New Waves
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TAEX Programs Help Reduce Landscape Water Use

Two programs of the Texas Agricultural Extension Service (TAEX) are helping to reduce the amount of water being applied to urban landscapes.

Joe Henggeler, a TAEX irrigation specialist, recently surveyed the amount of water applied by more than 40 automatic irrigation systems in Fort Worth, Fort Stockton and Andrews County. His results suggest that up to half the water applied to urban landscapes may be wasted.

One of the main problems is that timers on many automatic irrigation systems are not set properly. If this happens, some areas receive too much water and others don't get enough. Many well-watered areas in landscapes receive nearly 4 times as much water as the least-watered zone. Automated irrigation systems need to be individually set to account for changes in infiltration and precipitation. He also notes that homeowners need be aware of how much water they are using and what it is costing them. Inserts can be sent with water bills to accomplish this.

Henggeler is part of a TAEX team that has developed a training program to improve the efficiency of urban irrigation. Other team members include Doug Welsh of the TAEX Horticulture Department and Agricultural Engineering specialists Guy Fipps, Bruce Lesikar, and Rose Mary Seymour. The Landscape Irrigation Auditor (LIA) training program is a joint venture of TAEX, the Lower Colorado River Authority, and the Texas Water Development Board.

The program teaches students how to evaluate and audit new and existing systems and how to determine application rates and distribution efficiencies. The two-day course includes classroom and hands-on training, and the use of a computer software program. The course serves a prerequisite for individuals that want to take the LIA certification test.

For details, call Welsh at (409) 8457341 or Henggeler at (409) 845-5614.

TWRI Studies Provide Data to Help Manage Edwards Aquifer

So far, it's been impossible to develop a strategy to manage the Edwards Aquifer that's agreeable to all those who rely on it.

However, a ruling by a U.S. District Judge in Midland sent a clear message to all the warring parties: develop a plan by May 31st or the Federal government will step in and implement a plan of its own.

One of the key stumbling blocks has been that there hasn't been enough research into what the effects of different plans would be on aquifer levels or the regional economy. The Texas Water Resources Institute (TWRI) is now sponsoring two research projects that may help provide some of this needed information.

In one study, Bruce McCarl and Lonnie Jones of the Texas A&M University Agricultural Economics Department worked with graduate students R. Lynn Williams and Carl Dillon to investigate the implications of management plans that have been proposed for the aquifer. Results of the study will be published soon by TWRI as a technical report.

The thrust of the project was to evaluate two specific plans developed by the Texas Water Commission (TWC) in 1992. "The Sector Plan" proposed specific cut backs for agricultural, municipal, and industrial users when aquifer levels in San Antonio dropped to key levels. "The Total Limit Plan," called for a total reduction in water use, but didn't specify where the cutbacks had to occur.

To assess the impact of both plans, the researchers utilized an economically and hydrologically based simulation model. The model estimates water use and incorporates that data to estimate annual aquifer levels and springflows. The model includes information about climatic factors like rainfall, recharge, and the chance that environmentally sensitive springs will keep flowing. A key feature of the model is that it optimizes water use. In other words, water is allocated to those activities that generate the greatest economic value.

The study results are revealing. For example, implementing the management plans may not guarantee that Comal Springs would keep flowing in a severe drought. The plans would likely result in annual losses for current water users ranging from $0.73 million to $1.5 million (based on 1988 demands) to $2.3 to $6.7 million in the year 2000. Agriculture may also be hard hit. By the year 2000, irrigated acres are projected to decline by 32% to 84% and agricultural income could drop by $1 million to $2.5 million. Thus, paying farmers to compensate them for using less water may be economically feasible in some cases. For example, by the year 2000, urban uses are expected to be worth about 6 times more than agricultural uses ($109 to $19 per AF).

Another TWRI-funded study is being carried out by Nisai Wanakule at the Edwards Aquifer Research and Data Center at Southwest Texas State University.

Wanakule is developing a simulation model that can utilize limited data to provide accurate, short-term estimates of aquifer levels and springflows. Previous models required massive amounts of inputs and generated only annual estimates. This model should also better describe flow patterns in karst limestone aquifers.

Inputs to the model include real time measurements of recharge from rivergauging stations. Outputs of the model will include forecasts of levels in seven key observation wells and springflows.

For more information on either study, call TWRI at (409) 845-1851.

Related articles in *New Waves*:

SW Texas State Developing Edwards Aquifer Simulation Model
Development of a Simplified, Easy to Use Computer Simulation Model for the Edwards Aquifer

Related technical reports:

Water and Solute Flow in a Highly-Structured Soil (TR-161)
Economic and Hydrologic Implications of Proposed Edwards Aquifer Management Plans (TR-158)
A Lumped Parameter Model for the Edwards Aquifer (TR-163)

Effectiveness of Retrofitting Homes with Water-Saving Devices

Researchers: Ronald Neighbors, Harris-Galveston Coastal Subsidence District, Friendswood, TX, and Roger Durand, School of Business and Public Administration, University of Houston, Clear Lake.

Problem: Because of excessive groundwater pumping in the Houston area, land subsidence has been a major problem. For example, lands along the Ship Channel sank by as much as 9 feet, while areas near the Johnson Space Center sank by 4 feet or more. Conservation will allow this area to use water more efficiently, lessening subsidence risks and allowing more water for future population growth. Objectives: To document and demonstrate that retrofitting homes with water-saving devices will save water and energy.

Methodology: Kits containing low-flow 2.5 gallon per minute (gpm) shower heads, 2 gpm bathroom faucets, and 2 gpm kitchen sink aerators were obtained and conservation literature was developed. Questionnaires were sent to 2,600 single family residences in Harris County Municipal Water District (MWD) 55 to see if they would take part in the study. An experimental group of 360 homes (these utilized the water saving devices), and a control group of 240 residences (these did not use the water conserving devices) was selected. Telephone surveys were conducted to obtain data on historical water use, the level of interest in conservation, and other variables. The experimental group was polled about whether they installed the fixtures and if they were satisfied with the performance of the units.

Results: Many of the variables including percentage of renters versus homeowners, length of time in the residence, attitudes about the importance of conservation, and household income were roughly similar. The experimental group reported an average water savings of 18% (1,400 gallons per month), while the control group showed a slight increase in water use (about 20 gallons per month). In addition, more than 90% of the people that used the water saving devices were satisfied with their performance.

Reference: Neighbors, Ronald, and Roger Durand, *Effectiveness of Retrofit in Single Family Residences*, Report Submitted to Texas Water Development Board, 1993.

Toxicity of Municipal Wastewater Effluents

Researchers: Marc Bentley, Aquatic Station and Biology Department, and Glenn Longley, Edwards Aquifer Research and Data Center, Southwest Texas State University, San Marcos, TX.

Problem: Regulatory agencies traditionally rely on numeric criteria for specific pollutants. These criteria may not adequately measure the actual toxicity of contaminants to aquatic organisms. Biomonitoring using test species such as "water fleas" or Daphnia species and fathead minnow larvae can more accurately depict the toxic effects of pollutants.

Objectives: 1) To evaluate the acute (short-term) and chronic (long-term) toxicity of wastewaters from municipal plants in San Marcos, Kyle, and New Braunfels, 2) to verify if the toxicity of raw wastewaters was reduced after conventional treatment had been provided, and 3) to compare acute and chronic survival data using chlorinated and dechlorinated effluents.

Methodology: Sites in the study included two secondary treatment plants in New Braunfels and San Marcos that discharge chlorinated effluents, and a secondary treatment plant in Kyle that does not chlorinate its effluents. Most of the flows to all plants consist of municipal wastes. Samples for the acute and chronic tests were collected at discharge points and were analyzed for temperature, conductivity, suspended solids, pH, and total residual chlorine. Organisms utilized for biomonitoring included two "water fleas" (Daphnia pulex and Ceriodaphnia dubia) and fathead minnows. Acute tests estimated the level of pollutants that killed 50% of the organisms within 48 hours. Chronic tests measured how prolonged exposure to pollutants affected the species' ability to survive and reproduce.

Results: All chlorinated effluents were acutely toxic, while all unchlorinated wastewaters were not. Chlorinated effluents from New Braunfels and San Marcoswere acutely toxic to all the test species. Most deaths occurred within the first 12 hours. Effluents from New Braunfels and San Marcos showed more chronic toxicity than the Kyle plant. Unchlorinated effluents from the Kyle plant did not exhibit chronic toxicity to fathead minnows, but they did reduce reproduction of water fleas.

Reference: Bentley, Marc H., *Acute and Chronic Toxicity of Three Central Texas Wastewater Treatment Plant Effluents*, M.S. Thesis, Southwest Texas State Univ., San Marcos, TX, 1990.

Use of Borehole Techniques to Determine the Quality of Groundwaters

Researcher: Hughbert Collier, Geology Department, Abilene Christian University, Abilene, TX.

Problem: Techniques are needed to accurately assess the quality and quantity of fresh and saline aquifers in Texas. Unfortunately, water samples from many aquifers are often not available. If analyses of groundwater samples cannot be performed, borehole geophysical logs can be utilized to estimate water quality.

Objectives: 1) To evaluate the applicability of various logging tools for groundwater studies, 2) To assess existing and new borehole geophvsical techniques for determining water qualitv and other parameters, and 3) To estimate total dissolved solids (TDS) concentrations by using conductivity values.

Methodology: Twenty-one wells were logged in 13 counties. More than 700 existing logs were compiled and analyzed. Graphs showing relationships between TDS and conductivity and log values were developed for major Texas aquifers. The impact of the borehole environment on log responses, and the effectiveness of different borehole technologies utilized to develop new logs were assessed.

Results: TDS values were accurately estimated by constructing graphs that utilize conductivity data. Guidelines were developed on how to obtain water samples and how to correct conductivity values for different temperatures. Surface conductance and calcium and magnesium levels were found to be especially critical factors when calculating TDS values. Openhole logging tools were evaluated for their applicability to geologic conditions in different regions. Single-point resistance tools that are widely used for mineral logging should not be used for groundwater logging.

Reference: Collier, Hughbert, *Borehole Geophysical Techniques for Determining the Water Qualityand Reservoir Parameters of Fresh and Saline Water Aquifers in Texas* (in press), Texas Water Development Board, Austin, TX.

Socioeconomic Impacts of Ray Roberts Lake

Researchers: Andrew Schoolmaster and Paula Norris, Geography Department, University of North Texas, Denton, TX.

Problem: As Ray Roberts Lake was being completed in the mid-1980s, numerous "predictions" were being made that the Lake would dramatically increase the populations of nearby towns, would create new jobs, and would bring new economic activity to the area. So far, this hasn't happened. Analyses of the social and economic benefits of reservoir projects like this one need to be performed to determine actual benefits.

Objectives: To determine how the construction of Lake Ray Roberts has affected socioeconomic factors such as populations, schools, employment, recreation and other factors.

Methodology: Federal, State and local data was utilized to gather information on population, school district enrollment, unemployment, real estate markets, and new home and office construction. People that had to sell property so that the Corps of Engineers could build the Lake were also interviewed and their experiences were recorded. They

were divided into those that were forced to relocate because of the project, those who sold property but continued to live at their current residence, and absentee landowners.

Results: Only slight population increases occurred in towns near the Lake (Sanger added about 75 residents per year, for example). As a result, lakeside schools have shown only slight increases in the numbers of pupils. However, the loss of inundated properties from the tax rolls has not resulted in any noticeable school tax increases. Unemployment rates remained relatively stable, suggesting that construction of the Lake has not created many additional jobs. Building permits have also shown a general decline. Surveys of real estate agents show that most of the sales of lakefront properties occurred before the Lake was filled in 1987. Since then, sales of lakeside property have slowed considerably. The families of people forced to sell land so the Lake could be built had lived in the area an average of 67 years. Attachment to the land was strong and several families said that parting with the land caused sadness or anguish. People forced to move from their lands moved an average of 7.6 miles. The Corps received high ratings from landowners in the areas of courtesy and providing information. Dissatisfaction was reported about the time it took to process sales, prices paid for property, uneven appraisals, and the loss of homesteads and landscapes. Based on data from other studies, crude economic projections show the Lake generates more than $663,000 a year in direct recreational expenditures. The most likely uses of the lake are fishing, picnics, and boating.

Reference: Schoolmaster, Andrew, and Paula Norris, "Socioeconomic Impacts," in *Lake Ray Roberts Post-Impoundment Environmental Study*, Institute for Applied Sciences, University of North Texas, Denton, TX, 1992.

Evaluation of Waste Management Systems for Central Texas Dairies

Researchers: John Sweeten, Agricultural Engineering Department, Texas Agricultural Extension Service, College Station, TX, and Mary Leigh Wolfe, Agricultural Engineering Department, Virginia Tech University, Blacksburg, VA.

Problem: Over the past decade, the dairy industry in Central Texas, and Erath County in particular, has undergone major changes. Traditionally, small dairies were utilized where cows grazed on pastures. Recently, however, many larger dairies with herds of 500 to 1,000 cows have begun operating in the area. Compounding the problem, these larger dairies confine many cows in small enclosures. The increased number of cows at concentrated sites have raised concerns that manure and nitrate loadings are threatening ground and surface water quality.

Objectives: 1) To assess the impact of large confined dairies on water use and quality of the Trinity Aquifer, 2) to develop techniques to prevent point and non-point source pollution from the dairies from entering groundwater and receiving streams, 3) to determine water use for manure management, and cow watering, and 4) to provide design information and guidelines for dairies in the region.

Background Information: The four dairies utilized in the study ranged in size from 280 to 1,900 cows. At each site, liquid manure and wastewater from the milking parlors was

collected in holding ponds and lagoons and irrigation systems were utilized for disposal. Runoff from open lots was collected either in detention ponds or in wastewater treatment and storage lagoons. Solid manure was collected and spread on pasture or cropland and was not stockpiled at the dairies. However, each of the dairies utilized a different method to treat wastewater.

Methodology: Different wastewater treatment and disposal technologies were evaluated including settling basins, primary lagoons, two-stage anaerobic lagoons, and effluent irrigation. Manure, wastewater, and runoff samples were collected in the field from 1988 to 1991. Effluents were collected and analyzed for total, fixed, and volatile solids; chemical oxygen demand, nitrate-nitrogen, pH, conductivity, and other parameters. Testing was performed by the Texas A&M Agricultural Engineering Water and Wastewater Laboratory and by the Texas A&M Soil and Water Testing Laboratory. Meters were installed at 11 dairies to measure the amount of water used to wash cows and manage manure.

Results: The study shows that groundwater was not contaminated by nutrients or minerals associated with dairy operations. Properly sized and operated settling basins can remove a high concentration of solids and can lower contaminant levels in the lagoons. This may allow smaller sized lagoons to be utilized. However, materials in settling basins must be removed regularly. A two-stage anaerobic lagoon system significantly reduced the concentration of contaminants in dairy wastewater. Annual loadings of total solids were reduced by 650 Ibs. per cow per year and annual loadings of nitrogen were cut by 25 Ibs. per cow per year. Effluents from the second lagoon were land applied without adversely impacting water quality. Water use data show that an average of nearly 40 gallons per day was used to wash each cow. Conservation techniques evaluated during the study allowed each dairy to reduce its water use by 2 gallons per cow per day.
Reference: Sweeten, John, and Mary Leigh Wolfe, *The Expanding Dairy Industry: Impact on Ground Water Qualityand Quantity with Emphasis on Waste Management Systems for Open Lot Dairies* (in press), Texas Water Resources Institute, College Station, TX.

FDA Proposes Better Labeling for Bottled Water

Consumers of bottled waters may soon have a better idea of just what's in the water they're drinking.

The Food and Drug Administration (FDA) has proposed new rules that will require clearer labeling of bottled waters For example, the rules propose "mineral water" must have at least 250 parts per million of total dissolved minerals and that "spring water" would have to originate from an underground source.

Municipal waters that are bottled and sold would have to be labeled as such, unless they were distilled or purified.

The proposed rules should become finalized by September and would probably take effect in early 1994.

Multi-Agency Study Famines Biology, Quality of Rio Grande Waters

A team of Federal and State agencies is conducting a massive study of water quality in the Rio Grande.

The study involves sampling water, sediments, and fish tissues at 46 sites. The scientists are testing to determine if trace amounts of 175 toxic chemicals are present.

The aim of the study is to determine whether cities, industries, and agriculture on both sides of the U.S.-Mexico border are contaminating the river. The first phase of the study sampled sites from El Paso to the Big Bend National Park and the second phase of the study examined the area from Rio Grande City to Brownsville. The final phase of the project, from Eagle Pass to Rio Grande City, was set for March.

Agencies taking part in the study include the Texas Water Commission (TWC), the Texas Parks and Wildlife Department, the U.S. Environmental Protection Agency, the International Boundaryand Water Commission, and several Mexican environmental agencies.

For details, contact Terry Hadley of the TWC at (512) 463-7674.

USDA Studiefs New Method to Slow Erosion

Planting crops that are not expected to survive cold winter temperatures may be a chemical-free way to reduce erosion, according to U.S. Department of Agriculture research in Big Spring.

James Bilbro, a scientist with the USDA/ Agricultural Research Service, is testing if warm-season crops like forage sorghum can be planted late in the summer or fall to provide a buffer against erosion.

Many farmers now plant crops that can survive cold winter weather to keep high winds from blowing their soils away. These crops usually have to be treated with herbicides in the spring so that other crops can be planted. If warm weather crops were used, however, they would normally die during the winter and herbicides would not be needed.

Bilbro's studies suggest that this method may be useful in arid areas where a lack of soil moisture and wind erosion are a problem. For details, call Bilbro at (915) 263-0293.

Water Development Board Recognizes Conservation Efforts

The Texas Water Development Board has recognized 14 cities, 15 water districts, four water authorities, and a university for a variety of water-saving programs.

Some examples cited by the Board include a program by the Harris-Galveston Coastal Subsidence District to retrofit homes and apartment complexes with water-efficient fixtures (see Abstracts in this issue); water auditing and leak detection activities carried out by the City of Bryan; rebate programs by El Paso Water Utilities to encourage

customers to use low-flow toilets; and activities by the High Plains Underground Water Conservation District No. 1 to monitor and evaluate agricultural water use and to demonstrate the effectiveness of new irrigation technologies.

Efforts by the University of Texas at Austin (UT) to recycle cooling water were also commended. UT now uses less water than it did in the 1970s even though it now has 10,000 more students.

Many of the conservation programs were begun as a result of a law that requires entities applying for State loans or grants to submit a plan to conserve or reuse water.

For more information on conservation, contact the Board at (512) 463-7847.

Grass Carp May Be Spreading in Trinity River

A new survey by the Texas Parks and Wildlife Department (TPWD) shows that weed-eating fish may have spread into the Trinity River.

More than 13,000 pounds of grass carp were taken out of the Trinity River by commercial fishermen from July 1991 to September 1992, according to the TPWD. The number of grass carp in the river could be much greater, because the fish are hard to catch.

The source of the grass carp isn't clear. In the late 1970s, grass carp were introduced into Lake Conroe to control nuisance vegetation like duckweed and hydrilla that made it hard for boaters to navigate in the lake.

Grass carp may have also been illegally imported to clear up water weeds on private lakes.

Although the grass carp were not expected to be able to reproduce, surveys conducted last year by TPWD biologists found many healthy grass carp eggs along the river. However, grass carp can strip a lake of vegetation and disrupt sensitive ecosystems.

TPWD biologists say that so far the effects on lake and stream vegetation have been minimal. Levels of popular sport fish like bass haven't been reduced, although some Lake Conroe fishermen complain that the lack of weeds makes it harder to locate and catch sport fish.

For details, contact Earl Chilton of TPWD at (512) 389-4652.

Groundwater at Closed Military Bases May Need To Be Cleaned Up

When military bases are closed, it isn't as simple as locking the front gate and throwing away the key. Unfortunately, bases in Texas and elsewhere also often leave another legacy: groundwater polluted by chemical and fuel leaks.

Now that bases are being closed in Beeville, Austin, and Fort Worth, State and Federal agencies have begun meeting to determine how the clean-ups will proceed and who will pay for them.

In January, the Texas Attorney General's Office and the U.S. Environmental Protection Agency hosted a conference on how to restore the polluted groundwaters. Speakers said a cooperative approach will probably be used in which the Department of Defense will clean up the bases as soon as possible and the EPA will determine when the bases are safe to turn over to local authorities.

Two other related items are worth noting. The U.S. Army Corps of Engineers plans to drill more monitoring wells at the Pantex weapons manufacturing plant near Amarillo to determine if perched groundwater has been contaminated. Monitoring suggested that low levels of solvents and gasoline had found their way into shallow groundwater supplies.

Also, a study conducted for the U.S. Energy Department suggests that storing plutonium weapons cores at the Pantex site would probably not have a "significant impact" on the Ogallala Aquifer.

Lubbock, Port Arthur, Face Drinking Water Problems

Towns in the Texas Panhandle and the cities of Port Arthur and Galveston are working to solve two different drinking water problems.

High levels of naturally occurring salts from Lake Meredith prompted the Texas Water Commission (TWC) to downgrade the status of drinking waters in Lubbock, Brownfield, and Levelland to "provisional." That means Lubbock must reduce the salinity within a year or remove TWC-approved signs that designate the water as an "Approved Public Water Supply." Lamesa, Tahoka, and Slaton have already been downgraded to "provisional" status and their signs have been removed.

A solution may soon be on the way. The Lake Meredith desalination project was authorized in January. The project involves intercepting salts that seep into the Canadian River from a shallow brine aquifer in New Mexico. Levels of salts in Lake Meredith are twice as high as those recommended by the TWC.

In Port Arthur and Galveston, lead is the culprit. These are the only Texas cities that violated EPA lead standards in tests carried out last year. Lead levels in some homes were as high as 28 parts per billion (ppb) in Port Arthur and 18 ppb in Galveston. The EPA action level is 15 ppb.

In both cities, the water utilities responded by mailing notices to its customers that recommended they take standard precautions (letting tap water run for a few minutes before using it). Port Arthur is also adding polyphosphates to its drinking water in an attempt to lessen the ability of the water to leach lead.

For general information on drinking water, contact the TWC at (512) 371 -6319.

Galveston Bay Program Publishes Proceedings, Reports on Coastal Management and Wetlands

A new conference proceedings and other reports are now available from the Galveston Bay National Estuary Program.

Proceedings: The Second State of the Bay Symposium (GB 23) was edited by Ric Jensen of the Texas Water Resources Institute and Frank Shipley and Russell Kiesling of the GBNEP. Sections of the book deal with such topics as water quality Doint and non-point sources of pollution, toxic substances in Baywatersand sediments, public health issues, and habitat management and restoration.

Other recent GBNEP reports include *Toxic Contaminant Characterization of Aquatic Organisms in Galveston Bay*(GB 20) by James Brooks and Terry Wade of Texas A&M University's Geochemical and Environmental Research Group (GERG), and *Status and Trends of Selected Living Resources in the Galveston Bay System* (GB 19) by Albert Green of the Texas Parks and Wildlife Department. Gary Mitchell of the Houston-Galveston Area Council and Duane Windsor of the Management Department at Rice University co-authored two studies: *Regulatory Effectiveness Study for Armand Bayou Coastal Preserve (GB 13) and Regulatory Effectiveness Study for the Christmas Bay Coastal Preserve* (GB 14).

Shoreline Survey for Unpermitted Discharges to Galveston Bay (GB 12) was written by Roger Fay, Stephen Sweet and R.J. Wilson of GERG at Texas A&M University. *Wetland Plant Communities in the Galveston Bay System* (GB 16) was written by William White and Jeffrey Paine of the Bureau of Economic Geology at the University of Texas at Austin. *Segmentation Development for Galveston Bay* (GB 18) was written by Jones and Neuse, Engineering, Inc.

To order any of these reports or any other GBNEP publication, call (713) 332-9937.

Texas Tech Engineer Co-Authors "Environmental Assessments"

A guide to developing environmental assessments has been co-authored by a Texas Tech University engineer.

Lloyd Urban, the Director of Tech's Water Resources Center, wrote *Environmental Assessments* in cooperation with R.K. Jain of the University of Illinois, G.S. Stacey of Battelle-Europe and H.E. Balbach of the Army Construction Engineering Research Laboratory.

The book describes detailed steps for preparing, processing, and reviewing documents needed to prepare environmental assessments which are needed to comply with the Federal National Environmental Policy Act. For example, assessments are usually conducted whenever projects affecting water and the environment, like dams or drainage systems are undertaken. Biophysical and socioeconomic factors that should be considered are also included.

The book is available from McGraw-Hill at 1-800-2-MC GRAW. Urban can be reached at (806) 742-3597.

TAES Reports Look at Turfgrass Water Use; South Texas Issues

New research reports from the Texas Agricultural Experiment Station (TAES) describe water use by turfgrass and water use by rangelands and irrigated crops in South Texas.

Texas Turfgrass Research‹1992 contains research results dealing with turfgrass varieties, growth and development, environmental factors, the impact of pests (diseases and insects), weeds, and management strategies.

Water for South Texas contains information on water use on rangelands, results from the Seco Creek Demonstration Project, water conservation strategies for field crops in the Winter Garden area, and the economic benefits resulting from more efficient irrigation.

TAES reports can be ordered by contacting the Department of Agricultural Communications at (409) 845-6571.

Ways to Plan for Flooded Freeways Outlined in TTI Report

A new study by the Texas Transportation Institute at Texas A&M University provides guidelines on how to prepare to deal with highways that may be closed or damaged by heavy rainfall and other emergencies.

The report, *Planning Guidelines for Major Transportation Emergencies*, was written by Gerald Ullman and Nada Trout. Sections of the study deal with how to plan for major emergencies and ways to increase agency preparedness.

Case studies of the impact of 1992 floods on Houston and Brownwood illustrate the difficulties flooding can cause for highway managers. For example, tropical storms and hurricanes flooded freeways throughout Houston and delayed 120,000 motorists who were trying to evacuate. In Central Texas near Brownwod, a foot of steady rains created a scene where people were unexpectedly driving into flooded areas where roads were either closed or damaged. The report emphasizes the need to effectively gather and quickly disseminate emergency information.

For details, call Ullman at (409) 845-1727.

Water, Wastewater Rates Summanzed in Ernst and Young Study

A new report summarizes water and wastewater rates for major Texas cities and other areas of the U.S.

1992 Water and Wastewater Rate Survey was produced by the consulting firm of Ernst and Young. It includes data on monthly water and wastewater charges, rate structures, billing cycles, and additional charges and discounts. Information for Austin, Beaumont, Corpus Christi, Dallas, Fort Worth, Houston and San Antonio is included. The report also

presents an overview of such topics as conservation pricing, factors to consider when designing rate structures, and how to compare rate structures from different cities.

This free report can be obtained by calling Ernst and Young at (704) 335-4250.

TWC Publishes Water Quality Assessment," Other Reports

A Comprehensive assessment of Texas' water quality and other new reports have been produced by the Texas Water Commission (TWC).

State of Texas Water Quality Inventory (LP 92-16) contains detailed information on the water quality of rivers, bays and lakes. Information on wetlands acreage and groundwater is also included. According to the report, 16% of the rivers, more than 10% of the reservoirs, and more than 22% of the bays, could not support their "designated uses" because of water quality problems. The causes listed most often include fecal bacteria, low oxygen levels, naturally occurring salinity, and toxic chemicals.

Other recent TWC studies include *An Assessment of Water Quality and Fish Kills in Upper Oyster Creek* (SR 9205), *General Survey of Stream Sediment Pesticide Concentrations in Kaufman County* (SR 92-06), *Geophysical Investigation of Shallow Groundwater Contamination in Yoakum County* (R 92-03) and *Rapid Bioassessment of Deer Creek* (SR 92-07). Resources for local water districts have also been produced: *Water District Accounting Manual* (LP 92-21), and *Handbook for Board Members of Utility Districts* (LP 92-15).

For details on any of these reports, call the TWC at (512) 463-8028.

TWDB Publishes 1992 Update to Texas Water Plan, Edwards Model, Wastewater Treatment Options

Four new reports have recently been published by the Texas Water Development Board (TWDB).

Water for Texas: Today and Tomorrow outlines a series of recommendations for the 1992 update of the Texas Water Plan. The report includes policy options for financing water projects, regional groundwater management, innovative water allocation techniques, conservation and reuse, environmental needs, and other issues.

The 1992 update reflects changes that occurred since the 1990 Plan was published. For example, the update presents new information for El Paso, the Coastal Bend Region, groundwater use in the Austin area, and other sites. For a copy of the update, call (512) 445-1442.

Model Refinement and Applications for the Edwards Aquifer in the San Antonio Region (Report 340) was co-authored by David Thorkildsen and Paul McElhaney. The study used simulation models to predict the response of the Edwards Aquifer to various

management strategies, recharge amounts, and pumping levels. The study reports that large reductions in pumping would be needed to maintain springflows at Comal Springs.

Implementation of a management plan proposed by the Texas Wster Commission would provide for continuous flows at San Marcos Springs and Comal Springs that would be interrupted only during severe droughts, the report said. For a copy, call (512) 463-8043.

Wastewater Treatment Systems for Small Communities: A Guide for Local Govemment Officials, and Technical Summary: Appropriate Technologies for Small Community Wastewater Treatment Systems, were written by Joseph Malina and Michael Barrett of the Civil Engineering Department of the University of Texas at Austin. They summarize simple and low-maintenance wastewater collection and treatment systems for small communities. The studies discuss technologies that may be appropriate for various regions of Texas. Specific strategies are recommended for each region, based on soil types, topography, climate, and other factors. Technologies described in the reports include constructed wetlands, lagoons, land application projects, septic tanks, cluster systems, low-maintenance treatment methods, and others. Information from the reports will be used in seminars that will be presented throughout Texas in upcoming months.

For information about the reports or the seminars, contact the TWDB at (512) 463-7853.

Texas A&M Computer Model Predicts Water Use, Irrigation Needs, of Peach Trees

A computer model that predicts water use and irrigation requirements for peach trees has been produced by scientists with Texas A&M University.

The model calculates water requirements based on the size of the tree and weather conditions. Using the program, producers can estimate the amount of moisture that is stored in the soil and how much supplemental irrigation is needed. In areas where there isn't sufficient rainfall, the model lets irrigators predict peach growth and the optimal time to harvest.

The model was developed by Jody Worthington, James Lasswell, and Joe McFarland of the Texas Agricultural Experiment Station (TAES) at Stephenville, Calvin Lyons, an Extension specialist in the Horticulture Department at Texas A&M University, and Susan Steinberg, a graduate student in the Agricultural Engineering Department at Texas A&M University.

For information about the model, call Worthington at (817) 968-4144. The model and a user's manual are available by contacting John Roemer of the Texas Agricultural Extension Service at (409) 845-9689.

Offshore Water Level Gauges Could Aid in Oil Spill Cleanup, CCSU Researchers Say

A series of water level gauges off the Texas coast may yield an unexpected side benefit. They may provide data to better predict the paths of oil spills in bays, estuaries, and the Gulf of Mexico.

The gauges are part of the Texas Coastal Observation Network, which is being operated by Corpus Christi State Universitv and Lamar Universitv. More than 40 monitoring stations are capable of transmitting real-time data on such parameters as water levels, wind speed and direction, air and water temperature, barometric pressure, pH, salinity and oxygen.

Gary Jeffress and Michael Garrett of CCSU's Blucher Institute have been working with the network. Jeffress says that offshore and coastal data are transmitted to the Institute where they are downloaded and displayed on a geographic system. If an offshore oil spill occurred, the real time wind speed data could provide the input needed to drive computer models that quickly and accurately forecast how and where the spills are most likely to spread. This could aid clean-up operations.

For details, call Jeffress at (512) 994-2376.

UT-Arlington Biologists Find "Spiny Water Flea" in Texas Lakes

A bizarre type of exotic water flea that grows spines on its head and tail appears to be spreading quickly to lakes across Texas. But, that shouldn't be cause for alarm, according to the biologists at the University of Texas at Arlington who first learned it was in Texas.

Bob Stemer and Kathryn Sorensen, a graduate student, discovered the water flea, (*Daphnia lumholtzi*), in Fairfield Lake in 1991. Since then, they've been studying its life history, why and how it grows spines, where it has spread, and what the implications may be for Texas lake ecosystems.

Sterner and Sorensen speculate that the species may have been accidentally introduced when Nile perch and African tilapia were stocked in Fairfield Lake. Water and climate conditions turned out to be ideal for the water flea so it stayed, flourished, and eventually spread into lakes from Houston to North Texas.

Daphnia lumholtzi is an interesting candidate for study because it is so unique. For example, it may form spines as a way to defend itself against predators. Sterner and Sorensen have been taking *Daphnia* and water quality samples at Fairfield Lake to see if there are links between spine formation and temperature, food supplies and predators. One thing they've learned is that nearly all of the *Daphnia* sampled from Fairfield Lake have lengthy spines.

How will this new species impact Texas lakes? Sterner says it may actually improve water quality by eating algae, especially in warm summer months.

For details, contact Sterner at (817) 273-2424.

SFA Biologists Measure Impact of Oilfield Activities on Streams

Just how do oil and gas activities affect forest stream ecosystems? That's the issue being studied by biologists at Stephen F. Austin State University and the National Forest Service.

During the past two years, oil exploration and production has increased dramatically in the Yellowpine District of the Sabine National Forest. To make sure that streams aren't being adversely affected, Jack McCullough and graduate students Lance Mason, Boyd Guthrie, Uli Balk-Martin, and Greg Rogers are monitoring aquatic insects, fish, and water quality.

Macroinvertebrate sampling is being conducted to measure the diversity of species that live in streams and how they may be affected by pollution. In particular, researchers will be assessing population levels and sensitive species that may indicate if stream water has been degraded. For example, if mayflies and stoneflies are found, this may suggest that the water quality is good. On the other hand, discovering midges and bloodworms may indicate that pollution is taking place. Fish populations are being sampled by electroshocking and other methods and individual species are being identified.

Particular attention will be focused on monitoring fish kills. Chemical tests will measure heavy metals, turbidity, salinity and hydrocarbons and will determine baseline levels and any man-induced changes.

For details, call McCullough at (409) 569-3601.

Texas Tech Biologists Learn How Insects Cope with Floods

When flash floods roar through Central Texas rivers, most of the attention is focused on what happens to humans: how many cars, highways and homes are swept away and how many lives are lost.

Biologists Michael Willig and Brian Cole and entomologist David Herrmann of Texas Tech University are looking at flooding from a much different perspective. They're simulating floods in a laboratory to see how the world of bottom-dwelling insects is turned upside down. The aim of the studies is to determine how different species of creeping water bugs and larvae called hellgrammites respond to rapidly changing water levels.

Many of the studies have focused on species in the diverse South Llano Riverecosystem near Junction Insects are gathered from the Llano and are placed in an indoor stream model to gauge how they react to the effects of fast, medium and slow moving water. Goals of the studies are to determine if the insects react differently to flooding near various substrates (like gravel and pebbles), and to see if the mix of species changes to some kind of regular pattern after the floodwaters recede.

For details call Willig at (806) 742-2590.

TCU Biologists Say Algae Eating Fish May Boost Water Quality

Biologists at Texas Christian University are testing an unconventional way of improving water quality. They want to find out if algae-eating fish can be used in a system to remove nutrients from waters that are contaminated with sewage and agricultural runoff.

Ray Drenner of Texas Christian University monitors the performance of fish in these tanks. The goal of these "mescosm" studies is to determine whether these fish can improve water quality by eating nutrients.

Ray Drenner of TCU's Biology Department is leading the studies, which involve flowing water through channels stocked with tilapia and minnow-like fish called stonerollers.

Typically, nutrients such as nitrogen and phosphorus are assimilated by algae. If fish are introduced, they could feed on the algae and bacteria. Fecal matter from the fish would contain many of the nutrients. Because the fecal matter would be heavier than lake water it would sink to the bottom where it could later be removed. The quality of the remaining "treated" water would be much improved.

The system is being tested at facilities at Eagle Mountain Lake, in conjunction with the Tarrant County Water Control and Improvement District #1.

For details, contact Drenner at (817) 921 -7165.

Lamar Engineers Compile, Refine Soil Sorption Ratios

Scientists at Lamar University are examining the process of sorption that influences how pollutants flow through soils and into groundwater.

Sorption also influences how easily contaminants can be degraded into less harmful by-products. One problem is that specific chemicals have individual and widely different rates of sorption and degradation.

Chang Yeng, Daniel Chen, and Carl Yaws of the Chemical Engineering Department have been refining and compiling equations to develop soil sorption ratios for more than 300 hydrocarbon and organic chemicals. The ratios contain data that could be useful in engineering and environmental impact studies.

In case studies, they've assessed how benzene can be assimilated into river bottom sediments and how atrazine levels can build up in shallow groundwater.

For details, contact Yaws at (409) 880-8787.

North Texas Scientists Study Effect of Runoff on Drinking Waters

Scientists at the University of North Texas recently analyzed the composition of rainfall runoff at sites along the Trinity River to see if it may make the water unsafe for drinking.

Farida Saleh, an associate researcher in Environmental Chemistry at UNT's Institute for Applied Sciences, heads the research. Last May, she and a team of UNT scientists and students collected water samples at seven sites along the river during a 4-hour storm. The study was performed for the City of Dallas' Water Utilities Department.

Data on temperature, pH, dissolved oxygen and conductivity were gathered on-site. Samples were later analyzed in laboratories on the UNT campus for 82 priority pollutants including volatile organic compounds (VOCs), pesticides, and heavy metals.

Results show that there were no measurable amounts of VOCs, polynuclear aromatics or heavy metals. Trace amounts of three pesticides (aldrin, lindane, and DDT metabolites) were found in samples from the Bachman Creek water treatment plant. Low levels of several phthalate esters (PEs) were found in samples from the Bachman Creek and Elm Fork water treatment plants.

Saleh says that the results of the testing are basically positive: high levels of harmful chemicals were not found. However, one point for concern is that some of the highest levels of clusters of unknown compounds were found near the intake structures for the Bachman Creek Plant, which serves as a raw supply for Dallas' drinking water.

For details, contact Saleh at (817) 565-2983.

Innovative Hazardous Waste Technologies are Difficult to Implement, UH Researchers Say

If you hope that new and innovative technologies may be the answer to solving the dilemma of how to properly treat and dispose of hazardous waste, researchers at the University of Houston have some bad news for you.

Sanford Gaines and David Duncan of the Environmental Liability Law Program and Jack Matson and Beth Ayer of the Environmental Engineering Department assessed whether innovative methods to manage hazardous waste technologies can be easily implemented.

As a case study, they looked at a plan that would pulverize, inject, and permanently store hazardous wastes in a salt dome near Dayton, 40 miles north of Houston. The planned facility appeared to be technically sound. However, because it was innovative, regulatory

agencies were confused in how to apply existing environmental laws and regulations to the project.

The plan was rejected after widespread controversy because of concerns that it could contaminate Lake Houston, which is the source of drinking water for the City of Houston. Other reasons the plan was defeated included fears that accidents could occur when transporting the waste and that floods can wash away wastes stored in the low-lying area.

Ultimately, the project's sponsor spent millions of dollars in engineering, design, and legal fees in its unsuccessful attempt to get a permit for the facility. This will probably discourage others who attempt to develop similar facilities, the UH researchers said.

For details, call Matson at (713) 743-4267.

University of Texas Study Assesses Galveston Bay Wetlands

Researchers at the Bureau of Economic Geology (BEG) at the University of Texas at Austin have just completed a project to inventory the wetlands of Galveston Bay.

The study was led by William White and Jeff Paine of the BEG. In the project, the researchers examined more than 150 sites and gathered information on topography, wetlands plants, and 40 soil types. Data were entered into a geographic information system.

The scientists found that brackish marshes make up the vast majority (65%) of wetlands habitat in the Bay, followed by saltwater marshes (25%) and freshwater marshes (10%). Roughly a third of the plants that were identified in Bay wetlands were "obligate" species (those that occur in wetlands almost all the time under natural conditions). Plant species that were encountered most often included cordgrass, seashore salt sumpweed, and sea ox-eye.

A report about the research was recently published by the Galveston Bay National Estuary Proqram (see Publications section in this issue). White and Paine can be contacted at (512) 471-7721.