard six-foot column. It has multistage impellers creating pressure that forces the water up the pump column. With a centrifugal pump, both the pump and motor sit above water level and have a suction pipe with a foot valve and intake screen going into the water.

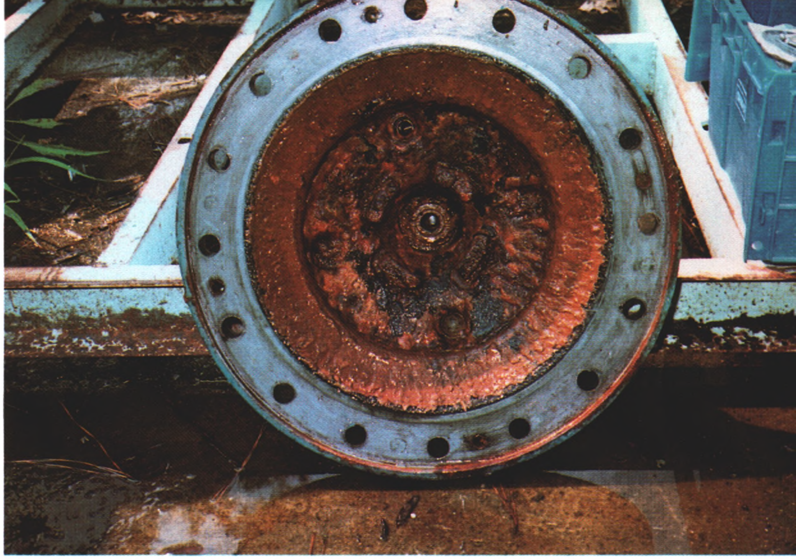
The different components are situated on a steel base or concrete slab near a lake or pond. Each part contributes to the overall purpose of bringing a controlled water supply to the irrigation system.

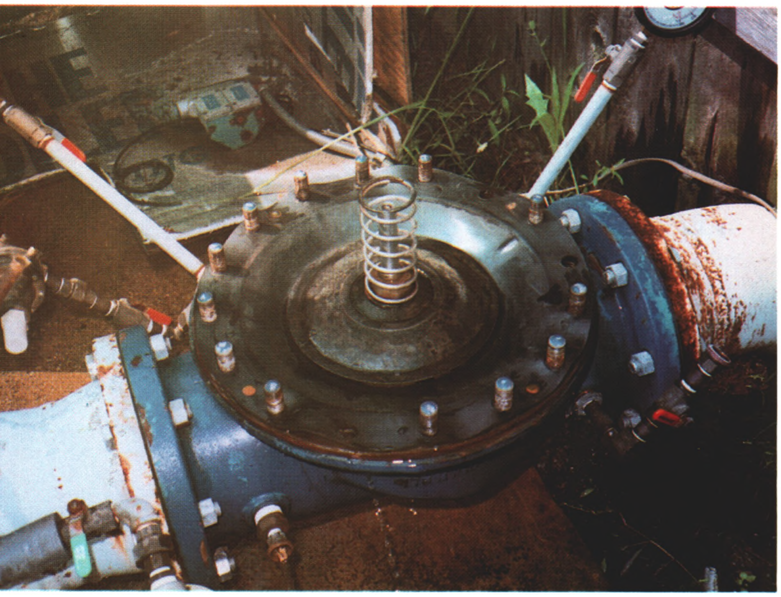
A jockey pump is a small pump, usually with a 10- to 25-horsepower motor, that maintains irrigation line pressure. It allows for minimum power use without the expense of a booster pump. The jockey pump is the first pump to come on. It begins the job of supplying water while maintaining pressure. When more water is needed, the booster pumps come on.

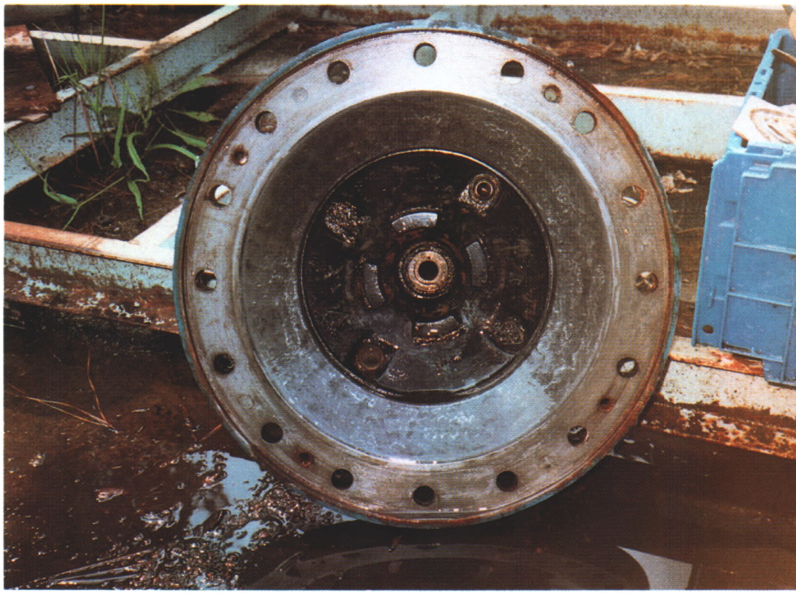
What does a booster or main pump do?

A booster pump is a pump with a 50- to 125-horsepower motor. Most pump stations generally have two, but it varies according to the demands of the golf course. Booster pumps force water from









the pond into the hydropneumatic tank. They come on in stages. The more sprinkler heads that are on, the more pumps come on. Pressure and flow determine how many pumps operate; the greater the demand for water, the greater the need for pumping capacity.

What is the purpose of the hydropneumatic tank?

The hydropneumatic tank, which is also known as the surge tank, has two functions:

1. When the pumps start, they try to send a shock or surge of air into the irrigation system. The tank absorbs this shock and the air that precedes the flow of water. The tank is filled with 60 percent water and 40 percent air. There is an air-release valve on the tank that regulates and monitors the air/water ratio.

2. The pressure in the tank is used to start the various pumps.

Where does the air come from?

The air seeps into the column pipe through the stuffing boxes or reversed check valves when the vertical turbine pumps are not running.

When the pumps are turned off, the water seeks its own level. This allows the air to fill the space between the pump head check valves and the pond level. When the pumps start, the air is trapped in the column and forced into the hydropneumatic tank. If the tank did not absorb the shock, the water (mass) following the free-flowing air (non-mass) would shatter the irrigation pipes. It is desirable to have the pipes completely filled with water at all times. The irrigation lines should maintain a constant pressure. When the pressure drops, the pipes contract; with the pressure, they expand. This creates wear and tear on the irrigation system.

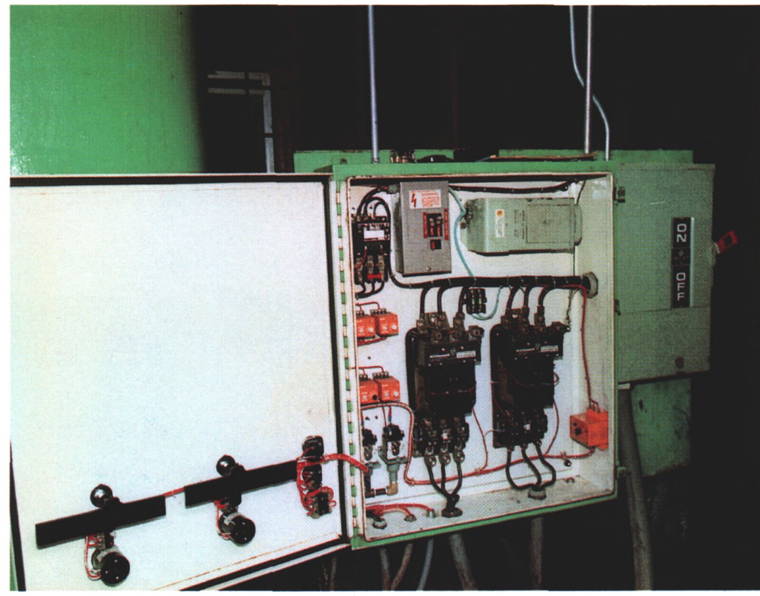
What is the control valve?

The control valve regulates the water from the hydropneumatic tank to the irrigation system. The standard control valve has a cast-iron body, and is piped with three different pilots. These three pilots serve to regulate the irrigation pressure, act as a safety for the irrigation pressure, and maintain tank pressure.

The pressure-reducing pilot is affectionately known as the husband. It maintains a set pressure on the irrigation system.

A surge-protection pilot is known as the mother-in-law. It overrides the husband if he fails to close at the set pressure. The key words here are override the husband (standard procedure for most mothers-in-law).

The sustaining pilot, or the wife, is set to make sure there is always backpressure against the pumps when they start. This is to keep the pumps from cavitating (when pumps spin too freely or fast they will not pick up water).



(Right) Bear Creek Golf World, Houston, Texas, owned and operated by American Golf Corporation.

What is the pump station controller?

It is an electrical board wired to the control valve. The hydropneumatic tank sends pressure signals to the controller that start the pump after a time delay. When the watering cycle is complete, the control valve closes. Limit switches on the valve send a signal to the pump controller telling it to turn off the pump after a time delay has cycled.

Why is a time delay necessary?

It is less expensive to keep the pumps running than to start and stop them. It takes six times the in-rushing amperage to start a pump. The time delay settings range from three to 60 seconds. Some irrigation systems take longer than others for their sprinkler heads to shut off or come on during sequencing.

What are some special features of a pump station controller?

Computer technology is finding its way into golf course maintenance. There is technology that can gauge and reveal the moisture content of the soil along with recording the daily effects of the weather conditions through special weather instruments. All this data, with help from the computer, will be used to analyze and redirect irrigation practices. It will tell how many gallons per minute and electrical consumption per hour are being used. This will enable the superintendent to conserve not only electricity, but most of all water.

These new pump stations now basically consist of:

Phase protection monitors the incoming voltage to the pump station. If it varies plus or minus 10 percent or a loss of phase or phase reversal occurs, the device will shut the pump station down before excessive heat is generated.

Low level shutdown. This circuit protects the pumps from running without water. There is a probe that hangs inside the wet well. When the water level falls below it, the station shuts down.

High pressure shutdown. This feature indicates the control valve has failed to operate properly. Time to check the mother-in-law.

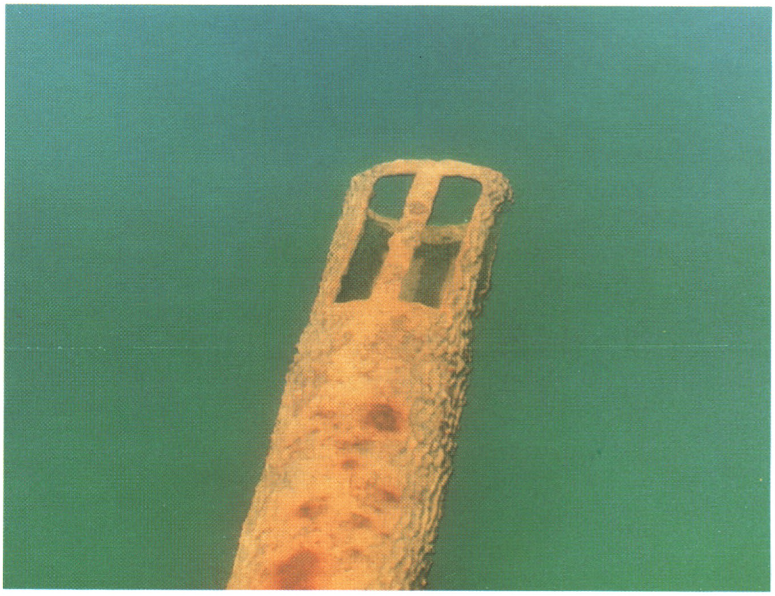
What about high-temperature circuit shutdown on centrifugal pumps?

Centrifugal pumps usually have the same safeties as vertical turbine pumps, but will have a shutdown circuit monitoring high temperatures. This is because when a centrifugal pump cavitates, the impeller spins freely in the water, causing friction and creating heat.

What is the most common problem affecting the pump station?

Dirt and trash are the primary contributors to the superintendent's headaches. Dirt inside and around the pump station areas builds up, causing dust and debris to gather on the motors and electrical components. This interferes with the components' ability to make solid connections.

Just as dirt above the ground causes problems, dirt and trash in the water lead to other miseries. When dirt in the water makes its way into the pumps, it begins to wear or plug the impellers. Its abrasive action works like sandpaper as it erodes the impellers and bearings. The trash works its way up into the pumps and clogs them. It plays havoc with the check valves. Most check valves have brass seats and ding very easily. Once a ding is created, it inhibits the ability of the seat to seal completely. The dirt then moves through the tank to the con-



trol valve and plugs it. As it continues its journey through the irrigation system, it clogs the sprinkler heads as well.

How can this be avoided?

First, insure the pump station is installed properly during construction. It is not advisable to place the pump station at the end of the pond where the wind blows all the surface trash. Eventually the trash becomes waterlogged and sinks to the bottom of the pond. If this is where your intake pipe is located, the trash is in the direct flow of the water entering the pipe, and is carried with it. To avoid this, locate the pump station at the end of the pond, but extend the intake pipe to the middle of the pond. Always keep the intake at least 30 feet from the edge of the pond.

When you are installing the wet well or intake pipe, place it where it will draw clean water. This can be done by keeping the intake pipe at least three feet above the floor of the pond and 30 feet from the edge of the bank. During construction, dig silt traps like moats around the intake pipe. Always keep the pond at its highest possible point. The lower the water level, the higher the chance of bringing in trash from the bottom of the pond.

What does the future hold for your water source?

With the water shortages looming, I expect to see between 75 and 80 percent of all golf courses using some type of effluent water by the year 2000. With the expense of potable water rising and the restrictions on drilling new water wells, effluent water will be the only water affordable. This will cause a few problems that will have to be overcome, such as the injection of chlorine into the irrigation system, and/or installing filter units or separators after the pump station to keep the irrigation system clean. I recommend cleaning the water before it reaches the pump station.

How do I increase the longevity of my pump station?

Take care of it. Treat it like you would your own heart. Listen to the noises it makes. Visit it every day. Keep notes on everything you hear or do to it — changing the oil, packing the pumps. Knock the rust away. Paint it once in a while. Blow the panels out with air once a month. Keep the area clean. Get into a preventive maintenance program with the station manufacturer or qualified representative. Check with the pump manufacturer and motor manufacturer for their recommended servicing. Treat the pond or lake. The cleaner the water, the longer the life.

Is preventive maintenance expensive?

No. The average is between $400 and $500 a year. Fairly inexpensive insurance when you consider the stress on the superintendent and the value of the turf the pump station is serving.

To wrap it all up, when a sprinkler head comes on, a pressure drop occurs that activates the jockey pump. The heart begins to beat, and the water starts its journey. It goes from the pond, through the intake pipe, and into the wet well. The pumps force the water up the column into the hydropneumatic tank. The tank absorbs the shock and air. Then the water passes through the control valve, travels into the discharge pipe, to the irrigation lines, and out to the spinkler heads. Finally, the golf course turf absorbs the water, thrives, and grows for the good of the game.

TURF TWISTERS

APPARENTLY

Question: Does 2,4-D have an accumulated adverse effect on soil microorganisms essential to soil fertility? (Wisconsin)

Answer: Apparently not. Studies in Saskatchewan conducted by Ag Canada scientists and reported recently by *Crops and Soils* magazine, indicate that 35 *annual* applications to experimental plots had no effect on the mineralization of nitrogen or the microbial biomass. There was some temporary depression of enzyme activity and respiration, but they were slight when compared to changes caused by normal weather stresses.

NOT EVERY MEDIA REPORT

Question: I have heard that a fungicide sprayed on golf greens caused the death of a Navy lieutenant a few years ago. Has this been proved beyond any doubt? (Pennsylvania)

Answer: It has absolutely not been proved at all. In fact, death was caused by toxic epidermal necrolysis, a condition not associated with the fungicide. The matter is going to court where, the manufacturer states, the media's reports are wrong "and this will be clearly and unequivocally demonstrated."

IS FACTUAL

Question: Milorganite, a natural organic nitrogen fertilizer frequently used on golf courses, has been reported by the press to be linked to Lou Gehrig's disease: amyotrophic lateral sclerosis — ALS. Has this been proved beyond any doubt? (Indiana)

Answer: It has absolutely not been proved at all. In fact, federal and state (Wisconsin) health officials have stated there is no connection and no need to study further the relationship between Milorganite and ALS. The federal and state epidemiologists criticized the ALS researcher who made the "suggestion" in the first place.