COVER STORY

# ...TO THE LAST DROP

A diminishing water supply is forcing the green industry to take a hard look at conservation and alternative sources of water for irrigation.

*by Jeff Sobul, assistant editor*

*Water. It is a resource we have long taken for granted. But like the Great Plains buffalo in the 19th century, it is one we can also drive to near-extinction.*

*Though 70 percent of this planet's surface is covered by water, only one percent of that water is fresh and usable.*

*Groundwater, our hidden resource, is a major contributor to our water supply. But humans syphon an average of 82 billion gallons of water each day from groundwater, only 61 billion of which is replaced through rainfall and runoff.*

*We put increasing demands on water resources as the United States modernized this century, and demands will continue to increase into the next.*

## STOPPING GLUTTONY

The most obvious way to avoid waste is through water management. Millions of gallons can be saved just by adjusting irrigation practices to maximize water efficiency without changing the landscape.

To begin with, stop watering sidewalks, driveways and parking lots by adjusting sprinkler heads.

A Landscape manager must know the water needs of the turf or plant material. Overwatering is common. "By far," says Suzanne Butterfield of the California Department of Water Resources, "landscape plants suffer more from overwatering than from underwatering."

Knowing evapotranspiration (ET) rates (the amount of moisture which is returned to the atmosphere via evaporation from the soil and transpiration through plant leaves) will give the precise amount of irrigation needed, expressed in inches.

The Water Conservation Office of the Denver Water Department, upon request, provides a simple device for converting inches of irrigation into time. Denver's Water Office also announces the ET rate daily. Check local papers or water department offices for ET rates in specific areas.

Increase water efficiency further by adjusting the time when irrigation is done. If it's sunny, 85 degrees with a breeze and the sprinkler system is on, as much water is probably evaporating as is reaching the roots of the turf. Irrigate when the chance of evaporation is at its lowest. "Water between midnight and 10 a.m.," instructs Mike Agnew, Ph.D., of Iowa State University.

"Because of past drought, we only run our water system between 4 p.m. and 10 a.m., with most starts between 10 p.m. and 12 a.m.," says Gary Tollison, highway landscape supervisor for District 7 in California. With less chance for evaporation at this time, more water reaches the plant root zone where it does the most good.

Agnew also recommends deep and infrequent watering. In heavier soil, though, he says "a gradual soaking in short periods is more effective."

Water management also includes finding and developing new sources of water for irrigation. Most of the country's aquifers and surface water supplies are already known. Therefore, developing new sources of water is becoming necessary.

The most promising new source is really an old one: effluent or reclaimed water. The water is recycled, filtered so it can be re-used. Applications so far are limited mostly to golf courses, though this will soon expand. Effluent use is only in its infancy, but a rapid maturation is in the offing.

Researchers say that certain cultural practices will help turf conserve water naturally. The key, says Virgina Tech's John Hall III, Ph.D., is to "maximize root development."

The deeper root system provides more water-drawing potential for the plant. Hall emphasizes using late fall fertalization. At this time, the plant's energies are focused more on root development than shoot development so the nitrogen will work more on that end of the plant. Higher potassium rates are also beneficial, he notes.

Mowing heights can also be adjusted for optimum root devlopment and water efficiency. A higher mowing height helps root devlopment, though height restrictions can come into play on golf courses. There is, of course, a trade-off. The longer leaf blades use more water. Hall says that to keep the use rate constant increase mowing frequency, for home lawns perhaps from once to twice a week.

Thatch is another area of concern. "Thatch is an inefficient water holder," Hall says. Spring aeration and coring prior to periods of limited rainfall, Hall notes, will maximize infiltration.

## A SPLASH IN THE FACE

Effective water management will invariably have to go beyond simple adjustment of cultural and irrigation practices. One key will be public education, notes Gene Williamson, superintendent of parks for the North Jeffco Metropolitan Recreation and Park District Parks Department, Arvada, Colo.

Williamson's department has been meeting with citizens and homeowner associations to convince them that low-water landscapes such as xeriscapes (see story page 29) are beneficial. But, Williamson says, "they want nothing but bluegrass in the parks. And that's costing us money. We tell them the grass might not look quite as good, but it's just as healthy."

Waking up a doubting public to the present and future water situation in Denver's semi-arid climate has been difficult at best for the parks people. Williamson notes that when a park planning meeting with a homeowner group occurs, "we ask them what they want, we tell them what they need, and then we compromise."

For now, his district has reduced watering where it can, implemented isolated xeriscapes—low turf, water efficient landscapes—and experimented with more drought-resistant turfgrasses.

Extensive research is being con-

ducted to determine and breed more drought-tolerant and drought-avoidant turfgrass varieties.

"Drought avoidance is actually more important than drought tolerance," says Robert Shearman, Ph.D., of the University of Nebraska. "The plant just doesn't wilt. It avoids wilt symptoms."

Turfgrasses of this variety "maintain adequate water potential with low use rate or get water from the soil better," Shearman says. He adds that Adventure and Mustang tall fescues are the best examples of turf that combine both drought tolerance and wilt avoidance.

Plant breeder Terry Riordan, Ph.D., works with Shearman. He is trying to breed the most water-frugal and hearty plants. One grass variety Riordan is working with is buffalograss, a warm season variety native to the Great Plains. "This (buffalograss) is the area we're most optimistic about now," he notes. "It already has a lot of good characteristics."

Riordan's research project to find low water-use grasses is in the third year of a seven-year project funded by the USGA and GCSAA. Through his work, he has made some major improvements in the buffalo species. The biggest improvement has been in germination time. "A buffalograss burr (which holds the seed) normally requires a year to germinate. We've got that down to three days," he says.

Perhaps the biggest strike against buffalograss in cool-season climates is its dormancy. "Most people don't want the dormant tan color for five to six months of the year," notes Dorothy Borland of The Turf Expert, Denver.

But Riordan sees buffalograss being used in golf course roughs, industrial sites, roadsides and even home lawns. He notes that a couple of lower budget golf courses in Nebraska are actually using buffalograss on fairways.

Another problem with buffalograss is that it is "not very competitive with cool-season grasses" like blue or rye, Riordan explains. However, he says, "applications of simazine at normal rates keep cool-season grasses at bay so buffalograss can propagate."

Riordan believes buffalograss will be able to adapt to the heavier soils of the Southwest, though Florida soils could be a problem because they are rather sandy. In all, he concludes, "I think we've made significant progress."

Further benefit can be gained by implementing native shrubs and trees into the landscape instead of import-

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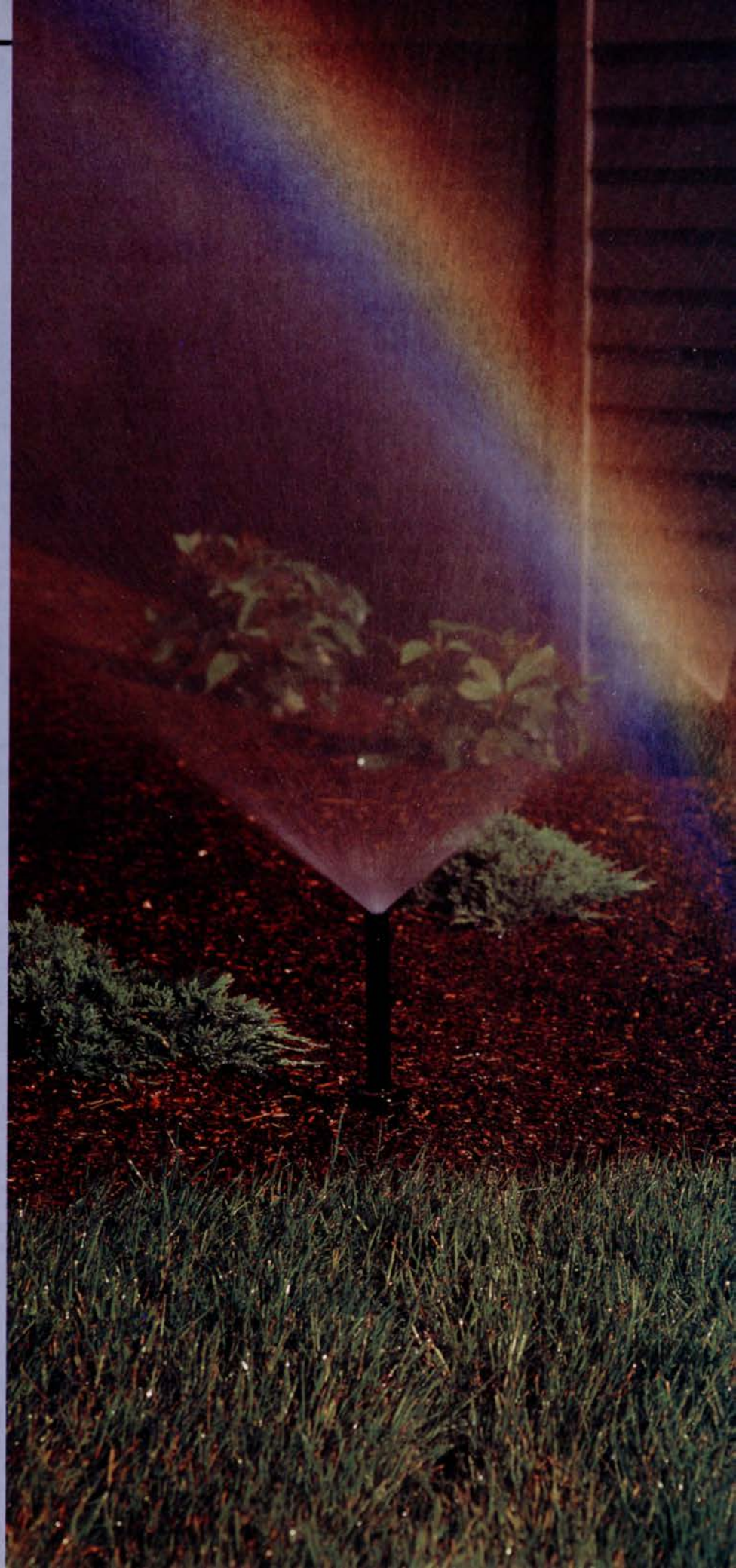

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ing less adaptive breeds. Natives tend to require less water after establishment and grow well in local soils. "Natives are emphasized in xeriscaping," notes Cyrus McKell, Ph.D., of Native Plants, Inc., a plant biotechnology firm. He recommends also selecting plants with greater stress tolerance.

According to LANDSCAPE MANAGEMENT research, nearly 52 percent of the magazine's readers are engaged in some form of irrigation. In 1986, readers spent over $101 million on irrigation equipment, $59 million on sprinklers alone.

Expenditures on electronic irrigation controls increased more than $5 million from 1984 figures, to $20.8 million.

"Irrigation will become more computerized and automatic," comments Steve Bock, an assistant golf course superintendent in Papillion, Neb.

"One (advancement) would probably be a control box that could be placed in the office," adds Gregg Wilson, co-owner of Southern Turf, a landscaping/lawn maintenance firm in Goldsboro, N.C. "With it, all systems could be programmed or controlled. This would discontinue any hustling to a site in case of rain during the time set for irrigating."

## CHANGING TIMES

"The computer is really the thing that's going to change the irrigation industry," says Vince Nolletti of Buckner, Inc. Adds Tom Fermanian, Ph.D. of the University of Illinois, "Over the next 20 years they will be widely accepted in the industry."

Much of the technology needed for efficient systems exists already, and some of it is not new at all. Computers already run irrigation systems.

Computers can make use of the latest technology that reads the environment. Golf courses can now have weather stations installed as part of irrigation systems. Weather stations monitor atmospheric and ground moisture conditions to determine the evapotranspiration (ET) rate and adjust irrigation rates and timing accordingly (see sidebar below).

Included in weather stations are tensiometers, instruments measuring soil moisture content. Palm Springs, Calif., recently experimented with tensiometers. According to Ronald L. Baetz of the Desert Water Agency, the city took a 6½-acre park served from two irrigation meters, divided it in half and installed tensiometers in one half. For the two-year life of the project, water use was cut by 54 percent on the fitted half, translating into a savings of $11,000, just for that one small area. Not surprisingly, "the city is following a program to retro-fit most of its landscaping with tensiometers," Baetz says.

Edward Hunter of Hunter Industries sees low-cost plastic rotors replacing the fixed heads used today. To use tensiometers effectively, sprinklers must "apply evenly and at an acceptable rate. Most apply too fast for absorption," Hunter says, about 1½ to 2 inches per hour.

These new heads are likely to oper-

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# More 'eyes' for turf managers

New irrigation equipment can help turf managers save water, a resource that is becoming increasingly valuable. However, further technical evolution is needed; landscape managers can never have enough "eyes" to help them monitor water usage.

Irrigation manufacturers are taking a hint from these signs of the times by trying to develop sophisticated yet easy-to-use equipment. Not often in irrigation industry have manufacturers generally agreed on marketing plans, but in this instance they do.

Rain Bird Sales of Glendora, Calif., has devised a complete irrigation system which can include weather stations that can calculate probable daily evapotranspiration loss and automatically set the controller so that the correct amount of water can be put back into the turf. The system is called the Maxi ET.

But just because it's almost fully automated, the Maxi ET does not waste the landscape manager's expertise.

"He is the expert," notes Rene Evelyn-Veere of Rain Bird. "The Maxi first draws on his experience because the superintendent or landscape manager can modify the weather station data for specific weather conditions. Then, once the turf manager gets 'tuned into' the system, he can slowly, more precisely replace the water."

The weather station, placed centrally on a golf course for instance, senses temperature, solar radiation, relative humidity and wind speed to calculate the water lost to evapotranspiration over 24 hours. It then subtracts rainfall during the period and, through an IBM PC computer, adjusts irrigation to replace the lost water.

"The user defines ET upload time," notes Evelyn-Veere, "and the system then automatically adjusts the irrigation."

Adds Ed Shoemaker of Rain Bird Golf Sales: "We're finding very few superintendents who have any problem with this concept." If there is a problem, it is trying to get golf course superintendents to think in terms of *inches* of water rather than amount of *time* the system is switched on.

A handy secondary function of the system is that it can switch lights, open gates, operate fountains—virtually anything that has an on-off switch.

Toro's entry is the Network 8000. Its user chooses one of the four ET measurement methods, and that method is used to drive the system, determining each day what amount of water must be dispersed to replace the water lost to ET. The four choices are based on:

(1) Temperature: every Network 8000 satellite has a built-in ability to measure temperature, and ET can be calculated from an equation based on the high and low daily temperature and the area's latitude and longitude;

(2) Solar radiation and other data available from an attached weather station (temperature, wind speed, relative humidity);

(3) Historical ET data: ET data for the last 30 years is available, and if monthly values are assigned, a projection can be made automatically of how much water to apply at a specific time of the year;

(4) CIMIS, California Irrigation Management Information System: a network of 60-plus weather stations around California that daily collect data and feed it to the University of California at Davis, where phone modem access is provided to anyone who wants to use the data for a specific locale.

The Network 8000 is fully automatic, but a key requirement is that all nozzle data be entered into the system's IBM personal computer. With

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ate under lower pressure. Low-pressure irrigation is a new concept for which technology and equipment have only recently been developed and implemented (see story page 20).

Low-pressure systems work at lower P.S.I. than present systems, delivering a more accurate amount of water at lower pump energy, saving money on both water and energy. Pumps will be designed more efficiently, as will other equipment used in irrigation systems, such as piping.

According to Rain Bird's Ed Shoemaker, pump technology has advanced significantly over the last 10 years. Improvements have been made in controls, pressure regulating valves and surge tanks.

A key to the future, he says, will be to match irrigation systems to pumping plants for the most efficient system.

Pumping systems are designed now as a series of smaller pumps installed with demand sensors which control pump flow. If someone is just using a hose to water flowers around the clubhouse, only the first, smallest pump will be activated to provide water to save energy and wear and tear.

Computerization of the pumps and low-pressure systems will make them even more accurate.

Advanced technology for irrigation efficiency will be simplified further through portable infrared thermometry instruments. "Infrared thermometry reads the canopy temperature to schedule irrigation times," says Bob Carrow, Ph.D., University of Georgia.

"The canopy temperature rises when moisture stress begins and before wilt shows," Carrow says. The technology is designed to prevent both over- and under-watering. Irri-

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tem's IBM personal computer. With nozzle radius, spacing, and flow data entered, the precipitation rate can be accurately determined for each Network 8000 station, and the desired water flow more closely matches actual ET.

A further enhancement of matching water dispersion to ET demand is accomplished through entering data from each station into the system. "We knew that turf managers would want to customize their watering based on the characteristics of each course," says Toro Irrigation's Terry Mylne, "and that's really the only way you're going to be sure you're not over- or under-watering.

"Our solution was to create a system that assigned values for type of soil and turf, soil compaction levels, and slope of soil for each station. Special groupings such as north or south facing slopes, and rocks, trees and beaches may also be entered. All of these 'attachments and attributes,' as we call them, become associated with every station, and can all be scaled up or down for relative importance."

Motorola has been using weather station technology in agriculture for about 15 years, according to Motorola's Eric Scott. But it has only been within the last year that the company has entered the golf course market with a weather station-equipped irrigation system. The reason: "The education of superintendents is increasing, and these people are becoming more aware of these things," Scott says. "The industry is more receptive to high-tech."

Motorola's systems, the 3500 and 5000, gather data which is transferred by radio, technology which the company is noted for, to a central computer which adjusts the system accordingly. Software for the system was written along Motorola specifications by International Hydrological Services, a consulting firm of former irrigation industry members.

**Rene Evelyn-Veere of Rain Bird says the golf course superintendent remains the expert, despite new technology.**

The system only operates under optimum flow and pressure conditions, Scott says. If conditions necessitate it, the computer will prioritize areas to be irrigated: greens first, then tees and so on.

A hand-held monitor that measures plant stress much like a weather station is being marketed by Standard Oil. The ST-27 Turf Monitor, a "gun" attached to a computer worn at the waist on a shoulder strap, monitors the physiological state of the turf. After measuring the plant's leaf temperature, ambient temperature, relative humidity and solar radiation load, the data is processed by the computer. The resulting "stress index" gives the turf manager information needed to analyze irrigation effectiveness and project irrigation requirements.

"Its ultimate purpose is to serve as an additional set of 'eyes' for the superintendent," notes Steve DeSutter of Standard Oil.

New water-saving technology is not just limited to hardware. Indeed, most turfseed marketers are currently studying varieties with better drought-tolerance characteristics. It is generally known that Bermudagrass, zoysiagrass, tall fescue and creeping bentgrass have excellent to good heat hardiness. As improved varieties are released over the next few years, water use promises to decrease—as it must.

*—Jerry Roche*

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gation models have been developed for a number of turfgrass species.

Three companies market infrared thermometry instruments: Everest Instruments, AgriTemp and Standard Oil. Carrow says only Standard Oil has combined the thermometry with a computer.

According to Standard Oil's Bronson Gardner, the six-pound unit combines a thermometer gun with a 64K computer worn by a strap over the shoulder.

"Based on field research, we've developed a model which measures what the canopy temperature is and should be," Gardner says. "There doesn't seem to be a difference from warm- to cool-season grasses in evaporation rate and canopy temperature."

In some respects, says Gardner, the instrument works like a portable weather station. Called the ST-27 because it can store information for up to 27 holes on a golf course, it monitors air temperature, humidity, sunlight intensity and canopy temperature for fairway, green, tee, rough and another spot of choice on each hole.

Steve DeSutter, sensor technologies manager for Standard Oil's Engineering Materials Company, says that, since the ST-27 is portable, it is more area specific than a weather station, giving more accurate readings for more areas on the course.

The computer makes readings four times a second and can recall a three-day history for each spot and print the history in graph form when downloaded onto a printer. From this data, a landscape manager could work out an irrigation schedule. The ST-27 was expected to be in distribution at the end of June.

"The sky's the limit" for technological advancements, notes Neil J. Bustamante, a superintendent at a Hawaiian resort golf course. But, he cautions, "it should be remembered that those assigned the responsibilities of operation of these systems have their 'limitations.'" **LM**

# A dry idea, sort of

It is water conservation brought to an art form. And it draws from every aspect of water conservation.

The only thing new about the concept is its name: "xeriscaping," a term that originated in the Denver area less than 10 years ago.

The name is appropriate, though slightly inaccurate. It is derived from the Greek "xeros," meaning dry. However, xeriscaping is not a totally dry method of landscaping. All living plants require a certain amount of water.

Rather, xeriscaping is a combination of landscape design techniques: reducing areas of ever-thirsty turf, using water-conserving plants well-adapted to native soils grouped together in "hydrozones" (areas containing plants with like irrigation needs), and efficient irrigation systems used *only* when necessary.

Xeriscaping is based on seven fundamental principles:

- Start with a good design.
- Improve the soil.
- Use mulch.
- Limit lawn areas.
- Choose low water-use plants.
- Irrigate efficiently.
- Practice good maintenance.

Mulch is recommended to reduce soil moisture evaporation, decrease weed growth and control soil temperatures, eliminating extremes.

Adjusting maintenance practices is also a benefit. Applying less fertilizer, weeding quickly to reduce competition for water, raising mowing heights and mowing more frequently, and aerating for improved water penetration are all beneficial.

Research has been conducted to find the most drought-resistant and water-efficient turfgrasses for use in xeriscaping.

**A non-watered, non-mowed roadway corridor in Orange County, Calif. is safer, more attractive and more water-efficient.**

Dorothy Borland of The Turf Expert in Denver recommends buffalograss or buffalograss mixed with blue grama for low water use and drought tolerance. But, she notes, the warm-season grasses go dormant from October to May. "Most people who choose buffalograss know something about it," she says.

An added benefit, she notes, is that the native buffalograss only grows to about six or eight inches, and is therefore low-maintenance. But, she stresses, "I am still careful before recommending this grass. It has poor shade tolerance and when thinned by too much water or shade, bluegrass and other weedy plants will invade." She notes that the grass also has a long dormancy period.

In addition, Borland recommends using wheat grasses and smooth brome grasses. Borland says she also has been satisfied with the drought tolerance of improved tall fescues.

The major objective is to reduce bluegrass areas, Borland says, but also

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to choose alternatives other than buffalograss. She says that one-third of her clients choose xeriscaping.

Native plants are always recommended for new xeriscapes and conversions to xeriscapes. They are naturally adapted to the soil and environmental conditions and require less maintenance and irrigation. But as with all new plants, natives need to be watered sufficiently until proper root development has occurred.

As for irrigating lawns, Borland says, "so much of it is what they (customers) expect. How little water can we use and still get by with a good-looking lawn?" The key is to find a balance between giving the customer the lawn desired while also giving them the maintenance desired, she adds.

The management principles naturally apply to arid areas where natural rainfall cannot keep up with public consumption, though xeriscaping can be used anywhere. "Inquiries are coming in on a global basis," says Ken Ball of the Denver Water Department. Ball is also secretary of the National Xeriscaping Council.

And xeriscaping is effective, often cutting down on water use outside the home by 40 percent or more.

Becky Garber of Colorado Landscape Enterprises, Arvada, Colo., says her company worked with a group of Aurora homeowners to implement xeriscaping and general water conservation practices on a 6½-acre property called Sunstone. She says the program reduced water bills by $15,000 in one year.

A study was conducted among 548 townhouses in Marin and Sonoma counties in California. Xeriscaped townhouses averaged about an $85 savings compared to conventional landscaping over the eight-and-a-half month test period. More importantly, water use was cut by 30,000 gallons per townhouse, a 54 percent reduction.

Xeriscaping councils exist in seven states (see list for contacts), with an eighth, New Mexico, expected this summer.

To help promote xeriscaping, many community xeriscaping councils have established exhibition gardens to give people a visual idea of what to expect.

"They show plants and how xeriscaping can be pulled off," explains Ball. "If there's something a person can go and wiggle their toes in and sit down with, it's more effective."

*—Jeff Sobul*



## SLIDING AWAY

A valuable resource not given enough thought is soil. Topsoil is frequently lost from runoff due to heavy rainfall or improper irrigation.

While irrigation rates can be adjusted to correct a problem, rainfall can't. The impact of falling water on surface soil can destroy the structure of surface soil, cause surface to settle and seal, decreasing infiltration and increasing runoff, says Penn State's Tom Watschke, Ph.D. Therefore, it becomes necessary to protect the soil from eroding away.

The four basic types of erosion are:

- splash erosion when raindrops strike the soil surface an break soil aggregates into fine particles which can be carried away;
- sheet erosion when water moves across the soil surface and removes thin sheets of soil;
- rill erosion when water moves across the soil surface and cuts small ditches a few inches across; and
- gully erosion when water flows across one spot long enough to cut large gullies.

The best method of erosion control is establishing a good stand of turf. Under good conditions, and without stringent time requirements, reseeding can do the job.

But if the problem is severe, and immediate, Watschke notes it is better to use sod. The sod is more dense, and with bluegrass sod, "it's an instant fix. The day you lay it, the effect on runoff and erosion is immediate," he says.

The slow-establishing seed is less dense and subject to runoff. The problem with sod is a purely economic one. It costs more. Notes Watschke, it comes down to a cost vs. benefit decision.

But other methods are often more economical. They involve using geotextiles, either natural or synthetic.

On reseeded soil, says Watschke, putting a mulch/straw mix on top reduces the impact of rainfall. "The structure of the soil remains, the runoff decreases. Once the plants establish, they will take care of the runoff."

Other natural geotextiles come in blanket form, such as North American Green's straw and/or coconut fiber blankets. According to the company, the blankets are designed to reduce moisture loss while allowing

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moisture to infiltrate, and also to keep seed warm to facilitate germination. In time, the blankets brake down to provide a mulch covering.

Synthetic geotextiles come in a number of materials though they generally serve the same purpose as natural. American Enka's Enkamat, actually considered a geomatrix rather than a geotextile, is contructed of nylon monofilaments fused into a three dimensional form which leaves 90 percent of its area open. This area can be filled in with soil, gravel, etc. This stabilizes the soil, allowing seed to germinate. When the turf is established, the material continues to stabilize the soil substrate.

Geotextiles like the polyesters from Warren's and polypropylene Typar from Du Pont control erosion and also prevent weeds from growing. They can be used on flat areas as well as slopes such as river and lake banks, road and rail cuts, etc.

In the end, though, there is only one way to stop erosion, and that is to treat different parcels of land according to the individual needs and capabilities.

*—Jeff Sobul*



# Local xeriscaping councils

A number of councils exist as part of the National Xeriscape Program Network. The following is a list by state and city with a contact included.

*indicates the program has a xeriscape demonstration garden.

**National Xeriscape Council, Inc.**, c/o Highlands True Value Hardware & Nursery, 8080 S. Holly, Littleton, CO 80122; (303)779-8822. Contact: Jim Grabow, president, NXCI.

**ARIZONA**

Flagstaff, (602) 774-5281. Contact: Frank Abeyta, Jim Clevenger or Vicki France.

Phoenix, Arizona Municipal Water Users Assn., (602) 256-0999. Contact: Robin Stinette.

Tucson*, Southern Arizona Water Resources Assn., (602) 881-3939. Contact: Marybeth Carlile.

**CALIFORNIA**

So. California Xeriscape*, Santa Ana, (714) 973-1023. Contact: Mary Cooper

State of California, Department of Water Resources, Office of Water Conservation, Sacramento, (916) 445-4403. Contact: Suzanne Butterfield.

Contra Costa, Contra Costa Water District, Concord, (415) 674-8000. Contact: Debora Maxon.

Fresno, Water Division, (209) 488-1408. Contact: Dave Todd.

Oakland*, Alamo, (415) 820-6600. Contact: Richard Bennett.

San Diego*, San Diego County Water Authority, Cuyamaca College Office of Public Information, (619) 297-3218. Contact: Pete Rios.

**COLORADO**

Arvada*, Parks Department/Utilities Division, (303) 420-0984/431-3035. Contact: Mike Lee or Sterling Schultz.

Aurora, City of Aurora Utilities, Water Conservation Dept., (303) 695-7387. Contact: Kim Hout.

Boulder, Planning Department, (303) 441-3270. Contact: Peter Pollock, Ron Donahue or Stan Zemler.

Denver*, Denver Water Department, (303) 628-6329. Contact: Ken Ball

Ft. Collins*, Water Utilities Department, (303) 221-6681. Contact: Molly Nortier.

Genesee Estates*, Homeowners Assn., E. Golden, (303) 526-1339. Contact: Muff Mackey.

Greeley, Ext. Svc. Weld County, (303) 356-4000 x.4465. Contact: Donna Liess

Lakewood, Parks & Recreation, (303) 987-7800. Contact: Bill Jewell.

Longmont*, Municipal Utilities, (303) 776-6050. Contact: Kathy Faatz.

Wheat Ridge, Parks Dept., (303) 237-6944 x.283. Contact: Bill Cassel.

**FLORIDA**

Southern Fla., S. Florida Water Mgmt. District, West Palm Beach, (356) 686-8800 x.391. Contact: Bruce Adams.

**NEVADA**

Reno*, Great Basin Xeriscape, Inc., (702) 329-4329. Contact: Tom Stille.

Sierra Pacific Power Company*, Reno, (702) 689-4116. Contact: John M. Metcalf.

**TEXAS**

Abilene, Water Administration, (915) 676-6000. Contact: Cynthia Manning.

Arlington, Utilities Dept., (817) 275-3271. Contact: John Kubala.

Austin*, City of Austin Xeriscape Program, Resource Management Dept., (512) 462-6265. Contact: Martha Latta.

Brownsville*, Public Utilities Board, (512) 544-3800. Contact: Pamela Gross Downing.

Corpus Christi*, Corpus Christi Botanical Society, (512) 992-5337. Contact: Dr. Sue Gardner.

Denton, Operations & Energy Mgmt., (817) 566-8448. Contact: Lisa Tindel.

Ft. Worth*, Ft. Worth Water Department, (817) 870-8220. Contact: Cari Hyden.

McKinney, Heard Natural Science Museum and Wildlife Sanctuary, (214) 542-5566. Contact: Marcia Coale.

San Antonio*, South Central Texas Xeriscape Program, c/o Bexar County Extension Service, (512) 220-2776; Contact also: Doug Welsh, Texas A&M College Station, (409) 845-7341.