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COLORADO WATER

Newsletter of the Colorado Water Resources Research Institute, Fort Collins, Colorado 80523

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WATER ITEMS AND ISSUES . . .

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COLORADO WATER ENGINEERING AND MANAGEMENT CONFERENCE, February 27-28, 1991 (tentative date) Call for Papers Announcement on Page 2

AVAILABLE SOON
Colorado's Water: Climate, Supply & Drought
From CWRRI, 410 University Services Center
Colorado State University
Fort Collins, Colorado 80523 - Phone: (303)491-6308

NOTICE: We are sad to report that Warren A. Hall of Meeker, Oklahoma died in Aurora, Colorado on June 24, 1990 of an apparent heart attack. Hall was known worldwide for his active involvement in water resources research and education.

COLORADO WATER ENGINEERING AND MANAGEMENT CONFERENCE
FEBRUARY 27-28, 1991 (tentative date)

CALL FOR PAPERS

Conference Objective

The purpose of the 1991 Colorado Water Engineering and Management Conference is to evaluate technical and management methods necessary to solve state water problems. Colorado is dependent on water management for economic and social development, and engineers and managers have key roles in water decision making. The Conference serves as a forum to exchange ideas about technological and management solutions for current state water problems.

Who Should Attend

The Conference will be of interest to water resource engineers, water district managers, utility and municipal officials, agricultural and industrial water managers, public officials, and other citizens interested in the engineering and managerial aspects of water management.

Conference Topics

- Water Resources Management and Problem Solving
- Water Management by Exchanges, Banking, Conjunctive Use
- Computing and Telecommunications in Water Management
- Flood and Stormwater Management
- Urban Water Supply
- Drought Planning
- Wastewater and Water Quality Issues
- Groundwater Management
- Climatic Issues
- Agricultural Water Management

Co-Sponsors Sought

If your organization with a water resources mission desires to cosponsor, please notify us. No financial commitment is required.

To Submit a Paper for Consideration
Send a brief abstract by **November 1, 1990** to:

Neil S. Grigg, Director
Water Resources Research Institute
Colorado State University
Fort Collins, CO 80523
Telephone: (303) 491-6308
FAX: (303) 491-2293

A SMALLER APPROPRIATION DOCTRINE

Editorial by Neil S. Grigg

The Appropriation Doctrine isn't dead, but it has shrunk.

At the CWC annual meeting in January Gregg Hobbs and Malcolm Murray debated whether the Appropriation Doctrine is still alive, and they made many interesting points. What we have to see, however, is not the fine points of this tried-and-true water law principle, but how far water law has gone beyond the question of property rights ownership concepts.

The Appropriation Doctrine of water rights determines how an individual or corporation gains ownership of a "right" to use water by diverting the water and putting it to beneficial use. In the East they refer to a "Riparian Doctrine" to deal with the same question. I have found that the Appropriation Doctrine works, but the Riparian Doctrine doesn't because eastern water rights decisions are made on the basis of permits, politics and de facto diversions to serve water users. However, the East is set for a lot more legal action in water.

Today the Appropriation Doctrine still governs the basic element of water rights, the entitlement and priority to divert, but clearly it is inadequate to deal with larger questions of public interest such as environmental disputes, and it doesn't deal at all with interstate allocation of water. With the Federal Government owning much of the land in Colorado, the Doctrine doesn't really deal with the issue of federal reserved water rights. It is popular to say that in the future

the main water rights issue will be water quality, and the Appropriation Doctrine doesn't deal with it.

So what does the Appropriation Doctrine do? It played a large role in staking out the patterns of ownership of water in Colorado that exist today, and these patterns determine who farms and who doesn't, whether water is in a stream or a ditch, and whether a city or industry can buy water or not.

But with ownership patterns settled, how can the Appropriation Doctrine be used to solve emerging problems of city-farm disputes, environmental conflicts and loss of interstate entitlements? The answer is: it can't; it can only serve as one chapter in the rulebook that governs the water management game. Other chapters are called: working with federal agencies; water marketing; a guide to environmental groups; the Clean Water Act; inter-regional politics; the Endangered Species Act; and California's water games. Some chapters haven't been written yet.

Water management may well be the most complex public policy issue in Colorado. Providing enough high-quality water for all users is the public interest goal. Achieving this goal will require more than the Appropriation Doctrine itself: it will require innovations in planning and management that provide for the three "C"s of coordination, cooperation and conflict management.

COLORADO WATER: LIQUID GOLD

1990 COLORADO STATE FAIR TO FEATURE WATER RESOURCES EXHIBIT

The 1990 Colorado State Fair Industry and Technology Exhibit will be devoted to telling the Colorado water story. The exhibit will promote the theme that a basic knowledge of water resources is essential to understanding the importance of water to Colorado.

A committee representing a broad spectrum of the Colorado water community has been working on the exhibit since September of 1989. The Office of the State Engineer has been coordinating these efforts under the direction of John Kaliszewski. Nearly forty organizations are involved in this major effort.

The 13,000 square-foot Industry/Technology Building will be fully devoted to this exhibit. The exhibit will be fully staffed and will run the entire length of the State Fair, from August 24 through September 3, 1990. Over 500,000 people are expected to view the exhibit. The exhibit will be divided into three basic sections:

WATER: Where does it come from?
WATER: How is it managed?
WATER: How is it used?

The exhibit hall, arranged to set the mood of water in Colorado, will include these major features:

A dynamic model of the hydrologic cycle

A theater where water-related films and videos will be shown

A live exhibit with "Doctor Water," answering questions about municipal water treatment and quality

The "Water Wheel of Fortune," where contestants can win prizes for correctly answering water-related questions

The "Water Resources Simulator" computer model, where the public can see the effect of water management decisions

A live wetlands, complete with real wetlands inhabitants

The "Water Slide" game, to emphasize the many and intricate steps in planning and constructing a water resource project

A satellite-linked monitoring station, where the public can transmit and receive water messages through space

Two large fish tanks, where the public can go eye-to-eye with both cold water and warm water fish found in Colorado Genetic "designer" plants that consume less water than conventional plants

Pictorial history of water resources use and development in Colorado

A full-size gaging station, with cutaway view to demonstrate operation

A microscope and video screen showing bacteria breaking down raw sewage

A dynamic physical groundwater model

Source: John Kaliszewski, State Engineer's Office

Colorado State University faculty are preparing exhibits for the display in the areas of agriculture, agronomy, agricultural engineering, civil engineering, and climatology. Colorado State's exhibit will include a working model of the Parshall Flume. CWRRI will also have a display at the exhibit.

THE COLORADO WATER WORKSHOP CELEBRATES FIFTEENTH ANNIVERSARY

More than three hundred people are expected to attend the Fifteenth Anniversary of the Colorado Water Workshop at Western State College on July 22-24, 1990. Through the years, the Workshop has developed into what many consider to be Colorado's leading annual event on water issues. This year's program, "Colorado Water Institutions: Valuable Traditions-New Frontiers," will focus on how the state's agencies, laws and decision-making processes can ensure optimal use of our water for both traditional needs and more recently developed uses.

"Colorado's water institutions are faced with the challenge of providing for the needs of the state's established water users such as agriculture and municipalities while taking into consideration the growing interest in the environmental, recreational and social values of water," states Lucy High, director of the Water Workshop. "As Colorado's undeveloped water resources become increasingly scarce," High adds, "conflicts among users will intensify and Colorado's water institutions will be forced to seek solutions."

Highlights of the Workshop will include a debate on the role of public interest in water management decisions, a case study concerning methods of providing river flows for various instream uses, and a speech by Congressman Hank Brown. A wide variety of water users will present their concerns and suggestions in a users' forum. Experts from other western states will discuss how institutions deal with conflicting interests in their own states.

Key sponsors of the Workshop include American Water Development, the City of Aurora, the City of Gunnison, the Colorado Division of Wildlife, the Colorado River Water Conservation District, the Denver Water Department, and the Southwestern Water Conservation District. The workshop is also supported by Coors Brewing Company.

Western State College offers academic credit for the conference. Continuing Legal Education (CLE) credits are available for Colorado attorneys and judges. The registration fee, which includes meals and materials, is \$215. A limited number of partial scholarships are available. Interested persons should write a letter of application to: Colorado Water Workshop, PO Box 1264, Gunnison, Colorado 81230. For more information, call (303) 943-3232.

HESTER MCNULTY KEYNOTE SPEAKER AT CONSERV90 CONFERENCE

Hester McNulty, Chairperson, Water Committee of the League of Women Voters of Colorado, will be a keynote speaker at the CONSERV90 Conference Plenary Session on August 13. The national conference and exposition, **Offering Water Supply Solutions for the 1990s**, is scheduled August 12-16, 1990 in Phoenix, Arizona. Ms. McNulty has been deeply involved in lobbying and public education activities relating to water conservation, water quality and other environmental issues. Her contributions have been made on national, regional and local levels. "I joined the League in 1956 when it was one of the first national organizations to really study water problems in the United States," she says. As a member of the League's national office in Washington, D.C., one of her first assignments was to investigate and help preserve water resources in the Potomac River Basin.

She moved to Colorado in 1972, where she utilized her water expertise as a key member of the Colorado League of Women Voters. Over the years, she has been a highly visible spokesperson on the state's groundwater needs and problems. Earlier this month, state officials honored her for her tireless efforts to communicate conservation messages in Colorado.

On May 16 Ms. McNulty will receive the Chevron Oil "Conservation Award" in Washington D.C. for her outstanding contributions to water conservation over the past decade. She will be cited for her work as the environmental quality head of the national League of Women Voters' Board of Directors as well as for her contribution to EPA advisory committees, the Army Corps of Engineers, the Colorado Ground Water Advisory Committee and the American Society of Civil Engineers. Ms. McNulty holds undergraduate and graduate degrees from the University of Colorado. Her Master's degree is in biochemistry and nutrition. She is a native of Pittsburgh, Pennsylvania.

SAVE THOSE WATER PAPERS

You never know when they might come in handy - a wide variety of old records can be useful and may provide small, very valuable clues to verify water uses and help validate water rights. This was the theme at the National Archives Symposium "Water in the 20th Century West - Documenting the Arizona Experience" held in Phoenix on March 30-31. Doug Kupel, historian at the Phoenix Water Department, related how old water delivery and pumping records helped illuminate a complex groundwater contamination problem in the city. The records, from a water company the City of Tucson acquired several years earlier, were preserved by the City. Kupel said it is very important, especially for municipalities, to have a record retention policy. Other speakers explored the information sources available to water rights researchers, including state historical archives, federal repositories and The Natural Resource Library of the Department of the Interior on Washington, D.C.

Source: Water Rights, May 1990

PROJECTS SELECTED FOR CWRRI FY1990 WATER RESEARCH PROGRAM

The Institute's FY 1990 water research program, submitted to the U.S. Geological Survey for review and approval, includes ten projects that concentrate on policy issues and management problems that concern Colorado water resource managers and users. Members of CWRRI's Research Planning Advisory Committee (a statewide group of water management practitioners) and its Technical Advisory Committee (faculty representatives from CU, CSU and CSM) reviewed 31 preproposals that were submitted to CWRRI. Based on the combined ratings of the two advisory committees, the following ten projects were selected for funding in FY1990.

Fate and Effects of Heavy Metals on Stream Organisms in the Arkansas River.

Water quality in the upper Arkansas River Basin is recognized as being extremely poor, and although several point and non-point sources of impact have been identified, mining activities in the Leadville area have received the most attention. The Yak tunnel, a U.S. EPA Superfund site, releases approximately 600 gallons per day of highly contaminated water into California Gulch, which flows directly into the Arkansas River. Tributaries draining several mining districts in the area also contribute significantly to the river's total mass load of heavy metals. Investigations suggest that the Arkansas River has the potential to support an excellent brown trout fishery, but reduced populations and poor survival of adult brown trout have been attributed to heavy metal contamination of the river. Benthic invertebrates, the main food source of brown trout, rapidly accumulate metals from contaminated water, and this may contribute to the brown trout's poor survival rate, beyond three-four years, in the Arkansas River.

This project will investigate the potential transfer of heavy metals through aquatic food chains concentrating on caddisflies, a significant portion of the brown trout's diet. They are found in abundance at stations immediately downstream from California Gulch. Samples will be collected at 15-20 sites throughout the upper basin above and below California Gulch and differences among stations used to delineate zones of impact and recovery in the Arkansas River. *Principal Investigator: William H. Clements, Department of Fishery & Wildlife Biology, CSU.*

Development of a Decision Support System for Water Rights Administration.

Water managers and the multitude of water users on the Upper South Platte recognize that improved management of the water rights system would make more water available on a more timely basis, reduce administrative errors and streamline management. Personnel from the City of Aurora and the State Engineer's Office have approached the Center for Advanced Decision Support in Water and Environmental Systems (CADSWES) for assistance in improving river management.

Using the resources of CADSWES, this project will develop a user-friendly, interactive computer graphics system on a work-station computer to depict the flows, water rights, diversions, and reservoirs for the Upper South Platte River. The system will be developed as a prototype for real-time use. *Principal Investigator: J. Ernest Flack, Department of Civil Engineering, CU.*

Development of a Water Database for the South Platte River Basin.

The South Platte and its tributaries make up the most densely populated hydrologic basin in the State of Colorado. In addition, the basin supports the irrigation of 1.3 million acres of productive farmland. With growing concern for improved water management, a central repository for water data in the basin needs to be established. Water users and agencies in the basin need ready access to information regarding the distribution, quantity, quality and availability of water resources. This project will prepare a detailed facilities and management plan for the development of a water database for the South Platte River Basin at Colorado State University, and also prepare a hydrologic data assessment report describing the current status of available and emerging water data in the South Platte Basin. The project will be closely coordinated with data-gathering activities by the State Engineer's Office. *Principal Investigator: Timothy K. Gates, Department of Civil Engineering, CSU.*

Graphical-Based Decision Support System for Conjunctive Stream-Aquifer Management Under Prior Appropriation.

Colorado's water future seems to be increasingly characterized by the polarization of various interest groups: environmentalists/water developers, cities/farmers, groundwater users/surface water users, state/federal agencies, upstream water users/downstream water users, and interregional/territorial concerns. To minimize conflict and maximize the beneficial use of water resources, a computer-based decision support system (DSS) is needed for comprehensive basinwide and regional analyses that include both surface water and groundwater and incorporate the constraints of Colorado's Appropriation Doctrine.

This project will integrate the existing computer models MODSIM/CONSIM, including the best capabilities of each, into one comprehensive, graphical-based DSS package. The DSS will include several options for modeling the various components of stream-aquifer systems. It will be helpful for: (1) drought contingency planning; making use of the extensive groundwater storage capacity available in alluvial aquifers; and developing ways to capture Colorado's water before it flows out-of-state. As a regional scale model, the DSS package can be applied to the problems of urban encroachment into agricultural water supply availability and the hydrological impacts of water rights on marketing. The system will be interfaced with a GIS-based groundwater modeling package being developed by the State Engineer's Office. It will be designed for compatibility with microcomputers and virtually any computing environment that currently exists among Colorado's water management agencies, and will allow eventual interfacing with water quality models. *Principal Investigator: John W. Labadie, Department of Civil Engineering, CSU.*

Drought Characteristics in Colorado.

Drought is a frequent visitor to Colorado; yet there is constant confusion and misunderstanding over what constitutes drought. Does it occur randomly or in regular cycles? How typical or unusual is any given episode? What is the potential for forecasting drought? All Colorado water users and water providers share a common interest in this topic. This project will develop a comprehensive statewide description of the

duration, extent and severity of drought in Colorado based on historic precipitation and snowpack records. Time histories of site-specific precipitation and snowpack will be investigated using the Palmer Drought Index, Z-Index and Colorado Surface Water Supply Index to define spatial patterns and drought durations. Relationships between the primary hydrologic components will be described in the context of Colorado's climatic characteristics. *Principal Investigator: Thomas B. McKee, Department of Atmospheric Science, CSU.*

Prediction of Effect of Natural or Artificial Recharge Operations on Timing, Extent and Location of Return Flows. Augmentation plans that compensate for stream depletion due to pumping often incorporate artificial recharge from spreading basins or canals. For example, a canal located between the recharge zone and the targeted stream may negate the effectiveness of recharge operations. With the evaluation of recharge plans a frequent necessity in Colorado, a realistic, site-specific groundwater model is needed to understand and manage the impacts of interception on historic return-flow timing and utilization. Designers of augmentation plans for the South Platte and those concerned with potential impacts of future water right transfers have started monitoring groundwater levels so that a data base will be available for site-specific modeling development.

This project will develop a procedure to predict the effectiveness of a recharge operation when canals may intercept the return flows intended for a depleted stream. A complete program will be developed and documented that can be used independently for quick, preliminary investigations of proposed augmentation by artificial recharge. Designed for use on a personal computer, it will require a minimum of data about the system. The methodology will also be implemented as an optional module in SAMSON. *Principal Investigator: H.J. Morel-Seytoux, Department of Civil Engineering, CSU.*

Assessment of Recharge Conditions in the Denver Basin. The nature and rate of recharge to the Denver Basin is unknown, and current numerical models of the basin use recharge rates that are uncertain. If recharge rates are incorrect, this could lead to erroneous basin simulations and poor management decisions. It is also uncertain, at contaminated sites, whether the contaminants migrate vertically downward into the bedrock or move laterally in the soil zone, and each requires a different remedial action. Ongoing assessments suggest a lateral, higher rate of recharge to the soil zone, and the calibration of basin groundwater models indicates low recharge rates to the bedrock. If correct, discharge likely occurs via lateral flow above the bedrock followed by evapotranspiration or seepage to a stream.

This field study will provide quantitative field measurements of recharge in the Denver Basin and compare them with values currently used in groundwater models which are estimated from indirect calculation and paper studies. *Principal Investigator: Eileen Poeter, Department of Geology and Geological Engineering, CSM.*

Forecasting Streamflow for Colorado River Systems. Water agencies and water managers need accurate runoff

forecasts to administer Colorado's water resources both in-state and out-of-state, since Colorado has a number of compacts with other states related to water use. Reliable runoff estimates help managers match water supply with estimated demands, and they also help maximize beneficial use within Colorado. For example, streamflow forecasts on the Rio Grande River are routinely made at the state line in order to more effectively administer the river's water supply.

Using the Rio Grande River system as a case study, this project will develop a multiple input (snow-water equivalent, temperature and precipitation) modeling method to improve the accuracy of monthly runoff forecasts. The project will be closely coordinated with the Office of the State Engineer, who is in charge of the daily administration of water resources in Colorado, and the Northern Colorado Water Conservancy District, which has important operational responsibilities in supplying supplemental water in Northeastern Colorado. *Principal Investigator: Jose D. Salas, Department of Civil Engineering, CSU.*

Pilot-Scale Field Testing of Biological Denitrification with Widely Varied Hydraulic Loading Rates. Numerous Colorado communities, located in rural or semi-rural areas, have water supplies polluted by nitrates. Previous laboratory research demonstrated that nitrates can be reliably and economically removed by biological denitrification, and a field demonstration has been very successful. A pilot-scale denitrification reactor and slow sand filter, installed in Brighton, produces water that has met state drinking water standards for nitrates and turbidity continuously since operation began. However, all previous work was conducted with steady flow rates through the denitrification reactor. A large change in demand from season to season, with water use often five times as high in the summer months as in the winter, represents a potential impediment to implementing the biological denitrification process.

This project will investigate practical methods of operating the current demonstration plant over a five-fold range of denitrified water production rates. In very small plants with only a single denitrification reactor, the only option for varying water production is by varying the hydraulic loading to the denitrification reactor. A cycle of varied hydraulic loading will be carried out to determine how rapidly it can be increased from the minimum value to the maximum value without degrading reactor effluent quality. Following this, additional options available to larger plants with more than one denitrification reactor will be investigated. *Principal Investigator: JoAnn Silverstein, Department of Civil Engineering, CU.*

Economic Evaluation of Policy and Institutional Changes for Improved Conjunctive Ground and Surface Water Management. With an estimated storage in excess of 10 million acre-feet, the South Platte probably contains Colorado's most economically significant tributary aquifer. This is many times the total surface water storage in the basin and several times the annual withdrawals in the region. The State Engineer estimates that tributary groundwater provides all or part of the irrigation water supply to about two million irrigated acres in the state. Colorado's "Plans of Augmentation," provided for in the state's water law, guarantee surface water right holders security of supply while

permitting groundwater use as pump owners find it profitable. An evaluation is needed of the economic impact of policy and institutional changes in the basin, and how conjunctive ground and surface water management could be improved.

This project will adapt HELM, a Hydrologic-Economic-Legal Model that models the South Platte stream-aquifer system from Henderson (right below Denver) to Kersey (beyond Greeley), so that it can be used to evaluate two policy options: (1) augmentation plans and the hydrologic and economic impacts on senior and junior surface right owners and groundwater users; and (2) dry-year options purchased from irrigators by urban entities, under which farmers could temporarily replace water rented out by pumping. Refinements to the model will include the ability to: (1) select the most profitable cropping pattern and irrigation practices under variable water supply conditions; and (2) specify the legal and institutional details of policy options under consideration. *Principal Investigator: Robert A. Young, Department of Agricultural and Resource Economics, CSU.*

COLORADO AND NEW MEXICO LOSE WATER LEADERS

We're sad to report on the deaths of two leaders in western water: Steve Reynolds and Glenn Saunders. Each of these men was widely known for leadership and intellectual command of western water issues. We'll miss them.

Glenn Saunders, Denver native, architect of Denver's water supply system and dean of Colorado water lawyers, died on May 8 at the age of 85. "Glenn Saunders played the vital part in obtaining for Denver and this metro area the crucial water that we currently enjoy," said Wayne Williams, chief lawyer for the Denver Water Board. Saunders began his career as an assistant city attorney in 1929, securing Denver's right to divert water from the South Platte, Blue, Fraser and Williams Fork Rivers. In 1937 he took over full responsibility for DWB water rights development. He wrote a landmark city charter amendment in 1959 enabling the Denver Water Board to sell water to the suburbs. In 1966 Saunders left the Denver Water Board to form the law firm of Saunders, Snyder, Ross & Dickson.

Saunders also played a key role in federal water legislation. He helped draft the 1952 McCarran Act which forces the federal government to use state courts to obtain water for federal land, a water doctrine that is important in Western states where the federal government owns much of a state's land. He also persuaded former Senator Gordon Allott to amend the Wilderness Act to allow the construction of water projects in wilderness areas if the President grants special permission.

Saunders served as principal lawyer in 49 Colorado Supreme Court decisions on water. His colleague, Jack Ross, described him as "an absolutely brilliant trial lawyer." He was a longtime foe of federal intrusion into local water projects, and was particularly upset about the Environmental Protection Agency's planned veto of Two Forks Dam, which he had worked on since the 1930s.

Source: Denver Post 5/12/90

Steve Reynolds, New Mexico's State Engineer for 35 years, died on March 23 of complications following surgery. Reynolds served under ten governors, both Republican and Democrat. During his long reign he exercised the sole power to regulate water issues in New Mexico, and he implemented some of the strongest laws and enforcement in the arid West. It's estimated that the federal government lavished more than \$1 billion on water developments benefiting New Mexico during his tenure. Reynolds was instrumental in gaining funding for the San Juan-Champ project that diverts water from the Colorado River system through the Continental Divide into the Rio Grande basin. In the middle 1950s, Reynolds made a key decision affecting water pumping in the Albuquerque area that many experts have said prevented the Middle Rio Grande from losing much of its groundwater supply to excessive pumping.

In 1987 he made a landmark decision dealing with interstate water rights. He refused El Paso's demand for the right to cross the state border to tap New Mexico's groundwater aquifers. He ruled, after nine months of hearings, that El Paso had not proved it would need the water within 40 years, the same time span that other cities in New Mexico are required to meet for valuable groundwater. Reynolds' decision is being challenged in court by El Paso. The state Supreme Court helped give Reynolds complete control of state water resources when it upheld his powers to manage both surface and underground water.

NEW MEXICO SEARCHES FOR STATE ENGINEER

Philip B. Mutz, named Acting New Mexico State Engineer by Governor Garrey Carruthers, has served in the State Engineer's Office since 1956. For the last 10 years he was Interstate Stream Engineer, charged with protecting New Mexico's waters. Earlier this year Mutz announced plans to retire, so a search for a new State Engineer for New Mexico has begun (See POSITIONS AVAILABLE section of this newsletter). Mutz earlier worked for the Bureau of Reclamation for seven years and for the Colorado Water Conservation Board for two years. He said all the projects Steve Reynolds was working on will continue.

VOLUNTEERS SOUGHT

The Consulting Engineers Council, State Engineer's Liaison Committee, in cooperation with the Colorado Water Resources Research Institute and the Colorado State Engineer, is compiling sections for a Colorado Water Atlas. The atlas is intended to be a comprehensive resource for all those working with or interested in Colorado water. It will include hydrologic and geologic information, water quality, water law, existing project information, maps, and other information pertinent to Colorado water resources. Anyone wishing to contribute to this project should contact Neil Grigg at the Research Institute in Fort Collins, 491-6308, or George Fosha, W.W. Wheeler & Associates in Englewood, 761-4130.

SHOWER POWER - A water-saving showerhead can save 50 gallons of water for every 10-minute shower you take. Install a water-saver in your shower.

UNIVERSITY WATER NEWS

CSU COSPONSORS OHIO CONFERENCE--Colorado State was a cosponsor of a midwest water conference, **Water Sufficiency in Ohio for the 21st Century**, and coinciding **Water Day II** festivities held on May 17. The events were planned by the International Center for Water Resources Management at Central State University, Wilburforce, Ohio. The conference provided an opportunity for water managers and policy makers to examine what has been done to develop water supplies and allocation measures since the drought of 1988. Central State University is a historically black university with a rich heritage of academic achievement dating back to 1887. It's International Center for Water Resources Management is a multidisciplinary cooperative education and research center devoted solely to water resources management.

JOHN NELSON CHOSEN FOR PEC 1990 ENGINEER OF THE YEAR--The Awards Committee of Professional Engineers of Colorado selected John Nelson as the 1990 recipient of the PEC Engineer of the Year Award. Nelson is Head of the Department of Civil Engineering at Colorado State University. PEC President Orville F. Stoddard said the award was made for Nelson's contributions to the advancement of the engineering profession through research and education and promotion of understanding between different peoples. The award was presented at the PEC Annual Convention in Pueblo on June 9th.

JIM LOFTIS RECEIVES EPA ENVIRONMENTAL AWARD--Jim Loftis was honored for his outstanding efforts to prevent agricultural water pollution with an award presented on June 6 by the Environmental Protection Agency. Jim is Associate CWRRI Director and Extension Specialist/Associate Professor of Agricultural and Chemical Engineering at CSU. Three other Coloradans, a Colorado association and *The Denver Post* were recognized by EPA for their efforts to preserve the environment: **Robert Bragg**, agriculture instructor at the San Juan Basin Vocational Technical School in Cortez, for teaching safe pesticide use to farmers; **Winifred Bromley**, school asbestos coordinator for the Colorado Department of Health, for protecting human health and the environment; **The Colorado Industrial Pretreatment Coordinators Association**, for contributions to healthier streams in the state; and **Herman Wooten**, program manager of the Colorado Rural Water Association, for helping small public water systems provide safe drinking water; and *The Denver Post* for its efforts in recycling newsprint and unused ink.

CSU ENGINEERING GRAD AND USDA/ARS ENGINEER ELECTED TO NATIONAL ACADEMY OF ENGINEERING--Larry Roesner, 1965 graduate of Colorado State, was elected to membership in the National Academy of Engineering in February. Academy membership honors those who have made "important contributions to engineering theory and practice..." or those who have demonstrated "unusual accomplishment in new and developing fields of technology." Roesner, Senior Vice President of Camp Dresser & McKee, is a nationally recognized expert in the development and application of hydrologic, hydraulic and water quality simulation models. He is principal developer

of CDM's urban stormwater runoff and quality models; the Corps of Engineers model STORM, a simplified urban stormwater management model; and EPA's SWMM EXTRAN model, a sophisticated flow-routing model for urban drainage systems. Roesner is presently CDM Technical Director of Water Resources and Environmental Sciences for the middle and south Atlantic states. He received a B.S. in Civil Engineering from Valparaiso University, Indiana in 1963, a M.S. in Hydrology from Colorado State in 1965, and a Ph.D in Sanitary Engineering from the University of Washington in 1969. He is registered as a professional engineer in Virginia, Michigan, California, Maryland and Ohio.

David A. Woolhiser, an engineer with the USDA's Agricultural Research Service, was also elected a member of the academy. Woolhiser pioneered research that coupled the power of computers with mathematical formulas to simulate water movement and thus improve prediction and control of floods, erosion and pollution. Since 1981 Woolhiser has been Research Leader of USDA's Aridland Watershed Management Unit in Tucson, Arizona and adjunct professor at the University of Arizona's Department of Hydrology and Water Resources. "During his 27-year career with the research agency, he has lectured in England, Spain, Mexico, Belgium, Hungary and Italy and is recognized as an international authority on hydrology," said Dr. William G. Chace, Jr., Director for the Pacific West Area that includes Arizona. From 1967 to 1981 Woolhiser was Research Leader for the Agricultural/Surface-mined Hydrology Research Group, Fort Collins, and also a faculty affiliate in the Department of Civil Engineering at Colorado State.

The induction ceremony will take place at the Academy's annual meeting in Washington, D.C. in October.

KEN BOLEN, EXTENSION DIRECTOR, GOES TO NEBRASKA Cooperative Extension Director Ken Bolen will leave Colorado State to become Dean/Director of the Nebraska Cooperative Extension Service. Bolen has been Director of Colorado Cooperative Extension Service since January 1, 1986. Prior to that, he was Assistant Director of the Nebraska Cooperative Extension Service with responsibility for Agriculture and Natural Resource programs from 1981 to 1985. Bolen has about 25 years experience with the Cooperative Extension System including county, multi-county, state and national assignments. Dennis Lamm will serve as Acting Extension Director.

USGS MATCHING GRANT AWARDED TO CAROLE MAKELA - A Home Economics Professor at Colorado State has received a grant to determine the extent of damage caused by dissolved minerals in household water supplies - including the shortened lives of household appliances. Colorado's Arkansas River Basin was chosen as the study area, because it includes headwater communities that have low minerals concentrations (200 mg/l) and plains area towns with salinity ranging up to 2500 mg/l. In addition to household surveys, the project will include a parallel survey of at least 75 appliance repair and plumbing enterprises.

HOW WATER CONSERVATION COULD WORK

by Loretta C. Lohman

While recently reviewing various water conservation programs developed in the last few years, I was struck anew by their fragmented nature--from agricultural water conservation to augment city supplies; rate structures to encourage less use; farm to municipal transfers; xeriscaping; water reuse; residential water efficiency; and so on. However, few programs addressed the issue of what water conservation or maximizing efficiency could really do for an area facing water supply problems. Certainly we here along the Front Range of Colorado have been bombarded with can dos and can't dos of conservation. Emotions have been so high on both sides of the issue that it doesn't seem possible to seriously examine the possibilities of a comprehensive program. For the most part all our talk about water conservation remains a mirage. Why? Because we tend to isolate each water-saving act. We have programs to subsidize a low-flow toilet or xeriscape. We talk about more efficient outdoor irrigation, private and public. At the same time, we still charge virtually nothing for water and continually fail to institutionalize a conservation ethic. We treat water like air--but water is a market commodity, one in relatively short supply.

Looking at the experiences in another area might be one way of getting a better handle on the issue. In Arizona conservation plans are mandated for three active management areas--Phoenix, Tucson and Prescott metropolitan areas--and there are some startling changes in that three years ago not much was being done, except in Tucson, about water conservation. Three years ago many communities in the Phoenix area were relying on very saline and very hard groundwater for a large share of domestic supplies, and most homes in those communities were using either bottled water or point-of-use treatment systems for cooking and drinking. Today, due to both the Central Arizona Project and management changes, tap water is back in use. This new water is generally subject to inverted rate structures, and plans for its conservation, recycling and reuse are increasingly common.

However, Phoenix and its environs are relatively new to the game of water conservation, and it is a concept which is being addressed with differing levels of vigor. The greatest changes in directing the public toward more efficient water use are occurring in new developments where purchasers can have turf or a swimming pool in back, not both. In some new developments homeowners must xeriscape their front yards, or do so as a result of neighborhood pressure. Some new developments are installing dual water systems--reclaimed water outside and so-called first use water inside. Reuse plans include recharge projects which will store any excess supplies for future uses. Some cities now have plumbing codes requiring low water-using fixtures and programs limiting residential and public turf. Even so, there are areas in and around Phoenix who as yet have no water conservation program at all, not even on paper. Some communities are meeting planning goals for reduced gallons per capita per day rates by developing parks to use effluent as a way of showing lower demand. Others are challenging the planning goals through litigation while implementing

minimal public conservation measures. While there is a lot of talk about water conservation in utility offices and at conferences, there is not a lot of publicly visible conservation effort in the Phoenix metropolitan area.

Then there is Tucson. Tucson is the oasis, where Phoenix and Denver are the mirage. In Tucson conservation has become a way of life. With a program begun from severe and immediate need, Tucson has institutionalized water conservation. Each year the City Council requests and receives an updated conservation plan from the Water Department. The plan is discussed and voted upon, each and every year. In Tucson, water conservation is whole. Each aspect of the water-using community is involved--the government, the homeowner, the business owner, golf course proprietor, gardening center, cemetery--in the conservation program. While the cost of water, even in Tucson, is less than one percent of most users' net expenses, users recognize that the low cost cannot be sustained without a full program involving indoor and outdoor conservation, reuse, reduction of groundwater pumping, and maximizing Central Arizona Project supplies. Tucson citizens have been shown that these measures are more cost-effective than development of any new supplies, supplies that essentially would come from the purchase and transport of water rights held by distant agricultural interests. Even more importantly, area water purveyors now meet on a monthly basis to plot progress, share problems and address the future without historic infighting.

Tucson represents what a multi-faceted conservation program should be and what it can do. Tucson's program targets all areas of water use. The effectiveness is monitored and adjusted on a yearly basis. The costs of conservation methods are compared to more traditional water supply methods and that information is presented to the public. While it's not perfect, the regular adjustments to the program remedy defects on a timely basis. The latest pricing structure, for instance, includes conservation incentives for multi-family dwellings and commercial users and new plumbing code funds up to \$100 for purchase and installation of low-flow toilets. Because of its comprehensive program, Tucson feels that present water supplies will be sufficient at least until 2050. After that, the long-range plan estimates that shortfalls will be most cost-effectively addressed by potable wastewater reuse, a plan that has already been endorsed by a citizens' committee.

Tucson can be cited as an example of a successful integrative system. Lessons from Tucson can be applied elsewhere in the Southwest. In the end conservation is a matter of will. Do we or do we not want to pursue conservation--efficiency of water use--as an option in water supply management and planning? If we do, we might look at a complete, institutionalized approach, one that becomes a part of daily life, one that is not a response to a short-term need. This is the way in which conservation programs seem to contribute significantly to stretching available water supplies.

TAKING STOCK OF METROPOLITAN DENVER'S WATER RESOURCES

*A Report on the 10th Annual Thornton Symposium
By Loretta C. Lohman*

The Thornton Symposium, moderated by Mayor Margaret Carpenter, featured a keynote speech by State Representative Scott McInnis (text reprinted in this issue). Further perspectives on the metropolitan area's water resources were offered by Hubert Farbes, Chairman of the Board of Denver Water Commissioners, Pam Spivey, manager of a number of special water districts, Larry Berkowitz, President of the Metropolitan Denver Water Authority, Rich Ferdinandsen, Chairman of the Jefferson County Board of Commissioners, James Griesemer, Vice Chancellor of Business and Financial Affairs, University of Denver and former Aurora City Manager, and Chips Barry, Executive Director, Colorado Department of Natural Resources (text reprinted in this issue).

In reaction to the keynote talk, Hubert Farbes reminded the audience about the impacts of Federal government decisions which affect water resources well beyond the metropolitan area. While Farbes noted that compromise will be required by all parties in water planning, he intimated that the time is fast arriving when a crisis will produce public support for Two Forks or at least for sustained planning. Farbes feels that new alternatives, not yet known or recognized, will be the ultimate solution. Finally, he noted that the State will have to "bite the bullet" on water planning.

Ms. Spivey discussed the eight and one-half year cooperative effort on the part of water providers in the metro-wide SEIS. She noted that one solution for her districts may be water reuse so that developers, hospitals, businesses, and others might have some level of assured water supply.

Larry Berkowitz noted that the Metropolitan water providers are in conflict on water rates with Denver. He urged a go-slow policy on water planning, urging a metropolitan rather than a statewide approach.

Rich Ferdinandsen resurrected former Representative Mick Spano's concept of a metropolitan water authority. He stated that as a county commissioner he could recognize water as the key to metropolitan cooperation. Water cooperation is the first step to metropolitan cooperation and problem solving. There has to be a way to bring together the water independent entities. This will require great patience and persistence in an evolutionary, complex, process with institutional changes being made. He recommends a metropolitan water authority independent of all existing authorities, with equal representation, asset transfers, and wholesale capabilities.

Jim Griesemer, agreeing with the tenor of the keynote speech, noted that the problem is economic and the solution is political. Local governments need to find common ground and begin to understand the economic realities from all sides. Without a coherent metropolitan economic interest, clearly understood by all parties, there will be no solution.

After a question and comment period Denver Post columnist Woody Paige recalled Mark Twain's comment that whiskey

was for drinking and water was for fighting as a basis for his observation that it is going to take careful development of the interpersonal relationship statewide, east and west, north and south, in order to address the problem of water supply. Finally, he pledged his efforts to keeping the myriad issues concerning water before the public.

NEW WATER QUALITY PLAN TO PROTECT BEAR CREEK RESERVOIR

One of the Front Range's newer lakes, Bear Creek Reservoir, was filled with water in the summer of 1977. The reservoir was built as a flood control facility, and is owned by the Army Corps of Engineers with the area surrounding the lake leased by the City of Lakewood and known as Bear Creek Park. Fishing is the primary recreational activity at the park, and trout are stocked by the Colorado Division of Wildlife. The fishery has been poor in recent years due to deteriorating water quality. Bear Creek Reservoir is described as eutrophic, a term that means "accelerated natural aging process." Eutrophication is caused by the lake having too much nutrient input along with sediments and organic matter. Nutrients like nitrogen and phosphorus affect lakes by acting as fertilizer. Eutrophication causes excessive plant production which reduces oxygen levels. Reduced oxygen levels decrease fish populations. In Bear Creek's situation, the reservoir is affected by the high amounts of nitrogen and phosphorus, other nutrients, and sediments that are carried into the reservoir from the watershed.

A task force, comprised of representatives from The Denver Council of Governments (DRCOG), the Jefferson County Mountain Water Quality Association, the City of Lakewood, the Colorado Water Quality Control Division, EPA and the U.S. Army Corps of Engineers, is working to develop a restoration program for the reservoir. Control strategies for "non-point sources" will be an integral component of an overall watershed management program. The plan will have all wastewater treatment facilities equally removing phosphorus from their wastewater discharges, a staged non-point pollution source control program, ongoing monitoring, a public education program, special intergovernmental agreements and in-reservoir treatments. Details of this management plan should be completed by mid-summer.

EVENTS OF INTEREST

American Lyceum plans water meetings - July 11 will begin a series of water forums planned by the American Lyceum - the Past, the Present and the Future. On the program will be Bob Sears of the Irrigation Institute, Washington D.C.; Harold Miskel, Manager, Planning and Resource Development, City of Colorado Springs; Water Attorney Ward Fischer of Fort Collins; and Brian Werner of the Northern Colorado Water Conservancy District, who will give a preview of the District's State Fair exhibit. Earl Butts, former Secretary of Agriculture, will speak on September 22 as part of the series. The meetings will be held at the Windsor High School Auditorium and begin at 7:30 p.m. The programs will be videotaped. For additional information contact Richard Hergert, Greeley, Colorado at (303)352-1821.

Urban Non-Point Source Pollution and Stormwater Management Symposium - The Kentucky Water Resources Institute is sponsoring a symposium on Urban Non-point Source Pollution and Stormwater Management, July 22-24 on the University of Kentucky campus. The seminar will have nationally and internationally known speakers on the topics of: Financing stormwater and non-point programs; Stormwater and non-point management models; Structural design of stormwater and non-point facilities; Stream control and urban wetlands; Models to assess the impact of storm events; Monitoring stormwater quality; Sediment control; and Biomonitoring of non-point source urban pollutants.

Mini-courses will deal with: design of stormwater and non-point source pollution monitoring networks, stormwater utility ordinances and administration, integrating federal, state and local urban runoff programs; groundwater protection from non-point source pollution; design of wetlands for urban non-point source pollution control; design of stormwater and sediment detention basins; the introduction of hydrograph generation and detention pond design; and soil bioengineering techniques for streambank stabilization and uplands erosion control. Call (606)257-2820 for further information.

Colorado Water Congress Water Law Seminar - September 27-28, 1990. Topics will include: The History of Colorado Water Law; Water Distribution Organizations; The Water Court System and Procedure; The Relationship Between the Federal Government and Colorado Water Law; The Impact on Colorado of Interstate Compacts; The

Colorado River, The Colorado River Water Conservation District, and Western Colorado Water Projects; Overview of Colorado Groundwater Law; Federal and State Water Quality Laws; Engineering Aspects of Water Rights; Historical Overview of the Denver Water System; The Responsibilities and Roles in Water Matters of the Colorado Division of Water Resources, the Groundwater Commission, the Office of the State Engineer, Conservancy Districts, The Colorado Water Resources and Power Development Authority, The Colorado Water Conservation Board, The Colorado Water Quality Control Division, and The Colorado Water Resources Research Institute. For further information contact The Colorado Water Congress at 837-0812.

Workshop on Nitrate Contamination: Exposure, Consequences and Control - The University of Nebraska at Lincoln (UNL) will host a workshop related to the magnitude, adverse health effects and the high cost of control of groundwater nitrate contamination. The mission of the workshop is to provide interaction among hydrologists, toxicologists and environmental engineers and develop an integrated framework for nitrate risk management. This will improve the common practice of focusing on just one of the three specialties. The workshop is sponsored by the North Atlantic Treaty Organization (NATO), and invited participants will include 20-30 representatives from the NATO countries. The workshop director is Istvan Bogardi, Professor of Civil Engineering at UNL, and co-organizer is Bob Kuzekla at the Nebraska Water Center. For further information call Kuzekla at (402)472-3305.

AN OVERVIEW OF GLOBAL WARMING

Global warming, or the "Greenhouse Effect," became a public environmental concern only a few years ago. Yet the theory of human-induced climate change was first introduced as early as 1896 when Swedish chemist Svante Arrhenius, using a simple model, estimated that if the atmospheric concentration of carbon dioxide doubled, the Earth's temperature would warm by approximately 5 degrees celsius.

Today, according to a recent international survey, three-fourths of the 1,500 scientists involved in climate change research who were polled believe that global temperatures are rising, but fewer than half said they believed that scientific theory supports this conclusion. The survey, conducted by Global Change Environmental Report, found that 96 percent of the respondents believed in the basic greenhouse effect theory - based more on intuition and general knowledge of climate than on specific research about the subject. Seventy-one percent said they believed that temperature increases over the past century were within the range of normal climatic fluctuation; however, two-thirds said they believed that the odds are better than 50-50 that global temperatures will rise by three degrees over the next century. This issue is being hotly debated and extensively researched, and regardless of the outcome it is worthy of much discussion.

What We Know So Far - According to worldwide weather records collected by scientists in the United States and England, the six warmest years of the last 110 years were 1989, 1988, 1987, 1983, 1981, and 1980. There is

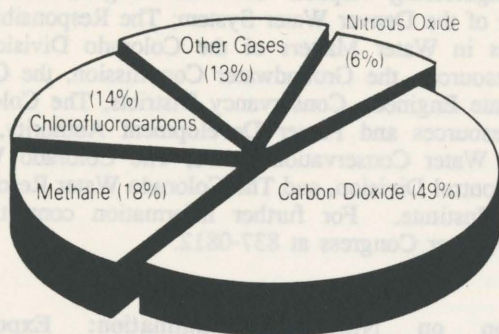
disagreement among scientists, however, about the causes of the current warming trend, which some say are merely the result of large natural variations in climate and temperatures, or perhaps cyclic periods of the earth's cold and warm ages. Others say steadily increasing greenhouse gases caused by expanded energy use, agricultural practices and population growth since the industrial revolution began about 200 years ago have caused the higher temperatures.

Why Some Scientists See a "Greenhouse" Signal

The Ozone Hole--In May 1988, 200 researchers from nine countries met in Snowmass, Colorado and reached a consensus that CFCs are causing the ozone hole above Antarctica. The ozone layer, three-millimeters deep, envelops the planet and shields it from ultraviolet (UV) radiation. Scientists believe that an increase of UV could cause mutations in the organisms that anchor the food chain of the world's oceans, cause more cases of skin cancer, and also damage the body's immune system.

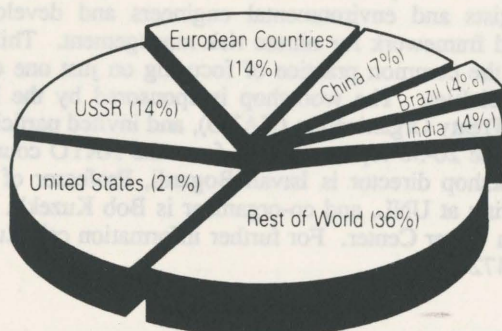
In December 1988, the National Science Foundation reported on experiments conducted near McMurdo Station, the main NSF research base in Antarctica, by a scientific team from the State University of New York at Stony Brook. Scientists measured amounts of chlorine monoxide both day and night at the altitude where most ozone depletion occurs. Chlorine monoxide, consisting of one atom of chlorine and one atom

Greenhouse Gas Contributions to Global Warming (1980s)



Source: J. Hansen et al

Regional Contributions to Global Warming



Source: EPA

of oxygen, is formed when chlorine destroys ozone. They found that ozone depletion increases quadratically with chlorine monoxide concentration, and the ultimate source of most of the chlorine monoxide and chlorine at these altitudes was CFCs. The researchers said polar stratospheric clouds, which form at very cold temperatures, appear to change the chemistry of chlorine by removing oxides of nitrogen from the atmosphere and preventing the oxides from binding chlorine into a harmless form. During the Antarctic spring the polar vortex, a band of winds, encircles the continent and prevents the air there from mixing with the atmosphere in other parts of the world. The hole disappears in the summer when the winds change. Now there are signs that an ozone hole about the size of Greenland opens in the Arctic too.

Historical Levels of Greenhouse Gases--Scientists can measure historical concentrations of Greenhouse gases by drilling into the Antarctic ice cap and extracting air that is trapped in small packets of ice and then analyzing the air samples in the laboratory. The thawing and refreezing of different layers of ice provides a good estimate of the air sample's age, and air has been extracted that was trapped as long as 163,000 years ago. With this information pre-industrial concentrations of Greenhouse gases can be compared with today's concentrations.

Water Vapor's Contribution to the Greenhouse Effect--The hypothesis that airborne water vapor amplifies the warming effect of carbon dioxide and other gases is crucial

Fossil fuel combustion and deforestation are the primary sources of increases in atmospheric CO₂.

Methane increases in the atmosphere are caused by agriculture (particularly rice cultivation and animal husbandry), landfills, coal seams, natural gas exploration and pipeline leakage and biomass burnings associated with deforestation.

Nitrogen-based fertilizers, land clearing, biomass burning and fossil-fuel combustion contribute to increased concentrations of nitrous oxide.

Chlorofluorocarbons (CFCs), thought to be the primary cause of the ozone hole above Antarctica, are used in refrigeration, air conditioning, industrial solvents, and in many other countries as aerosol propellants.

to the Greenhouse theory. A December 1989 report by University of Chicago scientists concluded that amplification does take place, and that it is of about the same magnitude as that predicted by mathematical models which indicate global warming. The report was based largely on readings taken by infrared sensors aboard the 1985 space shuttle and on ocean-surface temperatures measured aboard ships and buoys. The measurements showed that twice as much heat is trapped in warm oceans, where moisture evaporates and is held in the air, than in colder oceans. Scientists also found that in the western tropical Pacific Ocean, the warmest part of the world, warming exceeded levels predicted by the models. They cautioned, however, that the theory must pass several more tests, and the most important is how clouds affect global warming.

Projected Changes from the Greenhouse Effect

Advocates of the Greenhouse Theory foresee a shift in weather patterns that would bring less rain to many areas, including the American West, which could decrease the Colorado River Basin's annual flow as much as 40 percent. Scientists at the University of Colorado's Center for the Study of the Earth from Space have used infrared satellite photos and dating techniques to document giant sand dunes underlying the topsoil of America's High Plains area. Infrared photos show that hundreds of dunes have broken through the relatively weak High Plains topsoil. Experts say that if a global warming causes the sand dunes to spread, it would be far more expensive to irrigate and nearly impossible to salvage vast areas.

A report released on May 25 by the United Nation's Intergovernmental Panel on Climate Change predicts an

overall temperature increase in the next century greater than that of the previous 10,000 years combined - 5.4 degrees by the end of the 21st century if nothing is done. Dr. John Houghton, Chairman of the panel and Britain's Chief Meteorologist, said only a handful of scientists in the panel disagreed with its findings. Two other working groups of the panel are preparing reports on the effects of global warming, which they say will include rising seas, the spread of disease, and widespread starvation in poor countries. The three reports will be presented in November at the World Climate Conference in Geneva.

What the Skeptics Say

Reports on data collected from 1979 through 1988 by the TIROS-N series of weather satellites show no evidence of global warming, say scientists, but by the turn of the century a trend should be evident. Richard Sloan, a leading skeptic, says present models that predict global warming do not reproduce the earth's own efficient way of cooling its surface - the intensity and distribution of air currents in cumulus clouds, storm systems and large-scale circulations. Sloan is a Professor of Meteorology at Massachusetts Institute of Technology. Other skeptics even say that if the warming is modest it could bring benefits like longer growing seasons in temperate zones and more rain in dry areas.

Options for Slowing the Trend

The most common options for reducing Greenhouse-gas emissions involve reducing fossil-fuel consumption, developing alternative energy sources, switching to fuels that release less carbon dioxide, improving energy efficiency, and starting programs for reforestation. According to a recent report in the Los Angeles Times, the World Resources Institute says destruction of the world's tropical forests is occurring nearly 50 percent faster than the best previous scientific estimates, and tree burning accounts for an estimated 30 percent of total carbon dioxide emissions worldwide.

More than 200 lawmakers from 42 nations gathered in Washington D.C. for a conference on global warming convened in May by the U.S. Congress. Delegates called for immediate action to curb greenhouse pollutants and recommended a "global Marshall Plan" to help developing nations cope with environmental problems.

The Bush Administration announced on June 15 that it would back creation of an international fund to help developing countries end use of ozone-depleting chemicals. If other countries accept the administration's idea, the proposed fund would be administered by the World Bank. Before yesterday's announcement, the Administration had maintained that any assistance for phasing out CFCs should come from existing World Bank resources and not new funds.

Gaining a Better Understanding of Possible Global Change

Satellite Imaging of Environmental Trends--A 14-member team of University of Colorado scientists is developing

NASA's HIRIS or High Resolution Imaging Spectrometer. The 1,000 pound imaging device will be aboard the Earth Observing System, to be launched in 1997 and 1999. The polar-orbiting platforms will orbit about 20 years, providing detailed looks at environmental trends. With each orbit HIRIS will look for details on vegetation, geology, water chemistry and cycles, soil, snow and ice. Alexander Goetz, leader of the team, is a University of Colorado professor and director of the Center for the Study of Earth from Space.

Studying Grasslands with Remote Sensors--Colorado State University scientists say an intensive study of the Great Plains area may be the key to helping people understand global warming and the effect it can have on grasslands. CADRE, the Center for Analysis of the Dynamics of Regional Ecosystems, will also place remote sensors on platforms in space. Aimed at the grasslands, the sensors will serve as a warning system to detect environmental changes in the prairie caused by climate change. Scientists will also conduct periodic studies of prairie grass to show how temperature changes affect the chemical and biological content of the soil. CADRE director Robert Woodmansee says this information will allow Coloradans to foresee dry years and perhaps avoid conflicts over water and economic problems associated with low snowfalls.

Solar Energy Development--The new director of Colorado State's Solar Energy Applications Laboratory, Douglas C. Hittle, says the solar lab and its work in solar-energy system development are part of the solution. Hittle said the lab will expand its research focus to include energy conservation, control of energy systems, building design and operation optimization and other aspects of building energy use. The solar lab was founded in 1972 by George Lof, a pioneer in solar energy research, who now serves as the lab's senior adviser.

Atmospheric Research - Colorado State's Department of Atmospheric Science has many ongoing research projects related to global warming (see Colorado Water Research) sponsored by state, regional, national and international agencies. Faculty interests within the department related to global warming include atmospheric chemistry and air pollution, atmospheric radiation, atmospheric transport processes, cloud and precipitation physics, cumulus convection and cloud dynamics, general circulation modeling, global and regional climatology, remote sensing, and weather modification. The Cooperative Institute for Research in the Atmosphere (CIRA) provides a continuing relationship between Colorado State and the National Oceanic and Atmospheric Administration (NOAA). The U.S. Army Center for Geosciences which supports education and research in remote sensing, atmospheric modeling, hydrology and information extraction is also coordinated through CIRA.

Sources: EPA Journal, May 1990; Newsweek 7/11/88; National Science Foundation News 12/8/88; Knight-Ridder News Service 1/7/90; Gannett News Service 1/13/90; New York Times 12/15/90; Associated Press 12/14/89, 5/3/90, 5/27/90; Denver Post 2/7/90, 4/28/90, 4/19/90, 6/16/90; Coloradoan 12/13/89, 2/25/90, 5/4/90, 5/26/90; Los Angeles Times 5/4/90; World Watch, May-June 1990;

**COLORADO'S WATER GAME:
ARE THINGS COMING TOGETHER OR FALLING APART?
Presented to the Thornton Water Symposium May 11, 1990
Representative Scott McInnis**

I appreciate this opportunity to address you today and to give you my perspective regarding water matters in Colorado. I believe we are in serious trouble in Colorado with respect to water resources. Picking up on the title of this speech ... **Are Things Coming Together...or Falling Apart with Respect to Colorado's Water Game...** I believe they are more falling apart. Colorado does not have a coherent water policy which can sustain us through the 1990s. There continues to be more in-fighting than cooperation on water matters in Colorado...and I believe we are headed for some very difficult years unless we turn things around. Today I would like to address seven basic issues:

- The need for a realistic state water policy;
- The importance of metropolitan cooperation for all of us in Colorado;
- The real disaster of Two Forks;
- The unique and continuing powerful role of the Denver Water Board;
- The role local government must assume in water matters;
- Why basin of origin protection must be a matter of state policy;
- And finally why we had better pay closer attention to what is happening in Southern California.

A State Water Policy...It's Time We Enact One:

For twenty years, there has been a cry for a state water policy in Colorado. During that time, Colorado's "water experts" have almost uniformly cried..."it can't be done--our Constitution is our water policy, and it would be to disruptive to go beyond current law." At the same time:

- The single new water storage project to which Denver latched its future, **Two Forks**, has been killed.
- Denver and the suburbs continue to fight over Denver's role as the dominant water provider in the region...and over water rates.
- Some suburban entities are now pursuing their own expensive and difficult water projects.
- Several suburban entities have no long-term water supply...they haven't got a clue how to serve their future growth.
- Incredible plans are being pursued to pump vast amounts of ground water from the San Luis Valley to Denver.
- Headwater communities on the Western Slope have never been under greater pressure. And we've yet to enact fair and proper laws to protect them.
- And all this chaos plays out while Southern California enters its fourth straight year of severe drought.

On March 19th of last year, Carl Miller of the Denver Post wrote a column in which he said that "Colorado must develop a water policy that makes sense in every part of the state, not just the Denver Metro Area." Carl Miller was absolutely correct. But I would go further. Colorado not only needs a policy which will work in both Eastern and Western Colorado...but it needs a water plan for urban Colorado which will foster cooperation, will provide for an efficient use of the resource and provide a predictable future for all Colorado communities. I'm not sure any one of these observations are completely accurate. But I am deeply disturbed by what I see happening in Colorado.

Metropolitan Cooperation - There isn't Much of it...and all of Colorado suffers:

Traditionally, Western Colorado has feared the organization of Front Range water interests. It has long thought that a "metro-wide Water Board" would be sufficiently powerful to overtake West Slope water interests. I personally believe, however, that the current chaos in water management, the lack of cooperation, lack of a plan...and the potential crisis that may result in a matter of years...is far more threatening than a coordinated entity with which the Western Slope can deal and negotiate. In Western Colorado, we followed your effort to achieve "Metro Cooperation" very closely. You will pardon me if my analysis is somewhat distant and not completely on point, but the fact that you could not come together as a region is a tragedy. Not because such cooperation would have saved Two Forks, but because you lost three to four years in putting together some coherent metro-wide water plan. From the other side of the "Hill" it seems two things went wrong in the Metro Cooperation discussions. First, they were driven by a naive, almost cheerleading mentality that Metro area cities and districts could just throw all of their water into a common pool. The problem was these entities were each individual and different. Many had made long-range decisions backed by enormous financial commitments that they couldn't walk away from. A system never emerged that would have allowed a common regional water plan with separate and independent, but sharable resources.

Second, from what I gather from the Denver papers, the regional water issue was linked to other metropolitan services. While I am sympathetic with the **City and County of Denver's** concerns that they get broad value for a regionalization of its water system...the linkage issue might have been over-played. Regional and state-wide water issues are sufficiently complicated and to add them into a broader regional puzzle seem self defeating. The four-city **Front Range Water Authority** is interesting and may prove helpful to those four entities. But it is a far cry from the more comprehensive plan we need.

Two Forks - The disaster was not so much in the demise of the project, it was in not seeing the demise earlier and not having an alternative.

Many people believe the Environmental Protection Agency killed Two Forks...and that technically may be true. But regardless of your opinion on the project, the reality is it was dead well before Bill Reilly threw down the gauntlet. Sponsors failed to see that Two Forks had become a national issue. When the National Audubon Society declared protection of the South Platte River as its top priority, bells should have gone off that the project was in trouble. When poll after poll in Metro Denver disclosed building public opposition for the project, someone should have taken note. But rather than understanding what was happening, project sponsors mounted their own public opinion survey to show the project had public support. Either project sponsors did an inadequate job educating the public about the need for Two Forks, or the public was never going to buy it. The public in Metropolitan Denver virtually rejected the project...not just EPA Administrator Reilly. While I am sure some will hotly debate this observation, I believe Two Forks was, and perhaps remains, the only alternative the Denver Water Board ever had in mind.

Two Forks was the reason for the Metropolitan Water Providers organization. Two Forks was the only serious project considered by Denver in the very expensive EIS process. And the firm belief that Two Forks would be developed was the base upon which extensive metropolitan cooperation discussions were held for over three years. And as you know, those discussions produced virtually nothing. Two Forks was brinkmanship of the highest order... and it failed. And now, when everyone else in the world knows that Two Forks is dead, water planners talk about elaborate plans of suspending the EPA decision process and putting the project on the shelf to be pulled off and restarted some day when all other alternatives...by design...fail. In a nutshell, Two Forks may have been the best project for Denver from an engineering and hydrology standpoint, but from a public policy perspective it has been rejected. The faster that reality sinks in, the faster we can move beyond Two Forks and develop a practical water policy for this state.

Role of Denver Water Board - Still the Most Influential Water Entity in Colorado:

The Role of the Denver Water Board has been mixed in all of this debate and drama. The one thing it has not been is altogether even. During the early stages of Two Forks, in the late 1970s and early 1980s, Denver sat back and challenged the suburbs to go out and create the political climate for the project. Although it desperately wanted Two Forks to perfect its system, it allowed the suburbs to take the lead...claiming "Denver had all it needed for the future." This was an obvious miscalculation...because the public always saw Two Forks as a Denver project. Over thirty metro-area districts are dependent on Denver for water. If it decides to change its tap allocation policy...or its water rates, turmoil reigns through the entire metropolitan area. After EPA's decision to kill Two Forks, Denver announced a "separatist" policy which seemed intent upon punishing the suburbs for failing to pull off Two Forks and punishing the public for not getting behind the project. In order for a coherent metro-wide water plan to ever be developed...in order for a fair and workable state water plan to ever be enacted, the Denver Water Board must resume a role of leadership. Not leadership to further Denver's position at the cost of other cities and regions, but leadership to avert a water crisis which is looming several years into the future. What Denver's cooperation could give the metro area would be increased yield in Northern Colorado...a better distribution system throughout the Denver Metro Area. Denver cannot be expected to make investments at the expense of its citizens, and a fair value for Denver's services and access to its system must be realized. However, the fighting and bickering must stop and action begin.

Role of Local Government:

The Two Forks debacle underscores one of the most fundamental changes in water development over the past decade. Water development is no longer...nor should it be, a black box decision process owned and operated by the water experts. That's of course an uncomfortable reality for those who have long cherished their secret water models and engineering data that produce the one "correct" answer or project. Time after time we see the public pushing its way to the table to register an opinion. Two Forks is a dramatic demonstration of public interest. The agreement between Denver and the Colorado River District is another. They may have signed an agreement, but Western Colorado didn't broadly buy into it, and in the end Two Forks was vigorously opposed in Western Colorado. Gunnison...another example of an initial agreement between governments that came unraveled when the public became active. The point of all this is that water development has become an openly public matter in Colorado. This, local governments must play a stronger role. Locally elected officials, with broad public welfare responsibilities should be in a position to integrate water decisions into broader public policy. This should not be left to the water experts.

Basin of Origin Protection Must Become State Policy:

One sometimes gets the impression that urban Colorado's strategy for dealing with basin of origin protection is to ignore the issue until reapportionment. Then the issue will go away. That is as naive as believing opposition to Two Forks will go away. Very simply, Colorado's public ethic demands that one community not wreck the economy of another, regardless of whether a certain community had the leadership and foresight to claim water rights fifty years ago part of any state-wide cooperation and eventual policy must be some form of protection for those areas which are in the unenviable position of being headwater communities. Basin of Origin legislation should not be used to deny the fundamental right to develop water...but this is a bullet that urban Colorado simply must bite at some point.

Southern California - Disaster Forming for Colorado:

Southern California is in its fourth year of a severe drought. Cities there start the summer with only 55% normal rainfall in their reservoirs. There are more members of Congress in one "neighborhood" in the Los Angeles area than in all of Colorado. And when reapportionment comes Southern California will be getting more than a dozen new seats! Political pressure will continue to build in Southern California for a solution...and unless we get our act together, mortgaging Colorado's future will be that solution.

Conclusion - Leadership is Needed Now:

The leadership is needed now to put our differences aside in Colorado and develop a water policy for the entire state. That's why I'm calling on Governor Romer to do something very similar to what Governor John Love did more than twenty years ago...personally convene a state water panel...much like the "Committee of 100"...which will develop for this state a modern, functional and fair state water policy. I believe such a panel should be convened following the November elections.

One of our biggest problems in Colorado is that many people may not believe we face an imminent water crisis. Everybody who wants a tap can get one now...so what's the problem? Well, the problem is this:

Farmers are fighting with the cities...
Northern and Southern Front range is fighting with Denver Metro...
Denver is fighting with the suburbs...
The East Slope is fighting with the West Slope...
And California is going dry.

I couldn't think of a worse equation for the future of Colorado. It's time to get our act together. About sixty years ago, a young man by the name of Glen Saunders gave a very special gift to the City and County of Denver...he gave the city his wisdom and planning. As a result Denver developed one of the most remarkable water systems in America. What we need now is a Glen Saunders for Colorado.

COLORADO'S WATER GAME: ARE THINGS COMING TOGETHER OR FALLING APART?

Presented to the Thornton Water Symposium May 11, 1990

Chips Barry, Executive Director, Colorado Department of Natural Resources

The topic is "are we coming together or falling apart on water," and I will address that from the state government point of view and talk a little about what the state government has done in the past and what we will do in the future. The first thing to say is that the answer to the question seems to depend entirely on your point of view. If you're an environmentalist you probably think maybe we're coming together - we're making progress. If you're a traditional water developer you are rather pessimistic about the way things are. I'd like to talk about that in the context of the state role, past and present. Before I do that let me talk about our water system, because I sometimes think that we do not all recognize the fundamental underpinnings of the system that we have and how it works. It is imperative that we understand that. Let's go back to the basics, first of all.

In Colorado, water is believed to be a common good. It's like air or parkland. Everybody is entitled to it; it's a basic necessity. You turn on the tap to get water, just like opening your lungs to get air. That is what people believe. Now the point is that for common goods like air and parkland, there is either no need to allocate that, like air, or government allocates it, like parkland or medicare. Now there are other necessities in life, food and gasoline, for example, that are not common resources and which are allocated by the free market. Water is a necessity. Is it a common resource or is it a commodity like food, gasoline or airline tickets? It seems to me that in Colorado we are schizophrenic about this issue, and that is the source of most

of our problems. Our system makes water a free-market commodity but the public demands, and more now than in the past, that we, i.e., government, do something for them - that we allocate water, that we preserve streams, that we recognize the non-economic values of water, that we protect the basin-of-origin, and that we get water to people that don't have it. That's what people demand, but we have a system that is set up to do something rather different. So it seems to me that the conflict and tension between these two ideas, water as a common good and water as a free-market commodity, underlie many of our problems and the issues. We must remember that's the system that we've set up for ourselves. I am not here today to say that's bad or that's good; it has pluses and minuses. If we talk about the metropolitan cooperation issue, or the basin-of-origin issue, or many of the issues, we have to remember what we have set up and what the underlying principle is.

Now, under those principles there is no historic state role to allocate and distribute water. State government is not in the business of saying who gets water and who does not. In fact, nobody in this room, in the largest sense, is in that business either. The free market allocates the water. Because of this, state government historically has had no role in that fundamental decision. The state role has been to make the prior appropriation system work and that is the job of the State Engineer, who works for me. He makes sure that the gates get open and closed and people who under the prior appropriation doctrine have a water right get that right

when they are supposed to. Or, the state role has been to lobby for federal dollars and to protect our compact rights. That is the job of the Colorado Water Conservation Board, also in my department.

None of these roles contemplates allocating water, distributing water, planning for water, conserving water or coordinating the activities of entities such as are here today. We decided collectively, the people of Colorado, more than 20 years ago, that the free market would take care of all those roles. But it does not take care of all those roles, and it cannot by definition. The consequences become more apparent as needs grow and free-market competition increases. I do not say that the free-market system is a failure. I don't say that we must change it, and I don't say necessarily that we can change it. What I'm trying to explain is that we are where we are because we have a system that grows out of this kind of schizophrenia. People expect water to be like air or the parkland, and we treat it like it's food. There are a lot of tensions in there, and there are no easy common answers.

Now, have we got our act together on metropolitan water cooperation? No. I think there is no question that we do not. But the reason is not the fault of Two Forks, Monte Pascoe, Margaret Carpenter, EPA, or the environmental community. The reason is that the free market and prior appropriation doctrine mean that competition rules, and that there is no required coordination or planning. It all is fine when there is plenty of water, but under the rules that we have established for ourselves warfare is entirely appropriate, expected, anticipated and looked forward to, at least by the water attorneys.

So there is under our system no required sharing, no rationing of water, no equitable rule for determining water allocations in times of shortage, and no comparative weighing of social values of water. These are all the kinds of considerations that, if you were determining a different way to allocate a scarce resource, you might crank into the system. We have not done that here. I'm not sure that it's possible to do it. But my first and major point is that we must understand where we are and where we have been, and why there is historically no state role, no statutory role, no traditional role for state government.

That leads me to make an aside here to Scott McInnis's request for a statewide water policy. I have spoken on this issue before. I once tried to write one, and I gave up on the word policy pretty quickly. It became a state water study, not a policy. I am reminded a little bit of my 13-year old who came to me the other night and said, Dad, we need a new allowance policy. Well, you understand what he means. He means he is not getting enough allowance and wants more. Well, to a great extent people who want a statewide water policy are saying, this system is not giving me what I want. Therefore we need a new policy because maybe that will give it to me. It's the same thing about a state water plan. The people who want a state water plan are the people who don't get water under the prior appropriation doctrine, under the market allocation system, so they want a policy and they want a plan. I don't demean the interests of those who aren't getting the water, but I go back to my fundamental point: let's understand why we are where we

are. We are there because we decided, for better or worse 100 years ago, that we are going to allocate this resource by who can pay. And that leads to problems, to competition, and to a lack of metropolitan cooperation. It's easy to stand up here and say we should all cooperate, but the fundamental, underlying principles mean it's very difficult to do that. You have to be very careful, and you have to understand the economic interests of people as you do that. It is easy to say basin-of-origin protection, easy to say metropolitan cooperation, but when we do that we set up tension between basic principles.

Are we coming together or are we falling apart? Well, if you are an environmentalist you say we're probably coming together. The shortcomings of the market system are more apparent now than they were in the past. And because that is true, we are going to see more change that leads to greater recognition of the environmental problems occasioned by the system. You'll see greater demand for change, and that change will move in the direction in which we've all seen it move: the Clean Water Act, the Endangered Species Act, the instream flow laws, etc. If you're an environmentalist you say we're coming together; we're getting wiser as we get older. We understand that we have a scarce resource and we have to accommodate all these different values, and through one means or another we're doing it.

If you're a water developer or a city, you probably look at what's happened and say you're not sure that we're doing so well. We can't rely on the systems and the things we have relied on in the past, and I'm not sure we can rely on the future. Maybe that leads to my last point, which is: let's look at the last six months of developments in Colorado: Two Forks was denied; there is an enormous debate growing in the lower Colorado Basin about how Lake Powell should be operated. Should it be operated for power, for water compact purposes, or, as is being alleged by many people, should it be operated to maximize the preservation of the Grand Canyon? There is an enormous movement in Congress that is going to say, "We're going to operate Glen canyon so water releases will do the minimum damage to the Grand Canyon regardless of the power requirements and regardless of the water requirements." And finally, look at what happened this week with Animas la Plata. You have a major water project, 20 years in the making, 10 years of negotiations, and you have the Fish and Wildlife Service saying it's going to hurt the fish and they don't think it should be built.

I look at those together and say, what does that mean for Colorado? What it means for Colorado is that what we have is what we are going to get, and the Colorado compact and the other compacts don't guarantee Colorado anything. They are worth the paper they're printed on, but not more. What we have is what we are going to get. And that's not a conspiracy. There are people, I suppose, who believe that, but it is a reflection of changing federal law, a reflection of changing public values, and a reflection of the scarcity of the resource and the competition that is going on all across the West. We can always say we are entitled to x-thousand additional acre-feet out of all our compacts, but when you try to take it you run smack against various kinds of public policies and pressure: the Endangered Species Act, the concern over the Grand Canyon, the concern over need. I

guess in the long run I look at what has happened this week and say, I think we should all remember and think about what this means for the compacts. We have drafted enough compacts for years, and my personal belief is we will not be able to develop a lot of additional water in Colorado for a lot of different reasons. As an aside, I think the Animas la Plata project may well go through, but it is not going to go through because it's a great water project or because of the compact. It's going to go through because I think there are enough people, me included, who believe that the Indian water rights settlement is the modern equivalent of a treaty, and it's time that the U.S. Government and the state Governments live up to treaty obligations. If we get an exemption from the Endangered Species Act, it will be for that reason and not because it's a great water project. I support it as a water project, but if it sells as an exemption it will be because we have an obligation to the Indian tribes.

Why did Two Forks fail? There are a lot of reasons for it. One is, in my view, that EPA never understood that Two Forks was not a water project; it was a catalyst for metropolitan government. EPA was incapable of comprehending that concept, and therefore it failed. It failed partly because when planning started for the project the projections for growth and need were substantial, and over time we saw loss to the economy in Colorado and less need, which cast great doubt on the validity of all those projections. People began to question the need. I think partly it failed because while it postulated cooperation, there are those who would say it was coerced cooperation in the metropolitan area and there was a lot of tension caused on that basis. Finally, I think there was a lack of public support. That is not the fault, by the way, of the Providers or anyone. It's a reflection of the fact that everybody here who now votes can turn on the tap and get water. There's no big need when everyone can do that.

We talked for a minute about basin-of-origin - it is a very big political problem. I want to relate it again to the basic principles: that you can move water from one place to another under the rubric of a free market. There is no restriction on your taking cereal from the East Slope to the West Slope, and generally there is no restriction on moving water either. My own personal position is that there is some basis for saying we need basin-of-origin protection for

environmental reasons. By and large, the environment is not considered in a free market economy. The environment can't pay; therefore, the values inherent in environmental protection aren't accommodated. But I wouldn't support basin-of-origin protection for economic reasons, because we don't and probably should not spend a lot of money subsidizing parts of the economy that aren't working as well as they used to.

So if you move water from the West Slope to the East Slope and there is an economic effect in the future, I think you're going to have to live with it. It's no different than when Ingersoll Rand or Harrison Western picks up a plant that used to operate in Fort Collins and moves it somewhere else. That's the free market at work, and even though we may not like the results we have a hard time figuring out how to fix it. I think that would be true for basin-of-origin.

About a state water policy and a state water plan, I personally believe that if a policy is a statement of where we intend to go, we can write a policy. We can't implement it tomorrow, however, because we have a free-market economy that says we allocate it by who can pay. If you want to allocate it differently you have to change the fundamental, underlying assumption.

Finally, getting our act together in the metropolitan area won't keep water from flowing down the stream. And our cooperation internally won't help all that much, because even if you are taking water from the west slope and moving it to the east slope and have everybody in Colorado agreeing with it, you will still have a lot of people who believe that water both economically and environmentally is better put to use by flowing all the way down our streams and out of the state to California. I am not here to say that it is, I'm just saying that even if we get our act together in the metropolitan area, people will say, "Let that water flow to California; it's better for Colorado that it work that way because we have tourists, and we have to help the environment, and that is just the way it ought to be." So we have a lot of problems, but I do think we have to pay great attention to metropolitan cooperation and we must respect, or at the least understand, the fundamental principles: how we allocated this resource and the kinds of tensions that are set up internally and have been throughout the years.

WATER NEWS DIGEST

WATER SUPPLY OUTLOOK

Released by Sheldon G. Boone

State Conservationist, Soil Conservation Service

Weather patterns in May did little to improve Colorado's water supply prospects. Projections for this spring and summer remain below normal throughout most of the state, with the most severe shortages expected in the southwestern river basins. Recent precipitation events have contributed to a general improvement in soil moisture over the mid-winter conditions. However, summer rainfall will remain a critical factor in producing near average crops in the dryer basins, as the state ends its fourth consecutive year of below normal snowpack. In the last survey of the season, the statewide statistics are only 54 percent of average. Below normal

totals have been consistently measured at nearly all of the automated SNOTEL sites, with the exception of just a few of the high elevation sites in northern Colorado. The loss of lower elevation snowpack has decreased the percentages in the Gunnison, San Miguel, Dolores and Animas Basins to less than 40 percent of average. The snowpack in the Yampa, White and Arkansas River Basins showed only a small change from May 1 readings. The highest snowpack in the state remains in the North Platte River Basin at 91 percent of average, while the lowest readings are in the San Juan, Animas and Dolores River Basins with only 34 percent of average totals.

Streamflow forecasts are below average to much below average nearly statewide. Volumes of less than 70 percent

of average are forecast for the Western Slope streams and rivers, including much of the Rio Grande Basin. Streamflows of 70-90 percent of average are expected in the Arkansas and Upper South Platte River Basins. The highest forecasts are projected on the northern tributaries of the South Platte River. Streamflow forecasts decreased this month in the Yampa, Gunnison, Colorado and South Platte Basins. Slight increases in forecasted runoff were seen in the Rio Grande, San Juan, and Animas Basins. The lowest forecasts continue in the southwestern river basins, where many rivers are expected to flow less than 50 percent of their normal volume.

WATER DEVELOPMENT

Animas-La Plata--Following a meeting with Interior Secretary Manuel Lujan on May 16, Representative Ben Nighthorse Campbell issued a press release from his Washington office saying that alternatives to stopping the project exist. Campbell said it may be possible to redistribute and supplement river flows by releasing water from Navajo Dam in New Mexico, managing habitat to create backwaters for the squawfish spawning and increasing hatchery production of the fish. Navajo Dam controls much of the flow on the San Juan River downstream from Shiprock New Mexico, where the fish are found.

The Animas-La Plata project, which is to supply water to southwestern Colorado's ranchers and Indian tribes, is threatened because the U.S. Fish and Wildlife Service has issued a draft jeopardy opinion saying the project would harm a small population of Colorado squawfish, an endangered species. The USFWS called for the project's postponement pending a long-term study of how it would affect the squawfish. The agency issued a "no jeopardy" opinion in 1979, and the reversal came on the eve of the project's groundbreaking. It also recommended that operations be curtailed on the existing basin projects including the Navajo and San Juan-Chama projects.

On June 22 the Associated Press reported that biologists conducting a fish survey from Palisade to the Utah border found that 3 of 21 squawfish discovered had hatchery tags. Two of the fish were found in the Colorado River as it flows through Grand Junction and the third downriver near Fruita. USFWS biologists were extremely pleased, because squawfish produced in hatcheries and stocked in the river over the years have shown a dismal survival rate. USFWS project leader Lynn Kaeding said he couldn't comment on the effect of his team's findings on the Animas-La Plata issue.

The article also said U.S. Representative Ben Nighthorse Campbell has met with USFWS Director John Turner to talk about the water project dispute. Campbell said Turner agreed to send his agency's scientific experts to a meeting on Monday, June 25, with scientists from the Bureau of Reclamation and others hired by the various water districts and Indian tribes that support the water project.

Sources: Associated Press (Grand Junction Gazette Telegraph); Rocky Mountain News Washington Bureau 5/25/90; Associated Press (Coloradoan 5/9/90, 6/22/90).

Eagle-Colorado Reservoir--The Denver Water Board has approved a \$51,000 expenditure for drilling tests for the proposed Eagle-Colorado reservoir and tunnel system that would bring Colorado River water to Dillon Reservoir for use in metropolitan Denver. The Eagle-Colorado project would include a reservoir as large as the existing Dillon reservoir near the town of Wolcott and a 24-mile tunnel under the Eagle's Nest Wilderness Area near Vail. It would require presidential approval and likely face environmental opposition.

The project could be built as part of another major new water development, the \$595 million Green Mountain Pumpback project, which would pump water 26 miles uphill from the existing Green Mountain Reservoir to Dillon Reservoir. Green Mountain Pumpback would require approval by Congress because it would change the operation of Green Mountain Reservoir, operated by the U.S. Bureau of Reclamation. In approving the expenditure, Board members discussed the futility of tests for water projects that may never get federal construction permits. Denver's Straight Creek project, intended to divert water into Dillon Reservoir, already has been rejected by the Corps of Engineers because of water quality concerns. Green Mountain Pumpback, however, is viewed somewhat favorably by environmental groups.

Sources: Rocky Mountain News 5/16/90; Denver Post 5/15/90

North St. Vrain--Boulder County commissioners voted unanimously on May 15 to recommend that dams be banned on an 18.7-mile section of North St. Vrain Creek under the federal Wild and Scenic Rivers Act. The recommendation comes after five years of debate over water rights. Water developers want to allow dams above and below the protected section. How much water the dams could trap has yet to be resolved. U.S. Representative David Skaggs and committee members will review concerns before putting the proposal before Congress.

Source: Denver Post 5/16/90

Grand Junction--In January the City of Grand Junction bought an 11,000-acre cattle ranch near Palisade for its water rights of 1,600 acre-feet per year. To maintain water rights the ranch must remain a water-consuming operation, raising cattle and hay, and the City intended to keep the ranch's permit to graze cattle on Grand Mesa National Forest lands. Forest Service officials, however, now say that they erroneously informed the city that there would be no problem with the grazing permit. A little-known regulation prohibits cities from holding grazing permits on federal lands. When the city filed for the permit application, the Forest Service's regional official in Delta rejected it even though the day before the city bought the ranch, local Forest Service officials detailed what the city should do to secure the grazing permit. The City is appealing to Representative Ben Nighthorse Campbell and Senators Bill Armstrong and Tim Wirth for help.

Source: Rocky Mountain News 5/19/90

SCHROEDER MOBILIZES EFFORT TO CONTINUE OPERATION OF DENVER'S REUSE PLANT

University, business and government representatives gathered in Denver on June 4 at a meeting organized by Representative Patricia Schroeder to determine how water reclamation research can continue at Denver's Potable Reuse Demonstration Plant. In December 1990, after a five-year research program to investigate and demonstrate the feasibility of producing drinking water from treated wastewater, the plant will close.

The reuse project currently recycles a million gallons daily from the Metropolitan Denver Sewage District, most of which is then returned to the South Platte River. Operated by the Denver Water Department, the plant started as an EPA demonstration project in 1979. Schroeder was instrumental in obtaining the EPA grant. The project, unique worldwide, successfully demonstrated that treated wastewater can be transformed to a near contaminant-free water safe for drinking. If the need develops for potable water reuse, the program has provided the basis for building a full-scale plant.

In June 1989 Colorado State University and the University of Colorado began working with the Denver Water Department to explore options for continued operation of the reuse plant. From these efforts evolved the concept of an Advanced Water Treatment Research Center (AWTRI) to continue the development of water treatment processes. The Center would be administered jointly by the University of Colorado and Colorado State University with the collaboration of the Denver Water Department.

One million dollars in funding for AWTRI, as an exploratory research center, will be sought from EPA. The plant's highly specialized equipment would be invaluable to researchers trying to find new ways to treat mine pollution, tainted groundwater and hazardous wastes.

"It would be a shame to lose this investment," says Representative Schroeder. "My sense is that the facility can eventually stand on its own, helping to solve the world's ever-growing water quality problem. But right now it takes some creative and energetic minds to plan and implement the way."

LARRY KALLENBERGER APPOINTED NEW LOCAL AFFAIRS DIRECTOR

Governor Romer named Larry Kallenberger Executive Director of the Colorado Department of Local Affairs on May 24. Kallenberger said he plans to focus on greater understanding of respective needs between urban and rural areas and on metropolitan cooperation. The Department has a staff of about 160 employees and a \$15 million annual budget, excluding federal funds it channels to local governments. Kallenberger, formerly deputy director of the department, replaces Tim Schultz, who resigned to join the Denver office of a Washington consulting firm.

Source: Denver Post 5/25/90

TRIAL TO DETERMINE FEDERAL RESERVED WATER RIGHTS WILL BE COSTLY

Federal and state taxpayers and water users may pay up to \$10 million in legal fees and other costs associated with the ongoing trial in Greeley involving federal reserved water rights. Ward Fischer, Fort Collins attorney representing several water users in the trial, said a total of \$10 million "is probably not far off the mark." The trial began on January 8 and for four weeks the federal government presented its case. The second phase began March 19 as the State of Colorado presented its case, and was scheduled to run through June 28. Judge Robert Behrman has set July 23 to August 16 for water users to present their objections. At issue is whether the US Forest Service is legally entitled to any water flowing through four Colorado national Parks.

Source: Greeley Tribune 6/3/90

WATER QUALITY

Horsetooth Reservoir, which provides about 60 percent of Fort Collins drinking water, also serves as a center for recreational activities. This year the City of Fort Collins will have reservoir water tested for 15 substances, including byproducts of motor oil and gasoline. The Environmental Quality Laboratory at CSU will conduct the tests. Kirke Martin, Assistant Director of the Lab, describes the tests as "background work" that will provide "baseline" information to determine if the quality of the water declines in the future.

Source: Coloradoan 6/3/90

South Platte - The US Army will build two underground barrier systems outside the Rocky Mountain Arsenal in an attempt to contain a groundwater plume that has migrated four miles to the South Platte River. The system will pump out tainted groundwater, filter it, and allow it to flow down hill toward the river. EPA and army officials say pollution levels reaching the river are so minute that they pose no immediate health threat. Contaminants include a nerve gas byproduct (DIMP), an industrial solvent (PCE), two pesticides (dieldrin and DBCP), and chloroform. By the time the plume reaches the river, it is contaminated mainly with DIMP at tiny concentrations of 7 parts per billion. Army officials say DIMP is safe for human consumption at levels up to 600 parts per billion. The EPA and Colorado Department of Health will test drinking water wells used by 150 homes north and northwest of the arsenal for DIMP. Results are expected later this summer.

Sources: Denver Post 5/31/90, 6/1/90, 6/2/90; Associated Press (Coloradoan 6/1/90)

Leadville - The U.S. House of Representatives approved on June 16 legislation to provide \$20 million for water treatment in the Leadville area.

Source: Denver Post 6/15/90

COLORADO WATER RESEARCH

A summary of water research awards and projects recently initiated is given below for those who would like to contact the investigators to receive information.

COLORADO STATE UNIVERSITY, FORT COLLINS, CO 80523

Quantification of Federal Reserved Water Rights for the National Park Service, Thomas G. Sanders, Civil Engineering
 Characterization of Soil Hydraulic Properties for Pesticide Study, Greg Butters, Agronomy
 The Diurnal & Seasonal Response of Boundary Layer Clouds to Solar Warming, David A. Randall, Atmospheric Science
 Application of Computer Modeling Techniques for Management of Water Resources, Marshall Flug, Civil Engineering
 Development & Application of Biological Assessment Techniques to Water Resources, Terence P. Boyle, Recreation Resources and Landscape Architecture
 Fluvial Terraces: A Tool for Integrating Geomorphic Processes, Ellen E. Wohl, Earth Resources
 Microphysical Studies of Precipitation Using the Advanced, Polarimetric DFVLR Radar, Viswanathan N. Bringi, Electrical Engineering
 Numerical Modeling of Cloud & Precipitation Chemistry in Frontal Rainbands, Steven A. Rutledge, Atmospheric Science
 Mississippi River Bed Sediments, Carl F. Nordin, Civil Engineering
 ARO-Les and Mesoscale Model Simulation, William R. Cotton, Atmospheric Science
 Waste Minimization Assessment Center, Harry W. Edwards, Mechanical Engineering
 ARO - Climatic Geomorphology, Stanley A. Schumm, Earth Resources
 ARO - LES and Mesoscale Observational Comparisons, William R. Cotton, Atmospheric Sciences
 Sport Fish and Endangered Fish Interactions in the Green and Yampa Rivers, Eric P. Bergersen, Cooperative Fish & Wildlife Research
 Desert and Grassland EMAP Project, David S. Schimel, Natural Resources Ecology Lab
 Monitoring the Response of the Uppertroposphere/Lower Stratosphere to a Greenhouse Gas Scenario, Stephen K. Cox, Atmospheric Science
 Advancing Toward Closure of the Carbon, Water, and Nutrient Cycles in the Temperate Forest Ecosystems, Robert G. Woodmansee, Natural Resources Ecology Lab
 Studies of an Earth Radiation Climate Radiometer (ERCR) for the Earth Science Geostationary Earth Observatory (GEO), Thomas H. Vonderhaar, CIRA Admin Unit
 Fish Habitat Structural Diversity Indices & the Reconstruction of Lake Basins at Rocky Mountain Arsenal Following Basin Decontamination, Eric P. Bergersen, Cooperative Fish & Wildlife Research
 National Atmospheric Deposition Program IR-7 -Coordination, Chemical Analysis & Support Services for NADP/NTN Deposition Monitoring Sites, James H. Gibson, Natural Resource Ecology Lab
 Investigation of the Influence of Surface Heat & Moisture Fluxes on Mesoscale Climate and Weather, Roger A. Pielke, Atmospheric Science
 Crop Management Expert Systems for Reducing Ground Water Contamination, Jim C. Loftis, Agr. & Chem. Engineering
 Predicting Pesticide Leaching from Spatial Variability of Transport Properties, Jim C. Loftis, Agr. & Chem. Engineering
 Water Quality of Streams Draining Forest and Range Lands, Daniel E. Binkley, Forest & Wood Science
 Larval Fish Laboratory Involvement in Implementation of Recovery Actions for the Endangered Species...Robert T. Muth, Fishery & Wildlife Biology
 Scientific Analysis of Satellite Earth Radiation Budget Measurements Related to Atmospheric Circulation and Climate, Thomas H. Vonderhaar, Atmospheric Science

UNIVERSITY OF COLORADO, BOULDER, COLORADO

Glen Canyons Environmental Studies, Thomas Huber, Geography and Environmental Studies
 Fracture Mechanics of Concrete Gravity Dams Part III: Dynamic Testing and 3D Analysis, Victor Saquma, Civil, Environmental & Architectural Engineering
 Work Plan for Study of Dissolved Gases in Ground Water as a Measure of Oxidation-Reduction Status-Supplement to Existing Award, Donald Runnells, Geological Sciences
 An Actualistic Model of Cementation Patterns in a Modern Regional Carbonate Aquifer, David Budd, Geological Sciences
 Mapping Atmospheric Water Vapor and its Motions with SSM/1 Data and the Consequences for Moisture Flux from the Ocean to the Atmosphere, William Emery, Aero-Colorado Center for Astrodynamics Research Aerospace Engineering
 Brittle Ductile Failure Mechanics of Mortar and Concrete, Stein Store, Civil, Environmental Architectural Engineering
 Artificial Intelligence for Geologic Mapping with Imaging Spectrometers-Supplement to Existing Award, Fred Kruse, Cooperative Institute for Research in Environmental Sciences Geological Sciences
 Icesheet Sea-Level, Climatic Interactions, During the Younger Dryas/Cockburn Interval (11-8 KA0: Evidence Based on a Lake Coring Program, Outermost SE Baffin Island, N.W.T., John Andrews, Institute of Arctic and Alpine Research
 Development and Implementation of ADSS (Advanced Decision Support Systems) for River Operations in the West-Supplement to Existing Award, Kenneth Strzepek, Civil, Environmental & Architectural Engineering

CALLS FOR PAPERS

South Platte River Resource Management: Finding a Balance, October 2-3, 1990, University Park Holiday Inn, Fort Collins, CO. The Colorado Division of Wildlife, Northern Colorado Water Conservancy District, U.S. Fish & Wildlife Service, Colorado State University, and Denver Water Department propose a two-day multi-disciplinary workshop in Fort Collins, Colorado on October 1 and 2, 1990, to specifically define the status of biological and hydrological information on the South Platte ecosystem and its tributaries. In addition, they plan to identify what additional data are needed, how to obtain the additional information and ways in which information may be utilized by all interested parties in their respective planning efforts. Hopefully, through this endeavor an integrated approach to the management of the South Platte system and utilization and maintenance of that vital resource may be optimized.

The workshop is envisioned as a series of 10-20 minute presentations which describe and summarize research projects on terrestrial and aquatic biology, water quality, plant communities, riverine history, and hydrology of the South Platte River Basin. Each presentation should include a discussion of current status, research objectives, conclusions, and future management and research needs. Following the formal presentations, a group discussion will be held to develop a method of coordinating data to summarize future utilization and research needs. A summary of the discussion and abstracts of formal presentations will be published for all participants.

South Platte River System researchers are invited to submit a one page abstract to Chuck Grand Pre - Colorado Division of Wildlife, 6060 Broadway, Denver, CO 80216, phone - 291-7202, by July 31, 1990. Please submit abstracts on disk in "wordperfect", if possible, or other common language. Presentations will be selected based upon criteria outlined. All abstracts, however, will be published upon conclusion of the workshop.

Issues and Technology in the Management of Impacted Wildlife, symposium sponsored by Thorne Ecological Institute, April 8-10, 1991 in Snowmass Village, CO. Papers should focus on research or management approaches for identification and mitigation of impacts to, and the management of, wildlife resources. Regional approaches are encouraged. Send to: 5398 Manhattan Circle, Boulder, CO 80303. For more information, call 499-3647. Deadline is October 1, 1990.

Conference on Water Management of River Systems, September 8-13, 1991, New Orleans, LA. Topics: The Watershed as a River System, Management of Water Resources, Managing Extreme Hydrologic Events, Data Collection & Analysis for Management of River Systems, and Institutional & Legal Issues in Management of River Systems. Submit 3 copies of 200-word abstract including complete address and telephone number to: Conference Technical Chairman Harry C. McWreath, USGS, P.O. Box 6976, Fort Worth, TX 76115. Phone: (817)334-5551. All attendees expected to pay registration. Deadline: November 15, 1990.

Symposium on Water Supply and Water Reuse: 1991 and Beyond, June 2-6, 1991, San Diego, CA. Topics: Water Supply: Emergency & Drought Management, Wetlands Policy, Conservation Impacts & Experiences, Political & Legal Aspects; Methods for Valuing Future Supplies, Watershed Management, Groundwater Resource Management, Financing Methods. Water Reuse: Desalinization Experiences, Reuse Implementation & Experiences, Water Quality, Industrial & Military Applications, Agronomy, Artificial Recharge, Potable vs. Non-Potable Uses, Public Perception of Reuse. Submit 3 copies of 200-word abstract including complete address and telephone number to: Symposium Technical Program Chairperson Carol Forrest, Woodward-Clyde Consultants, 1550 Hotel Circle No., San Diego, CA 92108, Phone: (619)294-9400; Water Supply Co-Technical Chairperson: Lester Snow, San Diego County Water Authority, 3211 Fifth Ave., San Diego, CA 92103, Phone: (619)297-3218; Water Reuse Co-Technical Chairperson: Harold E. Bailly, Clean Water Program for Greater San Diego, 401 "B" St., Suite 710, Mail Station 970, San Diego, CA 92101-4230, Phone: (619)533-4205.

1990 Mineral and Hazardous Waste Processing Symposium, First week of October, 1990, Butte, MT. The conference program will be coordinated with the Northern Rocky Mountain Water Congress. The two-day meeting will provide opportunities for exchanging data and results of waste processing techniques and will include tours of the largest EPA Superfund site in the nation. Send 300-word abstract, typed double spaced and include author's name, address, telephone number and affiliation to: Northern Rocky Mountain Water Congress, c/o Brenda C. Sholes, Hydrology Div., Montana Bureau of Mines and Geology, MONTANA TECH, Butte, MT 59701. Phone: (406)496-4152. Deadline: July 9, 1990.

International Seminar on Efficient Water Use, October 21-25, 1991, Mexico City, Mexico. Topics of the seminar are Efficient Water Use in: Houses, cities and rural areas; industry; power generation; agriculture and aquaculture; and hydrological basin. Submit one-page abstract in Spanish or English to: International Seminar on Efficient Water Use, Instituto Mexicano de Tecnologia del Agua, Paseo Cuauhnahuac 85332, Col. Progreso., Jiutepec, Morelos, Mexico C.P. 62550. Phone (73)19-43-81; Telex (0234900008980.IMTA), FAX (73)19-37-42. Deadline: November 15, 1990.

POSITIONS AVAILABLE

State Engineer, New Mexico - Chief Executive Officer responsible for the supervision, administration, development, conservation and protection of New Mexico's water resources. Any candidate selected must be a registered professional engineer in New Mexico at the time of appointment. Applicants must have, at a minimum, a Bachelor of Science degree from an accredited institution in engineering, physical sciences, or mathematics; but civil engineering is preferred. Demonstrated administrative and managerial experience is required. The State Engineer shall not engage in any private practice, cannot have a New Mexico ownership interest in water rights, nor have any interest in a water user entity or organization. Any candidate

with such an interest will be required to divest prior to appointment.

The State Engineer is appointed by the Governor subject to confirmation by the New Mexico Senate for a minimum two-year term. Headquartered in Santa Fe, New Mexico, the combined staff of the State Engineer's Office and Interstate Stream Commission exceeds 170 employees and the budgetary management and control of a regular program of nearly \$12 million annually. The annual salary range for the position is \$50,000 to \$70,000. Anticipated appointment date is September 1990.

Applicants should submit a comprehensive resume of professional credentials, experience and references by June 28 to: Anita Lockwood, Cabinet Secretary, Energy, Minerals and Natural Resources Dept., 2040 So. Pacheco St., Santa Fe, NM 87505, Attn: State Engineer Position. Applicants who have questions may contact Mr. Phil Mutz, State Engineer, at (505)827-6091.

Water Resource Scientist-University of California, Davis - Assistant/Associate/Full Professor and Assistant/Associate/Full Water Resource Scientist in the Agricultural Experiment Station, Department of Land, Air and Water Resources. This is an eleven month (plus one month paid vacation) teaching and research position in the College of Agricultural and Environmental Sciences. Qualifications: A Ph.D in Hydrology, Water Resources, Hydrogeology, Engineering, or a closely related field. Some formal background and training in water resources policy and management are also required. Salary commensurate with experience within the Assistant/Associate/Full Professor ranks at the University of California. Applications will be reviewed with the expectation that the appointee will be available November 1990 or sooner. Submit applications to Dr. Graham E. Fogg, Resource Scientist Search Committee Chair, Department of Land, Air and Water Resources, University of California, Davis, CA, 95616, telephone (916) 752-6810/0453. Include resume, official undergraduate and graduate academic transcripts, research and teaching interests and experience, publications, and names, addresses and telephone numbers of four references. Completed applications should be postmarked by August 1, 1990.

Experienced Urban Planners & Public Administrators Needed in Poland-Five volunteers are needed as part of the U.S. Peace Corps' entry into Poland to serve as **Senior Economic Development Advisors** in one of the following areas: Municipal Finance; Tourism Planning; Environmental Planning; Public Transportation; Water Systems Development; Infrastructure Development. Positions require BS/BA in Urban or Regional Planning, Public Finance, and 5 years professional experience, including 3 years experience directly related to one of the categories shown above. Preference will be given to candidates with master's degrees, and to those with experience working with municipal or county governments. Polish language is desired. The program begins in October 1990. Married couples may be considered

provided a spouse also qualifies for this program or an English teaching assignment in Poland. Phone: 1-800-424-8580, ext. 2293.

Hydrologic Engineering Center-U.S. Army Corps of Engineers is hiring recent college graduates (BS, MS, PhD) to work on research and technical assistance projects in river hydraulics, watershed runoff, reservoir systems analysis, real-time water control, and analytical methods in water resources planning. The positions are career entry-level Federal Civil Service ranging from GS-7 to GS-11 with promotion potential to higher grades. Salary and grade level are dependent on education and experience. Entry-level annual salaries are: BS with "B" grade average (GS-7, \$26,255), MS (GS-9, \$31,490), and PhD (GS-11, \$33,846). Applicant must be a U.S. citizen with a degree in civil engineering or closely associated field. For further information, contact HEC's Director, Mr. Darryl Davis, at (916) 756-1104. To apply, send Federal employment form SF 171 or resume and transcript of college courses to US Army Corps of Engineers, 650 Capitol Mall, ATTN: CESPD-R, Sacramento, CA 95814-4794. Or contact Mr. Robert Vincent at the Sacramento District personnel office at (916) 551-1955.

Hydrogeologic Scientists-The Water Resources Center, one of five scientific research centers within the Desert Research Institute, University of Nevada System, seeks applicants for the positions listed below. Successful candidates will be expected to fit into ongoing research projects as well as to develop creative programs of his/her own. The positions are to be filled in the Las Vegas Office.

Senior Hydrogeologist-A PhD is preferred, with emphasis in hydrogeology or a related field. The successful candidate must show demonstrated theoretical and field ability, preferably including publication in peer-reviewed journals. Research interests in the following areas are preferred: regional aquifer analysis and modeling, designing and implementing drilling programs, developing aquifer testing programs and analysis of aquifer test data.

Hydrogeologist-A PhD or MS is preferred. The successful candidate must show demonstrated theoretical and field ability, preferably including publication in peer-reviewed journals, in one or more of the following areas: analysis of regional groundwater systems; hydrogeochemistry; use of geophysical methods in hydrogeologic investigations; fracture flow and transport; design of aquifer testing programs; and analysis of aquifer test data. The successful applicant must be able to qualify for a Security Clearance.

The closing date for these positions has been extended to **September 30, 1990**, or until suitable candidates are found. For additional information, call Dr. Roger Jacobson at (702) 798-8882. Send curriculum vitae, transcripts, list of references and a statement of research interests to: Personnel Office, Desert Research Institute, P.O. Box 60220, Reno, Nevada 89506.

CONFERENCES

July 29-Aug 1 UTAH 45TH ANNUAL SOIL AND WATER CONSERVATION SOCIETY, Salt Lake City, UT. Contact: Tim Kautza, 7515 NE Ankeny Rd., Ankeny, IA 50021-9764, (515)289-2331.

- July 31-Aug 1 UCOWR '90, WATER ISSUES IN AN ENVIRONMENTAL ERA, West Point, NY (Hosted by the U.S. Military Academy). Contact: Margery Robinson, UCOWR Executive Director's Office, 4543 Faner Hall, Southern Illinois University, Carbondale, IL 62901, (618)536-7571.
- Aug. 7-9 TREATMENT TECHNOLOGY FOR CONTAMINATED GROUND WATER, Dallas, TX. Contact: NWWA, 6375 Riverside Dr., Dublin, OH 43017, (614) 761-1711.
- Aug. 12-15 CONSERV 90. NATIONAL CONFERENCE AND EXPOSITION FOCUSING ON WATER SUPPLY SOLUTIONS FOR THE 1990s, Phoenix, AZ. Contact: Kathy Butcher or Lisa Ammerman, 6375 Riverside Dr., Dublin, OH 43017, 615/624-6358.
- Aug. 12-17 IBM PC APPLICATIONS IN GROUND WATER POLLUTION AND HYDROLOGY, Princeton, NJ. Contact: NWWA, P.O. Box 182039, Dept. #017, Columbus, OH 43218, (614) 761-1711.
- Aug. 13-24 AMERICAN WATER FOUNDATION 1990 INT'L SEMINAR & WORKSHOP: DESIGN & CONSTRUCTION OF ROLLER COMPACTED CONCRETE DAMS, Denver, CO. Contact: Amer. Water Found., P.O. Box 155787, Denver, CO 80215.
- Sept. 6-7 THE ARIZONA GROUNDWATER MANAGEMENT ACT, Contact: Mary G. Wallace, Water Resources Research Center, The University of Arizona, Tucson, AZ 85716, Tel: (602) 621-7607.
- Sept. 17-18 AMERICAN WATER FOUNDATION 1990 INT'L SEMINAR & WORKSHOP: HYDROPOWER-DESIGN, CONSTRUCTION & EQUIPMENT REQUIREMENTS, Denver, CO. Contact: Amer. Water Found., P.O. Box 15577, Denver, CO 80215.
- Oct. 14-18 ASSOCIATION OF STATE DAM SAFETY OFFICIALS 7TH ANNUAL CONFERENCE, New Orleans, LA. Contact: ASDSO, P.O. Box 55270, Lexington, KY, 40555-5270, 606/257-5140.

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