

Wassup in the South Platte Basin



*Proceedings of the 12th Annual
South Platte Forum
October 24-25, 2001
Longmont, Colorado*

Jennifer Brown, Editor

October, 2001

Information Series No.93

Sponsored by:

**Colorado Division of
Wildlife**

Denver Water

**U.S. Environmental
Protection Agency**

**Colorado Water Resources
Research Institute**

**Northern Colorado Water
Conservancy District**

**U.S. Fish and Wildlife
Service**

**Colorado State University
Cooperative Extension**

U.S. Bureau of Reclamation

U.S. Geological Survey

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U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Geological Survey

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October 24-25, 2001

Raintree Plaza Conference Center

Longmont, Colorado

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Colorado Water Resources Research Institute

Colorado State University

Fort Collins, CO 80523-2033

Robert C. Ward, Director

PREFACE

“Water reminds us of high mountains and streams, of deep chasms and gurgling brooks, and the quiet sounds of the wilderness. Even in a city, the sound and sight of water stirs the most elemental and basic roots of our human nature.”

- Lawrence Halprin

The South Platte River exemplifies all the mental images of Lawrence Halprin and more. From high in the Rocky Mountains to the flat plains of Eastern Colorado, from the heart of Denver to the smallest of rural-Colorado towns, the South Platte takes on a course with as many political and legal challenges as topographical.

The South Platte Forum is an annual venue that explores many of the issues surrounding this ever-changing and ever-challenged river. This year the forum examines quality and quantity issues, taking a look at the never-ending user demands placed on the river. It reviews conservation and reuse efforts to maximize the limited water available in the Basin. The Forum also presents current legislation, studies and popular opinions affecting water banking and well augmentation in the basin.

We hope you find the Forum to be an open exchange of ideas and technology to enhance the River and its many uses. Please take advantage of our question and answer sessions to respectfully share your opinions with the audience and speakers.

The South Platte Forum was initiated in 1989 to provide a venue for a timely, multi-disciplinary exchange of information and ideas important to resource management in the South Platte River Basin. Its stated mandates are:

- to enhance the effective management of natural resources in the South Platte River Basin by promoting coordination between state, federal and local resource managers and private enterprise, and
- to promote the interchange of ideas among disciplines to increase awareness and understanding of South Platte River Basin issues and public values

The expressed opinions and information are not necessarily endorsed by the South Platte Forum or any of its sponsoring agencies.

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**UNTYING THE GORDIAN KNOT:
HOW TO RECOVER ENDANGERED SPECIES IN NEBRASKA AND
AT THE SAME TIME ALLOW WATER USERS TO RECEIVE THEIR
WATER**

Ralph Morgenweck¹

Dr. Morgenweck’s presentation focuses on the status of negotiations to formulate a Proposed Platte River Recovery Program, discusses remaining tasks, and offers insight on some tough issues from the water users, environmental groups, states, and the agency charged with administering the Endangered Species Act points of view.

A successful recovery program identifies the Reasonable and Prudent Alternative that can be relied upon for both “historic” and “new” water-related activities to proceed in compliance with the ESA. Ralph will discuss his perspectives on what is necessary to get to a successful program.

The Platte River effort is similar in some respects, and different in many others, from other large-scale recovery efforts such as the CALFED Bay-Delta Program and the Plan to Restore America’s Everglades. Issues are specific to this area of the western United States, and interact with a number of inter-state Compacts, Decrees, and social forces occurring apart from the ESA. These trends include increased urbanization, increased competition to meet water demands, and recognition of ground water and surface water relationships. Recognizing these ongoing changes while developing a legally sufficient program that all parties may not totally agree to, but can live with, and avoiding a “Klamath Train Wreck” along the way remains the Fish and Wildlife Service’s primary goal and all parties’ challenge.

NOTES:

¹ Regional Director, U.S. Fish and Wildlife Service, PO Box 25486, Denver Federal Center, Denver, CO 80225, (303) 236-7920

WATER PLANNING LEGISLATION

Senator John Evans¹

By 2020, Colorado’s population is projected to increase by over 1.7 million to over six million, with much of the growth occurring in the Denver metropolitan area. Each new family of four will need approximately two-thirds of an acre of water per year, which is roughly 290,000 acre-feet for the 1.7 million new residents. I will provide a brief description of possible water supply opportunities and point out challenges communities may encounter when capitalizing on these opportunities.

NOTES:

¹ 19563 E. Mainstreet, Parker, CO 80138, (303) 840-2431

Senator John Evans

Republican

Attorney

Senate Dist. 30 (Douglas, Elbert, Arapahoe and Jefferson Counties): 1st Term

Wife: Mary Ann

2001 Committees	Education; Health, Environment, Children and Families; Legal Services
Career	<i>Founder</i> of John Evans, P.C., a law firm in Parker, 2000; <i>Professor</i> of Graduate Program, College of Financial Planning, 1997-1998; <i>Founder</i> of Western Institute for Agricultural Land Use, 1995-1998; <i>General Counsel</i> , American Constitutional Law Foundation, 1992; <i>Professor</i> of Law and Education, 1986-1992; College Dean, 1979-1984; <i>Life member</i> since 1979 of American Vocational Association; Chapter President of Phi Delta Kappa, 1980-1985; <i>Chair and Conference Chair</i> of Colorado Bar Law Section, 1992-1993; <i>Member</i> of the Board of Governors, Colorado Bar Association, 1993-1994
Government	Elected to the Senate in 1998 and elected member of the State Board of Education At-Large in 1995-1998. Vice Chair of the Senate HEWI committee and appointed to the Transportation and Judiciary Committees; Chair of the Senate House Interim Subcommittee on Access to Health Care; Member of the National Commission to Study Education Facilities in America, 1996-1997; Member of the National Commission to Study Teacher Education in America, 1997-1998
Agenda	Health care, auto insurance, tort, property tax, water and education reform. Past successes include: Physician's Freedom to Practice Act; teacher education reform; conservation easements; property tax reduction for seniors; and, tax credits for corporations promoting natural fuels.
Honors	Friend of Business, Colorado Association of Commerce and Industry, 1999 and 2000 ; Leadership Award for Support of Senior Issues, American Association of Retired Persons (AARP), 2000 ; Legislator of the Year for Outstanding Leadership on Behalf of a Clean Environment, Natural Fuels Corporation, 1999 ; Leadership Recognition Award, Colorado Library Association, 1998 ; National Award for the Protection of Private Property, National Association of Royalty and Land Owners, 1994 ; Who's Who in Emerging Leaders in America, 1988
Personal	Born May 17, 1949 in Scottsbluff, NE. to Merf and Florence Evans. Merf was a Colorado businessman and State Director of Highway Safety under four Governors. Florence was Administrative Assistant to the Colorado Commissioner of Education and a homemaker. His wife, Mary Ann, is a former college teacher and theater director. They have two children: Evan, born in 1992 and John Paul born in 2000. The Evans family are active members of the Ave Maria church in Parker Colorado.
Civic	Parker Chamber of Commerce, 1992-present ; Board of Directors, Colorado Leadership Institute, 1996-1999 ; Parker Rotary Club, 1992-1996 ; Advisory Board, California Institute for Rural Studies, University of California, Davis, 1989-1992
Recreation	Skiing, fly fishing, reading Will Rogers, and spending time doing anything with his family

Russell George

Russell George was named director of the Colorado Division of Wildlife in September, 2000. George, 54 was born and raised in Rifle. He was the Speaker of the House and spent eight years in the Colorado General Assembly. He graduated from Harvard Law School and had been in private practice in Rifle for 24 years. He and his wife Neal, a Rifle public school teacher, have four sons.

NOTES:

WHO WANTS TO BE A WATER MANAGER

Bob Steger³

This will be an interactive presentation providing the audience with a sense of the kinds of decisions a water manager must make.

NOTES:

³ Water Resource Engineer, Denver Water, 1600 W. 12th Ave, Denver, CO 80204, (303) 628-6000

Bob Steger

Bob is a water resource engineer with Denver Water. He's been with Denver Water for 12 years. He has BS and MS degrees in Civil Engineering from University of Wisconsin and University of Colorado at Denver, respectively.

Bob's job is to help manage the raw water collection system of Denver Water. He enjoys sports and traveling.

NOTES:

20 horizontal lines for notes.

USE LESS, REUSE MORE:
SAVING WATER FOR TOMORROW

Donna Pacetti¹, Moderator

Donna Pacetti is currently employed with Denver Water, Denver, Colo., as a Conservation Specialist. She manages several programs for the Conservation Section including Residential, Multi-Family and Low-Income Audit Programs. Donna has a Bachelor of Science degree in Soils and Irrigation from California State University, Chico, California and a Masters in Environmental Policy Management from the University of Denver. Donna is a Trustee for the Rocky Mountain Section American Water Works Association.

NOTES:

¹Conservation Specialist, Denver Water, 1600 W. 12th Ave, Denver, CO 80204, (303) 628-6000

DENVER WATER REUSE PROJECT

Jane Fisher¹

The Denver Water Reuse Project is ultimately planned to treat and disinfect to a tertiary level up to 45-mgd of Denver Water's legally reusable portion of Metro Wastewater Reclamation District's (Metro) secondary treated effluent, and to distribute this reuse water to customers for nonpotable uses such as landscape irrigation and industrial cooling tower make-up. The project is being planned in multiple phases. The initial phase includes 30-mgd treatment plant and distribution storage, pumping, and piping as needed to convey reuse water to the northern and central portion of Denver Water's service area. Subsequent phases will include extension of distribution facilities in the northeastern portion of the service area as well as an increase in plant capacity to 45-mgd. The initial phase of the project is scheduled to be completed in early 2004. The final water quality produced by the treatment plant is planned to exceed State regulations and was established by considering both State and customer requirements.

NOTES:

¹ Project Manager, Denver Water, 1600 W. 12th Ave, Denver, CO 80204, (303) 628-6000

Beneficial Partnerships

Beth Conover¹

The “Green Industry” is comprised of all of those companies who provide landscape products and services. The Green Industries of Colorado (GreenCO) is an umbrella group that represents nine landscape trades. GreenCO is a \$2 billion dollar industry, and employs over 36,000 people.

Over 50% of all treated water on the Front Range is used to irrigate landscapes. At best, this represents the inefficient use of a scarce resource. And yet people have always sought to cultivate, beautify “green” their land, be it rural or urban. Urban landscapes also offer diverse benefits, including air cooling and the mitigation of air and water pollutants. Increasingly, the Green Industries of Colorado has focused on the reality of existing and future water shortages in the state. They have decided to work proactively, to provide leadership and resources toward goals of improved water quality and water conservation statewide. Toward that end, GreenCO’s WELL (Water Efficient Leaders in Landscape) program is pursuing four priority initiatives to improve the water use practices of green industry companies and their customers. Partners include the Colorado Water Wise Council, Colorado State University and the Colorado Water Resources Research Institute. Ms. Conover has worked extensively with GreenCO over the past year to develop this program and will describe it at the forum.

NOTES:

¹ Principal, Headwaters Consulting, LLC, (303) 477-7200

AUTOMATING AUTOMATIC SPRINKLER SYSTEMS

Brent Mecham¹

For most municipalities along the Front Range of Colorado, landscape watering uses more than 50% of the treated municipal water annually. Approximately half of all homes and most commercial properties now have automatic sprinkler systems. However, the only thing automatic about the systems is their ability to turn on and off at appointed times and days. They can't respond to the environment and supply only the water that the plants need. Typically, most lawn sprinkler systems are not programmed correctly or frequently enough, thereby resulting in over watering. This waste of water can be corrected and ease the impact that lawn watering has on city water resources, treatment capability and distribution systems or allow the same water resources to be provided to more customers.

The automation of automatic sprinkler systems can be done using various sensors to help in determining how much water should be applied to the landscape or at the minimum prevent irrigation when weather conditions are not favorable for irrigation. The types of technology that exist or will soon be commercially available include:

Weather sensors that respond to unfavorable weather conditions to prevent irrigation such as rain shut off sensors, wind sensors, humidity sensors and freeze sensors.

Soil moisture sensors that will respond to the amount of available soil moisture in the plant's root zone and will determine when and how much irrigation will be required to supply the needed water.

ET Controllers that use ET information to calculate the amount of run time is needed for each sprinkler zone to supply the correct amount of water for the plants. The ET information can be calculated by the controller with appropriate sensors, or downloaded from a nearby weather station or rely on historical information which is programmed into the controller.

Computerized central control systems can be great management tools for large landscape projects such as golf courses, parks departments or school districts.

Results from tests and demonstrations show the effectiveness of using new technology to assist in better landscape water management.

NOTES:

Brent Mecham

Brent Mecham is a Landscape Water Management and Conservation Specialist with the Northern Colorado Water Conservancy District creating and implementing demonstration and training programs to promote better management of water resources. He has written numerous articles and papers dealing with landscape sprinkler systems and irrigation scheduling and is a Supervising Regional Authorized Instructor for the Irrigation Association teaching a variety of classes that improve the expertise of irrigation professionals. He is an irrigation professional having earned the following certifications—

¹ Landscape Water Management & Conservation Specialist, Northern Colorado Water Conservancy District, PO Box 679, Loveland, CO 80539, (970) 667-2437

WHAT'S IN THE WATER?
A WATER QUALITY UPDATE

Robert Sakata¹, Moderator

Robert T. Sakata, a Colorado native, resides in Brighton, Colorado. In partnership with his parents, who started farming in Brighton in 1946, Robert is vice president of the family operation. Robert completed his first term on the State of Colorado Water Quality Control Commission February 15, 2000. He presently serves as the Commission's liaison to the Water Quality Forum, the Colorado Nonpoint Source Council, and the Colorado Department of Agriculture. He has been a member of the SB90-126 agricultural Chemicals and Groundwater Protections Act Advisory Committee since its inception and is participating in the formation of the Colorado Groundwater Protection Council. He is currently Chair of the Colorado Water Quality Control Commission.

NOTES:

¹Chair, Water Quality Control Commission, 4300 Cherry Creek Dr. South, Denver, CO 80246-1530, (303) 692-3469

WATER QUALITY NUTRIENT STANDARD DEVELOPMENT

Kathryn Hernandez¹

The EPA is working with States and Tribes to adopt nutrient criteria as part of water quality standards. To support such an effort, the EPA has developed technical guidance that provides options for the development of nutrient criteria as well as methods to assess waterbodies for nutrient impacts.

This presentation will review EPA's strategy and guidance for nutrient criteria, provide information regarding nutrient impairments as identified in Section 303(d) waterbody lists, and identify options a particular State or Tribe can utilize in developing its nutrient criteria. Further, this presentation will provide an update on the particular aspects of the guidance that relate to lakes/reservoirs and streams/rivers. Finally, activities for development of nutrient criteria for the South Platte River will be discussed.

NOTES:

¹ TMDL Specialist/Nutrient Coordinator, EPA Region VIII, 999 18th Street, Ste. 300, Denver, CO 80202 (303) 312-6101

WATER QUALITY IN THE SOUTH PLATTE BASIN: THE SECOND DECADE OF NAWQA

Cathy M. Tate¹

In 2001, the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program began its second decade of intensive water-quality assessments. NAWQA scientists will revisit 14 major river basins and aquifer systems that were assessed in the first decade (1991-2001), including the South Platte River Basin which was intensively sampled during 1992-95. Another 2 groups of 14 river basins and aquifer systems will be studied beginning 2004 and 2007. In the second cycle of studies (2001-2011), NAWQA will build upon its initial assessments of water-quality conditions with increased emphasis on studies of long-term water-quality trends and factors affecting water quality.

Over the next four years (2002-2005), the South Platte NAWQA studies will assess trends in water quality by re-sampling: (1) 4 surface-water (stream) sites that represent different land uses, and (2) 30 wells in the South Platte alluvial aquifer (ground water adjacent to and connected to the South Platte River.) Stream studies will investigate changes in the physical, chemical (nutrients and pesticides), and biological characteristics (algae, invertebrates, and fish) of four sites representing undisturbed (Big Thompson River below Moraine Park near Estes Park), urban (Cherry Creek at the mouth, Denver), agricultural (Lonetree Creek near Greeley), and mixed urban and agricultural (South Platte River near Kersey) land uses. The ground-water study will examine changes in nutrients and pesticides in wells located in the alluvial aquifer beneath irrigated agricultural lands from Brighton, Colorado, to near North Platte, Nebraska.

In addition, two new studies will be implemented to assess water quality conditions in the shallow ground water of the Denver Basin aquifer. The first study will examine water quality beneath agricultural areas that have greater than 50 percent wheat cover. The second study will examine water quality beneath urban areas in Douglas County.

The South Platte NAWQA study has the potential to participate in two or three national studies that focus on factors affecting water quality. These include studies of the effects of urbanization and nutrient enrichment on streams and a study of how contaminants are transported to public supply and domestic wells. Questions addressed by these studies include: (1) How do the hydrologic (flow), geomorphic (habitat), chemical, and biological characteristics of stream ecosystems respond to land-use changes associated with urbanization across contrasting environmental settings nationwide?, (2) How do biological communities and processes respond to varying levels of nutrient enrichment among agricultural streams from contrasting environmental settings nationwide?, and (3) What are the primary factors that control the fate and transport of anthropogenic and natural contaminants through aquifers that are important sources of water to public-supply or domestic wells?

¹ Project Chief, South Platte NAWQA, U. S. Geological Survey, Box 25046, MS 415, Lakewood, CO 80225, (303) 236-4882 ext. 287

ATTAINMENT OF WATER QUALITY STANDARDS IN THE SOUTH PLATTE BASIN

Phil Hegeman¹

Section 303(d) of the federal Clean Water Act requires states to identify waters that do not, or are not expected to meet applicable water quality standards with technology based controls alone. These waters are compiled into the 303(d) list of impaired waters. The Colorado Water Quality Control Division (CWQCD) is required to submit its next iteration of the 303(d) list to the U.S. Environmental Protection Agency (EPA) by

April 1, 2002. In addition, the methodology by which such listing decisions are made must be submitted to the EPA by November 1, 2001.

In July of 2000, the EPA adopted a new federal rule addressing implementation of the Total Maximum Daily Load (TMDL) Program. Subsequent Congressional action delayed implementation of the rule until October of this year. The status of the rule remains in doubt pending review by the new administration and the outcome of potential lawsuits.

The CWQCD has proceeded with development of the year 2002 303(d) listing methodology to comply with the recently promulgated federal requirements. The CWQCD also compiles a Monitoring and Evaluation (M&E) list of waters for which data is insufficient to document suspected water quality problems. Development of the 2002 303(d) and M&E lists involves review of available water quality information by the CWQCD Assessment Unit staff. Information developed by the CWQCD in support of ongoing basin specific standards, as well as information submitted by third parties, is considered. Drafts of both lists will be made available for public review. This will be accomplished via the Colorado Water Quality Control Commission (CWQCC) website and the Colorado Water Quality Information Bulletin. After a thirty-day public comment period, the draft lists will be the subject of an informational hearing before the CWQCC. Any additional public comment will be considered at that time. The final lists will be submitted to the EPA after incorporation of any changes adopted by the CWQCC.

The CWQCD and others have developed a number of TMDLs for waters within the South Platte River watershed included on the 1998 303(d) List. Monitoring of M&E listed segments within the watershed is ongoing.

NOTES:

¹ Water Quality Assessor, Dept of Public Health and Environment, Water Quality Control Division, WQCD-B2-AU, 4300 Cherry Creek Drive South, Denver, CO 80246, (303) 692-3518

WATER QUALITY EFFECTS OF WILDFIRES ALONG THE COLORADO FRONT RANGE

Deborah Martin¹

Large areas of the South Platte River watershed are susceptible to high-severity wildfires. The Buffalo Creek Fire of 1996 and Hi Meadow Fire of 2000 have highlighted the risk of wildfires to communities along the Colorado Front Range. These events have also thrust into the spotlight some of the consequences of wildfire, mainly post-fire flooding and erosion. Runoff from burned watersheds increases because of the loss of storage capacity in the canopy and in the litter and duff layers, and because of various processes that decrease infiltration. Burned material such as ash, charcoal, and other solids are transported to water bodies. Erosion from burned areas tends to increase for three to eight years after a wildfire. The erosion produces sediment, dissolved chemicals leached from ash and charcoal (such as manganese and nutrients), floatable organic debris, and chemical fire-suppressants (used to fight the wildfire) that may impact rivers and streams.

Flooding after the Buffalo Creek Fire significantly impacted the quality of water and the storage capacity of Strontia Springs Reservoir, a major water supply reservoir for Denver and Aurora. Both the North Fork of the South Platte and the South Platte Rivers transported sediment and organic debris from the area burned by the Buffalo Creek Fire to the reservoir. The Denver Water Department removed several tons of floating logs from the reservoir. Also, the Department added supplemental chlorine to drinking water to counteract the effects of elevated dissolved manganese. Currently, the Denver Water Department is exploring options for removing sediment from the reservoir that has decreased the storage capacity. The U.S. Geological Survey is in the process of synthesizing data on post-fire water quality effects. Additional knowledge of the effects of wildfire on water quality and the on aquatic organisms is needed to better help water and land managers respond to the consequences of wildfire.

NOTES:

¹ Hydrologist, U.S. Geological Survey, Water Resources Division, 3215 Marine Street, Suite E-127, Boulder, Colorado 80303-1066, (303) 541-3024

WELL AUGMENTATION:
BALANCING THE ACCOUNT

Tom Cech¹, Moderator

Tom Cech was born and raised on a farm near Clarkson, Nebraska, (just down the gravel road from Howells). He graduated from Kearney State College with a teaching degree in mathematics and then received a Masters Degree in Community and Regional Planning from the University of Nebraska - Lincoln. He has been Executive Director of the Central Colorado Water Conservancy District in Greeley since 1982.

NOTES:

WELL AUGMENTATION IN THE SOUTH PLATTE RIVER BASIN

¹ Executive Director, Central Colorado Water Conservancy District, 3209 West 28th St., Greeley, CO 80631, (970) 330-4540

Hal Simpson¹

Purpose of Presentation

- Summarize operation of augmentation or replacement plans in 2001

Legal Requirements for Augmentation

- 1974 Rules concerning the use of tributary ground water
 - Must replace out-of-priority depletions or be subject to curtailment
- South Platte River Compact
 - Diversions junior to 6-14-1897 must replace depletions when state line flow is less than 120 CFS (April 1 - October 15) or be curtailed

State Engineer Authority to Approve Augmentation or Replacement Plans

- 1974 Rules
- Substitute Water Supply Plan Statute CRS 37-80-120

Approved Plans for 2001

- GASP
- Central Colorado Water Conservancy District
- Lower South Platte Water Conservancy District
- Others

Projected Depletions for 2001

- Total
- Out-of-Priority

Operation of Plans in 2001

- Reporting
- Accounting with daily spreadsheet; improved significantly in 2001
- Amount of augmentation or replacement water provided

Conclusions

- Significant cooperation in 2001 – second consecutive dry year
- Accounting and reporting capabilities improving each year
- Need for better data and modeling tools to improve process through South Platte DSS

Hal Simpson

Hal Simpson was appointed State Engineer on August 7, 1992. As State Engineer, Mr. Simpson is responsible for the direction and management of the Division of Water Resources, which has a staff of 240 FTE and a budget of approximately \$14 million. The Division is responsible for distribution and administration of water in accordance with statutes and interstate compacts; the implementation of a statewide dam safety program; the permitting of the use of ground water and construction of wells; the collection and dissemination of data on water use and streamflow; and conducting various studies concerning water resources and the availability of water supplies. The State Engineer is Colorado's

¹ Director, State Engineer, Colorado Division of Water Resources, 1313 Sherman Street, Room 818, Denver, CO 80203, (303) 866-3581 x229

commissioner on five interstate compacts and is responsible for assuring compliance with these compacts. The State Engineer is also the Executive Director of the Colorado Ground Water Commission and is the Secretary of the Board of Examiners for Water Well and Pump Installation Contractors.

Mr. Simpson served as Deputy State Engineer and held that position from 1984 to 1992. As Deputy State Engineer, he was responsible for the operations of the Division of Water Resources and Office of the State Engineer in the absence of the State Engineer. He was also the engineer adviser to the State Engineer on interstate compacts, and directed the litigation activities of the division. From 1980 to 1991, he was also in charge of the Engineering Section of the Division where he was responsible for the work of six programs within the Division, which included the Water Management Branch, the Water Supply Branch, the Geo-Technical Support Branch, the Dam Safety Branch, the Hydrographic Branch, and the Satellite-Linked Water Resources Monitoring Program. He was also the engineer adviser to the State Engineer for interstate compacts.

From 1972 to 1979, he was Chief of the Water Management Branch where he supervised the work of the branch in evaluating the dependability of water supply plans for new subdivisions, the review of substitute water supply plans, and the review of mining operations on the hydrologic system.

Previous work experience includes approximately two years as an officer in the U.S. Army Corps of Engineers assigned to the Omaha District where he supervised construction by civilian contractors at Fort Carson, Ent Air Force Base, and the Air Force Academy. After completion of military service, he was employed by the firm of Wright-McLaughlin for approximately one year as a water resources engineer.

Education experience includes a B.S. and M.S. in Civil Engineering from Colorado State University in 1967 and 1969, respectively. The Masters degree specialized in water resources and ground water hydrology. Additional post-graduate work in water resources has been done at the University of Colorado in water resources.

Mr. Simpson is a registered professional engineer in Colorado and is a member of Chi Epsilon. He is also a second generation native from the Greeley area and grew up on a dryland wheat farm with a small dairy.

COLORADO'S DECISION SUPPORT SYSTEM DATABASE AND VIEWING TOOLS

Ray Bennett¹

Colorado's Decision Support System (CDSS) contains a comprehensive database of water resource data for the State of Colorado. Containing both relational (tabular) and spatial (GIS) data, it is available to download from the web or for purchase by CD. This paper describes the system's relational and spatial database and the viewing tools that are available to assist in using that data to analyze water resource issues.

NOTES:

¹ Special Projects Manager, Colorado Division of Water Resources, 1313 Sherman St, Room 818, Denver, CO 80203, (303) 866-3581

SOUTH PLATTE MAPPING AND ANALYSIS PROJECT

Dr. Luis Garcia¹

The South Platte Mapping and Analysis Project (SPMAP) was created to address the data and tool development needs of water user groups in the Lower South Platte River Basin from below Denver to the state border. One of the primary functions of this project is to provide the tools needed by water user organizations to estimate agricultural demands on groundwater wells that require augmentation and to assist other water management objectives. To develop a consensus on the tasks needed for this project an advisory committee was formed. The committee is comprised of representatives from the Northern Colorado Water Conservancy District (NCWCD), the South Platte Lower River Group, Inc. (SPLRG), the Colorado State Engineers Office (SEO), Groundwater Appropriators of the South Platte (GASP), the Central Colorado Water Conservancy District (CCWCD), and the Lower South Platte Water Conservancy District (LSPWCD). This committee meets regularly to determine approaches and tasks needed and to evaluate the software being developed. All members of the committee have provided funding for this project as well as the Colorado Water Resources Research Institute, Colorado Cooperative Extension and the Colorado Agricultural Experiment Station.

As part of this project, three main components have been identified for tool and/or data development. These components are collectively called the South Platte Mapping and Analysis Program (SPMAP). The ArcView Geographic Information System component (SPGIS) contains spatial data assembled for this project and can be used to develop input files for the South Platte Consumptive Use (SPCU) Model, which in turn can be used to develop input for a Stream Depletion Factor interface (SDF View). Data and tools developed as part of this project are in direct response to the needs expressed by water providers in the basin and are currently being used to meet the modeling and data needs of the eight water user groups. All the documentation and software is available at the Integrated Decision Support Group website, subject to the approval of the advisory board:

<http://www.ids.colostate.edu/projects/spmap>

NOTES:

¹ Associate Professor, Director, Integrated Decision Support Group, Colorado State University, Department of Civil Engineering, Fort Collins, CO 80523, (970) 491-5144

Luis Garcia, Ph.D.

EDUCATION:

University of Colorado, Boulder, Colorado
Ph.D. Civil Engineering, February 1990
Texas A&M University, College Station, Texas
M.S. Civil Engineering, December 1985.
B.S. Civil Engineering, December, 1983.

CURRENT EMPLOYMENT:

Director - Integrated Decision Support Group (IDS), The Water Center, Colorado State University.
January 1992 to present.

Interim Associate Director, Colorado Agricultural Experiment Station, March 2000 to present.

Associate Professor – Department of Civil Engineering, July 1998 to present.

RESEARCH INTERESTS

Dr. Garcia's main research interest is in the application of Decision Support Systems (DSS) in natural resources systems, specifically in applications for water resources, and irrigation and drainage. He has been working with South Platte River Basin water users for the past five years developing computer tools. He also has been working with salinity issues in the Arkansas River basin for the past four years.

Dr. Garcia has done international work in the area of water resources in Italy, Netherlands, and Austria and in the area of drainage in Egypt.

Dr. Garcia has been PI in over 30 projects at CSU.

NOTES:

MANAGED GROUNDWATER RECHARGE IN THE LOWER SOUTH PLATTE RIVER

Jon Altenhofen¹

Managed groundwater recharge is the diversion of excess river flows by wells next to a river or canal for delivery to recharge basins away from the river. The water seeps into the underground South Platte alluvial aquifer for return as groundwater inflows to the river at a later time during river flow shortages. These returns provide benefits of maintaining augmentation of irrigation wells and enhancing riparian habitat. Enhancing the flow of water in the river channel and sloughs during low flow periods benefits minnow species of concern. The State of Colorado's water contribution to a cooperative ESA Basin Program between Colorado, Nebraska, Wyoming, and the U.S. Department of the Interior is being developed through managed groundwater recharge on public and private lands in the lower South Platte River in Colorado.

NOTES:

¹ Professional Engineer, Supervisory Water Resources Engineer, Northern Colorado Water Conservancy District, PO Box 679, Loveland, CO 80539, (970) 667-2437

WATER BANKING:
MAKING A DEPOSIT FOR THE FUTURE

Harold Miskel¹, Moderator

Biographical sketch not available.

NOTES:

¹ Board Member, Colorado Water Conservation Board, 1313 Sherman St., Room 721, Denver, CO 80203, (303) 866-3441

AN OVERVIEW OF WATER BANKING

Lawrence J. MacDonnell¹

Water banking refers to a specially designed process for facilitating the transfer of appropriated water to a new use. Such approaches are emerging across the West in response to the growing need to make some portion of the already developed water supply available to meet new and changing demands for water.

This presentation will introduce the basic considerations for creating and operating a water bank. It will provide some examples from other places. And it will address the key issues raised by water banking and suggest some options for addressing these issues.

NOTES:

Horizontal lines for taking notes.

¹ Lawrence J. MacDonnell, P.C., 929 Pearl Street, Suite 300, Boulder, CO 80302, (303) 545-6467

Lawrence J. MacDonnell, P.C.

EXPERTISE

Since the early 1970s, Dr. MacDonnell has been working on environmental and natural resources issues as a lawyer, an economist, and an academic. He is a nationally recognized expert on water law. He has special expertise as well relating to oil and gas law, mining law, public land law, and endangered species matters. His work often emphasizes incentive-based approaches to problem solving, developed through collaborative processes. He has written more than 40 publications, including books, law review articles, and articles in other journals and has authored or co-authored 26 research reports. He has given over 100 invited presentations. He is co-founder and president of Stewardship Initiatives, a tax-exempt nonprofit corporation providing services for conservation partnerships.

EDUCATION

Ph.D., Mineral Economics, Colorado School of Mines (1975)

J.D., University of Denver College of Law (1972)

B.A., Political Science, University of Michigan (1966)

WORK EXPERIENCE

1998-present: President, Stewardship Initiatives

1995- present: Lawrence J. MacDonnell, P.C., Attorney and consultant

1983-1994: Director, Natural Resources Law Center,
University of Colorado School of Law

1981-1983: Research Economist, Denver Research Institute

1977-1980: Instructor and Course Director, Colorado Outward Bound School

1974-1977: Assistant Professor, Department of Mineral Economics,
Colorado School of Mines

1967-1971: U.S. Air Force

OTHER

Member of the Colorado Bar since 1972

Member of the American Bar Association

Member of the Colorado Bar Association

NOTES:

WATER BANKING LEGISLATION

Representative Diane Hoppe¹

Arkansas Valley Water Banking Pilot Project

The goal of this legislation is to:

- Test the usefulness of water banking
- Find a more efficient use of water
- Keep water in the basin
- Call for voluntary participation
- Reaffirm the Colorado Constitution's recognition of water as a private

Property rights

- Facilitate the ability to move water in a basin
- Reduce costs

This pilot is to test the concept of a market place for water, using strict parameters. The intent is to:

- Simplify water leasing, exchanges and sales of water within a basin.
- Reduce the costs associated with those transactions.
- Increase the efficiency of water use within a basin.

NOTES:

¹ State Representative, Colorado State Legislature, 200 East Colfax, Room 223, Denver, CO 80203, (303) 866-3706

Representative Diane Hoppe

Representative Diane Hoppe is serving her second term in the Colorado House of Representatives. She is Chair of the House Agriculture, Livestock, and Natural Resource Committee; Chair of the Water Committee; and is a member of the House Local Government Committee.

Since being sworn in on January 20, 1999, she has received various legislative awards including “Legislator of the Year, 2000” by both the Colorado Livestock Association and the Greenhouse, Landscape and Nursery’s Association; she was selected as one of the “Top Ten Freshmen Legislators,” 1999-2000 by the Rocky Mountain News”; she was chosen as the “1999-2000, Top Republican Representative Member” by the Colorado Farm Bureau; she received the “Distinguished Legislator” Award from the Colorado Association of Soil Conservation Districts in 2001; she received the “Guardian of Small Business” award from the National Federation of Independent Businessmen and for two consecutive years she has received the “Top Ten Legislator Award” from the Colorado Association of Commerce and Industry.

Diane served as a District Aide to Congressman Hank Brown (1987-1990) and as Field Representative to Senator Brown (1990-1995).

In addition to her public service, Diane worked for Intermountain Forest Industry Association as a Forest Programs Coordinator and now works as a Forest Consultant.

Diane attended Colorado Women’s College and then the University of Colorado, where she received her degree in microbiology. She is the mother of two adult sons, John and Dan Hoppe.

NOTES:

COMMUNITY ISSUES AND PARTNERSHIPS

Dr. John Wilkins-Wells¹

Various efforts are being made by communities to address concerns about water transfers of native water supplies out of local basins-of-origin. Some of the solutions being discussed include water banking, water exchanges and water rentals. In the Cache La Poudre River Basin, communities and agricultural water suppliers have for years attempted to address this issue and related issues through water exchanges and rentals. Recent efforts have focused on the concept of water banking. Although water banks are known in other areas of the West, as evidenced by the research of one of our guest speakers (Lawrence J. MacDonnell), it is a fairly new concept for the northern Colorado Front Range. A brief summary of thoughts and approaches to water banking being discussed by the Larimer and Weld Water Issues Group will be presented.

NOTES:

¹ Assistant Professor, Senior Research Scientist, Department of Sociology, Colorado State University, Clark Bldg. B258, Fort Collins, CO 80523, (970) 491-5635

CHUTES, RAMPS AND LADDERS:
A RECREATION QUANTITY
ISSUES PANEL

Paul Flack¹, Moderator

Hydrologist, Colorado State Parks, 1994-present

Water Resource Engineer, City of Aurora, 1987-1994

Master Degree, Watershed Hydrology, University of Arizona, 1984-1986

Bachelor Degree, Natural Resources, Colorado State University, 1979-1982

NOTES:

¹ Hydrologist, Colorado State Parks, 1313 Sherman St, Room 618, Denver, CO 80203, (303) 894-2583

RECREATIONAL IN-CHANNEL DIVERSIONS

Dan Merriman¹

Colorado water law has expressly recognized recreational use of water as a beneficial use for some time. But recently, *in-channel* diversions for recreational use have raised unique challenges for Colorado.

To obtain a decree for a water right in Colorado, the user must demonstrate that water has been diverted, stored, or otherwise captured, possessed, and controlled and has been applied to a beneficial use. Most of the decrees issued for recreational uses in the state are for reservoirs and other off-channel locations.

In the mid 1980's the City of Fort Collins filed a water right claim for a boat chute within the active channel of the Cache la Poudre River. State law provides that only the Colorado Water Conservation Board can appropriate stream flows between specific points in natural streams without the need for diversion or control structures. This conflict spurred new legislation reaffirming the Board's exclusive authority as well as a Supreme Court decision that held that a properly designed and constructed boat chute could constitute a diversion. Fort Collins was ultimately awarded a water right for the boat chute.

Other municipalities have relied upon that 1987 Supreme Court decision permitting an entity to protect a flow amount through a stream channel for recreational purposes, so long as the requisite control exists.

Last year, the City of Golden filed an application for an in-channel recreational water right that tested the limits of the Supreme Court decision. Golden claimed a water right for up to 1,000 cfs on Clear Creek for boating, piscatorial, and general recreational uses. This application, which effectively claimed the entire natural flow of the creek, raised significant concerns regarding its effect on future appropriators as well as the state's ability to fully utilize its compact entitlements.

Prompted by these concerns, the State Legislature passed SB 01-216 to provide "balancing requirements" for future recreational instream water rights. The new law requires the Water Conservation Board to make specific findings concerning the impact of any proposed recreational in-channel diversion on other water users and the state's compact entitlements. The Board is currently developing rules and regulations to implement this legislation and has held public meetings throughout the state to solicit input. A formal rulemaking hearing will be held in late September.

The Division 1 Water Court has since granted Golden's water right claim in full. The Board has appealed that decision to the Supreme Court. The challenge for Colorado remains -- to assure that water is appropriated in reasonable amounts and used efficiently, and to allow for some reasonable future water use. Time will tell if Colorado successfully achieves this balance.

¹ Stream and Lake Protection, Colorado Water Conservation Board, 1313 Sherman Street, Room 721, Denver, CO 80203, (303) 866-3441 x317, <http://cwcb.state.co.us/>

Dan Merriman

Dan Merriman is chief of the Stream and Lake Protection Section for the Colorado Water Conservation Board. In this capacity he is responsible for the daily administration of Colorado's Instream Flow and Natural Lake Level Program (ISF Program) which involves overseeing the following sub-program areas: New Appropriations, Acquisitions, Legal Protection, Physical Protection and the necessary biological and engineering support for these sub-program areas. (Colorado's ISF Program provides for the protection of over 1900 water rights representing 8000 miles of stream and nearly 500 natural lakes.)

Dan has worked for the Colorado Water Conservation Board for over 20 years and has been involved with various water-related environmental and natural resource issues ranging from floodplain analysis and delineation, to wild and scenic rivers studies, instream flow protection, wilderness designation and federal reserved water right issues.

Dan graduated from Northeastern Junior College in Sterling, Colorado with a degree in Physical Sciences with a Forestry emphasis and from Colorado State University with a degree in Watershed Management/Watershed Sciences. Before coming to the Board, Dan worked for the Salt River Project, a water and power utility serving the Phoenix, Arizona area. He worked in the Project's Watershed Division and was involved in reservoir feasibility studies, water right protection activities, and various water resources studies.

In addition to the daily administration of the state's ISF Program, Dan is currently involved in the development of Rules to implement SB 216, the Recreational In-Channel Diversion bill, USFS reserved water right negotiations in Water Division 7, and the Rio Blanco river restoration project. In carrying out his responsibilities for the Board, Dan works closely with the Division Engineers and staff, other state agencies, local water user organizations, local communities, landowners, water users, federal agencies and environmental organizations and interests.

NOTES:

RESERVOIR LEASE NEGOTIATIONS: THE IRRIGATION PERSPECTIVE

Tim Buhcanan¹

- I. Many agricultural water supply entities own reservoirs to store water for later use for crop irrigation or other purposes. The reservoir provides an excellent opportunity for flat water recreational activities and fishing and other wildlife interaction.
- II. The right to use the water in the reservoir for recreational purposes is an asset of the water supply entity. The water supply entity has the obligation to provide the best possible rate of return on the use of the recreational use of the reservoir.
- III. Many water supply entities view reservoirs as more of a “head ache” than an opportunity.
 - A. The reservoirs require constant maintenance of the dam and other facilities to ensure that the reservoir will safely store water.
 - B. The primary obligation of the water supply entity is to supply water at times and amounts required for users. Recreational use of the water is generally secondary to other uses.
 - C. There is a significant liability associated with authorized and unauthorized use of the reservoir for recreational purposes.
 - D. Vandalism associated with authorized and unauthorized use of the reservoir and associated facilities increases maintenance and repair costs.
- IV. Agreements for public use or private recreational use of reservoirs must address several key issues.
 - A. Compensation: Compensation for the recreational use of the reservoir should reflect the market value of the recreational use, which is difficult to determine.
 1. Acquisition of recreational use rights includes (1) purchase of recreational rights, or (2) lease for a period of years the recreational rights. The valuation process and compensation is different for each option.
 2. Compensation methods include (1) annual payment, (2) lump sum payment for recreational use for a period of years, and (3) payment based on level of use. The compensation method will frequently determine the actions of the parties in enhancing recreational opportunities.
 - B. Nature of Interest: Owners of reservoirs frequently do not want to sell the recreational rights and only want to lease the rights. Public and private entities prefer to own the rights to avoid future problems. Where the water is owned by one entity and the land inundated by the water is owned by another, the permission of both is required for the recreational lease.
 - C. Liability: Providing for public or private recreational use of a reservoir results in a significant increase in liability. While some statutory provisions provide limited liability relief, the cost of liability insurance and potential governmental immunity must be factored into the recreational use transaction.

¹ Special Projects Manager, Colorado Division of Water Resources, 1313 Sherman St, Room 818, Denver, CO 80203, (303) 866-3581

Tim Buchanan, P.C.

EDUCATION AND BAR ADMISSIONS:

Admitted to practice before State of Colorado Bar, October 1982

Admitted to practice before Federal District Court of Colorado, October 1982

Juris Doctor, University of Colorado at Boulder, May 1982

Bachelor of Science with Honors, Civil Engineering, University of Colorado at Boulder, May 1979

LEGAL EXPERIENCE:

TIMOTHY R. BUCHANAN, P.C., Arvada, Colorado, June 1988 - Present

ALLBRIGHT & BUCHANAN, P.C., Denver, Colorado, January 1987 - June 1988.

MOSES, WITTEMYER, HARRISON AND WOODRUFF, P.C., Boulder, Colorado, June 1980 - January 1987.

Associate, October 1982 through January 1987; Law Clerk, June 1980 through October 1982.

- Legal practice has emphasized water rights, water rights titles, water quality, real property, environmental, and public land law and state and federal permitting. Experience with state and federal environmental laws and regulations including National Environmental Policy Act, Clean Water Act, and Federal Land Policy and Management Act.
- Litigation experience before Colorado courts, including Colorado Water Courts in Divisions 1, 5 and 6.
- Administrative agency practice, including rulemaking and adjudicatory hearings before the Colorado Ground Water Commission, Colorado Water Quality Control Commission, Colorado Water Quality Control Division and the Colorado State Engineer.

REPRESENTATIVE CASES:

Litigation regarding acquisition of water rights for major municipalities and corporations, and for individual farmers; litigation to protect water rights from contrary claims and potential water quality impairment; investigated and rendered opinions regarding title to several million dollars worth of water rights; represented clients in stream and reservoir water quality standard setting proceedings, and in state discharge permit processes.

MEMBERSHIPS, OFFICES AND HONORS:

American Bar Association: Natural Resources Section, Economics of Law Practice Section

Colorado Bar Association: Water Law Section, Agricultural Law Section

Boulder County Bar Association: Water Law Section,

Member: Colorado Water Congress, Colorado Ground-Water Association, Phi Delta Phi Legal Fraternity

Miscellaneous Honors and Offices: Guest Lecturer, University of Colorado School of Law; Guest Lecturer, Colorado Farm Land Institute; Guest Speaker, National Farmers Union National Convention; Guest Speaker, Rocky Mountain Farmers Union Convention; Guest Speaker, various real estate and title organizations regarding *Contracting and Conveyancing of Water Rights*; National Farmers Union Policy Drafting Committee; Outstanding Senior Civil Engineering Student Award; Tau Beta Pi, National Engineering Honor Society; Chi Epsilon, National Civil Engineering Honor Society

RESERVOIR LEASE NEGOTIATIONS: THE RECREATION PERSPECTIVE

Joe Maurier¹

Of the more than 200,000 acres managed by the Colorado State Park system, only 24% are owned by the State (50,267 acres). A full 33% are areas managed for water entities such as the Bureau of Reclamation, Corp. of Army Engineers and Irrigation Companies. Management of Irrigation Company reservoirs accounts for about 25% of the total system.

The State Park system and the various irrigation companies form a valuable partnership for the citizens of the State. The demand for water recreation is great and will only increase as the population continues to grow. It is critical to foster and maintain good working relationships because few new reservoirs are being built. By working together there are many mutual benefits. The Companies are able to generate income from leases and easements, security of infrastructure and management of people is at a high and consistent level and in many areas of the state the boost to the local economy is often very significant. However, there is a limited pot of money that must be spent in prudent ways to maximize benefits to the citizens.

In addition, new elements are being added to the mix. The recreation user has little knowledge of water management but they are demanding the park system provide stable water levels and good water quality. Innovative approaches such as water leasing programs and exchanges as well as methods for improving quality are now part of the formula for working together and will be in the future.

NOTES:

¹ Northern Region Manager, Colorado State Parks, 3745 East Prospect Road, Fort Collins, CO 80525, (970) 491-0954

FISHABLE, SWIMMABLE, AND IRRIGATABLE:
A RECREATION QUANTITY
ISSUES PANEL

Jay Skinner¹, Moderator

Biographical sketch not available.

NOTES:

¹ Colorado Division of Wildlife, 6060 North Broadway, Denver, CO 80216, (303) 291-7260

THE ROLE OF PRIVATE RECREATION RELATED TO WATER AND OTHER CONSERVATION ISSUES

Rick Sandquist¹

Habitat for ducks, geese, and other water-dependent species has been the catalyst for significant riparian and wetland restoration and protection projects.

Water Augmentation History

Prior to 1970, few impoundments and watercourses existed, except for major reservoirs and the River proper, to maintain needed stopover resting habitat for migrating waterfowl. The mid 1970's brought the first private water rights applications for augmentation ponds and recharge projects. Once proven to be viable, the 1980's saw dramatic increases in these types of applications with lower costs, accepted and centralized accountability, and fewer opponents. In the 1990's the trend continued, but with higher emphasis on water quality issues. The late 90's brought concerns over multi-state agreements and endangered species concerns.

State of the Art Today

The benefits of, and partners for, developing and protecting wetland and riparian areas today have never been greater. Ducks Unlimited, Partners for Wildlife, The Wetland Initiative, Centennial Land Trust, Colorado Division of Wildlife, and several other government and non-governmental organizations are helping to develop, maintain, restore, and protect wetland habitats on private and public lands.

Benefits

Most of these projects, whether developed for augmentation or not, benefit the River by providing return flows of higher quality than the inflows to the projects. More and more well depletions are being offset with individual projects, and Irrigation company augmentation plans are getting closer to being made whole. Landowners see economic benefits from maintained static water levels in their wells, increased return from crops in the form of hunting lease fees, and increased property values due to recreation potentials. More stable seasonal river flows, availability of emergency release sites, and riverbank stabilization are also benefits.

NOTES:

¹ Owner/Operator, Wildland Management Services, PO Box 23, Orchard, CO 80649, (970) 481-6129

NUTRIENTS IN AGRICULTURAL AND RECREATIONAL RESERVOIRS

Lori Sprague¹

In 1995, the U.S. Geological Survey conducted a study to characterize nutrient concentrations in five off-stream reservoirs – Riverside, Jackson, Prewitt, North Sterling, and Jumbo – during the irrigation season from March through September. These reservoirs are critical sources of irrigation water for agricultural areas in the lower South Platte River Basin, and several also are used for fishing, boating, swimming, hunting, and camping. One threat to the recreational value of the reservoirs is an overabundance of nutrients such as nitrogen and phosphorus. Nutrients are necessary for plant and animal life, but in excess quantities they become a health concern to humans and aquatic animals and can cause algal blooms that deprive deeper waters of the sunlight and oxygen needed by aquatic plants and animals.

Nitrogen concentrations in the reservoirs were highest in March and decreased through September as a result of dilution from river inflows and biological activity. From March through June, decreases in nitrogen concentrations in the river contributed to corresponding decreases in reservoir concentrations. From July through September, inflows from the river were cut off, and biological activity in the reservoirs led to further decreases in nitrate concentrations, which fell to near or below detectable levels. The timing of minimum nitrate levels in each reservoir was related to the timing of river inflows and the depth of the reservoir. With the reservoirs acting as a sink for nitrogen, concentrations of total nitrogen in the outflow irrigation-supply water decreased over the study period.

Phosphorus concentrations in the reservoirs did not show the same consistent decrease from March through September. With the exception of Riverside, which was in closest proximity to wastewater dischargers, concentrations of biologically available orthophosphate were decreased to near or below detectable levels by July. Phosphorus was recycled back to algae, however, through processes such as excretion from fish, decay of aquatic plants and animals, and release of orthophosphate from bottom sediments during periods of low oxygen. Due to these fluctuations, concentrations of total phosphorus in the outflow irrigation-supply water did not consistently decrease over the study period.

The results of this study indicate that the practice of storing South Platte River water in off-stream reservoirs decreases nitrogen concentrations. However, storage may also contribute to the growth of nuisance algae that could affect the recreational use of these reservoirs.

¹ Hydrologist, U.S. Geological Survey, P.O. Box 25046, MS 415, Denver Federal Center, Lakewood, CO 80225, (303) 236-4882, ext. 262

EFFECTS OF OFF-CHANNEL WATER STORAGE ON WATER QUALITY AND RECREATIONAL OPPORTUNITIES

Dr. John D. Stednick¹

Recent years have seen increasing competition between urban/industrial areas and irrigated agriculture for the limited water resources of the western United States. One attempt to ease this tension in Colorado has been through the utilization of agricultural water decrees for urban purposes through augmentation, transfer and exchange agreements. A key requirement of these arrangements under Colorado water law is that water returned to the stream must be of "acceptable quality" compared with historical use. However, there is a growing concern among agricultural water users regarding the interpretation of what is "acceptable quality." At times, the South Platte River, which supplies the most productive agricultural region of Colorado, consists largely of secondary treated sewage effluent from the Denver metropolitan region. The mixing of first use water with wastewater treatment plant effluent results in variable water quality. The effects of variable water quality from wastewater mixing and urban runoff, on crop quality are unknown. The influence of variable nitrogen and phosphorus loads makes crop selection difficult and crop production variable. This presentation will focus on water quality changes from off-channel storage especially in Barr Lake, but includes results from other downstream reservoirs.

Barr Lake State Park is a popular recreation site with fishing, birding, biking, boating, and related environmental education programs. Barr Lake receives relatively high nutrient concentrations and nutrient loads from the Burlington Canal diversion on the South Platte River. The lake water has a relatively short residence time (inflow/storage), but is able to develop reducing conditions (low dissolved oxygen) in the deeper water, helping reduce nutrient concentrations. Both nitrogen and phosphorus concentrations show pronounced seasonal variations. In summer months, Barr Lake is nitrogen-limited, but nitrogen-fixing algae quickly dominate the lake and may represent a detriment to recreational opportunities.

Off-channel storage may represent an effective means of nutrient removal, especially for nitrogen, and to a lesser extent phosphorus. Salinity as measured by the sodium adsorption ratio also suggests that off-channel storage may provide better water quality than run-of-the-river water.

¹ Professor and Program Leader, Watershed Science, Colorado State University, Fort Collins, CO
80523-1482, (970) 491-7248

POSTER SESSION

ASSESSING REGIONAL CHANGE AND VULNERABILITY

**William Riebsame Travis, James Huff, Rutherford Platt,
David Theobald, and Thomas Dickinson¹**

This poster lays out our efforts to "take the pulse" of the South Platte River basin, the first case study in the Western Water Assessment. Applying the template now well developed in global change research, we first assess regional trends in population, economic development, and land use, while developing hypotheses about regional vulnerability to climate fluctuations. We illustrate these baseline trends in this poster. Given our interest in shorter-term climate variability, though, we add an effort to assess sensitivity to improved climate forecasts, which is often neglected in global warming studies.

The South Platte includes both urban and rural areas, though urban growth, fueled by a robust post-industrial economy, is the main development trend. To examine whether this makes the region more or less vulnerable to climate impacts, we first posit definitions of vulnerability, resiliency, absorptive capacity, and risk, and apply them to different sectors and at different scales for the study area. For example, urban water systems appear to have large absorptive capacity, because they have been planned using risk-averse principles. In short, urban systems are designed never to fail (they are robust). Because urban water often comes originally from agricultural supplies, net regional urbanization may make agriculture more vulnerable. However, many agricultural systems may be more flexible and resilient, that is, better able to recover from "failure." Indeed, we believe this tendency is heightened in an urbanizing area like the South Platte as agricultural water is sold to cities but leased back to farmers on an interruptible basis. Farming systems that cannot cope with supply interruptions, like orchards, either disappear or hold on to reliable supplies. Initially, it makes sense to suggest that robust systems are relatively insensitive to climate forecasts, yet our initial look at one urban system indicates that some of their robustness comes from flexibility—the existence of multiple sources, storage, and options in a seasonally-adaptable management plan. In this way, urban systems begin to demand more and improved climate information, and develop the potential for applying climate forecasts of a certain resolution and reliability.

¹ University of Colorado, Boulder, CO 80309

CLIMATE IMPACTS ON WATER SUPPLY AND DEMAND ZONES IN THE SOUTH PLATTE

**Klaus Wolter, Marty Hoerling, Masha Medovaya, Craig Anderson, Jon Eischeid,
Connie Woodhouse, Gary Bates, and Martyn Clark¹**

For almost a half century, the Northern Colorado Water Conservancy District (NCWCD) has diverted runoff from the western slope of the Front Range to agricultural and municipal water users on the eastern plains of Colorado. Among other factors, the annual demand for such water is driven by the regional rainfall anomalies over eastern Colorado during the growing season. Although the NCWCD reservoirs are large enough to buffer against shortfalls of individual years, the amount of vulnerability of this regional trade between west slope water supplies and east slope water demands against the vagaries of climate is unknown.

Therefore, we analyzed the precipitation co-variability on seasonal time scales over the area managed by the NCWCD. Long-term climate records in mountain valleys and eastern plains location are compared against two decades of automated SNOTEL records in the higher elevations of the Front Range. Seasonally varying associations between west slope and east slope precipitation anomalies are diagnosed and related to runoff data. A sizable fraction of this variability is related to ENSO, with a seasonally dependent sign of this association. Nevertheless, the ENSO-precipitation links present the opportunity to assess the potential predictability of water supplies and demands in the NCWCD domain.

Another major concern for water management in the NCWCD is the occurrence of drought on multi-annual time scales, for which existing infrastructure would be unable to provide the necessary supply buffer. We evaluate the historical risk of long-term drought on both sides of the Continental Divide, and for this purpose are exploiting paleo-climatic reconstructions of annual streamflow in the South Platte Basin that extend back into the 18th century.

¹ NOAA-CIRES Climate Diagnostics Center, Boulder, CO 80303

COLORADO'S STREAM AND LAKE PROTECTION PROGRAM – PRESERVING THE WATER-DEPENDENT NATURAL ENVIRONMENT

Dan Merriman and Anne Janicki¹

New water right appropriations and water right acquisitions are tools that the Colorado Water Conservation Board can utilize to ensure protection of instream flows and natural lakes within the existing water right framework.

In 1973, the Colorado legislature recognized the need to “correlate the activities of mankind with some reasonable preservation of the natural environment” and vested the Colorado Water Conservation Board with the exclusive authority to appropriate or acquire water for instream flows. The Board accomplishes this mission in two ways: 1) through new appropriations for instream flow or natural lake water rights, and 2) by the acquisition of senior water rights from donors or lessors.

Each year, the Board requests recommendations from state and federal agencies for streams and lakes to be considered for new appropriations. The Board works with these agencies or other interested parties to plan and coordinate data collection, develop flow recommendations and appropriate the water rights. Once decreed by the water court, these new water rights are monitored and protected by the Water Conservation Board staff. To date, the Board has filed for water rights on 1,422 stream segments, covering 8,446 stream miles and 475 natural lakes.

The Board may also acquire senior priority water rights through a variety of contractual and legal mechanisms to preserve the natural environment. The Board is prohibited from acquiring water by eminent domain, therefore, water right acquisitions are typically initiated by water users and water right owners. To date, all of the Board's acquisitions have been through donations or leases of water rights. Each transaction is governed by an Acquisition Agreement that outlines the responsibilities and obligations of each party. Typical agreements include terms related to monitoring and enforcement of the rights, reversions for drought and emergency conditions, and responsibilities in any water court proceedings. The acquisition of senior rights allows the Board to protect the natural environment on streams where water may not be available for a new junior priority water right. In addition, the Board may rely on the acquired senior rights to supplement existing junior instream flow water rights. By working with conservation groups, private parties, government agencies, and municipalities, the Board has acquired over 390 c.f.s and 3, 652 acre-feet of senior rights on streams and lakes throughout the state.

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THE COMMUNITY COLLABORATIVE RAIN AND HAIL STUDY

Nolan J. Doesken¹

The Colorado Climate Center has long recognized that important variations in precipitation affecting the South Platte River Basin and other areas of Colorado are not adequately measured by traditional hydrologic observing systems. Beginning in 1998 and motivated by the devastating but highly localized Fort Collins flash flood of July 1997, a special educational project involving students, teachers, and other citizens of all ages was initiated to help show just how variable precipitation can be in Colorado. By the summer of 2001 this network had grown to several hundred active volunteers in northern and eastern Colorado using simple but effective instruments for measuring rain and hail.

Rainfall patterns from a variety of storms will be presented that show the highly localized nature of summer convective precipitation. Winter precipitation is also highly variable even on the scale of a few miles. The most highly variable precipitation element is hail. Despite the well-deserved reputation that Colorado has for extreme, damaging hail, the results so far indicate that the majority of Colorado hailstorms produce small stones that do not cause damage.

Several benefits are being derived from CoCo RaHS including local scale data for hydrologic studies, documentation of local rain, snow and hail patterns for land use planning, and improved relationships between precipitation and subsequent plant growth, water requirements and productivity. Special benefits from CoCo RaHS are the educational opportunities it is providing teachers and young students (pre-high school). Many of the participants are kids getting their first taste of the important role of basic data collection for research and discovery.

Opportunities for water resources organizations in the South Platte River Basin to participate in this project are numerous. More volunteers and more sponsors are needed to help the project and achieve maximum results.

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DENDROHYDROLOGIC RECONSTRUCTIONS: APPLICATIONS TO WATER RESOURCE MANAGEMENT

Connie Woodhouse and David Meko¹

Water resource planning is primarily based on 20th century instrumental records of climate and streamflow. Unfortunately, even the longest gage records capture only a limited portion of the range of natural hydrologic variability that is possible. Tree-ring reconstructions of streamflow (i.e. dendrohydrologic reconstructions) have proven to be useful for augmenting existing instrumental streamflow records. These proxy records of streamflow have provided an expanded temporal context from which to evaluate the 20th century instrumental record and have provided scenarios for events such as severe sustained drought impacting the Colorado River basin. Tree-ring reconstructions of hydrologic variability may provide more than an extended record of seasonal or annual variability. In this study, we are working with the City of Westminster (Colorado) water planners to tailor reconstructions and information from reconstruction to better meet water resource planning and management needs. Dendrochronological techniques have yielded a high quality reconstruction of total annual flow for Clear Creek, the sole source of water for Westminster. However, planners' needs would be better met with other products. Our efforts have been concentrated on methods to generate more accurate reconstructions of low flow and probability estimates for flow values for specified thresholds. Ultimately, we hope to provide estimates that are suitable as input for hydrologic forecasting models.

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DISTRIBUTIONAL CHANGES OF MAYFLIES, STONEFLIES, AND CADDISFLIES ALONG THE URBAN CORRIDOR OF THE SOUTH PLATTE RIVER BASIN, COLORADO

Boris C. Kondratieff¹ and Robert E. Zuellig²

The Colorado Front Range is currently being subjected to extreme urban growth. The United States Census Bureau (2000) indicated that Colorado has grown 30% over the last decade of which most occurred along the Front Range. This combined with past land use practices has altered the natural condition of regional streams. Returning these streams to their pre-European settlement condition is no longer an option due to the current demand for water and current land use.

Little historical information exists about the ecology of regional streams before the establishment of irrigated agriculture that began in the 1860's and was well established by 1900. Few collections of aquatic insects were made in the South Platte River Basin prior to 1900. Urban centers have been built along most regional streams and rivers at or near the plains mountain interface. These transitional zone streams are extremely important to aquatic community diversity in Colorado. Many would argue that these streams and their plains tributaries were more diverse before human induced alterations occurred.

As an example, transition zone streams are the only area in Colorado where many fish species exist in the state of which all are listed as state threatened, endangered, or of special concern. Other fish species whose habitat was also transitional zone streams have been extirpated from the state or have had range reductions.

Aquatic insect information is less known but it is expected that aquatic insect species diversity has also decreased in these transitional zone streams. A recent example is the apparent disappearance of stoneflies and other aquatic insects from the small streams of Boulder and Fort Collins investigated during 1999-2000. Previous studies report a species of caddisfly *Arctopsyche grandis*, the stonefly *Claassenia sabulosa* and the mayfly *Ephemerella* sp. from local Fort Collins streams as recently as 1995. These aquatic insects have apparently disappeared from small urban streams of this region. Additionally, the winter stonefly, *Mesocapnia frisoni*, is only known in the South Platte Basin from the transitional zone areas of the Little Thompson River near Berthoud, Colorado, again emphasizing the importance of transitional zone streams.

Contemporary data from the 90's indicate that during years having high snowmelt events common mountainous forms of invertebrates occurred several kilometers from the plains mountain interface than in those years having lower snowmelt flows. However, these species never become established which is probably due to altered flow regimes and the numerous filters that prevent drift and other dispersal mechanisms from occurring during low water years.

These filters include diversion structures, dams, channelization projects, wastewater treatment plants, and industrial effluent. Additional filters that may prevent the establishment of certain aquatic insect species include stormwater effluent, sedimentation, and irrigation return flows. These filters occur extensively throughout the South Platte Basin. We hypothesize that under historical flow conditions mountainous forms were probably established well out onto the plains during years of high flow conditions. The greatest diversity of this basin occurs in the mountainous / foothills portion with some

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specific transitional zone species. Therefore, diversity of invertebrates along the plains mountain interface is probably associated with the success of colonization events that occur from upper reaches of the basin during high snowmelt events.

EVALUATION OF FIELD MEASUREMENTS OF DISCHARGE FROM IRRIGATION WELLS IN SOUTHEASTERN COLORADO

Russell G. Dash⁴

Discharge measurements are used to estimate ground-water withdrawals; however, field certainty in the flow rate measured at the site is seldom known. Portable flowmeters may provide ease of data collection, but do they provide equivalent data to permanent inline flowmeters?

The U.S. Geological Survey, in cooperation with the Colorado Division of Water Resources, began a study in 1997 to directly compare instantaneous ground-water discharge measured using portable flowmeters to discharge measured using inline totalizing flowmeters (TFM's).

This poster graphically compares field methods for measuring ground-water discharge at irrigation wells located in the shallow alluvial aquifer of the Arkansas River Valley in Colorado and describes techniques to reduce common measurement errors made during data collection. Statistical comparisons are made for hundreds of paired discharge measurements that were collected using the TFM and portable flowmeters.

New TFM's were installed at 93 wells during 1997 and 1998 to directly measure ground-water withdrawals. The TFM's were factory-calibrated to record pumpage with an assumed maximum error of +/- 2 percent. Instantaneous discharge measurements were repeated at TFM sites using commercially available portable flowmeters, including propeller-type meters, transit-time meters, and manometers. The collection of multiple discharge measurements during each site visit allowed verification of discharge data in the field and enabled the field technicians to identify possible causes of unexpected results.

Comparison of discharge measurements made during 1997-98 indicated portable flowmeters and inline TFM's could provide equivalent data with different types of meters and irrigation systems. Side-by-side boxplots show the median (center) and spreads of data around the median are similar for each comparison. Statistical analyses of 643 paired measurements indicate a mean difference of less than 2 percent of flow.

Although this study was conducted in Southeastern Colorado, these field methods may be applicable for measuring ground-water discharge at irrigation wells located in the shallow alluvial aquifer of the South Platte River Valley.

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HYDROLOGIC IMPACTS OF OUT-OF-PRIORITY GROUNDWATER DIVERSIONS IN THE SOUTH PLATTE RIVER BASIN

Charles F. Leaf¹

Statistical analyses of the South Platte River water yields have shown that on an annual yield basis, river depletions from out-of-priority groundwater diversions upstream from Julesburg have been compensated for by returns from transbasin diversions and increased runoff from urbanization along the Front Range. Nevertheless, it has been argued that unaugmented out-of-priority well depletions during the growing season (April 1 – Sept. 30): (a) cause injury to senior surface water rights and (b) contribute to Compact shortfalls at the state line between Colorado and Nebraska. One solution proposed to solve this problem is the curtailment of groundwater diversions during drought years. This study shows that a curtailment of groundwater diversions by as much as 235,000 af during a given drought year would reduce April 1 – Sept. 30 river depletions from unaugmented out-of-priority wells by only 16,200 af. A massive shutdown of wells would not ease Compact shortfalls at Julesburg. Moreover, the potential benefits to senior surface water diverters is just 6.9 percent of the quantity of water that would be denied to well irrigation in the Lower Basin.

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IMPLICATIONS OF CLIMATE VARIABILITY FOR LOW FLOWS AND DILUTION OF DISCHARGES FROM POINT SOURCES

James F. Saunders, III and William M. Lewis, Jr.¹

The National Pollution Discharge Elimination System (NPDES) was created through the Clean Water Act as a mechanism for regulating the release of toxic substances to streams in the U.S. The concentration of each toxic substance in a wastewater discharge is governed by an NPDES permit, which is intended for the protection of designated uses such as maintenance of aquatic life. The allowable concentration limit in the effluent is usually determined with a steady-state model using mass balance calculations, one element of which is the dilution flow available in the receiving water. Dilution flow is defined by analysis of historical data using a specific set of critical, low-flow conditions. The use of historical data implies that the past is a good indicator of future conditions, at least for the duration of a discharge permit. In most cases, the hydrologic record that can be used for the analysis extends no more than a decade or two, depending on the availability of gage records and recent alterations to the flow regime (e.g., dams, diversions, etc.). Short records introduce great uncertainty in the estimation of low flows because they are unlikely to capture events with periodicities of multiple years. For example, ENSO events, which have a frequency of 4-6 years, would be poorly represented by hydrological records that did not extend several decades. Major droughts are even less frequent.

We conducted an analysis of daily flows at several gages with long records in the South Platte basin of Colorado. Low flows were calculated for successive 10-y blocks of data, and these were compared with low flows calculated for the entire period of record (>70 years). Historical variability of stream flows is great enough that it raises concerns about the extent to which low flows derived from a 10-y record will be protective of water quality. In unregulated streams, there was no trend over time, but the low flows for a single 10-y block could differ from the long term value by as much as a factor of 2. Low flows taken from a 10-y block selected at random would be protective of aquatic life in fewer than half of the years for the full period of record. The hydrographs of most streams in Colorado have been influenced by dams, diversions, or water transfers. These alterations to the natural flow regime shorten the record available for analysis and generally result in a trend of increasing low flows that is visible when successive 10-y blocks of data are analyzed. Use of a shorter record decreases the chance that significant climate variation will be reflected in the low flows. The presence of a trend based on present patterns of water use may carry an unanticipated risk by failing to incorporate societal response to severe drought conditions, for example. There is a clear need for a mechanism that will incorporate the effects of climate variation in the determination of low flows for NPDES permits.

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INSTITUTIONAL FACTORS AFFECTING ENVIRONMENTAL MANAGEMENT IN THE SOUTH PLATTE RIVER BASIN

Berton Lee Lamb and M. Dawn King¹

What are the obstacles and opportunities for environmental management presented by existing institutional arrangements in the South Platte River basin? We cataloged agencies with overlapping, congruent, or interacting jurisdictions related to management of air and water in the South Platte watershed. From this catalog we report the number, types, and variety of governmental organizations that play a role in collaboratively addressing air and water quality, water availability, and land use patterns. We examine the mandates of these agencies using two decision models and suggest the obstacles and opportunities for collaborative management. We present ideas on how those factors are connected to issues like declines in biodiversity, human quality of life, and other environmental indicators.

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NITROGEN PHOSPHOROUS RATIOS IN SOUTH PLATTE BASIN RESERVOIRS: A RECIPE FOR EUTROPHICATION AND BLUE-GREEN ALGAE?

Emile Hall¹

Barr Lake, Milton Reservoir, Riverside Reservoir, Jackson Reservoir, Prewitt Reservoir, North Sterling Reservoir, and Jumbo Lake in the South Platte Basin are all classified as eutrophic or hypereutrophic, based upon total nitrogen and total phosphorous concentrations. Secchi disk depth and algal biomass also indicate eutrophic conditions in some of the reservoirs. Eutrophic conditions lead to low carbon dioxide and high pH conditions that favor blue-green algae growth. Low nitrate concentrations, as well as other alterations stimulated by eutrophic conditions, provide an environment conducive to blue-green dominance. Blue-green blooms in several reservoirs along the South Platte River were observed this year.

In aquatic ecosystems, phosphorous is typically the nutrient in shortest supply relative to other nutrients, or limiting nutrient. Nitrogen and phosphorous concentrations in seven reservoirs filled with South Platte River water show that in early summer the nitrate and nitrite concentrations comprise a significant portion of the total nitrogen, but by the end of the summer nitrate and nitrite are below detection limit in all of the reservoirs. The total nitrogen:total phosphorous (TN:TP) ratio provides a general measure of nutrient limitation. In general, $TN:TP < 7.2$ indicates that nitrogen is limiting while $TN:TP > 7.2$ indicates that phosphorous is limiting. Over the summer season the TN:TP ratio decreases in each of the reservoirs and at some points in late summer indicates that nitrogen is the limiting nutrient.

Although nitrogen may be limiting in the water, a source of nitrogen is readily available in the atmosphere for any species capable of converting it to a usable form. Certain blue green algae are capable of fixing free nitrogen from the atmosphere. This ability may give them a competitive advantage in situations where other forms of nitrogen are in short supply, as in late season reservoirs of the South Platte Basin. Blue-green algae dominate in late summer and as eutrophication increases. This can lead to nuisance blooms that produce toxins, which are harmful to other aquatic species and humans.

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