New Waves
The Research Newsletter of the Texas Water Resources Institute
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Water Resources Research Institutes Mark 25th Anniversary in 1989

This year marks the silver anniversary of the creation of water resources research institutes at land grant colleges across the United States.

On July 17,1964, President Lyndon B. Johnson signed the Water Resources Research Act (Public Law 88- 379). The act created water resources research institutes in all 50 states and Puerto Rico. In 1971, additional institutes were created in the District of Columbia, Guam, and the U.S. Virgin Islands.

The institute program has undergone several organizational changes. The institutes were originally a part of the Office of Water Resources Research (OWRR) in the Department of the Interior. In 1974, OWRR was renamed the Office of Water Research and Technology. Since 1983, the institute program has been a part of the U.S. Geological Survey, which coordinates the program and provides a national framework to solve key water issues.

The Texas Water Resources Institute (TWRI) at Texas A&M University was designated by Governor John Connally to represent Texas in the program in 1964. In this role, TWRI sponsors research at public and private universities across Texas, publishes technical reports and newsletters, encourages the training of future scientists through research programs, and administers a fellowship program to assist graduate students at Texas A&M University.

The water resources research institute program serves three missions: research, training of future scientists, and dissemination of scientific information and technology transfer.

Nationally, each institute sponsors an annual competitive research program at universities throughout its state. Individual projects are selected with the help of advisory panels comprised of university scientists and representatives from federal and state water agencies. Projects are often funded through a mix of federal, state and private monies. In 1988, non- federal funds exceeded federal dollars by an average of 1.5 to 1.

In 1988, 249 research projects at 96 different colleges were sponsored through the program. Groundwater quality is a major national emphasis of current institute research. For example, 70 of the 1988 projects focus on groundwater contamination and protection. Major issues being investigated include pollution by organic compounds, nitrate

contamination of groundwater from agricultural activities, and the flow and transport of contaminants in aquifers.

Other major areas now receiving focused national research attention include acid rain, contamination of ground and surface water resources by heavy metals, excessive nutrient levels in lakes that lead to eutrophication, innovative water and wastewater treatment technologies, flooding, drought, water conservation, and water policy issues. At TWRI, research is currently focusing on issues such as water quality, water management, and water conservation.

The program assists in training future scientists by providing funds that allow undergraduate and graduate students to work side- by- side with researchers on institute-sponsored projects.

Since the program was created, more than 40,000 students have been involved in such projects. Many former students are now practicing professionals in water- related fields and many have become leaders in water- related industries and governmental agencies.

Technology transfer and the dissemination of scientific information is the third major thrust of the institute program. In many cases, institutes work to communicate research results to the public or to encourage the adoption of new technologies by user groups. Efforts include newsletters, technical reports, videotapes, and conferences.

In the future, the institute program will continue to focus on research, training, and technology transfer. "Cutting edge" issues which the institutes are likely to be involved with include global warming, increasing water use efficiency, and the application of new biotechnologies to reclaim contaminated water and improve the water use efficiency of crops and landscape plants.

For more information on TWRI or its programs, contact the address or phone number listed on the back panel of this newsletter.

Distribution and Identification of Sources of Nitrate in Groundwater, Texas

Author: Charles W. Kreitler, University of Texas, Austin, TX.

Problem: High concentrations of nitrate in groundwater are being recognized across the U.S. There is widespread concern about the distribution and sources of nitrate, and about adverse health affects that may result from excessive nitrate levels. Although much of the literature focuses on nitrate levels resulting from application of nitrogen (N) fertilizers to agricultural cropland, nitrate also occurs naturally in many groundwater systems. This paper assesses both manmade and natural nitrate levels in Texas.

Discussion: High levels of nitrate have been found in agricultural areas in Texas and many other western states. In Texas, high nitrate concentrations typically occur in shallow, easily recharged, oxidizing, water- table aquifers in agricultural areas. Dominant

N sources that result in elevated nitrate levels include animal wastes, feedlots, sewage treatment plants, and agricultural fertilizers, as well as such natural sources as lightning and the oxidation of organic soil N without cultivation.

Nitrate sources can be identified by measuring the variations of naturally occurring, stable N isotopes (15)N and (14)N. As N compounds are chemically altered within the biosphere, the ratio of these isotopes changes. In experiments in Runnels, Caldwell and Williamson counties, scientists measured N isotope changes to distinguish manmade and natural nitrate sources. Results indicated that dominant sources of nitrate in Runnels County was probably the oxidation and leaching of organic soil nitrogen, and that the source of nitrate in Caldwell and Williamson counties was probably a combination of cultivation and animal wastes.

Related Publications: Kreitler, C.W., and L.A. Browning, "Nitrogen Isotope Analysis of Groundwater Nitrate in Carbonate Aquifers: Natural Sources Versus Human Pollution," *Journal of Hydrology*, 61: 285- 301, New York, NY, 1983.

Fate and Transport of Pesticides Used in Rice Product

Author: Kirk W. Brown, Texas A&M University, College Station, TX.

Problem: The acreage used in rice production is flooded during the growing season when most of the pesticides are applied. Large rainfall events and the common practice of managing irrigation to cause a nearly continuous flow of water through the fields result in pesticide- contaminated runoff. Other pesticide losses from rice fields occur by: 1) vapor loss to air, 2) photodegradation, 3) biodegradation, 4) vegetative retention, and 5) soil adsorption. While pesticides are needed to sustain current production levels by controlling weeds, insects and fungi, methods must be developed to minimize discharges that are harmful to the environment.

Discussion: Concentrations of pesticides such as molinate and thiobencarb dropped below the detection limit within four days of their application to the field. However, some highly volatile pesticides, such as propanil may cause significant damage to nearby vegetation.

Concentrations of marinate in vegetation peaked at 918 parts per billion (ppb) and thiobencarb concentrations peaked at 1754 ppb within four days of application. Concentrations of both pesticides gradually decreased over the next 28 days.

To prevent pesticides from entering surface waters, only recommended amounts of pesticides should be applied. Discharge waters should be retained until the pesticides are sufficiently degraded and/or adsorbed to the soil. Runoff water could be retained in holding ponds before being discharged until a specific quality criteria is reached, or it could be recirculated through the rice field.

Flood water management practices need to be designed to allow for retention of large amounts of rainfall shortly after pesticide application which may wash high concentrations of pesticides off the leaves and into surface waters.

Related Publications: Ross, L.J. and R.J. Sava, "Fate of Thiobencarb and Molinate in Rice Fields," *Journal of Environmental Quality,* 15:220- 225, Madison, WI, 1986.

Controlling Water Pollution from Non-Point Source Livestock Operations

Authors: John M. Sweeten, Texas Agricultural Extension Service, College Station, TX, and Stewart W. Melvin, Iowa State University, Ames, IA.

Problem: Research has confirmed that unconfined livestock production is an environmentally sound water quality management practice. However, cattle feedlots require systems that prevent discharge of pollutants. Nonpoint source pollutants from both unconfined and confined cattle operations are generally controllable through Best Management Practices (BMPs) rather than wastewater treatment methods.

Discussion: Sediment loads at unconfined, high- impact cattle feeding and watering sites can be minimized by: 1) protecting fragile stream banks; 2) maintaining vegetative cover; 3) stocking fewer cattle; 4) distributing salt and water; and, 5) providing feed, salt and water away from streams.

If possible, feeding facilities, watering sites and shelters should be dispersed to reduce manure accumulation, and soil compaction and erosion. Grazing programs and stocking rates should be tailored to the climate, soil, vegetation, topography and geology of the area, and an erosion control program should be adopted. For crucial situations, management practices include: 1) use of tillage to break up manure deposits; 2) modifying runoff and drainage paths; and,3) restricting animal access to sensitive areas.

BMPs for nonpoint source water pollution control at small feedlots include: 1)locating facilities away from streams and drainage channels; 2) diverting runoff away from the feedlot surface; 3) collecting runoff water; 4) installing grass filter strips if the feedlot is located near a stream or water body; 5) installing a runoff holding pond if filter strips are not feasible; and, 6) applying manure to cropland at rates selected based on soil sample analyses, and manure nutrient analysis. Typical manure application rates are 10 tons/acre/ year for irrigated corn, grain sorghum, wheat,vegetablesand hay crops, and 5- 6 tons/acre/year for dryland crops.

In 1984, the EPA recommended to Congress that states should be responsible for management of nonpoint source pollution control. Barriers that prevent adoption of BMPs by ranchers and farmers are economic, educational and institutional. Adoption of BMPs can be increased by: 1) demonstrating the economic viability of each practice; 2) providing cost- sharing incentives for those practices that are not economic; 3) providing educational programs; and,4) establishing agricultural policies that encourage investment in pollution control and resource management projects.

Related Publications: Dixon, J.E., "Controlling Water Pollution from Cattle Grazing and Pasture Feeding Operations," *Profit Potential of Environmental Protection Practices of Cattlemen,* National Cattlemen's Association, Englewood, CA, 1983.

Pecos River Compact: Recent Developments

Author: Neil S. Grigg, Colorado Water Resources Research Institute, Fort Collins, CO.

Problem: The Pecos River originates in northern New Mexico and flows through Texas where it joins the Rio Grande. The amount of water that should be divided between New Mexico and Texas has been a subject of litigation between the two states for many years. A Special Master has determined that New Mexico has withdrawn roughly 340,100 acre-feet more water than it was entitled to between 1950 and 1983. To determine the amount of water each state is withdrawing from the river, and to decide the amount of water that needs to be repaid, a River Master was appointed. The author is currently the River Master in this dispute.

Discussion: The controversy about interstate water allocation dates back to about 1914 when the Bureau of Reclamation reported the need for a reservoir on the Texas- New Mexico border to regulate Texas' share of the water. As a result, Red Bluff reservoir was completed in 1936. In 1942, after numerous legislative attempts to resolve the dispute had failed, the Pecos River Compact Commission was formed. It is still functioning today.

The compact states that New Mexico can not deplete the flow of the Pecos River at the state line below the amount that was available to Texas in 1947. This point has been the source of considerable litigation before the U.S. Supreme Court. To resolve this conflict, an "inflowoutflow" method of apportioning waters was accepted. It involves determining the inflow to a basin, as measured at certain gaging stations, and the outflow from the basin.

The future enforcement of the compact involves: 1) the concept of the water year and accounting year on which water withdrawals are based; 2) the Pecos River Master's Manual; 3) annual calculation by the River Master of the New Mexico delivery obligation utilizing the inflowoutflow method; 4) procedures for modifying the manual; and,5) development of a plan by New Mexico to make up shortfalls.

The first calculation of New Mexico's obligation using this method was conducted in 1987. In that year, Texas received 15,400 AF more than it was entitled to because of higher than normal amounts of rainfall.

Related Publications: Meyers, Charles J., *Report of Special Master,* Supreme Court of the United States, No. 65 Original, Washington, D.C., filed November 1987.

Some Institutional Implications of Urban Non-Point Source Pollution Characteristics

Authors: Michael A. Collins, Mark Boyd and Roger O. Dickey, Southern Methodist University, Dallas, TX.

Problem: Nonpoint source pollution, commonly known as urban or agricultural runoff, creates major impacts on aquatic life and habitats. Despite this, nonpoint source pollution is difficult to describe and measure. Because it occurs erratically, nonpoint source pollution is difficult to evaluate. Measuring pollutant conditions during runoff events is often inadequate. As a result, there are many theories as to the most effective institutional strategies for nonpoint source pollution control.

Discussion: Historically, nonpoint source pollution has been described in terms of the physiochemical composition of the contaminants that originate in nonpoint source pollutants. The description in use today requires that nonpoint source pollutants must meet three criteria: 1) nutrients, solids, and oxygen- demanding materials must be measurable using established procedures; 2) impacts of these pollutants must be well known and measurable; and, 3) these descriptions should be well- suited to regulatory control. The EPA has identified nonpoint source pollution according to contaminant sources and activities.

It is difficult to characterize the effect of nonpoint source pollution. The impacts are diverse, they evidence themselves in different ways and over different time periods, and they are not fully known. Yet, if cost effective nonpoint source pollution controls are to be devised, more attention must be given to such identification. Obvious adverse impacts include the following: 1) impairment of water use and associated water and land resources; 2) dangers to public health; and, 3) risks to aquatic and coastal life.

Four major implications arise from the diverse characterizations of nonpoint source pollution and its impacts. First, the EPA identifies urban runoff as a nonpoint source pollutant when it is the contaminants in the runoff that pose a threat to the environment. This could lead to resources being devoted to end- of- pipe control technology when the problem could better be solved upstream at the source.

Second, defining standards to use in nonpoint source pollution control is difficult. It may be impossible to have standards for every contaminant and to check for all contaminants when testing. Third, the infrequent and rapid occurrence of many nonpoint source pollutant events requires more intense monitoring than the water management community has used for point- source pollutants. This makes it difficult to track contaminants and to assess their impacts on the environment. Longterm commitments to increased, sophisticated data collection and analyses are necessary.

Last, the spatial extent of nonpoint source pollution makes it difficult to identify who is responsible for its control and the costs of remediation. A system for creating cooperative action must be developed.

Related Publications: US EPA, *Results of the Nationwide Urban Runoff Program*, Executive Summary, Water Planning Division, US EPA, Springfield, VA, 1983.

DRASTIC: A Systematic Approach to Groundwater Pollution Potential Mapping in Texas

Author: Margaret Hart, Texas Water Commission, Austin, TX.

Problem: As part of its statewide groundwater assessment and protection program, the Texas Water Commission has sought to develop tools to classify aquifers and evaluate their pollution potential. Although attempts have been made to map the pollution potential of aquifers, a detailed analysis of the state's groundwater resources was needed to effectively plan for resource allocation and to delineate priority areas for monitoring and enforcement of groundwater protection rules.

Discussion: DRASTIC is a methodology for identifying vulnerability to groundwater pollution. It uses seven parameters, which are a combination of geologic, hydrologic, geomorphologic and meteorologic factors,to relate an aquifer to the sources of its water and the constituents within that water. The parameters (**D**epth to water, annual **R**echarge, **A**quifer media, **S**oil media, **T**opography, vadose zone **I**mpact, and hydraulic **C**onductivity) are weighted according to their relative importance in determining the ability of a pollutant to reach an aquifer. The parameters are used to produce DRASTIC index numbers from which maps are constructed.

The methodology was developed around a set of basic assumptions concerning a generic contaminant. They are: 1) material introduced at the land surface as a soluble solid or liquid travels to the aquifer with recharge waters derived from precipitation; 2) the mobility of the contaminant is assumed to be equal to that of the groundwater; and, 3) attenuation processes are assumed to go on in the soil, vadose zone and aquifer. DRASTIC was not specifically designed to deal with pollutants introduced in the shallow or deep subsurface, such as leaking underground storage tanks or deep mine wastes.

Ratings for each parameter are assigned depending on the impact of the factor on contamination potential. Ratings vary from 1 to 10 with higher values describing greater pollution potential. These ratings and ranges are used for all evaluations, but the weighting of each parameter changes to account for differences between general land use and agricultural use. Weights vary from 1 to 5 with higher weights representing greater pollution potential. The DRASTIC index number is the sum of the products of each set of rates and weights for each parameter.

DRASTIC was used to produce two Texas maps, one depicting general vulnerability to groundwater pollution, and the other specifically aimed at agricultural pollution. The next step will be to analyze the maps. Questions about the sensitivity, reproducibility, accuracy and subjectivity of the results have not been answered, and it is not yet known how well DRASTIC represents actual pollution potential.

Related Publications: US EPA, *DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings*, EPA/ 600/2- 87/035, Ada, OK, 1987.

Medina, Uvalde Counties Vote to Leave Edwards District

Residents of Medina and Uvalde counties voted to leave the Edwards Underground Water District (EUWD) in January, and that decision leaves the future of a proposed regional water plan in doubt. In Medina County,2,181 voters opted to withdraw from the EUWD, while only 846 people voted to remain a part of the district. The totals were even more lopsided in Uvalde County, where 3,120 voters cast ballots to secede from the EUWD, and only 305 votes were cast to remain with the district.

The elections were called after talks to develop a regional water plan to regulate pumping of the Edwards Aquifer had broken down. The final draft of that plan had called for a controversial limit on aquifer pumping, that some Medina and Uvalde county residents believed violated their constitutional rights and could have limited growth in the area.

Recently, hearings have been held in Uvalde and Medina counties to create county- wide water districts. Meanwhile, two bills have been introduced in the Texas Legislature that may give the Texas Water Commission and EUWD primary authority to regulate the aquifer. HB 2771 was sponsored by Terral Smith (R- Austin), and SB 1441 was co-sponsored by Cyndi Krier (R- San Antonio) and Frank Tejeda (D- Bexar County). The bills are being sponsored by EUWD, the cities of San Antonio, New Braunfels, and San Marcos, and the Guadalupe- Blanco River Authority.

State Agencies Clash Over Arsenic Levels in Texas Groundwater

A recent EPA interim report, *Pesticides in Ground Water Data Base (1988),* has touched off a controversy. The study indicates there are widespread problems with pesticides in Texas groundwater supplies. In its report, EPA relied on test results conducted by the Texas Department of Agriculture (TDA) which show widespread groundwater contamination, but ignored comprehensive reports from the High Plains Underground Water Conservation District in Lubbock which found very little contamination.

TDA officials say their tests showed traces of arsenic in more than 30% of the 116 wells which were sampled statewide. According to TDA, the most polluted samples came from the Lubbock and El Paso areas. However, the the High Plains District tests showed virtually no contamination. District officials say they may seek congressional action if the EPA does not act on a recent letter of protest from the TWC and correct the error. TWC officials have said that they believe the TDA results lack substance and are overexaggerated.

McCarl Named Associate Editor of Water Resources Research

Bruce McCarl, with the Department of Agricultural Economics at Texas A&M University, has been appointed Associate Editor of *Water Resources Research* from

January 1, 1989, through December 31, 1991. *Water Resources Research* is a publication of the American Geophysical Union based in Washington, D.C., which is concerned with the earth and space sciences.

Japanese Professor Studying Aging Water Facilities at UT

Yoshihiko Hosoi, an associate professor from the University of Tokushima in Tokushima, Japan, is visiting The University of Texas at Austin for a year to study methodologies related to aging water facilities. He holds degrees from Kyoto University in environmental and sanitary engineering. Water treatment plants have only been in existence in Japan for abut 100 years. Having recently completed construction of facilities to serve Japan, the government is now concentrating on developing a system to handle older facilities.

Speitel Joins Faculty of UT-Austin

Gerald E. Speitel, Jr. recently joined the faculty of The University of Texas at Austin as an assistant professor of civil engineering. He earned his master's and doctorate degrees from the University of North Carolina at Chapel Hill and has taught in the University of Houston's civil engineering department. Speitel received the 1988 Hering Medal from the American Society of Civil Engineers for demonstrating that the detachment of microorganisms from granular activated carbon depends on the growth rate of the microorganisms as well as the physical shearing forces related to the water velocity through the carbon- packed beds.

San Antonio Proposes to Buy Water from Lake Texana

The San Antonio City Council is considering purchasing the rights to as much as 57 percent of the water in Lake Texana to supplement its water supply. Currently, San Antonio is one of the few cities in the U.S. that is totally dependent on groundwater resources. Recently, it has been exploring the development of surface water resources, including the possible construction of Applewhite Reservoir.

Lake Texana is located 110 miles east of San Antonio in Jackson County and is operated by the Lavaca- Navidad River Authority. Although the lake has an annual yield of 75,000 acre- feet (AF), the only major current purchaser of water from the lake uses roughly 5,000 AF per year. San Antonio would like to buy at least as much as 57 percent of the water in the lake. If the purchase is approved, the water would probably be conveyed to San Antonio via a pipeline that could cost as much as $180 million.

Conservation, Low Crop Prices Lead to Irrigation Water Use Decline

Falling crop prices, rising energy and equipment costs and conservation practices resulted in a sharp decline in irrigation water use in Texas in 1987, according to the Texas Water Development Board (TWDB). Texas farmers used 6.6 million AF to irrigate slightly more than 6 million acres in 1987. In 1985, 8.26 million AF of water was utilized to

irrigate roughly 6.76 million acres. In 1974, 13 million AF of water was used to irrigate 8.6 million acres. Since 1974, water use per acre has improved from roughly 1.5 AF per acre to 1 AF per acre and much of that savings results from improved conservation practices, according to TWDB officials.

Drought Lowers Lake Levels; May have Led to Huge Bird Kill

The 1988 drought lowered lake levels in many parts of the state, but the hardest hit areas were the Brazos and Colorado river basins, according to the Texas Water Commission (TWC). Last September, reservoir storage statewide had dropped to 81 percent of capacity or 26 million AF. At the same time, reservoir storage in the Brazos and Colorado river basins dipped to only 74 percent of capacity.

Fortunately, before the drought developed, statewide reservoir storage was at a record high of 95 percent. TWC officials warn, however, that if current conditions continue, reservoir storage statewide could be reduced to only three fourths of reservoir storage capacity.

Two other effects of the drought are worth noting. The drought may have contributed to a huge bird kill in the Houston area in December, according to the *Houston Chronicle.* More than 5,000 birds died in one of the worst outbreaks of avian cholera ever recorded in Texas. State and federal officials speculate that declining water levels left the birds with fewer places to roost. As a result, the waters had higher concentrations of bird droppings, which may have contributed to the cholera outbreak. In a separate incident, low water levels in the Neches River in east Texas forced the Lower Neches Valley Authority in Beaumont to install temporary salt water barriers across that river to keep salt water from the Gulf of Mexico away from pumping stations.

Governor's Committee Report Recommends Coordinated Water Planning and Policy

The report of the Governor's Committee on Water Resources Management is recommending the formation of a Water Resources Coordinating Council that would improve the way state agencies work together on waterrelated projects. The council, which could be created by executive order, would consist of the Attorney General and the chairmen of the following agencies: Texas Water Commission, Texas Water Development Board, Texas Railroad Commission, Texas Parks and Wildlife Department, Texas Department of Health, Texas Department of Agriculture, and the State Soil and Water Conservation Board. The Council would meet on a quarterly basis and could submit periodic reports to the Legislature. Some of its main functions would be to coordinate programs to reduce duplicative activities and to mediate disputes between the different agencies.

The report, which was released in December 1988, also recommends that river authorities be subject to increased state supervision; that the process for defining critical groundwater areas be streamlined; that areas be identified where conjunctive management of ground and surface water resources would be beneficial; and that

increased funding be provided for water resources research, regional water projects, groundwater monitoring programs, and other efforts.

El Paso Loses Lawsuit to New Mexico

A 10- year- old legal battle between the City of El Paso and the state of New Mexico that would have allowed the city to import groundwater from southern New Mexico has apparently come to an end, according to the *El Paso Herald Post* A federal judge in Albuquerque ruled in late January that El Paso's Public Service Board (PSB) cannot reopen its lawsuit against New Mexico. The on- going lawsuit has cost El Paso ratepayers an estimated $6 to $8 million in attorney's fees and court costs.

Since the judge's ruling, a new plan has surfaced that might reclaim Rio Grande water that could be used instead of the groundwater supplies. This plan would call for the construction of a 100- mile pipeline or cement- lined channel that would carry water from Caballo Reservoir in New Mexico to the El Paso area. The project would utilize as much as 200,000 AF of surplus Rio Grande water that is currently lost to evaporation or seepage. Currently, El Paso produces 110,000 AF of water - 67 percent of which is groundwater for area needs. H the plan is adopted, it could reduce the mining of area aquifers.

Rio Grande Pollution May Threaten Drinking Water

Many Mexican border cities that are too poor to build sewage treatment plants are dumping raw sewage into the Rio Grande, which may threaten drinking water supplies for cities on both sides of the border. According to a copyrighted story in the *Dallas Morning News,* the Mexican city of Nuevo Laredo empties 24 million gallons of untreated wastewater into the river each day. As a result, counts of fecal coliform bacteria in the Laredo area have been as high as 22,000 fecal bacteria per 100 milliliters of water - over 100 times the level U.S. officials consider safe for swimming and human contact.

The problem may be difficult to correct. Laredo, TX operates two sewage treatment plants and both are in compliance with state and federal standards. However, Nuevo Laredo does nothing to treat its wastewater beyond tossing in chemicals to help break up solids, according to the article.

Some help may be on the way. Before leaving office, President Reagan proposed that $7.5 million be allocated for engineering work on a Nuevo Laredo sewage plant, and Texas Governor Bill Clements has promised state aid for the cleanup.

TWDB OK's $200,000 Loan to High Plains Underground Water District

The TWDB has approved a $200,000 loan to the High Plains Underground Water Conservation District No. 1 that will allow farmers to borrow money at low interest rates to purchase water- conserving irrigation equipment. The program is part of a statewide Pilot Agricultural Loan Program that was passed by voters in 1985 and is up for review in the Texas Legislature this year. That program al lows qualifying farmers to borrow up to

75 percent of the purchase price of permanently installed water conservation equipment and 50 percent of the cost of non- recoverable items and services.

Since the program began, the District has loaned almost $2 million and has approved additional bans totaling $600,000. So far, the loans have been used by irrigators to purchase 111 low- pressure center pivot sprinkler systems, 40 surge valves, two furrow dikes, one laser land levelling machine and several LEPA conversion kits.

Groundwater Districts Proposed for Five Texas Counties

At least five Texas counties are considering forming districts to manage and protect their groundwater supplies. The potential districts would be located in Dawson, Pecos, Burnet, Bell, and Harrison counties. In most cases, the Legislature would call an election to create the districts, pending approval by local voters. Maintaining local control over groundwater pumping seems to be the major motivating factor leading many counties to consider forming districts. There were concerns that the Texas Water Commission may form districts with more stringent controls if counties did not take the initiative to form local districts. There were reports that a bill may be introduced in this session of the Texas Legislature that would give the TWC control over groundwater supplies in areas without water districts.

TWRI Publications Report on Crop Yields and Water Use

The Texas Water Resources Institute recently published two free technical reports dealing with water conservation using furrow diking, and factors affecting water use in Texas cities. TR-140, *Furrow Diking Technology for Agricultural Water Conservation and its Impact on Crop Yields in Texas,* reports on the long-term effects of diking on crop yields. The study indicated that furrow diking can be a valuable management practice for about 3.4 million ha of cropped area in semiarid and sub-humid regions of Texas. The practice may be useful in other areas to mitigate the effects of short duration moisture stress on crop yields.

TR-143, *An Analysis of the Effects of Sociodemographic Factors on Daily Per Capita Residential Water Use in Texas Cities* gives information on the relationships between water use and social and demographic factors. Results show that there is substantial regional variation in water use depending on factors such as the total number of housing units, the percentage of the population that is made up of minority groups, age and the level of urban development in the area.

Both publications are available from the Texas Water Resources Institute, 301 Scoates Hall, Texas A&M University, College Station, TX 77843-2118, or call (409) 845-1851.

Proceedings from Conference on Agrochemicals and Groundwater Protection Now Available

Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management is a new conference proceedings available from the Freshwater Institute. The conference was held in October,1988, in Minneapolis.

The proceedings includes papers dealing with best management practices for agriculture; the U.S. Department of Agriculture program for soil and water conservation; pesticides and drinking water; welihead protection; the national pesticide usage data base; funding state and local groundwater protection programs; waste disposal initiatives; sustainable agriculture; computerized systems that apply specific amounts of pesticides and fertilizer; and others.

The 416- page book is available for $35 from: Freshwater Foundation, Box 90, Navarre, MN 553920090. The

phone number is (612) 471- 8407.

Executive Summary of Dryland Farming Conference Now Available

The executive summary of the International Conference on Dryland Farming, which was held last August at Amarillo, TX, is now available. The conference focused on a number of water- related issues including cropping systems that rely on rainfall, development of data bases with specific information on climates; droughts; soil characteristics and water needs of crops; and improving the cost- effectiveness of dryland farming techniques.

Copies of the executive summary are available at no cost from: Texas A&M University Research and Extension Center at Amarillo, 6500 Amarillo Blvd. West, Amarillo, TX, 79106. The phone number is (806) 359- 5401.

Red Tide, Hazardous Wastes Topics of TWC Publications

The Texas Water Commission has released two new publications dealing with red tide, and oil and hazardous waste spills. *Observations on the 1986- 1987 Texas Red Tide* (Report 88- 02), provides information on monitoring of the tide by the Texas Water Commission, its affect on oxygen and pH levels, and maps of the areas affected by the tide. Red tide is made up of patches of single- cell plants that cloud coastal waters. The organisms release toxins that cause paralysis, diarrhea and affect the nervous system of exposed animals. Airborne toxins can cause people i n and around the water to cough and become nauseous and dizzy. Another publication, *State of Texas Oil and Hazardous Waste Substances Spill Contingency Plan (GP* 88- 01) provides general guidance for a coordinated response to spills. It also describes procedures for reporting spills to state and federal agencies.

Both publications are available from the Texas Water Commission, PO Box 13087, Austin, TX 78711. The phone number is (512) 463- 7834.

Texas Water Law *Gives an Up-Close Look at Water Issues*

A new 348- page book provides a comprehensive view of Texas water laws. The book, *Texas Water Law, Vol. I,* was written by Frank F. Skillern, a law professor at Texas Tech University. The book treats such issues as unresolved water problems for the future, including the marketing of water rights and conjunctive management of ground and surface water, and provides a detailed summary of the history of Texas water law. It also examines current Texas water rights and explains how they are administered, and reviews laws governing diffused surface water, groundwater and rate- setting. A companion book, *Texas Water Law, Vol II,* will *soon* be available. Topics in *Vol. II* will include recreation rights, interstate compacts, water agencies and organizations, water quality, and the Texas Superfund program. *Vol. I* is now available for $125 from Sterling Press, Inc., 2161 N.W. Military Highway, San Antonio, TX 78213- 1831. The toll free number is (800) 852- 2123.

LBJ School of Public Affairs Publications Cover Rio Grande Water Issues, Coastal Zones

The LBJ School of Public Affairs at the University of Texas at Austin has published numerous reports dealing with Texas water issues. *Water Management Institutions along the Texas/ Mexico Border(PR* 56) and *A Sourcebook for Rio Grande/Rio Bravo Water Management* (PR 57) are available for $7.50 each. PR 56 outlines local, state and federal institutions in the U.S. and Mexico responsible for the management of water resources throughout the Rio Grande watershed. Details on legislative authority, budgets, board membership and geographical areas are provided. PR 57 is an annotated bibliography outlining articles, monographs and books on topics relating to water resources management along the Rio Grande.

An Institutional and Legal Assessment of an Instream Aeration Project in the Houston Ship Channel (PRI 3), available for $5.00, provides the legal and historical background of the institutional issues surrounding the adoption of an instream aeration project on the Houston Ship Channel. It evaluates possible management schemes and details the legal requirements for the project. *Texas Water Management Issues* (PR 77), originally produced to provide research support to a Texas Senate committee, studies and reviews the powers and duties of major river authorities and water districts in Texas, and can be purchased for $10.00.

To order any of these publications or obtain a complete list of publications, contact the Office of Publications, LBJ School of Public Affairs, The University of Texas at Austin, Austin, TX 78713. The phone number is (512) 471 - 4962, ext. 218.

Toxic Chemicals Found in Trinity River Fish, Wildlife

High concentrations of toxic chemicals, usually found only in water or sediment, have recently been discovered in the Trinity River's fish and wildlife, according to a U.S. Fish and Wildlife Service report, *Impacts of Toxic Chemicals on Trinity River Fish and Wildlife* (November 1988).

Samples of turtles in downtown Fort Worth contained 20 parts per million of PCBs, which is 17 parts per million above the maximum concentration allowable by the U.S. Department of Agriculture and 18 parts per million above that allowable by the Food and Drug Administration. Other contaminants found in high concentrations include PAHs (polycyclic aromatic hydrocarbons), chlordane, chromium, lead and zinc.

The study, which was written by Roy J. Irwin, concluded that chlorinated and raw sewage contributed most heavily to the damage, but added that industrial and residential runoff, landfills and illegal dumping also add to the problem. The report is available from the U.S. Fish and Wildlife Service, Ecological Services Field Office, Room 9A33, Lanham Federal Building, Fort Worth, TX 76102. The phone number is (817) 3342961.

Gulfwatch *Focuses on EPA Gulf of Mexico Program*

Persons wishing to follow the progress of the EPA Gulf of Mexico Program may have an interest in a new bimonthly newsletter titled *Gulfwatch.* The newsletter, a joint effort between Sea Grant Programs in Texas, Louisiana, Alabama, Mississippi and Florida, is free. It focuses on issues that affect the Gulf of Mexico and monitors the activities of the Gulf of Mexico Program. Eventually, that program will coordinate the views of different interest groups and will develop a management strategy for the Gulf of Mexico. To receive a copy, write to *Gulf watch,* Texas Sea Grant Program, PO Box 1675, Galveston, Texas 77553- 1675. The phone number is (409) 740- 4460.

Texas Water Front *is New TWC Newsletter*

The Texas Water Commission has combined its two bimonthly newsletters, *Texas Hazardous Waste Bulletin* and *Texas Water,* into one monthly publication, *The Texas Water Front.* The new publication will cover issues such as water quality, water utilities, water rights and uses, and hazardous and solid waste. Anyone on previous mailing lists is included on the new mailing list.

For a free subscription, contact the Texas Water Commission, Office of Public Information, PO Box 13087, Capitol Station, Stephen F. Austin Building, Austin, TX 78711- 3087 or call (512) 463- 8028.

Milestones *Recaps Century of TAES Research*

The first 100 years of Texas Agricultural Experiment Station (TAES) research, including irrigation and water efficiency research has been summarized in a new book titled *Milestones*, that was produced by the Agricultural Communications Department at Texas A&M University.

Water and irrigation research have been a concern of TAES since it was established in 1888. Over the years, TAES water research has included projects on water quality, irrigation efficiency, water conservation and brush management.

Examples of TAES research include the Low Energy Precision Application (LEPA) irrigation system, which includes the use of furrow diking, conserves water and reduces the rate of depletion of groundwater. If widely adopted, it could add 10 years of irrigation to the High Plains. Studies of alkali soils and saline water have helped farmers learn how to test soil and water to plan efficient management practices.

Studies suggest that reduction of woody plants, which deplete Texas' limited water supplies, would raise agricultural productivity and reduce water scarcity. TAES is now actively involved in research involving water conservation, water supply, water quality, water policy and institutional issues.

Milestones costs $15 and is available from the Agricultural Communications Department, Texas A&M University, College Station, TX 77843- 2112. The phone number is (409) 845- 2211.

Yearbook *Summarizes Geological Survey Research Efforts*

Recent research efforts of the U.S. Geological Survey (USGS) are summarized in *The United States Geological Survey Yearbook (Fiscal Year 1987).* The USGS is currently involved in many research projects including computer modeling and sampling of organic compounds in water systems, and the fate and transport of these pollutants. Other research activities include groundwater protection programs, seismic imaging to reveal the structure of the deep crust of the Earth, and advanced mapping systems.

The yearbook also contains information on USGS efforts to produce geologic maps of west Texas using COGEOMAP, a Federal/State Cooperative Geologic Mapping program that can identify mineral, energy and water resources, and can delineate geological hazards. In the Texas High Plains, USGS studies suggest that playa basins were developed by movement of clay and organic and inorganic material from the surface into the unsaturated zone, thus enlarging the volume of the basin. USGS models may also yield clues as to how playa lakes formed.

Copies of the *Yearbook* are free while supplies last from: U.S. Geological Survey, 8011 Cameron Road, Building 1, Austin, TX 78753- 6716. The phone number is (512) 8325791.

Red River Chloride Control Project Successful, Report says

Salt beds lie under the entire Red River basin and dump salt into the river, making it unsuitable for most beneficial uses. In an experiment to see if the Red River could be turned into a fresh water supply, the U.S. Army Corps of Engineers designed the Red River Chloride Control Project. The pilot project, completed last year, was summarized in a study titled *Report on the Evaluation of the Effectiveness of Operation of Area VIII Red River Chloride Control Project.* Area VIII consists of a series of dams, pipelines and pump stations in Knox County, TX which were part of a network that reduced saltwater flows into the river.

According to the study, saltwater dams diverted 87 percent, or 192 tons of brine daily, exceeding projections of 80 to 85 percent. If $200 million were provided by Congress to fund the construction of 10 more diversion structures, the project could provide 2 million acre- feet (AF) of additional water to municipalities in Texas and Oklahoma and could turn Lake Texoma into a fresh water supply.

For a copy of the report, write to: Red River Authority, 520 Hamilton Bldg., Wichita Falls, TX 76301, or call (817) 723- 8697.

Device to Cut SO_2 Emissions, Acid Rain, Developed at University of Texas

Acid rain damage from sulfur dioxide (SO_2) may be reduced as a result of research at the University of Texas at Austin. A patented method for removing virtually all of the SO_2 emitted by coal- fired manufacturing and power plants has been developed by a group led by Leornardt Keisle, the director of the Mechanical Engineering Design Projects Program at UT. Keisle and UT graduate students designed a synergistic reactor that they believe can be attached to flumes and smokestacks to reduce SO_2 emissions.

In simple terms, low- pressure steam and lime shoot through aerodynamic nozzles into gases formed by burning coal and other organic materials. Moisture is added to form condensation, producing a chemical reaction that removes the SO_2 and produces dry gypsum, which can be recovered and has commercial value. No runoff or other by-products are created by the reaction. The reactor is a fraction of the size of conventional dry air scrubbers and uses half as much energy. It also acts more quickly and makes less noise than other scrubbers.

High concentrations of SO_2 have been found in many metropolitan areas and have been linked to acid rain. The EPA has requested that 10 million tons of SO_2 to be removed from the atmosphere annually, a process estimated to cost $5 billion in the first year.

UT Studies Aim to Biodegrade Hazardous Wastes

A researcher at The University of Texas at Austin is investigating methods to biologically degrade water and soils that have been contaminated by hazardous wastes.

Gerald Speitel, a scientist in UT's Civil Engineering Department, is investigating if beds packed with granular activated carbon (GAC) can remove hazardous wastes through biodegradation and adsoption. In the adsorption process, chemicals accumulate on the surface of the GAC filters. Later, they can be removed from the water. Speitel is now working on ways to make the process more economical. Speitel has also isolated aerobic bacteria that grow on methane that biodegrade such chemicals as chloroform and other solvents and form carbon dioxide. This technique may be used to treat contaminated groundwater on site.

Texas Tech Researchers Hope to Remove Water from Archaeological Site

Texas Tech archaelogists are hoping to learn more about the men and animals that visited Yellowhouse Draw a source of water near Lubbock for more than 10,000 years. They're

running into one obstacle, however. Potential excavation sites are now covered by water. Ken Rainwater of Texas Tech's Civil Engineering Department said that a section of the Lubbock Lake Landmark area is often covered with as much as 5 feet of water when water wells in the area are not being used. Unfortunately, some of the best artifacts are suspected to lie under the areas that most often flood.

To combat the problem, Rainwater and other scientists are developing a computer model that will determine the number of wells needed to allow the area to dry out. Rainwater suggested that non- stop pumping may be needed to keep the area dewatered.

Ancient Sea Rise was Swift, Rice University Scientist Believes

Rice University geologist John Anderson is studying the sea floor off Texas to determine if a rapid melting of polar ice sheets thousands of years ago may have led to a sudden catastrophic sea level rise. As a result, the Texas coastline may have been eroded by as much as a mile per century - 20 times greater than the current rate of erosion.

Anderson and his students have been charting the sea floor and taking sediment samples from the continental shelf off Galveston Bay, the Colorado River delta, Sabine Lake and other locations in a small boat equipped with highly sophisticated equipment. Anderson speculates that changes in ocean currents may have led to rapidly increasing sea levels. He proposes that as warmer water flowed under Antarctic ice sheets, they melted, broke off and drifted away. Once the ice shelves broke free, glaciers may have spilled into the oceans and destabilized other ice sheets in a chain reaction. Anderson hopes that his findings may shed some light on what could happen to coastal areas of Texas if sea level rises in the Gulf of Mexico occur as a result of anticipated global warming.

Texas Radon Levels Highest Along Gulf Coast, Researchers Report

Researchers at the University of Texas are measuring levels of radon and radium in water supplies throughout Texas. A number of researchers took part in the project including Irina Cech, Howard Prichard, Mengistu Lemma and Paul Siegley of the University of Texas School of Public Health in Houston; Alfonso Holguin of the University of Texas School of Public Health in San Antonio; and Charles Kreitler of the University of Texas in Austin. Their results indicate that the highest radon levels in the state are in the Houston area, along the lower Gulf Coast and in west central Texas.

Samples were obtained from both public and private water supplies from four regions: the northern Texas High Plains; Concho, McCullough and San Saba counties in west central Texas; three counties near Houston (Harris, Fort Bend and Montgomery); and nine counties north of Corpus Christi (San Patricio, Refugio, Victoria, Goliad, Calhoun, Karnes, Aransas, Bee and Live Oak). The samples were analyzed at the UT School of Public Health in Houston.

Results indicate that radon levels taken from the Ogallalla Aquifer on the High Plains were within normal ranges, averaging 300 picoCuries per liter (pCi/l). Radon levels from aquifers in west central Texas varied significantly but the highest level recorded for the region was 1400 pCi/l in northern McCullough County. In the Houston area, higher

readings were generally recorded. Radon levels near salt domes in the Tomball area were as high as 3300 pCi/l, while levels as high as 2900 pCi/l were recorded near a salt dome in southern Harris County. Greater concentrations, up to 26,000 pCi/l, were encountered along the lower Gulf Coast.

Results suggest that radon levels may be elevated near salt domes and along fault lines. The study, "Radon Distribution in Domestic Waters of Texas," was printed in the September- October 1988 issue of *Ground Water,* Urbana, IL.

Southwest Texas State Researchers Use DRASTIC Approach to Assess Groundwater Vulnerability

A scientist with the Edwards Aquifer Research and Data Center at Southwest Texas State University is using a tool termed DRASTIC to evaluate the susceptibility of groundwater in the San Marcos region to contamination.

Jane Maler, a researcher at the center, has been studying Hays County, TX, to see which areas are most prone to contamination. Maler said the DRASTIC analysis confirmed suspicions that a narrow recharge zone that runs from the north to the south end of Hays County was the most vulnerable area. It also showed that the Edwards Aquifer was more likely to be contaminated than other aquifers in Texas because it is comprised of porous limestone. Maler is developing maps that show floodplains, recharge zones, and faults in the area to supplement the results.

More information about DRASTIC is contained in the Abstracts section of this issue of *New Waves.*

Texas A&M University, TAMU-Galveston to Take Part in EPA Center for Waste Minimization and Management

Texas A&M University and Texas A&M University at Galveston have been chosen to be part of an EPA Research Center for Waste Minimization and Management. The center is headquartered at North Carolina State University and will serve 13 southern and southwestern states.

The center is the only competitively awarded EPA hazardous waste research center in this region and will bring $1.6 million in research funding to Texas A&M University over the next eight years.

Kirk W. Brown of the Texas A&M University Soil and Crop Science Department specializes in fate and transport of toxic wastes, and will direct administration and research for the Texas A&M University System- based activities of the center. Immediate goals for the center include developing methods to clean up industrial fuel and solvent spills, in- situ decontamination techniques, improving the safety of landfill liners, and strategies that encourage recycling.

Governing Galveston Bay is Focus of Texas A&M University Researchers

Political scientists at Texas A&M University are trying to sort out who controls Galveston Bay. Six federal offices,12 state agencies and hundreds of local governments share authority to develop and regulate the state's largest bay, and each has a different view of how to solve its problems, according to James Anderson and Charles Wiggins of the Political Science Department at Texas A&M University.

Anderson and Wiggins are conducting a systematic study to determine the specific authority of each entity and how the various administrations coordinate their duties. They concluded that no one agency has the authority to control such vital factors as wetlands and land use around the bay. Anderson and Wiggins do not expect that politically unpopular programs such as zoning will be introduced in the region in the near future. Results of their research could be utilized to improve the way the bay is utilized and protected in the future.

TCU Researchers Use New Facility to Study Environmental Problems

Researchers at Texas Christian University have developed a series of large outdoor tanks to study environmental and ecological problems. The facility consists of thirty,1300 gallon f fiberglass tanks, walkways for sampling and a mobile lab for on- site analyses. The system can be used to run controlled experiments using fish and plankton communities and to address a variety of environmental concerns.

Ray W. Drenner, Kyle D. Hoagland, Durward Smith, Wayne Barcelona and Phil Johnson have recently used the tanks to study the effects of insecticides on fish species such as the gizzard shad, and on the aquatic environment. Drenner and Smith have also used the tanks to study the effects of fish and nutrients on plankton populations and water quality.

Texas Tech Receives NSF Grant to Upgrade Water Quality Lab

Texas Tech University has received $46,991 in matching funds from the National Science Foundation to update an instructional laboratory for water quality analyses. The grant will be used to purchase analytical instruments, computers, instructional software, and interactive video discs to provide undergraduate students with formal hands- on instruction in modern research techniques.

Members of the Civil Engineering Department at Texas Tech including R.H. Ramsey, Tony Mollhagen, and Ken Rainwater, will supervise instruction and research in the lab. They believe the new capabilities may provide an estimated 200 graduates with increased employment opportunities over the next five years.

North Texas Scientists Use Earthworms to Test Effects of Toxics

University of North Texas researchers are using earthworms to study how pollution affects humans. Lloyd Fitzpatrick, Barney Venables, and Art Goven of UNT's Environmental Effects Research Laboratory are experimenting with earthworms to assess the impact of pollutants found in industrial waste, city landfills, sewage sludge, and river and lake sediments on human and animal health.

Fitzpatrick says that exposing the earthworms to the pollutants can determine the potential shortterm and long- term risk to humans, since earthworms and humans share similar immune systems. He added that the worms are a perfect biological sentinel because they live underground where the wastes are concentrated. The research is sponsored in part by the National Institute of Environmental Health Sciences (NIEHS).