GreenZapr™

Germicidal UVC has been used in the eradication of pathogens, viruses, mold, and fungus for over 100 years. Now adapted for mobile use, the GreenZapr uses the strength of UVC in a simple tow-behind unit. With an on-board generator with intelligent power regulator, the GreenZapr efficiently sends and controls power to the light banks. The spring tine rake module lifts material, preparing it for exposure. Total immersion in the UVC is executed with a three-pass technique that results in a 99.9% kill factor.

The spring tine rake attachment is equipment with 42 tines that comb through the turf surface, lifting fiber and infill, preparing the turf for exposure.

The two 3' x 3' light banks, housing 16 shatterproof bulbs, provide the UVC energy required to kill dangerous MRSA & HIV.

The miniZapr is also available, which is a great solution for hard to reach spaces, locker rooms, weight rooms, fitness areas, and bathrooms.

Turfgrass water conservation essentials:
modified rootzones & current water management technologies

TURFGRASS WATER CONSERVATION is not just a concept of the minimum amount of water that can be used for turfgrass survival, it is also the concept of optimizing water use as a significant factor in getting the maximum performance from turf and not wasting water. Key elements of this concept are modifying root zones to promote optimal turf growth and taking advantage of improvements in turf irrigation technology.

MODIFIED ROOTZONES FOR EFFICIENT WATER USE

Soil uniformity. Uniform soil conditions make it easier to grow uniform turf and provide more efficient irrigation. However, turfgrass is frequently grown on nonuniform modified soils where topsoil has been removed or mixed with subsoil. Sod is often laid on compacted subsoils, which limit rooting into the underlying soil.

Soil variability increases the need for site-specific management in irrigation programming, using the knowledge of soil properties such as texture, structure, organic matter content, compaction, drainage, slope, fertility, and pH, as well as lighting and air movement. Water relations in soils depend on retention and transmission of water: soluble salts can control how much water is available to roots in salt-affected soils. As a soil dries or as soluble salt content increases, less water becomes available for plant uptake.

Sand-based designs. Sand-based profiles that have relatively narrow particle size distribution are widely used with or without amendment for highly trafficked turf areas such as golf putting greens and other sports turfs to ensure adequate water infiltration, percolation, and drainage, and to prevent the buildup of excessive soil water content. Profile designs that encourage the development of a water table can conserve water. These designs on limited slopes and when drained to field capacity can have a water content distribution ranging from unsaturated and well-aerated at surface depths to nearly saturated at the lowest depths.

Placing a finer-textured sand over coarser material such as gravel creates a zone of greater water retention (a perched, or suspended, water table) in the sand above the interface with the gravel layer. For example, the USGA Green Section specifications for putting greens use a 2-layer or 3-layer profile. The 2-layer profile is most widely used and has a 300-mm sand root zone mix of a specific particle size distribution placed over appropriately sized gravel. Drain tiles are installed in the gravel layer. During construction, these specifications are sometimes followed carefully, sometimes not; if not, undesired conditions may occur in plant-available water or drainage patterns.

The California design is a 1-layer system consisting of a specified well-draining sand placed over compacted (impermeable) native soil. Drain tiles are installed in trenches in the native soil. Water retained at the bottom of the root zone is more typical of a perched water table if there is very limited or no drainage into the underlying soil.

Drainage from the 2-layer USGA putting green profile tends to be independent of the sand mix, while the 1-layer California green profile drains slower, with finer sand mixes. Thus, the 1-layer profile tends to hold more water for turf use than does the 2-layer profile. The 2-layer profile has only a short-term effect on the perched water table due to the downslope subsurface movement of water. If the root zone mix is too deep, water stress increases, leading to localized dry spots, especially in the highest elevations of a putting green. If the top mix is too shallow on putting greens, it may be difficult to place the hole liner, and wet areas may occur, which can enhance development of black layer.

Better turf performance has been observed on root zones that retain more water with reduced rooting compared with root zones that retain less water with greater rooting. In sand-based root zones, greater rooting depth has not been related to better turf performance or greater efficiency in water use. There is evidence to suggest that greater water conservation can

Further Reading

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be achieved with sand-based root zones that retain more water.

Subirrigation. Subirrigation can use 70 to 90% less irrigation water than surface irrigation. Drainage tiles placed on top of plastic liners in subirrigation systems can be closed to prevent leaching. These tiles can be attached to pumps to draw water out or pump water into the sand profile. The water table can be raised or lowered as needed, depending on root depth. The particle size range and depth of the sand dictate the degree of capillary rise of water. Problems with subirrigation include managing high levels of soluble salts and sodium, as well as maintaining uniform root zone water content in sloping putting greens.

Topdressing with sand. Repeated sand topdressing increases infiltration on native soil putting greens and other sports turfs. Water that had previously run off sloping turf surfaces tends to be held in the sand layer. When dry, topdressed sports fields have a lower surface hardness. However, hydrophobic soil conditions, as found in localized dry spots or dry patches, frequently develop in sand media. These spots often occur in areas where irrigation coverage is inadequate, on slopes where water tends to run off rather than infiltrate, and on slopes facing the sun. Fully developed localized dry spots are difficult to rewet. Application of wetting agents, cultivation (aerification), thatch control, careful monitoring of soil water levels, and syringing are the most common corrective practices.

Several states offer automated, Web-based potential and reference ET values for irrigation scheduling. In California, the most commonly accepted source of ET data is the California Irrigation Management Information System (CIMIS, wwwcimis.water.ca.gov).

Avoiding black layer. Sand sports surfaces grown with aggressive, high-density cultivars of creeping bentgrass and bermudagrass can accumulate excess organic matter, which can seal the surface, causing loss of roots, turf stress, and the formation of black layer. Management practices to prevent or remove black layer include providing more oxygen to the affected zone through reduced irrigation (with emphasis on syringing), cultivation, topdressing to prevent layer formation, improving drainage, controlling organic matter, and monitoring fertility practices.

CURRENT WATER MANAGEMENT TECHNOLOGIES

Strategies to reduce unnecessary irrigation water use should include efficient irrigation systems and scheduling irrigation based on the actual water requirement of turf needed to maintain a desired quality level.

High-efficiency irrigation. To achieve high-efficiency irrigation, minimize losses such as droplet evaporation, surface runoff, leaching, and wind drift. Correct sprinkler head selection and spacing can match water spray patterns with the shape of the landscape, which helps avoid areas that are over- or underirrigated. Divide larger irrigated areas into hydrozones, areas of similar watering requirements. Consider subsurface irrigation systems: they have shown great potential for water conservation, despite difficulties associated with determining spacing and depth of trays, pipes, or emitters; higher cost of installation; difficulty in monitoring and/or troubleshooting damaged parts; potential interference with maintenance practices; and the inability to establish turf from seed when irrigated below the surface.

Estimating irrigation amounts. Irrigation amounts can be estimated based on climatic factors or calculated from the plants' water status by monitoring soil moisture or by using remote sensing technologies that detect and quantify drought stress. Evapotranspiration (ET) losses from a turfgrass stand provide an accurate measure of irrigation water requirements. These losses have been closely correlated with atmometer evaporation, open pan ET, and potential (model) ET estimates (ETp and ETo). ETp and ETo estimates are most commonly used when turfgrass irrigation scheduling is based on ET losses.

To match actual turfgrass ET, most ET estimates require adjustments in the form of multipliers or crop coefficients (Kc) to meet local climatic conditions and specific maintenance situations. Kc can vary from 0.4 to 1.1, depending on ET reference, quality expectations, season, grass type, maintenance level, and micro- and macroclimate. Crop coefficients can also be used to calculate irrigation amounts. Irrigation below 100% ET replacement (deficit irrigation) does not necessarily result in a significant loss of turfgrass quality and function.

Several states offer automated, Web-based potential and reference ET values for irrigation scheduling. In California, the most commonly accepted source of ET data is the California Irrigation Management Information System (CIMIS, www-cimis.water.ca.gov).

Smart controllers. Smart controllers automatically adjust to daily changes in evapotranspiration. Using them instead of traditional irrigation scheduling can yield water savings as high as 80%. Some municipal water authorities and utilities have introduced rebate programs for installing smart irrigation controllers. Irrigation scheduling based on soil moisture aims to keep the root zone within a target moisture range by replenishing ET and drainage losses. This is considered to be the most intuitive way of determining how much and when to irrigate.

Soil moisture sensors. Soil moisture sensor technologies currently used to schedule landscape and turf irrigation include dielectric sensors and heat-dissipating sensors for measuring soil water content, and tensiometers and granular matrix sensors (gypsum blocks) to measure soil water potential. Both types have advantages and disadvantages, and consideration must be given to the soil type, range of moisture measured, and expected soil salinity.

Tensiometers estimate soil matric potential and do not require soil-specific calibration, but they do need regular maintenance. Granular matrix sensors measure the electrical resistance between two electrodes embedded in quartz material and correlate the resistance with the matric potential of the root zone.

To calculate irrigation requirements based on volume, soil moisture tension or suction values must be converted to volumetric soil moisture content using a moisture release curve. Dielectric sensors record volumetric soil moisture directly; measurements can be affected by the length of the rods, soil texture, soil density, and soil electrical conductivity.

Absolute moisture values can vary considerably over a landscape. If a sensor is installed in a location representative of an irrigated area, and if it records moisture extraction between maximum and minimum over time, using this data can lead to more consistent irrigation scheduling than using absolute values alone. Reported reductions in irrigation water applied range from 0% to 82% when soil-moisture-based controllers were used for scheduling compared with either traditional or ET-based irrigation scheduling.

Crop water stress indices and normalized difference vegetation indices calculated from remotely measured reflectance of canopies have been suggested for irrigation scheduling of cool- and warm-season turfgrasses. However, to date no automated remote sensing irrigation scheduling technology based on reflectance is commercially available.

How do modified root zones and current water management technologies relate to sports turf? The construction and management of sports fields are directed to support the performance characteristics of safety, playability, durability, and aesthetics at some level of expectation. Water management, as expressed in irrigation, is key to meeting those expectations. Occasionally one finds a sport field that has been built by merely scraping off a spot and seeding it. Most often, though, the construction involves modifying the root zone in some manner. In either case, the turf manager must learn how to irrigate that field and ensure that the root zone grows the best grass possible. Water management technologies have been developed to make that job just a little easier and to obtain the highest efficiency from the water that is applied. ■

This article was adapted from *Turfgrass Water Conservation*, Second Edition (University of California Agriculture and Natural Resources, ©2011, Regents of the University of California), which was written by scientists for turfgrass managers and decision makers to address many of the issues relating to turfgrass irrigation. This excerpt is used by permission.

This publication, along with many other useful resources for the turf professional, can be found at http://anrcatalog.ucdavis.edu/TurfLawns/

Polo fields:

uniquely challenging turf management

>> The fields were built without drainage, without proper grading and it appears as though 4 to 6 inches of sandy loam was thrown on top of the native soil and rock that were left over from the cobblestone mine that the area was used for at the beginning of the century.

AT THE BEGINNING OF 2011, all I knew about polo was that Prince William liked to play the sport and that I could buy a t-shirt with a polo player in the corner for more money than I am willing to spend on a t-shirt. As an assistant golf course superintendent, I didn't even know that Colorado had polo fields.

As I toured the J-5 Equestrian Center during my first interview, I knew immediately that my first year managing polo fields might provide a unique variety of challenges.

When these polo fields were built more than 20 years ago, the intention was to use them for polo as a hobby, not as a professional polo facility. The fields were built without drainage, without proper grading and it appears as though 4 to 6 inches of sandy loam was thrown on top of the native soil and rock that were left over from the cobblestone mine that the area was used for at the beginning of the century.

When our team, Valiente, took a lease on the fields the team owner and players realized that in order to play at a competitive level, the condition of the fields would need to change dramatically. Valiente's vision is to bring these polo fields to a level beyond past expectations and to create a standard for the turf and playing surface that could be compared with the world class polo fields in Florida, California and Argentina that they are used to playing on.

POLO BASICS

Outside of polo circles, little is known about the sport, so let's start with a few polo basics. These fields are regulation size, 300 yards long by 160 yards wide. That is just less than 10 acres per field. In perspective, each polo field is larger than 9 football fields. This facility has two regulation playing fields and a 3-acre practice field. The entire length of each field is lined with 11-inch high side boards. Although the side boards and end lines indicate the boundaries of the field of play, the areas outside of these boundaries are not considered out of bounds. If the ball or the players move outside of these borders, they simply continue playing and move back into the boundaries. The field markings are simple. The end lines are painted across the length of the field; the center is indicated with T-shaped markings, and the 30, 40 and 60 yard lines are marked for penalty shots. The goal posts are 10 feet high, 24 feet apart, and are placed in the center of each end line.

Each player rides 4 to 6 polo ponies during the course of the game to keep the ponies rested for maximum performance. Each team has four players on the field, plus two umpires on horses. The game is played in 6 chukkers (periods) of 7 minutes each. So there are 10 horses running, stopping, and turning at full speed for 42 minutes. Every step a horse takes creates four divots. I don't know how many divots are made when 3 to 5 games are played each week, but I can assure you, it is a lot, and that is where the job of turf manager comes in.

The divot operation is probably the most unique aspect of polo field maintenance compared with other sports. A 1,100-pound horse running at 40 mph

Polo Illustration above ©istockphoto.com/anelluk

John Mascaro's Photo Quiz

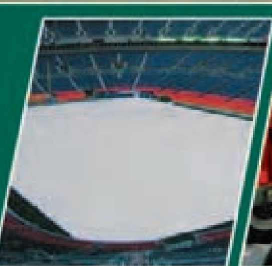
John Mascaro is President of Turf-Tec International

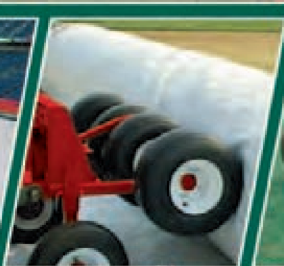
Can you identify this sports turf problem?

Problem: Brown turf
Turfgrass area: Stadium baseball field
Location: Burlington, Iowa
Grass Variety: Kentucky bluegrass

Answer to John Mascaro's Photo Quiz on Page 33

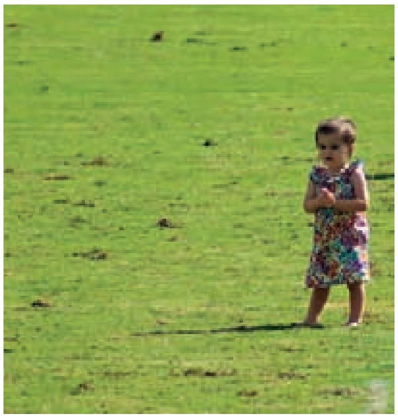
Background illustration courtesy of istockphoto.com





and cutting at 180 degrees creates a whole new category of divot. Most of you have probably heard about the divot stomp, where the spectators enter the field between chukkers and stomp down the divots. This is very helpful, but we only hold one formal event each year where we have spectators to fulfill this duty. The first thing the turf crew does after each match is walk the field, flipping and stomping the divots. Doing this immediately is extremely important so the divots don't dry out. The field is then rolled to keep a smooth surface and to protect the mowers from scalping the mounds that each divot creates. Now it's time to fill 10 acres of turf that are covered in divots wall to wall. Sod is not an option. If a horse slips on unrooted sod and breaks its leg, then that horse, unfortunately, has played its final match. Therefore, we must use seed.

Most of you have probably heard about the divot stomp, where the spectators enter the field between chukkers and stomp down the divots.



COMPOST NEEDED IN DIVOT MIX

The divot mix is 80% sand and 20% compost. The compost is an absolute necessity to hold moisture for germination because we are restricted to a very delicate watering regimen (more on this later). We use an 80% Kentucky bluegrass and 20% perennial ryegrass blend for the divot mix. The ryegrass germination is critical to hold the divot together until the KBG comes in. We always are experimenting to find the best methods for germination. In the heat of the summer, we began experimenting with pre-germination. The methods were extremely scientific and calculated, meaning we threw the seed bags in a horse trough full of water and poked holes in them, letting them soak for a day. Did this help? I can't tell you for sure, but I believe that it worked to our benefit.

I plan on continuing pre-germination and comparing with other methods like using a pre-coated-seed for higher germination rates. The best and most efficient process will never be found because there always will be something new to try and see what happens. Once the seed and sand are mixed we load it into a trailer. The trailer is pulled back and forth slowly with 8 to 10 divot fillers following, each with a bucket in hand. For the next 6 to 8 hours, it's scoop, drop, smooth and move until all of the divots are filled. A final drag with a chain between two carts will help clean up any sand piles and save the life of the reels for the next mow.

Our watering situation is also very unique compared to most turf properties, mostly because there is no in-ground irrigation on the fields. We use large water reels, each 300 yards long. We also have water cannons outside the playing field that are spaced at every 75 yards. The reels are pulled out with a tractor and reeled in as the water pressure turns the turbine to move the gears. I mentioned before that we are on a very delicate irrigation regimen. These fields have no drainage, and the reels, even at their fastest rates, will put out enough water to replace the ET on a 90 degree day, so it is impossible to throw a light syringe over the property to cool it down.

The moisture level in the soil directly affects the horses' ability to run, turn and stop. Too wet and the turf becomes too soft and sloppy, too dry and the turf becomes too firm and slippery. There is a 4-to-6 hour window of optimal playing conditions where the irrigation has dried enough to play on and before the fields are too dry and firm. Timing is everything and adjusting to weather conditions is extremely important. For spot treatment over such a large area the best option is to pull around above ground lines with pods that hold the irrigation heads upright. This allows us to keep the moisture levels adequate and even due to the inconsistencies of the fields. As if all that weren't difficult enough, we share our pump station with the HOA and cannot water at night due to pressure loss. The irrigation challenges are plentiful, but with a strong dedication to spot watering we have been able to keep a consistent playing surface and green grass throughout this season.

These fields were not originally intended for professional polo. They had been aerated, but need more than a simple aeration twice a year. Compaction from polo requires increased cultivation. Using a verti-drain we were able to get down 8" on the 1st attempt, 11" on the 2nd and 15" on the 3rd. Adding 3 core aerations, 5 times slicing, 3 times verti-cutting for thatch removal, and adding over 2,000 tons of top-dressing sand, the turf and soil received a sigh of relief from 2 decades of compaction and thatch build up. These cultivation practices brought the surface firmness to an acceptable, and at a few times this season, an optimal level for polo play.

The increased cultivation is a key factor in the level of improvement that these fields experienced this year. Paying attention to details that may have been overlooked before has created a more optimal growing environment for the turf. Adding practices such as adjusting fertility based on soil tests, getting disease diagnosis from extension labs and the introduction of wetting agents have all contributed to a very successful product for our polo team to play on.

My goal when I arrived here was to make our fields comparable with the world class facilities where the highest level of polo is played. I believe at times during this season, we have achieved that goal. With a little fine tuning, my goal now is to keep those conditions on a consistent level throughout the playing season. There will always be new methods to try, new innovations in our industry and more opportunities to learn from mistakes. Improvement is always on the horizon, and perfection, although never obtainable at its true definition, is the only acceptable outcome for the future. ■

Dave Radueg is Polo Fields Manager at the J-5 Equestrian Center, Littleton, CO.

>> BATTER BOARD was used to define and elevate the infield arc to establish a diversion around the infield.

>> Top Left: BASE PATH: Offset foul lines minimize lip buildup in the grass adjacent to 1st and 3rd base.

>> Middle Left: "WALK SOFT AND CARRY A BIG RAKE." Low ground pressure equipment was used to install the big roll bluegrass sod.

>> Bottom Left: RED SCREENINGS were used to create wide paths and minimize turf wear.

Considerations in infield construction and renovation

MOST OF US have managed an infield under less than perfect conditions at one time or another. The infield may be in need of reconstruction due to years of use or it may have inherent problems caused by improper construction. Whether simply a facelift for an existing infield, or the construction of a new facility, a successful project requires consideration by those involved in the construction process and by those who manage the use of the field.

It's natural to want the best infield you can have when the opportunity arises to renovate or construct an infield. Typically, designers and engineers look to construction practices used on professional infields as a reference when designing for schools and municipalities.

For the sake of this article I would like to take the liberty of providing my perception of a professional infield. A professional infield is an infield constructed on a full gravel blanket below a loamy sand or pure sand root zone. It has a ½% slope radiating out in all directions from the area around the pitcher's mound. The skinned area is constructed with two distinct layers. The base is constructed using an infield mix with less than 70% sand. This mix is managed at a precise moisture level to provide just the right resilience to the players. The base is covered with a thin layer of topdressing such as calcined clay, vitrified clay or possibly a mixture of both. The integrity of these layers is protected with the utmost care. For most of us, managing a professional infield such as this would be like Charlie Daniels playing Tchaikovsky's Violin Concerto. Rather most of us maintain infields in the grey area of right and wrong somewhere between a professional infield and chase out the cows close the gate and play ball.

PERCEPTION IS NINE TENTHS OF THE FLAW

I have witnessed municipal infields constructed on a full gravel blanket using heavy textured impermeable top soil and a heavy clay infield mix because the perception is that this gravel blanket is going to provide superior drainage for the infield. These designers don't realize that unless the root zone has a very high rate of hydraulic conductivity and is capable of allowing water to pass through it efficiently, the only real benefit to any subsurface drainage is the control of ground water or a high water table.

These same designers like the ½% slope because; actually I don't know why they use it other than because it's used on professional infields. What they fail to realize is that ½% slope is almost as ineffective as a gravel blanket in a turf area unless again, you have a very permeable root zone and some

Some designers recommend a heavy textured clayey infield mix like XYZ stadium, not understanding that unless the moisture in that mix is impeccably managed, it's going to get hard as a rock.