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Green Section RECORD



Seeding Greens The Hydromulch Way

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Green Section RECORD

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Vol. 25, No. 1

JANUARY/FEBRUARY 1987

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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 finished job.

Need Insurance? Hydromulching Is One Good Policy

by **PATRICK M. O'BRIEN**

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and **ROBERT BARKSDALE**, Landscape Supply, Virginia

AGRICULTURE HAS always been a risky business, but in recent years, every business has become tremendously more risky as insurance horror stories go on and on. Not so long ago *Time* ran a cover story "Sorry, America, Your Insurance is Cancelled." Everyone is affected and everyone is paying more and more for this litigious society.

That said, it's nice to know there are still some things in life that are relatively simple and easy to understand. There are still some things we can do to protect an investment and to ensure success. For example, if you are going to seed some new greens, or a golf course, or hillsides, or even wildflower areas, there's an insurance policy you should know about. It's called hydromulching!

Hydromulching got its start in the early 1960s when state highway departments learned that mulch was an asset in establishing grasses quickly and economically on non-irrigated hilly terrain. The protective mat provided a favorable micro-environment for seed germination and growth while also protecting the seed, fertilizer, and top mix from wind and rain erosion.

Historically, a light straw mulch has been used on golf greens for a long time to stabilize the soil and to gain improved germination. Straw or some similar material is applied by hand over the entire green surface immediately after seeding. It isn't an easy job, particularly in determining the proper thickness and in applying the material uniformly. Of course, once germination takes place,

the straw cover has to be carefully removed and in a timely manner to avoid both disease and smothering the young grass. The straw frequently contains weed seeds, which contaminate the green. Under high winds, it can be blown away. For all of these reasons, it is rarely used today.

Hydromulching is becoming more and more popular. With the current shortage of bentgrass seed and with architects designing greens with more undulations and contours, hydromulching takes on new importance. Hours of careful labor and expensive seed, soil, and fertilizer can be washed away by a sudden storm, irrigation malfunction, or high winds. Not only is repair, re-grading, and reseeded expensive, but any delay in the construction schedule

has incalculable consequences. Field experiences also show hydromulching increases total seed germination, because evaporation rates and soil moisture levels are better controlled. These considerations increasingly assume precedence over the extra costs of hydromulching applications.

The practice of hydromulching greens is becoming especially prevalent along the Atlantic seaboard and in the Southeast in the fall. It is a good tool to help ensure fast, uniform turf establishment, particularly on sandy soil mixes. These tend to dry out, and hydromulching helps hold some moisture for the new seed. Clubs seem interested in this kind of insurance, because it frequently pays dividends in the form of saved labor and time.

HYDROMULCHING, fortunately, need not be a significant cost factor, since the process doesn't require much labor or equipment. However, several points should be considered before taking out this insurance policy on your course:

1. Applying hydromulch to a putting green is an art. The most important variable is a skillful operator. Not all operators have the knack to do the job correctly and to apply the proper amount of material.

2. Although hydromulching materials are much improved, no mulch is perfect. All mulching materials are subject to movement in the event of heavy rains. The chances of erosion are significantly less, however, if the proper hydromulching technique is followed.

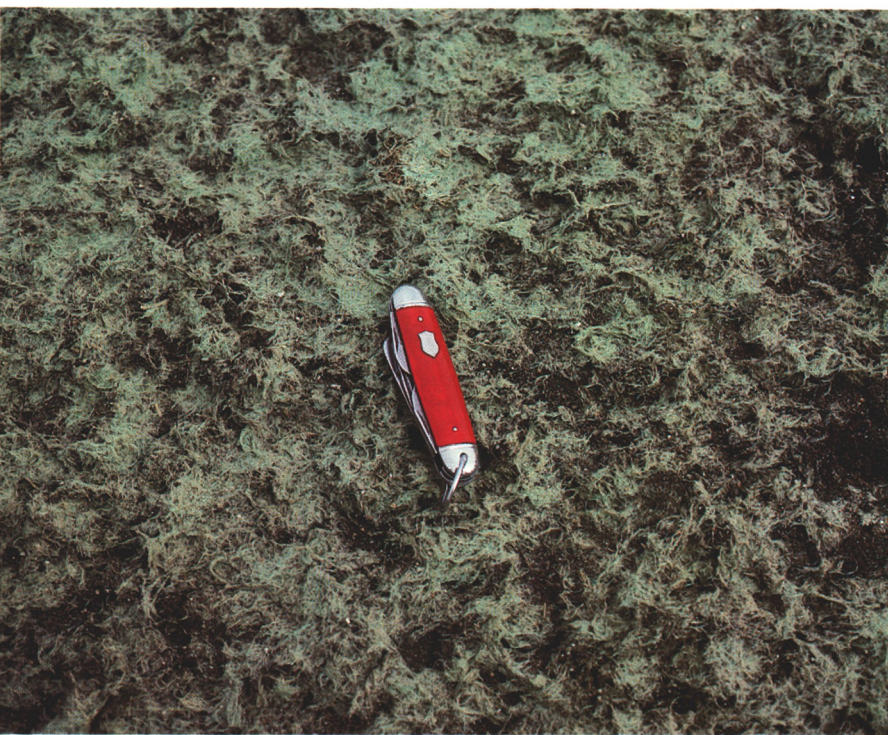
3. The putting green area should be seeded and fertilized prior to the hydromulching operation. Bentgrass seed is too small to be included in a tank mixture with the mulch. The mulch itself may tie up the seed and germination will occur in the mulch layer instead of in the soil. Seed contact with the soil is important for the highest percentage germination.

4. The germination rate will be faster and more uniform by lightly rolling the surface after seeding and before hydromulching. The purpose of rolling is to firm the surface. When the mulch is degraded and mowing begins, smoothness will be significantly better.

Selecting a good operator for your hydromulching job is a most important step. Most golf courses hire an outside contractor for both his experience and machinery. Seldom is this work done by the golf course crew. The hydraulic mulcher is the basic piece of equipment.



(Above) Straw or, in this case, palm leaves were used in years past as a cover for new seed. (Top) The paper mulch is compressed and very dry when loaded into the tank. (Opposite page, top) Applying mulch with a hose operated by a remote valve. (Bottom) Most paper mulches are recycled newspapers or corrugated cardboard.



It is a fairly simple unit with an agitation system for mixing and keeping the mulch in suspension, a pump with a gun for application, and a gasoline engine to power the agitator and the pump.

An experienced operator will always clean the tank as a first step. Too often the hydraulic mulching equipment has been used previously for a highway roadside development, private or commercial real estate sites, or park con-

struction. These jobs use grasses and fertilizers that are undesirable for golf courses, especially putting greens. Filling the tank with water and discharging through the nozzle is always a good idea.

Once the tank is clean, it is important to prepare the mix properly. A good operator will always preside over the tank-filling operation. To start, the tank is loaded half full of water. Usually of

at least 500-gallon capacity, the tank is trailer-mounted and pulled behind a tractor or truck. The mulch is added through the loading hatch while the tank continues to fill with water, and it is thoroughly mixed with the water by agitation in the tank. If too much mulch is added, the nozzle might clog.

A nozzle is selected to produce a fine mist, not a coarse spray. The pump is generally set at full pressure (100-150 psi) to maximize the shooting range (30-50 feet). With a fine mist nozzle and proper pump speed, a uniform application of mulch mat can be applied.

Once the load is prepared, the operator is ready to "shoot" the green. The mulch is applied either from a tower-mounted gun on the tank, or for even better control, through a hose and a remote valve. An experienced operator knows exactly how much mulch to apply over a new putting green, all the while considering wind direction and speed. The operator can visually meter his pattern and rate by the color and the thickness of the mulch. Mulches contain a water-soluble, harmless green dye for application and aesthetic purposes. The color eventually disappears as the mulch decomposes. If the operator applies too much mulch, the soil surface may be sealed. This impedes the seedlings' growth. The goal is to apply just enough mulch so that a degree of anchoring and protection is produced for the seed without having it buried.

TABLE 1.
A Few Selected Commercial Paper and Wood Fiber Mulches

Brand Name	Type	Ingredients
1. Cellin Mulch	Ground Newspaper	Wetting Agent and Dye
2. Cellin Plus	Ground Newspaper	Wetting Agent, Dye, and Tackifier
3. Cellin K	Ground Cardboard	Wetting Agent and Dye
4. Cellin K Plus	Ground Cardboard	Wetting Agent, Dye, and Tackifier
5. Super South	Ground Newspaper	Wetting Agent and Dye
6. Spray Mulch	Ground Magazine	Wetting Agent and Dye
7. Weyerhaeuser	Ground Cardboard	Wetting Agent and Dye
8. Sunlock	Ground Newspaper	Wetting Agent and Dye
9. Terra Mulch	Ground Newspaper	Wetting Agent and Dye
10. Hydro-Loc	Ground Newspaper	Wetting Agent and Dye
11. Conweb	Wood Fiber Mulch	Wetting Agent and Dye
12. Conweb 2000	Wood Fiber Mulch	Wetting Agent, Dye, and Tackifier

SEVERAL MULCHING materials other than straw are available for golf courses today. Paper products or ground wood fiber are the most popular. The first paper mulch was produced in 1961. Most paper mulches are recycled newspapers, corrugated cardboard, or magazine paper. Those derived from newspapers or corrugated cardboard are considered to be the best. The corrugated cardboard source has longer wood fiber, offering more stability and protection for the seed. A paper mulch will contain no germination- or growth-inhibiting substances. It is also weed free. The application rate is 1,000 to 1,500 pounds per acre over bentgrass seed. The higher rate is advised for more undulating greens. More than ten different commercial brands are available today (Table 1).

The wood cellulose mulch derived directly from a natural wood source is another form of wood cellulose fiber. It has the advantage over paper mulches by being even more effective on potentially high-erosion areas. However, these are significantly more expensive and the gently sloping terrain of most putting greens does not justify the extra cost. If a wood cellulose mulch is selected, the application rate is 10 to 20 percent less to achieve the same results as a paper mulch.

There usually is not a tackifier or sticker-type material included with the mulches. These erosion-control agents are usually purchased separately and added to the mulch, although some manufacturers offer mulches with a tackifier. The water-insoluble tackifier is added to the tank at the rate of 5

gallons per 500 pounds of mulch. This ingredient is very important not only in holding the individual mulch fibers together, but also allowing them to hold more tenaciously to the putting green surface, particularly on greens with severe undulations. This helps to create a more crusty surface that is less susceptible to erosion from excess water. If site conditions are ideal and excessive moisture is not expected, a tackifier is unnecessary.

A wetting agent is also mixed into all paper and wood cellulose mulches, enhancing the flow of the mulch from the tank through the nozzle. The wetting agent reduces the surface tension of the water, so the mulch slurry will pass through the equipment better. Furthermore, many of the mulches are compressed into a bale for packaging purposes, and the addition of a wetting agent helps wet the paper and wood mulch chunks as they are loaded into the mixing tank. The manufacturers remove as much of the moisture from the mulches as possible for easier shipping. Consequently, the material entering the tank is usually very dry.

Once the mulch is applied, all that remains is to keep it moist through bentgrass establishment. Less water than usual is needed during the germination stage since the evaporative water loss from the soil surface is reduced. Most mulches reduce the syringe frequency from four to five times a day down to one or two times.

The bentgrass seeding rate for greens is 1.5 pounds per 1,000 square feet. Most superintendents have noted germination in four to five days after hydromulching,

whereas bentgrass usually germinates in seven to ten days in favorable weather without hydromulching. A uniform turf cover is usually achieved in four to five weeks, using less seed with a higher germination yield encouraged by the properly applied mulch.

Since the sand in the upper profile is stabilized sooner using a mulch, putting green mowers pick up less sand with the first mowing, which reduces the need for extra lapping on the mowers.

WHAT IS THE COST of this insurance? If it is figured on a per-acre basis, actual mulching costs are not great. Paper mulches range from \$200 to \$240 per acre, while the wood cellulose mulches cost between \$300 to \$340 per acre. If a tackifier is added to the tank mixture, there is an additional \$50 to \$60 per acre. It is usually just as economical to purchase a paper or wood mulch with a tackifier than to add the tackifier separately.

A contractor usually charges \$500 to \$700 per acre for renting the equipment and applying the mulch. The biggest variable in the cost is how far the contractor must transport his equipment to the site. In most instances, the total contracted cost is between \$2,000 and \$3,000 for 18 putting greens. This equates to a range of \$110 to \$170 per green. Expensive? Well, since the basic construction cost of most new putting greens today is \$25,000 or more, this is less than 1/2 percent of the total cost. It seems worth the expenditure.

Because of economic needs or membership requirements, many golf courses must seed their new greens later in the growing season than desirable. This need to stretch the normal seeding season is met to a large degree by hydromulching. The mulch has a buffering effect on the soil temperature in the upper profile. It keeps the soil warmer later into the fall, and it will also protect the new seedlings during high summer temperatures.

Hydromulching is a useful tool worth consideration by golf courses planning to build or reconstruct putting greens. It helps establish bentgrass more uniformly, and it protects against seed movement. It saves labor and time. The short supply and high cost of bentgrass seed, not to mention the benefit of reduced irrigation, uniform establishment with faster and higher germination rates, and reduced erosion possibilities, makes hydromulching a valuable tool in successful putting green establishment. It is a proven management technique.

Never Compare Golf Course Budgets

by DAVID BAILEY

CGCS, High Ridge Country Club, Palm Beach, Florida

ONE OF THE most controversial subjects in the golf course maintenance business is the comparison of budgets. Nothing makes a superintendent shake his head faster than being asked, "Do you know what they spend at the neighboring course?" It is even more absurd to compare courses in different geographic sections of the country.

What is an average course? They vary as much as the players. Did you ever find one of those "typical average families" with 4.3 members?

Courses are different in turfgrass types, amount of play, cart traffic, terrain, acreage, green size, fairway size, tee size, bunker size and number, height of rough, soil type, climate, irrigation system, water source, trees, landscaping, fertilizer and chemical usage, amount and age of mowing equipment, personnel . . . the list is endless.

The main budget difference in a northern and southern course is in the work load. Sunbelt area courses with the 52-week full-time daily operation of staff and employee benefits with payroll tax can cost in payroll alone what many northern courses spend for their total maintenance budget. Since Sunbelt courses are maintained 12 months of the year, it stands to reason their annual cost will be much higher, even if the quality level is the same.

Course design also has an effect on the expense, with the modern version usually more expensive. Since the advent of the triplex riding greensmower, architects have designed larger greens. Think how fairway sand bunkers have increased in number and size with the invention of the mechanical bunker rake. Artificial-looking Scottish mounds, now in vogue, require hand mowing that costs more. The trend in the last 20 years of real estate and resort developments has raised the standards of turfgrass maintenance and its cost. This is because real estate developers are in a very

competitive market and funds are made available to try to outdo each other. This forces all neighboring courses to upgrade and keep pace. Some southern and western developments have such elaborate entrances and common ground areas that their costs alone are similar to the total budget of a small northern course.

Most of all, two courses, no matter where they are located, will be different in the intensity of maintenance accomplished. What do the golfers or their management demand? Some courses mow greens 200 days per year, others 365. Some mow fairways and tees 180 times per year, others less than 100. Some courses rake sand bunkers daily while others have no bunkers at all.

Budget comparisons are as out of place as a \$2 bill.



Some clubs edge cart paths, others have none. Sunbelt courses may irrigate triple the amount of a northern course. All these factors affect equipment life spans and repair costs.

Northern courses work on repair of equipment all winter; southern courses wear them out and must buy new. Equipment in southern Florida lasts half the time it does in Maine. All this proves there is no way to compare. But people always have and always will try to make comparisons.

MAINTENANCE COSTS for an 18-hole regulation-length course vary on a national level by over 500 percent. If the price of any other commodity had that discrepancy, there would be cause for concern. Actually, some items of similar nature differ in cost. A golf shirt from K-Mart costs under \$25, while one from Gucci costs nearly \$150. Ever compare the price difference between a Ford Escort and a Porsche 928? Both get you there, but which gives the better ride? Why does an ultra-private club with a high quality standard compare its expenses to a neighboring daily-fee course? It's only human nature to want the maximum value for the money spent. The question that should be asked is, "Are we getting an efficient dollar spent for the level of desired maintenance we expect for our course?"

In 1986, financial figures for an 18-hole regulation course varied from \$200,000 to over \$1,000,000. Some regional generalizations can be concluded from the following information supplied by leading superintendents in different geographical areas. None of these prices reflects any capital improvement in projects or equipment purchases. For example, metropolitan New York budgets range from \$325,000 to \$450,000, with \$375,000 the median. Their labor cost can account for 65 percent of the budget because of unionized hourly rates.



Holes designed with natural terrain and vegetation lower maintenance cost and increase esthetic value.

This labor cost is about 10 percent above the national figure. A few hundred miles away in Massachusetts, the average is \$300,000. With six full-time employees and an emphasis on summer students at lower hourly rates, the total costs will naturally be lower.

The Massachusetts courses spend \$10,000 to \$15,000 on fertilizers. Chemical costs are \$24,000 to \$32,000. Figures from the Midwest transition zone of St. Louis reveal nearly the same total expenditures. Their average is \$325,000, with a breakdown for fertilizer at \$20,000 and chemicals at \$18,000. If you operate in Florida or California, numbers like these will get you seven months through your fiscal year!

The southern portions of both Florida and California have higher maintenance costs than those in the northern portions. Courses from Los Angeles to San Diego spend \$500,000 to \$600,000. This is the same average figure for Florida from Palm Beach to Naples. The high is over \$800,000. Courses in both states spend more for fertilizers than northern states spend on both fertilizers and chemicals.

The most unusual cost area in the United States is Palm Springs, California. When you think of lush turfgrass in a desert environment, add some dollar signs. Their range is from \$750,000 to

\$1,200,000. The extreme cost of water and a \$200,000 winter overseeding budget make this another world. Now you have a better understanding of why it costs more to play golf in Florida or California.

THE 1984 SURVEY conducted by the National Golf Foundation and the Golf Course Superintendents Association of America concluded that private clubs spend 15 percent more than municipal courses and 58 percent more than daily-fee courses.

A 1985 Pannell, Kerr, Forster survey of their accounts listed south Florida expenditures only 25 percent above the national average. They concluded nationwide 1985 costs increased 8.9 percent. At best, most national surveys can be used only as very general guidelines. Accounting procedures vary and differ. All budgets do not include the same items. How can anyone compare? Most surveys have a breakdown in the useless statistic "cost per hole." Since courses vary greatly in size, shape, and everything else, perhaps we should learn to think more along the lines of "cost per acre" instead!

James Faubion, director of golf operations for the Country Clubs of America, handles courses from coast to

coast. His experience shows the following trends. He states, "A course in Texas will spend at least \$50,000 more than one in the southeast. A California or Florida course will be at least \$100,000 to \$150,000 higher. We have had two courses on the same property vary 30 percent, even with the same management and membership demands."

A dozen superintendents from Palm Beach, Florida, at clubs with common members and similar maintenance levels, gather yearly to discuss their budgets. This became necessary because of the constant comparison by club members at cocktail parties. The group exchanges copies of each maintenance budget so the facts are known. This process is done in total confidence within the group and is used at their discretion as needed.

In all financial matters, it's the bottom line that counts most. So what should you conclude from all these numbers? If your course looks and plays the way a majority of your members want, that's fine. If the members want improvements, they must be willing to pay for them. With total confidence in the management staff at any course, why worry about what the other clubs are doing, especially if they are a thousand miles away?

Slow Down . . . You're Going Too Fast

by JAMES T. SNOW

Director, Northeastern Region, USGA Green Section

A DAY for the record books. It's only noon, yet the greens, tees, and fairways have been mowed, the sand bunkers have been raked, the cups have been changed, and even the rough mower is well along on its travels. The routine jobs have been done quickly. Now it's on to special projects.

The model of efficiency, you might say. Time is money, after all, and getting things done quickly is what it's all about on a busy golf course. Or is it?

While the cost savings of a couple of hours of labor may be easy to calculate at first glance, the actual figure would be much different if the cost of getting the job done *too* quickly were taken into account. The effects of high-speed maintenance on turf, on equipment wear, and on the appearance and playability of the golf course are often overlooked by golf course superintendents and workers, who sometimes feel that saving time represents a job well done. An understaffed crew and pressure from the green committee to work on special projects is sometimes at the root of the high-speed maintenance approach. Even under these circumstances, though, these tactics can extract a high price.

The damage from high-speed maintenance is often cumulative and subtle, showing up as visual symptoms only after days, weeks, or even months. Very often the visual symptoms are blamed on other factors, such as soil problems, disease and pest activity, excessive rainfall, irrigation system problems, mowing too closely, or just plain wilting from too much heat. These may indeed be contributing factors to the problem, but the basic cause may also be traced to speed.

Take, for example, the triplex ring problems around the perimeter of greens, where triplex greensmowers



Changing cups requires patience and attention to detail.

make their cleanup pass. While several elements are involved with the thin, weak turf on these areas, making the cleanup pass too quickly is one of the more important factors causing these symptoms. Sometimes, just slowing down the mower can reduce the severity of the damage.

THE INJURY to turf by turning mowers and other maintenance equipment is, in fact, one of the primary consequences of high-speed maintenance. Consider a golf cart traveling across a wet fairway at a high rate of speed and suddenly making a sharp turn. As long as the cart is going in a straight line, little or no turf damage would be readily apparent. Making the turn, however, would probably cause the turf to be ripped up, and might even dig ruts. Turning any vehicle creates a lateral, downward pressure on the turf and soil, causing greater turf abrasion and soil compaction than a vehicle traveling in a relatively straight line. The sharper the turn, the larger the vehicle, and the faster it is traveling during the turn, the greater the turf injury and soil compaction.

In addition to the triplex ring symptoms on greens, several other areas on the course show the effects of excessive mower speed. The collars around greens, for instance, are often the victims of the sharp, fast turns of triplex and walk-behind greensmowers. During hot summer weather, turf on the collars can easily wilt in precisely the areas where the mowers make their fast turns. Other familiar problem spots include the ends of fairways where the larger mowers regularly turn, and the ends of narrow tees where mowers must turn quickly. In all of these areas, smaller mowers making wider turns and slowing the ground speed of the mower during the turn cause less damage. If circumstances allow, turning in adjacent rough areas, rather than on the collars, tees, and fairways, would be the best solution.

Maintenance utility vehicles and golf carts do their share of damage, too, when operated at fast speeds. Maintenance personnel should be advised of this and should be asked to take it easy when they travel from one part of the course to another and, whenever it's possible, to avoid crossing important play areas, such as fairways. When abuses occur consistently, throttle governors are sometimes used on utility vehicles and golf carts to help limit ground speed.

Though damage to turf areas due to fast mower speed is not quite so common in the roughs, there are nevertheless examples of the speed problem. Bark injury to young trees is common where rough mowers are used carelessly and at high speeds. Often, the injured trees eventually die and must be replaced. The mowing units themselves are sometimes the victims of clashes with trees, rocks or other obstacles. The greater the speed of the vehicle when the collision occurs, the worse the damage to the mowing unit.

ASIDE FROM direct damage to mowers or vehicles that results from a collision, the more subtle wear and tear on maintenance equipment can be aggravated when equipment is run at greater than recommended speeds. Increased engine temperatures and greater vibration effects can increase maintenance costs and reduce the useful life span of maintenance equipment.

In the realm of turf playability, the ground speed of the mower can have a direct effect on the quality of cut. Certain types of mowing units simply do not produce a smooth, even cut when they are pulled or run too fast. A poor-quality cut can also occur over uneven ground, with individual units skipping or bouncing, causing a ragged appearance. Many equipment manufacturers recommend that their mowers be run at certain RPM levels or ground speeds for best results. The owner's manual should be consulted and the recommendations followed.

Quality mowing suffers in other ways from excessive speeds. Trying to follow a precise line of demarcation with a mower when traveling at high speeds is a real challenge. As a result, scalping often occurs along the border between greens and collars, tees and roughs, and fairways and roughs. It is even more common for the worker using the mower to leave some extra space when cutting along these borders, resulting in the gradual encroachment of higher-cut turf on greens, tees, and fairways until these areas have been significantly reduced in size. In addition, interesting perimeter contours on greens and fairways are often lost by encroachment. Ultimately, lost playing areas must be reclaimed by scalping back adjacent turf and causing unsightly but temporary scars.

One of the more common examples of the use of excessive ground speed occurs with mechanical rakes in sand

bunkers. These machines are almost invariably run so fast that sand in the center of a bunker is gradually pushed closer and closer to the outer edges. This process continues until the sand is pushed over the edge, and the lip and bunker definition is lost. Even more common, sand is often pulled over the edge of the bunker where the rake exits. Major renovation work may eventually be required. The use of the mechanical rake at a fast speed can also leave long ridges in the sand, justifiably raising the ire of golfers unfortunate enough to land next to the ridges. All this for the sake of getting the job done quickly.

Cup changing is not immune from the race for efficiency, either. A fast job





(Above) Sharp, fast turns with large mowers on wet soils can spell trouble.

(Left) Mower damage to tree bark is a major cause of disease, decay, and premature death of golf course trees.



can result in poor cup location, a flagstick that is set a few degrees from vertical, or a series of replacement plugs on the greens that are set either too high or too low. Either way, depressed or scalped plugs detract from both the appearance and playability of the greens.

AFTER ALL the talk about the effects of high-speed maintenance on the turf and other areas, perhaps the best reason to take it easy is for the sake of worker safety. Racing around the golf course on utility vehicles is an open invitation for an accident. Workers on various types of mowers and careless golfers on golf carts have been known to slip into ponds, off banks, over edges and into trees. With high staff turnover and inexperienced help being the rule rather than the exception at many golf courses, the golf course superintendent has an important responsibility to help educate his crew as well as the golfers about the potential dangers of the vehicles and golf carts they use.

It is obvious from this discussion that high-speed maintenance and golf cart use can be a real problem in terms of the appearance, health and playability of golf course turf, and of sand bunker maintenance, equipment repair, and worker and golfer safety.

How fast is too fast? Common sense suggests that the appropriate speed for any golf course vehicle might vary significantly depending on local circumstances. The golf course superintendent can only look for the symptoms of high-speed maintenance and then make the necessary changes. However, a few simple common-sense tips can help save turf and provide better playing conditions.

- Avoid turning sharply.
- Slow down making turns.
- Make as many turns as possible in the roughs rather than on collar, tee, and fairway edges.
- If there is ever any doubt, take it slower . . . haste makes waste.
- **THINK SAFETY FIRST!**

Taking this approach to golf course maintenance may not produce too many days for the record books, but it will produce healthier turf, better playing conditions, and a safer golf course.

Scalping back turf to reclaim lost teeing areas. Taking time to maintain the edge on a day-to-day basis would preclude having to take this measure.



Figure 1. A view of the world-famous Number 6 Hole of the Mauna Lani Golf Course, island of Hawaii.

Water... The Limiting Factor for Golf Course Development in Hawaii

by **DR. CHARLES L. MURDOCH**

Department of Horticulture, University of Hawaii

COMMON MENTAL images of Hawaii include lush tropical rain forests, rainbows, waterfalls, and exotic tropical flowering plants. While these are all certainly part of Hawaii, the availability of adequate high-quality irrigation water is the limiting factor for development of golf courses in many parts of the state.

How could this be? Why is water a limiting factor in golf course development in a state that includes the wettest spot on earth? The problem is not in the amount of water that falls, but in the groundwater system of the islands, and where good water is found in relation to where golf courses are developed.

The Hawaiian Islands are relatively high islands. Northeasterly trade winds carry moisture-laden clouds over these volcanic peaks. As the clouds rise, cool-

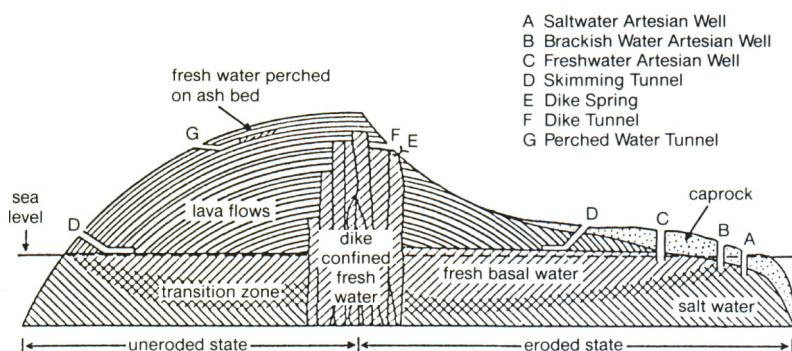
ing occurs and moisture is released. Extremely heavy amounts of rainfall may occur in some areas. Mount Waialeale, on the Island of Kauai, for example, is said to be the wettest spot on earth, with an annual rainfall of 460 inches. The leeward side of all islands, however, is very dry because most of the moisture is released by the clouds as they sweep up the windward slopes. Great variation in rainfall can occur in very short distances. For example, famous Waikiki beach, on the Island of Oahu, is located at the foot of Manoa Valley. Annual rainfall at the beach is approximately 20 inches. At the back of Manoa Valley, perhaps less than five miles as the crow flies, annual rainfall is about 250 inches.

The freshwater system typical of those of all islands is shown in *Figure 2*. Rainfall occurs at higher elevations, perco-

lates through the porous lava, and perches as a lens of fresh water of varying thickness on top of the heavier salt water in the porous rock formation of the island. The older islands, Kauai, Oahu, and Maui, have caprock formations at their coasts. These are denser lava formations that occurred after the islands were almost completely formed. Caprock formations, being dense and practically impervious to water, help to hold the fresh water in and greatly increase the thickness of the freshwater lens.

The island of Hawaii, which is still in the formation process, does not have a caprock formation, and thus the lens of fresh water is not nearly as thick. In addition to the basal lens of fresh water, significant amounts of water may be held in porous materials between denser

(Below) Figure 2. Typical groundwater system of the Hawaiian islands. (Right) Figure 3. Resort golf courses in Hawaii are typically near the beach on the drier side of the islands. (Opposite page, top) Figure 4. Diagrammatic illustration of the method of obtaining soil solution samples by means of suction lysimeters. (Bottom) Figure 5. Golf courses on the leeward coast of the island of Hawaii are often constructed in raw lava flows.



lava in vertical formations. This type of formation is termed a dike. There is also some water perched in porous material on impervious volcanic ash formations. The latter two types of water systems are being developed for potable water on Oahu.

FORTUNATELY, because of high rainfall on the windward elevations of all the major islands, there has been ample water of very high quality for potable water supplies. Recently, however, because of tremendous population increases on the island of Oahu, the thickness of the basal lens has been decreasing at an alarming rate. The period from 1978 through 1980 saw three consecutive years of extremely low rainfall. At this time, the Oahu Board of Water Supply instituted severe water restrictions, with limits on the amount of water per household, as well as restrictions on commercial users of water, such as golf courses. Golf course water allotments were set at 50 percent of the average use of preceding years. Since that time there have been periodic appeals to homeowners and others to conserve water. Because of the large amount of development in recent years,

the water supply on Oahu is particularly critical.

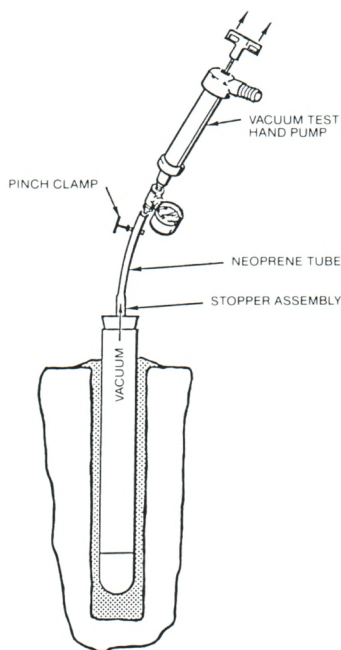
With the exception of Oahu, there is little concern for potable water supplies. There are severe problems, however, in regard to water for irrigation of golf courses, especially on Oahu and Hawaii. Most golf courses in Hawaii are constructed as part of resort developments or real estate projects. Because of the attraction of the ocean with the beautiful sand beaches and palm trees, resort developments and real estate projects are usually located near the ocean, usually on the drier, leeward side of the islands.

Figure 3 shows a typical resort golf course on the leeward coast of Oahu. This presents a critical problem of obtaining water of suitable quality to irrigate the golf course. On the leeward coast of Oahu, wells near the coast have become increasingly salty as the thickness of the freshwater lens has decreased. On the leeward coast of Hawaii, the freshwater lens is very thin because of the lack of a caprock formation. Large demands placed on the lens, as in the case of several golf courses located in close proximity, results in mixing of underlying salt water and increasing

salinity. Because of low rainfall, high temperatures, and constant winds, water use requirements of turfgrasses is high on the leeward coasts, further increasing the demands on available water.

Golf courses being constructed on the leeward coast of the island of Hawaii present special problems in obtaining suitable materials for growth of turfgrasses. This coast of Hawaii is composed of raw lava flows that have undergone little weathering. Golf courses are constructed by first crushing the lava to a workable size by heavy equipment, grading to the golf course architect's specifications, adding a filter layer of cinder or other available material, and finally adding a rootzone layer of volcanic ash soil, fine cinders, or whatever material is available. The contrast between raw lava flows and green grass results in some of the most beautiful golf courses in the world.

Figure 1 shows a view of the sixth hole of the Mauna Lani golf course. Figure 5 shows a closer view of a fairway bordered by raw lava. This type of construction, with a fine rootzone material overlying a coarser lava subsurface layer, results in a perfect example of a perched water table, which is the under-



lying principle for the USGA Green Section specifications for construction of golf putting greens. Water will not move out of the finer layer until it is completely saturated. Then water only moves by gravity.

Because of low rainfall at this location, there is little chance of extended periods of rainfall to saturate the soil and leach accumulated salts. Since the available water in this area of Hawaii is brackish (average salinity readings of 3.0 to 3.5 mmhos/cm) and the water infiltration rate of the rootzone material is slow, extremely high salt buildup is occurring in some cases.

BECAUSE OF the problems with obtaining adequate high-quality irrigation water, research is being conducted at the University of Hawaii on effects of sewage effluent and brackish irrigation water on soil chemical properties and growth of turfgrasses. As part of this research, soil solution sampling stations have been established at four golf courses, two each on Oahu and Hawaii.

The soil solution is sampled monthly by means of suction lysimeters installed at different depths (*Figure 4*). *Table 1* shows selected soil chemical properties from these four locations. It is clearly apparent that soil salinity levels have reached excessive levels in certain cases.

Fortunately, bermudagrasses are used on golf courses in Hawaii and are very salt tolerant. Experiments are presently being conducted to determine if salinity levels can be reduced by increasing leaching, gypsum applications, and aeration treatments.



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TURF TWISTERS

THE BLACK LAYER

Question: This past summer I heard a lot of talk about what some say is a new putting green disease called "The Black Layer." It appears in the soils of greens, even USGA spec greens, usually about two or three inches below the surface, has a swampy odor, and the grass roots and plants die. What do you know about it? (Indiana)

Answer: Enough to say it is *not* a new disease and is *not* even associated with a disease. At least no causative pathogen has ever been identified. The so-called "Black Layer" has been around a long time. (See USGA GREEN SECTION RECORD, July 1970, "Solving Drainage Problems at El Macero," by Dr. D. W. Henderson, Dr. D. T. Bradley, University of California, Davis, and J. Jagur, Superintendent, El Macero C.C.)

It is, pure and simple, an irrigation problem or a drainage problem or both, depending upon how one wants to look at it. The soils have become too wet for too long. The swampy odor attests to that fact. Dry out the soil profile, and the Black Layer (and odor) disappear.

Even sandy soils and USGA spec greens can become too wet and compacted (in particular zones) if there was a poor or incorrect soil mix, incorrect construction, a migration of silt or other fine particles into a layer, poor internal tile drainage techniques, etc.

With insufficient soil permeability and continued rains and/or unrelenting irrigation, all pore spaces become saturated with water to the exclusion of air (oxygen). Couple this with warm summer soil temperatures and the presence of some organic matter, and anaerobic processes, indicated by the blue-black color and foul smell, naturally set in. Normal growth requirements are destroyed, and the plant dies.

How to correct or prevent the phenomenon? Step one is to drastically curtail or stop all irrigation, including syringing. Dry out the green. Aerify, spike or slice, even in the middle of the summer. Get some air back into the rootzone. Syringe only when moderate to severe blue wilt or footprinting develops, and even then syringe only for a minute or two over the entire green. Do not irrigate. It may be several days or even weeks (depending on climatic conditions) before new irrigation is needed. There must be a longer period for drainage between future irrigations. A very light dusting (two pounds per 1,000 square feet) of hydrated lime following aeration or spiking may also be helpful.

As Professor L. S. Dickinson once said, "Help the little grass plant to grow. Don't try to make it grow." Words of wisdom.