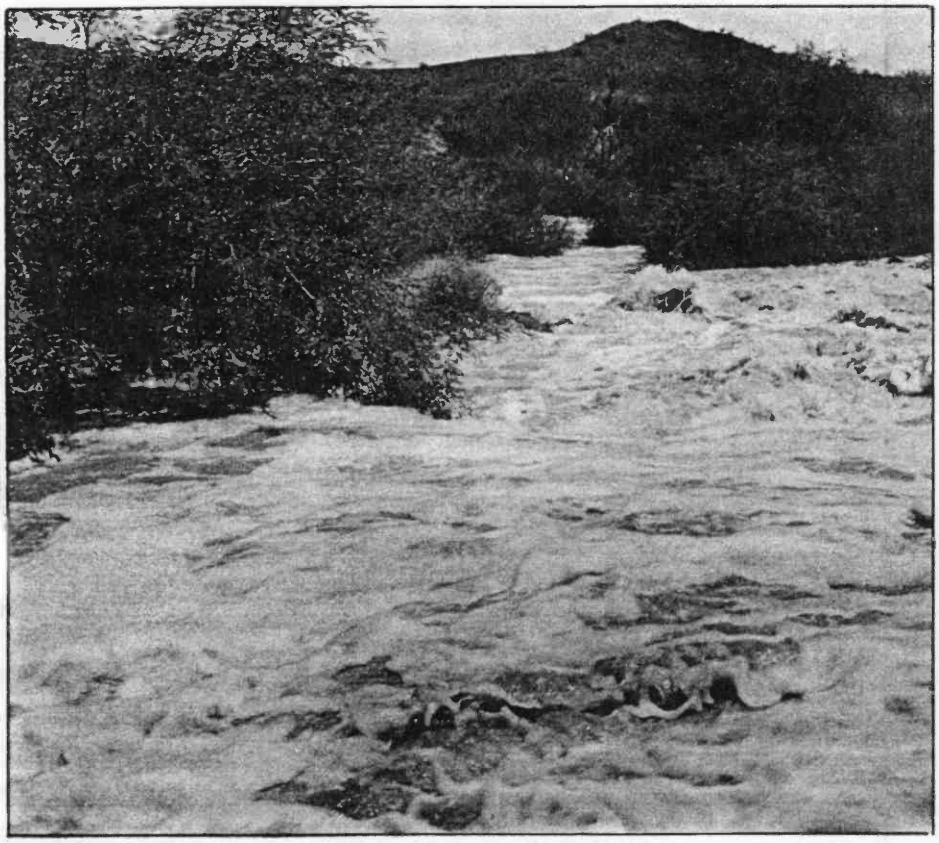
ARROYO

Vol. 1 No. 1 Spring 1987



New Name, Format For Newsletter

Arroyo replaces *Water Resources News Bulletin* as the name of the Water Resources Research Center's quarterly newsletter. A new name was chosen to go along with other recent changes to the newsletter—expanded coverage, enlarged mailing list, new format. We thank those who returned the questionnaire from the last issue since their suggestions provided helpful ideas and insights as the newsletter was revised.

Arroyo was chosen as a name because it seems to fit a newsletter about water in the arid Southwest. Water centers in other states have newsletters with such names as *Water Current*, *Ripples* and even *Fresh Drops*. Obviously, arid lands evoke a different type of water image. *Arroyo* conveys an image of water as it is known in Arizona—uncertain, infrequent, often inaccessible and occasionally coming down in a deluge to flow away in a flood.

Arroyo will bring you water news from Arizona and the Southwest.

Arizona Department of Water Resources Developing Second Management Plan

The continued funding of the Central Arizona Project depended upon Arizona implementing water conservation measures in several critical areas in the state. Water consumption patterns in these Active Management Areas (AMAs) will be guided between 1980 and 2025 by a series of five management plans to be developed by the Arizona Department of Water Resources (ADWR).

ADWR is now in the final stages of preparing the Second Management Plan (SMP) which will be in effect between 1990-2000. The Groundwater Code specifies that a plan for this period will be promulgated no later than January 1, 1988. The plan's major objective is to achieve significant progress toward safe yield (annual water withdrawal balanced by annual recharge) for the Phoenix, Tucson, and Prescott AMAs. The plans also intend to maintain the agricultural economy of the Pinal AMA, while ensuring adequate water supplies for future non-irrigation purposes in the region.

The SMP will be prepared through a three-step process. Step one includes plan formulation, data collection, and

development of baseline studies of agricultural, municipal, and industrial water use patterns. Step two will concentrate on developing conservation requirements for each use sector, and identifying conservation requirements for distribution systems. Also during step two, the ADWR will examine water augmentation options, including incentives for artificial groundwater recharge. Finally, during this phase, ADWR, in cooperation with the Arizona Department of Health Services (and subsequenty, the Arizona Department of Environmental Quality), will develop strategies to assess groundwater quality in the AMAs. The ADWR will prepare the actual plan document in step three.

A series of planning committees and subcommittees have been developed to guide the plan preparation process. A Steering Committee (which includes the ADWR's Chief Deputy Director, Chief Counsel, Deputy Directors of Engineering, Adjudication, and Administration and Water Management, as well as the four AMA Directors) is responsible to oversee the process to ensure that plans are consistent with legal requirements of the Groundwater Code and ADWR goals. A Plan Development Committee has also been formed to review work plans from five technical subcommittees; to identify issues needing resolution; and to coordinate the planning process. The five technical subcommittees (concerned with agriculture, municipal and industrial uses, water resources, augmentation and reuse, and water quality) were developed to prepare the work programs for the SMP.

The five technical subcommittees have made substantial progress developing the work program elements. The Agricultural Conservation subcommittee has determined potentials for using effluent; determined conservation requirements for irrigation district distribution systems; developed and reviewed crop water requirements; identified characteristics of alternative irrigation systems; and determined areas of similar farming conditions and developed maximum conservation goals for each.

The Municipal and Industrial subcommittee has collected water use data from large providers; identified alternative methods to achieve conservation; determined conservation potentials for each provider; and begun to develop programs to achieve conservation.

The Water Augmentation and Reuse subcommittee has developed a priority listing of augmentation sources for further study. Also, for each identified source, the subcommittee has conducted a literature search; collected data on water availability; and identified potentials for direct use and/or water storage. The subcommittee has also begun an analysis of management strategies.

The Water Resources subcommittee has developed baseline water budgets and has begun to develop scenario-generating strategies to identify the effects of various management alternatives on future water supplies.

Finally, the Water Quality subcommittee is conducting a joint ADWR/ADHS assessment of existing water quality. In addition, this subcommittee is examining ADWR's statutory authority under the Groundwater Code to identify the most effective ways for the department to integrate water quality considerations into the developing SMP.

Preliminary draft documents from the five technical subcommittees are anticipated to be completed by the end of July, 1987. These draft documents will then be reviewed by the Steering Committee, the Groundwater Users Advisory Councils (which are five-member boards created by the Groundwater Code to make recommendations on management programs and policies, and to provide comment and guidance to the AMA directors in the development of the management plans), and other public advisory bodies. The final draft of the Second Management Plan will be completed by October 1, 1987, and will be subject to review in formal public hearings to be held in each of the four AMAs during November. The Second Management Plan will then be promulgated on January 1, 1988. ▼

INVITED COMMENT

ADWR Chief Outlines Plans, Progress

Alan P. Kleinman, director of the Arizona Department of Water Resources, contributed the invited comment. Dr. Kleinman, who took over as director in February, is a resource economist with 25 years of experience working with water resource issues in the West.

Growing up on a Mesa, Arizona, dairy farm I had the opportunity to learn firsthand the critical role water supply problems play in economic survival. As a resource economist for the past 25 years, I have worked on water supply issues throughout the West. Now, as director of the Arizona Department of Water Resources, I face the challenging task of helping to ensure a dependable water supply for future generations. Luckily, the department has a very professional, dedicated staff to assist me in this task.

Arizona's major water problem is the imbalance between the water consumed and the dependable supply. We currently rely on groundwater for over 60 pecent of our water supply. Arizonans annually consume approx imately 2 million acre-feet more groundwater than is replenished by nature.

Arizona's water future will be more secure if we reduce mining of our groundwater supplies and reserve them for times of emergency, such as a prolonged drought. Many factors will contribute to our success in elin. inating groundwater overdraft, including completion of the Central

Arizona Project, implementation of the 1980 Groundwater Management Code, encouraging groundwater recharge, and increasing our water supplies through effluent use, weather modification utilizing storm-water runoff and watershed management.

The Central Arizona Project will be a tremendous help in solving our groundwater overdraft problem. The estimated long-term CAP water supply is 1.2 million acre-feet annually—approximately two- thirds of the current rate of overdraft in central Arizona. The Department of Water Resources will continue to be a strong supporter of CAP and Plan 6 features of the project. I'd also like to expedite use of our full CAP water allocation. Arizona should be recharging as much CAP water as possible while we are waiting for municipal treatment plants and agricultural distribution systems to be completed.

Arizona is fortunate to have the most comprehensive groundwater law in the nation. One of the primary goals of the Groundwater Code is to control the severe overdraft of groundwater currently taking place in many parts of the state.

The department's staff has done an excellent job of implementing the Groundwater Code over the last six and one-half years. Groundwater rights have been quantified; the first management plans have been adopted; work is well underway on the second management plans; and our enforcement program is in full swing.

January 1, 1987, was the compliance date for the first mandatory conservation requirements in the Tucson, Phoenix and Prescott Active Management Areas. The department will be able to verify compliance when the 1987 pumpage reports are submitted.

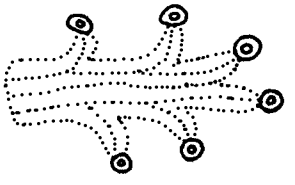
During this legislative session (1987) two bills were introduced in the Arizona Legislature (S.B. 1452 and H.B. 2309) that would significantly impact the Groundwater Code. The department is opposed to most of the provisions of these bills, and I testified so at a Joint Legislative Hearing. The Groundwater Code is not perfect, and each year the department supports legislation that fine-tunes the Code. However, as director of the Department of Water Resources, I could never support legislation that severely hampers the state's ability to achieve safe yield.

While the Code strives to reduce groundwater use, the department is also assessing the potential for increasing Arizona's water supplies. Watershed management, weather modification, utilization of storm-water run-off and effluent use are all being studied.

During the 1986 legislative session new groundwater recharge legislation was passed. Under this legislation the department is responsible for issuing permits, site inspection and record keeping for two types of projects. Recharge Projects are designed to replenish groundwater aquifers, with no specific withdrawal rights for project sponsors. Storage and Recovery Projects store surplus water for future withdrawal by the project operator.

In addition to these activities the department will also resume some long-range planning efforts. At the request of Governor Mecham we are working on a 50-year plan which will project future water supplies and demands.

As you can see, many efforts are continuing to ensure that Arizona has a plentiful water supply for future generations. ▼



Aztec glyph of dry, sandy riverbed.

LEGISLATIVE NEWS

The new federal Water Quality Act became law on Feb. 4, 1987, not, however, before confronting some obstacles. The 99th Congress unanimously passed clean water legislation, but it was pocket-vetoed by the president. A new congress passed the same bill, and it again met with a presidential veto. Congress then overrode the veto.

The new legislation amends and reauthorizes the Clean Water Act of 1972 (PL 92-500) which controls water pollution by establishing limits to wastewater discharges into lakes and streams. The 1987 amendments, however, also set up new initiatives, including a program to control pollution from non-point sources. This means rainfall runoff from farm and urban areas, construction, forestry and mining sites and other diffuse or non-point sources will now be controled to limit pollution. Many see this as a needed new emphasis to the act which previously focused on pollution from point sources; i.e., distinct sources such as industrial or municipal facilities.

Non-point sources of pollution are emerging as a major concern since pollution from point sources is being reduced through regulatory actions. As a result, pollution from non-point sources now contribute a larger proportion to the nation's water quality problem. Estimates indicate that as much as 50 percent of the U.S. polluted water comes from non-point sources.

Arizona's non-point pollution comes from various sources. Agricultural runoff includes salts and nutrients from fertilizers as well as pesticides. Areas heavily grazed by cattle also contribute non-point pollution. Mining and industrial sites are believed to be sources of non-point pollution. Also,

Arizona's limited surface water attracts intensive recreational use; the many boaters, swimmers and other visitors who visit Oak Creek Canyon, Lake Powell and the Chain of Lakes along the Salt River are sources of non-point pollution.

The 1987 amendments contain the following provisions to control non-point sources of pollution:

Within 18 months each state is required to submit a program for managing its non-point-source pollution to the Environmental Protection Agency for approval.

EPA will approve or disapprove programs within 180 days. States whose programs are disapproved will be notified of changes needed to gain approval. EPA will draw up programs within 30 months for states that do not submit plans. Also, local agencies can draw up their own programs with EPA assistance.

EPA is authorized to provide grants of up to 37.5 percent of the total cost to states to implement approved non-point source management programs.

EPA is authorized to make similar grants to states having approved plans to carry out groundwater quality protection projects with a federal share of up to 33.3 percent of the total cost.

Although applauding the emphasis on non-point sources of pollution, some critics fault certain aspects of the act. Some complain that the amendments do not call for mandatory controls on non-point sources; instead, states are directed to conduct planning studies to look into such controls. Others are disappointed that a statutory program is not set up that would record early results to determine later progress.

Arizona is ahead of the federal government and most other states in its concern with non-point sources of pollution. The state's Environmental Quality Act, which became effective last summer, establishes authority for control of pollution from non- point sources. ADHS is now working to draw up EQA regulations. Final regulations on non-point-source pollution are expected to satisfy EPA's requirement that states have a program to control this threat to water quality. ▼

RESEARCH NEWS

Each issue of Arroyo *presents brief descriptions of water research projects relevant to Arizona. Presented in this issue are abstracts of some of the papers presented in the hydrology section at the 31st annual meeting of the Arizona-Nevada Academy of Science on April 18, at Northern Arizona University. The complete proceedings will be published this summer and will be available from the Arizona Section, American Water Resources Association, 845 North Park Avenue, Tucson, AZ 85719, c/o Dale Wright.*

Simulating the Impacts of Fire: A Hydrologic Component

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William O. Rasmussen
D. Phillip Guertin
University of Arizona
Tucson, AZ 85721

To aid land managers in estimating the impacts of fire on ponderosa pine forest ecosystems, a computer simulation model has been developed to obtain estimates of benefits and losses after a fire on vegetative components, wildlife components, and hydrologic components. Regarding the hydrologic components, annual streamflow and changes in water quality, if any, are estimated through analyses of time-trend response functions. For simulation purposes, the time-trend response functions are translated into an index of benefits or losses by initially determining streams of annual ratio values. The technique also converts the flows of benefits or losses (that is, the streams of annual ratios) to annuities, or equal annual returns from the resource. While annuities are normally thought of in terms of dollars, the concept is equally applicable to non-monetary flows such as annual streamflow and changes in water quality.

Predicting Solar Radiation From Cloud Cover For Snowmelt Modeling

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Peter F. Ffolliott
University of Arizona
Tucson, AZ 85721

Much of the water in Arizona originates as snowmelt runoff. Improvement of techniques to predict the amount and timing of snowmelt runoff may increase the efficiency by which this water can be used. To improve the prediction techniques, efforts have been made to model snowmelt processes through computer simulation. Most snowmelt models require measurement of solar radiation, a primary source of energy for snowmelt. Unfortunately, direct measurement of solar radiation is not routinely available. To estimate solar radiation from readily available information, equations have been developed to predict daily direct and diffuse solar radiation from knowledge of opaque and transparent cloud cover. Through use of these equations, a watershed manager can apply snowmelt computer simulation models to areas without direct measurement of solar radiation by using daily cloud cover information obtained by on-site observations.

Flood Routing in Broad Ephemeral Stream Channels

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Hebert Osborn
Agricultural Research Service
United States Department of Agriculture
Tucson, AZ

Flood modeling in broad, sandy channels is complicated by the presence of transient, meandering subchannels. A simple functional relationship between flow rate and channel cross- section geometry was incorporated into an existing computer model (KINERSO). Both the original and altered versions were used to route seven flows between measuring stations (Walnut Gulch, Arizona). The bed abstraction component

was adjusted to match simulated and observed peak flow rates. Simulated and observed total flow volumes were compared. The altered model reduced the error in volume by an average of 35 percent. Perhaps more significant, the optimal bed abstractions were much more reasonable.

Analysis of Natural Ground-Water Level Variations for Aquifer Conceptualization

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Ross Wolford
Donald R. Davis
Soroosh Sorooshian
University of Arizona
Tucson, AZ 85721

Statistical evaluations of time-series groundwater data can be used to infer groundwater flow concepts. Advantages of such passive methods of analysis may include relative simplicity, low cost, and avoidance of disturbances typically associated with stress testing of aquifers. In this analysis, selected statistical methods were used to draw inferences on the characteristics of an aquifer within the Columbia River basalts in the Pasco Basin of south-central Washington. This information will be used in developing a conceptual model of groundwater flow and in the planning of future hydrologic field investigations.

Among the types of conceptual information derived from statistical methods are time-series relationships between the basalt aquifer and the Columbia River and the probable roles of structural deformations (primarily anticlinal folding) for providing impediments to lateral groundwater movement. Hydrographs recorded in observation wells straddling a known subsurface hydrologic barrier transverse to the Cold Creek Syncline were correlated to determine the effectiveness of the barrier in isolating hydraulic stresses. The conceptualizations derived from statistical analyses were, in several cases, able to be compared with interpretations derived on the bases of subsequent stress responses.

A Seasonal Analysis of Colorado River Flows Through the Grand Canyon, Arizona, 1914-1984

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Stanley S. Beus
S.W. Carothers
Northern Arizona University
Flagstaff, AZ 86011

Seasonal and periodic variations in Colorado River flows through the Grand Canyon regulate the biological/riparian communities that have become established in the area. Fluctuating flows also have a marked effect on the existing beaches formed as river terrace deposits in the Grand Canyon. Both the above features are considered critical resources to recreationists in the Grand Canyon. The timing and magnitude of reservoir releases as well as other aspects of river regulation are thus important considerations in recreational resource management and in total systems management of the Colorado River.

Glen Canyon Dam has controlled flows through Grand Canyon since 1962; this study presents monthly statistical data for both pre- and post-dam periods and demonstrates the relation of the 1983, 1984 high water releases to the historic record.

Water Quality of the Upper San Pedro Basin, Arizona

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Arizona State University
Tempe, AZ 85281

Due to rapid population growth, quality of the limited water resources of the Upper San Pedro Basin (USPB) in southeast Arizona has become a major concern. Available data shows water quality is generally good except for several localized problems. An area near St. David is now on the EPA's superfund priority list. High nitrate concentrations make surface and groundwater unpalatable and potentially harmful to infants younger than three months old. Coliform concentrations are the most frequently violated state surface water quality standard in the USPB. Probable sources include occasional releases of raw sewage from a wastewater treatment plant in Naco, Mexico; runoff from grazing land; leaky septic tanks; and ineffective sewage treatment plants. Reports indicate continuing occasional minor releases of acidic, heavy metal polluted water from the Cananea mine operations in Mexico. Several major mine water releases occurred during the 1970s that seriously affected water quality of the San Pedro River killing all aquatic life along 60 miles of its length. Other USPB water quality issues include mine waste spills and leaks, rainwater contamination by smelter emissions, spills of hazardous material in transport, and potential contamination from pesticide applications, landfills, and underground storage tanks.

A Risk Analysis Approach to Groundwater Quality Management in the Upper Santa Cruz Basin

T. Richardson, Donald Davis
University of Arizona
Tucson, AZ 85721

Potential groundwater contaminant sources in the upper Santa Cruz basin that pose risks to human health include copper mines, irrigated agriculture, and urban wastewater. Analysis of these risks provides useful information for comparing groundwater quality management alternatives. Alternatives include preventing the input of contaminants at their sources, preventing migration of contaminants in groundwater to withdrawal points, and removal of contaminants at the points of groundwater withdrawal. The framework for risk analysis is composed of hazard identification, hazard evaluation, risk evaluation, and identification of risk response alternatives. Potential contaminants identified range from inorganic ions to complex organic molecules. Hazards have been evaluated in terms of fate of potential contaminants in the environment and their toxicity. Risks to groundwater quality and human health in time and space are described with the use of a groundwater contaminant transport model. Because information for the

analysis is incomplete, the evaluation of risks is not without uncertainties. Major uncertainties remain in data on contaminant concentrations and toxicology of contaminants.

RESOURCES AND INFORMATION

Arroyo will feature in each issue a resource or source of information of interest to people concerned with water issues. The intent is to inform readers of the varied water-related resources and information sources available to both professionals involved with water projects and to the general public. This issue features state government agencies that are involved with water—Arizona Departments of Water Resources and Health Services and the Arizona State Land Department.

Arizona Department of
Water Resources
99 East Virginia
Phoenix, AZ (602) 255-1550

The following water resources data are available from ADWR:

The Groundwater Site Inventory (GIS) is a computerized data base with information on over 30,000 wells and springs in Arizona. Available information includes well location, construction, depth, ownership, water levels and limited water quality measurements. For information, contact ADWR's Hydrology Division, (602) 255-1586, extension 31.

ADWR's Operations Division has computerized information about the following: 1) all registered wells; 2) cities, towns and private water companies providing water; 3) irrigation districts; 4) grandfathered groundwater rights; 5) Groundwater Withdrawal Permits issued since 1980; 6) water usage and rights in Irrigation Non-Expansion Areas; and 7) surface water rights. For information, contact ADWR's Operations Division, (602) 255-1581.

Written reports are available from ADWR's Basic Data Section, (602) 255-1543. The "Hydrologic Map Series" is produced by the Basic Data Section and is available for a small fee. The USGS "Water Resource Investigation" series is available at no charge.

Arizona Department of
Health Services
Division of Environmental
Health Services
2005 North Central
Phoenix, AZ 85004
(602) 257-2306

The Arizona Department of Health Services' Division of Environmental Health Services is concerned with the administration and regulation of state water quality programs and can provide the following information: the regulations and statutes concerning wastewater, water pollution and hazardous waste; annual reports that summarize the activities of hazardous waste, drinking water and water pollution compliance programs; engineering reports on drinking water, wastewater and septic tank systems; and various reports from studies on surface and groundwater quality. ADHS maintains a bibliography of technical and research reports on environmental topics which is to be updated quarterly.

Also, ADHS participates in the STORET national water database. The STORET system contains a comprehensive base of water quality data, in addition to an expanding coverage of data on soils, water discharge rates, groundwater and other topics. Data retrievals can be made in a variety of formats. For information regarding details of data retrieval, call 1-800-424-9067 and ask for STORET User Assistance.

Arizona State Land Department
1624 West Adams
Phoenix, AZ 85007
(602) 255-4629

The Arizona State Land Department administers about 9.8 million acres of state trust lands for the benefit of the common schools and numerous other beneficiaries. Since water resources are a valuable product of state lands, ASLD collects and processes a considerable amount of water-related information derived from water sales, adjudication, and the documentation of groundwater use. Sale of water from state lands through a bidding process necessitates appraisals based on data regarding water quantity, location and use. Also, the continuing process of adjudication of surface-water rights in Arizona's major river basins involves the ongoing collection of surface-water data. This data is entered into the ASLD's natural resource database. Call (602) 255-4061 to inquire about the database. ▼

PUBLICATIONS

The Magnificent Experiment: Building the Salt River Reclamation Project
by Karen L. Smith

This book details an extended case study of water resources planning and management in an arid environment. It examines the cooperative and conflicting relationships between individuals and institutions that culminated in the creation of the Salt River Project. The University of Arizona Press, 1615 East Speedway, Tucson, AZ 85719. $22.50.

Issues With Risks
by Harald Hiessl and Marvin Waterstone

This issue paper is published by the Arizona Water Information Center. The publication provides a general but practically-oriented examination of the complicated issues which underlie decision-making in risky situations. The booklet is the first of a series with

other papers to follow addressing more specific water-related risk situations. The series is designed for professionals whose work requires an understanding of risk analysis.

To purchase this publication, write to: Librarian, Arizona Water Information Center, Geology 318, University of Arizona, Tucson, AZ 85721. (602) 621-1648. $4.

Government Publications

Distribution and Movement of Trichloroethylene in Ground Water in the Tucson Area, Arizona

Water-Resources Investigations Report 86-4313

This report states that TCE groundwater contamination in the Tucson Airport area encompasses about five square miles of aquifer surface area. Also, most of the TCE contamination is in the uppermost 100 feet of the groundwater flow system because a clay layer restricts the downward movement of groundwater and TCE.

Copies are available for inspection at U.S. Geological Survey offices and can be purchased from the U.S. Geological Survey, Books and Open-File Reports Section, Building 810, Federal Center, Box 25425, Denver, CO 80225. Microfiche $4.75; paper copy $11.00.

Potential for Aquifer Compaction, Land Subsidence, and Earth Fissures in the Tucson Basin, Arizona

Open-File Report 86-482

Aquifer compaction and land subsidence are occurring in the Tucson basin as a result of groundwater pumping. This report indicates that the magnitudes of measured compaction and subsidence are small at present, but may increase substantially in the future if groundwater levels continue to decline.

Copies are available for inspection at U.S. Geological Survey offices and will be published at a later date as *U.S. Geological Survey Hydrologic Investigations Atlas.*

Hydrologic Map Series Report Number 12

This report contains maps showing groundwater conditions in the West Salt River Valley, East Salt River Valley, Lake Pleasant, Carefree and Fountain Hills Sub-basins of the Phoenix Active Management Area.

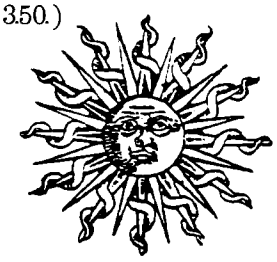
The report can be obtained for a small fee from the Arizona Department of Water Resources, 99 East Virginia, Phoenix, AZ 85004; or call (602) 255-1543.

Proceedings

Arid Lands: Today and Tomorrow

Described as an international research and development conference, this meeting was held in Tucson October 20-25, 1985. The proceedings contain papers by more than 130 arid lands scientists covering a broad range of topics on critical arid lands issues, including desert ecology, irrigation and water management, small-scale water management and water policy.

Expected publication date is summer, 1987. The volume can be ordered from: Publications, Office of Arid Lands Studies, University of Arizona, 845 North Park Avenue, Tucson, Arizona 85719 (602) 621-1955. U.S. price, $70. (Arizona residents add 5% sales tax, $3.50.)



Water Markets and Transfers: Arizona Issues and Challenges

These proceedings are from a symposium organized by the Arizona Section of the American Water Resources Association and cosponsored by the Arizona Hydrological Society. The symposium was held in Tucson on November 7, 1986.

To order this volume and other AWRA publications, contact: Ms. Dale Wright, Office of Arid Lands Studies, College of Agriculture, University of Arizona, 845 N. Park Ave., Tucson, AZ 85719. (602) 621-1955. $12.

CONFERENCES AND SEMINARS

Call For Papers

Regional Conference on Water Marketing

October 8-9, University of Denver, CO

Topics include an overview of current market activities and issues; practical perspectives from water managers, appraisers, attorneys and irrigators; a review of the expanding government role and the public interest; and assessment of future trends.

For additional information about submitting papers, contact: Steven J. Shupe, Watershed West, P.O. Box 8854, Santa Fe, NM 85704; (505) 983-9637.

Meetings

International Symposium on Design of Hydraulic Structures

August 24-27, Fort Collins, Colorado

The major objective of the symposium is to collect and motivate creative, theoretical, and practical approaches to the design of hydraulic structures.

For additional information contact: Department of Civil Engineering, Room 203, Weber Building, Colorado State University, Fort Collins, CO 80523 (303) 491-5753.

Agricultural Impacts on Ground Water

September 29-October 1,
Des Moines, Iowa

The Association of Ground Water Scientists and Engineers has scheduled its second Agricultural Impacts on Ground Water Conference to stimulate the exchange of ideas regarding agricultural practices and ground water quality.

For additional information contact: Agricultural Impacts Conference, National Water Well Association, P.O. Box 182039, Department 017, Columbus, OH 43218 (614) 761-1711.

Geological Society of America's Annual Meeting & Exposition

October 26-29,
Phoenix, AZ

For information about the meeting, call (303) 447-2020. Preregistration is due September 25.

American Water Resources Association Conference and Symposium

October 31-November 6,
Salt Lake City, Utah

The theme of AWRA's twenty-third annual conference is *Averting Water Crises. Water Resources Related to Mining and Energy—Preparing for the Future* will be the topic of discussion at the symposium.

For information about the conference contact: A. Bruce Bishop, Dean, College of Engineering, Utah State University, Logan, UT 84322-4100 (801) 750-2775.

For information about the symposium contact: Richard Dworsky, Chief of Planning & Evaluation, U.S. Bureau of Land Management, 701 "C" Street, Box 13, Anchorage, AK 99513 (907) 271-3349.

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