

ARIZONA WATER RESOURCES NEWS BULLETIN

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SELECTED WRRC RESEARCH FINDINGS

The following articles outline recent, selected University of Arizona Water Resources Research Center (WRRC) research findings along with actual or potential applications to water resource problems in Arizona or, perhaps, in other arid-semiarid regions. These findings were prepared initially for the U.S. Department of the Interior Office of Water Research and Technology.

*Extended Use of Treated Municipal Wastewater by the Buckeye Irrigation Company: A Documentation of Effects (A-050-ARIZ)**

It was assumed in the beginning of this research project that reluctance on the part of some farmers to use treated municipal wastewater might be overcome if more information on successful use of effluent were available.

Treated municipal wastewater does contain agriculturally valuable nutrients which can be an important source of plant food if properly used; or, it can become a serious problem if allowed to pollute surface water and groundwater resources, a condition that may have turned some farmers away from employing such treated wastewaters in the past. In fact, many instances of municipal wastewater use in agriculture during the last century were expedient means of waste disposal rather than planned attempts to derive agricultural benefits.

Research data indicate that the estimated value of treated municipal sewage effluent as a source of water and nutrients for crop production in the greater Tucson area alone would be \$1 million annually. And that estimate does not include the value of extra crop yields obtained from using treated effluent. Every field crop except safflower produced higher yields when irrigated in part with wastewater as compared with crops irrigated solely with well water.

These findings followed a case study of the Buckeye Irrigation Company where such an irrigation regimen was being practiced and hence was an excellent program for study.

"Reporting results of this case study where wastewater is used successfully in combination with other irrigation water

sources seem to be prerequisite to wider acceptance of such irrigation regimens by farmers and the public," said WRRC Director Sol Resnick.

This irrigation regimen is applicable throughout arid regions where both treated municipal wastewater and freshwater sources are available to farmers.

Text and Commentary for a New Weather Control Chapter of the Arizona Water Code (A-064-ARIZ)

Legal scholars perceived potential conflicts between the law and new weather modification technologies shortly after discovery of those new technologies. And because of the scattered litigation and minimal federal legislation that followed, state legislatures and the rule-making of administrators have dominated legal control of weather modification.

The net response to weather modification technology across the country has been legislation in 31 states, at one time or another, to cope with or regulate cloud seeding. These statutes have not been uniform, however, with some merely mentioning atmospheric water resources; even those deemed to be most complete have deficiencies.

It becomes obvious, then, that a comprehensive weather modification control law with wide application would reduce considerably potential litigation stemming from weather modification activities.

Through this study, a weather modification control law was prepared as a substitute for the present weather control chapter of the Arizona Water Code and, further, as a document which could be adapted to improve weather control laws in other jurisdictions.

The tentative draft of the statute was drawn and circulated for comment by experts in weather modification, water resources management, water law and political science. Responses were incorporated into the final document.

That document delineating a proposed weather modification control law has been presented to various interest groups, circulated among weather control agencies and weighed by numerous legislatures across the nation.

*Additional projects information is available from Water Resources Research Center, University of Arizona, Tucson, AZ 85721.



*Effects of Various Pumping Regimens in the Cienaga Basin
on Surface-Water and Groundwater Flows
in Adjoining Basins (A-070-ARIZ)*

Increased groundwater pumpage by industrial, municipal and agricultural users in Arizona necessitates the accurate delineation and inventory of the state's water resources within groundwater basins, especially as water levels decline more rapidly.

A major problem facing investigators is determining interrelationships between surface water and groundwaters. Usually, problems arise in one basin but surface water and groundwater divides are not always coincident and several basins may be affected.

Interrelationships between surface waters and groundwaters, then, must be known to properly manage a given basin's water resources. And it is equally important to know the effects of pumping in one basin on surface-water and groundwater flow in adjoining basins.

Methods for quantifying these interbasin relationships were developed through this study. These methodologies also are applicable to interrelationships within a single basin. Further, it is believed that the products of this research program will be relevant to decision-making processes at the state and county levels.

CONDENSATION

Groundwater Problem-Solving Models

Groundwater-related problems practically unsolvable 15 years ago now can be readily addressed because of new advances in groundwater modeling techniques, according to *U.S. Geological Survey (USGS)* hydrologists Charles Appel and John Bredehoeft of the USGS National Center, Reston, VA.

When these new modeling techniques are "... coupled with reliable knowledge of the geology and hydrology of a problem area," Appel and Bredehoeft note in their recently published report, they become "... powerful investigative and predictive tools for problem solving and water management."

Numerical models of groundwater problems that have been solved on computers since the late 1960s helped predict pollutant migrations, analyzed the interaction between hydrologic and economic considerations, and analyzed the groundwater systems in more than 90 groundwater investigations across the country.

The models involve use of analogs as well as digital computers and mathematical equations. In the analog model, elaborate networks of resistors and capacitors simulate and predict geologic and hydrologic conditions.

"In simplified terms, the resistors represent the resistance to the flow of groundwater in aquifers, the capacitors the storage of water underground, and the movement of electricity through the model represents the flow of groundwater," the authors explain. "By changing the flow of electricity at any point, we can simulate the effect of changes in groundwater recharge or withdrawals," they continued.

National attention has turned to our groundwater resources, water resources that may be 15 to 20 times as abundant as those of the nation's streams, lakes and reservoirs, the authors say. Groundwater accounts currently for about 20 percent of the country's water supplies but increased national

reliance on this resource is inevitable. Further, groundwater reservoirs also may play important roles as artificial storage vaults for excess fluid wastes.

And as the nation turns more to groundwater resources to meet its water needs, water resource scientists and technicians likely will turn more to these computerized, model problem-solving techniques for planning and decision making. Some 55 USGS water resource field offices currently are tied into a central computer through remote terminals, the authors point out.

Copies of the Appel-Bredehoeft report, *Status of Ground-water (sic) Modeling in the U.S. Geological Survey*, USGS Circular 737 are free and available from the Branch of Distribution, U.S. Geological Survey, 1200 S. Eads St., Arlington, VA 22202.

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The Problem of Irrigation Pump Energy

Energy shortages rather than water shortages may strike first to limit crop irrigation practices, according to U.S. Department of Agriculture Economic Research Service researchers Gordon Sloggett and Earle Gavett.

Groundwater supplies in the vast, irrigated portions of the U.S. Southern Plains will be limited by the year 2000 but energy availability to power the irrigation pumps may become a limiting factor within 10 years, at least in some portions of the region, the researchers told the annual meeting of the Soil Conservation Society of America recently in Minneapolis, MN. Many agriculturalists in Arizona could face the same dilemma.

"The total energy used to pump irrigation water, produce additional fertilizer and pesticides for irrigated land, and to accomplish additional tillage and harvesting of irrigated crops is equal to 78 million barrels of crude oil" to work the nation's 35 million acres of irrigated lands, said Sloggett and Gavett.

Thirty-five of the 50 million irrigated acres of cropland in the nation are irrigated with water pumped from wells, lakes, reservoirs and streams. These lands require about 21 percent of all energy consumed in the United States for on-farm food production, the researchers noted.

... *And One Solution to that Problem* could be a prototype deep-well system using solar-powered irrigation pumps. Such a system is under development by the U.S. Energy Research and Development Administration (ERDA) and the State of Arizona. Southwestern farmers facing impending curtailments of natural gas allotments could find a viable alternative to conventional pumping systems in a solar-fired system.

This month ERDA is expected to award three design contracts, each amounting to some \$300,000, for developing cost-effective, 150-kilowatt irrigation pumping systems by the end of 1979. Systems subsequently submitted to ERDA must be capable of pumping water from a depth of 380 feet below earth surface.

The deep-well system selected will be integrated with technology derived from an ERDA-New Mexico joint venture to build a 19-kilowatt solar system in Estancia Valley, east of Albuquerque, to produce the \$1 million prototype solar-powered system.

"The idea is to stimulate the solar industry to use technology it already has and to put it to use irrigating the entire Southwest," according to Porter Grace, project chief of technical evaluation.

PUBLICATIONS

Remote Sensing of Soil Moisture with Microwave Radiometers-II describes soil surface emissivity determination by the dielectrical properties of the surface soil layer several tenths of a wavelength thick. Thermal sampling depths are much greater. The publication, *Report NASA TN D-8321*, is available for \$3.75 per copy from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161.

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Volumes I and II of *Urban Runoff Characteristics* are available now. Volume I, *Analytical Studies*, discusses stormwater management models development and analyses and includes storm hyetographs development and infiltration capacity curves determination for use in hydrologic runoff models; development of *The University of Cincinnati Urban Runoff Model*; and, a general description of the EPA Stormwater Management Model. Results of computer model testing using field data are included. The volume, *Report PB-258 033/OWN*, costs \$10.50 per copy.

Volume II, *Field Investigations*, is a compilation of hydrologic and water-quality data collected from a typical combined sewer-watershed of some 2,380 acres in Cincinnati, OH. Data were gathered over a three-year period and used to test computer models included in Volume I. Volume II, *Report PB-258 034/8WN*, costs \$18.75 per copy. Both volumes are available from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161.

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Polluted Groundwater: A Review of the Significant Literature regarding man-caused groundwater pollution, including causes, occurrences, procedures for control, and methods for monitoring has been published by the Water Information Center, Inc.

About 30 areas of interest are discussed under chapter headings of urban pollution, industrial pollution, agricultural pollution, pollution from wells, salt water and surface water, pollutants and effects, and evaluating pollution.

Not an annotated bibliography, the book is a review of groundwater pollution literature presented in essay form by the authors after they studied some 595 references. Each essay addresses a specific topic.

"This book should serve as a valuable reference for students interested in environmental protection and water pollution control," the publisher states. "It should also be most useful to planners, engineers, government officials, and consultants who are involved with the environmental consequences of land use alternatives," the publisher continues.

About the authors—David Keith Todd is a civil engineering professor at the University of California, Berkeley. His teaching and research interests encompass hydrology and water resources management. Daniel E. Orren McNulty was a student at Boalt Hall School of Law, University of California, Berkeley, when the review was begun.

The 178-page, hardbound book sells for \$16 and is available from Water Information Center, Inc., Dept. 26, 14 Vanderventer Ave., Port Washington, NY 11050.

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A how-to-find-it book for information in the water resources field, *Sources of Information in Water Resources—An Annotated Guide to Printed Materials*, has been published by the Water Information Center, Inc.

"The water resources field is a hybrid, involving civil engineering, law, economics, geology, geography, political science, public administration, and the environmental sciences," according to the publishers.

"This book brings together the sources of information from these various disciplines into one convenient publication," the publisher continues.

More than 1,100 water resources information references useful to students and researchers are cited and annotated. Arranged under 62 subject subdivisions, the cited sources include guides and manuals, bibliographies, indexes and abstract journals, encyclopedias, dictionaries, glossaries, publication lists, handbooks, annuals and directories and data compilations.

Author Gerald J. Giefer has been Water Resources Center Archives librarian at the University of California, Berkeley, since 1959.

The 290-page, hardbound book is available from Water Information Center, Inc., Dept. 25, 14 Vanderventer Ave., Port Washington, NY 11050. It sells for \$23.50 per copy.

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The proceedings of the annual joint meeting of the Arizona Section, American Water Resources Association (AWRA), and the Hydrology Section, Arizona Academy of Sciences, held in Tucson April 28-May 1, have been published as Volume 6 of *Hydrology and Water Resources in Arizona and the Southwest*.

Volume 6 consists of 44 papers including those related to groundwater, water harvesting, solar energy for powering irrigation pumps, water law and policy in Arizona, weather modification, sedimentation, water simulation response on small watersheds, mining and water quality, denitrification in soil columns, recreation and water quality, and grasslands hydrology.

The publication is available at \$10 per copy. Send orders to Linda White, Center for Quantitative Studies, College of Agriculture, University of Arizona, Tucson 85721. Make checks or money orders payable to AWRA, Arizona Section. Earlier proceedings volumes also are available through Linda White.

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An extensive bibliography of research projects and personnel involved in water resources research in the Lower Colorado River Basin has been published using data collected by the Universities of Arizona, California (Los Angeles), and Nevada.

Water Resources Research in the Lower Colorado River Basin, 1972-1976 was prepared for the Bureau of Reclamation and the Office of Water Research and Technology (OWRT), U.S. Department of the Interior.

The purpose of the publication is to advise governmental agencies, private individuals, businesses and members of the university community of current or recently completed water resources research in the lower basin to increase research coordination and information exchange with an eye to preventing research duplication.

Financial support for the 186-page publication came from OWRT, the Bureau of Reclamation and the states of Arizona, California and Nevada.

The bibliography was published by the Desert Research Institute, University of Nevada System, 4582 Maryland Parkway, Las Vegas, NV 89109, and is available from the Institute for \$5. It also is available for \$5 from the Office of Arid Lands Studies, University of Arizona, 845 North Park Ave., Tucson, AZ 85719.

MEETINGS

The **Second Conference on Hydrometeorology** will be held Oct. 25-27, 1977 in Toronto, Canada. Conference objectives focus on the hydrometeorological needs of applied hydrologists and engineers. A call for papers has been issued; titles and short abstracts are requested for sessions emphasizing hydrometeorological aspects of hydrologic design and forecasting of streamflow and water supply, environmental impact, snowfall and snowmelt, and remote sensing. Further information is available from H.L. Ferguson, Program Chairman, Second Conference on Hydrometeorology, Atmospheric Environment Service ARQH, 4905 Dufferin St., Downsview, Ontario, Canada M3H 5T4.

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A call for papers has been issued for the 13th annual conference of the American Water Resources Assn., **Assessment, Management, and Politics of Water**, to be held Oct. 31-Nov. 3, 1977 in Tucson, AZ.

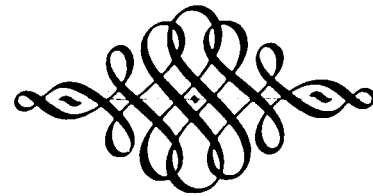
Invited are papers related to any aspect of water resources research, planning, development, management, education, and information systems. Tentative session topics are: national water assessment, water law, water and energy, water and industry, water-based recreation, water quality control, desalination, water conservation, water reuse, limnology, irrigation practices, hydrologic modeling, water planning, flood plain management, education and manpower, decision making, climatic change, and world hunger and water development.

"Authors **must** submit detailed abstracts of their papers no later than March 31, 1977 to be considered," according to the program committee.

"Abstracts may not exceed 200 words in length and are to include the paper's title and authors' names and affiliations. Typing should be single spaced with a left-hand margin of one inch and other margins not less than half an inch. Paragraphs are to be indented five spaces and should be separated by one blank line," say spokesmen for the program committee.

"Five copies of the abstract should be sent, one of which should be the original. Authors **must** also enclose on a separate page the full mailing address, including position, firm or institution, department, and telephone number, for all authors of the paper, and the appropriate topic area for the paper from the above list," the committee says.

Abstracts should be addressed to one of the co-chairmen of the Technical Program Committee, Dr. Stanley N. Davis or Dr. David B. Thorud, Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ 85721.



Please address your news items or comments on the News Bulletin to any of the three editors:

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