have to assume that what this statement translates into is daily irrigation of an 80/20 putting green at something less than actual ET. I'm going with a figure of 75% of actual ET and will assume a rooting depth of 4 inches. From the data in Table 1, this means that our AW is 0.316 inch when the green is at FC. According to my calculations, by the start of the second day, the soil is at 80% of AW and irrigation has brought the top 3.2 inches back to FC. The next day begins with 62% of AW and 2.5 inches of the green at FC. The third day is trouble. The soil is now down to 38% of AW and the previous night's irrigation re-wet only the top 1.5 inches of the green.

My conclusion is that using this type of an irrigation program during the heat of summer under the conditions I assumed will satisfy the turfgrass water requirements for about 2 days, after which the full 4 inches of the soil must be brought back to its FC, either with 0.55 inch of rain or irrigationwater.

An irrigation regime sometimes used on fairways is irrigation at 70% of ET every 2 to 3 days. I'll use the Noer Facility bentgrass fairways established on silt loam soil with rooting to 8 inches to analyze this irrigation regime. I'll not go through the calculations here, but with irrigation every 3 days at 70% of actual ET rates in mid-July, I estimate that after 5 rainless days 60% of the AW was used up and the potential for moisture stress was unacceptably high. My conclusion here is that this type of an irrigation regime is based on the assumption that there will be a meaningful rainstorm every 4 to 5 days. How much rain am I talking about? In this scenario, it would have taken 0.85 inch of rain to restore the 8 inches of soil to its FC.

Localized Moisture Stress on Putting Greens

The USGA recommendations for putting green construction emphasize the importance of uniformity in the depth of the root zone mix. Whatever contours one wants in the green should be built into the underlying soil. My experience is that all too often this recommendation is ignored. Greens, more often than not, are contoured by varying the depth of the root zone mix. What are the consequences?

A golf course I visited a few years back had just reconstructed all of its greens "according to USGA recommendations." The

reason I was called upon was that the superintendent was successful in getting bentgrass to establish on some areas of the greens but not on others. A few minutes with a pipe probe revealed that the depth of root zone mix on individual greens varied from approximately 8 to 22 inches. More recently, I looked at some new greens where in April the bentgrass was badly desiccated on the ridged areas and a nice, bright green in the low areas. That time, the depth of the root zone mix varied from about 23 inches on the ridges to 13 inches in the low areas. I took soil samples from both areas. On the ridges, the moisture content in the top 4 inches was 5.2% while the low areas averaged 12.3% water. Both of these situations reflect the effect of soil depth on moisture retention in sand-based putting greens. The greater the depth of the root zone mix, the greater the gravitational force exerted on the water and the lower the amount of water retained. In both instances, the superintendents were advised to either put up with extensive hand watering or have the greens reconstructed.

I've also been called upon to address complaints about the need to hand water the perimeters of greens during hot weather when there is heavy reliance on irrigation. Occasionally, part of the problem can be attributed to poor irrigation coverage. But more often, what I find is that during construction a plastic sheet barrier was not installed between the root zone mix and the surrounding soil. This results in abutment of two soils with contrasting matric forces. The native soil, with its much higher matric force, pulls water out of the perimeter of the green. The result is not only a need for hand watering, but turf that is more susceptible to development of triplex ring.

Bunker Drainage

If you had problems with slow draining and very wet bunkers this past spring, hopefully you attended the Wisconsin Golf Turf Symposium on November 14 and 15 and learned some techniques for resolving these problems. Just in case you didn't attend, let me explain to you why bunkers are often slow to drain and then remain wet for a seemingly long period of time. Knowing the causes of these problems is the first step in correcting them.

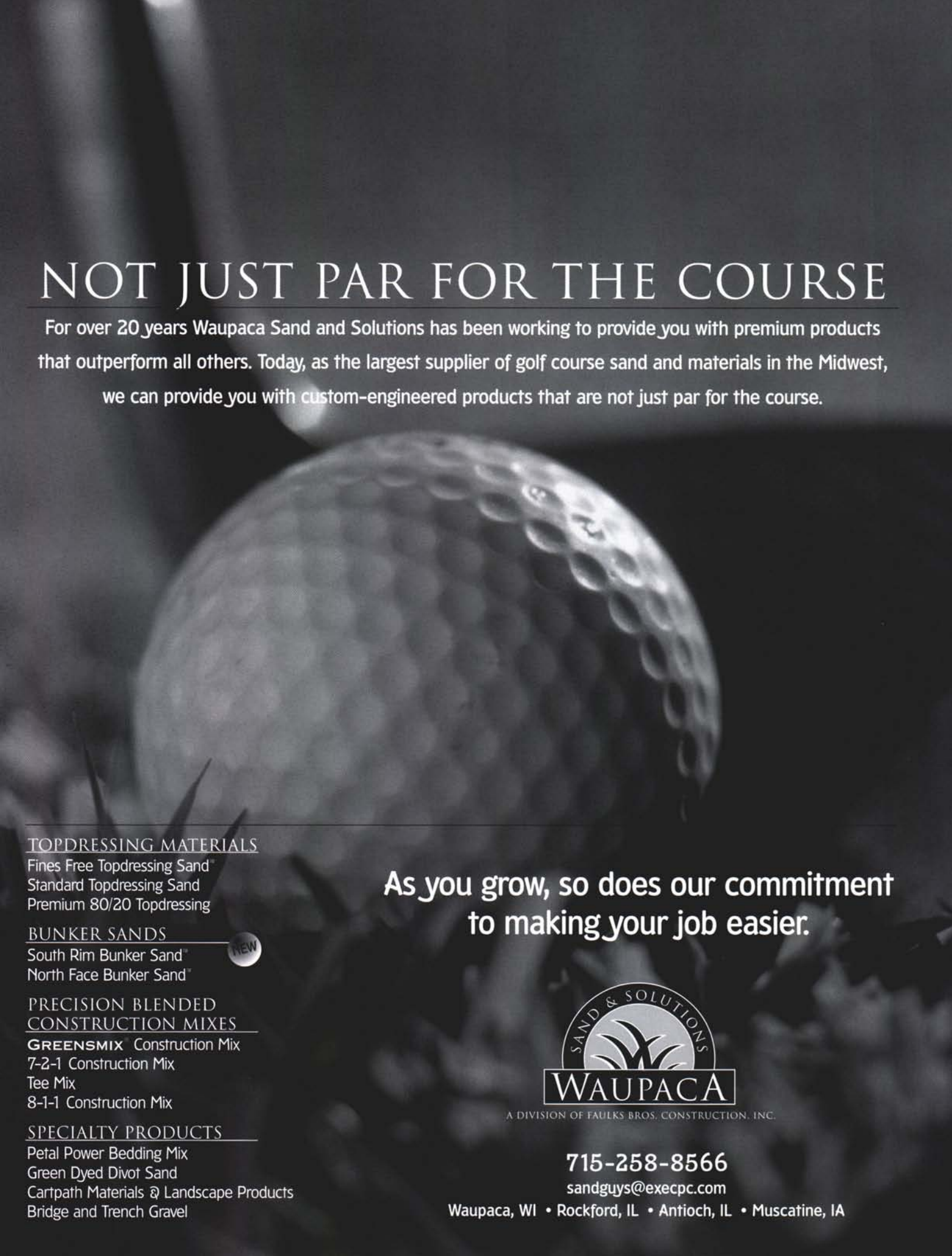
A question I frequently hear is, "Why don't my bunkers drain as well as my putting greens? They're both constructed with drain pipe underlying sand." While these two situations may seem to be very similar, there is a fundamental difference. That difference arises from the fact that soil water will not flow from a zone of high matric force to one of low matric force. To get water flow, into the zone of low matric force, the zone of high matric force must first become saturated with water. This reduces the matric force on some of the water to near zero, which allows it to flow into the larger pores. In putting greens and bunkers, you're trying to get water to flow into a drain pipe, a "pore" whose diameter is commonly 4 inches. This will only happen when the material surrounding the pipe is saturated with water. In putting greens, saturation is in the bed of pea gravel and you still have 12 inches of root zone mix above that. In a bunker with 6 inches of sand over the drain pipe, you have at best 4 inches of sand over the zone of saturation. The difference in the amount of gravitational force acting on water near the surfaces of the putting green and the bunker is obviously very different and it is simply not possible for drainage to reduce the moisture content of the sand surface in the bunker to the same level as in the putting green.

Three factors account for the relatively slow drainage of bunkers. One is capacity. Putting greens can take in much more water than bunkers before excessive surface wetness becomes apparent. The second is the difference in the amount of gravitational force acting on the water. The third factor is the medium through which water must flow in the saturated zone in order to reach the drain pipe.

At least in USGA greens, flow is through the pea gravel bed while in bunkers it is through sand.

Water simply flows much faster through the very large pores in the pea gravel.

So what are some options for getting faster and more complete drainage in bunkers? One is to increase gravitational force by increasing the depth of sand. The other is to reduce the distance the water must travel to get to the drain pipe by using closer spacings than in putting greens.



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Old Chalkboards Provide Snapshot of History

By Monroe S. Miller, *Golf Course Superintendent, Blackhawk Country Club*

We've added to our maintenance facility twice in the 28 years I have been at Blackhawk. I started in 1973; in 1974 we put an addition onto the existing shop. In 1984/85 we built a large new building and relegated the other buildings mostly to storage. In each move, the chalkboards were left with the last few days of notes and instructions and assignments. Although tempted many times to clean them up, I have resisted. Resistance has given us a glimpse at how some things were on our course then.

Actually, the oldest board - provided as a freebie, I'd guess, by Mallinkrodt (only very veteran golf course superintendents will even remember that company!) - was in the shop I inherited and I didn't use it. But I left it as I found it and chuckle when I see the phone numbers for Maple Bluff and Nakoma that haven't changed in fifty years. Also fun are the amounts of CaloClor (sublimate of mercury) and water that Harry Hanson applied to each green to control any and all diseases! Harry, if you look at the GCSAA directory, was one of the founders of GCSAA and one of the last founders to pass away. Those oddball notes he left also gave a clue to how few people were on a golf course crew as recently as the late 50s.

More interesting is the chalkboard we abandoned when we moved into our currently building in the late winter of 1984/1985. Funny thing how we still refer to it as the "new" shop - new 16 years ago! The first thing most notice are the posted heights of cut for the various play areas - greens: 9/64", tees: 7/16", collars: 11/16", and fairways: 3/4". Of course these days we measure heights more accurately, namely to three decimal points. Also, we now cut shorter, a fact that I am not sure can be called progress.

There are messages from still familiar people - Dr. Bob Newman, Joe Wollner (who represented Brayton Chemical at that time), Tom Wentz (still with Scotts, if there still is a Scotts), and Bill Roberts. Among those people, I haven't heard from Willie Roberts in a long time. What is he up to, anyway?

The club president had called and asked for a call back. Neil Richter (who ran Hanley Implement at the time and whom I have not seen in years) also called but left no message.

Names and phone numbers are still on the chalkboard.

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Some of the names of former employees at Blackhawk most of you will recognize. Dave Noltner was still a rookie in 1984/1985; he had only started in 1974! Tom Parent, George Magnin, Dave Doring and Kendall Marquardt are named. All were superintendents after that year - Tom in Minnesota, George at Cherokee (he still is there), Dave at the par three 9-hole course at Augusta National Golf Club and Kendall at Lake Wisconsin CC (he still is there after stints in Denver and in Philadelphia).

Mike Lee and Anthony Grosso are on the old chalkboard; Mike's well known in the WGCSA and Anthony is currently president of the Connecticut GCSA. Wayne Horman could be reached at 251-6581 at that time; today you have to call the Scotts Company or his home in metro Columbus, Ohio to visit with him.

Dave Schaller worked on our staff then - Dave is Tom's son and Scott's first cousin. He was another excellent employee. I received a surprise e-mail from him two years ago. He is now a missionary in Asia. John Findley landed in Denver after marrying a girl from Shorewood Hills who lived close to our club. Chuck Leafblad worked as an undergrad and grad student in Plant Pathology and last I knew was back home in the Chicago area. I wonder what he is up to these days? Brian Sather left BCC and now heads the grounds maintenance department for American Family Insurance here in Madison. He's doing a good job, I am sure.

Some of the guys had sketched a proposed golf hole with the caption "Proposed irrigation, tee, fairway and green reconstruction, submitted to the board by MSM (Respectfully turned down)." If you saw the comical sketch, you'd laugh like I do each time I see it.

I can remember almost everyone who worked at our course during my years as the golf course superintendent. What I have trouble with is pinning down the time they spent on our course. Leaving that old chalkboard hanging with its last words has preserved at least for a few of those great employees when they were part of our family. It also proves that little bits of our own personal history can be lots of fun and very sentimental.

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Rich Land

Can Kentucky Bluegrass Cultivars Be Effectively Selected For Fairways and Roughs?

By Drs. Geunhwa Jung[1] and John Stier[2], [1]Department of Plant Pathology and [2]Department of Horticulture, University of Wisconsin-Madison

During the last couple of months two articles dealing with the same topic, Kentucky bluegrass cultivars as fairways and roughs, caught my attention. Since my appointment as a researcher and extensionist at the University of Wisconsin–Madison we have been working on similar research, the genetic characterization of Kentucky bluegrass cultivars using DNA marker technology. We would like to contribute additional information obtained through the recent research for superintendents to make a wise choice of Kentucky bluegrass cultivars.

Dr. John Stier from the University of Wisconsin-Madison wrote a review article titled "Fairway Grass Selection" published in Grass Roots (John, 2000). He made a concise and full discussion of the on pros and cons for each category of Kentucky bluegrass cultivars recommended for fairways in Wisconsin. These recommendations were based on the Kentucky bluegrass classification developed by researchers at Rutgers University (Murphy, 1997).

Another article with a similar topic was just published by researchers at Rutgers University in Golf Course Management (Bonos et al., 2000b), entitled "Kentucky bluegrasses make comeback on fairways, roughs". The paper talks about a more detailed classification of Kentucky bluegrass cultivars based on morphological characteristics (growth habits and performance in fields) and disease reactions than the previously published ones (Murphy et al., 1997; Bonos et al., 2000a).

Additionally, blending options for each category of bluegrass cultivars were recommended. They also made an intelligent argument for planting Kentucky bluegrass cultivars for fairways and roughs by illustrating the great disease pressure on perennial ryegrass. P. ryegrass is very susceptible to gray leaf spot caused by *Pyricularia grisea* common in southern regions of US, the disease favors prolonged periods of high humidity and relatively high air temperature (>80F) for infection.

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