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PET networks a resource for irrigators

By scheduling irrigation to closely match a crop's needs using potential evapotranspiration (PET) data referenced to that crop, farmers can produce maximum yield for the amount of water used per unit land area.

PET is a sort of benchmark--the water requirements of a well-watered green plant growing in deep soil. A coefficient is calculated for each crop based upon the crop's size and stage of growth, as well as type of soil and climatic conditions. PET of a reference growing plant is multiplied by the crop coefficient to calculate the water requirements for the specific crop.

The variables of the PET equation are temperature, relative humidity, wind speed, and solar radiation. "PET quantifies the evaporative demand from atmospheric conditions," wrote Rosemary Seymour, formerly of the Texas Agricultural Extension Service and one of the developers of the Southern High Plains PET Network.

The components of evapotranspiration are evaporation (water evaporating from the adjacent soil or from the surface of leaves of the plant) and transpiration (the water entering the plant root system and used to build plant tissue or transpired through the leaves into the atmosphere).

Five discrete PET networks in Texas make available to growers, agents, industry, and even the home gardener data on the water replacement needs of crops and plants. Oklahoma, California, Arizona, and Colorado also have well-developed PET networks.

The widest-ranging Texas PET network is accessed via the Texas Evapotranspiration Web Site (http://texaset.tamu.edu), developed under the direction of Guy Fipps of the Extension Service. PET data is compiled from 18 sites in North Texas, Central Texas, the Edwards Aquifer, and the Lower Rio Grande Valley.

The Texas Evapotranspiration Website provides crop coefficients for sorghum, cotton, corn, and winter wheat grown in the North Plains at various stages of development. (In Texas, verified crop coefficients exist only for the North Plains, and were developed by the North Plains PET Project Team.)

Useful to producers is another feature a grower's guide entitled, "Using PET for Determining Crop Water Requirements and Irrigation Scheduling," which can be downloaded.

The site also includes efficiencies of various irrigation systems. Growers can divide the crop water requirement by the system efficiency to determine the amount by which to increase irrigation to compensate for system inefficiencies.

Complementing the equations for crop coefficients are two useful tables: generalized PET and average historical monthly rainfall for 19 Texas cities.

Two PET networks have been developed at Panhandle-area Agricultural Research and Extension Centers. The South Plains PET Network and North High Plains PET Networks both offer daily PET data on a subscriber basis, and the North Plains web site keeps archived data at http://amarillo2.tamu.edu/nppet/petnet1.htm.

Irrigated agriculture accounts for more than 85% of water use in the Texas Panhandle. The level of the Ogallala Aquifer there is declining as much as 1 foot per year, but in the past 20 years, drops of as much as 2 feet per year were recorded. More efficient methods of agricultural irrigation methods are responsible for curbing this decline; still, well yields have diminished as the aquifer's saturated thickness has declined, according to the Texas Water Development Board.

PET data from both sites is used by irrigators, production consultants, seed production representatives, agronomists, agricultural engineers, researchers, extension specialists, water district technicians, regulators, design engineers, city water personnel, and golf course managers.

The South Plains PET Network, initiated in 1992 by a TAEX/Texas Agricultural Experiment Station team, has weather stations in Lubbock, Halfway, and at the Agricultural Complex for Advanced Research and Extension System (AG-CARES) research farm in Dawson County, and is funded in part by the High Plains Underground Water Conservation District #1.

PET and other weather data are faxed daily to subscribers and the media in 20 counties. Local print media publish PET data with the daily weather report. Growers use a computerized irrigation management spreadsheet, called the South Plains Irrigation Management Software, developed by researchers to schedule irrigation.

Researchers learned that even deficit irrigation produced an acceptable yield. For example, using the highly efficient low-energy precision application (LEPA) center pivot methods to replace only 75% of the water needs of a cotton crop at the AG-CARES test farm at the AG-CARES test farm produced between 72% and 82% percent of the yield expected from 100% replacement.

For more information on the South Plains PET network, contact Robert Lascano of the Agricultural Research and Extension Center in Lubbock at (806) 746-6101 or r-lascano@tamu.edu.

The North Plains PET Network is a cooperative effort of the US Department of Agriculture Conservation and Production Laboratory in Bushland and the Texas A&M University Research and Extension Center in Amarillo. In operation since 1995 under research leader Terry Howell from ARS and Leon New, a professor at the Center, funding assistance is provided by regional water districts and producer's groups.

The North Plains PET Network operates 10 separate weather stations across 30 counties in the central and northern Texas Panhandle. Each night, the network automatically faxes PET and other crop data to more than 325 subscribers.

The faxes include PET and growth data for corn sorghum, cotton, and wheat, as shown above. Consultants and industry, who require more detailed data for computerized models, can download archived micrometeorological data from the web site.

For more information on the North Plains PET Network contact Thomas Marek at t-marek@tamu.edu or Leon New at l-new@tamu.edu. Both can be reached at (806) 359-5401. Terry Howell can be reached at (806) 356-5746 or tahowell@ag.gov.

A fourth network of 22 weather stations has evolved in the Coastal Plains area out of need for weather data to run cotton and sorghum simulation models developed and used by Juan Landivar of the Agricultural Research and Extension Center in Corpus Christi.

When Landivar, an agronomist, started to use computerized cotton and sorghum physiological development models, he found a lack of sufficient weather data specific to the Coastal Bend region for making PET calculations.

"Dryland farming has historically dominated the Coastal Plains region so there was little need for PET data," Landivar said. Farmers relied on the vagaries of the weather for rainfall, so irrigation scheduling and the PET data it relied on were not well developed.

It seems Landivar popped the lid off a previously unmet need in the region. Starting with three weather stations, the network has evolved to include 22 stations, 19 of them privately owned. Two more stations are planned on the King Ranch and in Refugio.

"This weather station network has grown beyond all our expectations. In fact, it has met with more popular success than the original research it was developed to support," quipped Landivar.

For example, Cotton, Inc. a grower-owned cotton research and marketing concern, purchased several weather stations to link to the network.

Chemical companies, interested in research on how weather affects the performance of their agricultural products, have also contributed weather stations.

For more information on the Coast Plains PET Network, contact Juan Landivar at (512) 265-9201 or j-landivar@tamu.edu.

The fifth weather network is now under development. Texas A&M University and Texas Tech meteorologists are working in tandem on a Texas MesoNet, an integrated statewide network of 330 inland and 30 offshore weather stations. The researchers are exploring the possibility of posting data gathered by the network on an Internet site. PET could easily be derived from this data, and farmers would benefit by having access to wind speed and direction for pesticide applications. Plans are for Texas A&M to cover the eastern part of the state, Texas Tech, the western.

Researchers Gary Sickler and Bruce Gammon see a natural fit between Texas power companies and the MesoNet, due to the fact that "Power companies have their communications systems already in place, and their data could be relayed back to a central computer," said Gammon.

For more details, contact Gammon at (409) 862-1580 or bgammon@ariel.tamu.edu or Sickler at (409) 845-3305 or sickler@ariel.tamu.edu or Tim Doggett of Texas Tech at (806) 742-3477.

Using PET data, crop coefficients, and irrigation system efficiencies, growers can fine-tune the amount of moisture replaced in the soil, as well as accurately schedule irrigation for maximum benefit, even when practicing deficit irrigation. Both TAEX and the Texas Agricultural Experiment Station, with their public and private partners, continued to educate Texas producers on methods of irrigating efficiently.

Valley researchers exploring effects of drip irrigation for sugar cane

Scientists in the Lower Rio Grande Valley are exploring two alternative methods of irrigating sugar cane--one method uses drip irrigation rather than the conventional flooding and the other tests yields using a variety tolerant of salty water.

Bob Wiedenfeld of the Texas Agricultural Experiment Station at Weslaco says that as much as 40,000 acres of sugarcane are grown annually in the Lower Valley. Most growers apply a large amount of water through flooding. Four years ago, Wiedenfeld began working with agricultural producers to see if there was any interest in using water-saving drip irrigation to grow the crop. Since then, three growers in the region are managing 600 acres of sugarcane with drip irrigation.

The overall goal of this project is to compare the use of drip and flood irrigation for sugarcane production in the Lower Rio Grande Valley. An automatic drip irrigation system takes the data from the tensiometer, which measures soil moisture, factors in

potential evapotranspiration, and uses the results to automatically apply water when needed, based upon the crop's needs.

"The key is to apply enough water to keep the sugarcane crop from being stressed," Wiedenfeld says. "Flood irrigation isn't practical because it requires so much water, and you typically can't apply water more often than once every 10 days. More frequent irrigations that use less water and less time do better."

Results are encouraging, Wiedenfeld says. Sugarcane yields were 45 tons per acre with drip irrigation, compared to 40 tons per acre with flood irrigation. The drip irrigation used 30% less water. Wiedenfeld is also working with scientists at the United States Department of Agriculture Agricultural Research Service (ARS) in Weslaco to study how water quality affects sugarcane production. These studies suggest that high levels of potassium can substantially reduce the amount of sugar that is produced.

Agricultural producers are also considering whether alternative water resources (often of a poorer quality) can be successfully utilized to grow crops. Wiedenfeld and Jim Irvine and Sarah Lingle of the ARS in Weslaco conducted experiments to assess if high salinity waters can be used to grow sugarcane without lessening the amount and quality of sugar that is produced.

The project consisted of comparing the growth and sugar yields of two sugarcane varieties. NC0310 has been used for many years and can tolerate salty water, but typically doesn't produce high yields, while CP70321 is a new early-maturing variety that may produce more sugar. Both varieties were treated with four levels of saline water (rain water, tap water, and blends of shallow groundwater and tap water). The salinities in these waters ranged from 6 to 3,000 parts per million (ppm).

Wiedenfeld says results of the project show that yields from the two sugarcane varieties are similar when salinity levels are less than 800 ppm. However, when salinities become greater, growth and yields of CP70321 declined significantly.

"The importance of this study," Wiedenfeld says, "is that it shows you can grow the higher yielding sugarcane varieties with waters that are moderately saline. Because sugarcane requires so much water, the use of saline waters will influence how much of the crop farmers are able to grow here."

For details, contact Wiedenfeld at b-wiedenfeld@tamu.edu or (512) 968-5585.

BOR web site delight for kids, adults

The U.S. Bureau of Reclamation's (BOR) Virtual Water Conservation web site, "Watershare," offers fun-based educational pages for kids and some serious stuff for their parents at http://watershare.usbr.gov. Especially entertaining is the "WaterLearn" section, which shows, in a cartoon format, urban water conservation practices, water's importance to fish and wildlife, and the pros and cons of three agricultural irrigation techniques. Of special interest to teachers will be the extensive grade-level-targeted lesson plans on water audits, fish life cycles, and irrigation efficiencies.

The document links offer access to the Reclamation Reform Act, and several downloadable water management and planning documents, including *A Guidebook for Preparing Agricultural Water Conservation Plans*, *Incentive Pricing for Agricultural Districts*, and documents related to California's Central Valley Improvement Act (see related story, below). The links page provides an avenue to a wide variety of educational, general, kids, agricultural, and nature sites, with heavy emphasis on California-related information. The Bureau of Reclamation also has its own water conservation policy page at http://ogee.hydlab.do.usbr.gov/rwc/rwc.html.

For more information, e-mail watershare@usbr.gov.

Dramatic Cadillac Desert poses tough questions

Cyber visitors to the dramatic and aesthetic Cadillac Desert web site (http://www.crpi.org/cadillacdesert/) will leave pondering the implications of the competing interests of exploitation of natural resources to serve population growth and the implications of that exploitation on the earth as a whole.

Subtitled "Water and the Transformation of Nature," the *Cadillac Desert* television documentary examines the political and environmental implications of three of the largest public works projects in American history. The *Cadillac Desert* television series was a production of Trans Pacific Television and KTEH/San Jose Public Television.

The web page summarizing the first episode documents the building of an aqueduct to appropriate water from the Owens River to serve the thirst of progress in the desert that was to become the city of Los Angeles.

Each episode is summarized in text, highlighted with historical photographs, as well as quotations and portraits of persons with links to the events in question, including Catherine Mulholland, daughter of Water Department chief William Mulholland, the self-educated hydraulic engineer who managed the construction of the Los Angeles Aqueduct. Although Mulholland "desperately tried to make the population conserve water, growth sabotaged everything he did."

The second episode shows how damming and over-allocation of the Colorado River left it a mere trickle, to the detriment of downstream users. The third episode summarizes the

demise of California's Central Valley Project (see related story, above), the largest water works project in history.

The Cadillac Desert series' fourth and final episode, "Last Oasis," offers a report on the ways in which water is used--and misused--is affecting millions of lives worldwide, with the associated political and ethical issues. Based on Sandra Postel's apocalyptic book of the same name, "Last Oasis" explores "how advances in water conservation may be humanity's last water source."

In the interest of thinking globally, acting locally, another link on the site suggests some common-sense, easily adopted techniques for conserving water.

Narrow row spacing under drip irrigation shows best cotton yield

Texas produces more cotton than another other state, but this abundance is due to a vast land resource. Limited seasonal rainfall and groundwater hobble yields to among the lowest in the country, according to Joe Henggeler, formerly Extension Agricultural Engineer in Fort Stockton.

Education on water use efficiency is a big part of the row-width study in West Texas. At the fall crops tour, local producers take a close look at the various water and row-pattern treatments in the final stages of the season.

A study begun in 1997 on a West Texas cotton farm comparing the effect of row widths and planting patterns on yield found that ultra-narrow row (UNR) spacing of 10 inches showed significantly better yield than wider-spaced rows. In fact, in 1997, just under 6 inches of in-season irrigation produced 1,200 pound/acre lint yield in the UNR-planted cotton; whereas it took more than 11 inches of irrigation to match that yield with more conventional 30- and 40-inch row-widths.

For this three-year study, a highly efficient subsurface drip system was installed at the farm of Kenneth and Shirley Braden near St. Lawrence in West Texas. Much of the equipment for the study was donated.

Subsurface drip irrigation minimizes evaporation from the soil surface, as the surface area of wet soil is kept to a minimum. Instead, soil is wet from below by capillary action. In this study, the subsurface drip lines were buried 12 inches deep below each planted

row. Drip lines under UNR-planted cotton were spaced 30 inches apart. Each drip line had emitters spaced 24 inches apart.

The goal of the research was to determine the effect of different planting patterns and irrigation levels and effective row widths on yield. Cotton was tested in four different planting patterns: solid (every row planted) and with skipped rows every one, two, and four planted rows using conventional 30- and 40-inch spacing. UNR 10-inch spacing was planted solid (with no skip rows).

Four irrigation amounts were applied to one of each planting pattern. Nitrogen fertilizer was injected through the irrigation system throughout the season. The amount of fertilizer, of course, was proportional to the water level in each treatment. Approximately 8 inches of irrigation was applied pre-plant.

Irrigation levels ranged from 0.7 acre-inch for 40-inch 1x1 planted cotton to 11.3 acre-inches for UNR solid-planted cotton. Skip-row patterns had proportionally lower irrigation levels since there are fewer planted rows, and therefore, fewer driplines.

Results also revealed a trend of increasing yield as skip rows were minimized. There was no significant difference between yields from the 30- and 40-inch rows. In general, however, skip row patterns yielded less than solid-planted row patterns.

This research was begun by Henggeler at Fort Stockton and continued by Extension Agronomist Bryan Unruh of Fort Stockton and Extension Agent Warren Multer of Garden City. This research was supported by a grant from St. Lawrence Cotton Growers, Trans-Pecos Cotton Association, El Paso Valley Cotton Association, and the Texas State Support Committee, in cooperation with Cotton Incorporated. Other donations and in-kind contributions came from Ag Products, Inc., Cliff-Brown and Associates, Eco-Drip, Inc., Geo-Flow, Inc., Nelson Irrigation, and Spears Manufacturing Company.

Bryan L. Unruh is a Texas Agricultural Extension service Agronomist at Fort Stockton, Texas. He can be reached at (915) 336-8585 or b-unruh@tamu.edu. Warren Multer is an Extension Agent specializing in integrated pest management in Garden City. Contact Multer at (915) 354-2477.

Specialists focus on urban turf water management

Turfgrass specialists Gene Taylor and Scott Abernathy from the Department of Soil and Crop Sciences at Texas A&M University are recent additions to a team being assembled by the Texas Agricultural Extension Service to help address water conservation issues across the state.

Their focus is to educate the public on turfgrass water conservation practices. In an attempt to more effectively handle this issue, they have teamed up with groups from the Horticultural Sciences and Agricultural Engineering departments. This interdepartmental effort will focus its efforts on multiple levels of training programs.

Field days, specialized training programs, and lectures will give participants hands-on experience in turfgrass water management and conservation techniques. Initial training programs are being geared toward county agents, master gardeners, and other individuals who disseminate this educational information to the public.

A water conservation training program for athletic field managers took place September 1 in Bexar County. Also, a Landscape Water Conservation Training Program will be held for county extension agents September 17 in College Station. This program will be offered to select county extension agents from around the state who have an interest in or responsibilities for turf and landscape issues in their counties. These agents will then be expected to train other agents and master gardeners and spread information in their counties and districts.

Two new master gardener training programs are currently under development: Turfgrass Specialist and Landscape Water Conservation Specialist. These programs will offer training in all areas of turf management, focusing on landscape water conservation practices.

Taylor and Abernathy are also preparing eight publications on turfgrass and water conservation issues targeted at the general public, including homeowner turfgrass management during drought and a Bermuda grass maintenance calendar.

Several demonstration/research projects are being developed in an attempt to establish management criteria for drought conditions. The effects of multiple irrigation treatments, fertility levels and mowing heights will be examined on a variety of warm-season turfgrass species.

Abernathy can be reached at (409) 862-5693 or s-abernathy@tamu.edu. Taylor can be reached at (409) 845-4826 or gtaylor@tamu.edu.

Five cloud-seeding ops aim to enhance rainfall

In effect in Texas are five weather modification projects encompassing 19 million acres permitted by the Texas Natural Resource Conservation Commission (TNRCC). Permits are pending for another 16 million acres.

The longest ongoing program in the country is run by the Colorado River Municipal Water District in Big Spring in West Texas, which has been in operation since 1971. Empirical evidence points to an increase of 3 to 5 inches of rain during the growing season in the years when

clouds were seeded compared with years with no cloud seeding.

The West Texas Weather Modification Association serves an 11-county target region roughly bounded by San Angelo, Midland-Odessa, the Rio Grande River, and the Edwards Aquifer Region. The South Texas Weather Modification Association encompasses the counties south of Bexar County. The Texas Border Weather Modification Association, based in Del Rio, targets the large West Texas counties bordered on the south by the Rio Grande.

In 1946, the modern science of weather modification was born at General Electric Laboratories in upstate New York. Researchers found that ice crystals formed around dry ice in an artificial cloud chamber. A literature search revealed that silver iodide, which mimics the molecular structure of ice, could serve as a condensing nucleus or template for crystal formation. In clouds, ice crystals collect water vapor until they become heavy enough to fall as raindrops.

Not every cloud is a candidate for seeding. Suitable cloud formations are convective, meaning they exhibit an unstable atmosphere. Cloud tops must pass through the 23-degree Fahrenheit level, and the cloud base must be less than 12,000 feet above ground level for cloud seeding to be effective. TNRCC research suggests that clouds with a warm base, a vigorous updraft, and enough latent heat to carry water vapor to the cloud tops are the best candidates for seeding in Texas.

To seed a cloud, an aircraft flies into the thunderstorm updraft. Based upon the project meteorologist's recommendations, the pilot deploys silver iodide flares at the cloud top or uses pressurized wing-tip generators which burn a silver iodide-acetone solution for cloud-base operations.

Typically, clouds produce precipitation 20 to 30 minutes after seeding; therefore, clouds are seeded upwind from the target rain destination. A common misconception is that cloud seeding would increase rain in one area at the expense of another. Actually, clouds release only about 1% of the total atmospheric moisture at any time. If cloud seeding doubled the efficiency of a cloud formation, it would theoretically release only 2% of the available moisture. In his book, *Texas Weather,* TNRCC Weather Modification Specialist George Bomar said that no scientific studies have shown that some residents get rain at the expense of others.

The state's largest weather modification program, the Texas Central Southern High Plains Rainfall Enhancement Program encompasses a 10 million-acre target area in 17 Texas

High Plains counties. The High Plains Underground Water Conservation District in Lubbock was granted a four-year permit from the TNRCC, and Weather Modification Inc. of North Dakota conducts operations under contract. The water district's permit allows year-round operations, but the current project operates during the growing season (from May 1 through September 30). A meteorologist makes a daily weather forecast and makes the determination whether to seed that day. Operations, which involve pilots based in Lubbock; Amarillo; and Portales, New Mexico are directed from a C-band radar station in Littlefield. Planes on alert status must be airborne within 25 minutes of the request to launch.

Three Texas underground water conservation districts and an association of adjacent New Mexico counties sponsor the project. Each sponsor pays a pro-rata share of the fixed and reimbursable costs based on the number of acres in each sponsor's target area. The estimated 1998 program costs is $500,000 or about five cents per acre.

Information on the Precipitation Enhancement Program, including radar images, map of the target area, aircraft flight tracks, and weekly log narratives can be viewed at http://www.hpwd.com.

New legislation offers financial incentives for water conservation and reuse equipment

Gradually, the tide of policy in Texas is changing to offer financial incentives to encourage the efficient use of water, bolstered by the far-reaching Senate Bill 1 and by constitutional amendments.

Tax exemptions

By passing Proposition 3 in November, Texas voters amended the constitution to allow local taxing authorities to exempt all or part of the value of water-conserving equipment from property tax. The property tax exemption is implemented by Senate Bill 1.

This amendment had the effect of extending the reach of the Texas Administrative Code (30 TAC 277), which already granted tax exemption for pollution control equipment (*Texas Water Savers,* Spring 1996).

Proposition 3 gives taxing authorities, such as cities, counties, and school districts, the option of voluntarily offering tax breaks for water conservation equipment. Each authority has the latitude to decide what types of conservation projects are most beneficial to its community, and whether the benefit of increased water supply would offset lost tax revenues. The most inexpensive source of water, of course, is existing water. The Texas Water Development Board estimates that conservation can contribute between 15 and 20 percent of the state's water supply in the next century.

Exempt equipment is defined as that which is installed to reduce water use and wastewater flow volumes, to reuse and recycle wastewater streams generated within a

plant, and to treat wastewater from another industrial or municipal source for the purpose of replacing fresh water in the manufacturing process.

Low-interest loans for agricultural equipment

Supported by the Texas Department of Agriculture, Proposition 3 allows property (called ad valorem) tax exemptions for irrigation equipment which conserves water, such as low-energy precision application (LEPA) center-pivot irrigation systems.

There's more good news for agricultural producers. In February, the Texas Agricultural Finance Authority approved low-interest loans for water-conserving equipment under the Linked Deposit Program created by Senate Bill 1. The program's expansion, which required no new tax dollars, was adopted by the legislature in Senate Bill 1 during the 1997 regular session.

The loans will encourage implementation of water-conserving projects, such as installing drip irrigation systems, building stock tanks, and conducting brush control operations.

Linked Deposit Loans are available in amounts up to $250,000, and at interest rates about 2 percent below prime, borrowers can save up to $27,300 in interests costs on a 15-year loan.

For more information on low-interest loans, contact the Texas Agricultural Finance Authority at (512) 475-1614.

Conserved water is considered beneficial use

Formerly, appropriative doctrine in Texas stipulated a "use-or-lose" scenario--water not put to beneficial use was considered surplus water. There was some question as to whether conservation and reuse were considered beneficial use.

Senate Bill 1 refined the definition of beneficial use in Texas Water Code to specifically include conserved water. Conserved water is defined as "water saved by a permit holder through efficient practices and technologies."

The legislation also provided for the reuse of water by redefining the requirement for the return of surplus water. Senate Bill 1 changes the Texas Water Code on surplus water to state that water diverted under a water right may "be beneficially used and reused by the holder of a permit" for the same purposes designated in the permit.

Also, water recirculated in a pond for cooling purposes is not considered surplus water.

Surplus water, then, is defined as water in excess of the initial or continued beneficial use of the appropriator.

A copy of Senate Bill 1 can be downloaded from Texas Water Development Board website at http://www.twdb.state.tx.us/sb1/archive/sb1_hpn.htm.

Alternative pollution control

Senate Bill 1591, passed by the 75th Legislature, allows the Texas Natural Resource Conservation Commission regulatory flexibility to achieve pollution control and abatement. The TNRCC may exempt an applicant from a commission rule if an alternative method of pollution abatement can be proven to be at least as protective of the environment as the TNRCC's standard rule.

Water, more than any other natural resource, will determine Texas' future in the decades to come. The state's population is expected to double in 50 years, and with developable water supplies all but exhausted, conservation and reuse of existing sources has emerged as a necessity to preserve the viability of this state. Senate Bill 1, the omnibus water supply planning and drought management bill, forms the structure upon which the state's water future can be built.

San Marcos indirect reuse request raises bed-and-banks, environmental issues

An indirect reuse face-off has been brewing for the past two years in the Central Texas town of San Marcos, but regardless of the outcome, the case may not serve as a legal precedent due to the fact that its application was filed in 1995, before passage of Senate Bill 1.

At issue is the conveyance of about 10,000 acre-feet of tertiary treated wastewater via the San Marcos River about two miles downstream to a proposed surface water treatment plant to serve municipal and industrial users. The City of San Marcos, population 29,000, applied to Texas Natural Resource Conservation Commission (TNRCC) for a bed-and-banks permit in 1995.

The San Marcos River Foundation, whose mission is "to protect the flow, natural beauty, and purity" of the San Marcos River, objected to the City using the pristine San Marcos River to polish wastewater, according to the group's president, Jack Fairchild.

The City maintains that since the city's water derives from groundwater, any effluent remains private property when it is discharged, assuming the city uses the water for the same purposes as stated in its original wastewater discharge permit. In Texas, of course, groundwater is governed by the rule of capture, which grants absolute ownership to as much groundwater as can be put to beneficial use. Surface water in rivers and lakes, however, is regulated by the TNRCC by a systems of water rights permits.

The courts and the TNRCC, thus far, have sided with the city.

In June 1997, a Travis County District Judge, in a lawsuit filed by the San Marcos River Foundation against the City of San Marcos and two state agencies, ruled in the City's favor, saying that TNRCC has jurisdiction over the City's bed-and-banks permit and that groundwater remains property of the city even after discharge into the river.

In April, an administrative law judge, who is charged with identifying ownership of the water, submitted to the TNRCC a certified question regarding applicable state law in this case.

Late in June, the TNRCC responded with an interim order. The order, citing two cases concerning groundwater conveyance in natural channels, stated that San Marcos' discharged effluent remains private groundwater, assuming the source of San Marcos' water is groundwater and that the city's stated intent is to reuse the effluent. Downstream water rights and environmental uses, however, must be taken into consideration.

Further, the interim order stated that polishing should not be an issue; rather, the hearing before the administrative law judge should focus on conserving the state's natural resources and protecting the environment.

Once the administrative law judge rules on the ownership of the water, the case will be placed on the Commissioner's agenda.

"This case will not have far-reaching value as a precedent in that it will not affect bed-and-banks applications filed after the passage of Senate Bill 1," said Richard O'Connell of the TNRCC General Counsel's Office. Senate Bill 1 was passed in September 1997.

The city looks at the indirect reuse of wastewater in a pragmatic way. "We look at [reuse] as a way to multiply resources from the aquifer," said City Attorney Mark Taylor last year. "We are obviously faced with the challenge of finding new supplies. One way of doing this is to reuse aquifer water for municipal purposes." Using the river for conveyance of effluent is much less expensive than building a pipeline.

On the other hand, the San Marcos River Foundation is suspicious of the city's motives in this case.

"From Cummings Lake, the reservoir which will feed the proposed drinking water treatment plant, the city would need to build a one-mile or so pipeline anyway to the surface water treatment plant," said Fairchild. "We would rather the city build a pipeline directly from the wastewater plant and use the effluent to irrigate parks, athletic fields, and the Quail Creek Golf Course, as well as a number of farms."

"The only logical reason the city is doing this is because they want to pick up 95 percent of the nice, clean river water along with the wastewater they are putting into the river," he said.

By the end of this year, however, the San Marcos wastewater treatment plant will have completed an upgrade to conform to more stringent discharge limits. The improved plant will discharge tertiary treated (conforming to a TNRCC 5521 permit), rather than secondary treated wastewater (the less restrictive TNRCC 202 permit) into the San Marcos River. Fairchild said the San Marcos River Foundation was a principal in pushing for the upgrade.

Adjunct to the indirect reuse issue is the fact that since 1990, the City of San Marcos has been paying $265,000 per year for rights to 5,000 acre-feet from the Guadalupe-Blanco River Authority's Canyon Lake. The city is now exploring the possibility of doubling that allocation. Currently the Edwards Aquifer supplies 100% of San Marcos' water.

Also in that year, San Marcos voters approved an $8.5 million bond election to build a regional surface water treatment plant and help fund construction of a pipeline to bring that surface water to San Marcos. This treatment plant would function as a regional facility, serving neighboring communities, as well as San Marcos.

PET drives automated irrigation of cotton fields

Several years ago, Juan Landivar, a plant physiologist at the Texas Agricultural Extension Center (AREC) at Corpus Christi, was adapting a Mississippi State University simulation model of the physiological development and water requirements of the cotton plant to the Coastal Plains climate.

Juan Landivar, an agronomist at the Texas Agricultural Research and Extension Center in Corpus Christi, stands before a weather station which transmits climatological data to a central computer for computation of potential evapotranspiration.

To gather the necessary meteorological data, Landivar cobbled together a network of three county- and AREC-owned weather stations.

Since then, the idea has taken hold, and 19 other stations have joined the network, including many owned by private concerns, such as agricultural chemical companies and growers' cooperatives.

But now Landivar has taken the irrigation concept to its next logical step--automated irrigation control. He has developed a prototype radio-controlled water management system driven by the water demands of the plant, as determined by the simulation model. (Radio-controlled agricultural and commercial irrigation systems are common, but most are limited by length of cycle, rather than the calculated plant requirements.)

Landivar's weather stations log data, then transmit them to a central computer where they are compiled. From these temperature, solar radiation, relative humidity, and wind speed data, the computer calculates PET, in a similar manner to the other PET networks across the state.

The program then figures that day's required irrigation and distributes the amount among three irrigation cycles during the day.

The data are then transmitted to cotton fields, where Motorola electronic controllers automatically operate the irrigation equipment.

"This is a dream come true," said Landivar. "There is no reason why this computer-managed irrigation system could not be used on a farm. All the components are commercially available. We wrote the software and would be happy to share it with anyone"

Landivar predicts more irrigation in the Coastal Plains' future, as irrigation becomes more cost-efficient.

For more information on the Coast Plains PET Network, contact Juan Landivar at (512) 265-9201 or j-landivar@tamu.edu.

Cities experience record water demand

Virtually every large metropolitan area in Texas is experiencing record demand, and several have instituted odd-even watering scheduled. But in outlying areas served by smaller water systems, demands are challenging the ability of distribution systems to deliver water.

Agricultural losses from the 1998 drought have already surpassed 1996 levels, with the threat of further damage probable without significant rainfall. The Texas Agricultural Extension Service reports that agricultural losses could amount to $2.1 billion for Texas farmers and ranchers, which translates to an overall impact of $5.8 billion on the Texas economy. Gov. George W. Bush is seeking federal disaster aid for the entire state.

But urbanites are feeling the pinch, also.

The Tarrant Regional Water District called for its customers in the Fort Worth area to ban all outdoor watering the first weekend in August due to a rupture in a 90-inch main carrying water from the Richland-Chambers Reservoir to a treatment plant. A combination of dry, shrinking soil and weeks of pushing the main to near capacity are blamed for the break.

Northeast of Fort Worth, the City of Keller, a wholesale customer of Fort Worth Water Department, experienced a scare on July 12. On that day, temperatures reached 110 degrees, and the water level in the city's elevated storage tank dropped from 20 feet to 7 feet in 2 hours, according to Jerald Cooksey, Superintendent of Utilities.

"It seemed as if everyone in the city was watering their lawns," Cooksey said. The system's pumps could not keep up with the demand. In order to maintain the integrity of the system, police, parks and recreation, and public works employees were called out at 10 p.m.

Two-by-two, they rang doorbells at every residence in the service area of 9,500 connections, asking people to keep automatic irrigation systems from cycling, finishing up at 7 a.m. The automated irrigation systems of residents who were not at home--or who refused to comply--were cut off manually by employees at the residence.

From July 13 through July 15, there has been no outdoor watering. Now the city, like many served by small suppliers, is on an odd-even schedule with watering before 10 a.m. and between 8 and 10 p.m.

San Antonio is in Stage 2 of the Aquifer Management plan imposed by the Edwards Aquifer Authority when the level of the Edwards Aquifer drops to 642 feet. Among other restrictions, residential landscape watering is restricted to twice a week between the hours of 8 p.m. and 10 a.m., charity car washes are allowed only at commercial car washes certified as water-conserving or that use recycled water, restaurants may serve water only upon request, 25% of swimming pool surface area must be covered when not in use, aesthetic fountains are prohibited unless water is recycled, washing of impervious surfaces with water is prohibited, and golf courses are limited to a 20% replacement of evapotranspiration.

In the Lower Rio Grande Valley, which is experiencing its fifth consecutive year of drought, a Water Smart program has been initiated in the cities of McAllen, Harlingen, Edinburgh, and Donna. A media campaign including billboard and bumper stickers will send home the water conservation message. Nursery professionals in the region are being brought on board to disseminate the water use efficiency message to their customers. A "Prime the Pump" campaign has the goal of finding sponsorship for the Water Smart program from local engineering companies. The Water Smart program is based upon a similar program organized during the 1996 drought.

The ability of the Lower Rio Grande River to deliver water is also hampered by the choking growth of water hyacinth and hydrilla. A task force composed of federal and state agencies, including the Texas Agricultural Extension Service, has been assembled by the Drought Response and Monitoring Committee (a group sanctioned by Senate Bill 1) to solve the problem.

An effort parallel to Water Smart was kicked off by Texas Natural Resource Conservation Commissioner John Baker in Tyler in East Texas on July 31. Designed to enlist the support of area citizens and businesses in curbing demand for drinking water, the long-term effort's goal is water conservation awareness. As of late July, about 70 water systems in TNRCC's East Texas Region 5 had experienced problems meeting customer demands.

The Texas Natural Resource Conservation Commission organized promotion of this effort, with materials development by the Texas Water Development Board. The Texas Section of the American Water Works Association and the Texas Water Rural Association have agreed to participate.

Thirteen Central Texas water management and supply entities have formed a partnership, the Central Texas Water Wise Council, to promote outdoor water conservation throughout the dry summer months with a coordinated every-five-day watering schedule.

High water usage owing to dry weather in May and June combined with population growth in the region has caused both large and small water utilities to set usage records and raised concern among utilities about ability to meet peak day demands during August. For several small utilities, water use is four times as high in summer as the year-round average. In Austin, water use almost doubles because of outdoor watering.

Another concern is the possibility of limited supplies available for fire fighting, since the amount of water utilities can treat is finite.

In addition to the common watering schedule, the partnership espouses several "Water Wisdoms," such as cutting grass no less than three inches high to provide shade for roots and top-dressing lawns with less than 6 inches of high-quality topsoil. Also, the partnership encourages customers to delay new landscape installations until the fall and to chose plants that will survive Texas summers with a minimum of water.

Partners of the Central Texas Water Wise Council are the cities of Austin, Cedar Park, Pflugerville, and Round Rock; Aqua Water Supply Corporation; Hill Country Water Supply Corporation; Water Conservation Improvement District No. 10; Anderson Hill, Brushy Creek, Lakeway, and Shady Hollow municipal utility districts; the Barton Springs/Edwards Aquifer Conservation District; and the Lower Colorado River Authority.

Fertilizer use, pest management, and irrigation analyzed in athletic field auditing program

Catch cans allow irrigation auditors to quantify sprinkler output, as on this baseball field in Midway. In the School Athletic Field Education course, athletic field managers learn to adjust water use to be in concert with turfgrass requirements. Pesticide and fertilizer use is also addressed in the course.

Although automated irrigation systems have revolutionized water management practices for sports playing fields, dependence upon them without regard to turf water needs can contribute to under or overuse of water. The Sports Athletic Field Education (SAFE) project aims to correct these deficiencies in athletic field irrigation.

Originally a fertilizer management program for athletic fields, SAFE has added a pilot program which includes irrigation management in Texas Agricultural Extension

Service District 8, roughly the Blacklands Region in North Central Texas. Jim McAfee, Extension Turfgrass Specialist, meets with the site manager to analyze fertilizer use and pest management while Extension Associate David Smith performs the irrigation audit and prepares a report. The audit is sent to the county agent, who in turn relays that information to the site manager. This program has surveyed 16 sites at high school athletic fields around Texas.

An irrigation audit consists of three phases: the site inspection, performance testing, and an irrigation schedule calculation. The site inspection identifies physical problems with the irrigation system, especially those that may go unnoticed with systems that run during the night or early morning. Performance tests of the system use catch cans to determine the application rate and uniformity of the system. The irrigation auditor tests for operating pressure, soil type, and root zone depth. Finally, the irrigation schedule calculation determines proper number of irrigations per week and the correct run times for each irrigation, assuming normal weather conditions.

Irrigation auditing saves water in three main ways. First, physical problems such as broken, misaligned, or sunken heads which produce abnormally high or low water pressures within the irrigation system are corrected during the site inspection. Second, the run times of each irrigation station are adjusted according to that station's precipitation rate to eliminate excessive or inadequate irrigation. Third, station run times are adjusted according to seasonal water demands so that less irrigation will occur during rainy times and more during dry periods.

Wilemon Field in the Waxahachie Independent School District is an example of a successful irrigation audit. The irrigation system consisted of seven heads attached to an automated controller and irrigated 77,400 square feet. The site inspection revealed several broken heads and water pressure of 14 to 30 pounds per square inch (psi), much lower than the necessary 45 psi. Performance testing showed precipitation rates of 0.18 to 0.23 inches per hour and a distribution uniformity of 29% to 62%.

The irrigation audit team recommended that the hardware problems be corrected and the operating system pressure be raised to 45 psi. Using the Landscape Irrigation Auditor Software, a base irrigation schedule was calculated, giving the run time in minutes and frequency in days per week.

In a related project, Smith has teamed up with Texas A&M University turfgrass specialists Gene Taylor and Scott Abernathy to present a turfgrass irrigation management course to sports athletic field managers in Bexar County. School athletic field are traditionally overwatered, said Bexar County Extension Assistant Karen Guz, although watering turf in excess of evapotranspiration can actually be detrimental by preventing the turf from developing a deep root system. In the Edwards Aquifer area, athletic directors are being asked to justify their water budgets in terms of evapotranspiration for a particular time of year.