COLORADO WATER

Colorado Water Resources Research Institute • Colorado State University • Fort Collins, Colorado 80523

October-December, 1985

COLORADO'S WATER RESEARCH CONFRONTS CHALLENGES FACED BY WATER USERS AND MANAGERS

A physician, if asked why medical research is necessary, would be puzzled because everyone knows what continuing advances in medical technology and scientific knowledge mean to the human condition. A water scientist, if asked why water research is necessary, would be equally puzzled with the question because water is essential to life — more so than any other resource — and certainly crucial to the quality of life in the water-short West.

Water is seldom in the right place at the right time in the right amount. Population growth pressures and regional shifts in population have brought new and competitive demands for water, sometimes conflicting with the traditional and historical patterns of water use. While this remains the basis for Colorado's water problems, the issues to be resolved are vastly more complicated today than ever before. The many new considerations such as water quality, endangered species protection, wild and scenic rivers and recreational uses have added substantial limitations to water development and management. Colorado's water research program is designed to produce the scientific knowledge and new technologies that are needed to help resolve these problems.

Water scientists in Colorado's four major research universities are ready and willing to be called upon for their contributions. Through the Institute their work can be directed, coordinated and managed to focus on Colorado's priority water problems. What is needed is a fiscal base that will allow continuity and stability in the research program. Federal fiscal support is no longer adequate for this purpose and further, federal funds are only available to cost share with state funds. If Colorado chooses to have a managed water research program directed at priority problems, the budget request now before the Joint Budget Committee will have to be recognized and favorably acted upon (as has been done in all of our neighboring states).

Directed research in the State water research program for the past two decades has helped water managers solve their problems in such areas as urban water supply management and conservation; municipal and industrial waste treatment and disposal; protection and enhancement of environmental quality; recreation resources management; fishery and wildlife management; optimum basinwide water utilization; interstate compact requirements; interbasin water transfer; groundwater management; and many others.

This issue of *COLORADO WATER* describes current Institute research that is designed to meet both water development and water management challenges which confront Colorado water users and managers. Research and technology development are being conducted on priority problems in: groundwater quality protection and management; impacts of the Endangered Species Act; compensation for out-of-basin export; low-flow criteria for waste discharge permits; the Closed Basin Project; agricultural water conservation; optimum reservoir siting and sizing; voluntary, integrated basinwide water management; drought analysis; and computer-based river basin simulation.

GROUNDWATER

Monitoring Strategies for Groundwater Quality Management

One of the reasons that we continue to face water quality crises is that in many cases the problems have been undetected by existing water quality monitoring programs. This is especially true for groundwater quality.

This Institute project is developing criteria for a groundwater network design and data management system that can be integrated with the decision-making processes of governmental regulatory agencies. Project activities include an investigation of: (1) the legal and administrative requirements for groundwater quality monitoring; (2) the current state of monitoring activities; (3) statistical characteristics of groundwater quality random variables; (4) statistical methods for analyzing groundwater quality data; and (5) the implications of these findings on the network design and data management system.

Potential Aquifer Contamination from Chemigation

This project is investigating and assessing the potential hazard of groundwater contamination from chemigation and the feasibility of aquifer cleanup in case of accident. The probability of failure and the reliability of backflow preventive systems is being assessed.

Groundwater Aquifer Recharge

Artificial groundwater recharge is coming into focus as a very important technology yet to be fully utilized. Four out of five Colorado water supply systems rely at least partially on groundwater for their drinking water. A substantial portion of Colorado's irrigated agriculture also relies upon groundwater fully or in part. Replacement of groundwater storage, like replacement of surface reservoir storage, will be a critical future step in water supply management for Colorado's water users.

A strong irrigated agriculture economy in Colorado's Eastern High Plains depends upon the Ogallala Aquifer. Its useful economic life is projected to be only a few decades. Already significant acreage of land has been withdrawn from irrigation because of increasing pumping lifts with associated high costs. Indications are that the life of irrigation for the area will be even less than forecast. (See the Institute's analysis and report with those projections, TR No. 34.)

San Luis Valley. — The fertile crop-growing valley of the Rio Grande River in San Luis Valley is another very important contributor to Colorado's economy, dependent in heavy measure upon groundwater. Innovative methods of conjunctive management of surface and groundwater in that valley offer the only real hope for future economic stability. Again, groundwater recharge is a critical technology in that future. (See the Institute's report on a recharge project in the San Luis Valley, CR No. 123.)

The Denver Basin. — The deep bedrock acquifers of the Denver Basin are another important groundwater resource with an uncertain future. Legal uncertainties concerning the "tributariness" of that groundwater to the South Platte River is a major water management problem. Recent enactment of S.B. 5 is intended to facilitate orderly development of that water supply. However, a sustained supply from that source will depend almost entirely upon development of new technology to recharge the groundwater aquifers. Injection wells offer an approach which may be practical to replace local groundwater overdrafts for high-value water supply needs. The Institute is currently working on some aspects of that technology problem in cooperation with the Colorado Division of Water Resources.

The South Platte Basin. — The South Platte Basin has an annual native water supply of less than 2 million acre-feet, yet the total annual diversions from surface streams are almost three times that amount (4.5 million acre-feet). This is simply because heavy groundwater recharge occurs through seepage from canals and reservoirs and through percolation of water applied to irrigated lands. The recharged groundwater returns to the stream and is recycled. In addition, pumping by more than 7,000 wells from the groundwater makes the recycling process effective and efficient. Nevertheless, around 300,000 acre-feet of Colorado's entitled water flows downstream into Nebraska each year. Artificial recharge of that water offers a splendid opportunity for closing the gap in a water-deficient agriculture in the lower part of the basin, where not more than 80 percent of the agricultural water requirements are currently met.

Recognizing the future critical importance of artificial groundwater recharge, the Institute embarked upon a planned research program to produce the new scientific knowledge and technologies that will be needed. Currently CSM groundwater geologists and geochemists are working to discover the chemical interactions between recharge water and the bedrock aquifer materials in preparation for experiments on injection well recharge.

CSU groundwater hydrologists are working with conservancy districts and other water-user organizations in the South Platte Basin to establish the requirements for sustained artificial groundwater recharge. Currently recharge is practiced for augmentation of surface waters to avoid damage by pumping to priority surface water rights. Future recharge will be designed to enhance the water supply recycle system and make it even more efficient on a basinwide basis.

SAMSON — THE SOUTH PLATTE SIMULATION MODEL

The Colorado Institute has put priority on development of high technology for computer-based river basin simulation. The South Platte River simulation model SAMSON is one product of that ten-year research program. The original model was developed for the 100-mile reach of the South Platte River from Balzac to Julesburg. A 1983 appropriation of $130,000 from the Colorado General Assembly provided for completion of the model for the entire South Platte Basin. A panel of experienced water managers and potential users of the computer simulation model have followed its development and advised on data selection to make the model an accurate representation of the basin.

First and second generation versions of SAMSON were used to conduct research in the Balzac-Julesburg reach of the South Platte River. A study conducted for the State's Drought Coordination Office in 1977 showed that pumping water from the aquifer during dry years in excess of quantities permissible by current law would provide a normal supply during those years with no long-term detrimental effect on the groundwater system. A second study, conducted for the Groundwater Appropriators of the South Platte, Inc., evaluated the GASP augmentation plan and pinpointed inequities. A third study, sponsored by the Colorado Commission on Higher Education and conducted in cooperation with the State Engineer's Office, investigated the effect of specific artificial aquifer recharge proposals on timing and location of return flows to the river.

SAMSON is currently being used to develop efficient water delivery alternatives for releases from a hypothetical mainstem storage reservoir on the South Platte River. Preliminary studies have also been conducted with this new technology for the Rio Grande-Conejos wedge area in the San Luis Valley to (1) investigate pumping methods that would control waterlogging and reclaim land, and (2) to evaluate the effects of pumping on surface streamflows, water rights and compact deliveries.

A new technique is being added to SAMSON to enable prediction of not only the impact of water management strategies on quantities of flow in the stream and aquifer but also the changes in salt concentration of that water as it moves through the basin. Another promising new development is designed to give SAMSON the capability to evaluate the economic impacts of any water management strategy.

LOW-FLOW CRITERIA AND WASTE DISCHARGE PERMITS

Colorado dischargers of municipal and industrial wastes are paying unnecessarily high costs to meet current waste discharge permit limits. This is an assertion made by discharge permittees as well as officials of federal and state regulatory agencies. New criteria which will protect surface water quality at desirable levels without imposing unnecessary costs for waste treatment are needed. The USEPA, the Colorado Water Quality Control Division and 16 major municipalities and industries in Colorado pooled funds to finance this research.

The principal thrust of the investigation is to find an acceptable alternative to the current low-flow criteria on which discharge permit waste loading is computed. Annual savings in both capital and operating costs for waste treatment running into millions of dollars will be realized in Colorado alone if the development is successful.

Investigators are following two major innovative approaches. The first includes variations on permitting techniques that enable fuller use of stream assimilative capacities while still maintaining stream standards. Examples include different upstream flow frequency/duration criteria, seasonal water quality standards, and timing of effluent release. The second approach involves reallocating waste loadings through discharge trading to achieve the most economical allocation. Examples are point-source trading, point/nonpoint trading, and banking.

Eight stream sites for case study investigations have been selected. The sites cover a range of waste effluent types, streamflow hydrologic characteristics, and degree of man's impact (e.g., diversions). Streamflow data have been analyzed for frequency/duration and frequency of exceedence statistics. These technical descriptions of low-flow conditions will form the basis for new low-flow criteria to be tested.

THE ENDANGERED SPECIES ACT AND WATER DEVELOPMENT IN COLORADO

The national policy to preserve/enhance endangered species (the Endangered Species Act of 1973) is an important constraint to flexible use and management of Colorado's water entitlement. Its impact is being felt in the Colorado River Basin where the endangered squawfish species may impede development of storage projects and in the South Platte River Basin where protection of Whooping Crane habitat in Nebraska could limit use of Colorado's entitled water. Two current projects have produced results which promise to aid in the resolution of the problem.

ESA's Legal Aspects

A project by faculty of the University of Colorado Law School analyzed legal aspects of the Endangered Species Act and the limitations it potentially imposes. A major objective was to explore the legal requirements of the ESA as well as the legal limits that exist in its application.

A focus of the research was Section 7 of the Act — considering the scope of ESA as expressed in the Act itself, as interpreted by the courts, and as implemented by the concerned Federal agencies. The researchers examined:

- proposed water development within the South Platte Basin and expected impact on the Whooping Crane habitat;
- the statutory basis and subsequent judicial interpretation for endangered species protection;
- the key legal issues at stake; and
- management approaches to resolving conflicts.

(The complete report is available in CR No. 137, $5.00.)

Crane Habitat Maintenance — Platte River

A second project addressed the following question: How can required habitat for the Whooping Crane in a section of the Platte River in Nebraska be achieved with minimum adverse impacts on Colorado's South Platte basin water supply?

Institute research has shown how an innovative management approach can provide the low flows required for crane habitat conditions on the Platte River most of the time simply by changing the operating procedure of an existing upstream storage reservoir. The needed operating changes can be implemented without seriously interfering with existing hydropower or irrigation release requirements. Present operating policy is based purely on meeting irrigation demand and maximizing hydropower production. If the present operating rule is continued, there is more than 50 percent probability that the minimum habitat flows cannot be met in each of the months of April, September, and October. By revising the present operating policy the minimum flows can be met most of the time. The exception that would have occurred had the revised policy been in effect during the past 40 years of record would have been only for the 22 months between July 1955 and April 1957. This was because of the three-year extreme drought of 1954-56 in which the mean annual flow fell below 60 percent of long-term mean for three consecutive years.

(The project report will be available in January, 1986.)

COMPENSATION FOR OUT-OF-BASIN WATER EXPORTS

The compensatory storage principle, established in a 1933 agreement between east and west slope interests involved in planning the Colorado-Big Thompson Project, was incorporated into the 1937 Congressional authorization for its construction. Compensatory storage has since been advocated by many for all out-of-basin water exports. A 1973 report by the National Water Commission noted this approach may cause "economic waste because the area of origin may not be prepared to use the compensatory storage for many years."

This research is directed toward producing a set of guidelines for use in negotiating area-of-origin compensation based on acceptable and effective alternatives to compensatory storage. Other approaches such as improving agricultural water-use efficiency in the basin-of-origin, the creation of a development trust fund, and the possible purchase of instream flow rights to protect the water conditions essential for recreation and tourism in the area-of-origin are considered. A research team including water lawyers and water economists at the University of Colorado is conducting this project.

The project report will be available in February, 1986.

EVAPOTRANSPIRATION — THE CLOSED BASIN PROJECT

This project in the San Luis Basin is being constructed by the USBR under sponsorship of the Rio Grande Conservancy District. Pumping of groundwater from the Closed Basin into the Rio Grande River will supply part of the water needed to meet the interstate compact flow requirement at the New Mexico state line. This will remove some of the burden from Colorado water right owners who are now forced to restrict their diversions at critical times.

The investigation will help establish a factual basis for determining how much water can be pumped out of the Closed Basin. The relationship between water table depth and evapotranspiration will be determined by field measurements of evapotranspiration (ET) being conducted by the USBR. This Institute project supplements USBR measurements with new technology that measures ET instantaneously by collecting and analyzing the gaseous vapor emitted by native vegetation. The results of this project will help Colorado justify and defend the amount of pumping to be allowed and at the same time advance the technology of instantaneous, direct measurement of ET.

This project is conducted in cooperation with the USBR, the USDA-ARS, and the State Engineer.

VOLUNTARY, INTEGRATED BASINWIDE WATER MANAGEMENT — SOUTH PLATTE BASIN

In 1983 the Institute targeted the South Platte Basin for a concentrated effort to examine options for best development and management of the basin's limited water supply. A team of ten scientists and engineers, representing three Colorado research universities (CU, DU and CSU), explored the long-range impacts of agriculture/energy/industry development, population growth, and other activities on water supplies in the South Platte River Basin. Team members provided the technical and scientific information needed to synthesize the diverse elements of development and management scenarios and produce an integrated picture of the entire river basin operation — a "Master" basinwide framework. This synthesis can be used to improve development and management of the basin's limited water supply now and provide a better basis for future decisions including the location, timing and size of new storage projects, exchanges, augmentation, recharge, and the like.

With completion of Phase I, the ten-man study team concluded that guidelines are needed that will be helpful to government leaders and water-user organizations in their search for comprehensive planning, evaluation of options, and coordination of leadership in water supply development as well as in basinwide management improvements. Team members are therefore refining a "layman's" document to show how modern, computer-based technology can provide information that will lead to better basinwide water management. The results and products of this program will be transferable throughout the state and throughout the region.

OPTIMUM RESERVOIR SITING AND SIZING

Hydrologic optimization computer modeling of basinwide reservoir siting and sizing, developed and tested in previous Institute research, is being applied in this demonstration project. The model, given a specific set of current or projected demands, determines the best combination of reservoir sizes and locations for a basin to optimize use of available water. Any number of demand scenarios and any number of potential reservoirs can be investigated — the criteria are cost effectiveness and water availability to meet the demands. This demonstration of new technology is being conducted in collaboration with the Colorado River Water Conservation District by CSU hydrologists.

DROUGHT ANALYSIS

The computer planning model MODSIM, a product of Institute research, is being used by the Water and Wastewater Utilities Department of the City of Fort Collins as both a planning and an operational tool. Development of optimum plans for storage releases from a multi-reservoir system and planning for complex exchanges of water involving several water right owners have demonstrated the model's usefulness.

MODSIM was recently used by the City to test its water supply for several potential drought scenarios. A synthesized 50,000-year runoff record was produced for each of three basins from which the City takes water. Tree-ring records verified that the synthesized runoff record is realistic. From it, droughts of various intensity and duration were found — for example, the 1-in-100-year drought was found to be typically 8 years in duration; the 1-in-500-year occurrence was 11 years in duration.

The city's supply system operation was then simulated on MODSIM for several of the potential droughts to assess reliability of the current supply. MODSIM proved an invaluable asset to the City in planning for a water supply sufficient to meet potential drought emergencies.

MODSIM has been adapted and is being used regularly by several professional consulting firms in water supply planning studies.

AGRICULTURAL WATER CONSERVATION

Improving Irrigation Efficiency

Legal and financial constraints to improving on-farm irrigation efficiency are being examined using an economic model to quantify benefits and costs to present and potential future water users. This is Phase I of a three-phase plan to ultimately produce a combined hydrologic-economic model which can test incentives for improving irrigation efficiency. The work is being done by water resource economists at CSU in collaboration with the Law School faculty at CU.

URBAN WATER CONSERVATION

Conservation Impact on Residential Lawn Quality

The quality of lawns and landscaping is being compared in six cities in the Front Range region of Colorado which operate under different kinds and degrees of water conservation practices. The degree to which water demand reduction in residential communities results in deterioration in the visual quality of the lawns is being studied. The question repeatedly raised by municipal water managers as to whether or not various conservation practices are compatible with public preferences for visual quality of the urban environment will be addressed by the project at the University of Colorado.

COLORADO WATER ISSUES PUBLIC FORUM

The 1986 Forum Season continues the tradition of informing the public on key statewide water issues. Each luncheon, the **3rd Tuesday of each month,** features an expert on a timely topic. **The public is invited and no reservations are required.**

TIME: 11:45 a.m.-1:30 p.m.

NEW LOCATION: Wyatt's Cafeteria - LAKESIDE SHOPPING CENTER, Sheridan and 44th Avenue.

(Take I-70 to Exit 270 — Harlan St., then 2 blocks south on Harlan to Lakeside Mall)

February 18, 1986 — *Status and Outlook of the Metropolitan Water Providers and the Metropolitan Denver Water Authority;* Bob Tonsing

Please mark your calendar for the **3rd Tuesday of each month** through June 1986.

GIARDIA CONTAMINATION ON THE RISE

Many neophyte backpackers, campers, hunters, fishermen and outdoor-oriented people come to regret their simple act of consuming untreated water in backcountry areas. Mountain streams, cold, clear and flowing, are sometimes deceptively considered a pure and safe source of drinking water. Experienced outdoor people understand that it is much better to be safe and treat the water they drink and avoid the unpleasant results of contracting a bacterial, viral or parasitic waterborne disease.

The parasite *Giardia* has become a particular problem in areas with cold surface waters such as the Rocky Mountains and the Pacific Northwest. Such water-dwelling mammals as beaver and muskrats are common vectors. In 1984 Colorado reported 928 cases of laboratory-confirmed giardiasis, and Oregon reported 1,057 cases during the same year. A large percentage of these cases resulted from drinking untreated surface water.

Generally the symptomatic cases are the only ones treated. There are currently three prescription drugs and one experimental drug used to treat giardiasis in the United States — most have side effects and all must be monitored closely.

Prevention remains the best method of controlling *Giardia* — by informing the public of the dangers of drinking untreated water in the backcountry and training people in the best methods for backcountry water treatment. Analysis of water samples for *Giardia* is complicated and must be done in a laboratory by trained specialists. Be safe and treat water before drinking it.

"*Giardia* and Other Pathogens in Western Watersheds," was presented at the Society of American Foresters 1985 National Convention in Fort Collins, Colorado by Kirke L. Martin, Senior Research Associate, CSU Department of Microbiology and Environmental Health; Sam H. Kunkle, Hydrologist, National Park Service Water Resources Division; and George W. Brown, Head, Forest Engineering Department, Oregon State University.

USBR STUDIES GLACIAL AQUIFER WATER STORAGE

A special investigation by the USBR's Missouri Region will focus on the possibility of using glacial morain aquifers as storage reservoirs and determine if this method compares favorably with other types of water storage and development. Hydrological studies, engineering cost estimates and economic and environmental evaluations will be made at 71 potential glacial aquifer sites in Colorado's Continental Divide region. If these sites can be used as storage reservoirs they would capture water at a time of high flow and release it when needed downstream. They could also be developed for replacement and/or compensatory storage for the movement of water from one tributary basin to another. Water transfers could be entirely on one side of the Continental Divide or involve a transmountain diversion.

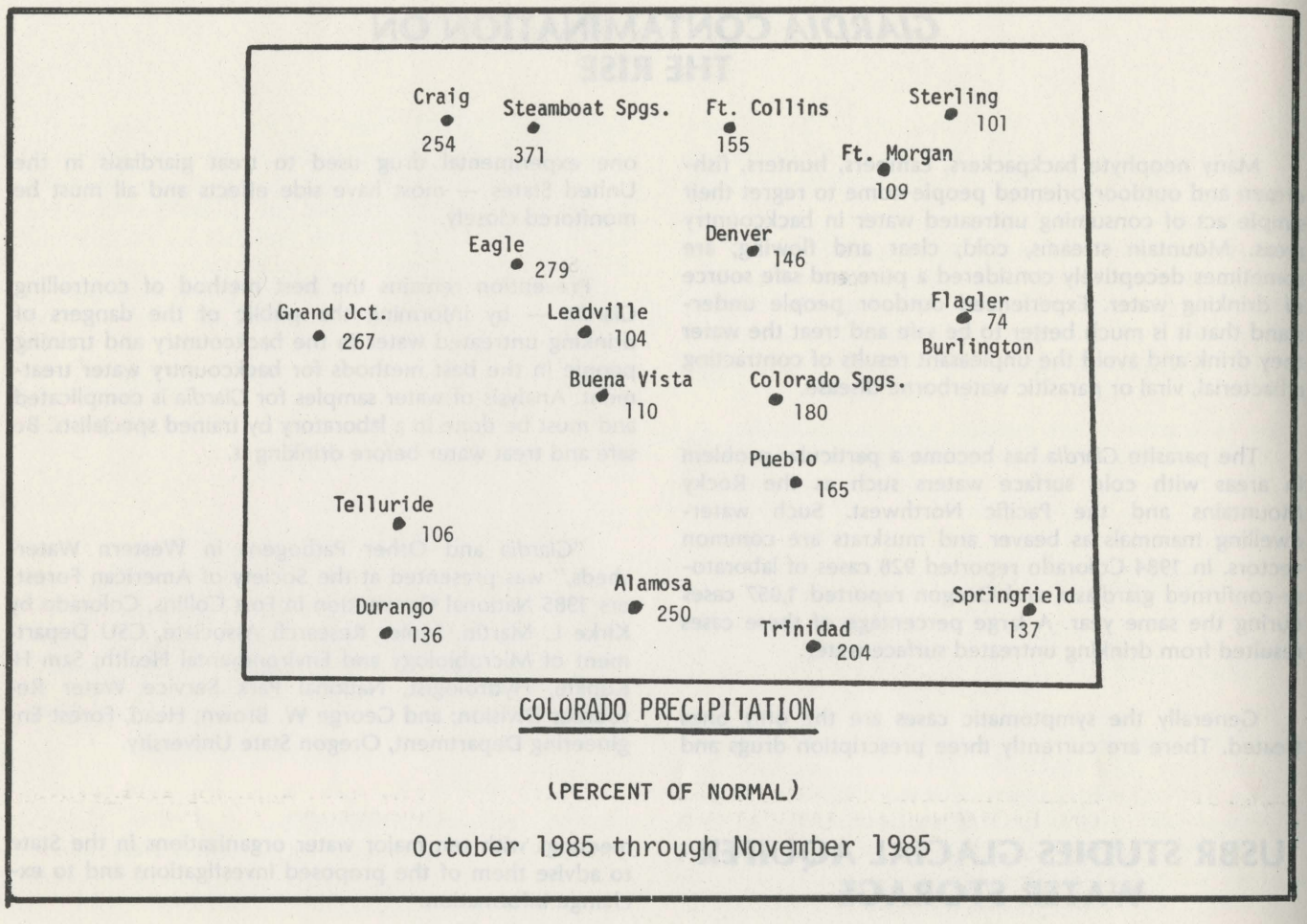
The study will also look at the legal constraints involved in developing the potential glacial aquifer sites for water storage, but resolving state water rights issues will not be included.

The investigation will conclude in 1990 with a special report presenting study findings. The USBR has held meetings with ten major water organizations in the State to advise them of the proposed investigations and to exchange information.

INDIA WATER MANAGEMENT TRAINERS PROGRAM

A pilot program at Colorado State University provides irrigation water management training for 20 professionals from Government Irrigation Departments and universities in India. The specially designed curriculum prepares Indian professionals to staff new institutes being established to train irrigation project field staff. The first group of Trainers completed their seven-month program in January, 1985. Dr. Norman A. Evans, Institute Director, served as academic coordinator for the training program. The second group of Trainers arrived in September and a third group is expected this year.

This training program is sponsored jointly by the U.S. Agency for International Development and the Indian Government. It is managed at CSU by Dr. R.K. Sampath in the International School for Agricultural Resources Development (ISARD).



COLORADO PRECIPITATION

(PERCENT OF NORMAL)

October 1985 through November 1985

OTHER PUBLICATIONS

DRIP/TRICKLE IRRIGATION IN ACTION, Proceedings of the 3rd International Drip/Trickle Irrigation Congress, ASAE, Dept. 250, 2950 Niles Rd., St. Joseph, MI 49085-9659.

COLORADO WATER ALMANAC AND DIRECTORY — 1985 EDITION, Colorado Water Congress, 1390 Logan St., Suite 312, Denver, CO 80203.

TROUBLED WATERS: FINANCING WATER IN THE WEST, by Rodney T. Smith. Publications Dept., CSPA, Room 291, 400 No. Capitol St., Washington, D.C. 20001. Telephone: 202/624-7880.

HYDROLOGICAL SCIENCE AND TECHNOLOGY, Short Papers, Vols. 1 and 2. American Institute of Hydrology, P.O. Box 14251, St. Paul, MN 55114.

IDENTIFICATION AND MODELING THE IMPACT OF MARINE SHALE BEDROCK ON GROUNDWATER AND STREAM SALINITY: UPPER COLORADO RIVER BASIN, by Christopher J. Duffy, Jerome J. Jurinak and Sanjay Sangani and Ali Azimi. Hydraulics and Hydrology Series UWRL/H-85/01. Utah Water Research Laboratory, Utah State University, Logan, UT 84322-8200.

The following publications are available from:
American Water Resources Association
5410 Grosvenor Lane, Suite 220
Bethesda, Maryland 20814
301/493-8600

A CRITICAL ASSESSMENT OF FORECASTING IN WESTERN WATER RESOURCES MANAGEMENT, Edited by John J. Cassidy and Dennis P. Lettenmaier,

1985. Proceedings of a Symposium held in Seattle, Washington.

OPTIONS FOR REACHING WATER QUALITY GOALS, 1985. Edited by Theodore M. Schad. Proceedings of a Symposium held in Washington, D.C.

NONPOINT SOURCE POLLUTION, Edited by Bruce W. Vigon. Reprinted from Water Resources Bulletin, Vol. 21, No. 2, 1985.

GROUNDWATER CONTAMINATION AND RECLAMATION, 1985. Edited by Kenneth D. Schmidt. Proceedings of a Symposium held in Tucson, Arizona.

The following publications are available from:
Lewis Publishers, Inc.
121 So. Main St.
P.O. Drawer 519
Chelsea, Michigan 48118

IRRIGATION WITH RECLAIMED MUNICIPAL WASTEWATER — A Guidance Manual, 1985. Edited by G. Stuart Pettygrove and Takashi Asano.

ARTIFICIAL RECHARGE OF GROUNDWATER, by Margaret O'Hare, Paris Hajali, Deborah Fairchild, and Larry W. Canter, 1985.

CONFERENCES

Jan. 18 — NATIONAL POLICY ON GROUNDWATER QUALITY PROTECTION, Denver, Colorado. Contact: Colorado Water Resources Research Institute. Telephone: 303/491-6308.

Jan. 23-31 — ASTM INTERNATIONAL SYMPOSIUM ON GEOTECHNICAL APPLICATIONS OF REMOTE SENSING AND REMOTE DATA TRANSMISSION, Cocoa Beach, Florida. Contact: Symposium Chairman A. Ivan Johnson, Consultant, Woodward-Clyde Consultants, Harlequin Plaza-North, 7600 E. Orchard Rd., Englewood, Colorado 80111. Telephone: 303/425-5610.

Feb. 2-7 — ASTM SYMPOSIUM ON FIELD METHODS FOR GROUNDWATER CONTAMINATION STUDIES AND THEIR STANDARDIZATION, Cocoa Beach, Florida. Contact: Donald Viale, ASTM Standards Development Division, 1916 Race St., Philadelphia, Pennsylvania 19103 or Mr. Gene Collins, Symposium Chairman, National Institute for Petroleum and Energy Research, P.O. Box 2128, Bartlesville, Oklahoma 74005. Telephone: 918/336-2400.

Feb. 10-11 — NONCOMPLYING MUNICIPAL WASTEWATER TREATMENT PLANTS, Madison, Wisconsin. Contact: Engineering Professional Development, 432 North Lake Street, Madison, Wisconsin 53706. Telephone: 800/262-6243.

Mar. 4-6 — HAZARDOUS WASTES AND HAZARDOUS MATERIALS, Atlanta, Georgia. Contact: HMCRI, 9300 Columbia Boulevard, Silver Spring, Maryland 20910. Telephone: 301/587-9390.

Mar. 6-7 — 7TH HIGH ALTITUDE REVEGETATION WORKSHOP, Fort Collins, Colorado. Contact: Gary L. Thor, Department of Agronomy, Colorado State University, Fort Collins, Colorado 80523. Telephone: 303/491-6904.

Mar. 24-27 — 4TH FEDERAL INTERAGENCY SEDIMENTATION CONFERENCE, Las Vegas, Nevada. Contact: G. Douglas Glysson, Chairman, Fourth Interagency Sedimentation Conference, U.S. Geological Survey, WRD, 415 National Center, Reston, Virginia 22092. Telephone: 703/860-6834.

Mar. 27-28 — 6TH INTERNATIONAL SYMPOSIUM ON ENVIRONMENTAL POLLUTION, Miami Beach, Florida. Contact: Dr. Vijay Mohan Bhatnagar, President, Alena Enterprises of Canada, P.O. Box 1779, Cornwall, Ontario, Canada K6H 5VT.

Mar. 31-Apr. 4 — 3RD INTERNATIONAL SYMPOSIUM ON RIVER SEDIMENTATION: ESTUARINE AND COASTAL SEDIMENTATION, Jackson, Mississippi. Contact: S.Y. Wang, School of Engineering, The University of Mississippi, Jackson, Mississippi 38677.

May 14-17 — INTERNATIONAL SYMPOSIUM ON FLOOD FREQUENCY AND RISK ANALYSIS, Louisiana State University, Baton Rouge, Louisiana. Contact: Dr. Vijay P. Singh, Symposium Director, Department of Civil Engineering, Louisiana State University, Baton Rouge, Louisiana 70803. Telephone: 504/388-6697.

May 19-23 — AMERICAN GEOPHYSICAL UNION SPRING MEETING, Baltimore, Maryland. Contact: AGU Meetings, 2000 Florida Ave., N.W., Washington, D.C. 20009.

June 22-27 — URBAN RUNOFF TECHNOLOGY, Henniker, New Hampshire. Sponsored by the Engineering Foundation. The conference chairman is Ben Urbonas, Urban Drainage and Flood Control District, Denver. Contact: The Engineering Foundation, 345 E. 47th St., New York, New York 10017. Telephone: 212/705-7835.

July 22-25 — COLD REGIONS HYDROLOGY SYMPOSIUM, Fairbanks, Alaska. Sponsored by AWRA with Univ. of Alaska. Contact: Dr. Douglas Kane, Institute of Water Resources/Engineering Experiment Station, University of Alaska, Fairbanks, Alaska 99701. Telephone: 907/474-7808.

July 23-25 — 12TH INTERNATIONAL SYMPOSIUM ON URBAN HYDROLOGY, HYDRAULIC INFRASTRUCTURES AND WATER QUALITY CONTROL, Lexington, Kentucky. Contact: Ralph R. Huffsey, Symposium Chairman, Kentucky Water Resources Research Institute, 223 Transportation Research Bldg., University of Kentucky, Lexington, Kentucky 40506-0046.

Aug. 4-6 — WATER FORUM-86 — "WORLD WATER ISSUES IN EVOLUTION," Long Beach, California. Contact: Harry Tuvel, ASCE Headquarters, 345 E. 47th St., New York, New York 10017.

Aug. 4-8 — INTERNATIONAL SYMPOSIUM ON DRAINAGE BASIN SEDIMENT DELIVERY, Albuquerque, New Mexico. Contact: Prof. R.F. Hadley, Department of Geography, University of Denver, Denver, Colorado 80208.

Nov. 9-14 — AWRA'S MEETING ON INTERNATIONAL CONFERENCE ON WATER AND HUMAN HEALTH, Atlanta, Georgia. Contact: Dr. Phillip E. Greeson, U.S. Geological Survey, Richard B. Russell Federal Bldg., 75 Spring St., S.W., Suite 772, Atlanta, Georgia 30303. Telephone: 404/221-3389.

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Published by the

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Fort Collins, CO 80523

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