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# COLORADO WATER

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

## WATER ITEMS AND ISSUES . . .

March 1991

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### COLORADO WATER ENGINEERING AND MANAGEMENT CONFERENCE

February 27-28, 1991

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COLORADO STATE UNIVERSITY



## EDUCATING COLORADANS ABOUT WATER

*Editorial by Neil S. Grigg*

K-12 education is in the spotlight; everyone has something that the kids need to know, and there is intense competition to "get into the curriculum." Teachers try to cram more and more into already-full schedules.

We're trying to get water resources in the curriculum too. People say, "Let's do a better job of educating the next generation about water; then our problems will be solved." Environmental concerns are there too, with the goal of teaching the kids how to protect the environment, including water.

As we applaud these efforts we also look at the demands being placed on K-12 education and wonder if the kids and the teachers can take it. In the sense that this is general education, it reminds me of the story of the generalist and specialist: "The generalist is the one who learns less and less about more and more; the specialist learns more and more about less and less; the end result is the generalist knows nothing about everything; the specialist knows everything about nothing."

I was delighted to learn recently of the heightened desire in Colorado to improve water resources education. Don Hollums, a specialist at the Colorado Department of Education, recently convened a meeting to coordinate efforts and the level of interest and resources was impressive. Representatives of water districts, colleges and universities, associations, and state and federal government all had resource material and creative ideas about how to educate in the water field - the problem that remains is how to get the attention of the teachers and give them what they need?

CWRRI will highlight water education on February 28 at the Colorado Water Engineering and Management Conference. John Kaliszewski and Tom Cech will describe their recent activities at the State Fair and in organizing a children's water festival in Greeley. Their insights will give the water community better ideas about how to help.

In water education it is true that the "harvest is rich but the workers are few" - but the workers are our teachers!

### COLORADO WATER ENGINEERING AND MANAGEMENT CONFERENCE

Denver Marriott Southeast  
February 27-28, 1991

The Colorado Water Resources Research Institute at Colorado State University and the Office of the State Engineer are pleased to present the program for the **Colorado Water Engineering and Management Conference**.

**Conference Objective**--The purpose of the Conference is to evaluate technical and management methods necessary to solve water problems in Colorado and the West. It serves as a forum to exchange ideas about technological and management solutions for current state water problems and policies.

**Registration**--The fee for registration on-site is \$200.00. There is a one-day registration fee of \$100.00. Substitution of participants is permitted. The registration package includes one copy of the Conference Proceedings, luncheons, reception, educational displays, refreshments during breaks, and attendance at all sessions.

**Accommodations** - Block reservations have been made with the Conference Hotel, the Denver Marriott Southeast, Interstate 25 at Hampden Avenue, Denver, CO 80222. For reservations call direct (303-758-7000) or toll-free in the USA (800-228-9290). Please mention the "Colorado Water Conference" to receive a special room rate of \$58.00/night (single/double).

**Transportation** - The Hotel is approximately 20 minutes from Denver's Stapleton International Airport via commercial airport limousine service, taxi or rental car.

#### For general information:

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#### Cooperating Organizations:

American Water Resources Association, Colorado Section; Bureau of Reclamation; Colorado Water Conservation Board; League of Women Voters; Natural Resources Law Center, University of Colorado; US Geological Survey, Water Resources Division, Colorado District; and Wyoming Water Research Center, University of Wyoming. Colorado State University: Agricultural & Chemical Engineering Department, Agricultural Experiment Station, Civil Engineering Department, Colorado Institute for Irrigation Management, Cooperative Extension, and International School for Water Resources.



# FINAL PROGRAM

## COLORADO WATER ENGINEERING AND MANAGEMENT CONFERENCE FEBRUARY 27-28, 1991

Wednesday, February 27, 1991

8:00-10:00 AM Ballroom Registration Booth

8:00-10:00 Coffee and Educational Displays

Salon E  
10:00-10:15 Opening Session - Welcome - Neil S. Grigg, Colorado Water Resources Research Institute  
Salon D Will Burt, Office of the State Engineer

Remarks: Michael Callihan, Lt. Governor, Colorado

10:15-12:00 N Session 1 (Plenary)  
Salon D Water Resources Decisionmaking - Moderator: Neil S. Grigg

The Federal Reclamation Program--New Directions and Priorities - William McDonald, Assistant Commissioner,  
Resources Management, Bureau of Reclamation

Colorado Water Management Decisionmaking: Parting the Waters - Barbara Green, Attorney, Popham, Haik, Schnobrich & Kaufman,  
Ltd.

Colorado Water Policy - Representative Scott McInnis, House Majority Leader

Water Transfers in Colorado - Lawrence J. MacDonnell, Director, Natural Resources Law Center, University of Colorado

12:00-1:30 PM Luncheon Speaker - Evan Vlachos, Professor of Sociology and Civil Engineering, Colorado State University, "Future  
Salon 3-5 of Water Resources Management"

1:30-3:00 Session 2A: Water Policy and Management - Moderator: Uli Kappus  
Salon D

Water Management - Colorado's Oxymoron: A.S. "Andy" Andrews

Colorado Water Rights-A Shame and a Shambles: Edward F. Carpenter

Barriers to Water Supply Acquisition: A Case Study: John R. Clark and Douglas Kemper

Economic Impacts of Rural to Urban Water Transfers: A Colorado Case Study: R. Garth Taylor and Robert A. Young

1:30-3:00 Session 2B: Controlling Salinity in the Colorado River System - Moderator: Stan W. Gappa  
Salon B-C

The Colorado River Salinity Program: An Overall Perspective: S.W. Gappa

The USDA Colorado River Salinity Control Program: Kenneth A. Pitney

Why and How, Colorado River Salinity Control - A State Perspective: Jack Barnett

Salinity Control - A Feature of the Dolores Project: Errol G. Jensen and Ken Beck

1:30-3:00 Session 2C: Groundwater Management - Moderator: Deanna Durnford  
Salon F-G

High Water Table Irrigation Management for the Alamosa-La Jara Delivery System of the San Luis Valley, Colorado: Alan C. Early and  
Brian G. Leib

Phase 1 Aquifer-Test Results From Well OX-2, Ouray, Colorado: John M. Kaufman and J. Ben Wesley

Simulation of Shallow Groundwater in the Morgan Drainage District to Test Alternative Management and Structural Strategies: Alan C.  
Early and Yasuhiro Sakai

Infiltration Trenches: Lot by Lot: Robert J. Houghtalen

3:00-3:30 Break With Educational Displays  
Salon E



3:30-5:00 **Session 3A: Water Supply Development - Moderator: David Harris**  
**Salon D**

The Regional Water Supply Study for Northern Colorado: Karl Dreher and Edward Harvey  
 Loveland Water Supply Study: Planning to Meet a City's Future Raw Water Needs: Joe Stibrich, Larry Howard and Jeff Heden  
 City of Glendale Water Supply: A Local Solution to Water Supply Problems: Gary Sears and Leo M. Eisel  
 Water Issues for Urban Water Supplies: Joe Bergquist, E. June Busse and Curtis A. Thompson

3:30-5:00 **Session 3B: Water Quality Management - Moderator: Darrell Fontane**  
**Salon B-C**

Eutrophication of Bear Creek Reservoir Affects Basin Wastewater and Non-Point Source Management: Russell N. Clayshulte  
 Lake Management Plan for a Reclaimed Water Lake: Laurel S. Saito  
 Groundwater Pollution in the San Luis Valley: D. Ellerbroek, K. Thompson, D. Durnford and S. Davis  
 Determination of Dispersion Coefficient in Solute Transport: Hubert J. Morel-Seytoux and Mahmood Nachabe

3:30-5:00 **Session 3C: Groundwater Issues and Possibilities - Moderator: Steve Lautenschlager**  
**Salon F-G**

Denver Basin Aquifers Iron Management: F. Robert McGregor and Kenneth R. Wright  
 Study of Near-Surface Flow Through Soil Macropores: Tissa H. Illangasekare  
 The Role of Tributary Groundwater in Irrigated Crop Production in the South Platte Basin: Results From a Survey: P.K. Bash and R.A. Young  
 Dowsing: The Past or the Future?: Greg Storozuk

5:00-6:30 **RECEPTION WITH EDUCATIONAL DISPLAYS**  
**Salon E**

Thursday, February 28, 1991

7:30-8:30 AM **Ballroom Registration Booth**

8:30-10:00 **Session 4 (Plenary)**  
**Salon D** **Colorado's Environment: Issues and Options - Moderator: Steve Gloss**

Environmental Water Issues in Colorado - Melinda Kassen, Attorney, Environmental Defense Fund  
 View From the U.S. Fish and Wildlife Service - Robert D. Jacobsen, Assistant Regional Director, U.S. Fish and Wildlife Service  
 An Overview of the Global Climate Change Response Program - Ronald J. Schuster, Coordinator, GCCRP, Bureau of Reclamation  
 Water for Colorado's Outdoor Future - Stephen Norris, Program Director, Colorado Joint Review Process

10:00-10:30 **Break With Educational Displays**  
**Salon E**

10:30-12:00N **Session 5A: Computer Aided Decision Support 1 - Moderator: Vernon Norman**  
**Salon 1**

Use of Reservoir Simulation in Evaluation of Fryingpan-Arkansas Project: Donald K. Frevert and Roger A. Weidelman  
 Dynamic Programming Model for the Capacity Expansion of an Integrated Treated Water Supply System: Keqiang Mao and Dennis A. Bode  
 Williams Fork Reservoir Inflow Forecasting Using Stepwise Multiple Linear Regression: Robert G. Steger  
 Forecasting Monthly Flows in the Rio Grande System: Jose D. Salas and Ding-Chin Wang

10:30-12:00 **Session 5B: Water Resources Engineering - Moderator: Steve Abt**  
**Salon 5**

Water Management and Conservation: Reclamation's Hydraulic Research: Philip H. Burgi  
 Small Parshall Flume Rating Correction for Settlement: Steven R. Abt, Christopher Cook, Kenneth Staker and Richard Belt  
 Myth No. 3 Revisited, Soil Moisture Carryover Depletion Credits--Larceny by Design or Ignorance?: Ralph L. Toren  
 Hydrologic and Thermal Analyses of a Ground Water Supply for a Fish Hatchery in Central Washington: Catherine Kraeger-Rovey



**10:30-12:00 Session 5C: Water Administration and Management - Moderator: Hal Simpson**  
**Salon F-G**

Drought Management in Southwest Colorado 1990: Daries C. Lile  
 Water Right Transfers in Northeast Colorado: Changes and Trends: Ari M. Michelsen  
 Who Can Judge? Real Time Benefits of Reclamation to Projects: Loretta C. Lohman  
 The Riparian Doctrine vs. the Appropriation Doctrine - Is Integration the Answer?: Kathleen C. Klein

**12:00-1:30 PM Luncheon Program: Water Resources Education Forum Moderator: Neil S. Grigg**

**Speakers:** John Kaliszewski - Assessing the Public's Knowledge and Perceptions of Colorado Water  
 Tom Cech - Water Resources Education for the Public

**1:30-3:00 Session 6A: Computer Aided Decision Support - Moderator: Doug Kemper**  
**Salon 1**

Development of an Advanced Decision Support System for the Upper South Platte Basin: J. Ernest Flack, David Sieh and Charles Haines  
 Visualizing Groundwater Flow Model Results Using Public Domain Scientific Visualization Software: Roland H. Schweitzer and David W. Zachmann  
 Valuation by Visualization in Water Resources Planning: Lynn E. Johnson  
 A Modeling Approach for Assessing the Feasibility of Groundwater Withdrawal From the Denver Basin During Periods of Drought: Sigurd Jaunarajs and Eileen Poeter

**1:30-3:00 Session 6B: Agricultural Water Issues - Moderator: Dale Heermann**  
**Salon 5**

Farm Irrigation Performance in the Southern San Luis Valley: Alan C. Early and Mustafa Baskan  
 Conserving Colorado--Water, Energy, and Soils: Peggy J. Plate and Carrol E. Hamon  
 Conserving Water Through Management Changes on the Newlands Project: Franklin E. Dimick  
 Effects of Irrigation Water Supply Variations on Limited Resource Farm Operations in Conejos County: Erda Wang and Jerry B. Eckert

**1:30-3:00 Session 6C: Stormwater - Moderator: D. Earl Jones, Jr.**  
**Salon F-G**

Stormwater Quality Monitoring - One Approach: Cynthia L. Paulson  
 Basic Urban Drainage Uncertainties: D. Earl Jones, Jr. and Jonathan E. Jones  
 NPDES Stormwater Permitting - Is There Something Missing?: William P. Ruzzo

**3:00-3:30 Break With Educational Displays**  
**Salon E**

**3:30-5:00 Session 7A: Groundwater Issues - Moderator: Catherine Kraeger-Rovey**  
**Salon 1**

Groundwater Recharge for Effective Water Management: Bruce Glenn  
 Identification of Aquifer Parameters: Hubert J. Morel-Seytoux and Xianiou Guo  
 Studies of Surface and Ground Water Interactions in Two Arizona Stream Systems: Catherine Kraeger-Rovey  
 Conjunctive Use Management in Idaho - Past Experiences and Proposed Solutions in the Boise River Basin and the Big Lost River Basin: David R. Tuthill, Jr.

**3:30-5:00 Session 7B: Progress on Non-Point Source Control - Moderator: Jon Scherschligt**  
**Salon 5**

Shop Creek Project (urban/construction impacts) - James Wulliman, Muller Engineering  
 Control of Abandoned Mine Sources (mining impacts) - Camille Meyer, Mined Land Reclamation Division  
 Boulder Creek Restoration (agricultural/urban impacts) - Chris Rudkin, City of Boulder



## UNIVERSITY WATER NEWS

The EPA veto of Two Forks has spurred renewed efforts to improve water management in the South Platte Basin. To assist the basin's water managers and multitude of water users, this year's CWRRI research program includes three projects that are focused on improving water management for the South Platte River. These projects are: (1) Development of a Decision Support System for Water Rights Administration, J. Ernest Flack, Principal Investigator; (2) Development of a Water Database for the South Platte River Basin, Timothy K. Gates, Principal Investigator; and (3) A Graphical-Based Decision Support System for Conjunctive Stream-Aquifer Management Under Prior Appropriation, John W. Labadie, Principal Investigator. The projects were funded for \$15,000 each and initiated in September 1990. The first project is evolving into a cooperative effort on water management research among the CWRRI, the Center for Advanced Decision Support in Water and Environmental Systems (CADSWES) at the University of Colorado, the Office of the State Engineer, and water users on the South Platte River.

The CADSWES project's objective is to develop a demonstration/prototype of a computer workstation-based water rights administration system. Such a system would aid in the administration of water rights by the Colorado State Engineer's Office and allow individual water users in the basin to improve the management of their water supplies. The project is currently developing cooperative support among water users of the South Platte. To date six basin water users have signed on as cosponsors of the project, providing \$5,000 each in supplemental direct-cost funding. They are: the cities of Aurora, Denver, Englewood, and Thornton; the Centennial Water & Sanitation District; and Consolidated Ditches of Fort Lupton. The Bureau of

### CONGRESS APPROPRIATES FUNDS FOR ADVANCED WATER TREATMENT RESEARCH INSTITUTE

Congress has appropriated \$500,000 for development of the Denver Water Reuse Plant as a research facility. The funds will be administered by the U.S. Environmental Protection Agency. With the plant's close in 1990, Colorado State University, the University of Colorado, and the Denver Water Department formed the Advanced Water Treatment Research Institute (AWTRI) to explore options for continued operation of the reuse plant as a research facility.

University, business, and government representatives have met regularly in an effort to find funding sources for the plant's continued operation. A \$750,000 proposal was submitted to the National Science Foundation on January 15 with \$125,000 in matching funds promised by the Colorado Advanced Technology Institute (CATI). A number of other funding sources are also being explored.

The Denver Water Department's Ken Miller chairs the Steering Committee, whose members represent the following organizations and offices: AWWA Research Foundation - Jim Manwaring; EPA - Doris Sanders; USBR - Danny King;

### SOUTH PLATTE WATER USERS JOIN COOPERATIVE EFFORT TO IMPROVE WATER RIGHTS ADMINISTRATION

Reclamation also provides funding for the CADSWES research. J. Ernest Flack, project principal investigator and Professor of Civil Engineering at CU, sees the project's ultimate fruition as a "...cutting-edge operational decision support system for water rights administration in Colorado."

Tim Gates, assistant professor of Civil Engineering at CSU, is investigating the management of water resources data on the South Platte. Major changes in the ability to manage water information have been developed in the last 20 years, with advances in computer systems and increasing monitoring needs, however many organizations still make use of data management methods developed decades earlier. It is hoped that optimum management of the data will lead to greater cooperative water use within the system. The project is developing a feasibility-stage plan for cooperative water data management among water use organizations on the South Platte River downstream of Denver.

John Labadie's project involves integrating MODSIM-CONSIM models to simulate stream-aquifer management into one comprehensive, graphically-based decision support system. The regional-scale model is being designed to be compatible with micro-computers and provide for interfacing with water quality models. It is planned that the decision support system will be applied to problems such as urban encroachment into agricultural water supply, or hydrologic impacts of water rights on marketing. Labadie is a Professor of Civil Engineering at CSU.

For additional information about these projects contact Neil S. Grigg, CWRRI Director, at 491-6308.

Mayor's Office - Robert Ortlip; DWD - Ed Pokorney, Steve Work; Bill Lauer; University of Colorado - JoAnn Silverstein, Nevis Cook, Gary Amy, Dave Hubby, Risa Palm, Susan Avery, Richard Harpel, Richard Seebass; Black and Veatch - Dan Linstedt; Richard P. Arbor Assoc. - Rick Arbor; Governor's Office - Steve Eandi; and CSU - Fred Smith, Ralph Smith, Neil Grigg, Tom Sanders, and Dave Hendricks. Kip Cheroutes represents the office of Representative Patricia Schroeder and Jim Martin the Office of Senator Tim Wirth.

Denver's pilot water reuse program began in 1968 with a small plant that was operated jointly by the Denver Water Department and the University of Colorado. In the '80s the Potable Water Reuse Demonstration Plant began its wastewater reclamation program with the ultimate goal of transforming wastewater into high-quality drinking water.

The project included comparative testing of reclaimed water from the reuse plant and conventionally treated tap water. About two years ago the plant also began a health-effects



testing program on mice and rats that were fed potable water from the plant. The comprehensive testing is similar to that carried out for cancer research or for new drugs prior to their approval or use, says Bill Lauer, project manager at the plant. A detailed evaluation of the testing is nearly complete. Lauer noted that application of the water reuse process depends on three main factors: water supply and demand, cost, and public acceptance. Someday it will be used on a much larger scale, he said, when there won't be enough water to meet the demand.

Partial Source: AWWA MainStream Dec. 1990

## RECENT AND PENDING CWRRI PUBLICATIONS

Proceedings: Colorado Water Workshop, July 22-24, 1990, "Colorado Water Institutions, Valuable Traditions - New Frontiers" -- The proceedings of the 15th Colorado Water Workshop meeting, held July 22-24, 1990 at Western State College in Gunnison, is now available. The 1990 workshop focused on how Colorado's water institutions can meet the challenge of providing for the needs of traditional water users while considering the public's growing concern for the environmental, recreational, and social values of water. Price: \$30.00. (price includes transcription costs)

Screening Methods for Groundwater Pollution Potential From Pesticide Use in Colorado Agriculture, by Deanna S. Durnford, Kirk R. Thompson, David A. Ellerbroek, and Jim C. Loftis -- The San Luis Valley was used as a case study for this project, which evaluates the use of two models for predicting groundwater pollution potential under conditions typical of Colorado agriculture - a solute transport model called CMLS and a hydrologic index for ranking relative pollution potential called DRASTIC. The models were used to determine which pesticides had the highest potential for leaching to the groundwater and which areas had the greatest likelihood for groundwater contamination. Results obtained using the solute transport model and the hydrologic index were compared with those from a direct sampling program completed in the San Luis Valley in conjunction with the Colorado Department of Health. The direct sampling program indicated that the Valley's groundwater has high nitrate levels in some areas and may contain low levels of pesticides. The DRASTIC map developed in this study indicates that the San Luis Valley is highly vulnerable to groundwater contamination by pesticides compared to other areas in Colorado. Completion Report No. 157. Price: TBA.

Urban Water Supply Reliability: Preferences of Managers, Elected Officials and Water Users in Boulder, Colorado, by Charles W. Howe -- Presents the results of a CWRRI pilot study on the question: How should the optimum level of urban water supply reliability be determined? The study compares the attitudes of the water-using public, water officials, and elected officials toward water supply reliability (as measured by the likelihood of shortages). It also takes a step toward measuring the benefits and costs of different reliability levels in terms of water users' willingness-to-pay for increases in reliability and in terms of their willingness-to-accept compensation (in the form of lower water bills for lower levels of reliability). Completion Report No. 158. Price: TBA.

Adsorption of Copper, Cadmium and Zinc on Suspended Sediments in a Stream Contaminated by Acid Mine Drainage: The Effect of Seasonal Changes in Dissolved Organic Carbon -- by Donald L. Macalady. Summarizes research on the effects of dissolved organic carbon on the coprecipitation and sorption of trace metals onto suspended hydrous iron oxides in St. Kevin Gulch, Colorado, a stream contaminated by acid-mine drainage. Results confirm that the removal of trace metals to particulate phases can be viewed solely in terms of the behavior expected for hydrous iron oxides. Metals are removed, but in a manner dependent upon the pH of the stream environment in which the hydrous iron oxides precipitate, independent of the presence of dissolved organic matter. Completion Report No. 159. Price: TBA.

## FROM COOPERATIVE EXTENSION by Sharon Heiden Patterson

**Promoting Agricultural Safety and Health in Colorado-** Cooperative Extension and the Department of Agricultural and Chemical Engineering were recently awarded a grant through the National Institute of Occupational Safety and Health (NIOSH) to promote agricultural safety and health in Colorado. This grant is for one year with two renewable successive years available, and if carried out for the projected three-year term Colorado State will receive approximately \$500,000. This project will provide a wide variety of educational and teaching aids to the County Extension Offices in Colorado.

The project will be directed by Paul Ayers. Until his return from sabbatical leave (April 16, 1991), the project is being directed by Dennis Lamm and Bert Bohmont. Rich Gareis was hired on January 28 to help coordinate the project. Rich is a Colorado native who farmed in the Sterling area. For eight years he was with the Flatiron Companies where he served as a salesman and safety officer.

Plans include providing each Cooperative Extension Office with an agricultural safety and health notebook where Extension Agents can easily find agricultural safety and health resources. In addition, a monthly newsletter addressing agricultural safety and health will be developed. Each County Office will be provided with an agricultural chemical kit and video tape concerning the safe use of pesticides. In the near future, a display booth will be constructed for exhibition at major fairs and shows. In the second year, counties/areas will be provided with a display for use at local fairs and community meetings.

A grant program will be initiated during the second and third years that will allow Agents to request financial support to promote activities on a local level. In the meantime, Rich is checking all available audio/visual resources and will be seeking new materials that can be used by the Cooperative Extension personnel. He is also working with Colorado State's Public Relations Department in setting up a safety and health column in various publications throughout the state.

If you have any ideas you would like to contribute to help make this program a success, your input will be appreciated. Please give Rich a call at 491-6172. This project has unlimited potential for Colorado!



## COLORADO WATER RESEARCH AWARDS

Colorado State University, Fort Collins, CO 80523

A summary of water research awards and projects recently initiated at Colorado State University is given below for those who would like to contact investigators. Direct inquiries to investigator, c/o indicated department and university.

Deer Research Studies at Rocky Flats, William A. Alldredge, Fishery & Wildlife Biology  
 Data Analysis and Limnological Inventory, Stephen A. Flickinger, Fishery & Wildlife Biology  
 Carbon Balance in Global Grasslands, Davis S. Schimel, Natural Resource Ecology Lab  
 Rocky Mountain Arsenal Exposure Study, John S. Rief, Environmental Health  
 South Platte Management Program, Phase I, Neil S. Grigg, CWRRI  
 Coordination, Chemical Analysis and Support Services for NADP/NTN Deposition Monitoring, James H. Gibson, Natural Resources Ecology Lab  
 The Climatological Effects of Convective Cloud Systems, David A. Randall, Atmospheric Science  
 Training and Education for Agricultural Chemicals and Groundwater, Dennis W. Lamm, Cooperative Extension  
 Larval Fish Laboratory Involvement in Implementing Recovery Actions for the Endangered Fish in the Upper Colorado River Basin, Robert T. Muth, Fishery & Wildlife Biology  
 Sediment Sorting in Alluvial Rivers (Sabbatical Research), Mohamed Salama, Civil Engineering  
 Grassland/Atmosphere Response to Climate Change: Coupling Regional and Local Scales, Michael B. Coughenour, Natural Resource Ecology Lab (NREL)  
 Numerical Simulation and Analysis of Convective Storms, William R. Cotton, Atmospheric Science  
 Western Pacific Tropical Cyclone Motion Studies, Wayne H. Schubert, Atmospheric Science  
 Quantification of Federal Reserved Water Rights for the National Park Service, Thomas G. Sanders, Civil Engineering  
 Development and Application Management Systems for Water Quality and Water Resources, Duane C. Boes, Statistics  
 Rapid Biological and Chemical Assessment as Cost Effective Techniques for Monitoring Toxicity, Clarence Carlson, Fishery & Wildlife Biology  
 Development of Toxicity Evaluation Procedures (TEP) to Address Nonpoint Sources, John Tessari, Environmental Health  
 National Database Development for Nitrogen Management, William K. Lauenroth, NREL Lab  
 A Laboratory Study of the Effect of Soil Heterogeneity on Light Nonaqueous Phase Liquid, Deanna S. Durnford, Agricultural and Chemical Engineering  
 An Evaluation of the Leachability of Heavy Metals from Fly Ash Liner Materials, Charles Shackelford, Civil Engineering  
 Design Criteria and Integrated Management Technology for Surface and Center Pivot Irrigation, Israel Broner, Agricultural and Chemical Engineering  
 Range Improvement Research for the Central Shortgrass Plains, Harold Goetz, Range Science  
 Computer Modeling, Software Development and Documentation for Watershed Hydrology, Jose D. Salas, Civil Engineering  
 Study the Physics and Develop Theory of Infiltration for Improved Irrigation, Paul D. Ayers, Agricultural and Chemical Engineering  
 Mesoscale Analysis and Forecast Product Development for Severe Storm Nowcasting, Thomas H. Vonderhaar, CIRA Administrative Unit  
 Methodologies for Design of Soil Covers of Waste Disposal Sites, Steven R. Abt, Civil Engineering  
 Numerical Simulation of Atmospheric Phenomena, Thomas H. Vonderhaar, CIRA Administrative Unit

University of Colorado, Boulder, CO 80309

Transport and Fate of Multiphase Subsurface Contamination, Tissa Illangasekare, Civil Engineering  
 Fracture Mechanics of Concrete Gravity Dam; Part I; Static Loading, Victor Saouma, Civil Engineering  
 Work Plan for Study of Dissolved Gases in Groundwater as a Measure of Oxidation-Reduction Status, Donald Runnells, Geological Sciences  
 Verification of Soil Liquefaction Analysis by Coordinated Geotechnical Centrifuge Studies, Hon Yim Ko, Civil Engineering  
 Multiobjective Reliability-Based Optimization of Structural Systems, Dan Frangopol, Civil Engineering  
 Mapping Atmospheric Water Vapor and its Motions with SSM/I Data and the Consequences for Moisture Flux from the Ocean to the Atmosphere, William Emery, Colorado Center for Astrodynamic Research  
 Advanced Decision Support for Water and Environmental Systems, Kenneth Strzepek, Civil Engineering  
 The Role of Natural Organic Matter in the Partitioning and Transport of Polynuclear Aromatic Hydrocarbons in Groundwater, Gary Amy, Civil Engineering  
 Application of Special Sensor Microwave Imager (SSM/I) Data for Snow Cover/Climate Research, Roger Barry, Cooperative Institute for Research in Environmental Sciences (CIRES)  
 Studies of Global Sea Level and Ice Sheet Volume Changes, John Wahr, CIRES  
 Coordinated Research: Self-Adaptive Database Support for Derived Data in Distributed Engineering Design Systems, Roger King, Aerospace Engineering  
 Multivariate Description of Long-Term Change Over the World Ocean, Klaus Wolter, CIRES



## LOCAL/STATE WATER NEWS

### BUILD PUBLIC CONSENSUS, TRY AGAIN FOR LARGE STORAGE

*The following are highlights of the prepared text of the speech by Jim Scherer, Region VIII Administrator, U.S. Environmental Protection Agency, at the annual meeting of the Metropolitan Denver Water Authority on December 7. Reprinted with permission of the Metropolitan Denver Water Authority.*

When I agreed to talk with you a couple of months ago, I hadn't expected a Two Forks decision and had planned on skirting the permit issue. Since the timing on that decision changed, I'll give you my perception about where we go from here, but first I want to tell you a little about where the agency is going now and in the future. It is not my normal style to deliver a pre-written speech but with the sensitivity of the issue, I think it is important for me to be fairly precise in what I say.

I wouldn't be surprised to see a few looks of disbelief and maybe even a snicker when I say that the direction of the agency is not the solely regulatory role of the past and is moving to an expanded role of empowering, at the regional, state and local levels: - away from looking at environmental issues from only a single perspective of air, water or hazardous waste to looking at the whole environmental impact of a site or industry and prioritizing how to address the large impacts; - away from purely health risks concerns to more emphasis of overall ecological risks; - away from being an impediment to development to being the technical resource, helping others to make sure that development is done right; - that recognizes that minimizing waste production, preventing pollution, and anticipating problems are the priority.

I actually do not expect this group with your experience of Two Forks to believe all of this, and the transformation is not happening as fast as all of us would like - but it is happening. How does this more proactive role - this desire to be part of the solution, not part of the problem - jibe with a veto of Two Forks?

First, let's talk a minute about the veto and let me spread the blame a little. It's easy to say that the veto was all Bill Reilly, EPA, the environmentalists, and was Federal government driven. But isn't it fair to say that the proponents of Two Forks never convinced the people of Colorado (I mean any more than 50 percent of the people) that the reservoir was needed now and/or Two Forks was the best site? Was the West slope satisfied they were not being sacrificed to Metro interests? Was there even Metro agreement on the site? Did decision makers truly listen to concerns of the people and try to meet these? Did anyone foresee the environmental mood shift in the nation and this state? Did the attempt to be farsighted in looking at a long permit life cloud the lack of support that would come from the perception of "no immediate need?" Were all the benefits of conservation being explored, implemented, and communicated to the public? Little public consensus was

built. I personally agree that decisions should be made on the local level and not in Washington, but the local level decision must be open, completely analyzed; and although no project will come close to full support, a consensus statewide decision must be developed.

I'm encouraged that a consensus process will work and I am encouraged that EPA can be a positive part of that process. One of the parts of the veto document that should encourage you is determination that "No Federal Action" is not a practical alternative. This means that EPA has acknowledged that conservation and other small projects alone will not satisfy the long-term water needs of the Metropolitan area. This certainly does not mean that these should not be pursued vigorously. I am extremely pleased with the conservation initiatives of the Denver Water Board in the past year and think they need to be developed fully. But by the Agency saying definitely that even this will not serve the long-term needs, the environmental community has put on notice that EPA will permit a large basin reservoir at some time in the future and the environmental community better be part of the consensus on the best solution. Stonewalling will only mean no input.

Timing is critical in when this consensus should be developed. With litigation of the veto you may be perceived as standing in the way of further progress. Is time needed before a process should start anyway? Would litigation tend to drive some large, long-term wedges between public confidence and buy in to a consensus process or not? These are questions you need to answer. I think there needs to be some time of healing and maybe even some changes in personalities before a consensus can be formed. Where will the leadership for such a process come from? It would seem that senior elected officials must be part of this solution. Should EPA participate in the process? I think the agency has an obligation to help find an answer and LaJuana Wilcher feels the same way. Should the federal government add some resources to the study needed to determine the two critical question before you: When is real need going to require a Federal permit and what site will best meet the NEPA and 404 Federal requirements while meeting the local cost and supply needs? The leadership should be Colorado, but I think the Federal government must provide assistance.

I'm sure by now some of you are saying, "Some of this sounds reasonable but he tried to speak for EPA once and you know where that ended up." I can tell you that Washington EPA wants to be part of the solution. They have strongly indicated that they expect me or my successor to work toward that solution and that they will stay abreast of all steps in the process so that there will be no last minute surprises. Just as in some of the in-state and provider agreements that began to come apart in the last process, as much as possible must be formalized in agreements so that changes in personnel and politics through the process assures that past steps are not revisited.

None of this will be easy. All of it is necessary. I will be looking for a response from you whether any of it is possible and ideas how we should proceed and what the agency's role should be.

Source: Water Matters, January 1991.



## COLORADO WATER SUPPLY CONDITIONS UPDATE

State Engineer's Office, January, 1991--Colorado's water supplies are near normal. Conditions have improved considerably compared to conditions one year ago. Statewide precipitation was 84 percent of normal for the month of December with a high of 148 percent of normal in the Rio Grande basin and a low of 40 percent of normal in the Arkansas basin. Statewide precipitation totals for the water year (beginning October 1, 1990) are 109 percent of normal.

The Soil Conservation Service reported that the statewide snowpack on January 1, 1991 was only 81 percent of average. However, it is 144 percent of the snowpack measured on January 1, 1990. Snowpack development is highest in the Rio Grande basin with 109 percent of normal and lowest in the Yampa/White basin with 71 percent of normal. Although it is still early in the season, nearly 40 percent of the seasonal snowpack is received by January 1 in an average year.

The Surface Water Supply Index (SWSI) developed by the State Engineer's Office is used as an indicator of water supply conditions in the state. It is based on reservoir storage, snowpack, and precipitation for the winter period (December 1 through May 1). Weight factors are applied to each of the measured hydrologic factors in computing the SWSI values for each basin. During the winter period, snowpack is the primary component in each basin except the South Platte where reservoir storage is the primary component. The following SWSI values were computed for each of the seven basins on January 1, 1991, and on January 1, 1990.

|                  | Jan. 1, 1991 | Jan. 1, 1990 |
|------------------|--------------|--------------|
| Basin            | SWSI Value   | SWSI Value   |
| South Platte     | -0.6         | -0.4         |
| Arkansas         | +2.6         | -0.1         |
| Rio Grande       | +1.5         | -3.4         |
| Gunnison         | +0.2         | -2.6         |
| Colorado         | -0.3         | -1.4         |
| Yampa/White      | +0.1         | +1.5         |
| San Juan/Dolores | +0.2         | -3.5         |

### SCALE

|                |                  |                    |                     |                 |    |    |    |    |
|----------------|------------------|--------------------|---------------------|-----------------|----|----|----|----|
| -4             | -3               | -2                 | -1                  | 0               | +1 | +2 | +3 | +4 |
| Severe Drought | Moderate Drought | Near Normal Supply | Above Normal Supply | Abundant Supply |    |    |    |    |

The State Conservationist's Basin Outlook Report issued February 1, however, showed declining snowpack percentages across the state during January, increasing concerns for adequate water supplies next summer. Snow surveys conducted on February 1 indicate that Colorado's snowpack is 77 percent of average. Currently, the lowest snowpack percentages in Colorado are in the South Platte and Upper Colorado River Basins, at 70 percent of normal. Slightly better conditions exist in the Yampa, White, and North Platte Basins of Northern Colorado; and the Animas, Dolores, and

San Miguel Basins of Southwestern Colorado. Snowpack percentages in these basins range from 70 to 90 percent of average. Highest snowpack figures are in the Rio Grande Basin, where percentages are slightly above average. This year's snowpack is much higher than last year's throughout southern Colorado, and remains 27 percent above last year, statewide.

With below average snowpack totals nearly statewide, streamflow forecasts continue to call for below average volumes for the spring and summer months. These dry conditions will increase the reliance on the above-normal reservoir storage to supplement summer water supplies.

## CENTRAL COLORADO WATER CONSERVANCY DISTRICT TO HOST CHILDREN'S WATER FESTIVAL

The Central Colorado Water Conservancy District will host a Children's Water Festival on Tuesday, March 26, 1991, at Aims Community College in Greeley. Approximately 2,000 fourth and fifth graders will participate in the one-day event that will educate and entertain students regarding water quantity and water quality.

Source: Colorado Stream Lines, Fall 1990.

## WILLOWS WATER DISTRICT AND BUREAU SIGN AGREEMENT

Local research on whether water can be injected and stored in an aquifer deep below the southern Denver metro area received a boost today from several federal agencies interested in the unique project. The aquifer research, being conducted by the Willows Water District and the Denver Water Department, will be expanded with the support of the U.S. Bureau of Reclamation in cooperation with the U.S. Environmental Protection Agency, U.S. Geological Survey, and U.S. Fish and Wildlife Service. An agreement executed in December by representatives of Willows and the Bureau of Reclamation outlines the goals and contributions of the participating parties.

The research involves injecting treated water into the Arapahoe Formation, an expanse of underground sandstone that forms a natural water reservoir. The treated water will be put into the aquifer through a Willows state-of-the-art Arapahoe aquifer well. The Denver Water Department will supply up to 163 million gallons of treated water per year for the research project, which is expected to continue through the year 1995.

Researchers anticipate obtaining technical data for the successful restoration of the aquifer's previously depleted or extracted water by treated surface water injection. The Colorado Division of Water Resources will assist in the research project and the development of regulations relating to subsequent extraction of the injected water at remote locations within the Denver Basin.

The technical data developed from this project is expected to develop a methodology and policy relating to the injection of potable water into the underground aquifer during the period of time when the flow from snow melt is not



sometimes beneficially used and the same can be injected into the aquifer for extraction during periods of maximum use demands.

Willows, the Denver Water Department and Parker Water and Sanitation District have been cooperating on an aquifer recharge demonstration project for approximately 18 months. However, it was determined that a larger well and more advanced equipment would be needed to complete the research. The Bureau of Reclamation, recognizing the potential of this project, offered to lend financial and technical expertise to complete the mutually beneficial project.

Source: Willows Water District

#### **FOUR CORNERS' ECONOMIC FACELIFT ALTERS PUBLIC LANDS EQUATION, SAYS WILDERNESS SOCIETY REPORT**

Changing population and economic dynamics in the Four Corners states--Arizona, Colorado, New Mexico, and Utah--pose new tests for the millions of acres of ecological treasures found on public lands throughout the region, much of it still at risk from commodity development, according to a report released by The Wilderness Society today.

The report by Dr. Thomas Goerold, "Economic and Demographic Overview of the Four Corners States," notes that the region's population soared 19 percent between 1980 and 1988, double the national rate, to more than 10 million. Meanwhile, the contribution of natural resource industries declined by half to four percent of total regional earnings. Several factors, such as declining commodity prices and the growth of service sector industries, have contributed to the region's economy, the report says.

New residents in the region, attracted by the spectacular natural characteristics, have few ties to traditional commodity industries such as mining or ranching, the report notes. Many of these newcomers tend to hold environmental values at odds with oldline mining and ranching interests and offer heightened opportunities for protection of public lands. They also create a new set of environmental challenges and potential problems, warns Goerold. "Demands for water, land, and energy by a larger increasingly urbanized population threatens the very quality of life that attracts newcomers in the first place," says Goerold, director of The Society's Four Corners Ecoregion Project.

"At times, decisions affecting public lands are made in a vacuum, but reports like this give us the ability to better understand the interrelationship between economic forces and environmental protection," said George T. Frampton, Jr., president of The Wilderness Society. "Hopefully, this project will prove valuable to Congress in debating wilderness proposals for Colorado, New Mexico, and Utah this year," he added.

Overall, the region's economic picture mirrors the nation's in recent years. Growth of per capita income was slightly stronger in the Four Corners states during the past 25 years than in the U.S., rising to \$15,423 by 1989, although there was significant variation around the region. Colorado

personal income levels are the highest, while Utah trails the other three states.

In industrial activity, services surged ahead of all other sectors during the past 25 years and now claims 25 percent of the region's aggregate earnings, up from 15 percent in 1967. Earnings in the government sector slumped to roughly 18 percent, down from approximately 24 percent in 1967. Federal budget cutting appears to have had an impact on the earnings level in the government sectors. Earnings in the natural resources sectors fell to four percent, a drop from eight percent.

Employment in the four states is also strong, jumping 145 percent since 1967, compared to a national rate of 93 percent. Again, the service industries claimed the lion's share of employment growth with the total jobs rising to more than 2 million, up from 545,000 in 1967. And while employment in the natural resources sector also grew by 17 percent during the period, its importance in the total employment picture was off sharply, accounting for only four percent of jobs, down from nine percent 25 years ago.

The impact of tourism and recreation on the region's economy appears significant, although it is difficult to quantify precisely because earnings for these activities fall into several sectors, including services, transportation, trade, and others. What is known, according to the report, is that tourists spent \$5.6 billion in Arizona during 1985, \$5.6 billion in Colorado in 1988, \$2.0 billion in New Mexico in 1987, and \$2.0 billion in Utah in 1986. These are sizeable contributions when considering that total 1989 earnings for all industries were \$35.3 billion in Arizona, \$37.4 billion in Colorado, \$12.4 billion in New Mexico, and 14.6 billion in Utah.

"It's a whole new ballgame in these states because of the dramatic economic and demographic changes," says Goerold. "We need to consider land-use decisions in the new context that the changing economy now presents," he adds. The report suggests that more analysis is needed on the nature of the changing economic picture and the implications for traditional extractive industries in the Four Corners states.

Founded in 1935, The Wilderness Society is the only national conservation organization devoted primarily to public lands management issues. The Society has 16 field offices and approximately 400,000 members.

Source: The Wilderness Society "NEWS", January 10, 1991.

#### **NEW WAYNE N. ASPINALL WATER LEADER ANNOUNCED**

William H. Miller, newly retired manager of the Denver Water Department, is the Colorado Water Congress' Wayne N. Aspinall Water Leader of the Year for 1991. The Aspinall award was presented to Miller during the Water Congress' annual meeting on January 18 by Durango attorney Sam Maynes, last year's winner. The award, named for a long-time U.S. representative from Colorado known for his work on water issues, is given annually for extraordinary service statewide.



Miller, 65, was the 12th manager in the Water Department's history. He retired January 12 after 12 years as chief executive of an agency that provides drinking water to more than 900,000 people in a 450-square-mile area. During his tenure, Miller helped build coalitions locally, statewide and nationally on water issues ranging from supply and quality to research and education. A former newspaper reporter and executive assistant to two Denver mayors, Miller also has been recognized for his contributions by the American Water Works Association, the Denver Federal Executive Board, and Metropolitan Water Providers.

Source: Denver Water Department, January 24, 1991.

#### AWWA RESEARCH FOUNDATION NAMES DEPUTY EXECUTIVE DIRECTOR

Richard J. (Rick) Karlin has accepted the position of deputy executive director of the Research Foundation of the American Water Works Association effective October 12, 1990. Previous to assuming his new position, Karlin served as director of the foundation's Research Management Division.

Before becoming director of the Research Management Division in 1987, Karlin worked for the Colorado Department of Health for fifteen years, eight as director of the state's drinking water and groundwater protection programs. In that capacity, he was responsible for the development and implementation of Colorado's safe drinking water program.

Karlin is a registered professional engineer and has authored several papers on various aspects of waterborne disease, particularly Giardia and source evaluation.

Source: Water Research Quarterly, Oct.-Dec. 1990.

#### XERISCAPE - AN EDIBLE LANDSCAPE?

Xeriscape, a water-wise-yet-lush style of landscape design and maintenance, can make a splash on your palate--in dishes ranging from salads in edible tulip cups to flower petal cookies.

Popular author Rosalind Creasy brought the message of edible Xeriscape to Denver Saturday, January 26, in two seminars at the annual Colorado Garden and Home Show. Creasy's appearance was sponsored by the Denver Water Department as part of its Xeriscape display at the show.

Creasy, author of the widely known "The Complete Book of Edible Landscaping," gave seminars on edible Xeriscape. Her presentation at the Garden and Home Show complements the Water Department's own exploration of edible Xeriscape in its 1991 Conservation Calendar. Two Denver researchers-landscape architect Gail Barry and writer Andria Bronsten-teamed with local photographer Priscilla Montoya and designer Beckie Smith to provide a new showcase for edible Xeriscape. Featured in the calendar's photographs, recipes and plant notes are such treats as juniper berry marinade, quinoa and dried fruit stuffing, and green mint sorbet.

Creasy, who specializes in incorporating edible, native and drought-tolerant plants in urban landscapes, believes greenery

around houses should serve multiple purposes. "As a gardener, I enjoy flowers and all growing things; as a landscape designer, I am a seeker after beauty; and as a homemaker, I do not need any more chores," she said.

The seven-step Xeriscape system was developed by the Denver Water Department in 1981 and is now promoted by such non-profit groups as Metro Water Conservation Inc., Xeriscape! Colorado, and the National Xeriscape Council, Inc. For more information or a schedule of 1991 Xeriscape seminars contact Xeriscape Colorado, c/o Denver Water Department, Office of Water Conservation, 1600 West 12th Avenue, Denver, CO 80254 or call 303-628-6329.

#### NEED INFORMATION ON WATER CONSERVATION?

At last, there is one central source of information about water conservation in the metro area. Metro Water Conservation, Inc. (MWCI) has opened an office at 7839 W. Coal Mine Avenue, Littleton, Colorado 80123, phone (303) 979-2359.

MWCI's purpose is to develop and promote water conservation programs that will result in the most efficient use of water resources. MWCI has published four monographs on various aspects of conservation: system-wide leak detection, Xeriscape, residential retrofit, and educational programs. MWCI also has a collection of books, papers and audio/visual materials available to the public for research through the U.S. EPA Library at 999 18th Street, Denver, second floor. MWCI invites inquiries about any aspect of water conservation in the metro area.

Source: Metro Water Conservation, Inc.

#### FARMERS CAN HELP CONSERVE OIL

by Steven W. Horn  
Colorado Commissioner of Agriculture

Current events in the Persian Gulf should cause all of us to examine this nation's dependence on foreign oil. Agriculture is no exception, and in spite of substantial gains in energy efficiency, Colorado's farm and ranch operators may again be facing tough economic times if fuel prices continue to climb.

Colorado ranchers and farmers spend about \$100 million annually on fuel and other petroleum-based products used to produce food and fiber. They also purchase another \$45 million annually for fertilizer and agricultural chemicals. Not only is energy used to power equipment through the fields, it also is used to power irrigation pumps, to dry crops, for transportation of goods to market, for processing commodities, and for delivery of goods to retail markets. Already, increased fuel costs will add 10 to 15 percent or more to agriculture's 1991 bill for diesel fuel and gasoline. Additionally, the price of pesticides is projected to rise another 4 to 8 percent due to higher energy prices.

At the same time, prices received by farmers from grain and other commodities have dropped, some by a third or more. Farmers therefore are finding themselves in a serious cost-price squeeze. If these trends continue, many farmers could



face financial hardships similar to the mid 1980s - a time when many producers in Colorado became insolvent.

In the 1970s, when oil supplies were last threatened so directly, agriculture suffered greatly due to its reliance on petroleum. Since then, the industry has made steady progress in increasing its energy efficiency. Nationwide, expenditures for fuels and other energy inputs for farm production decreased from \$7.9 billion in 1980 to an estimated \$6 billion in 1989. In that same period agricultural output, measured in hours of labor to produce a unit of commodity, increased about 34 percent. Moreover, since 1980 the industry has increased its output/input ratio by nearly 20 percent. American agriculture uses a lot of energy, but clearly it is becoming more efficient.

On Colorado's eastern High Plains, farmers are growing irrigated corn using much less water (and energy for pumping) by monitoring soil moisture regularly. Programs are under way enabling these farmers to reach still greater energy savings by testing the operating efficiency of their pumping equipment. Conservation tillage is being practiced on hundreds of thousands of cropland acres, using technology designed primarily to reduce soil erosion, but that same technology results in fewer energy-using trips across the field. An increasing number of farmers are moving toward sustainable agriculture, which seeks to optimize production while reducing overall inputs.

Despite these steady improvements in energy efficiency, any further significant increase in energy costs would likely send many Colorado farmers into financial insolvency. Affordable fuel supplies for agriculture simply must be assured to enable producers to grow the food to feed this country and to continue food exports to help offset an even larger balance of payments deficit brought on by higher prices on imported oil.

In order to minimize the number of farmers who would be forced out of agriculture, and to minimize future oil-price economic shocks, the U.S. needs an immediate and sustained increase in investment in agricultural research and technology transfer. This would be a logical component to a badly needed overall energy policy geared toward minimizing our dependence on foreign oil.

More research in biotechnology will likely unlock new efficiencies in agricultural production - enabling plants to manufacture their own fertilizer or to get by on less water. More and better use of biological pest control and integrated pest - management techniques will result in lower production costs for the farmer and fewer synthetic chemicals in the environment at the same time.

Finally, agriculture has a direct and important role to play in reducing our nation's dependence upon foreign oil. Currently, 850 million gallons of ethanol are produced each year - largely from corn - and are used to stretch gasoline supplies. Our nation's alcohol fuels industry could expand five-fold relatively quickly which would nearly replace Iraq's previous 5-percent contribution to America's oil supply while improving air quality. Substitute fuels from oil seed commodities could also play an important role in stretching supplies to diesel and fuel oil.

This nation can meet the challenge of reduced oil supplies from the Middle East, but it will require a significant investment in research and technology transfer. American agriculture can help lead the way to increased energy independence.

Source: Denver Post, January 12, 1991. Reprinted with permission of Steven W. Horn.

### CITY OF GRAND JUNCTION RECEIVES NATIONAL DAM SAFETY AWARD

The City of Grand Junction recently received national recognition for its improved dam safety program by the Association of State Dam Safety Officials. The City was presented the Association's Western Region Award of Merit. Mr. Dan Vanover, Water Supply Supervisor for Grand Junction, accepted the award on behalf of the City at the Association's 7th National Conference held in New Orleans, October 14-18, 1990. Grand Junction was recognized for implementing an effective maintenance and monitoring program to improve the safety of its dams, as well as for major repairs it has made to several of the dams, and for its cooperation and support of Colorado's dam safety program.

Source: Colorado Stream Lines, Fall 1990.

### HARVEY JOHNSON DIES AT 95

We are sad to report that Harvey Johnson, water expert and former mayor of Fort Collins, died January 29 at his home. He was 95. Bill Hartman, Greeley historian and author, said of Johnson: "He was a frontiersman, a pioneer." Johnson, born in 1896 in northwest Kansas, came to Colorado in a covered wagon.

As mayor of Fort Collins from 1962 to 1967, Johnson helped reach a water-sharing agreement between the city and area farmers. "Fort Collins would have been nothing without that water," Hartman said. "In my opinion, he really made the town of Fort Collins." Johnson created the Fort Collins Water Board and also served as director and president of the Water Supply and Storage Company for 54 years.

When author James Michener was researching his novel Centennial, he called upon Johnson for information about water issues in the West, said Hartman. Johnson took Michener on tours of local ditches and gave him the background he needed for his book.

Fort Collins Coloradoan 1/31/91, 2/4/91

## REGIONAL/NATIONAL WATER NEWS

### CALIFORNIA SITUATION CRITICAL

California is in its fifth consecutive year of drought with statewide precipitation for the current water year at only 25 percent of average. The USDA Soil Conservation Service, in its January Water Supply Outlook, said that snowpacks



range from 15 percent in the south to 30 percent in the north, which suffers from the fourth driest period in 70 years. Even with normal weather for the remainder of the winter and spring, expected streamflows would be only about 50 percent of average. The Los Angeles Times reported that California is close to negotiating a deal for additional Colorado River water to ease the effects of drought on Southern California cities. Providing additional Colorado River water to California, which has treaty rights to less than 10 percent of the Colorado's flow, would require the approval of the six other basin states. The extra Colorado River water would total about 400,000 acre-feet, increasing the water supply available this year to California's Metropolitan Water District by about 15 percent. Interior Secretary Manuel Lujan, in a speech to members of the Colorado Legislature on February 12, suggested that Upper Colorado River basin states help drought-stricken Southern California. However, the Colorado River Commission's Wayne Cook said that Arizona - and not the headwaters states - would provide the extra water needed by California.

The New York Times, in a full page review Sunday, February 10, said: "With the announcement last week that irrigation authorities were cutting off all water to farmers, including those in the huge Central Valley, and with Southern California cities preparing rationing plans, the drought that is now in its fifth year has exposed more starkly than ever the precarious assumption on which California's civilization is built: that even in a desert an endless stream of water is an inalienable right."

Sources: Western States Water 1/18/91; The Coloradoan, 2/11/91; The Denver Post 2/12/91, 2/13/91

#### **STANFORD FINED \$209,000 FOR EXCESS WATER USE**

Stanford University has been fined \$209,000 for using about 54 million gallons more than the water allotment imposed by a utility to help cope with the state's four-year drought.

The utility said the university was penalized for exceeding its allocation in August, September, and October. The allotments were established by the San Francisco Water Department, which serves the campus and numerous Bay Area communities, and went into effect last May.

David Kaye, the university's utilities manager, blamed the excess water use on unseasonably dry fall weather and the demands of campus research facilities. He said steps had been taken to cut water use.

Source: The Chronicle of Higher Education, Dec. 19, 1990.

#### **WYOMING WATER ATLAS AVAILABLE**

Water sources, water quality problems, and water development projects in Wyoming are a few of the areas covered in the Wyoming Water Atlas, a 136-page hardbound volume now available. To obtain a copy of the atlas, send a check or money order for \$35 made payable to the University of Wyoming, to: UW Water Research Center, Box 3067, Laramie, WY 82071. Price includes shipping and handling.

#### **ICWP AND USGS SPONSOR NATIONAL WATER INFORMATION CLEARINGHOUSE WORKSHOPS**

The Interstate Conference on Water Policy and the USGS are co-sponsoring a series of four regional National Water Information Clearinghouse Workshops in 1990 and 1991. The series will provide a forum for water professionals to identify their needs for a national clearinghouse that would disseminate surface water and groundwater quantity and quality data and information. Two workshops were held in 1990, and two additional workshops are planned for 1991. The third workshop is tentatively scheduled for April 23-24, 1991 in Sacramento, California, and the last workshop in the series is tentatively scheduled for May 21-22, 1991, in San Antonio, Texas. To obtain more information please contact Flaiminia Mangone, Manager, Interstate Conference on Water Policy at (202)466-7287.

#### **SOUTHEASTERN STATES ATLAS FIRST IN SERIES ON US GROUNDWATER RESOURCES**

The first atlas in a new full-color series of regional atlases describing the groundwater resources of the nation has been published by the U.S. Geological Survey, Department of the Interior. Printed in a large, 18-by-24-inch format, the series of atlases will provide to the public, for the first time, a source of comprehensive information, written in non-technical language, on the nation's groundwater resources, region by region. The 28-page initial atlas in the series contains more than 100 maps and figures. It covers Alabama, Florida, Georgia and South Carolina.

Eventually, 12 more atlases will be published in the series to describe location, geology, geography, water quality, water use, productivity and hydrologic characteristics of the major aquifers across the nation. Information that might be particularly useful includes data on the effects of human activity on groundwater, which can result in such problems as poor quality, saltwater encroachment and land subsidence.

Copies can be purchased for \$12 each from the Branch of Distribution, U.S. Geological Survey, Denver Federal Center, Box 25286, Denver, Colorado, 80225, telephone 303-236-7477.

Source: U.S. Geological Survey, January 17, 1991.

#### **BUSH NOMINATES CONGRESSMAN FOR AGRICULTURE POST**

President George Bush has nominated Congressman Ed Madigan (R-IL) to become the next Secretary of Agriculture. Madigan's Congressional background includes: State Legislature, 1967-73; chairman, House Reapportionment Committee, and chairman, House Campaign Committee; election to the 93rd Congress and each succeeding Congress; ranking minority member, House Agriculture Committee, 98th Congress; chairman, House Republican Research Committee, 97 Congress; member, House Energy Committee; and Republican Chief Deputy Whip, 100th and 101st Congresses.

Source: Experiment Station Letter 2060, 1/25/91



## HISTORY OF IRRIGATION IN THE WEST AND THE DECLINE OF FEDERAL INVOLVEMENT

Dr. Henry P. Caulfield, Jr.  
Professor of Political Science  
Colorado State University

Presented at the Water Division I Program, COLORADO WATER; THE NEXT 100 YEARS  
Greeley, Colorado, March 17, 1990

I have been billed as a CSU professor of Political Science which I have been for 20 years, but am now retired. My claim to fame in terms of the topic I am going to be talking about is really my experience working for the Department of the Interior from 1951 to 1955 and from 1961 to 1966 on water policy. I directed the U.S. Water Resources Council until 1969 when I became a professor at CSU. I have been teaching the politics of water and of the environment. I have been the president of the Water Board of the City of Fort Collins for the last three years and have been on the board for 16 years.

I have been asked to talk on the history of irrigation in the West and the decline of federal interest. I am going to try to talk very categorically and conceptually about this matter. I am going to talk about why the federal government got into irrigation in the West and why it got out.

A basic perspective on the development of the federal republic of the United States can be said to be the development of the country from east to west, from the East Coast to the West Coast, by the humid East to the Mississippi River, and then to the 100th meridian, and then the arid West along to the Pacific Coast. Two basic climatic differences in the United States. The beginning of this process of development can be said to be the development of the commercial cities of the East Coast of the United States trying to develop their trade inland through navigation projects.

Now navigation was the key means of this because prior to 1828 when there was the advent of the railroad, navigation was considered to be the key public means of bulk transportation for commodities, raw materials, and supplies into the hinterland of the United States. Now it can be said to be a key public strategy because there was a report, for example, in 1808 by Albert Gallatin, then Secretary of the Treasury, indicating a comprehensive plan for the development of navigation facilities through to the Mississippi River.

Then in 1942, there was a revision of that plan by John C. Calhoun and the Corps of Engineers. John C. Calhoun at that time was the Secretary of War and so there was a basic strategy for this. The basic strategy was not carried out, however, right away because of the great controversy about the powers of the federal government to undertake navigation projects, that is to spend money, appropriations on navigation projects. It was not until the advent of the Republican Party and the particular provision of the Republican Party platform of 1956 which asserted the right of the federal government

to spend money to undertake navigation projects. The federal government really got into the business of spending federal money through the tariff revenues it got from the import of goods on navigation projects to the East. So the Republican Party and its advocacy of national involvement and looking upon navigation as the key public means of developing the country to the West can be said to be the basic idea in back of this early development of the humid East.

Now, there were two practical considerations involved. One was the money question which was solved by the use of the tariff revenues and also a basic strategy of the first Republican Party. And then there was the question of the technical means, the engineering competence. In those days, the Corps of Engineers (at the time West Point was an engineering school) got the technical competence and training of the civil engineers or military engineers and that is how the Corps got into the business of water development in the United States.

Now as that went on, the railroads came in as a means of development; subsequent to that the transcontinental railroads. But one of the reasons why the federal government got into this idea that the public means of the involvement of the West was because of the inadequacies of the finances of cities, states, and private enterprise in developing navigation and also the need for the competence of civil engineers as distinct from the common Irish labor to develop the canals and so forth. These two pragmatic factors have a lot to do with the question of the federal government getting into it.

Now we are out in the West and we are in Greeley, Colorado. Go West, young man, go West. The Greeley Colony. You people from Greeley know about this. Greeley was one of the first areas in the mid-nineteenth century to develop irrigation, along with Fort Collins, the Mormons in Utah, Arizonans around Phoenix, Southern California, the southern part of Idaho, and elsewhere as far as the Anglo development of irrigation is concerned.

There was a lot of real estate development here in Greeley and elsewhere trying to develop prospects for farmers to come out and have this land. There were a lot of bankruptcies in those days, a lot of difficulties. Finance had a lot to do with it. The inability to get adequate finance for capital development and wait long enough for the revenues to come in to make it a feasible economic enterprise. There was also criticism, at least at the federal level, about the competence of the engineering of this enterprise, and John Wesley Powell's report on arid lands in the West has some



remarks to say about the need for technical competence in the development of the irrigation of the West.

I will not go into the details of the irrigation of the West; around here you know what it has been. But the important point is that it is through the idea of development and settlement of the West that the federal government carried on this vision from the eastern part of the country on navigation into the western part of the country. Along with the pragmatic considerations of the importance of financial capital for long-term investments plus technical competence of engineers, the Bureau of Reclamation undertook big projects in the West.

This idea of development of the West, economic development of the West, is very important in explaining how the federal government got into this business. Now it was after Greeley and Fort Collins were established when the federal government began the Colorado-Big Thompson project in the 1930s. At least the contract was signed in 1938 and then the project came after World War II. That was when you really got the federal government into Northern Colorado. Prior to that, it had been all local enterprise.

The question then, is why did this stop? Why did the federal government get out of this business? I think that is the key thing that you are interested in and it is important to note when it happened. The last big authorization to the Bureau of Reclamation in the western part of the United States was in 1968. That is a long time ago; 1968 was the last authorization. The Colorado Basin Project Act essentially authorized the Central Arizona Project. There have been no big authorizations or any important authorizations in terms of development, particularly of irrigation, in the western part of the United States since that time.

Now just prior to that you had the Garrison diversion project on the Missouri River, you had the Oahe project and those are struggling to still go forward. You can say that about the Animas-La Plata project, that was authorized for the first time in 1956. It was re-authorized in 1968 and it has been struggling to get started ever since. And so what you have in the West since 1968 essentially, except for some rehabilitation work and so forth, is the carrying out, the appropriations to carry out the basic decisions of development which were made at the end of the 1960s.

Why was this so? Well, first you can say that so much development occurred on the Missouri River, in California, the Pacific Northwest, and elsewhere, that much of the development of the West in the sense of irrigation and power development and had been accomplished or had been authorized by that time. You had benefit cost analyses which indicated under the rules of the federal government that there were no really good projects left. There were repayment problems. There were agricultural surpluses. I remember in my time with the Department of Interior having to justify irrigation projects in the face of agricultural surpluses and why they should continue irrigation projects as of 1950s and 1960s when there were already arguments about agricultural surplus.

I think it is important to note that about the mid-1960s, the

electrical cooperative association, actually the National Rural Electric Cooperative Association, made a basic decision that it was no longer going to take a great interest in the development of power in the West, but was going to put its emphasis on development of the generation of transmission steam plants to be the source of supply for rural cooperatives in the West. The politics of the development of the West in terms of big projects, power development, had a lot to do with the support of the rural cooperatives in getting these projects authorized.

The importance of power has to do with repayment, because power and irrigation need to be viewed together. Power was essentially an important element in the repayment process for irrigation projects in the West right from the beginning of this century and therefore the decline of the political support from the power industry, the rural cooperative power industry, was very important in the decline of political support for this.

And so, you had a decline in what might be called the key public means for economic development and settlement of the West through irrigation and power development. Now you can say, "Well, why was it that there were no more projects, no more development of the West?" Well, I just want to remind you that there had been ideas about further development of the West. An example is reversing the Yukon River and bringing water down to the Ogallala aquifer to recharge it or bringing water down the Western Slope, down to Arizona. The argument was that there was 20 million acres of land in Arizona which could be developed if you only had water.

There has also been the idea of bringing water from the Columbia River down to Arizona. Water from the Mississippi River to West Texas, or water from the Great Lakes to western Nebraska. Many people who think of these latter two are forgetting that when they drive water from the Great Lakes to western Nebraska or from the Mississippi River to West Texas that they are driving uphill about 4,000 feet and the cost of bringing water up that distance makes it very expensive water.

So there have been ideas about further development of the West, but I heartily argue with you about the important economic considerations that have not made those possibilities attractive and thus, they are not politically attractive possibilities for the further development of the West.

One important conclusion from this is that the decline of federal involvement in the West dates back to before the budget crunch in the 1970s and 1980s, as well as the environmental movement. Much has been made of the environmental movement as a source of political opposition to water development, and it is true, there has been opposition. But as far as the federal program is concerned, the federal program in the West was already in a position to a decline prior to the budget crunch that we have come to know in more recent years and the degree of virility of the environmental movement that we have come to know in the last 15 to 20 years.

*(Transcribed at the Water Resources Research Institute.)*



## CONFERENCES, MEETINGS, SHORT COURSES

### NATIONAL ASCE CONFERENCE

The Irrigation and Drainage Division of the American Society of Civil Engineers is holding the National Conference in Irrigation and Drainage Engineering and Groundwater in the Pacific Rim and Lysimetry Symposiums July 22-26, 1991 at the Ramada Renaissance Ala Moana Hotel in Honolulu, Hawaii. The National Conference on Irrigation and Drainage Engineering will have over 120 papers on the program in 33 quarter-day sessions and a poster session. Topics on the program include surface water/groundwater interactions, water quality, on-farm irrigation management, irrigation system canal hydraulic modeling, hydrology in volcanic regions, groundwater infiltration, planning, management and operation of irrigation and drainage systems, and research and education needs for irrigation, hydrology and drainage.

The International Symposium of Lysimetry and Symposium of Groundwater in the Pacific Rim will be held concurrently with the conference. A total of 50 papers are scheduled for the lysimetry symposium. The symposium will act as a forum for the exchange of ideas and techniques in lysimetric measurement of evapotranspiration and on standardization of design, measurement and data reporting. A total of 10 sessions are planned for the lysimeter symposium.

The groundwater symposium will focus on groundwater in the Pacific Rim countries. A total of 34 papers will be presented by speakers from China, Japan, Korea, New Zealand, and the United States. Topics will include groundwater management, salt water intrusion, well efficiencies and economics, groundwater modeling, and groundwater quality protection.

For further information about the conference and symposiums contact William F. Ritter, Agricultural Engineering Department, University of Delaware, Newark, DE 19717. Telephone 302-451-2468, FAX 302-292-3651.

### 5TH SYMPOSIUM OF ARTIFICIAL RECHARGE OF GROUNDWATER

To be held at Westward Look Resort, Tucson, Arizona, May 29-31, 1991. The Artificial Groundwater Recharge Symposium is a biennial event sponsored by the UA Water Resources Research Center, the USDA-ARS Water Conservation Laboratory, and the Salt River Project. This year, the two and one-half day program will be filled with presentations by regulators, water utilities professionals, engineers, researchers, and consultants, and a field trip to demonstration and operational sites in the Tucson area.

The theme of the 1991 Symposium is CHALLENGES OF THE 1990s. The decade of the '90s will see many of the problems of previous years associated with groundwater recharge resolved, only to bring forth new challenges for researchers, managers, planners, and policy makers. One significant change brought about in the years since the first symposium in this series has been the nearly universal acceptance of artificial groundwater recharge as a valid water management tool. This symposium will try to place artificial

groundwater recharge into the greater context of water management in the 1990s and highlight technical and institutional challenges the decade is likely to hold.

Registration materials will be available beginning February 4, 1991. Materials will include a schedule of speakers, registration form, and hotel information. The total price of \$75.00 will cover the Symposium sessions, lunches and coffee breaks, and the symposium proceedings. If you would like to receive registration materials directly, write WATER RESOURCES RESEARCH CENTER, University of Arizona, 350 North Campbell Ave., Tucson, AZ 85721, or call (602) 621-7607, and ask that your name be added to the AGRS mailing list. For more information about the Symposium contact Susanna Eden, AGR Symposium Coordinator, at the same address and telephone number.

### INTERNATIONAL SYMPOSIUM OF LAKE, RESERVOIR, AND WATERSHED MANAGEMENT

Sponsored by the North American Lake Management Society (NALMS), the symposium will be held November 11-16, 1991 at the Sheraton Denver Tech Center, Denver CO. The theme of this 11th Annual meeting of NALMS is Lake, Reservoir, and Watershed Management in a Changing Environment. Topics include climate change, demographic and social change, political and legal issues, toxic pollution, acidification, eutrophication, basinwide management, point and nonpoint source control, wetland utilization, recreation management, and bioremediation. Technical presentations are sought for any of these topics of for any other lake management topic. **June 1, 1991**, is the deadline for submittal of abstracts. Anyone desiring to present a poster, video, or oral paper at the 1991 Symposium must submit four copies of each abstract by June 1, 1991 to the following address: NALMS '91 Symposium, P.O. Box 101294, Denver, CO 80250.

There is an increased emphasis on poster and video presentations. Poster sessions will be scheduled with author participation. Videos will be presented in a 68-seat theater. Authors may or may not be present for videos. Along with the extensive technical program, other events include: a Youth Program for High School students for the Denver area; a Citizens Workshop and sessions; special courses in lake modeling, computer program utilization, and algae identification; a mini-symposium on environmental consideration in reservoir construction and management cosponsored by the U.S. Committee on Large Dams; a Tailwaters Workshop; exhibits featuring new products, services, consultants, and manufacturers; and special events such as a 5-km race, field trips, and banquets.

Especially popular during NALMS Symposia is the nearly 60-space exhibit area. This year the Technical Poster Sessions will be incorporated into the exhibit area to provide attendees a large area for exchanging information. Anyone interested in sponsoring an exhibit should contact Jim Flynn, Hydrolab Corporation, P.O. Box 50116, Austin, TX 78763; (512) 255-8841.



During the past several years of these Symposia, an interest in exchange of resource information has increased. In response to this emerging technology transfer, resource rooms for printed material, computer software, and data base exchange are provided. The Denver Symposium will have three separate rooms in response to this need. Attendees will have the opportunity to spend time in a reading room of publications, books and other printed information on all subjects of lake, reservoir, and watershed management. Also, a room set aside with a variety of computer hardware and software dedicated to solving lake management problems will be available. The NALMS data base has been used for over ten years to put those needing information on a lake subject in touch with an expert who can help them with their problem. Anyone with printed material related to lake management should consider sending it to the above address for use in the resource rooms.

For additional information write or call Jim LaBounty, Bureau of Reclamation, P.O. Box 25007 (D3742), Denver, CO 80225; (303) 236-6002; or Bob Schroeder, Denver Water Department, 1600 West 12th Avenue, Denver, CO 80254; (303) 628-6382.

#### **COLORADO ENVIRONMENTAL REGULATION: HAS THE PENDULUM SWUNG TOO FAR?**

This program, scheduled to be held in downtown Denver on April 25-26, is cosponsored by many of Colorado's engineering and legal professional societies. Subjects will include: an overview of environmental regulation; putting public risks into perspective, surface water quality; groundwater quality; hazardous waste and municipal solid waste management practices; wetlands; and water rights/water supply. Both engineers and attorneys may obtain continuing education credits for the conference. Program chairmen for the conference are: Jonathan E. Jones, Vice President of Wright Water Engineers, and Howard Holme, Esq. of Fairfield & Woods.

#### **APPROPRIATE TECHNOLOGY FOR WATER SUPPLY AND SANITATION IN DEVELOPING COUNTRIES**

This international short course will be held at Colorado State University May 13-17, 1991. It presents training materials similar to those developed by the World Bank for Low-Cost Water Supply and Sanitation in developing countries. The course uses a multi-disciplinary approach, emphasizing socio-cultural and health considerations, in the planning, design, construction, operation and maintenance of water supply and sanitation systems. The main objective is to train and educate practicing engineers, students, and other field staff, and to inform decision-makers about low-cost appropriate water supply and sanitation. The course draws heavily on case studies and provides vivid examples of actual projects in rural areas and developing countries. The course will be directed by Dr. Maurice L. Albertson, Professor, and Dr. Berhane Abraha, Visiting Professor, Department of Civil Engineering, Colorado State University. For further information contact: Dr. Maurice L. Albertson, Department of Civil Engineering, Colorado State University, Fort Collins, CO 80523. Phone: (303)491-5753; Telex: 910 930 9000 ENGR CSU FTCN; FAX: (303)491-7727. (First page of FAX must say "To M. Albertson, 491-5753").

#### **CALLS FOR PAPERS**

**Symposium on the Availability of Groundwater Resources**, Raleigh, North Carolina, April 12-16, 1992, sponsored by the American Water Resources Association. The symposium will address (1) factors affecting the availability of this resource with respect to water quality and quantity, (2) recent progress in technologies to evaluate the resource, and (3) the management, regulations, and decision-making processes used to protect the resource. New advances and emerging technologies in groundwater resource evaluation will be stressed. Submit 3 copies of abstract to Technical Committee Chairman, Dr. Robert C. Borden, Dept. of Civil Engr., North Carolina State University, P.O. Box 7908, Raleigh, NC 27895, Phone: (919)737-7665. Abstract cannot exceed 200 words, must include title of paper, all authors' names, and their affiliations. On separate page include full mailing addresses. Deadline: July 12, 1991.

#### **GRADUATE FELLOWSHIPS**

**Water Resources Presidential Fellowships 1991-92**--The University Center of Water Research at Oklahoma State University invites applicants for Presidential Fellowships in Water Resources. These awards are offered for advanced study and research toward solving pressing water problems in Oklahoma, the region, and the nation. Focus areas include: water quality/quantity management and protection; efficiency of use, reuse, and conservation of the resources; and legal economic, social and institutional aspects of water resources management.

The Center welcomes outstanding students representing a diversity of scholarly interests, including but not limited to the biological, physical, and social sciences and engineering. The Fellowship competition is limited to U.S. citizens. An applicant must be a doctoral student in residence at Oklahoma State University whose proposal for research has been approved by academic authorities in the proposed field of study, or the applicant must be able to demonstrate that the proposed research will be conducted under standards of scholarship recognized at the doctoral level. Selection is based on the following criteria: Completeness and clarity of letter of application; Value of the proposed research to water resources management; Scholastic standing and accomplishments; Credentials and recommendations.

To receive full consideration, applicants should submit the following supporting documentation to the address provided below preferably no later than **March 1, 1991**, although later applicants will be considered. Send a letter describing career goals and research interests, a complete resume, current official transcript, three letters of recommendation. All applicants will be notified of the outcome of the selection process by May 1, 1991.

Recipients will receive stipends of \$1,200 per month, and may begin research July 1, 1991. Fellowships are renewable each July 1, and may be continued up to three years, provided satisfactory progress is demonstrated. Reapplication is required for each year of support. Send applications to: Norman B. Durham, Director, 003 Life Sciences East, Oklahoma State University, Stillwater, OK 74078-0281 or call (405) 744-9995.



## CONFERENCES

- Mar. 18-21 **Fifth Federal Interagency Sedimentation Conference, Practical Sediment Management: Issues and Answers**, Las Vegas, NV. Contact: USGS, Office of Water Data Coordination, 417 National Center, Reston, VA 22092.
- Mar. 20-21 **Nonpoint Source Pollution: The Unfinished Agenda for the Protection of Our Water Quality**, Mar. 20-21, 1991, Tacoma, WA. Contact: Washington Water Resource Center, Washington State Univ., Pullman, WA 99164-3002. (509/335-5531).
- Mar. 26-27 **Pipeline Crossings (ASCE)**, Denver, CO. Contact: Joseph P. Castrovono, Pipeline Crossings Conference Chairman, CH2M Hill, P.O. Box 1647, Gainesville, FL 32601.
- April 1-5 **Hydrology Days**, Fort Collins, CO. Contact: Prof. Morel-Seytoux, Civil Engineering Department, Colorado State University, Fort Collins, CO 80523. (303)491-6762.
- April 24-27 **14th Annual Meeting, Association for Arid Lands Studies**, Reno, NV. Contact: Claud Davidson, Dept. of Geography, Texas Tech Univ., Lubbock, TX 79409.
- April 14-16 **Virginia Water Resources Conference**, Richmond, VA. Contact: Elizabeth B. Crumbley, Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University, 617 No. Main St., Blacksburg, VA 24060-3397. (703)231-8038.
- May 13-16 **5th National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring, and Geophysical Methods**, Las Vegas, NV. Contact: NWWA, 6375 Riverside Dr., Dublin, OH 43017. (614)761-1711.
- June 2-6 **27th Annual AWRA Conference "Water Management of River Systems" and Symposium "Resource Development of the Lower Mississippi River"** - General Chairman: C. Russell Wagner, USGS, Bldg. 2101, Stennis Space Center, MS 39529. (601)688-1580.
- June 2-6 **Symposium on Water Supply and Water Reuse: 1991 & Beyond**, San Diego, CA. Contact: AWRA, 5410 Grosvenor Lane, Ste 220, Bethesda, MD 20814-2192. (301-493-8600); General Chairman: Steve Pearson, Woodward-Clyde Consultants, 1550 Hotel Circle N, San Diego, CA 92108.
- June 10-14 **15th Annual Conference, Association of State Floodplain Managers**, Denver, CO. Contact: Bill Stanton, Colorado Water Conservation Board, 721 Centennial Bldg., 1313 Sherman St., Denver, CO 80203. (303)866-3441).

**COLORADO STATE UNIVERSITY  
SEMINAR SERIES ON WATER RESOURCES SCIENCES AND ENGINEERING  
1991 SPRING SEMESTER**

- Thursday  
March 21  
12:10 pm **EFFECTS OF CLIMATE CHANGE IN IRRIGATION AND DRAINAGE** -- Dr. Luis Garcia,  
Associate Director, CADSWES, Boulder, Colorado. Room 202 Student Center
- Thursday  
March 28  
12:10 pm **USE OF INSTREAM FLOW TECHNIQUES IN WATER RESOURCES DECISION MAKING** --  
Mr. Terry J. Waddle, Hydrologist, National Ecology Research Center,  
U.S. Dept. of the Interior, Room 204 Student Center
- April 4 **NO SEMINAR - HYDROLOGY DAYS**
- Thursday  
April 11  
12:10 pm **ENVIRONMENTAL IMPACT ASSESSMENT IN WATER RESOURCES PLANNING** -- Dr. Evan  
C. Vlachos, Professor, Sociology Dept., CSU, Room 202 Student Center
- Thursday  
April 18  
12:10 pm **UNCERTAINTY IN PESTICIDE LEACHING ASSESSMENTS** -- Dr. Keith Loague, Assistant  
Professor, Dept. of Soil Science, University of California at Berkeley,  
203 Student Center.
- Thursday  
April 25  
12:10 p **THE ECONOMIC VALUE OF INCREMENTAL RUNOFF IN LARGE BASINS: A SYSTEMS  
APPROACH** -- Dr. Gustavo E. Diaz, Research Associate, National Park Service  
U.S. Dept. of the Interior, Room 202 Student Center



Thursday  
May 2  
12:10 pm

**THE ROLE OF FOREST IN GLOBAL CHANGE** -- Dr. Douglas G. Fox, Research  
Meteorologist, Forest Service, U.S. Department of Agriculture,  
Room 202 Student Center

Sponsored by: Hydrology and Water Resources, Groundwater, and Water Planning and  
Management Programs (Department of Civil Engineering)  
Watershed Sciences Program (Department of Earth Resources)

For further information, contact Dr. Jose D. Salas, Hydrology and Water Resources Program, Colorado State University, ERC, Fort  
Collins, CO 80523. Phone (303) 491-8460.

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