COLORADO WATER

Newsletter of the Water Center at Colorado State University

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James Pritchett, CSU Ag and Resource Economist, drives home a point about the economics of irrigation at the Colorado Water Congress. (See article on page 4.)

Special Issue: Water Transfers

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Table of Contents . . .

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Colorado Water Resources Research Institute
Colorado State University, Fort Collins, CO 80523
Phone 970/491-6308 **FAX: 970/491-1636**
E-mail: CWRRI@ColoState.EDU

INTERNET SITES

Colorado Water Resources Research Institute: **http://cwrri.colostate.edu**
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EDITORIAL

Water Transfers

by Robert C. Ward, Director, CWRRI

The Colorado Statewide Water Supply Initiative (SWSI), an assessment of Colorado's projected water demand and supply conditions, was completed in November 2004. The study, guided by the Colorado Water Conservation Board (CWCB), did not address specific projects to meet the anticipated new demand of 630,000 acre feet, other than those already underway by local water management organizations. The final report and Executive Summary can be viewed at http://cwcb.state.co.us/SWSI/Table_of_Contents.htm

The theme of the 2005 Annual Convention of the Colorado Water Congress, held January 27-28, 2005, tackled one of the more contentious options Colorado has for potentially meeting future water needs – water transfers, from West Slope to East Slope and from agriculture to municipal uses.

Water transfers, as a focus area of CWRRI sponsored research, has been examined from several different perspectives over the years. For example, in 1993 Teresa Rice and Larry MacDonnell, published CWRRI Completion Report 177 entitled *Agricultural to Urban Water Transfers in Colorado: An Assessment of the Issues and Options* (all reports can be viewed from URL http://cwrri.colostate.edu/pubs/series/completionreport/crlist.htm). The economic impacts on Crowley County, due to water transfers, were evaluated in the 1993 CWRRI Completion Report 171 entitled: *Some Economic Impacts of a Rural-to-Urban Water Transfer: A Case Study of Crowley County, Colorado*, by R.G. Taylor, R.A. Young and J.R. McKean.

In 1985, Larry MacDonnell, Chuck Howe, James Corbridge and Ashley Ahrens published CWRRI Completion Report 139 entitled *Guidelines for Developing Area-of-Origin Compensation*. Bob Young looked more generally at the economics of transferring water from agriculture to other uses in the 1983 CWRRI Completion Report 122, entitled *Economic Impacts of Transferring Water from Agriculture to Alternative Uses in Colorado*.

As early as 1976, Ray Anderson, Norm Wengert, and Bob Heil published CWRRI Completion Report 75 entitled *Physical and Economic Effects on the Local Agricultural Economy of Water Transfers to Cities*. In addition, CWRRI reports have addressed such water transfer related topics as estimating the recreation and economic values of instream flows (Completion Reports 101 and 91, respectively); recreation potential of high mountain reservoirs (Completion Report Number 62); and water system planning with a special focus on water reuse (CWRRI Completion Report 90).

Beyond the currently existing reports cited above, CWRRI organized two sessions at the Colorado Water Congress Annual Meeting addressing agronomic and economic aspects of water transfers. The four presentations made at the CWC meeting are included in this issue of *Colorado Water*.

Dan Smith and Gary Peterson, both with the Soil and Crop Sciences Department at CSU, discuss the options irrigators have to reduce irrigated water use while continuing to produce crops, whether with limited irrigation, dryland cropping, or alternating crops. James Pritchett and Eric Schuck, both with the Agricultural and Resource Economics Department at CSU, describe the economic impact on irrigators when reduced water availability forces reductions in crop production. James discussed potential economic impacts of reduced well pumping precipitated by the Republican River Compact Settlement, while Eric discussed the response of irrigators to the drought of 2002 when farmers, on average, had a greatly reduced water supply.

The above described reports, studies and presentations represent a small part of the expertise that higher education can bring to a dialogue on water transfers. CWRRI welcomes the opportunity to assist in interfacing higher education's water expertise with the research and education needs of Colorado's water managers and users as they address the difficult issues surrounding water transfers.

On another, but related, subject, I want to take this opportunity to thank the speakers who shared their experiences with faculty and students during CSU's 2004 fall semester Water Resources Seminar. The seminar examined past and current water resources planning efforts in Colorado and the U.S. Thanks go to:

Neil Grigg, Civil Engineering Department, CSU
Eric Wilkinson, General Manager, Northern Colorado Water Conservancy District
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Brian Person, Area Manager, Eastern Colorado Area Office, Bureau of Reclamation
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Leo Eisel, Managing Engineer, Brown and Caldwell
Rick Brown, Scientist, Water Supply Protection, Colorado Water Conservation Board

Economic Impacts of Reduced Irrigated Acres: Example from the Republican River Basin

James Pritchett, Assistant Professor
Phil Watson, Graduate Research Assistant
Jenny Thorvaldson, Graduate Research Assistant
and Lindsey Ellingson, Graduate Research Assistant
Department of Agricultural and Resource Economics, Colorado State University

Colorado's water is an important natural resource that contributes to the state's economic, cultural and social well-being. However, this resource is of a limited supply with many competing uses. Early in Colorado's history, water resources were very important to the mining industry, and later agriculture became a primary user. Currently, water is being transferred from irrigated agriculture in order to support Colorado's municipal and industrial use. These rural to urban water transfers create contentious, emotionally charged discussions that often center on the health of rural economies whose irrigated agricultural base is reduced with each transfer.

In the next twenty-five years, Colorado's population is expected to exceed 7 million people and an additional 632,000 acre-feet of water will be needed in cities to support their growth. Agriculture is the primary user of water supplies; consequently, an estimated 300,000 irrigated agricultural acres will "dry up" as water transfers occur (CWCB). Similarly, groundwater irrigation will be reduced as new augmentation rules take effect, as Colorado meets its interstate compact obligations, and as the Ogallala aquifer continues its "planned depletion."

Colorado's crop production has thrived with its water resources and, in turn, crop production has supported commercial livestock, meat packing and dairy industries. Each of these primary agricultural industries has encouraged economic development directly, through the purchase of inputs, and indirectly, through the wages and salaries of employees. Without other viable local base industries to generate revenues and provide employment, a reduction in the revenue generated in the agricultural sector will have adverse economic impacts throughout the regional economy.

The purpose of this article is to examine the regional economic impacts of reduced irrigation through the use of a specific example, Colorado's Republican River Basin. In the section that follows, the Republican River's specifics are discussed, and an economic baseline established for the Basin. This description is followed by a hypothetical impact analysis that demonstrates regional economic contribution of irrigated agriculture. The example quantifies the loss of economic activity when 20,000 acres are retired from irrigated agriculture via a voluntary conservation program, a hypothetical scenario that does not reflect the discussion or action of the Republican River Conservation Board.

Republican River Basin

The Republican River originates in eastern Colorado flowing through Kansas and Nebraska so that approximately 24,000 square miles are encompassed in the Republican River

Table 1. Seven county economic demographics*

Industry	*Value of Sales (million $)*	*Percent of Total*
Total	$3,552.00	100.00%
Notable Contributors		
Cattle Feedlots	$629.95	17.74%
Crops	$493.00	13.88%
Natural Gas & Crude	$165.47	4.66%
Banking	$130.54	3.68%
Hogs, Pigs, Swine	$124.04	3.49%
State and Local Government - Education	$122.46	3.45%
Wholesale Trade	$117.81	3.32%
Transportation (Trucking, Warehouse, Rail)	$109.21	3.07%
Ranch Fed Cattle	$97.61	2.75%
[a]From Year 2000 data except Crops Industry, which is the average value of dryland and irrigated crop sales for 1996-2000.		

Basin (7,700 in Colorado). An interstate compact allocates the Republican River's surface waters between Colorado, Nebraska and Kansas. In May 1998, Kansas filed a complaint against Nebraska claiming injury from the overuse of ground water in the Republican River Basin. Nebraska counter sued Kansas, naming Colorado as a formal party in November 2000.

A U.S. Supreme Court Master ruled in 2001 that the compact should include ground water use "to the extent it depletes the Republican River streamflows." In effect, the Special Master ruling altered the compact's accounting stance so that groundwater depletions are now included. In 2003, Colorado exceeded its compact allocation by several thousand acre feet; consequently agriculture's consumptive use of Republican River water must be reduced.

The Republican River Conservation Board (RRCB) is charged with meeting Colorado's Republican River compact obligations. While no decisions have been made, the Board is weighing compliance alternatives. The following study considers the economic impacts of removing 20,000 acres from irrigated production as a way of achieving conservation compliance. This scenario is hypothetical and does not reflect the Board's current discussion.

The counties in the Republican River Basin are heavily dependant on agriculture for their economic base. Because there are few economic alternatives to agriculture in the region, the reduction in irrigated cropland has implications not only for the agricultural sector, but also for the larger economy of the counties in the basin as well. Table 1 lists the major industrial sectors of the Republican River Basin, and it is noted that agricultural industries comprise more than 30% of the region's $3.55 billion dollar gross domestic product.

If 20,000 irrigated acres are removed from the Republican River's economic activity, impacts will ripple through the local economy. An input-output model is one way to capture these ripples. Reducing sales has three effects in the model:

Direct Effects: the actual reduction in sales.
Indirect Effects: the derived demand used to support crop sales.
Induced Effects: local spending by input suppliers.

An input-output model was developed using IMPLAN software for the Republican River Basin, and 20,000 acres of crop sales were removed from the region's economic activity. The economic effects are listed by sector in Table 2.

As indicated in Table 2, the crops sector loses $8 million in gross sales with the voluntary program. The revenues generated from the sales of crops outside the region support a number of related input industries (e.g., fertilizer, agricultural chemical, transportation). If sales are reduced by $8 million, the derived demand for these inputs will decrease by $2.1 million dollars, with the wholesale trade, real estate services and transportation and warehousing sectors absorbing the greatest share of reductions. Likewise, the wages spent on employees of the crops and related industries generate economic activity, and the reduction in this economic activity totals $686,017. In sum, effects total nearly $10.8 million per year.

The analysis in this article illustrates the potential economic impacts of reducing Colorado's irrigated cropland base, but

Table 2. Impact analysis of a 20,000 ac. reduction in the Republican River basin's cropland

Industry	*Direct*	*Indirect*	*Induced*	***Total***
Total Effect	**$8,000,000**	**$2,112,241**	**$686,017**	**$10,798,258**
Notable Impacts				
Crops	$8,000,000	$93,203	$2,814	$8,096,017
Wholesale Trade		$446,859	$26,952	$473,811
Real Estate		$293,288	$23,713	$317,001
Transportation and Warehousng		$213,894	$11,220	$225,114
Ag Services		$150,333	$231	$150,564
Nat. Gas & Crude Petroleum		$114,675	$8,833	$123,508
Banking		$71,033	$45,638	$116,671
Farm Machinery		$81,950	$251	$82,201
Maintenance and Repair		$76,120	$3,975	$80,095
Electric Services		$44,334	$26,531	$70,865
Miscellaneous Repair Shops		$65,048	$1,200	$66,248
Gas Production and Distribution		$54,036	$11,670	$65,706

regional differences will exist so a more accurate portrayal of economic effects requires analysis specific to the locale. Indeed, regions with a broader, more diverse economic base are likely to suffer reduced impacts versus areas relying more exclusively on irrigated agriculture for economic activity.

The scenario in this article is a hypothetical example of impact analysis, and it should be noted that this type of analysis has limitations. In particular, the analysis does not consider the potential erosion of local government's tax base as lands are converted from higher assessed values (irrigated land) to lower assessed values (dryland or rangeland). In addition, the analysis will not capture the dynamic adjustments of businesses that pursue new activities in lieu of the business traditionally used to support irrigated cropping. In spite of these limitations, the analysis does provide a basis for policy discussion.

Bibliography

Colorado Water Conservation Board. 2004. Statewide Water Supply Initiative. Available at http://cwcb.state.co.us.

Young's Book on Value of Water Now Available

"*The history of evaluation techniques, the critical review of a vast literature, and the author's recommendations for valuing water in various uses and situations are significant contributions." -- Ken Frederick, former Senior fellow, Resources for the Future.*

"This book will certainly be a valuable scholarly and policy contribution. It should attract a wide readership, and would be well suited for university classroom use. Its most notable accomplishment is its ambitious coverage of the many contexts in which water investments and policies need to be evaluated. – Bonnie G. Colby, University of Arizona

"every economist working in water resources would want a copy of this book as a reference. Young has done the best job I have every seen of outlining the particular conceptual problems of valuing water resources. He makes it clear that water is both undervalued and overvalued in different uses and that, as a consequence, the resource is misallocated. – Mark Smith, Colorado College.

Determining the Economic Value of Water: Concepts and Methods

Robert A. Young
January 2005 / 368 pages/ 6 x 9
Unjacketed cloth, ISBN 1-891853-97-X / $80.00

Paper ISBN 1-891853-98-8 / $39.00
www.rffpress.org

Water provides benefits as a commodity for agriculture, industry, and households – and as a public good for scenic values, waste assimilation, wildlife habitats, and recreational use. However, even as the nature and needs of economies change, water continues to be allocated to other than high –priority uses, water quality continues to decline, environmental uses get inadequate attention, and floods and droughts take an unnecessarily severe toll. One reason for this is that price signals that reflect scarcities of goods and thereby guide investments and resource allocation in the private sector are usually distorted or absent in decision-making relating to water. To aid in cost-benefit analysis under conditions where appropriate price incentives are absent, economists have developed a range of alternative or "nonmarket" methods for measuring economic benefits.

Robert Young aims to provide the most comprehensive exposition to date of the application of nonmarket economic valuation methods to proposed water resources investments and policies. He provides a conceptual framework for valuation of both commodity and public good uses of water, addressing valuation techniques appropriate to measuring public benefits – including water quality improvement, recreation and wildlife habitat enhancement, and flood risk reduction. However, in contrast to the existing environmental valuation literature, the emphasis here is on the commodity uses of water by agriculture, industries, and households. The discussion describes the various measurement methods, illustrates how they are applied in practice, and discusses their strengths, limitations, and appropriate roles.

Robert A. Young is emeritus professor in agricultural and resource economics at Colorado State University.

CWRRI Funds Three Graduate Fellowships for 2005

Editor's note: Due to higher education funding constraints, CWRRI was forced to suspend its annual research competition for 2005. Instead, CWRRI is now supporting Water Fellowships for graduate students studying topics of importance to Colorado water managers and users.

Occurrence and Fate of Organic Wastewater Contaminants in Wastewater Systems and Implications for Water Quality Management
Kathleen DeJong
Colorado School of Mines

In the Colorado Front Range and Rocky Mountain region, residential wastewater management in the suburban fringe and mountain resort settings is commonly achieved by Onsite Wastewater Systems (OWS). These systems, like their municipal counterparts, can and must be designed, installed, operated, and managed to protect human health and environmental quality. In Colorado there are over 600,000 OWS in operation, serving about 25% of the state's population, and 7,000 to 10,000 new systems are installed every year. These systems process over 1000 billion liters of wastewater each year that is then discharged into the environment. There is almost no information regarding the occurrence and fate of Organic Wastewater contaminants (OWCs) in these systems and the potential for adverse impacts of discharge into receiving waters including impacts on ecosystems and human health. Kathleen's study will provide new information on (1) the occurrence and magnitude of pharmaceuticals, consumer products, and other OWCs in onsite wastewater system effluents from different types of sources (e.g., residential, commercial, institutional) and (2) the removal efficiencies that can be expected for commonly occurring OWSs during wastewater effluent percolation through unsaturated soil prior to groundwater or surface water recharge.

Additional funding for this project is provided by Colorado School of Mines.

Colorado's Evolving Irrigated Agriculture: Economic Accounting and Impact Analysis
Jennifer Thorvaldson
Colorado State University

Colorado's irrigated agriculture is evolving as water is transferred from farming to urban uses. In the next twenty-five years, Colorado's population is expected to exceed 7 million people and an additional 632,000 acre-feet of water will be needed in cities to support their needs. An estimated 300,000 irrigated acres will "dry up" as water transfers occur. Similarly, groundwater irrigation will be reduced as new augmentation rules take effect, as Colorado meets its interstate compact obligations, and as the Ogallala aquifer continues its "planned depletion". Colorado's crop production has thrived with its water resources and, in turn, crop production has supported commercial livestock, meat packing and dairy industries. Each of these primary agricultural industries has encouraged economic development directly, through the purchase of inputs, and indirectly, through the wages and salaries of employees. Given the finite nature of water supplies, an important question is how the economic base will change as irrigated agriculture's scope is reduced. Importantly, the impacts may be quite different in Colorado's surface water basins because of the diversity in the basin's economic base and heterogeneous cropping patterns. Jennifer's study will establish the economic demographics for four basins (Arkansas, Republican, Rio Grande, and South Platte) and develop a model representing the economy and economic interactions within each basin with an end goal of analyzing the economic impacts of reducing irrigated agriculture.

Additional funding for this project is provided by the Colorado State University Agricultural Experiment Station.

Hydrologic Analysis and Simulation of the Upper Colorado River System
Julia Keedy
Colorado State University

The severe drought in the western United States in the past few years has reminded us how vulnerable water users in the state are to the variability of water supply. Many rivers of the state, including the Colorado River system, reached record or near record low flows causing widespread shortages and impacts to municipal water supply, agriculture, etc. Current procedures for analyzing the streamflows (e.g. based on the so-called index sequential techniques) rely completely on the observed historical records and may give an optimistic view of future flows, which in turn could lead to unanticipated water shortages. Julia will work to improve the hydrologic data base for the upper Colorado River system so that it includes records at least from 1906 through the current drought to allow a better understanding of the multidecadal flow patterns and better assessment of the long term flow trend of the system.

Additional funding for this project is provided by the Colorado River Water Conservation District.

Lessons Learned from the 2002 Drought

Eric Schuck, Assistant Professor, CSU Agricultural and Resource Economics
W. Marshall Frasier, Associate Professor, CSU Agricultural and Resource Economics
Robert S. Webb, NOAA-CDC Climate Diagnostics Center and Western Water Assessment, Boulder, CO

Colorado experienced arguably the worst drought in living memory in the summer of 2002. At the time of the drought, Colorado State University and National Oceanic and Atmospheric Administration researchers conducted the "Weathering Tough Times" survey of drought responses by Colorado producers (Schuck, Frasier, and Webb, 2003). The survey, which covered all types of agriculture in the state, examined the changes in management brought on by the drought.

To date, researchers have used the survey to examine three major questions stemming from the drought:
1. Did the drought change the rate of farms exiting production?
2. Did the drought affect culling rates by cow/calf ranching operations in the state?
3. How did the drought affect the choice of irrigation systems?
The results of these three projects are summarized here.

Did the drought change the rate of farms exiting production?
One of the questions in the survey asked farmers and ranchers to identify how likely they were to leave agriculture, both with and without the drought. This question, scaled between 0 and 100, provides a subjective measure of how likely farmers were to close their operation. More importantly, by looking at the difference between respondents' answers with and without the drought, it was possible to determine how much extra stress the 2002 drought put on agricultural producers in Colorado.

What showed up from a preliminary examination of this data is that respondents generally fell into either an "affected" or "unaffected" group. That is, around 40% of respondents reported no major change in their likelihood of exit from production due to drought, while the remainder reported significant increases in their likelihood of exit. To account for this, producers were stratified into 3 groups: those experiencing low risks of exit, those experience moderate risk of exit, and those experiencing high risk of exit. Nearly 60% of those surveyed fell into the upper two categories of risk (Schuck and Frasier, 2004).

Drawing on these stratifications, the likelihood of farms ceasing operation was estimated using an ordered probit regression analysis. Econometric results suggest that the type of water used to supply the farm (i.e., ground water versus surface water) was less critical than how much water was available. Unsurprisingly, ranches with higher on-farm water supplies during the drought experienced less stress.

The most interesting point to come out of the research is that while the type of water used to supply the farm did not affect farm survival rates, the available on-farm supply did vary across water source. This was particularly true in the South Platte, where respondents reported that groundwater users had around 36% of their typical supplies but surface water users reported only having about 22% of their typical supplies. This translated into most groundwater users being in the "moderate" risk of exit while most surface water users fell into the "high" risk category.

The end result of all this is that the drought did influence whether or not farms intended to cease production. Reduced on-farm water supplies, particularly when supplies dropped below 30% of normal supplies, caused farms to go from "low" to "high" risk. However, most farms generally went only from "low" to "moderate" risk, so while the drought did affect farms, the results could have been more severe.

Did the drought affect culling rates by cow/calf ranching operations in the state?
Part of the survey also examined how the drought affected the largest sector of Colorado's agricultural economy: livestock. This summarizes the findings of a working paper by Frasier, Schuck and Umberger (2003) exploring the factors increasing the probability that cow/calf producers would cull portions of their herds and how much of the herd would be culled once the decision to cull was made. General findings include that the decision of whether or not to cull tends to be a driven by the physical resources of a ranch – grazing acreage, herd size, and similar characteristics.

However, once the decision was made to cull, the choice of how much to cull generally did not vary much beyond 30-40% of the herd. This suggests that ranchers were generally following standard rules of culling within the industry. Having said that, federal drought assistance programs, and specifically feed credits, did exert a significant effect on culling rates. Participation in the feed assistance typically reduced culling rates by about 15% and put culling rates in the range of expected, non-drought culling rates. This result was both unanticipated and highly welcome, for it suggests that federal drought responses did slow culling rates by livestock producers.

How did the drought affect the choice of irrigation systems?

Adopting more technically efficient irrigation systems can mitigate the effects of drought by allowing irrigators to maintain water consumption with reduced applications. However, changes in irrigation technology are a long-run solution and generally are only used when drought is perceived as chronic rather than periodic. Using data from the "Weathering Tough Times" survey, Ellingson and Schuck (2004) econometrically evaluated the decision to change irrigation systems by Colorado irrigators. The decision to change systems was modeled as a two-part decision: whether or not to change, and if the decision was made to change, what system to choose. The choice of what system to adopt ranged from low technical efficiency systems like flood or furrow irrigation to relatively higher technical efficiency systems like sprinklers or drip.

Model results indicated that irrigators with lower water supplies were generally more likely to consider changing their irrigation systems. However, when it came to what systems were adopted, the only type of system that was influenced by water supply was "intermediate" types such as gated pipe or surge valves. This is in keeping with the short-run nature of the drought relative to the long-run nature of an irrigation system investment. Basically, irrigators would try to make partial modifications of existing irrigation systems, such as installing gated pipe or surge valves, to existing gravity systems in preference to larger investments such as the adoption of a sprinkler system. Furthermore, the other key factor affecting the decision were gross farm sales, suggesting that only those enterprises with sufficient cash flow will invest in less water-intensive irrigation systems during severe droughts.

Given these results, it appears that the drought did promote movement toward more technically efficient, less water-intensive irrigation systems, but generally only in a short-run setting and with changes that required less significant investment. On the whole, it appears that Colorado irrigators did respond to the drought in ways that are consistent with expectations, but also appear to have limited the use of changes in irrigation systems as a way of investing their way out of the effects of drought.

Summary and Conclusion

With two years to review the findings of the 2002 "Weathering Tough Times" drought survey, research is providing a clearer picture of just what the drought meant to the agricultural sector of the economy. While examining past behavior is useful in assessing the consequences of the drought, the lessons learned are most critical for what information they can provide for the next drought. Given the knowledge of how Colorado producers behave during severe droughts – and especially their resilience in the face of these challenges – researchers from Colorado State University and federal agencies will be in a much better position to assist the states' farmers and ranchers when drought makes its inevitable return to the state.

Citations:

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Schuck, Eric, W.M. Frasier, and R. Webb. "Preliminary Summary of the 2002 Colorado Drought Survey", Colorado Water, Vol 20, No. 3, (June 2003): 8-11.

Schuck, Eric and W. Marshall Frasier. *Coping with Natural and Institutional Drought*, Current Agricultural, Food and Resource Issues, Vol 5, (2004), pp. 119-130.

Arizona Center Will Study Water Resource Decision Making

Arizona State University's new $6.9 million Decision Center for a Desert City (DCDC) will use Phoenix as a laboratory to study concerns common to all developing desert cities. To address one of the most critical concerns of such cities – planning and managing growth with limited water resources – DCDC will study water resource decision making in the Phoenix area.

Funded by the National Science Foundation, the center aims to produce new knowledge, information and tools to promote informed decision-making. The program's primary focus will be to investigate human decision-making under climatic uncertainty, and it will take into account short-term climate variability and long-term climate change.

The project is a response to the growing awareness that even a reliance on the best available science will not significantly reduce uncertainty about global climate warming and the climate cycles that cause droughts, floods and other severe weather events.

Patricia Gober, professor of geography and project co-director says, "Society must learn to make better decisions in the face of uncertainty. Our theme is the creation of partnerships between scientists and decision makers to study and understand the complex relationships between rapidly growing population, finite water resources and climatic variability."

From November-December 2004, Arizona Water Resource

Agronomic Perspectives on Irrigation Water Conservation to Meet Growing Urban Demands

By Dan Smith, Professor, CSU Soil and Crop Sciences

The recently completed Statewide Water Supply Initiative (SWSI) conducted a comprehensive assessment of current water demand and supply relationships in Colorado and projections through the year 2030. The study focused on the balance between supply and future demands within each basin, without considering potential transbasin diversions. The greatest increase in demand was projected for Municipal and Industrial (M&I) supplies in the South Platte and Arkansas basins, largely because of population growth along the eastern front range. Surface waters in both of these basins are already overappropriated, which means that current demand exceeds the amount of water available on an annual basis. Thus, future increases in M&I demands will largely come from reallocation among existing uses. Because irrigated agriculture still accounts for more than 80% of water use in the South Platte and Arkansas basins, it is likely that water transfers from agricultural irrigation to urban uses will account for a substantial portion of this reallocation.

Under the assumption of no increase in diversions from the western slope or Rio Grande basins, the SWSI study projected substantial decreases in irrigated land in both the South Platte and Arkansas basins. The most conservative estimates, which assume the successful completion of projects currently in the planning stages, assume declines in irrigated acreage ranging from 156,000 to 298,000 acres in the two basins combined. Based on data from the 1997 USDA agricultural census, these estimated decreases account for up to 27% of the land irrigated with surface water supplies in the South Platte basin and as much as 23% of surface-water-irrigated land in the Arkansas basin. This article provides an overview of various water conservation strategies that could be used to reduce the amount of irrigation water use and briefly comments on the consequences of these efforts.

Conservation Strategies

Transfers of agricultural water rights have been used to meet growing urban demand in Colorado since the early 1900's. Historically, most of these transfers have been conducted on a wholesale basis, with the formally irrigated lands being fallowed or converted entirely to dryland (rainfed) agriculture. This type of conversion has generally produced at least short-term negative economic impacts on a regional or community basis because of declining land values, the resulting impact on public services, and reduced economic activity in the private sector because of the lower level of inputs used in dryland agriculture. In addition, land that was fallowed in many of the earlier transfers subsequently suffered from poor management or neglect. More recently, transfers involving land fallowing have been subjected to mitigation requirements for land restoration imposed by water courts.

Water conservation options other than complete land fallowing are numerous. The major consideration is that the requirement for a decrease in consumptive use must be satisfied. From a conceptual standpoint existing irrigated cropping systems can achieve this by either decreasing the land area under irrigation or decreasing the amount of consumptive use per growing season on the same acreage base. For the specific scenarios suggested below, it is useful to note that approximately 80% of the existing irrigated land area in the South Platte and Arkansas basins is devoted to feed grains, hay, or pasture. Thus, the basis from which changes would proceed consists of vast acreages of relatively low-value crops.

Reducing the land area under irrigation without changing the cropping mix would decrease the economic returns of an irrigation-based enterprise in most cases. However, decreased income could potentially be avoided if the mix of crops was also altered to include crops of higher value, such as vegetables. This approach would accommodate only a limited amount of existing irrigated land area because of the potential for market saturation with high-value crops. This is especially true for vegetable crops produced for fresh markets. Additional barriers to this conservation strategy include the higher risk associated with production of high-value crops and the start-up costs associated with the new crop(s).

Several options exist for decreasing the magnitude of consumptive use within a growing season with no change in irrigated acreage. Changing the cropping mix alone offers a wide range of potential conservation alternatives. Because feed crops dominate the existing irrigated acreage in the

Table 1. Irrigation water requirements of selected crops in the South Platte and Arkansas river basins.

Crop	South Platte*	Arkansas**
	--------- inches ---------	
Alfalfa	26.4	28.8
Grass pasture	20.4	23.8
Corn	15.8	18.9
Winter wheat	8.2	11.7

* Irrigation water requirement calculated as estimated consumptive use minus effective precipitation. Data are averages from Longmont and Sterling conditions, NRCS Irrigation Guide for Colorado, 1988.

** Irrigation water requirement calculated as estimated consumptive use minus effective precipitation. Data are averages from Rocky Ford and Lamar conditions, NRCS Irrigation Guide for Colorado, 1988.

South Platte and Arkansas basins, actual seasonal consumptive water use on most irrigated lands is relatively high as compared to most other crops. The most important factors accounting for this are that these crops are produced during the warmest period of the year, they have more prolonged active growing seasons than other crops, and they are produced under conditions of complete canopy cover for most of their growing season. Working from this general view, several alternatives are apparent, including those involving decreasing or altering the season of production. These alternatives are illustrated in Table 1, which contains summaries of irrigation water requirements (seasonal total consumptive use less effective precipitation) for selected crops in the two basins under consideration (Source: NRCS Irrigation Guide for Colorado, 1988). Switching from fully irrigated alfalfa and grass pastures to corn produces some conservation potential, but the greatest decreases in consumptive use could conceivably come by incorporating wheat into the existing irrigated acreage mix.

Deficit irrigation (applying less irrigation water to a given crop) is often suggested as another means of decreasing irrigation water use in a manner that results in actual water salvage. Many of the proposed scenarios, however, fail to meet the test of yielding predictable savings in water that could be interpreted as true salvaged water in a formal water transfer proceeding. The following example of deficit irrigation would likely pass this test. Hay and pasture crops represent a substantial proportion of the irrigated acreage in both the South Platte and Arkansas basins. These crops are generally irrigated for the entire growing season, even though all of the forage crops used for hay and pasture in Colorado are most productive during the spring.

One alternative for significant water salvage would involve partial season irrigation of alfalfa, which is the predominant irrigated hay crop in eastern Colorado. The values in Table 2 provide an example of savings under the climate conditions representative of Rocky Ford in the Arkansas basin. Again, the water use values are from the NRCS Irrigation Guide for Colorado (1988). Under average climatic conditions for this site, termination of irrigation after the first hay cutting in late May or early June decreases the net consumptive use of irrigation water from almost 30 inches to an estimated 6 inches. The magnitude of this decrease reflects the relative difference in atmospheric conditions (and, therefore evaporative demand of the atmosphere) in March, April, and May as compared to that for the hotter months of the growing season (especially June, July, and August). The relative advantage in crop productivity (because of cooler temperatures) during the months of March, April, and May further enhances the productivity of water use (the amount of yield produced from each increment of water applied) during this portion of the growing season. Alfalfa yields from the first cutting in this environment (out of a total of four for the entire season) constitute approximately 35% of the total seasonal yield (calculated from CSU alfalfa variety trials conducted at Rocky Ford, CO). The higher relative yield combined with lower water use prior to June, greatly increases the efficiency of irrigation water use for first-cutting hay as compared to the remainder of the hay production season.

Table 2. Net irrigation requirements and resulting irrigation efficiency from deficit irrigation of alfalfa in the Arkansas River basin.

		Irrigation management	
		Full irrigation	Deficit irrigation
Monthly irrigation requirement* (in)	March	0.5	0.5
	April	1.8	1.8
	May	3.6	3.6
	June	6.0	-
	July	6.6	-
	Aug.	5.8	-
	Sept.	3.7	-
	Oct.	1.2	-
Total seasonal irrigation requirement (in)		29.2	5.9
Alfalfa yield** (tons/acre)		5.8	2.0
Net irrigation water use efficiency (in/ton)		5.03	2.95

* Irrigation water requirement calculated as estimated consumptive use minus effective precipitation. Data are from Rocky Ford site, NRCS Irrigation Guide for Colorado, 1988.

** Yield values from CSU alfalfa yield trials conducted at the Arkansas Valley Research Center, Rocky Ford, CO.

For the example given above, other factors including economics have to be considered in such a scenario. However, using this concept of deficit irrigation in hay production systems could eventually produce substantial amounts of salvaged water in both the South Platte and Arkansas river basins. The potential for success of this alternative system will likely vary with local conditions, but ample data are available from previous studies in Colorado to make the preliminary assessments that account for the climate variability.

Dryland Farming: A Viable Option for Formerly Irrigated Land?

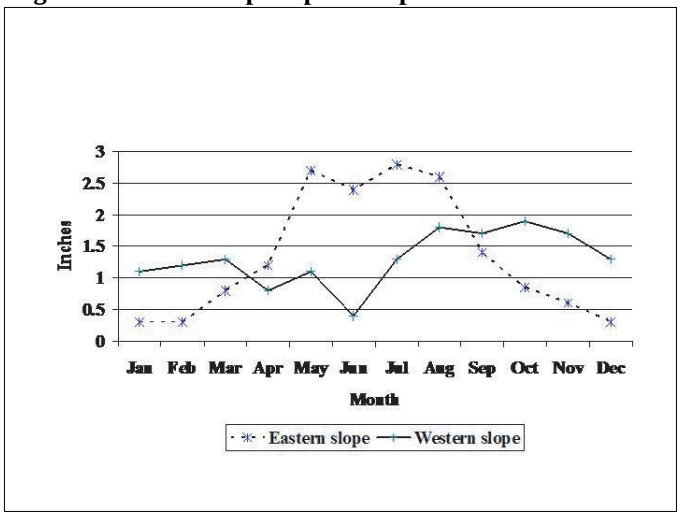
Gary A. Peterson
Professor, CSU Soil and Crop Sciences

Much of the Colorado irrigated land area affected by water diversion from agricultural to urban use lies along the Front Range. A key question is, "How successfully can we practice dryland cropping along the Front Range?" Can we use dryland systems data collected in other areas of Colorado to answer the question? The answer is "yes" and "no". "Yes" in the sense that we can predict with some certainty what will not work, but "no" in the sense of exactly what crops will be grown and what the economics of that might be.

Colorado State University in collaboration with USDA-ARS has been conducting dryland cropping systems work since 1985 along the eastern corridor of Colorado. Our goal has been to improve precipitation use efficiency and profit to the farmer in dryland systems. Substantial gains have been made in the West Central Great Plains region (Peterson and Westfall, 2004). Conversion from Wheat-Fallow (WF) to systems like Wheat-Corn-Fallow (WCF) increased annualized grain yields by 75 percent (Table 1). Using forage crops in addition to grain crops in an opportunity system increased annualized total biomass yields by 90 percent compared to WF (Table 1). Conversion from WF to WCF has increased net income to farmers by 15 to 35 percent (Kaan, et al. 2002). These results were obtained from a series of experiments conducted over a climate and soil gradient for a period of 12 years.

"How do these results apply to the Front Range environment?" Obviously precipitation drives dryland agricultural system productivity. Although most persons immediately think of total annual precipitation as the key driver in dryland system productivity, precipitation distribution plays a powerful modifying role in system productivity. It affects which crops we can grow, and which crop rotations will be successful. Precipitation distributions in Colorado have two extremes as shown in Figure 1. The eastern slope has a summer dominated pattern compared to a more uniform annual pattern on the western slope.

Figure 1. Dominant precipitation patterns in Colorado



Crops that require water in late summer, like corn, sorghum, sunflower, and millet are favored by patterns like that of the eastern slope (Figure 2). Note in Figure 3 that corn yield increases 7.5 Bu/A per inch of precipitation received during the period of 15 July and 25 August, which is the reproductive and grain fill period for that crop. Any environment that has lesser amounts of July and August precipitation is less desirable for corn production. With western slope patterns, summer crops are under more stress because their peak water demand occurs when only a small amount of precipitation is likely to fall (Figure 4). Critical water periods for winter wheat or other winter annuals differ from that of summer crops (Figures 2 & 4). Winter wheat has a greater dependence on stored soil water relative to the summer crops, and since it is a cool season plant, it is more adapted to non-summer dominated precipitation patterns. Forage crops are the most flexible regarding precipitation distributions because they have no water sensitive reproductive growth period. They can

Table 1. Annualized grain and total biomass yields from eastern Colorado (Peterson & Westfall, 2004).

Cropping System	Annualized Grain Yield	Annualized Total Biomass Yield
	----------Lbs/A----------	
Wheat-Fallow (WF)	1000	2500
Wheat-Corn-Fallow (WCF)	1750	3900
Wheat-Corn-Millet-Fallow (WCMF)	2000	3900
Opportunity (Continuous cropping)	----	4600

be productive under either the eastern or the western slope precipitation pattern.

Now let us focus on areas along the Front Range where there is more likelihood that farms will lose a portion of their irrigation water. Are there differences in precipitation patterns that will alter dryland cropping system management strategy? A comparison of the Stratton Colorado pattern with that found along the Front Range shows a subtle difference that may well affect system choices (Figure 5). Although the annual totals are within 1 to 2 inches of each other, the Front Range environment receives much less July and August rainfall than does Stratton. Obviously a crop like corn that is favored by late season precipitation (Figure 3) will perform less well along the Front Range than at Stratton. This indicates that productivity data reported for the more eastern Colorado areas is not directly transferable to the Front Range area. Note, however, that there is a definite spike in March precipitation along the Front Range relative to Stratton. Cool season crops like winter wheat would be favored by this phenomenon.

The precipitation pattern along the Brighton to Greeley corridor obviously is very different from eastern Colorado (Figure 6). Crop rotations like WCF are much less likely to be successful along the Front Range relative to the Stratton area. Crop rotations that include a greater number of cool season crops and fewer warm season crops are likely to be a better fit for the Front Range (Table 2). Producers desiring rotations with only cash grain crops, will probably experience poor corn, millet and sunflower yields and likely little profit. Of course the standard practice of wheat-fallow will fit, but it is a relatively low profit system compared to irrigated agriculture or the more intensive dryland rotations being adopted along the eastern Colorado corridor. The intensified cropping system most likely to be successful

Figure 2. Eastern Slope precipitation distribution relative to crop water need

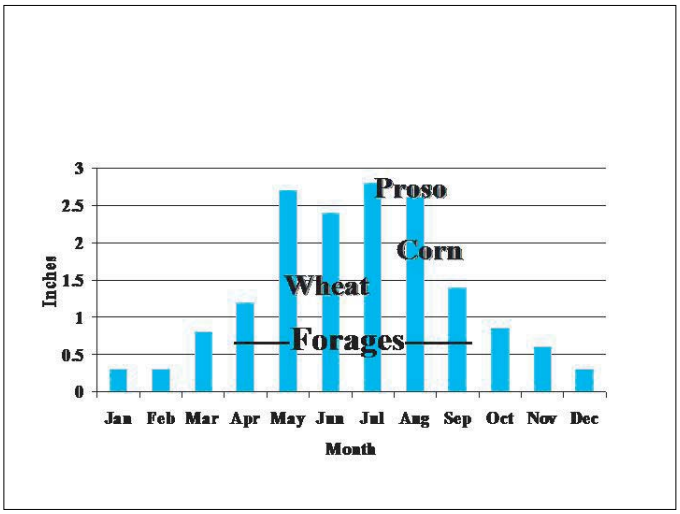


Figure 3. Corn yield as function of 15 July - 25 August rainfall

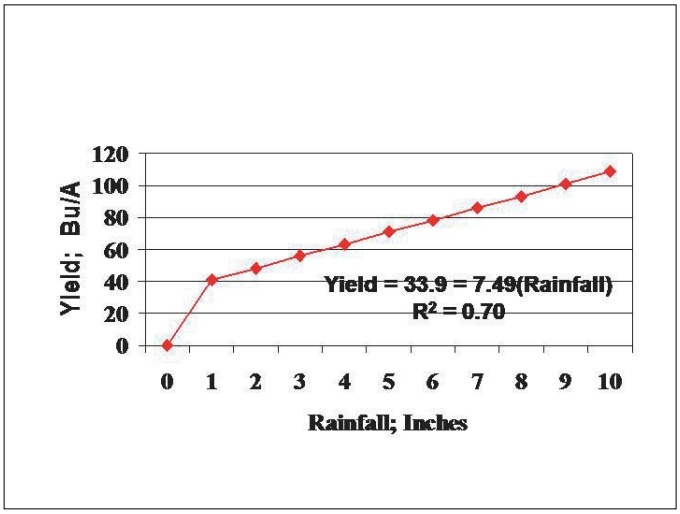


Figure 4. Western Slope precipitation distribution relative to crop water need

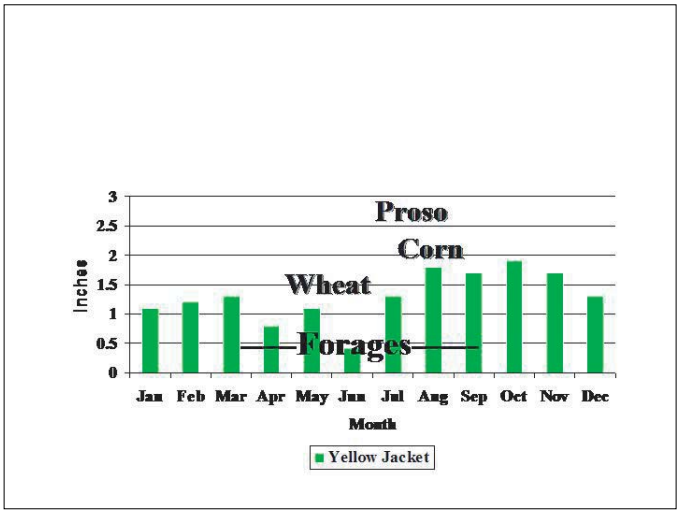
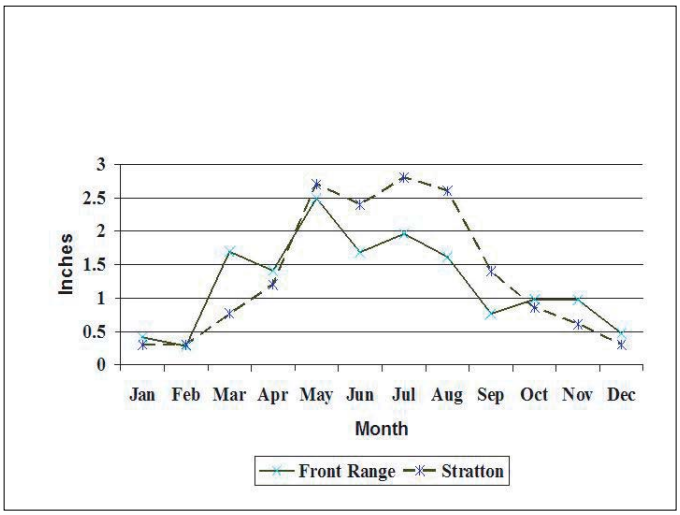
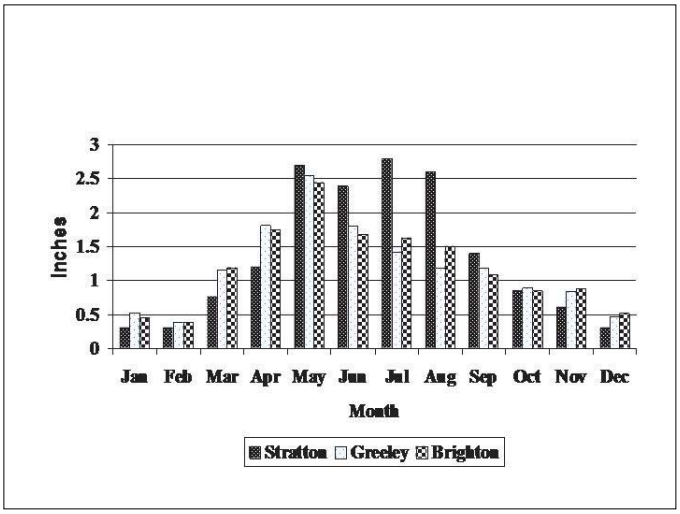


Figure 5. Precipitation distribution at three locations on the Eastern Slope of Colorado



for the Front Range would be a wheat-wheat-fallow system (Table 2). To do this successfully, a wheat variety with the "Clearfield" technology herbicide feature should be used as the second wheat crop in the three year sequence.
Other possibilities include grain-forage and totally forage based systems (Table 2). The triticale-hay millet-fallow system is likely to be very high producing along the Front Range. The precipitation spike in March would favor the triticale, which is a high producing crop with moderate quality. The hay millet, since it does not require late season precipitation for grain fill, also does well in this environment.

Figure 6. Precipitation distributions at three locations on the Eastern Slope of Colorado



Conclusions:

- Front Range precipitation pattern differs from that of eastern Colorado – (more spring and early summer precipitation and less in late summer).
- Dryland systems that fit eastern Colorado are not likely to fit the Front Range.
- Dryland cropping systems for the Front Range require cool season crops.
- Cool season forages are likely to be ideal for the Front Range.

References:

Kaan, D.A., D.M. O'Brien, P.A. Burgener, G.A. Peterson, and D.G. Westfall. 2002. An economic evaluation of alternative crop rotations compared to wheat-fallow in Northeastern Colorado. Tech. Bull. TB02-1. Agric. Exp. Stn. Colo. State Univ. Fort Collins, CO.

Peterson, G.A. and D.G. Westfall. 2004. Managing precipitation use in sustainable dryland agroecosystems. Annals Applied Biology 144:127-138.

Table 2. Rotation types, examples of each, and likelihood of success for the Front Range enviroment.

Types of Rotations	Examples	Likelihood of Success
Grain crop systems		
	Wheat-Corn-Fallow	Poor
	Wheat-Millet-Fallow	Poor
	Wheat-Sunflower-Fallow	Poor
	Wheat-Wheat-Fallow	Excellent
	Wheat-Fallow	Excellent (lower profit)
Grain-Forage crop systems		
	Wheat-Hay millet-Fallow	Excellent
	Wheat-Forage sorghum-Fallow	Excellent
Forage crop systems		
	Triticale-Hay millet-Fallow	Excellent
	Oat hay-Hay millet-Fallow	Excellent
	Triticale-Hay millet	Medium
	Oat hay-Hay millet-Austrian winter pea	Medium to excellent

Albertson Adds to Archive

By Patricia J. Rettig, Head Archivist for Water and Agriculture Archives, Colorado State University Libraries

The Water Resources Archive documents all aspects of water resources in Colorado, including individuals and organizations that work in related areas. At present, the Archive's strength relates to civil engineers and their work at Colorado State University. The Water Resources Archive is very pleased that its newest acquisition adds to this strength with a collection from one of the earliest builders of the modern engineering program: Maurice L. Albertson.

The post-World War II period was one of burgeoning scientific inquiry, and when Colorado A & M's new president, William Morgan, arrived in 1949, he made engineering a top priority along these lines. In place two years before Morgan started, however, was Maury Albertson, who was key to developing the engineering program and attracting new faculty members. "Albertson, a six-foot, six-inch dynamo infused with a seemingly boundless entrepreneurial spirit, was the catalyst for the unprecedented research activity at the College. Over the next forty years he would bring in millions of dollars in contract and grant money while leading both the engineering program and the institution into the field of international research." (Ann Hilfinger, *One Hundred Years of Engineering at Colorado State University*, p. 44)

That "forty," written in 1989, can now be revised to "nearly sixty"—Albertson retains an office at the Engineering Research Center (ERC) and is still active professionally, including travels to Indonesia to work with students there. Much of his work at CSU has been international in scope, most significantly being involved in the creation of both the Peace Corps and the Asian Institute of Technology.

The documentation of his work over so many years is extensive. Though he had previously donated materials to the University Archives, mostly related to the last two organizations mentioned, the Water Archive received the contents of a storage room at the ERC which was packed nearly to the ceiling. Imagine a room stuffed with more than a dozen full filing cabinets and nearly a hundred boxes piled on top of the filing cabinets and any other flat surface. Then imagine sorting through it all and moving out over 140 boxes of materials. All 140 boxes of materials is now in the archives, waiting for archivists to go through it in detail. Certainly time-consuming work, but willingly done to discover the wealth of material there.

The boxes do contain additional materials related to the Peace Corps and other endeavors, but there are materials concerning the water-related research that Albertson conducted and the classes that he taught. Approximately one third of the donation relates to civil engineering courses.

While this aspect of the collection may not sound important, it actually is for several reasons. One is that the documentation is extensive both in type and in time spanned: included are not just Albertson's notes for the class, but also his handouts and bibliographies, as well as student reports from the course. One set of field trip reports spans thirty years! The time span can show the evolution of a single course, such as CE 712, Hydraulic Structures Design, in terms of what was taught and how. Also, comprehensive documentation of CSU water-related courses has been lacking in the Water Resources Archive. It is one thing to know what work engineers do to test and build new water projects; it is something else to know how engineers are educated, especially at an institution known internationally for its water resources programs.

Archivists have yet to go through the Albertson collection in detail, but its significance causes it to rise to the top of our priority list. After archivists have a chance to go through it all and make a finding aid, details will be posted on the Water Resources Archive website. Until then, information on most of the Archive's other contemporaneous collections of CSU civil engineers can be found there [http://lib.colostate.edu/water/]. These collections, mostly documenting the period from the 1940s through the 1980s, include the following:

- **James L. Ogilvie:** Ogilvie attended the State Agricultural College (now CSU) and earned a civil engineering degree in 1933. He then had a long and fruitful career with the Bureau of Reclamation in the field of irrigation and water management, working on the Colorado-Big Thompson and the Fryingpan-Arkansas projects. His collection (10 boxes) contains mostly professional files related to his Bureau work as well as desk diaries, which serve as a guide to his daily activities.

- **Whitney M. Borland:** Though not employed by CSU, Borland was a Bureau of Reclamation engineer who spent several years in the 1930s in Fort Collins conducting model sedimentation studies in the CSU engineering lab designed by Ralph Parshall. His papers (40 boxes) consist mainly of the articles, reports and studies by himself or others that he saved and used over the years.

- **Robert E. Glover:** Spending most of his career as a Bureau of Reclamation engineer, Glover began his association with CSU in 1956 at age 60, employed by the Experiment Station and the civil engineering department as a professor. For the latter, he developed and taught a course for the solution of groundwater problems. He retired in 1980. His papers (46 boxes plus maps) focus on documenting the Bureau's dam projects he worked on, but also contain approximately thirty years of his CSU class materials and correspondence.

- **Morton W. Bittinger:** Dr. Bittinger was a professor in civil engineering at CSU from 1957 to 1967 and was in charge of groundwater research. He made important contributions to the science of groundwater hydrology, becoming one of the first in the field to apply modern computer technology to the solution of groundwater problems. His papers (1 box) consist mainly of writings and presentations authored or co-authored by him.

- **Vujica Yevjevich:** Dr. Yevjevich joined CSU's civil engineering department in 1960 and stayed until his retirement in 1979. He mainly taught courses in hydrology and with his colleagues built one of the nation's leading hydrology research programs. During his career, he also made significant contributions to the field of water resources internationally, particularly to his homeland, Yugoslavia. His papers (1 box) focus mostly on the international activities he engaged in.

- **Daryl B. Simons:** Dr. Simons was hired at CSU in 1963 as a professor of civil engineering, teaching classes on erosion and sedimentation, river mechanics and hydraulic structures. He was also the head of the River Mechanics and Hydraulics Program and was in charge of all research in civil engineering. In 1965, his position changed to associate dean of engineering research, director of the Engineering Research Center and associate director of the Experiment Station as well as professor of civil engineering. Simons retained all four positions until 1983 when he began a transitional retirement. His innovative teaching and research while a professor at CSU and his supervision of hundreds of water-related projects around the world have contributed to an outstanding international reputation. His papers (170 boxes) document his teaching, his international research as well as the extensive consulting work he has done.

- **Groundwater Data Collection:** This collection brings together the work of a number of CSU engineers, including Morton W. Bittinger, John Brookman, William E. Code, Harold R. Duke, Robert E. Glover, Robert A. Longenbaugh, Edmund Schulz, Morris M. Skinner and Daniel K. Sunada. The data, maps, charts, drafts, correspondence, photographs, final reports and reference materials that were produced by or collected for their groundwater studies mostly from the 1940s through the 1970s are what comprise this collection (21 boxes plus maps).

- **Colorado Water Resources Research Institute:** The bulk of the files in this collection encompass the tenure of Norman A. Evans, a civil engineer who directed the CWRRI from 1967 to 1988. In addition to the organizational files regarding research projects, Evans maintained numerous water-related files pertaining to Colorado and the United States that comprise a significant portion of the collection (48 boxes).

These collections dovetail nicely, both complementing and overlapping each other, especially with the Groundwater Data Collection bringing together the work of so many all

Water Advocates Come to the Aid of Carpenter Papers

Raising funds for the conservation of the papers of Delph Carpenter has been a focus of the CSU Libraries development office since late Fall of 2004. It all started when we learned that mold had formed on the collection as a result of water damage some time ago. Before the collection can be made available to researchers and the public, the mold needs to be removed.

Following a front page story by the Fort Collins Coloradoan on the plight of the collection, we received a generous gift of $3,000 from a local donor. Enter emeritus CSU History professor, Dan Tyler, author of a biography on Delph Carpenter, THE SILVER FOX OF THE ROCKIES. Dan not only made a gift in support of the conservation effort, but also offered to write a letter asking others who care about Colorado water to help.

Thanks to the support of the Northern Colorado Water Conservancy District, the Southwestern Water Conservation District, and the Colorado River Water Conservation District, as well as key individuals in the water community, we've raised nearly $13,000 of the $35,000 needed to clean and process the collection. We continue to seek donations, so if you would like to join in the effort, please contact Susan Hyatt at 970/491-6823 or Susan.Hyatt@Colostate.EDU.

in one place. Another example of this dovetailing is in the Borland collection. Borland kept travel reports for any trip he made, writing up the details when he returned to his office. A report dated August 6, 1956, has the subject line: "Trip to Colorado A&M College, Fort Collins, July 26, 1956, to discuss with Dr. M. L. Albertson and Professor D. B. Simons, data and the proposed report on tractive force and hydraulic data obtained on USBR and other canals." Three people represented in the Archive, brought together in one report!

As can be seen from this list and the descriptions, the engineering-related collections in the Water Resources Archive are a gold mine waiting to be explored. Having them all together, available in one place provides excellent, efficient opportunities for researchers.

Albertson's collection unifies the others in ways that nothing else can, making it a welcome addition. The Archive is always on the lookout for such additions and appreciates any tips or leads. A related development along these lines is that administrators and development officers from the University Libraries and the College of Engineering met recently to look at projects of mutual interest. Prime among these is increasing donations to the Water Resources Archive. A very promising partnership!

For additional information or to share tips, please contact the author at 970-491-1939 or Patricia.Rettig@ColoState.edu.

Bottled Water: Getting Consumers Back on Tap Water

Environmental groups like WWF [1], anti-privatisation activist groups like Public Citizen (USA) [2], and water supply utilities are among those who are attempting to get consumers to switch from bottled water to tap water. The latest campaign has been launched by the Syndicat des Eaux d'Ile-de-France (Sedif), the public water utility that serves four million inhabitants in the region surrounding Paris, France. Sedif is spreading its message through posters displaying bottles resembling known brands that are labelled "Eau du Robinet", or tap water. The posters carry texts like "You're free to pay 100 times more", "Ideal for those living on the fifth floor without a lift" and "What could be more environmental than no packaging at all?". France is not only a leading exporter of bottled water but has also seen consumption double in 20 years to reach 130 litres a year per inhabitant, second only to Italy. Sedif hopes its campaign will improve the image of tap water and also reduce the costs of plastic refuse collection.

[1] The real cost of bottled water, http://www.panda.org/news_facts/newsroom/news.cfm?uNewsId=2250&uLangId=1

[2] Public Citizen - http://www.citizen.org/cmep/Water/us/bulksales/

River's Natural Place In Landscape Focus of Wohl's Book

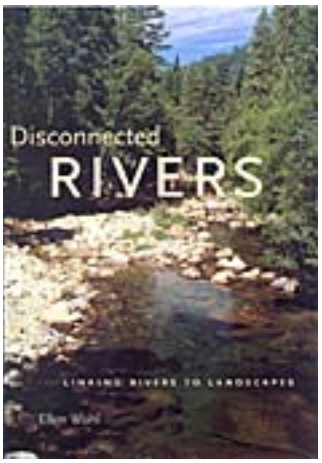
"Disconnected Rivers Linking Rivers to Landscape is the latest book of Dr. Ellen Wohl professor in the College of Natural Resources' Department of Geosciences. A study of the human impact on rivers, the book introduces the basic physical, chemical, and biological processes operating in rivers, discusses changes in rivers resulting from settlement and expansion, describes the growth of federal involvement in managing rivers, and examines the recent efforts to rehabilitate and conserve river ecosystems.

In each chapter she focuses on a specific regional case study and describes what happens to a particular river organism--a bird, North America's largest salamander, the paddlefish, and the American alligator--when people interfere with natural processes.

Disconnected Rivers
Linking Rivers to Landscapes

Ellen Wohl

320 p. , 6 1/8 x 9 1/4
ISBN : 0-300-10332-8



Proceeds from this book will benefit American Rivers, a nonprofit organization dedicated to protecting America's waterways.

Ellen Wohl is also the author of Virtual Rivers: Lessons from the Mountain Rivers of the Colorado Front Range, published by Yale University Press.

CUAHSI Names UC Berkely site of National Center for Hydrologic Synthesis

University of California, Berkeley was selected (Yoram Rubin, PI) as the site for the National Center for Hydrologic Synthesis (NCHS) by the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI). The NCHS will serve as a community facility and has the potential to transform hydrological sciences. The Review Committee which visited each site during the review process included Roni Avissar (Duke), Chris Milly (USGS), Steve Burges (U. Washington), and Leslie Smith (U. British Columbia).

While all four proposals for NCHS were strong and would have been acceptable, the Berkeley proposal was selected by the review team for its vision of how NCHS can operate, its involvement of the practitioner community, and the facilities that were available at Berkeley. A unique aspect of the Berkeley proposal was the degree of partnering and leveraged funding that was assembled for the proposal. The significant amount of funding stimulated an important discussion within the review team regarding the influence that external funders might have on NCHS. As a consequence the review team conditioned their decision on negotiating a governance structure which would assure that CUAHSI will achieve its stated goals.

A Standing Committee for Hydrologic Synthesis will oversee NCHS. Consisting eight members appointed by CUAHSI and seven members appointed by mutual consent of CUAHSI and UC Berkeley, the committee will develop policies and procedures for operation of NCHS, including how external funds can be utilized for the benefit of the community, true to the CUAHSI spirit, and subject to NSF regulations.

Jay Famiglietti (UC Irvine) was charged by CUAHSI to develop recommendations for the makeup of the Standing Committee. Rubin and his team will meet with the three other finalists over the next few weeks, working with them to craft the strongest possible proposal to NSF. Final approval for the NCHS proposal by NSF is still pending. Advance activities will begin in the fall including a cyber-seminar describing NCHS. For more information, go to www.cuahsi.org.

Department of Civil Engineering - Colorado State University
HYDROLOGY AND WATER RESOURCES SEMINAR SERIES

New Directions for Water Research in an Era of Integrated Water Management

12:10pm (Noon), Thursdays - Room 201 Glover Building
Colorado State University - Fort Collins, CO

This seminar seeks to define the changes sweeping over traditional water research – changes which attempt to integrate traditional, small scale, hydrological research with climate models, weather projections, new measurement technology, atmospheric chemistry, aquatic toxicology, ecosystem health, socio-economic impacts, and policy drivers for improved water management.

Date	Topic/Speaker
February 17	"Integrating climatology, hydrology, and social sciences to develop better water supply projections for the West" - **Brad Udall**
February 24	"Integrating climate models into the world of Western water managers"– **Tom Vonderhaar**
March 2	Join the **Distinguished Ecologist** series: A-202 Clark, 4:00pm March 2nd for "Trends in Pan Evaporation, Global Dimming and Brightening: Theory, Observations and Implications for the Terrestrial Water Balance" – **Graham Farquahar**
March 10	Join the Hydrology Days program, for more information, see http://hydrologydays.colostate.edu/
March 17	Spring Break
March 24	"Understanding water quality in the South Platte basin" – **Brett Bruce**
March 31	"Ecohydrology at Colorado's long-term ecological research sites" – **Mark Williams** and **Gene Kelly**
April 8	Join the **Distinguished Ecologist** series: A-202 Clark, 4:00pm April 8th for "Storm Climates and Vegetation" - **Bruce Hayden**
April 14	"Science in support of water policy: Weighing lysimeters in the Arkansas Valley" – **Tim Gates** and **Dale Straw**
April 21	"The Energy/Water Nexus of the 21st Century" – **Bill Karsell**
April 28	"The National Ecological Observatory Network - coming to a neighborhood near you" – **Jill Baron**
May 5	"NSF South Platte Hydrologic Observatory Proposal – Update" – **Jorge Ramirez**

Interested faculty, students and off-campus water professionals are encouraged to attend and participate.
For more information see www.cwrri.colostate.edu

MEETING BRIEFS

Scenes from the 2005 Annual Convention of the Colorado Water Congress

Counterclockwise from left: Herrick Roth and W. D. Farr

Julia Keedy (CWRRI Graduate Fellow) and Gene Scheiger (Northern Colorado Water Conservancy District)

Don Ament (Colorado Commissioner of Agriculture), Gale Norton (U.S. Secretary of the Interior), and Diane Hoppe (Colorado State General Assembly)

Dick MacRavey (Colorado Water Congress) and Gary "Pete" Peterson (Colorado State University professor)

Tracy Bouvette (Geomatrix Consultants engineer) and George Sibley (Western State College professor)

Mary Sterling (Colorado Water Congress) and Evan Vlachos (Colorado State University professor)

MEETING BRIEFS

Four States Irrigation Council Meeting Calls for Better Water Accounting Systems

Legal, ecological, climatological, and hydrological changes are confronting irrigators in Colorado, Kansas, Nebraska, and Wyoming - the states in the Four States Irrigation Council. The challenges, and irrigator responses, were highlighted at the Council's 52nd Annual Meeting January 12-14, 2005, in the midst of the remodeling under way at the University Park Holiday Inn in Fort Collins.

The impacts of the Republican River Compact Settlement, the drought, conjunctive management of ground and surface water, and endangered species on irrigation water supplies were described during the meeting. The situation is so extreme in some areas that irrigation districts have no water to deliver to farmers. Irrigation organizations and farmers are responding to the challenges with innovative institutional arrangements, new operating plans, new technology, and updated infrastructure. A common theme running through the responses is the need for enhanced water accounting - from improved measurement technology, through data storage and analysis, to timely data/information sharing and reporting. The extreme conditions facing irrigators bring forward a new sophistication in water management based on an open and accurate water accounting system.

The theme for the meeting, 'Water User Coalitions: The Real Survivors' reflected the feeling of many in the audience as they shared common, difficult experiences with water shortages. The Four States Irrigation Council educates and informs members regarding water issues, promotes water conservation and development, and serves as a forum for exchange of management and maintenance techniques.

The meeting opened with an update from the Bureau of Reclamation, which operates water projects in the four states and provides water to a number of irrigation districts. Maryanne Bach, who has directed the Great Plains Region for the past six years, which includes the four states, recently assumed the position of Director of the Bureau of Reclamation's Research Program in Denver. She noted that the Bureau's research program will be open to working with the private sector in developing new technology to solve water supply problems. She used the example of joint efforts to achieve affordable desalination technology.

Water leasing and banking experiences from the Arkansas Valley were discussed by a panel consisting of Tom Simpson and Gerry Knapp with the City of Aurora, Dan Henrichs with the Rocky Ford Highline Canal, and Jim Broderick, General Manager of the Southeastern Colorado Water Conservancy District. They reviewed the process by which the City of Aurora leased water from the Rocky Ford Highline Canal. It took 1.5 years to work through the lease details since such a lease had not been developed in Colorado before. It was noted that a simplified path through the legal requirements would greatly facilitate such leases. Given that farmers along the Rocky Ford Highline Canal were facing uncertain water supply conditions and growing debt, the certainty of the lease payments was welcomed by participating irrigators.

Jim Broderick, noting that the Southeastern District has returned management of the Colorado Water Bank Program to the state, indicated that water 'banking', as defined by the Bank Program, is really 'brokering'. He views water leasing, as defined within the context of the City of Aurora lease, as a 'water savings account', thus more closely serving the role envisioned by the initial water banking legislation. The City of Aurora lease arrangement insures future water supplies are available for irrigation in the Arkansas Valley.

Jim Broderick (Southeastern colorado Water Conservancy District) addresses water leasing and water banking in Colorado in a Wednesday session.

The conjunctive management of ground and surface water, as practiced in Kansas, Nebraska and Colorado was described and discussed by Ann Bleed with the Nebraska of Natural Resources, David Pope, with the Kansas Division of Water Resources, and Jon Altenhofen, with the Northern Colorado Water Conservancy District. The drought and legal decisions are forcing all three states to review and, in some cases, modify, their approach to conjunctive management of ground and surface water. The bottom line on all three approaches is the need to be accountable, in an open and scientifically sound manner, for the water used by all water users. Thus, there is a strong push to better model groundwater flows, measure water with drawn from the aquifer, and document consumptive use.

The Platte River Recovery Program's status was reviewed by John Lawson, Bureau of Reclamation, Alan Berryman, Northern Colorado Water Conservancy District, Roger Patterson, Nebraska Department of Natural Resources, and Mike Besson, Wyoming Water Development Commission. Negotiations to develop a Recovery Program are approaching the stage of seeking a Biological Opinion from the U.S. Fish and Wildlife Service, hopefully, in November 2005. There is also hope to obtain a Record of Decision by the Secretary of Interior by December 2005 and approval by the three Governors involved in January 2006. While there was comment that the water users would rather not have their use of water restricted by endangered species issues, it was agreed that if there were a better way to go, the water managers would go there! Developing a Platte River Recovery Program will permit federal projects to continue to operate in concert with local water needs. In particular, there is a need to gain sufficient certainty to begin solving other water problems, such as addressing the water needs of population growth in Colorado.

Above: Eric Wilkinson (Northern Colorado Water Conservancy District) talks to keynote presenter John Keys (commissioner, U.S. Bureau of Reclamation).

The Republican River Settlement was the focus of a panel consisting of David Pope, Roger Patterson, and Hal Simpson, Colorado State Engineer. The first 'accounting' of water under the Republican River Settlement, for the dry year 2003, shows that Nebraska and Colorado are using more water than they are entitled to under the conditions that prevailed that year. The Settlement provides for a moving 5-year average, but as noted by both Colorado and Nebraska, it is not good to begin the process with deficits. Both states are organizing to bring their use of water into compliance with the settlement. In Colorado, the new Republican River Water Conservation District is working with the State Engineer's Office to bring Colorado into compliance.

Below: Mike Delka (Bostwich Irrigation District), Hal Simpson (Colorado State Engineer) David Pope (Chief Engineer, Kansas Division of Water Resources) and Roger Patterson (Director, nebraska Department of Natural Resources) prepare for their presentation.

The impact of the drought was highlighted in a session entitled "Managing with Limited Water Supplies". Ken Nelson, Superintendent, Kansas-Bostwick District; Mike Delka, Manager, Bostwick Irrigation District; Allen Ringle, Superintendent, Colorado Canal Company; and Dave Ford, Central Nebraska Public Power & Irrigation Company described how their irrigation organizations are coping with extremely limited, and in some cases, no irrigation water during 2002-2004 and plans for another short year in 2005. In general, the districts struggle to keep operating when they are unable to deliver sufficient water for farmers to produce crops. During extreme water shortages, the districts formulate new strategies for best use of limited supplies (e.g. ease means of transferring water, seek alternative cropping patterns, and strategically retire lands). They downsize staff, reduce assessments, conduct O&M work on reservoirs and canals, seek grants, work with crop insurance companies, seek deferment of loan payments, set limits on irrigation season, and reduce inventory of irrigation equipment. Irrigation districts, during drought, face very difficult times and struggle to maintain a positive attitude for all involved, and in many rural plains communities, a large part of the community is dependent upon the irrigated agricultural economy.

If there is a bottom line challenge to research and education that emerges from the presentations and discussions at the Four States Irrigation Council, it is the need to examine alternative institutional arrangements and for better data and models to account for water supplies and deliveries within the more sophisticated management structures. Leasing agreements require careful water measurement. Conjunctive use demands accurate data to insure fair and equitable distribution of water by both surface and ground water users. Platte River Recovery Program implementation will require careful measurements, both of water flows and species numbers. The Republican River Settlement, with its need for all three states to reduce water use in a fair and equitable manner, will require careful measurement, as well as sharing of the data and information. During drought, distribution of limited supplies must be accomplished in a highly transparent, documented, and equitable manner.

RESEARCH AWARDS

COLORADO STATE UNIVERSITY, FORT COLLINS, COLORADO
Awards for December 2, 2004 to January 27, 2005

Primary PI	Department	Sponsor Title	Total
Level,Allison V	1019 Library	Cornell University Preservation of the Colorado Agriculture Literature	$41,646.00
Davis,Jessica G	1170 Soil and Crop Sciences	ACM-Texas, LLC Monitoring a Nutrient Recovery System for Dairies	$29,744.00
Qian,Yaling	1173 Horticulture and Land-scape Architecture	Noer Foundation Mowing Effects on Turfgrass Salinity Tolerance & Associated Mechanisms	$5,000.00
Norton,Andrew P	1177 Bioagricultural Sciences and Pest Management	State Board of Land Commissioners Monitoring Saltcedar (Tamarix) Biological Control (Diorhabda elongata) Insectary Establishment in Adams County	$12,000.00
Kummerow,Christian D	1371 Atmospheric Science	NASA - Natl Aeronautics & Space Admin. A Physical Validation Approach for Precipitation	$44,176.00
Cifelli,Robert C	1371 Atmospheric Science	Various “Non-Profit” Sponsors CoCoRaHS Charter Members Cost Share	$490.00
Cifelli,Robert C	1371 Atmospheric Science	Various “Non-Profit” Sponsors CoCoRaHS Charter Members Cost Share	$690.00
Ramirez,Jorge A	1372 Civil Engineering	KOWACO-Korean Water Resources Corp. Development of bias-correction techniques for numerical weather forecasts	$41,032.00
Shackelford,Charles D	1372 Civil Engineering	EPA - Environmental Protection Agency Evaluation of Hydrologic Models for Altrnative Covers	$79,163.00
Carlson,Kenneth H	1372 Civil Engineering	EPA - Environmental Protection Agency Assessment of Electrokinetic Injection of Amendments for Remediation of Acid Mine Drainage	$66,893.00
Ramirez,Jorge A	1372 Civil Engineering	USDA-USFS-Rocky Mtn. Rsrch Station - CO Development of Methodologies to Upscale/Downscale Cold Land Processes & Properties	$15,030.00
Julien,Pierre Y	1372 Civil Engineering	USDA-USFS-Rocky Mtn. Rsrch Station - CO Hydraulic Geometry and Sediment Transport of the Rio Grande	$73,002.00
Thornton,Christopher I	1372 Civil Engineering	USDA-USFS-Rocky Mtn. Rsrch Station - CO Hydraulic Modeling of Stabilization Techniques	$131,404.00
Thornton,Christopher I	1372 Civil Engineering	USDA-USFS-Rocky Mtn. Rsrch Station - CO Hydraulic, Hydrologic, Geomorphic, Sediment & Investigations of the Rio Grande	$86,745.00
Liston,Glen E	1375 Cooperative Institute for Research in the Atmo-sphere (CIRA)	DOC-NOAA-Natl Oceanic & Atmospheric Admn A High-Resolution Meteorological Distribution Model for Atmospheric, Hydrologic, and Ecologic Applications	$92,429.00
Stephens,Graeme L	1375 Cooperative Institute for Research in the Atmo-sphere (CIRA)	NASA-Goddard CloudSat	$220,000.00
Matsumoto,Clifford R	1375 Cooperative Institute for Research in the Atmo-sphere (CIRA)	UCAR-NCAR-COMET Atmospheric Tech. Divis. Inspiring the Next Generation of Explorers: The GLOBE Program	$638,525.00
Cooper,David Jonathan	1472 Forest Rangeland Wa-tershed Stewardship	DOI-NPS-National Park Service Developing Concepts for Stream Channel & Floodplain Restoration at Can-yon de Chelly Monument, Arizona	$20,000.00

Culver,Denise R	1474 Fishery and Wildlife Biology	Colorado Department of Natural Resources Exhibit 1-A: Survey of Critical Wetlands in Grand County, Colorado	$78,641.00
Rocchio,Joseph F	1474 Fishery and Wildlife Biology	Colorado Department of Natural Resources Exhibit 1-B: Vegetation IBI for Wetlands in Colorado: Phase 2	$75,924.00
Rocchio,Joseph F	1474 Fishery and Wildlife Biology	Colorado Department of Natural Resources Exhibit 1-C: A Floristic Bioassessment Tool for Colorado Wetlands	$32,765.00
Douglas,Marlis R	1474 Fishery and Wildlife Biology	Wyoming Game & Fish Department Molecular Genetic Analysis of Suckers in the Green River Basin	$23,766.00
Lyon,Margarette J	1474 Fishery and Wildlife Biology	The Nature Conservancy San Juan Public Lands Biodiversity Project	$56,000.00
Decker,Karin L	1474 Fishery and Wildlife Biology	e2M-Engineering-Environmental Management Vegetation Analysis for Capitol Reef NP & Colorado NM - Amendment 3	$14,470.00
Fausch,Kurt D	1474 Fishery and Wildlife Biology	Japan U.S. Friendship Commission A Documentary Film to Increase Understanding of US-Japan Collaboration in River Ecology and Conservation	$25,000.00
Winkelman,Dana	1484 Cooperative Fishery and Wildlife Research	Colorado Division of Wildlife 04/05 1:24,000 Scale Hydrographic Coverage for the State of Colorado (Exhibit I)	$24,500.00
Shaw,Robert B	1490 CEMML	DOD-ARMY-Fort Drum, New York Wetland Management Program Support at Fort Drum, New York	$4,970.00
Shaw,Robert B	1490 CEMML	DOD-ARMY-Fort Drum, New York Wetland Management Program Support at Fort Drum, New York	$60,030.00
Hanan,Niall P	1499 Natural Resource Ecology Laboratory	University of Nebraska Carbon, Water & Land Use in Conservation Reserve Program Lands…	$107,432.00
Chimner,Rodney A	1499 Natural Resource Ecology Laboratory	University of Nebraska C, N & H2O Dynamics in Mixed-Grass Prairie Following Coupled Changes in Winter Snow & Summer Precipitation	$120,009.00
Lee,Chun Man	1877 Statistics	UCAR-NCAR-Nat Ctr for Atmospheric Res Statistical Research for Weather Prediction & Climate Change	$5,961.43

Joseph Sax
University of California, Berkely

Private Property vs. Public Rights: Untangling the Mess

Thursday , March 3rd, 7 p.m.
220 Lory Student Center
CSU Campus, - Fort Collins, CO
Open to the public.

Sponsored in part by the MAC Foundation

Calls for Papers

USCID's Conference on "SCADA and Related Technologies for Irrigation District Modernization"
Call for Papers available online -- www.uscid.org/05scada.html.
The deadline for abstracts for the SCADA Conference is March 15.
Registration available online, also.
Larry D. Stephens, Executive Vice President
U.S. Committee on Irrigation and Drainage
1616 17th Street, #483
Denver, CO 80202 USA.
telephone: 303-628-5430
fax: 303-628-5431
e-mail: stephens@uscid.org
internet: www.uscid.org

Seminars

Western State College of Colorado
Gunnison, Colorado
"Water & The West" Short Courses and Workshops

"Western Water History, Law & Politics" (July 20-22, 1 credit)
"Natural History of the Gunnison River Basin" (primarily a field experience, July 22-26, 2 credits)
30th Annual "Colorado Water Workshop" (July 27-29, 1 credit).

For information about costs, times, et cetera, contact George Sibley at 970-943-2055, gsibley@western.edu.

25th Annual - American Geophysical Union

Hydrology Days

March 7 - March 9, 2005

Cherokee Park Room - Lory Student Center - Colorado State University
Fort Collins, Colorado, U.S.A.
Borland Lecturer in Hydraulics : Gary Parker, University of Minnesota
Borland Lecturer in Hydrology : Renzo Rosso, Politecnico di Milano, Milan, Italy
Hydrology Days Award: Dr. Charles A. Troendle, Rocky Mountain Research Station, U.S. Forest Service (Ret.)

For more information go to: http://hydrologydays.colostate.edu/

Seminars with Water Topics at Colorado State University for Spring 2005

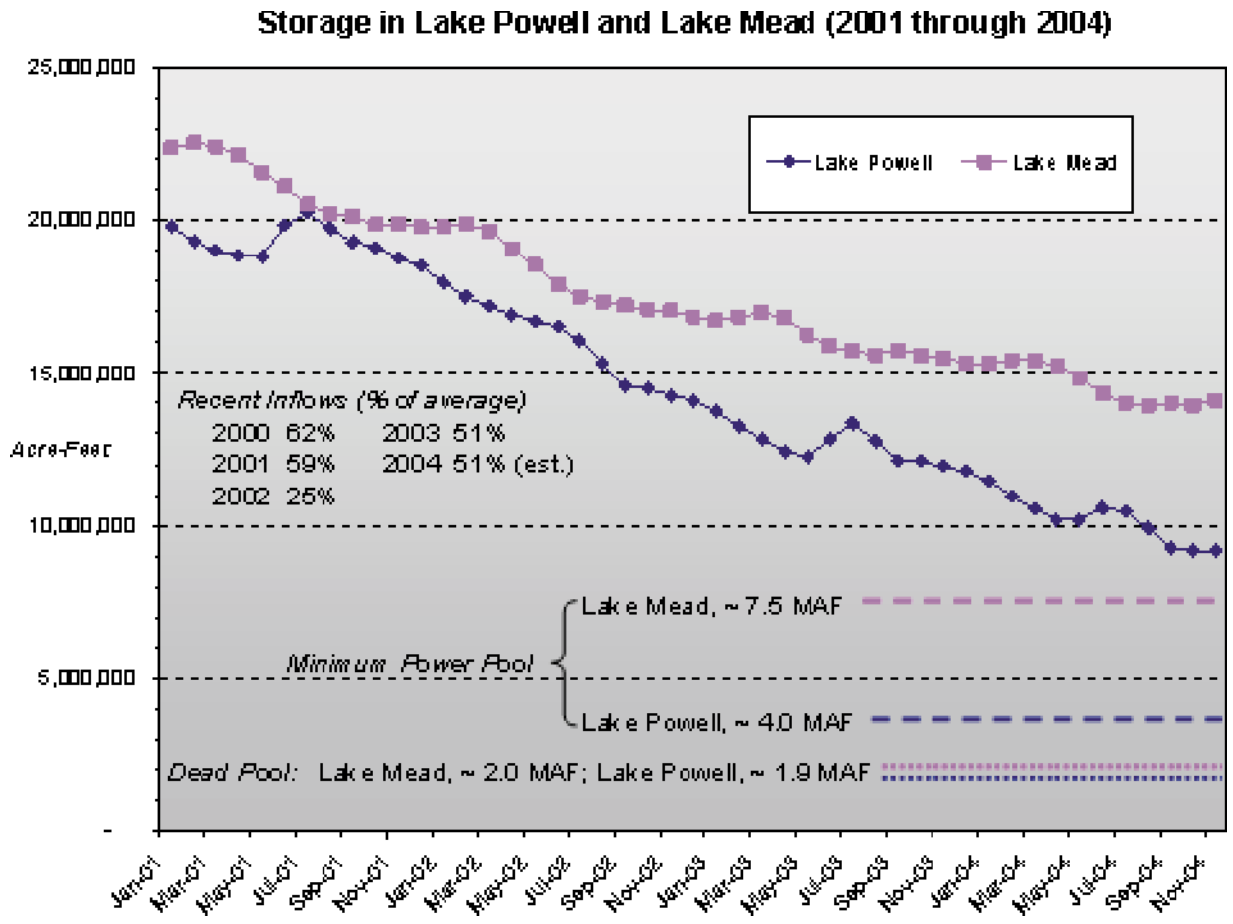
Date, Time and Location	Series/Sponsors	Speaker, Title of Presentation
Febr 28th, Mon noon to 1 p.m. 110 Animal Sciences Bldg, CSU Campus Fort Collins, CO	Dept of Agricultural and Resource Economics CSU Dept of Economics U.S. Forest Service Rocky Mountain Research Station	**Carol Malesky** Integrated Utilities Group, Denver, CO **Is Marginal Cost Pricing of Municipal Water to Encourage Conservation Practical for Front Range Utilities?**
March 3rd , Thurs, 7 p.m. 220 Lory Student Center, CSU Campus Fort Collins, CO	Dept of Agricultural and Resource Economics CSU Dept of Economics U.S. Forest Service Rocky Mountain Research Station MAC Foundation	**Joseph Sax** University of California—Berkeley **Private Property vs. Public Rights in Water: Untangling the Mess**
March 4, Fri 4:00pm A202 Clark CSU Campus Fort Collins, CO	Distinguished Ecologist Series Department of Fishery and Wildlife Biology	**Graham Farquhar** Environmental Biology Group, Research School of Biological Sciences, The Australian National University **Trends in Pan Evaporation, Global Dimming and Brightening: Theory, Observations and Implications for the Terrestrial Water Balance** For more information go to : http://www.colostate.edu/Depts/GDPE/Distinguished_Ecologists/overview.htm
April 8, Fri 4:00pm A-202 Clark CSU Campus Fort Collins, CO	Distinguished Ecologists Series Department of Fishery and Wildlife Biology	**Bruce Hayden** Department of Environmental Sciences University of Virginia **Storm Climates and Vegetation** For more information go to : http://www.colostate.edu/Depts/GDPE/Distinguished_Ecologists/overview.htm

Meetings

Save the Dates! June 8-10, 2005

Hard Times on the Colorado River: Drought, Growth and the Future of the Compact

26th Summer Conference of the Natural Resources Law Center, University of Colorado School of Law (Boulder)



The precipitous drawdown of Lakes Powell and Mead is once again highlighting a host of legal, policy and management issues clouding the long-term future of the Colorado River. Please join us in June for an exploration of topics pertaining to the Law of the River, the ability of the system to meet delivery and hydropower obligations, potential impacts of shortages to water users and the environment, and solutions for future management.

Topics, speakers and co-sponsors are currently being sought by the conference organizers. Contact Doug Kenney at the Natural Resources Law Center to inquire further and to make suggestions (Douglas.Kenney@colorado.edu, 303-492-1296). Additional details at: www.colorado.edu/law/summerconference

Major Co-Sponsors: CU/NOAA Western Water Assessment, CADSWES, Hydrosphere Resource Consultants, Rocky Mountain Mineral Law Foundation, and others

Arkansas River Basin Water Forum
"Cool Clear Water"

April 7 and 8, 2005
Quality Inn
Trinidad, Colorado

For more information visit www.arbwf.info or contact Thelma Lujan, 719-846-7285.

The Program and Registration Form for our
Third International Conference on Irrigation and Drainage
to be held in San Diego, CA
March 30-April 2
are now on-line - www.uscid.org/05idconf.html.

This will be an outstanding Conference with participants from around the world -- please plan to join us there!

30th Colorado Water Workshop
at Western State College of Colorado in Gunnison.
July 27-29

A recap and analysis of what's happened over the past 30 years that no one could have imagined, and speculations about what is coming for the next 30 years.

For information about costs, times, et cetera,
contact George Sibley at 970-943-2055, gsibley@western.edu.

For recent Colorado news articles about water, visit these web sites:

Colorado Water Foundation for Education at http://cfwe.org/
and
Colorado Nonpoint Source Pollution Program News at
http://www.npscolorado.com/news.html

SWSI - January

Basin	Jan 1, 2005 SWSI Value	Change From Previous Month	Change From Previous Year
South Platte	+0.6	+0.9	+1.4
Arkansas	-0.3	-0.7	+1.5
Rio Grande	+1.3	0.0	+0.9
Gunnison	+1.7	-0.7	+1.9
Colorado	+0.2	-0.3	+1.3
Yampa/White	-1.2	-1.0	-2.1
San Juan/Dolores	+0.8	-1.0	+0.2

Scale

-4 -3 -2 -1 0 1 2 3 4

Severe Drought | Moderate Drought | Near Normal Supply | Above Normal Supply | Abundant Supply

None of the SWSI values are drastically high or low, indicating conditions around the state at the beginning of the year were close to normal. January 1 snowpack was below normal in the northern mountains and above normal in the southern mountains, although neither fluctuation was extreme. Some of the index stream gaging stations shown on the following pages were above normal, some were below normal. Cumulative storage in the reservoirs shown in this report was 89% of average on January 1.

Post-January 1 storms provided a large boost to the snowpack across the state. While this brightens the possibilities for a good runoff next spring and summer, continued snowpack accumulation into April and spring temperature and wind conditions will have a significant impact on how beneficial the runoff will be.

The Surface Water Supply Index (SWSI) developed by this office and the U.S.D.A. Natural Resources Conservation Service is used as an indicator of mountain-based water supply conditions in the major river basins of the state. It is based on snowpack, reservoir storage, and precipitation for the winter period (November through April). During the winter period, snowpack is the primary component in all basins except the South Platte basin where reservoir storage is given the most weight. The following SWSI values were computed for each of the seven major basins for January 1, 2005, and reflect the conditions during the month of December.

For this report and past SWSI reports, go to www.water.state.co.us.

Short Courses

University of Colorado at Denver

Feb. 19 to Mar. 10 -- Fundamentals of Engineering Examination Refresher Course (NCES 8030)

Mar. 11, 18, and Apr. 1 -- Western Water Rights and Water Engineering (NCES 8380)

For more information go to www.cudenver.edu/engineering/cont

ROCKY MOUNTAIN SECTION, GSA
57th Annual Meeting
Mesa State College
Grand Junction, Colorado
May 23-25, 2005

The 57th Annual Meeting of the Rocky Mountain Section will be hosted by the Geology Program within the Department of Physical and Environmental Sciences, Mesa State College. The meeting will be held on the campus of Mesa State College.

Registration Information

The pre-registration deadline is April 18, 2005. GSA Headquarters will handle pre-registration. Registration details will be published in the February, 2005, issue of *GSA Today* and will be available at www.geosociety.org beginning in February, 2005. On-site registration will be in the W.W. Campbell College Center beginning Sunday, May 22 at 3:00pm.

Water- Related Symposia and Theme Sessions:

1. **Water Resources in the Colorado River Basin and the Western U.S. Co-chairs:** Robert Ward, Colorado State University, (970) 491-6308, Robert.Ward@colostate.edu; Gigi Richard, Mesa State College, (970) 248-1689, grichard@mesastate.edu

   This symposium will cover lessons learned from past water management and science efforts in the Colorado River basin (such as tree ring studies, biography of Wayne Aspinall, and an overview of legal developments) and how these lessons have been used to gain insight into current water supply issues facing the basin (such as Grand Canyon ecosystem health, recovery of endangered species in the upper Colorado River, and addressing the long-term yield limits of the basin). Invited speakers include Justice Greg Hobbs and Pat Mulroy from Las Vegas Water.

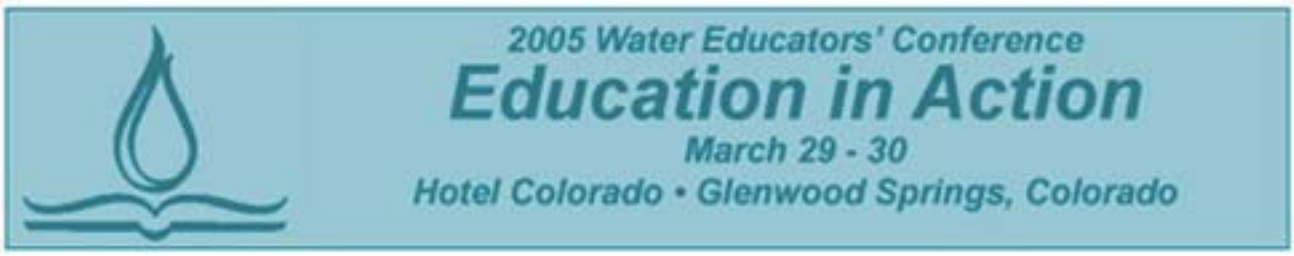
2. **Selenium-Sodium-Salinity-Sediment in the Upper Colorado River Basin: Origins and Impacts.** Co-chairs: Richard Grauch, U.S. Geological Survey, (303) 236-5551, rgrauch@usgs.gov; Paul von Guerard, U.S. Geological Survey, (070) 245-5257, pbvongue@usgs.gov.

   Submit abstracts by February 22, 2005. For more information, go to http://www.geosociety.org/ and select "meetings and excursions", then "2005 section meetings", then "submit an abstract". While emphasis will be placed on the upper Colorado River basin, process and impact oriented contributions addressing other portions of the river system or analogous systems will be welcome.

   This session will examine a variety of issues related to the health of the upper Colorado River Basin including the source, transport, and fate of selenium, sodium, salinity, and sediment. Topics include geomorphology; tectonics; physical and chemical erosion of sources; surface and ground water chemistry; sediment loads; impact on endangered species; distribution of native species; and effects of land-use and land-use planning.

3. **Buried Riches to Hazardous Wastes - Western Colorado's Uranium Legacy.**
4. **Mudslide Mania - Characteristics and Geologic Investigations of Debris Flows and Alluvial Fans in the Rocky Mountain Region**
5. **Sustainability of Ground-Water Resources of the Colorado Plateau.**
6. **The Colorado River System: Hydrology and Fluvial Processes.**

Additional Information:
For additional information contact general chair Rex Cole (970) 248-1599, rcole@mesastate.edu, vice chair Andres Aslan (970) 248-248-1614, aaslan@mesastate.edu, technical co-chairs Andres Aslan (970) 248-248-1614, aaslan@mesastate.edu, and Rick Livaccari (970) 248-1081, rlivacca@mesastate.edu, or the field trip chair, Gigi Richard, (970) 248-1689, grichard@mesastate.edu.



Sponsored by:

This two-day networking opportunity is geared toward water professionals and informal educators who teach both adults and children about the importance and management of Colorado's water resources.

Tuesday, March 29 - 1:00-5:30 p.m. K-12 Education

- **Keynote Speaker - 5th, 8th & 10th Grade Science Testing in 2006, Helping Teachers Prepare:** *Dr. Ray Tschillard, Greeley Schools District 6; Wendy Hanophy, Colorado Division of Wildlife*
- **Choice and Consequences:** *Betty Blinde, Colorado Foundation for Agriculture*
- **Teaching the Poetry of Rivers:** *Dr. Kathryn Winograd, Arapahoe Community College*
- **Project WET - Tried, True and New:** *Gerry Saunders, University of Northern Colorado*
- **K-12 TEACHER PANEL:** Practicing Teachers Report on the Success and Failure of Water Education in the Classroom

Wednesday, March 30 - 8:30 a.m.-3:45 p.m. Adult & Community Education

- **Keynote Speaker - Reporting on Water and the Environment:** *Jerd Smith, Rocky Mountain News (invited)*
- **AWARE Colorado:** *Cynthia Peterson, Colorado League of Women Voters*
- **Walking Through the Water Year:** *Nolan Doesken, Colorado State University*
- **Water & Property - What Realtors Need to Know:** *Jack Ferguson, Colorado Association of Realtors*
- **PANEL DISCUSSION:** Educators from Conservancy Districts, Watershed Groups, Utilities & Government Agencies Review Their Most Popular Program

Education in Action Reception starting at 5:30 p.m. March 29, offers participants a great venue to showcase their best programs and products. A wonderful networking opportunity for water education professionals. Sign up for your FREE exhibit booth!

Who Should Attend? Water or environmental educators from conservation districts, watershed groups, municipalities, state and federal agencies, water districts, private or charter schools, science educators from all over the state.

To register contact Susan Bond, the Conference Coordinator, at 303-996-9998 or visit our Web site at www.cfwe.org

CALENDAR

Feb. 14-15	**2nd National Water Resources Policy Dialogue.** Tucson, AZ. For more information go to: http://www.awra.org .
Feb. 19 – Mar. 10	**Fundamentals of Engineering (FE) Examination Refresher Course**, Saturdays, NCES 8030 . Denver, CO. University of Colorado at Denver Continuing Engineering Education Program. For more information go to: www.cudenver.edu./engineering/cont .
Feb. 17	**Big Thompson Watershed Forum Annual Meeting.** McKee Conference Center. Loveland, CO 613-6166 for more information.
Feb. 22	**Bureau of Rec. Projects in Colorado.** Denver, CO. For more information go to http://www.awra.org/state/colorado/ .
Feb. 23	**Lower South Platte Forum.** Sterling, CO. For more information contact Joel Schneekloth, jschneek@coop.ext.colostate.edu .

Mar. 11, 18 and April 1	**Western Water Rights and Water Engineering**, NCES 8380, Fridays, 10:00 a.m. – 5:00 p.m. $550. University of Colorado at Denver Continuing Engineering Education Program. For more information go to: www.cudenver.edu./engineering/cont .
Mar. 21-25	**Applied Environmental Statistics** ID # 05-1 with Denis Helsel and Ed Gilroy. Colorado School of Mines. Golden, CO. For information go to http://typhoon.mines.edu/short-course/.
Mar. 24-25	**Water Education Foundation's Executive Briefing: A Year of Turning Points and Decisions.** Sacramento, CA. For more information go to: www.watereducation.org.
Mar. 29	**Fountain Creek USACE Watershed Study.** Denver, CO. For more information go to: http://www.awra.org/state/colorado/ .
Mar. 30 – Apr. 2	**USCID Third International Conference on Irrigation and Drainage**: **Water District Management and Governance.** San Diego, CA. For more information go to: http://www.uscid.org/05idconf.html
Apr.	**Annual Symposium of American Water Resources Association Colorado State Section.** For more information go to: http://www.awra.org/state/colorado/ .
Apr. 7-8	**Arkansas River Basin Water forum (ARBWF)** For more information check the website at http://arbwf.info/ .
Apr. 7-8	**Water Management and Policy in the Great Plains: Implications of Drought and Climate Change, Second Annual Water Law, Policy, and Science Conference.** University of Nebraska-Lincoln. Lincoln, NE. For more information go http://snr.unl.edu/waterconference/ .
May 19-20	**Urban Flood Channel Design and Culvert Hydraulics.** University of Colorado at Denver Continuing Engineering Education Program. For more information go to: www.cudenver.edu./engineering/cont .
May 23-25	**Rocky Mountain Section, Geological Society of America, 57th Annual Meeting,** Mesa State College, Grand Junction, CO. For more information go to www.geosociety.org. See also Selenium-Sodium-Salinity-Sediment in the Upper Colorado River Basin below.
May 23-25	**Selenium-Sodium-Salinity-Sediment in the Upper Colorado River Basin: Origins and Impacts**, Mesa State College, Grand Junction, CO. For more information go to http://www.geosociety.org/ and select "meetings and excursions, then select 2005 section meetings. see also RMS,GSA, above.
May 24	**Scholarship recipient presentations of American Water Resources Association Colorado State Section.** Denver, CO**.** For more information go to: http://www.awra.org/state/colorado/ .
Jun. 8-10	**Hard Times on the Colorado River: Drought, Growth, and the Future of the Compact,** Natural Resources Law Center, University of Colorado School of Law, Boulder, CO. For more information go to www.colorado.edu/law/summerconference .
Jul. 12-14	**2004 NIWR Annual Conference. River and Lake Restoration: Changing Landscapes.** Portland, Maine. For more information go to: www.ucowr.siu.edu.
Jul. 20-22	**Western Water History, Law and Politics (1 credit course).** Western State College of Colorado, Gunnison, CO. For fee and schedule information contact George Sibley at 970-943-2055 or gsibley@western.edu.
Jul. 22-26	**Natural History of the Gunnison River Basin (2 credit course).** Western State College of Colorado, Gunnison, CO. For fee and schedule information contact George Sibley at 970-943-2055 or gsibley@western.edu.
Jul. 27-29	**30th Colorado Water Workshop.** Western State College of Colorado, Gunnison, CO. For fee, college credit, and schedule information contact George Sibley at 970-943-2055 or gsibley@western.edu.
Aug. 8-19	**Dam Safety, Operation, and Maintenance International Technical Seminar and Study Tour**, Denver, CO. For more information go to www.usbr.gov/international.
Aug. 25-26	**Colorado Water Congress 2005 Summer Convention.** Steamboat Springs, CO. For more information go to: www.cowatercongress.org, or phone 303/837-0812, or email macravey@cowatercongress.org .
Oct. 13-15	**MODFLOW: Introduction to Numerical Modeling** ID # 05-2 with Eileen Poeter Colorado School of Mines, Golden, CO. For more information go to: http://typhoon.mines.edu/short-course/.
Oct. 17-18	**UCODE: Universal Inversion Code for Automated Calibration** ID # 05-3 with Eileen Poeter. Colorado School of Mines, Golden, CO For more information go to: http://typhoon.mines.edu/short-course/.
Nov. 6-10	**American Water Resources Association 2005 Annual Conference.** Seattle, WA. For more information go to: http://www.awra.org/ .

Dec. 5	Call for papers: Proposals for MODFLOW and More 2006: Managing Ground-Water Systems (May 22-24, 2006). For submittal criteria go to http://typhoon.mines.edu/events/modflow2006/abstract_form.shtml.
2006	2006
Jan. 26-27	**Colorado Water Congress 48th Annual Convention.** Denver, CO. For more information go to: www.cowatercongress.org, or phone 303/837-0812, or email macravey@cowatercongress.org .
May 22-24	**MODFLOW and More 2005: Managing Ground-Water Systems**. International Ground Water Modeling Center. For more information go to http://typhoon.mines.edu/events/modflow2006/modflow2006.shtml
2007	2007
Jan. 25-26	**Colorado Water Congress 49th Annual Convention.** Denver, CO. For more information go to: www.cowatercongress.org, or phone 303/837-0812, or email macravey@cowatercongress.org .

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