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Desert Mountain
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ple, the computer could instruct the satellites to start or stop, based upon information from the sensors. Rain Bird called the new version MAXI II and installed the first systems in 1980.

When IBM introduced the PC (personal computer) in 1981, Rain Bird decided to concentrate on programming and leave the hardware up to computer experts. Evelyn-Veere took the irrigation language and converted it into English. This let the irrigator select from understandable options presented on the computer's screen. MAXI III was born.

As IBM graduated from the PC to the AT, considerably more memory was available for programming. Evelyn-Veere focused his attention on two areas, increasing the intelligence of field controllers and adjusting irrigation programs based upon the amount of water used by the turf and lost to the environment.

In 1987, Rain Bird introduced a solid-state field controller that had as much intelligence as early central computers. The superintendent could make many of the necessary adjustments in the field and the satellite would store these in memory.

The biggest challenge was to enable the computer to track weather and its effect on plant water use, not just for the general area, but for individual zones on the golf course. "The goal was to get the irrigation system in harmony with nature," explains Evelyn-Veere.

Agriculture had already developed a weather-based calculation to measure the amount of water that needed to be replaced by an irrigation system. It is called evapotranspiration (ET) and is measured in inches. A series of weather factors must be included to make the relatively complex calculation.

"A superintendent thinks in terms of the quality of each part of his course," Evelyn-Veere believes, "not in quantitative measurements. He needs a reference point to gauge the effect of weather without getting bogged down in complicated calculations for each different part of his course. We had to make it practical for him to utilize ET data. By using the superintendent's expertise in making qualitative judgments, the computer could determine the quantitative data."

"A superintendent thinks in terms of the quality of each part of his course, not in quantitative measurements."

Since the primary controlling factor in irrigation schedules is time, not inches, Evelyn-Veere made time the basis for ET adjustments. By entering one number that represents all environmental factors, and making qualitative adjustments for separate zones within the course, the superintendent could concentrate on other important matters. This one number is called the ET adjust factor, and it is expressed as a percentage of the system ET.

The MAXI-ET, which utilized an IBM AT, was released in 1987. "The next job was to bring the computer and the superintendent into harmony with the supply and delivery systems," says Evelyn-Veere. "ET would instruct the system to apply a certain amount of water. Basically, the system would run wide open until it satisfied this amount. We were saving water by applying only what was needed, but we could save more by balancing the delivery system with the pump system."

By dividing the irrigation delivery system into "flow zones" based upon the capacities of pipe, heads and valves, the computer can balance flow. By juggling the demand of individual zones, the computer can also control the overall demand placed on the pump system to match the most efficient operation of the pump station.

"A pumping system is designed to maintain a certain pressure," Evelyn-Veere explains. "It turns on pump motors until it satisfies the pressure requirement. Anytime a motor has to start or increase its speed to meet demand, it consumes energy. Motors are designed to be most efficient at certain speeds. By regulating demand to keep pumps operating at peak efficiency, you save a considerable amount of energy."

By telling the computer to regulate demand to match the efficiency of the pumps, peaks and valleys in pressure are avoided and the cost of electricity is reduced. If one pump goes down, the computer can rejuggle the combination of flow zones to match the efficiency of the remaining pumps. Evelyn-Veere's software to accomplish this is called Flo-Manager™.

One problem remained to be solved. ET would determine what amount of water needed to be applied and would instruct valves to stay open until it was delivered. If the infiltration rate of the soil was not great enough to accept all the water at one time, water was lost as runoff. Some soils require extra time to let the water soak in.

By adding one more data base to the computer, Evelyn-Veere enabled the superintendent to set a maximum continuous water time before runoff for each valve zone. If this time was less than that needed to apply the necessary amount of water, the controller would have to reopen the valve to meet the ET requirement. If it opened before the water had a chance to soak into the soil, water would still be wasted. So the computer also needed to be given a minimum soak period.

Evelyn-Veere called this new function Cycle + Soak. "If ET says an area needs 18 minutes of run time, the computer will divide this time by the maximum continuous water time—six minutes, for example. It then knows it will have to cycle three times after waiting at least the minimum soak period. Finally, this adjusted schedule is figured into the demand of the flow zone."

Flo-Manager and Cycle + Soak are the primary features of the new MAXI System IV. "Upgrading a MAXI-ET is just a matter of installing another program," says Evelyn-Veere.

When Renegade was built, a MAXI-ET was installed. Ken Christley of Water Management Systems helped get Ruppert up to speed on the system and then encouraged him to add the new program to upgrade it to a MAXI IV. Last year, the course became one of the first to upgrade.

"Before Flo-Manager came along, we made the daily plan by working up a dry run on the computer, combining all the irrigation schedules throughout the course into a single schedule for the following night," Ruppert recalls. "When the computer plotted our schedule into a flow graph, it sometimes looked like the Grand Teton mountain range. This meant our pumps were coming on and off all night to deliver the widely varying flow rates. We were wasting energy!

"Combining all those hundreds of schedules into one was challenging and time-

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Transition area next to two-flag green.

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Desert Mountain
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consuming; we spent anywhere from 45 minutes to two hours daily. Now we just punch in whatever adjustments we want based on field observation. The weather station provides the ET, and Flo-Manager works out the whole schedule in about 15 seconds. When we plot a flow graph, it looks like a plateau instead of a mountain range!" The result is a 23-percent energy savings.

Shortly after the program was installed, one of Renegade's pumps went down. The maximum efficient pumping capacity dropped from 2,000 gpm to 1,500 gpm. In 30 seconds, the irrigation for that night was revised. "When we lost that same pump once before," says Ruppert, "it took me four hours to revise it."

With the irrigation system under control, Ruppert has been able to devote the extra attention his desert course requires. His major concern is keeping the bentgrass greens healthy during the summer. "The toughest time is in May and June, when temperatures range in the 90s," he reveals. "For some reason, it's easier to manage the greens when temperatures get over 100 degrees. Fortunately, the temperature here drops as much as 40 degrees at night."

He keeps a close watch on the root depth of the Penncross. "When roots get shorter than six inches deep, we reevaluate all maintenance on that green," says Ruppert. "We'll raise the cutting height, change the pin placements, spoon-feed with micronutrients, and adjust the irrigation. I don't like to syringe unless I have to. A little stress forces the roots to look for water. When we syringe, we do it just for a couple of days."

Desert flows in and out of 18th fairway.

Keeping track of 4,500 sprinkler heads is a full-time job for two of Ruppert's crew. Instead of running to any one of 108 satellites to activate the valve-in-head sprinklers, they use hand-held radio valve controls. The units double as radios for the crew to communicate.

"We have to catch malfunctioning heads immediately," Ruppert adds. Each morning

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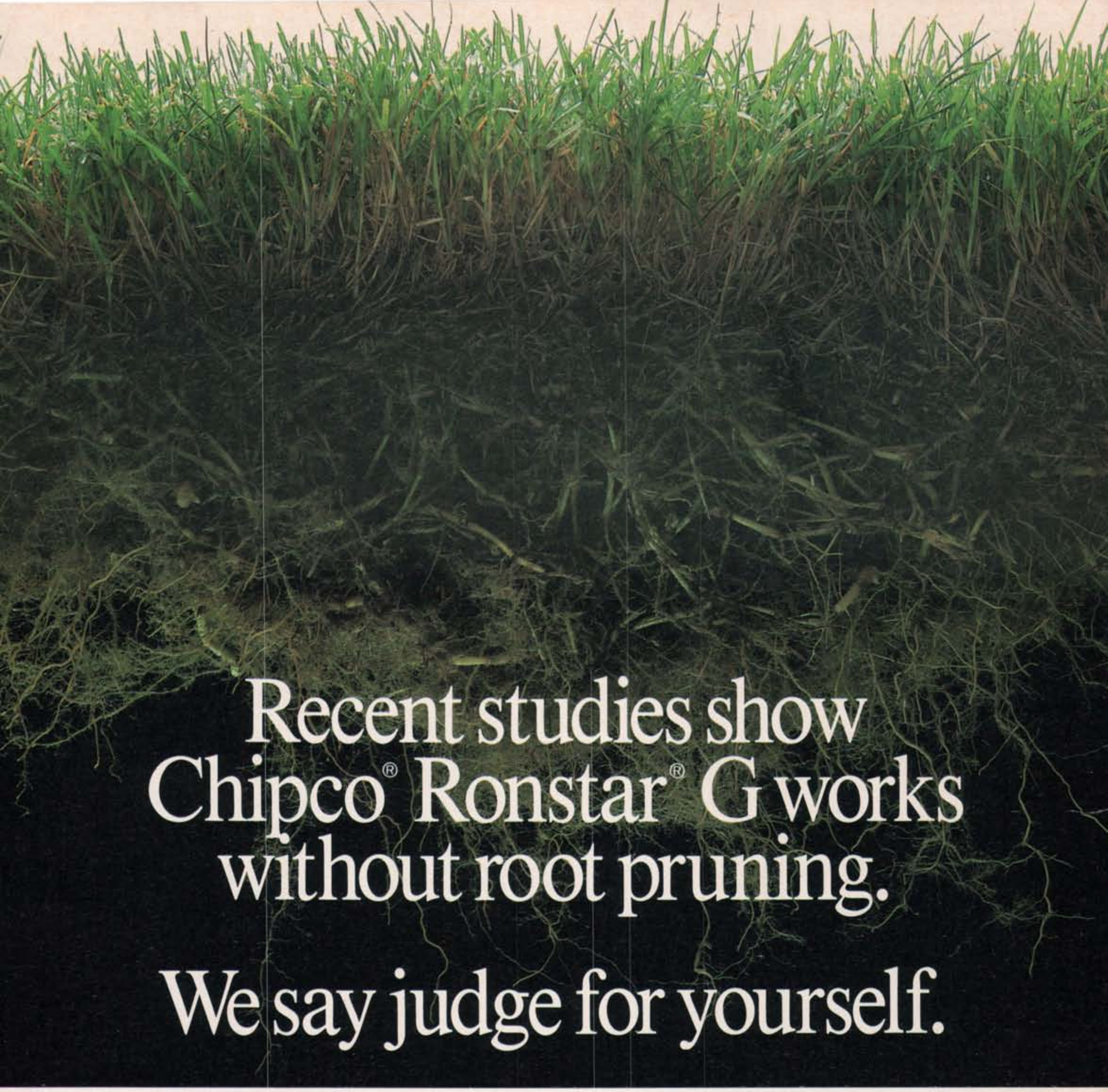

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Native plants conceal irrigation satellites.

Desert Mountain
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he scans the flow charts for anything unusual. "My rule of thumb is—if there is a problem, check the field first. Is the nozzle damaged? Is the valve functioning right? If that's not it, check the satellite, then the pump station. You work your way back toward the computer. So far, we have always located and corrected the problem before we got to the computer."

Ruppert's job is full of "musts." He must protect the native plants. He must keep the unique two-flag course in a condition which properly represents Mountain Desert and Jack Nicklaus. And he must conserve the precious water.

"We operate under the most stringent water conservation regulations in the U.S.," Ruppert declares. "The Arizona Department of Water Resources limits the acreage we can put in grass and the amount of water we can apply. Currently we are allowed 90 acres of turf for 18 holes and five acre feet of water per acre per year. That's a lot less than desert courses in other states." All water comes from two wells and is stored in lakes on the course.

Renegade is now past the grow-in phase, so Ruppert is continuously making adjustments to conserve water and energy. Initially he shared a weather station with Cochise, but Renegade is getting its own station this year. Every 1,000 feet of elevation represents a significant difference in both rainfall and temperature. "I want to track our local weather as closely as possible," he states.

When Geronimo is completed this year, it and Cochise will be restricted to members and their guests, while Renegade will be available to all owners in Desert Mountain and to certain permitted guest play. Ruppert expects play to rise dramatically in the next two years.

The first homes are rising from the desert floor around the courses. The Desert Mountain community is taking shape. Renegade, Cochise and Geromino are the center of attraction, exposing thousands of people to the beauty of the desert for the first time. Man and the desert are in harmony.

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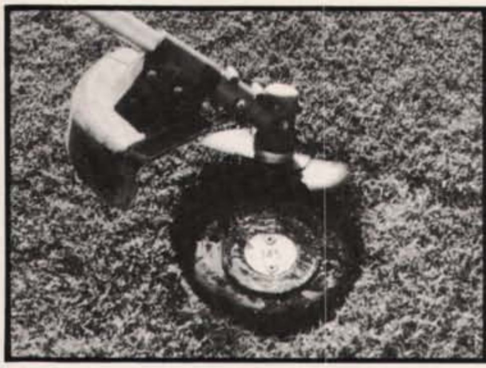

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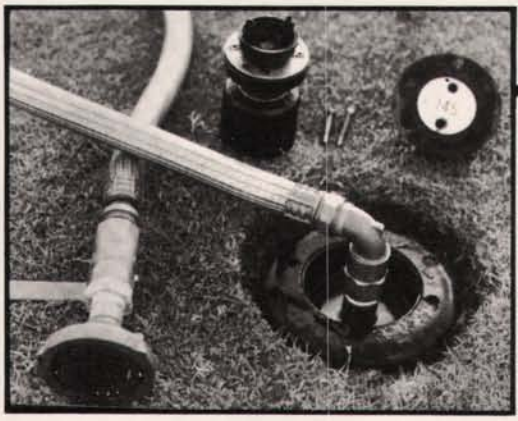

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PALM SPRINGS TURF BENEFITS FROM REUSE PROJECT

Golf courses and parks in Palm Springs, CA are benefiting from Desert Water Agency's (DWA) new six-million-dollar water reclamation facility which was officially dedicated late last year.

The first phase of this technologically advanced facility has a capacity of five million gallons per day. It went on-line in September 1988. Future addition of two more filter units will increase the capacity to 15 million gallons per day.

F. Gillar Boyd, Jr., DWA's board president, pointed out that using water twice by reclaiming wastewater for use in irrigating golf courses, parks, and greenbelts is a major community commitment to water conservation.

"The benefits of reuse are significant: It will help preserve our high-quality groundwater; it will reduce nitrate infiltration into our groundwater supply; and it will conserve energy," Boyd explained.

Edith Spitzer, DWA's vice president and water conservation committee chair, expressed the agency's appreciation to the State Water Resource Control Board for its assistance in obtaining a two-million-dollar loan which helped fund the project.

"I believe that DWA's excellent, long-term water conservation activities helped us get the loan," Spitzer said.

Three users (two golf courses and a city park) are now on-line, and six additional potential water-reuse sites have been identified, according to Jack H. Oberle, DWA's general manager.

"The 12-acre site has been landscaped as a water-efficient landscape laboratory, where we can continue our evaluations of plant materials, irrigation technology, and operations and maintenance techniques," Oberle said.

"Additionally, a three-acre area on the east end of the site has been set aside for a joint research project with the U.S. Department of Agriculture Soil Conservation Service to study the effects of reclaimed water on water-efficient plants. Planting is scheduled for the spring of 1989," Oberle added.

A nitrogen uptake study is also being planned, with guidance from the University of California Cooperative Extension Service, to determine the reduction of nitrogen infiltration to the groundwater when using reclaimed water on turf.

Reclaimed water is being sold at $120 per acre foot, which is half DWA's domestic water rate and is competitive with private well operational costs.

The DWA and the City of Palm Springs coordinate sewage treatment operations, with the city providing secondary treatment and DWA providing tertiary treatment to produce unrestricted-use irrigation water.

"These projects do not happen overnight," Boyd said, referring to the planning, regulatory agencies' requirements, environmental reviews, pilot studies, economic analysis, funding, design, bidding and construction process.

SAN FRANCISCO PARKS CUT WATER 40 PERCENT

More than 200 parks and five golf courses in San Francisco's Golden Gate Park District have been placed on a 60 percent water allotment, says park superintendent Barney Barron. The cutback is based on the amount of water stored in the city's reservoirs. While snowfall this winter in the Sierras was greater than last, it did not restore the reservoirs to a level needed for full park water use.

"The parks will be going brown a little earlier this year and staying brown longer," Barron predicted, "and golfers will be getting more roll." Irrigation on the golf courses will be restricted to tees and greens.

Barron will try to give Candlestick Park its normal allotment by conserving water at other locations. "There are too many contractual obligations at Candlestick to risk the turf," he explained.

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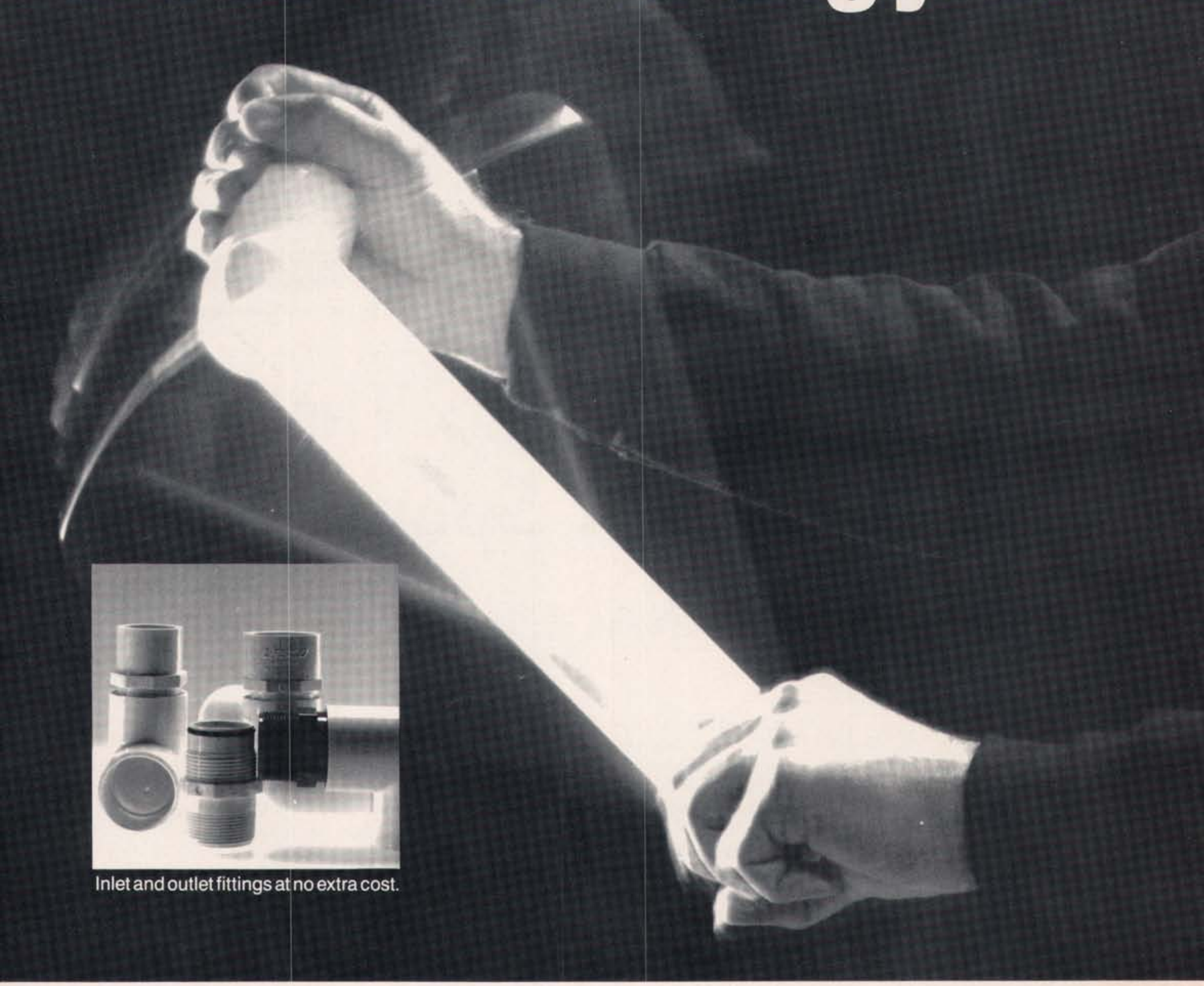

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Herringbone pattern of bypass drainage installed at Saratoga Country Club in Saratoga, CA. Photo courtesy: Turf Drainage Co. of America.

Drainage: The Safety Net of Sports Turf Management

Compaction, disease, annual bluegrass encroachment, salt buildup, shallow roots—all these turfgrass problems can be attributed largely to one cause, poor drainage. Turf managers spend millions each year treating its symptoms without digging beneath the surface to find and correct the real cause.

If golf course superintendents and other sports turf managers are expected to keep high-use recreational turf areas in play, they must have adequate control over soil moisture. It is remarkable that they have been able to apply technology to temporarily overcome seasonal drainage problems. They have skillfully concealed the oversight of architects who had failed to incorporate adequate drainage into their designs, as well as overcoming the effects of time on properly designed drainage systems.

They have also learned that drainage is a safety net for irrigation, allowing them leeway in estimating how much water sports turf requires. Drainage not only guards the turf from surface-applied water, it also protects it from high water tables and salt intrusion from subsurface water.

Drainage systems are more than conduits that remove excess water. Taken as a whole, they include the surface, the soil, gravel, numerous types of pipe, filter material, moisture barriers, soil layers, and even pumps to create suction. Each component can alter the effectiveness of a drainage system. For this reason, the turf manager needs a basic understanding of how each component contributes to the overall effectiveness of a drainage system.

The drainage needs of high-use recreational turf are unique. They are considerably different from those for agricultural production, commercial landscaping and residential turf. Control over water in the root zone is essential to enable turf to recover from traffic abuse and to assure playability.

The United States Golf Association was one of the first organizations to explore drainage systems designed specifically for sports turf. It sponsored university research into combinations of soil mixes and drainpipe to improve the condition of golf greens. This led to the development of the widely recognized USGA Green Section method, a fairly complex procedure of complete modification of the top 18 inches of soil combined with an arrangement of drainpipe.

Most research in sports turf drainage has centered around golf courses. Other methods developed for golf courses include the Purr-Wick and Cambridge systems. This technology has crossed over into athletic field construction and modification, perhaps most notably with the development of the Prescription Athletic Turf (PAT) system and other methods incorporating large quantities of sand.

At the same time, manufacturers of drainpipe have developed new products to give the sports turf manager more options when it comes to constructing or modifying drainage systems. Among these is smaller and thinner perforated drainpipe, which can be installed in narrow trenches to minimize surface disturbance. They have also begun to wrap perforated pipe or plastic cores with filter fabric to keep fine soil particles out of drain lines. Equipment to install new drain lines and to inject sand into existing root zones is also more widely available.

Simply installing drainpipe or replacing soil with sand will not completely solve drainage problems. These techniques may help, but they should be considered as just part of the solution. The sports turf manager needs to understand the strengths and weaknesses of every component of the drainage system. But first, he must distinguish between the different sources of excess water.

Surface Water. The most obvious way to control soil moisture is to restrict surface water. Natural rainfall, runoff from another site, and irrigation can be managed to varying degrees.

Frequently drainage problems are caused by runoff from adjacent slopes, paved surfaces or structures. Critical turf areas must be isolated from other areas with interceptor drains designed to remove both surface and subsurface water.

Tarps may be impractical for golf courses, but they play an important role for athletic fields. Tarps for football or soccer fields should be large enough to cover bench areas. Baseball groundskeepers can avoid rainouts by using one-piece infield tarps or individual tarps for the pitcher's mound, catcher's box, and bases.

Runoff should be a major consideration if tarps are used. Catch basins and/or french drains should be located to accept the runoff from tarps.

The slope of a turf area plays a major role in surface drainage. A one-to-two-percent slope is generally recommended. Soils are only able to absorb water at a certain rate. When rainfall or irrigation exceeds this rate, the excess water will flood the area unless the slope of the surface causes it to run off. Surface drainage also contributes to the effectiveness of subsurface drainage.

Great advances have been made in the past few years toward applying only the

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