New Waves
The Research Newsletter of the Texas Water Resources Institute
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Letter from the Editor

So Much Research, So Little Space

We hope that regular readers of *New Waves* notice that this issue is a little different than our standard fare.

That's because, we're happy to say, there's a lot of activity in new university research projects.

For example, for the second issue in a row, we're highlighting projects funded by the Higher Education Coordinating Board's Advanced Research (ARP) and Advanced Technology Programs. We're also describing new university research studies that were recently funded by the Texas Water Development Board. In future issues, we'll include information on projects the Board funded to non-university agencies. We're also telling people about the new and continuing projects funded by the Texas Water Resources Institute.

All of this is in addition to our usual coverage of recent abstracts and university research news.

Because of all the research information, we have had to shorten our News and Publications sections for this issue. However, those will return to their normal length in future issues, barring another avalanche of new university research.

Ric Jensen Editor, *New Waves*

TWRI Funds Projects on Reservoir Operations, Wastewater Irrigation, Aquifer Modeling

The Texas Water Resources Institute announced it would sponsor four new research projects and its technology transfer effort and would continue to fund two additional projects.

The new projects are described on pages 4-5. The studies begin on September 1,1992 and run until August 31,1993.

Projects which are being continued from last year include "An Expert Geographic Information System for Water Managements by Daene McKinney and David Maidment of the Civil Engineering Department at the University of Texas at Austin and Relationship Between Crop Production Activities and Groundwater Quality in the Texas Rolling Plains" by Ron Lacewell of the Texas A&M University Agricultural Economics Department, Jimmy Williams of the USDA/ ARS in Temple, Texas, and John Lee of the Agricultural Economics Department at Purdue University.

The technology transfer project includes newsletters and other publications produced by Ric Jensen, TWRI Information Specialist. For details on any of these studies, contact TWRI at 409-845-1851.

Trans-Texas Diversion May Bring Water from Toledo Bend to Houston, San Antonio

Transferring water from water-rich areas, like east Texas, to more arid areas has been spoken about for some time, but never has gotten off the drawing board. Now, a $2 million study has been proposed by the Texas Water Development Board to see if such a plan is workable.

The study will examine if it is feasible to transfer as much as 675,000 acre-feet of water from the Toledo Bend Reservoir on the Texas-Louisiana border through canals and pipelines to Houston, San Antonio, and Corpus Christi.

The water transfers could create a "domino effect" that could free up surface water supplies throughout Texas, according to TWDB officials.

Houston area environmentalists are delighted with the study because they believe it will make the controversial Wallisville Reservoir project unnecessary.

If the plan were not put into effect, many areas in central and west Texas would run into water shortages by the year 2040, according to the Board. For example, the Trinity and San Jacinto River Basins would need 560,000 more acre-feet (AF), the Brazos and Colorado River Basins 337,000 AF, the Guadalupe River Basin 204,000 AF, the San Antonb River Basin 264,000 AF, and the Nueces River Basin 117,000 AF. For details about the project, call the Board at 512-463-7847.

Change Your Maps, It's Now the Edwards River

In one of the truly landmark rulings in Texas' history, the Texas Water Commission (TWC) declared in April that the Edwards Aquifer is no longer a groundwater system‹it's an underground flowing river.

The main impact of the ruling is that water use in the Edwards, because it is now a river, would now be regulated by the TWC. Draft TWC rules say that all municipal, industrial and agricultural users of the aquifer will have to apply to the Commission by September 1 for a water rights permit. Well owners will have to document the dimensions and

pumping capacities of their wells, describe what the water is used for, and how much water is used. Wells for individual homes and livestock are exempt.

The ruling reverses Texas' long-standing policy that landowners could pump virtually as much water from beneath their land, with little regulation.

Using Discount Coupons for Revenue Neutral Water Pricing

Researcher: Robert Collinae. Economics and Finance Department, University of Texas at San Antonio, San Antonio, TX.

Problem: Many cities utilize average cost pricing of water supplies, but this can be inefficient in areas where water supply problems exist and can lead to overuse of existing supplies, shortages, and the development of unneeded water projects. A revenue-neutral water marketing system using discount coupons could promote efficient water use and could distribute water supplies equitably, while alleviating water shortages.

Objectives: To develop a theoretical revenue-neutral water pricing system that utilizes marginal costs and discount coupons and to test the system using a case study of San Antonio.

Background: A basic model was developed that consists of the following steps: 1) Discount coupons are printed that allow a specified discount off the base price of consuming a unit of water (100 cubic feet) in a given month; 2) Base prices are set equal to the replacement cost of supplemental water and discounted prices are set to equal the cost of water from existing sources; 3) A lump monthly sum would cover operating expenses that are not related to water use; 4) The total quantity of coupons issued for a given year would equal the expected yearly yield of existing supplies; 5) Each customer would receive a predetermined allotment of coupons along with their monthly bill; 6) If an individual had coupons left over because they didn't use their full "quota" of water, they could trade their coupons in an open market or they could receive a rebate or credit on future bills based on expected market prices.

Results: When water supplies are limited and others value and have access to purchase additional supplies, coupons can serve as an incentive to conserve by promoting markets. In the case study of San Antonio, fixed and overhead charges were estimated at $4.50 per month. The discount price (average cost of water usage including treatment and distribution) was $.60 per cubic foot (cf). The base price (water from supplemental sources like Applewhite Reservoir) was estimated at $3/ cf. To match sustainable yields, 120 million coupons (each equal to 100 cf) were issued translating to 3.4 coupons per household per month. Consuming more water than allowed by the coupons would cost $2.40 more per 100 cf per month. Many users were projected to sell their coupons, if they could sell them at a profit.

Reference: Collinge, Robert, "Revenue Neutral Water Conservation: Marginal Cost Pricing with Discount Coupons," Water Resources Research, March 1992.

Sediment Transport in the Lower San Antonio and Guadalupe Rivers

Researchers: Ed Holley, Civil Engineering Department, University of Texas at Austin.

Problem: Texas law requires that freshwater inflows be provided to bays and estuaries to maintain ecologially sound environments. Although sediments are an important "building block" for these ecosystems, there is little data available on the relationship between river flows and sediment transport. This information could be useful when dam sites are considered because it may help compare sediment transport rates before and after reservoirs are constructed.

Objective: To investigate correlations between sediment transport and river flows using previously collected data, and to conduct field studies to measure the amount and characteristics of sediment loads entering a Texas bay.

Methodology: No existing data on bedload transport were located. Existing data from 1924 to 1990 were utilized for the lower Guadalupe and San Antonio Rivers to correlate suspended sediment levels with: 1)simultaneous flow rates,2)flow rates that occurred before the sediment levels were measured,3) particle fall velocity, and 4) the phase of the hydrograph when the sediment samples were collected. Existing data were also used to determine which percentage of the flows carried given amounts of suspended sediments. Several sets of field data were collected and analyzed from the lower part of the Guadalupe and San Antonio Rivers. The two largest data sets were obtained in April and June of 1990. A pumping sampling system was tested to provide sediment samples for grain size analysis.

Results: Analysis of existing field data show that the primary correlation is between sediment concentrations and simultaneous flow rates. The greatest 10% of flows carried more than 80% of the suspended sediments in the Guadalupe River and more than 90% for the San Antonio River between 1966-89. Results of field sampling show that bedload transport rates are much smaller than suspended sediment transport rates. For the lower San Antonio River, there was a significant lag between the flow hydrograph and the suspended sediment hydrograph following a large rainfall near San Antonio.

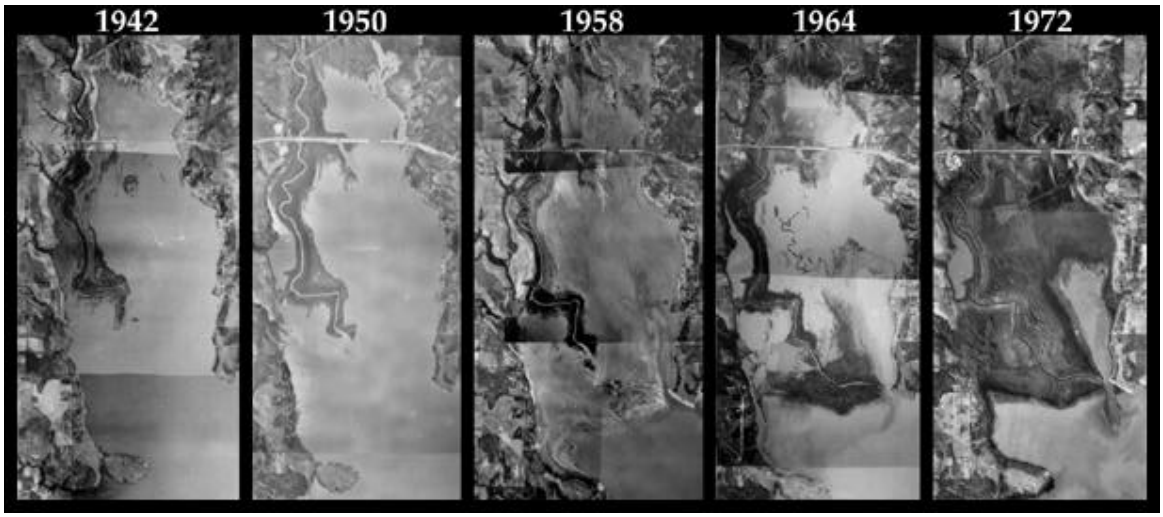
Reference: Holley, Edward, *Sediment Transport in the Lower Guadalupe and San Antonio Rivers*, TR-154, Texas Water Resources Institute, Texas A&M University, College Station, TX, 1992.

Sediment Movement and Delta Formations in Lake Lewisville

Researcher: Harry Williams, Geography Department, University of North Texas, Denton, TX.

Problem: When sediments flow into reservoirs they reduce storage capacity, increase the risk of flooding, and introduce contaminants. These sediments often form deltas near the mouths of the streams. Little attention has been paid to the growth rate, changing shape, and composition of these delta deposits.

Objectives: To 1) document the rate of growth of the Elm Fork Delta into Lake Lewisville; 2) define the volume, mass and morphology of the delta, and 3) analyze the texture and composition of the delta surface.



This series of aerial photographs shows how sedimentation has steadily increased near Lake Lewisville. In the earliest photos from the 1940s and 1950s, the lake is relatively clear. However, in the later photos, large areas where sediments have built up are easily visible.

Methodology: Aerial photographs from 1942, 1950, 1958, 1964, 1972, and 1990 were used to measure the growth of the delta. The shape of the delta was defined by measuring the depth of the delta beneath the lake at 70 sites along 11 transect lines using a small boat. These data were used to build a contour map with intervals of 2 feet. Sediment samples were also obtained at these same 70 locations and the thickness of the delta was determined with a hand corer. Four depth-sounder profiles were obtained to provide details on the morphology at selected sites. The volume of the delta was estimated by comparing the topography of the surface to the predelta conditions. Topographic maps were built into a geographic information system.

ResuIts: The delta built by the Elm Fork of the Trinity River into Lake Lewisville forms a sediment wedge nearly 7 miles long and up to 15 feet thick. Its volume was estimated at 32,332 acre feet and its mass was projected at more than 55 million tons. Delta deposits extend four miles upstream from and 11 feet above the original reservoir level. The delta grew nearly 2 miles from 1942 to 1990‹ an average of 218 feet per year. Growth rates were highest from 1950-58 at 485 feet per year. The growth of the delta is concentrated near the mouth of the channel due to channeling of the flow by levees. Sandy deposits are confined mainly to areas near the river channel, while clay-rich sediments can be found in areas bypassed by the channel. Sand-sized sediments are found almost exclusively within the delta.

Reference: Williams, Harry, "Character and Growth of Deltaic Deposits in Lewisville Lake, Texas," Texas Journal of Science, November 1991.

Chemical Characteristics of Municipal and Industrial Landfill Leachate

Researchers: Edwin Smith, Civil and Mechanical Engineering Department, Southern Methodist University, Dallas, TX, and Walter Weber, Environmental Engineering Department, University of Michigan, Ann Arbor, Ml.

Problem: Landfill leachates pose a unique environmental challenge because they are complex, vary from site to site, and contain potentially hazardous chemicals. The array of organic chemicals in landfills is especially complex and influenced by the types of wastes deposited, the method of land filling used, ambient conditions, and the age of the landfill. The ability to characterize the chemical composition of leachates needs to be developed so that appropriate treatment and disposal methods can be chosen and implemented.

Methodology: Municipal and industrial landfill leachates were collected from two nearby sites in Michigan that were less than 3 years old. Samples were pre-filtered to remove large suspended particles and inorganic analyses were performed. Total organic carbon (TOC) was measured and EPA priority pollutants were identified and measured using gas chromatography and mass spectrometry (GC/MS). Molecular weights were estimated using gel chromatography. Absorption isotherm and rate experiments were conducted in batch reactors using activated carbon to examine the efficiency of using a pump and treat strategy to improve leachate quality.

Results: Leachate from the industrial landfill contained much higher strengths of inorganic and organic contaminants than the municipal landfill. The organic fraction contained both synthetic organic chemicals (SOCs) and naturally occurring organic material. The dominant SOCs in the industrial landfill leachate were phenols and benzene, while diethylpthalate was found most often in the municipal landfill leachate. Two distinct classes of organic molecular weight fractions (MWF) dominated both landfills. Most of the organic chemicals had a MWF of less than 3,000, but a smaller yet still significant number had a MWF of greater than 70,000. Leachates with a MWF of less than 3,000 comprised 96% of the TOC in municipal landfill leachate and 89% of the TOC in industrial landfill leachate. Both leachates exhibited similar adsorption characteristics. However, competition between organic compounds was more evident in industrial than municipal landfill leachate, based on mathematical modeling.

Reference: Smith, Edward, and Walter Weber, "Comparative Assessment of Chemical and Adsorptive Characteristics of Leachates from a Municipal and an Industrial Landfill," Water, Air and Soil Pollution, October 1990.

Impact of Water Quality Laws on Dairy Profits

Researchers: Dave Leatham, John Schmucker, Ron Lacowell, Robert Schwart, Ashley Lovell, and Greg Allen, Agricultural Economics Department, Texas A&M University.

Problem: Texas regulations do not allow dairies to discharge dairy wastes and wastewaters into State waters. Dairies must have lagoons in place that are large enough to contain the runoff from a hypothetical storm that is expected to occur once every 25

years. Building these water holding facilities is expensive and may make dairies less profitable.

Objectives: To develop a framework that dairy operators can use to evaluate the impact of additional investments in waste management systems on profits, and to examine the cost of handling dairy wastes at typical small and large dairies.

Methodology: Typical conditions for a small (300-cow) dairy and a larger (720-cow) dairy in Erath County were used to generate a case study. The 300-cow dairy was assumed to lease 300 acres of pasture land and own 300 acres of cropland and buildings. The beginning value of assets was $1 million and cash reserves were set at $25,000. Milk production was estimated at 1,400 gallons per cow per year. The 720-cow dairy was assumed to own 10 acres of cropland and 150 acres of pasture land and to lease an additional 300 acres of pastures. Assets were valued at $1.5 million and cash reserves were set at $35,000. Budgets were developed to model the management operations, including costs to collect manure and to remove it from the site and to periodically clean the lagoons. Overhead expenses including depreciation and borrowing costs were also estimated.

Results: Expanding treatment and storage facilities to comply with no-discharge regulations will cost small dairies $420 per cow ($360 in new investments and $60 in operating costs) and larger dairies $290 per cow ($210 in new investments and $80 in operating costs), according to the simulations. Higher investment costs were estimated for the small dairies because it was assumed they had to purchase manure spreading equipment. Complying with the regulations reduced net farm income by 27% for typical large dairies with low debt positions and 63% for large dairies with high amounts of debt. Many smaller dairies, even those with low amounts of debt, would not be profitable after complying with the regulations unless they became much more efficient, according to the simulations.

Reference: Leatham, Dave, John Schmucker, Ron Lacewell, Robert Schwart, Ashley Lovell, and Greg Allen, "Impact of Water Quality Laws on Dairy Profitability," Presented at 1991 Summer Meeting, American Society of Agricultural Engineers, Albuquerque, NM.

SW Texas State Developing Edwards Aquifer Simulation Model

Up to now, computer models used to simulate flows in the Edwards Aquifer region required massive amounts of data to predict the annual impact of rainfall, river flows and pumping on groundwater levels and springflows.

Now, researchers at Southwest Texas State University are developing a simulation model that needs much less data to generate short-term predictions of aquifer levels. Nisai Wanakule, a hydrologist with the Edwards Aquifer Research and Data Center, is developing a lumped parameter model to project groundwater levels and springflows. The conceptual model will consist of a series of connecting tanks and each unit will represent a river basin that contributes water to the aquifer.

The model should be useful for forecasting how the aquifer would respond to different management options during droughts. It could be coupled with streamflow models to assess whether fragile spring ecosystems could be threatened by different levels of pumping.

For details, contact Wanakule at 512-245-2329.

Related articles in *New Waves*:

TWRI Studies Provide Data to Help Manage Edwards Aquifer
Development of a Simplified, Easy to Use Computer Simulation Model for the Edwards Aquifer
Related technical report:
Water and Solute Flow in a Highly-Structured Soil (TR-161)

TAES Study to See if High Frequency Irrigation Boosts Peanut Yields

Last year, scientists with the Texas Agricultural Experiment Station (TAES) in Stephenville were conducting experiments in controlled chambers called Iysimeters to define what constituted "unstressed" peanuts. In other words, they wanted to find out how many peanuts could you grow if water wasn't a limiting factor. The results were astounding. When adequate soil moisture was provided using a technique called high frequency irrigation, runner peanuts produced more than 10,000 pounds per acre‹three times the expected yield for irrigated peanuts.

Now, the researchers are working on a follow-up study to see H the Iysimeter results can be applied to field conditions. The research is being conducted by Jody Worthington, Charles Simpson and Ken Woodward of TAES and George Alston and Chip Lee of the Texas Agricultural Extension Service.

In the study, the scientists will measure the water use and productivity of peanuts grown in Iysimeters and in the field. Some of the peanuts will receive high frequency irrigation while others will be subjected to low amounts of soil moisture. The researchers hope to develop a crop stress index that can be correlated to weather conditions typical for the region. They will develop a computer program which tells irrigators how much water peanuts need, based on the amount of environmental stress and weather conditions.

For details, contact Worthington at 817-968-4144.

Recycling By-Products May Rebuild Reefs

Most of us know that recycling is good for the environment. Now, researchers at Texas A&M University at Galveston are taking that idea one step further. They say that recycling coal-burning byprodu cts may produce new homes for oysters.

Sammy Ray and Andre Landry of the Marine Biology Department at Texas A&M University at Galveston are working with the Houston Lighting and Power Company. They want to investigate if pellets made f from recycled fly ash and bottom ash can be used to create new oyster reefs. The reefs will be planted with oysters that have been head started in the University's oyster hatchery.

A goal of the project is to find ways to help large numbers of spat survive on the reefs. The researchers will evaluate how the oyster larvae survive, settle and grow on an artificia l reef planted next to a natural reef in Galveston Bay. Optimal ways to design and construct artificial reefs will be evaluated with input from oyster fishermen. Recreational fishermen will be surveyed to assess if the reefs are improving sport fishing. The technique maybe useful to mitigate or replace lost habitats.

For details, contact Ray at 409-7404525 or Landry at 409-740 4423.

Researchers Hope to Learn More About Bacteria

Learning more about a bacteria that has the potential to afflict Texas' $27 million oyster industry is the focus of a research project at Texas A&M University at Galveston.

John Schwarz of the Marine Biology Department and his graduate students are investigating the life history of a bacteria, Vibrio vulnificus, that afflicts Texas oysters. The bacteria can cause serious illness and death in susceptible humans who eat raw, infected oysters. Controlling the bacteria is vital to make sure oysters sold for human consumption are safe and of good quality.

Schwarz hopes to identify oyster-producing areas in the Gulf where the bacteria is widespread and to learn how and why it causes illness in humans. Other aspects will involve ways to minimize the occurrence of the bacteria while oysters are being harvested, stored and marketed. For details, contact Schwarz at 409-740-4528.

Texas Tech, South Plains College, Develop Soil Monitors

Researchers at Texas Tech University and South Plains College are working together to develop inexpensive soil moisture monitors that could provide information from remote field locations.

Purnendu Dasgupta of Texas Tech's Chemistry and Biochemistry Department is working with Jesse Yeh of the Chemistry Department at South Plains College on the project. The sensors are placed below-ground in fields and measure humidity in the atmosphere so that soil moisture can be calculated. They can be inexpensively mass produced (about $100 for an array of four units) and should last for a number of growing seasons.

The researchers hope to connect the sensors to an inexpensive radio telemetry device that can transmit the data from as many as six sensors to far away computer terminals or other remote locations. The information could make irrigation more efficient by telling irrigators of the exact amount of water that needs to be applied and by reducing the likelihood that too much water will be applied.

For details, contact Dasgupta at 806-742-3064.

Texas Tech Models Plant Water Use

Utilizing mathematical equations to model the water uptake of plants is the aim of a study at Texas Tech University.

Ron Anderson of Texas Tech's Mathematics Department is working with Dan Upchurch, a soil physicist with the USDA/ ARS in Lubbock to develop specific models. The first will simulate water uptake for roots in soils, and the second will model cotton roots with first and second order laterals grown in hydroponic operations. The third model will examine how water flows through the inner, protective, wall of cells in cotton roots to determine resistance values.

The models will help researchers better predict and understand complex interactions between plant roots and water use. For details, contact Anderson at 806-742-2566.

Texas A&M Works to Make Crops More Drought Tolerant

Making crops more drought tolerant is the goal of a study by scientists at Texas A&M University.

John Mullet of the Biochemistry and Biophysics Department is tagging genes that help grain sorghum survive in water deficit situations. The DNA information will be used to help crop breeders develop specific sorghum types with improved drought tolerance.

Long-term goals of the project are to identify the genes and to understand the reasons some crops are more drought tolerant than others. Specific proteins may play a key role in protecting plants from dehydration and damage . For details, contact Mullet at 409-845-0722.

UT-Dallas Research May Make Site Assessments Easier

A project at the University of Texas at Dallas is developing hightech ways to conduct environmental site assessments and protect groundwater supplies.

George McMechan of the Center for Lithospheric Studies is working to adapt ground penetrating radar technology so that it can be used to map aquifer characteristics. The research involves developing software programs that can create 3-dimensional images from data sets developed from ground-penetrating radar.

The technique could be useful to determine the stability of geologic formations beneath dams or bridges and could help assess whether sites may be vulnerable to pollution. It could also be useful in mapping areas where salt water is migrating into freshwater aquifers, and in identifying the aquifer's boundaries. The process has the advantage of being non-destructive.

For details, contact McMechan at 214-690-2424.

Stress Proteins, Reproductive Indexes, May Warn of Pollution

Scientists urge that there is a need to develop an "early warning" system to tell us when fish in coastal waters are threatened with pollution. Now such a system is being proposed that will measure reproductive health and the buildup of stress proteins in spotted sea trout in Galveston Bay.

Cynthia Howard of the Biology and Allied Health Sciences Department at the University of Houston at Clear Lake and Peter Thomas of the Marine Science Department of the University of Texas Marine Science Institute at Port Aransas are collaborating on the project. The study involves collecting seatrout from polluted and relatively clean sites in the Bay. Fish tissues will be analyzed to see if organic chemicals and heavy metals have built up to dangerous levels and to measure the amount of stress proteins. The project will find if links can be established between reproduction rates and levels of stress proteins and pollutants. Seatrout from polluted sites may show less of an ability to reproduce normally and may have high stress protein levels. Pollutants may also affect the amount and type of stress proteins.

For details, call Howard at 713-283-3745 or Thomas at 512-749-6743.

Impact of Wastewater, Soil Amendments, on Crops and Soils is Focus of Texas A&I Study

Duane Gardiner, a soil scientist in the College of Agriculture at Texas A&I University (now Texas A&M-Kingsville), is investigating whether soil amendments made from gypsum, sulfur, organic polymers, and iron pyrite can increase the amount of infiltration that crops need to grow and flourish when irrigated with wastewater.

Typically, when wastewater is used to irrigate crops, a number of problems usually develop. High salinity levels in the wastewater limit the crop's ability to extract water from the soils and high sodium levels lessen the ability of soils to allow water to infiltrate and reach plant roots. Often, the only response is to over-irrigate to prevent salts from building up in the root zone.

The project will also assess how wastewater irrigation will affect soil properties, whether water tables will allow adequate drainage to remove salts, and if economically important crops including coriander, peppers, and forage grasses can tolerate the effects of high-sodium wastewater and soil amendments.

For details, contact Gardiner at 512-595-3712.

Texas A&M Project to Measure Rio Grande Valley Water Quality

Determining the impact of agricultural on the water quality of the Lower Rio Grande Valley and evaluating best management practices that could prevent any contamination is the goal of a study by researchers with the Texas Anricultural Extension Service and the Texas Agricultural Experiment Station at Weslaco.

Guy Fipps, an agricultural engineer with TAEX in College Station, is collaborating with Robert Wiedenfield, a soil scientist with TAES Weslaco, and extension agents in Starr, Hidalgo, and Cameron counties in the project. The project is also being supported by the Soil Conservation Service and the Southmost Soil and Water Conservation District.

The project involves measuring the amount and quality of irrigation drainage water in locations in the region. Both ground and surface water will be tested for nitrate and selected pesticides that may have been contributed by agriculture. Amounts of drainage water and groundwater tables will also be gauged. Other goals are to develop recommendations on salinity management and leaching that will lessen pollution risks. For details, contact Fipps at 409-845-7451 or Wiedenfield at 512-968-5585.

Reservoirs Are Focus of Texas A&M Study

Improving reservoir simulation models to account for saline water and water rights is the aim of research by Ralph Wurbs of the Civil Engineering Department at Texas A&M University.

Simulation models are often used to determine the amount of water reservoirs can supply, but current methods may not be accurate if they don't account for water rights and unusable saline water.

This study will refine models developed by Wurbs. Very salty water will not be included in firm yield estimates. The study will focus on 12 reservoirs in the Brazos River Basin. Innovative reservoir system operating strategies, water supply contracts, and water rights will be evaluated. The study is also funded by the Texas Water Development Board. For details, contact Wurbs at 409-845-3079.

Texas A&M University to Evaluate Water Marketing Options

Developing policy options that utilize market-driven approaches to reallocate water supplies is the goal of a study by Ronald Kaiser of the Recreation and Parks Department and Fred Boadu of the Agricultural Economics Department at Texas A&M University.

According to many policy experts, Texas will soon be faced with the prospect of reallocating or redistributing substantial amounts of water. For example, conservation is expected to cut urban water use by 21% and agricultural water use by 4.7 million acre-feet by the year 2000. This raises an obvious question‹how should this newly "created" water be allocated?

To answer this question, the researchers will conduct a comprehensive review of Texas water laws as well as policies that have worked in other states and will interview experts and policy makers about the goals and values that can be achieved through water transfers. Recommendations for water marketing will be developed.

For details, contact Kaiser at 409-845-5303 or Boadu at 409-845-4410.

Follow-up article in *New Waves*:

Texas A&M Study Examines Potential for Water Marketing
Technical report abstract:
TR-167

UT to Evaluate Conservation Programs

As competition for scarce water supplies intensifies, the need for effective conservation programs for rural and urban water users increases. One basic problem is: how do you measure if conservation programs work?

That's the aim of a study by David Eaton of the LBJ School of Public Affairs at the University of Texas and Jobaid Kabir of the Lower Colorado River Authority . They want to develop and test methods to monitor the amount of water saved from agricultural conservation programs. Rice irrigation areas in the Lower Colorado River will be used as a case study. Means will be developed to compare the results of structural improvements, pricing and educational programs. They hope to isolate individual aspects of conservation programs. For details, call Eaton at 512-471-4962.

UT Study to Map Naturally Occurring Sources of Non-Point Pollution into Lake Meredith

During the past 10 years, the salinity of Lake Meredith in the Texas panhandle has nearly doubled to more than 430 parts per million. As a result, cities in the area that want to use lake water for drinking water are now faced with having to pump large volumes of relatively fresh water from the Ogallala Aquifer to dilute the lake water and make it suitable for drinking.

Tom Gustavson of the Bureau of Economic Geology at the University of Texas at Austin is working to understand the problem. He is beginning a study to identify and map natural sources of salt water in local groundwater supplies that may be causing the high salinity levels. The project involves using electromagnetic surveys of alluvial areas near the Canadian River and under the bedrock to measure the conductivity of groundwater supplies. That way, areas with high levels of sodium, calcium, chlorine and sulfates can be identified. Those elements combine to produce high levels of dissolved gypsum and salt which are major non-point source pollutants that enter the lake.

Gustavson says describing and mapping non-point source pollution is vital to developing strategies to solve the problem. For details, contact Gustavson at 512-471-1534.

Texas A&I, TAES, Study Water Savings in Orchards

A study by researchers at Texas A&I University and the Texas Agricultural Experiment Station at El Paso is investigating if using less sod between rows of citrus and pecan trees can prevent pesticide and nitrate leaching, while saving water and fertilizers.

The project is being led by Dariusz Swietlik, a plant physiologist at the Texas A&I Citrus Center. He is working with two researchers from TAES-EI Paso‹Lloyd Fenn, a soil scientist and Seiichi Miyamoto, who specializes in water salinity problems.

Part of the study will involve planting legumes and cool and warm season turfgrasses next to citrus and pecan seedlings. The plants and trees will be planted in Iysimeters with clay and sandy soils. Some of the plots will be treated with herbicides to control weeds. Soil moisture levels will be monitored and the drainage water will be monitored for nitrate, pesticides, and herbicides.

The project will evaluate the effect of different slopes and sod combinations on water use and pesticide runoff. The use of small "micro-jets" sprinklers on water use, plant and tree growth, and runoff will also be studied.

For details, call Swietlik at 512-9682132 or Miyamoto at 915-859-9111.

Texas A&M to Test Pump System that Uses Microbes to Remove Nitrate Near Wells

Nitrate is one of the most widespread groundwater contaminants, especially in rural areas where farming is common and many homeowners use septic tanks.

Researchers at Texas A&M University are beginning a project to determine whether an in-place treatment system comprised of large-diameter wells and denitrifying bacteria can protect drinking water wells from nitrate contamination.

Mike Stallard and Yavuz Corapcioglu of the Civil Engineering Department are leading the study. The project consists of developing and testing a pilot-scale system that would intercept contaminated groundwater in treatment wells upgradient from drinking water wells. Anoxic conditions would be maintained in the treatment wells to promote the growth of bacteria that would oxidize organic material and break down nitrates. Contaminated groundwater would be denitrified and returned to the aquifer near the top of the treatment wells. Only treated water would reach the drinking water wells.

Other parts of the project involve testing the technology in actual field conditions, developing operating strategies to manage the treatment wells, and writing computer software that environmental engineers could use to operate the system.

For details, contact Stallard at 409-845-1404 or Corapcioglu at 409-845-9782.

Technical Reports, Proceedings Available from TWRI

Two new technical reports are available free from the Institute. *Acute and Genetic Toxicity of Municipal Landfill Leachate* (TR 153) was co-authored by Kirk Brown, G.E. Schrab and K.C. Donnelly. *Sediment Transport in the Lower Guadalupe and San Antonio Flivers* (TR 154) was written by Ed Holley. A new conference proceedings is available. *Hydrology of Floods and Watershed Systems* is the title of the Proceedings of the 1992 Spring Meeting of the Texas Section of the American Water Resources Association. To order any of these reports. call TWRI at 409-845-1851.

Brazos River Bibliography Published by Baylor

Baylor University is now updating a bibliography about the Brazos River that will include information on its physical characteristics as well as the role of the river in Texas' history, culture and fiction.

A preliminary edition of the bibliography, *The Brazos River and Its Watershed in Texas and New Mexico*, was produced in 1991. It was the first known comprehensive work of that covered many different issues along the entire Brazos River basin. The preliminary edition was compiled by Marion Travis, Robert Klatte, James Good, and Susan Kimball of Baylor's Regional Studies Program. Travis and Klatte are continuing work on the second edition. Sections of the preliminary edition of the bibliography focus on biological, physical, and earth sciences issues; social sciences and humanities information (including fiction and poetry), graduate theses and dissertations, and historical accounts.

Limited copies of the first edition of the bibliography are available from the Regional Studies Program at 817-755-2190.

UT Reports Cover Global Warming, Use of Tracer Gases

A number of new technical reports dealing with water issues have been produced by The Univershy of Texas (UT) at Austin.

Texas and Global Warming: Water Supply and Demand in Four Hydrological Regions was co-authored by Jurgen Schmandt of the LBJ School of Public Affairs and George Ward of the Center for Research in Water Resources. The report examines regional impacts of global climate change in the Trinity, Colorado, and Rio Grande/ Rio Bravo river basins as well as the Edwards Aquifer. It is available from the LBJ School at 512-471-4962.

Two reports describe how tracer gas techniques now used to measure aeration rates in rivers and streams can also be used in bays and estuaries. *Field and Numerical Studies of Tracer Gas Transport and Surface Gas Transfer in Laterally Uniform Partially Stratified Estuaries* (CRWR 208) was written by Jerad Bales and Ed Holley. *Tracer Gas Method for Shallow Bays* (CRWR 233) was written by C.A. Downer, Ed Holley, and George Ward of the UT Civil Engineering Department.

Three reports by Earnest Gloyna of the UT Civil Engineering Department and his colleagues deal with a methodology to treat hazardous wastes called supercritical water oxidation. *Supercritical Water Oxidation of Anaerobically Digested Municipal Sludge* (CRWR 231)was written by Gloyna and C. Tongdhamachart, *Energy Consumption in the Destruction of Wastewaters and Sludges by Supercritical Water Oxidation Deep Shaft Reactors* (CRWR 230) was written by Gloyna and Christopher Stanford, and *Corrosion Behavior of High Grade Alloys in the Supercritical Water Oxidation of Sludges* (CRWR 229) was written by Gloyna and Albert Thomas.

For information on any report, contact the Center for Research in Water Resources at 512-471-3131.

Rice Engineer Co-Authors Hydrology and Floodplain Analysis

Phil Bedient of Rice University's Environmental Science and Engineering Department and Wayne Huber of Oregon State University have co-authored the 2nd edition of Hydrology and Floodplain Analysis.

The book contains revised information on infiltration, evaporation, hydrology, modeling and design issues. Several new case studies and computer programs and a new chapter on floodplain design are also included.

To order, contact Addison-Wesley Publishing at 617-944-3700.

Lamar Proceedings Focus on Groundwater

Ground Water: The Problem and Some Solutions is the title of a new pre-conference proceedings available from the Gulf Goast Hazardous Substance Research Center at Lamar University.

The pre-conference proceedings covers such topics as factors that limit the success of bioremediation efforts, the transport and fate of groundwater contaminants, evaluating EPA health-based cleanup goals based on exposure to polluted groundwater, and subsurface microbial ecosystems. A proceedings will be published later and will include the final versions of talks given at the meeting as well as additional experimental data. The pre-conference proceedings is available for $35 from the Center. Call 409-880-8768 to order.

CCSU Scientists Discover Exotic Venezuelan Mussel off Texas Coast

Normally, visitors from out of town are welcome. But, according to researchers at Corpus Christi State University (CCSU), a new shellfish from Venezuela may be particularly unwelcome.

Wes Tunnell and David Hicks of the CCSU Center for Coastal Studies have been documenting the population and characteristics of the edible brown mussel since it first appeared in the region. It was first spotted near the Port Aransas Jetty in February 1990 following a severe freeze in late 1989. By December of 1991, the mussels had colonized the intertidal zone of jetties and rocks at Port Aransas, Fish Pass, and Port Mansfield Pass.

How did the mussel get all the way from South America to Texas and why are scientists concerned about it? Tunnell speculates that the bivalve probably attaches itself to oil tankers that frequently travel from Venezuela to Corpus Christi. The main reason for concern, he said, is that non-native species like this one often introduce new strains of pathogens, algae, and diseases that can afflict native species. For details, contact Tunnell at: 512-994-2470.

Texas Southern Study Shows Nitrate in Harris County Stormwater

No one expects to hear the sound of mooing cows as they travel the freeways around Houston, but a survey by scientists at Texas Southern University suggests that a large number of dairies throughout Harris County may be producing sizeable amounts of non-point source pollution.

Ray Agbanobi is a researcher in TSU's School of Technology. He's been investigating whether confined dairies in urban areas can be major sources of non-point source pollution. Agbanobi surveys reveal that as many as 60 dairies‹many of them in urban areas and one near the Astrodome‹are spread over the County. One reason there are so many dairies in the city is the lack of local planning and zoning ordinances.

Agbanobi has been gathering stormwater samples for nitrate after heavy rains. He said preliminary analysis shows that significant levels of nitrate are present. Agbanobi hopes to increase the sampling to include other pollutants and to sample groundwater resources at sites close to the dairies.

For details, contact Agbanobi at 713-527-7681.

SMU Begins Environmental Programs

Southern Methodist University has recently launched two programs to help businesses cope with environmental problems.

SMU instituted a graduate program focusing on hazardous and waste materials management. The program follows a multidisciplinary approach which integrates air, water, and land pollution. Core courses include environmental regulations and law, risk assessment, sources and nature of hazardous wastes, and treatment technologies. Electives include hydrology, pollution and contaminant fate and transport.

SMU also just began an undergraduate degree plan in environmental geology. The course will deal with such modern problems as landfills, water and soil pollution, and hazardous wastes.

In addition to being offered on the SMU campus, many of the classes can be taken through an educational television network that is transmitted to corporations and institutions.

For details on the graduate program in hazardous wastes management, call 214-692-3050. For details on the Environmental Geology Program, call 214-692-2750.

Heat Islands May Not Produce Much Rain in Small Towns, SFA Researchers Say

Many weather observers say that cities should receive more rain than less populated rural areas. That's because many human activities such as driving cars create "heat islands which boost condensation and cloud formation.

This prompted researchers at Stephe n F. Austin University to ask H small towns like Nacogdoches also produce heat islands and if they too are rained on more often than the nearby countryside.

Mingteh Chang and Alexander Sayok of SFA's School of Forestry designed a study to answer that question. They set up 20 rain gauges at locations inside and outside the city limits and collected a year's worth of rainfall data.

The results show that urbanization in Nacogdoches had almost no effect on rainfall patterns. The movement of air masses from the Gulf of Mexico and elsewhere most influenced where and how often rain fell. There were more rain-producing events in the summer (May to October) than in the winter (November to April) . For details, call Chang at 409-568-2195.

Clay Soils Don't Always Protect Aquifers, Baylor Study Suggests

Lands overlying two geologic formations‹the Austin Chalk and the Ozan confining beds‹parallel a major urban growth corridor between Austin and Dallas and have been considered as popular candidates for waste disposal sites. The soils have a high clay content that would seem to help prevent pollution.

But a Baylor University geologist suggests that the areas contain shallow groundwater and are vulnerable to urban pollution.

Joe Yelderman has used fracture traces, field measurements, lineations, and aquifer tests to characterize these systems. His studies suggest that weathering, tectonic stresses, and the release of overburden pressures in areas close to the surface have increased the hydraulic conductivity. This makes h more likely that pollutants could flow into shallow groundwater supplies and enter surface water supplies through seeps and springs.

One lesson to be learned from the studies, Yelderman says, is that site-specific investigations are needed. Preliminary studies on a regional scale did not reveal that these pollution risks were present. For details, call Yelderman at 817-755-2361.

Rice Research Focuses on Reverse Osmosis

Research at Rice University is evaluating the performance of pressure driven water treatment processes including reverse osmosis (RO) systems, ultrafiltration, and microfiltration.

Mark Wiesner of Rice's Environmental Science and Engineering Department has been studying problems associated with the accumulation of contaminants that are trapped near the membrane surface. Materials that build up near the membrane can limit the flow of water across the surface and may lead to fouling.

The research involves evaluations of mass transport in membrane systems, and mathematical modeling of how raw water quality characteristics affect the system's performance. Wiesner is working on a theory that uses the shape of the membrane and

hydrodynamic conditions such as cross-flow velocity, permeation rate, and particle size, to identify particles that are most likely to build up on membranes. This could help predict when fouling problems are most likely to occur. For details, contact Wiesner at 713-285-5129.

Lavaca Bay Shrimp, Oysters, Have High Mercury Levels, Texas A&M Study Shows

Lavaca Bay north of Corpus Christi has been polluted by high levels of mercury since the 1960s, but until recently it was difficult to assess if the contamination was affecting marine life.

Ongoing studies by Bobby Presley of the Oceanography Department at Texas A&M University suggest that significant levels of mercury are building up in oysters, fish and smaller organisms in the bay. In the studies, shrimp, blue crabs and oysters were placed in cages in areas of Lavaca Bay that had been polluted by mercury and in parts of the Bay that were not contaminated. Mercury levels in the organisms were compared between the two sites.

Results show that the mercury levels in oysters ballooned from baseline levels of 189 parts per billion (ppb) to 1,340 ppb‹the highest levels in the Gulf Coast. Shrimp also rapidly accumulate mercury when confined to a contaminated area of the bay. Presley points out that some of the highest levels of mercury may build up in large fish like black drum and redfish, but even algae and the smallest organisms in the Bay are highly contaminated with mercury.

For details, call Presley at 409-845-5136.

Modeling of Aquifer Pollution, Clean-Up is Goal of UH Study

For years, it's been dfficult to determine the extent of shallow groundwater contamination or to decide on the best method to clean up the pollution.

John Killough of the Chemical Engineering Department at the University of Houston hopes that developing improved three dimensional computer models can help solve the problem.

The research focuses on improving current mathematical models. Three dimensional images of pollution plumes will be developed using "computer tomography."

The goal is to develop tools that can be used in "real world" situations that make pollution assessment and cleanup more accurate and less costly.

For details, contact Killough at 713743-4330.