tion group, the future looks bright for new and existing golf courses in San Diego County.

"We have been able to bring builders and developers together with the Municipal Water District people to share information about how golf courses are operated and the methods used for water conservation," said Moore, who works in golf sales for Hydro-Scape Products. "As a result of our joint cooperation, we were able to exclude greens from the Stage Four rationing laws that are now on the books."

Water audits have been performed for more than 70 golf courses by Marguerite Engles, program director for Large Turf Water Audit Programs in San Diego. "Generally, we've found them to be over 80-percent efficient in their water usage," she said.

Moore added that golf courses achieve this high rating in part is because they are one of the few businesses that employ full-time irrigation managers. Although many golf courses still use potable water for irrigation, the majority use runoff, recycled, or well water.

The water conservation group also arranged discussions among developers and environmental groups, such as the Sierra Club. The talks revealed that the groups were essentially trying to accomplish the same thing for the land.

"Golf courses are very pure environments," Moore explained. "They provide a wildlife habitat, a sanctuary for migratory waterfowl, clean and cool air, abundant plant life, and water sources. Golf courses use very few pesticides, and what is used are fungicides and fertilizers. Tests have shown that these chemicals do not find their way into the groundwater."

"We all want the same things for the environment," said Moore. "We just weren't aware of it."

TURF AND GROUNDS EXPOSITION

The New York State Turfgrass Association (NYSTA), in cooperation with Cornell University, will hold its 1990 Turf and Grounds Exposition on November 13-16 at the Rochester Riverside Convention Center, Rochester, NY.

The conference program begins on Tuesday, November 13 with three special seminars. The first seminar, a human resources management program, teams agricultural economists and business management specialists from Cornell University. The second seminar, entitled "Right to Know and Hazardous Materials Communication," covers information that affects members of the green industry. The third seminar is a back-to-basics, turfgrass management review presented by Cornell and SUNY agricultural and technical college faculty.

In his opening address entitled, "The Tenth Player," grounds manager and American League umpire Ken Kaiser will discuss how grounds managers can affect play in major league baseball. The golf course session will focus on the biocontrol and forecasting of diseases.

A trade show will be held in conjunction with the educational program. More than 300 exhibits will feature the latest in turfgrass and landscape maintenance equipment. The show opens Wednesday, November 14, at 10:30 a.m.

For additional information contact NYSTA, P.O. Box 612, Latham, NY 12110. Telephone (518) 783-1229.

Uncovering The Benefits Of Covers

Belle Meade Superintendent Doug Ward covers the back two-thirds of his tees during the winter. The front third is overseeded and left uncovered.

Last December, temperatures in the Southeast plunged below the 20s and stayed there for almost two weeks. Hundreds of bermudagrass greens from Georgia to Texas never recovered from the shock. This spring and summer, superintendents have been busy replanting their greens that suffered either partial or complete winterkill.

"This past winter was the most devastating for turf in 20 years," reveals Dr. Coleman Ward, professor of agronomy and soils at Auburn University in Auburn, AL. "We lost St. Augustine, centipede, zoysia, and a lot of bermuda cut below rough height. Superintendents and sports turf managers across the South are taking a much harder look at winter protection."

This spring and summer, superintendents have been busy replanting their greens that suffered either partial or complete winterkill.

Ward and fellow Auburn professor Dr. Ray Dickens believe turf covers prevented a considerable amount of winterkill in their state. Dickens has been studying different types of winter covers for more than six years. He has explored straw mulch, black plastic, and a number of geotextile covers in the process. All materials have been evaluated for their effect on cold protection and spring greenup.

"In areas where winterkill is likely, covering golf greens and tees has been a common practice for many years," reports Dickens. "Pine straw, cereal grain straw, or black plastic were the materials used until recently. However, the straws require considerable labor to apply and remove and may introduce unwanted weed seed. Black polyethylene generally lacks adequate strength to resist tearing, and does not allow free flow of air and water into the turf and soil. Neither of the materials is reusable over a period of years."

Dickens found that a few covers made of geotextile fabric were durable, permitted flow of air and water, could be installed or removed in a matter of minutes, and could be used for a number of years. Further research established that these covers prevented winterkill as well as mulches and improved spring greenup.

Since the new covers were easier to use, Dickens and Ward developed a procedure they call the "Put and Take System." Any time temperatures fall below 25 degrees F., the covers are installed on greens or tees and left on until the weather improves. Usually, this period is limited to short cold spells and corresponds with the amount of

play on area golf courses. "The longest subfreezing period I can recall was last December, when some greens were covered for 13 days," Dickens adds.

"Almost all covers work better than pine or wheat straw," he states. "You don't have to build temporary greens, as you would with straw. Spring greenup is significantly improved, and you don't have to worry about keeping straw in place." Dickens' tests did reveal that pine straw reduced the fluctuation in temperature better than covers.

According to Dickens, there appears to be little correlation between the amount of green bermudagrass in the spring and the temperatures observed under the various materials during cold periods. Ward and Dickens do see some differences in the way the fabrics hold water and debris. "You want the material to be dry and clean when you remove it," they remark. "Dry fabric is easier to handle and store."

Part of their responsibility during the year is to advise the golf course superintendents in Alabama's park system. Last year they recommended that Kenny Morgan, superintendent of Oak Mountain State Park Golf Course in Pelham, AL, try the Put and Take System with geotextile covers on half of his greens.

The nine uncovered greens, which had not experienced winterkill in previous winters, were severely damaged.

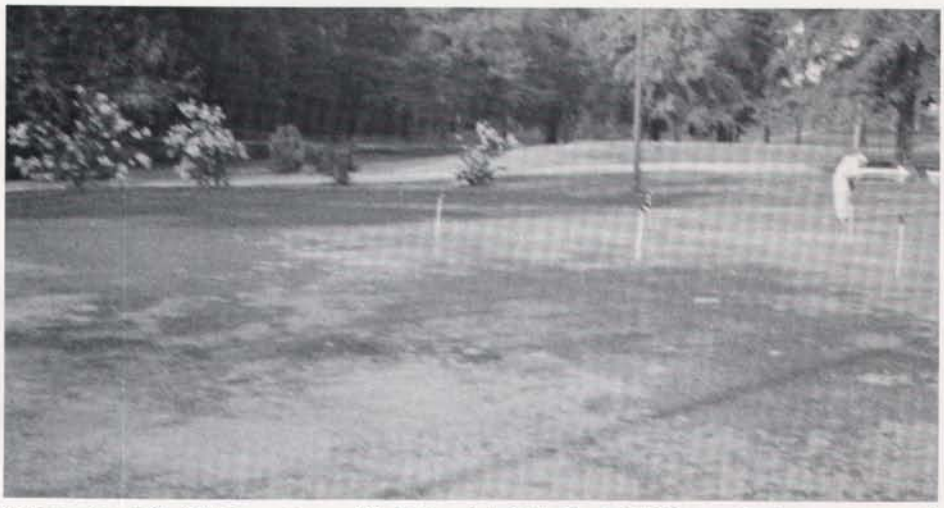
Oak Mountain has more than 70,000 rounds per year and does a sizable winter business. The course is overseeded each fall with perennial ryegrass. In previous years, nine greens had suffered varying degrees of winterkill. Four are on the front nine and five are on the back. These were the greens Morgan covered with Reemay's Typar when temperatures fell below eight degrees for four days.

In late March, the results were evident as the Tifgreen started to green up. The nine uncovered greens, which had not experienced winterkill in previous winters, were severely damaged. The nine that had problems before, but had been covered that winter, were healthy."We had to rebuild six of the nine uncovered greens," adds Morgan. "We removed the dead sod and the top three inches of soil, replaced it with sand, and rototilled the sand into the top ten inches of the greens. All nine damaged greens were resprigged with Tifgreen. It was tough finding 328 sprigs this spring."

When asked if he had considered bentgrass for his greens, Morgan responded that the heavy traffic, frequent 100-degree-plus summer weather, and high humidity would be too much for bent. "It's not unusual for temperatures to stay above 100 degrees for a week," he remarks. "That doesn't slow down the traffic. We stay busy from dawn to dusk, seven days a week. The turf on our greens and tees must be aggressive in July and August, because there is hardly any time to work on them."

In Nashville, TN, a few hundred miles northwest of Oak Mountain, Belle Meade Country Club Superintendent Doug Ward

continued on page 24



Severe winterkill of Tifgreen green at Oak Mountain State Park Golf Course that was not covered last winter.

Benefits of Covers

continued from page 23

has discovered that maintaining bentgrass greens in the summer is not as difficult as some would believe. "From the Fourth of July to the end of August we have to stay on top of the greens," says Ward. "Any bentgrass problems are minor compared to the winterkill of bermudagrass. Belle Meade has had Penncross greens for nearly 20 years."

This winter Belle Meade lost 90 percent of the common bermuda in the fairways and more than 30 percent of the hybrid bermuda on the tees. "We got hit hard," Ward admits. "It would have been much worse if we hadn't covered the tees. I also think raising the height on the tee mowers before we cover the bermuda in the fall helps."

Ward covers all but the front ten yards of each tee in the fall with Evergreen covers from HPI. Before the tees are covered, he lets the Tifway grow from 1/2 inch to nearly an inch in height. The covers are then put in place and secured with six-inch sod staples. Throughout the winter, and until the danger of frost has passed, the tees remain covered.

"When I joined the club four years ago, the tees were mulched with straw in the winter," Ward says. "Straw is messy and takes a lot of labor to clean up in the spring. It's usually wet when you need to remove it. Covers take a fraction of the labor to install and remove, and you don't have to worry about disposing of straw. When we pull them in the spring, the bermuda is greener and cleaner than with straw."

For two years, Belle Meade covered its tees without losing any bermuda to winterkill. Last winter the cold was so severe that not even the covers could save all the tees. "We had greens with no damage, and others with partial winterkill," reveals Ward. "But the covers definitely afforded some protection. This fall I plan to let the bermuda grow to 1-1/4 inch before we cover it."

The winter was kinder to the bentgrass greens. Ward was concerned that one green he renovated in October would not be ready for play this spring. "We started late," he admits. "By the time we seeded it was the end of October, so we put one of the covers on the green. We were able to cut the bent in three weeks and opened it for play the first of April. That's real good for a later fall seeding. The cover also prevented some heavy rains from eroding the green surface."

Speeding up germination of turf seed is one of the oldest uses for geotextile covers. For nearly ten years, superintendents and sports turf managers in the northern U.S. and Canada have utilized covers to trap and hold the heat of the sun.

"Temperatures underneath our covers are sometimes 20 degrees higher than uncovered areas," reveals Barry Britton, superintendent at Lionhead Golf Course near Toronto, Ontario. The 27-hole public course, set to open next spring, is months ahead of schedule. This is due in part to the covers.

"I've used Evergreen covers on greens, tees, and portions of the fairways," remarks Britton. "By seeding instead of sodding, we have saved thousands of dollars. We usually have germination within five days and solid cover within ten days. That's phenomenal under our conditions."

The course sits on a sandy plateau above Lake Ontario. Gusts of 25 m.p.h. can desiccate the Penncross greens and tees and the Pennway fairways during establishment unless precautions are taken. According to

Britton, the covers save three to four weeks during seeding and improve the percentage of germination. "We hydroseeded as low as 3/4 pound of bentgrass per 1,000 square feet and got a dense stand," he remarks. "We had roots nine inches deep on the greens in less than two months."

Britton dormant seeded some areas last November and left them covered all winter. He likes the way the covers disperse irrigation and rainfall without splashing. "Once we seed and roll, the surface remains smooth and solid," he adds. "Because the covers breathe, they dry quickly and can be installed or removed in 20 minutes."

Britton points out that the covers are also used by sports turf managers at schools and parks to speed up germination of Kentucky bluegrass and perennial ryegrass in the goal mouths of soccer fields and the center of football fields. "They are an alternative to sodding, especially where the growing season is short," he states. "You can get a two- or three-week jump in the spring by covering these areas in the winter. It's also a clear sign to people to stay off the turf. Skiers and snowmobilers don't seem to damage covered turf as much when it's under snow."

Covers may also have benefits in parts of the country where winterkill is not a threat. Near balmy San Diego, Larry Runyan, superintendent at Rancho Santa Fe Golf Club in exclusive Rancho Santa Fe, believes covers have a number of useful purposes.

"In the winter, nighttime temperatures drop below freezing pretty regularly," Runyan points out. "You never know if you'll get to work and the greens will be covered with frost. The ground is not frozen, just the foliage of the turf. You can't get on the greens to mow and open the course until the turf thaws out. Delays of two hours are possible when this happens. Tee times get pushed back for the rest of the day and the course can lose more than 60 rounds."

Runyan calculated that a busy resort course could lose more than $150,000 in revenue because of morning frost in one year. This past spring he implemented a program of covering the greens with geotextile at night when frost was predicted. The covers warmed the greens up rapidly by trapping the early morning sun. By the time the greensmowers were fired up, the covers could be removed from the first greens so they could be cut. "We didn't lose a single round this past spring," boasts Runyan.

The other headache of San Diego superintendents is *Poa annua*. The Mediterranean climate is apparently perfect for the light green prolific seed producer to invade golf courses. Runyan reasoned that part of the problem with annual bluegrass invasion was a lack of aggressiveness in the bentgrass caused by cold evening temperatures. "It made sense that if we kept the greens warmer at night, the bent would resist Poa invasion better," he states. "It looks to me the greens we covered this winter and spring have a lower population of Poa. Covers may be able to help some courses reduce the amount of preemergence herbicides they apply in the fall when Poa germinates."

The winter of 1989/90 was unusual in many parts of the country. There is no way superintendents and sports turf managers can protect their facilities completely against nature's fury. However, there are tools that soften the blow and reduce the vulnerability of increasingly valuable turf to natural disasters. Covers are simply one of those tools.

CAPTURING The Good Points Of Clay

During the second half of the 20th Century, sports turf managers of all types have been waging a battle against unsafe and poor playing conditions on large recreational turf areas.

By identifying the key flaws in soils, turfgrass selection, and maintenance, they have impressed both athletes and fans with their skill. Injuries have been reduced, playing conditions have improved drastically, and the quality and appearance of golf courses and athletic fields has never been better.

In the heat of battle, turf managers have focused on certain enemies of quality sports turf. One of these has been clay. This natural component of soils throughout the country has been linked to compaction, poor drainage, shallow rootzones, surface hardness, and poor footing. When sports facilities have the budget and ability to remove or amend clay in their soils, they will go to great lengths to eliminate the headaches it causes. However, in doing so, they also give up some of the beneficial characteristics of clay.

Clay acts like a sponge for water and chemicals. It can absorb and store significant amounts of moisture and nutrients and release them to plant roots gradually over a period of time. This gradual-release characteristic can protect plants from high concentrations of chemicals. The chemical term for it is buffering. Clays, due to their large surface area, also provide a vast number of sites for chemical reactions to take place. This reactivity is important in converting nutrients from their applied form to a form that plant roots can absorb. Cation exchange capacity is the measure of this reactivity.

Organic matter also buffers chemical reactions in the soil and provides important cation exchange capacity. Sand, on the other hand, offers very little in the way of buffering or exchange capacity.

Clay, like sand, is inert. It does not change or rapidly break into different components in the soil over time. Its properties remain consistent and predictable. Compare this to organic matter in the soil which does change as it decomposes. Decomposition of organic matter can supply nutrients for turf, but it also requires oxygen and nitrogen from the soil to occur.

The bad reputation of clay is based upon its size and tendency to plug pore spaces in the soil.

The bad reputation of clay is based upon its size and tendency to plug pore spaces in the soil. As the smallest of soil particles, clay settles between larger particles. It will form tight layers within the soil profile which disrupt drainage and aeration, processes necessary for healthy turf growth. Clay layers can restrict root growth and deprive plants of soil moisture and nutrients deeper in the rootzone. Clay also compacts easily when wet.

For more than 40 years, scientists have known that certain types of clay can be processed into crystalline aggregates hundreds of times larger than clay particles. By solving problems associated with the size of unprocessed clay, manufacturers were able to offer soil drainage and aeration similar to sand, in addition to moisture and nutrient retention, buffering, and exchange capacity.

The process, called calcining, heats clay to remove moisture and strengthen the bonds between particles. The resulting crystals retain their integrity in the soil, resist compaction, do not become slippery when wet, and provide a more controlled absorption and release of water and nutrients. They can be sized and screened to match the size of medium to coarse sand.

"Calcined clays rescued a huge number of greens in the late '50s and early '60s," points out Dr. William Daniel, retired Purdue University professor. This was before sand became popular in golf green construction. The clay improved the drainage and texture of compacted soil greens. "If you had a wet spot on a green, you topdressed it just like we do today with baseball infields."

When the USGA Green Section released its perched, sand-based rootzone in 1960, superintendents found that sand was easier to obtain than calcined clay. Because sand was available from a number of sources, it could be shipped more cheaply. "It became a question of the cost, not a failure of calcined clay," recalls Daniel. "At the time, the manufacturers also lacked a fine size of calcined clay which would have been more appropriate for incorporation in sand greens."

There are two reasons why calcined clay costs more than sand: It requires specific types of clay, mined only in certain locations, and the energy to process it. The two most popular calcined clays, Turface from Aimcor and Terra-Green from Oil-Dri, come from separate mines in Mississippi. They

are processed in the state and shipped to users from there.

Aimcor's mine is in Blue Mountain, MS. The unique deposit of montmorillonite and illite clays is removed and carefully heated to extract moisture without destroying the structure of the aggregates.

"To understand how Turface works, you really need to know the structure of the clay," explains Dr. Louis Ferrara. "There are six different types of clay. Montmorillonite clay is like a sandwich: Two layers of silica surround a layer of mineral, such as aluminum. Water is held both on the surface and within the layers. The surface can be relatively dry, even though moisture is stored inside the sandwich. Nutrients such as nitrogen, iron, potassium, or phosphorus can be stored in the clay by exchanging with the aluminum in the center."

The illite clay consists of two layers. It absorbs and releases water more slowly than montmorillonite. The combination of the two allows the product to absorb moisture at a rate and duration that fit the needs of sports turf managers, says Ferrara.

Terra-Green is montmorillonite clay from a mine in northeastern Mississippi. The raw clay is crushed, dried, screened, and then baked at temperatures up to 1500 degrees F. The finished product consists of red and grey granules ranging in diameter from .25 mm to 4 mm, depending upon the intended use.

"Clays have unique properties and definable structures," says Terry Kippley, Terra-Green product manager. "Superheating strengthens the structure and lowers the solubility of the granules. It creates and reinforces a network of pore spaces for air, water, and nutrients."

When asked about the durability of calcined clays, Kippley referred to a Purdue study conducted in 1962. Robert Montgomery, a graduate student, showed that several calcined clays had 94-percent stability or better when exposed to moisture, freezing, and thawing over a two-year period. Daniel, who was Montgomery's professor, reveals that calcined clay remained stable in a sand mix green at Purdue for more than 25 years.

Montgomery also reported that calcined clay improved the infiltration of fine-textured soils, allowed more intensive root growth, and increased the cation exchange capacity. In unirrigated plots, Montgomery found that rootzone mixes containing calcined clay and peat decreased the tendency of turf to wilt during droughts.

The primary uses of calcined clay today are for topdressing and soil incorporation on athletic fields for moisture control. The standard rate for topdressing turf after aerification is 50 pounds per 200 square feet. "This rate can vary depending upon the size of the core holes, the number of cores per square foot, and the height of the grass being aerified," explains Charles Selvik, Aimcor's director of marketing communications.

Topdressing provides backfill for the core holes and a layer of material on the surface. Any standing water will be absorbed rapidly to dry the surface to a playable level. The other potential benefits of topdressing are improved infiltration and compaction resistance.

Perhaps the biggest use for calcined clay has been incorporation into skinned baseball infields. By amending clay infield mixes with coarse fractions of calcined clay, infiltration and drainage improve.

The water storage capacity of calcined clay also controls the moisture level and texture of dirt infields and basepaths. Recommended rates of calcined clay for skinned infields depend upon the depth of

continued on page 28

DON PARKER

Don Parker, a golf product application engineer for Rain Bird Sprinkler Mfg. Corp. who worked with the company for 25 years, passed away recently. He was 54.

"Don epitomized service within our industry," said Peter Johnson, marketing manager of Rain Bird's golf division. "As our first golf product application engineer, he was renowned for his caring 'bedside manner' and was blessed with the ability to convert even our most difficult customers into ardent supporters of Rain Bird. We will miss Don Parker, a true friend and a most respected colleague."

The Don Parker Service Award has been established in his memory. It will be presented annually to a person in the golf industry who continues Parker's standard of service excellence.

BOSCH APPOINTED TURF SPECIALIST

Northrup King has appointed Fred Bosch to the position of turf specialist, Medalist Turf Division. He will be responsible for sales of Medalist Professional Turf Products in the Michigan, Ohio, western New York, and western Pennsylvania areas.

Bosch holds a bachelor's degree in agriculture from Ohio State University, where he majored in agronomy and specialized in turf management. Most recently, he was a technical sales representative for W.A. Cleary Chemical Corporation. Before that, he was golf course superintendent at TRW Golf Club in Chesterland, OH.

SOD COMPANY FORMED

John Foster, former president of Foster Turf, recently announced the formation of West Coast Turf, a commercial sod producer in California's Coachella Valley.

Joe Foster and Jim Cole, also former Foster Turf employees, have also joined West Coast Turf. The office manager is Jennifer Clark.

The company will market bentgrass, hybrid bermuda sod, and stolons.

The Good Points of Clay

continued from page 27

incorporation and the percentage of calcined clay desired in the dirt. Percentages range from ten to 35 percent.

A more recent use for calcined clay is for soil incorporation prior to sodding. Dr. Hank Wilkinson at the University of Illinois in Champaign/Urbana has been testing different rates of Turface in a poor clay soil for the past year. "We found that ten percent [mass/mass at three inches] was effective in improving a low-maintenance soil medium for the rooting of sod" he reports. "More than ten percent did not appear to provide additional benefit. We are now exploring lower rates. We also need to evaluate rates for incorporation into sand."

Calcined clay was used in the past three years in the sand rootzones at Joe Robbie Stadium in Miami, FL, and Soldier Field in Chicago, IL. Roger Bossard, groundskeeper with the Chicago White Sox, is mixing Turface and peat in the sand-based field at the new Comiskey Park. The clay improves the moisture and nutrient retention of the sand until the turf contributes its own organic matter. Finer grades of calcined clay are closest to the size of sands in sand-based rootzones.

The question becomes, if calcined clay is effective in the sand-based rootzones of these stadiums, why can't it make a similar contribution to sand-based greens and tees? If it can, then what amount or percentage of calcined clay in sand is appropriate?

"Calcined clay was not fractionated for greens construction until recently," Wilkinson states. "The particles were too large. Now these products are available in sizes below 1 mm. The fine-sized versions may expand the usefulness of calcined clay in golf."

One recommendation for construction of greens and tees with regular Turface was for about 20 percent of calcined clay in the top six inches of soil mix. The suggested rate for Terra-Green is about five to ten tons per average-sized green. Both manufacturers advise superintendents to discuss rates with their local supplier.

No manufacturer has been able to get the USGA to include calcined clay in its specifications for greens construction. Perhaps the introduction of smaller-sized particles may warrant consideration by golf organizations.

There is little argument that raw, unprocessed clay has many negative characteristics for turf managers. Calcined clays, however, offer important useful features that should not be ignored.

Evaluating Organic Amendments For Sand-Based Turf Systems

By Charles R. Dixon

Natural turfgrass surfaces are experiencing a comeback in several sports applications, including soccer, football, baseball, and thoroughbred horse racing. The success or failure of this movement will depend upon proper construction and maintenance of the turfgrass system.

The main type of turfgrass system leading the comeback is the sand-based rootzone. The golf industry has been one important source of sand-based technology. The United States Golf Association (USGA) method of constructing putting greens has been adapted to provide a high-performance surface for a wide variety of sports. With proper management and good construction materials, a USGA turfgrass system delivers a well drained, quality surface that is healthy and suitable for many types of sports activities.

Turfgrass systems that are not healthy can be a financial burden to the owner and/or a threat to the local environment. Because of the demands placed on high performance sports turf surfaces, a sound agronomic approach should be employed during construction that takes into consideration geographic location and available materials. Facilities constructed with the wrong technological approach or with poor quality materials can be a serious problem for the participants of the sport as well as the owners.

Lab evaluations concerning the selection of construction materials and the testing of materials during construction need to be performed by qualified individuals to make sure that the facility is installed correctly. For sand-based systems, the evaluations should include the sand, as well as all amendments.

Sometimes the initial cost of the materials, regardless of the quality, is the criterion used by decision makers to evaluate and select rootzone components. With such a limited selection process, serious technical mistakes can be made that impair the establishment of the turf system and result in poor quality turfgrass that is expensive to maintain. Inferior materials, selected by untrained individuals with an economic bias, may leave a problem that can plague superintendents and groundskeepers for many years. A full-scope evaluation of all materials will lower the risk of poor performance or total failure.

Components of Four Amendments As Received

Component	Reed-Sedge	Can. Sphagnum	Rice Hull Comp.	Fir Bark
Moisture	41.6	31.3	41.0	42.9
Carbon	53.4	66.4	46.3	49.6
Nitrogen	2.3	1.0	0.7	0.4
Mineral	2.7	1.3	12.0	7.2

Dry Weight Values For Amendments

Amendment ID	Total Carbon %	C:N Ratio	Moisture %	pH
Dakota Reed-Sedge	90.1	23	41.6	6.6
Canadian Sphagnum	96.7	65	31.3	4.3
Rice Hull Compost	78.5	74	41	5.9
Fir Bark	86.7	142	42.8	3.2

The USGA system consists of a gravel drainage field with a one-foot layer of a sand-based rootzone on top. In the early years, the rootzone consisted of sand, loamy soil, and an organic amendment such as peat. The use of soil in the rootzone has declined due to the compaction and restricted drainage that have been associated with the silt and clay in the soil.

The rootzone specifications used most often today include sand and an organic component. The sand contributes to the physical support of the surface and, more importantly, to the drainage characteristics of the rootzone. However, it has very little to offer the turfgrass system, especially during establishment. The interaction of the organic amendment with the sand contributes to the utilization and retention of fertilizer and water.

The main advantages of sand-based systems are the ability to move water through the rootzone profile to keep the surface dry during high rainfall and to allow adequate movement of air into the rootzone. The ultimate success of the turf surface in a sand-based rootzone depends on vigorous rooting. Deep-rooted turf will provide a more stable and durable surface. Good aeration and drainage are necessary to maintain a deep root system.

A valuable reference on specifications for selecting materials is the USGA publication *Turf Management for Golf Courses* by Dr. James B. Beard. The criteria for selecting sand and gravel components are fairly cut and dried. However, those for the or-

continued on page 30

Organic Amendments

continued from page 29

ganic amendment are not. They should receive more attention.

Most organic amendments used today are commercially available peat mosses or composts of various materials. The main criterion that has been utilized to evaluate organics is the total carbon or ash content.

The ash content represents the amount of minerals and silt/clay particles in the sample. The remaining portion of the sample is the carbon content. The recommended total ash content should be 15 percent or less. The carbon content should be 85 percent or greater. The purpose of the low ash requirement is to keep the introduction of silt and clay to a minimum.

Other requirements for the organic amendment pertain to its texture and state of decomposition. The amendment should be finely ground to achieve maximum surface area and coverage of the sand grains. The texture and complexity of the organic component also affect the microbial population of the soil, an important factor in decomposition. Complex organics contain chemical compounds that are resistant to degradation by soil microbes.

The state of decomposition of the amendment is very important. Soil microbes require oxygen and nutrients to break down undecomposed organic amendments. Plants also require oxygen and nutrients to grow. An undecomposed organic amendment can place a demand on the available oxygen and nutrients in the rootzone that can slow the establishment of the turf system or cause it to fail altogether.

There are several ways to assess the state of decomposition. The easiest and most direct is the carbon-to-nitrogen ratio. Laboratories calculate this ratio by first determining values for total carbon and total nitrogen (dry weight basis). The percentage of carbon in the sample is then divided by the percentage of nitrogen.

Carbon to nitrogen (C:N) ratios greater than 30:1 are believed to promote the immobilization (tie-up) of nitrogen. Ratios higher than this may result in an insufficient amount of available nitrogen in the rootzone. Ratios less than 20:1 promote the mineralization (release) of nitrogen. Low C:N ratios may lead to salt burn or to leaching of nitrogen before the turfgrass plant can utilize it.

The amount of nitrogen tied up is roughly equal to the amount released when the C:N ratio is between 30:1 and 20:1. Ideally, the ratio for rootzones should fall within the 15:1 to 30:1 range.

Although competition between the establishing turf and the microbial population for nitrogen can stunt turf, so can competition for oxygen. Many chemical and

continued on page 32

Nutrient Reactivity

Organic Amendment	Humic Acid %	Fulvic Acid %	CEC meq/100 grams
Dakota Reed-Sedge	21.1	12.0	118.0
Canadian Sphagnum	8.3	8.6	74.8
Rice Hull Compost	5.8	6.9	16.5
Fir Bark	3.1	5.8	18.3