



# COLORADO WATER

Newsletter of the Water Center at Colorado State University

JUNE 2003

Annual Hydrology Days Conference Honors John Dracup, University of California at Berkeley, and José Salas of Colorado State University. From left: John Dracup, José Salas, and Jorge Ramirez, Chair of the Organizing Committee for Hydrology Days.

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## EDITORIAL



### DELPH CARPENTER

by Robert C. Ward, Director

In the last issue of Colorado Water, publication of a new Delph Carpenter biography was announced. Dan Tyler, Professor Emeritus in History at Colorado State University, is the author of the biography, entitled *Silver Fox of the Rockies*. I read the new biography and want to share several of my observations about the book and the important western water history it addresses.

Besides the usual sources of information used to prepare such a biography, Dan had access to the Carpenter family papers – papers that cover the Carpenter family's move to Colorado during the founding of the Union Colony as well as a diary that Delph Carpenter maintained over the years. The extensive personal resource materials provide unusual insight into the life, times, tribulations, and water compact accomplishments of Delph Carpenter.

For those of you not familiar with Delph Carpenter, he was a Greeley water attorney in the early 20<sup>th</sup> century who stepped forward, often at great personal sacrifice, to help Colorado adjust to new legal requirements that states share the water in western rivers. He brought forward the compact clause in the U.S. constitution as a legal mechanism for the states to agree on division of western river flows, rather than using lawsuits before the U.S. Supreme Court. He is considered the 'Father of the Colorado River Compact' as well as a number of other river compacts to which Colorado is a participant.

Being a student of Colorado water history, I found the Delph Carpenter biography reveling and insightful. The description Dan Tyler provides of the founding of the Union Colony, into which Delph was born in 1877, provides a context for Delph's frontier individualism that guided his participation in western water negotiations. Understanding Delph's views of water

use and ownership helps people better understand the history of western water conflicts. In particular, the tensions between the Federal and state levels of government are a major part of Delph's work and it represents a history that is very much alive and real today.

The book reveals that some aspects of water use and management in Colorado do not change, while others change dramatically. On the side of no change, I was struck by Delph's observation in the late 1800s that newcomers to Colorado did not appreciate the way it was necessary to manage water in a semi-arid state. This aspect of water management in Colorado has definitely not changed.

An overriding theme in the book, however, and one that I found compelling, was constant change imposed on Colorado water management practices by development of the West, not just in Colorado, but in all downstream states. The early disputes between the states brought the U.S. Supreme Court into the allocation of the water in western rivers, whose legal decisions forced Colorado to change its strategy for water development.

The book highlights Delph's leadership in helping Colorado adapt to larger changes in the West in a way that minimized future negative impacts on the State. For example, during the late 1800s and early 1900s, Colorado water managers assumed that all the water originating in Colorado was available for use in Colorado. When Wyoming sued Colorado over plans to divert the entire flow of the Laramie River, the U.S. Supreme Court ruled that Colorado did not own all the flows originating in the State. Delph realized the uncertainties that faced Colorado, as a result of the Laramie River decision, and began, against the desires of many in the State, to formulate a legal response.

CSU President, Al Yates, in his address to the 2003 Colorado Water Congress

Annual Convention about values and leadership, noted that Delph Carpenter, today, is widely recognized as a rare visionary and consensus builder – a true western water leader for his lifetime of work developing water compacts in a very contentious environment. Delph's accomplishments, however, did not come easy. Quoting Dr. Yates talk, as published in the Spring 2003 Colorado Water Congress newsletter, Colorado Water Rights:

Carpenter himself observed that the criticism and scrutiny he endured because of his leadership in this effort isolated him in his profession and burdened him, at times, with a almost overwhelming loneliness. Yet, he rose to the challenge in spite of the uncertainty and these personal sacrifices. Somehow, he seemed always able to summon the courage to do the right thing. Still, his experience is a reminder that leadership demands a great deal from those who are called upon to provide it.

While making major contributions to Colorado's, and the West's, water management arrangements in the early 1900s, Delph was faced with major health problems and financial difficulties. When these two issues are considered, it is truly amazing that Delph Carpenter was able to make the contributions he did to western water management. He is an inspiration to all of us who work with Colorado's water resources.

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*Silver Fox of the Rockies*, by Dan Tyler, is available from the University of Oklahoma Press, 4100 28<sup>th</sup> Ave., N.W., Norman, OK 73069-3515.



## UPPER YAMPA WATER CONSERVANCY DISTRICT SCHOLARSHIPS AWARDED AT CSU

The Upper Yampa Water Conservancy District (UYWCD) is funding two scholarships during its third year of offering its support to CSU students preparing for careers in water-related fields. The scholarship program is administered by the CSU Water Center.

The scholarships provide financial assistance to committed and talented students who are pursuing water-related careers at CSU. The UYWCD \$2,500 scholarships are open to any major at CSU.



Dan Smith and Reagan Waskom, members of the CSU Water Center Scholarship Committee, (left and right ends of picture) congratulate Dan Woolley and Joel Wixson for receiving 2003-04 Upper Yampa Water Conservancy District Scholarships.

Criteria for the scholarships are: the recipient must be a full-time student enrolled at CSU; financial need may be considered; preference is given to students from the Yampa Valley area; and a minimum GPA of 3.0 is required. The scholarships are for one year.

The two Upper Yampa Water Conservancy District scholarship recipients

for the 2003-04 academic year are Joel Wixson and Dan Woolley.

Joel Wixson is a junior majoring in both Fishery and Wildlife Biology and Mathematics. Joel, who is from Hayden, Colorado, plans to pursue a career in some aspect of managing fisheries. As Joel points out, you cannot manage fish with-

out water, thus his interest in relating fish management to water management. He is interested in searching for the water-use balance that makes both fish and people happy. Joel worked on a CSU research project studying jumping brook trout. He is a member of the CSU Men's Ultimate Frisbee team and a coach for a youth soccer team in Hayden, among his many activities.

Dan Woolley, a junior majoring in Watershed Sciences at CSU, is from Glenwood Springs, Colorado. Dan plans to work in the general area of river restoration, somewhere in Colorado. Dan is currently working with Professor Lee MacDonald on a project studying hill slope hydrology in the Hayman fire burn area. He likes to be outdoors hiking, biking, skiing and kayaking. He has worked in the construction field for a number of years, including one year as a surveyor.



### Governmentwide e-grant site to debut in October

The federal government expects to have a single Web site for posting information on all available grants by October 2003. Ed Sontag, the assistant secretary for administration and management at the Health and Human Services Department, told a congressional panel that the department is the lead entity coordinating the e-grants initiative. It involves 25 other federal department and agencies that distribute \$400 billion in federal grants annually.

Linda Springer, controller for the Office of Federal Financial Management at the White House Office of Management of Budget, also testified that the office is working on streamlining government standards for grant applications, an effort that should be finalized by June. Recipients of federal grants have complained that they must know different standards and procedures for each agency and that the situation has been compounded by each agency crafting its own electronic grants system.

See the website at <http://www.govexec.com/dailyfed/0403/042903td2.htm>

National Journal's Technology Daily, April 29, 2003

## RESEARCH


 STREAM/AQUIFER ANALYSIS TESTS:  
 ESTIMATING AQUIFER AND STREAMBED PERMEABILITY

by

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## Introduction

Our research focuses on quantifying the complex interactions between surface water and ground water in stream/aquifer alluvial systems such as that found in the South Platte River Basin in Colorado. Understanding and quantifying these interactions will become more important as water managers struggle to meet the rapidly increasing demands on limited water resources in the semiarid west.

One aspect that we have studied in detail is the hydrologic exchange that occurs when pumping wells are located adjacent to streams. Many of the same concepts apply to managed groundwater recharge systems used to retune streamflows to allow out-of-priority well pumping. Managed groundwater recharge systems divert water from the river to recharge ponds during high-flow, low-demand periods. The diverted water infiltrates to the aquifer below the ponds and returns as sub surface flow to the river to augment streamflows at later times, during low-flow, high-demand periods. In the first case, water is drawn from the stream in response to pumping. In the second case, water is added to the stream from the recharge system.

There are two hydrologic factors that are particularly important to both the recharge and depletive interchange. These are the streambed permeability and the permeability of the aquifer.

Aquifer tests are typically performed to estimate aquifer permeability. In an aquifer test, a single well extracts ground water at a constant discharge rate and water levels are measured in observation wells. The observed water level response or drawdown is fit to an appropriate analytical equation to estimate the aquifer permeability using a “best-fit” procedure. The equations typically used, however, have a number of limit-

ing, simplifying assumptions. In particular, the permeability of the streambed is assumed to be the same or similar to that of the aquifer. In our research, we found that low streambed permeability can have significant effects on the interchange

of water between a stream and aquifer. The permeability of the streambed can be measured using field techniques (Landon et al., 2001), as demonstrated in Figure 1. However, field measuring the permeability results in localized estimates with large variations between points, making it difficult to determine a best estimate.

We developed an analytical equation that accounts for a low permeability streambed. Using this improved equation, we can estimate simultaneously the aquifer permeability and a “representative” streambed permeability using a single stream/aquifer analysis test that is no more difficult to perform than an aquifer test commonly used to estimate aquifer permeability alone.

## Stream/Aquifer Analysis Test Methodology

A stream/aquifer analysis test was performed at the Tamarack State Wildlife Area in Eastern Colorado (Figure 2). A pumping well (R3 in Figure 2) located 94 m from a 7-m wide backwater river channel (“slough” in Figure 2) was pumped at a constant discharge rate of 2000 gpm for 24 hours. Water levels were measured in five observation wells, the slough, and the South Platte River. We also measured streambed permeability in both the slough and river. The permeability in the South Platte River is similar to that in the aquifer; however, the permeability in the slough is much lower than the aquifer.

The water level measurements are fit to an analytical solution (Fox, 2003; Fox et al., 2002) to estimate the aquifer parameters and sloughbed permeability. The “best fit” between the



Figure 1. Field measuring the streambed permeability in the South Platte River.

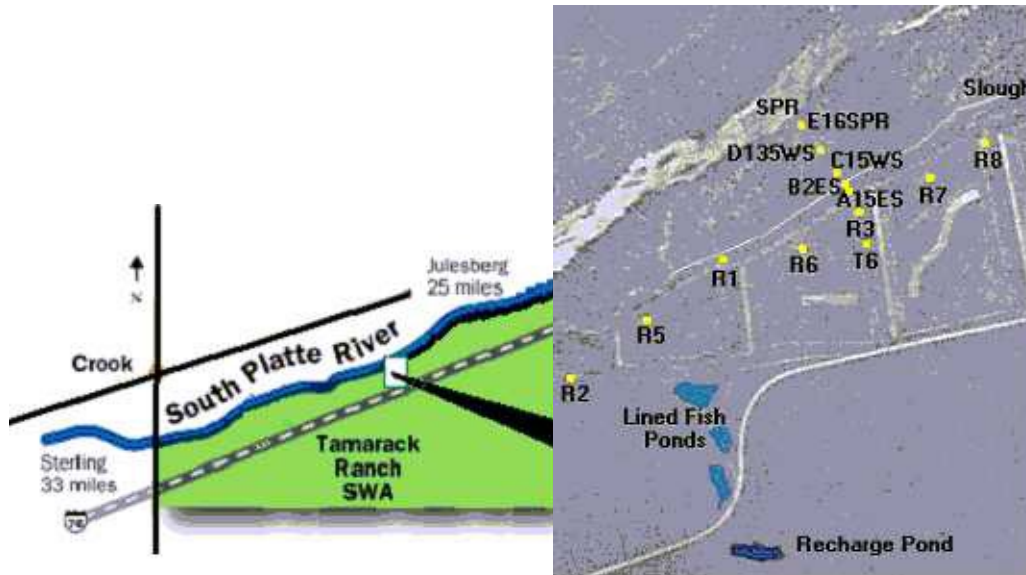


Figure 2. Depiction of the stream/aquifer analysis test performed next to the slough channel at the Tamarack State Wildlife Area. R1, R2, R3, R5, R6, R7, and R8 are pumping wells. SPR is the South Platte River. T6, A15ES, B2ES, C15WS, D135WS, and E16SPR are observation wells.

analytical solution and the drawdown data from two observation wells at the Tamarack State Wildlife Area is shown in Figure 3. Results are shown in Table 1, along with estimates of the parameters from other aquifer tests performed at the site

and in-stream measurements of the sloughbed permeability. As table 1 shows, the stream/aquifer test predicted both aquifer and sloughbed permeabilities that agree well with independently measured values.

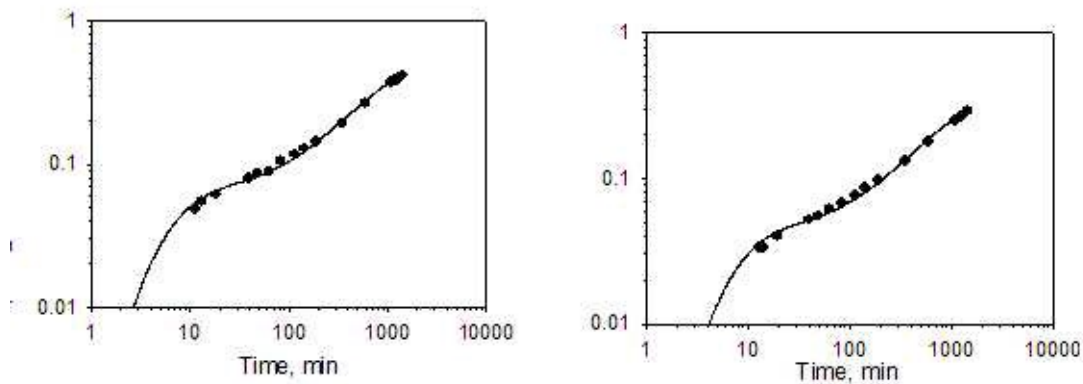


Figure 3. Comparison of field measured (●) and predicted drawdown (—) for observation wells A15ES and B2ES (Fox, 2003).

Table 1. Comparison of documented and inversely estimated aquifer and sloughbed parameters from the stream/aquifer analysis test of Fox (2003).

Parameter	SAA Test	Independently Measured
Aquifer Permeability, K	125 - 130 m/d*	120-140 m/d
Specific Yield, Sy	0.20 - 0.22	0.15-0.20
Streambed Permeability, Ksb	0.1 - 0.5 m/d	0.1-1.0 m/d

\* m/d = meters per day

## Conclusions

Research in the last several years has improved the capability of hydrologists to analyze stream/aquifer interaction during alluvial well depletion. An important hydrologic factor influencing the seepage from the stream in response to alluvial well pumping is a streambed of lower permeability than the aquifer. The streambed influences both the rate and quality of water exchange as well as stream ecology and fluvial temperature regimes.

Stream/aquifer analysis tests are an alternative to point sampling bed permeability in the field. In these tests, aquifer drawdown data are matched to analytical solutions that account for lower streambed permeability to estimate aquifer and streambed parameters. This test is similar to an aquifer test that is commonly used by hydrogeologists to estimate aquifer permeability.

The following conditions are most suitable for a stream/aquifer analysis test:

- A single pumping well at a constant discharge rate located close to a stream or slough with low bed permeability
- No other pumping or recharge sources near the study area
- Water levels measured for at least 24 hours in at least two observation wells, one located near the stream and one installed near the pumping well
- Straight, long stream or slough
- Constant water level in the stream or slough

## Acknowledgements

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### EPA Voluntary Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems Now Available May 5, 2003

EPA Assistant Administrator for Water, G. Tracy Mehan III, announced the release of new guidelines that are designed to help local governments strengthen their management of septic systems and other small, privately owned wastewater treatment systems.

The Voluntary Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems complements EPA's efforts to help state and local governments strengthen their oversight of septic systems and other small, privately-owned wastewater treatment systems. EPA worked with stakeholders from the public and private sectors to develop these voluntary management guidelines. The guidelines along with an accompanying management handbook, titled, Handbook for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems are now available for public comment, to provide local governments with a risk-based model for evaluating local conditions, and contains a five-tier system which helps develop an appropriate management program to address local conditions.

EPA has been working to help local governments build better septic system management programs. EPA recently released a CD-based outreach kit to assist communities in their efforts to educate citizens about proper septic system management.

The Voluntary Guidelines document (EPA 832-B-03-001) is available for download at [www.epa.gov/owm/onsite](http://www.epa.gov/owm/onsite). Copies are also available by calling (800) 490-9198. The public is also invited to review and comment on the companion handbook for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems. The public comment period closes on May 27, 2003.

For more information, please contact Joyce Hudson at (202) 564-0657 or Steve Hogue at (202) 564-0631.



PRELIMINARY SUMMARY OF THE  
2002 COLORADO DROUGHT SURVEY  
“WEATHERING TOUGH TIMES”

by

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To analyze how Colorado producers changed their on-farm production practices in response to the drought, researchers in the Department of Agricultural and Resource Economics at Colorado State University, in cooperation with researchers from the Climate Diagnostic Center of the National Oceanographic and Atmospheric Administration in Boulder, conducted the “Weathering Tough Times” drought survey in the Fall of 2002.

#### Introduction

The summer of 2002 brought drought conditions across much of the state that were comparable to the most extreme conditions observed in Colorado history. While the return of rains this spring and above-normal snow pack conditions offer welcome relief, the effects of 2002 linger and continued precipitation for the upcoming growing season remains uncertain. This tenuous break from the grip of the drought allows us an opportunity to examine the impacts of the drought and to learn how people responded so that we may be better prepared for the inevitable return to drought conditions, whether it be in the next year or a decade from now.

As the dominant user of water in the state of Colorado, agriculture was particularly hard hit by the drought of 2002. Winter wheat, the most widely planted crop in Colorado by acreage, saw production fall by nearly 30 million bushels between 2001 and 2002, a reduction of almost 60 percent (NASS “Crop Production”, 2003). Livestock, which accounts for almost 60 percent of the state’s agricultural economy, were also severely affected. At the start of 2003, total cattle numbers in the state were down 14 percent from 2002 levels (NASS “Cattle”, 2003).

The drought impacted Colorado’s agricultural economy both directly and indirectly. Direct impacts were mostly damages in the form of production losses due to low water supplies. Indirect impacts came through the decisions forced on producers

by a lack of water. The indirect affects arose from changes in production practices and enterprise management by individual producers and are the aspect of drought that is under human control. Ideally, these decisions will mitigate the direct effect and improve the likelihood of a farm or ranch surviving a drought. Unfortunately, some do not.

Winter wheat, the most widely planted crop in Colorado by acreage, saw production fall by nearly 30 million bushels between 2001 and 2002, a reduction of almost 60 percent...At the start of 2003, total cattle numbers in the state were down 14 percent from 2002 levels...

The survey questioned 3,501 randomly selected agricultural producers about changes in their farm and ranch management caused by drought. Producers with operations covering more than 50 acres were drawn from the Colorado Agricultural Statistics Service producer database and mailed a questionnaire on October 25<sup>th</sup>, 2002. Following the Dillman procedure, a single reminder

letter was mailed to survey recipients one week later (Salant and Dillman, 1994).

Questions in the survey covered all facets of agricultural production in Colorado, including irrigated and dryland farming as well as livestock grazing and feeding. Respondents were asked both how they changed their production and water management practices in response to the drought, and how these drought-induced decisions affected the farm’s financial standing. The survey also explored the role of climate and weather information in the decision making in response to the drought. Additionally, the survey addressed how producers intended to respond in 2003 year whether drought conditions persisted or abated across the state. Finally, producers were asked what



effect the drought had on the farm's financial health. As such, data from this survey provides one of the best indications not only of the effects of last year's droughts, but of the potential responses to this year's water supply conditions.

#### Preliminary Assessment of the Effects of Drought on Irrigators

Nearly 30 percent of those surveyed have responded since the questionnaire was mailed. While we have only recently completed entering the data, we have had an opportunity to perform a preliminary summary of irrigator response that we share in this article. More extensive analysis will be reported as our work progresses.

To start, we can relate just how short of water producers were across Colorado in 2002. Approximately 54 percent of all survey respondents indicated that they used irrigation water for their production. Among these respondents, 14 percent reported receiving no irrigation water at all during the 2002 growing season. Irrigators who did receive water generally received only about 50 percent of their typical supplies.

Water shortages were particularly severe for irrigators who receive their water from irrigation districts or ditch companies. For these irrigators, who comprised 70 percent of all irrigators, the average proportion of delivered shares was only 32 percent. Nearly 24 percent of irrigators receiving water from irrigation districts or ditch companies received no deliveries at all. Those irrigators who relied on other sources of water, primarily ground water or direct surface diversions, had higher water supplies than irrigators who received water only from irrigation districts or ditch companies.

The critical economic issue is how irrigators responded in their on-farm management to these extreme water shortages. Preliminary assessment of the drought survey reveals several trends in on-farm management. Among the returned surveys, approximately 57 percent were involved in irrigated crop production. This group of producers represents the largest category of participants in the survey, and the group of producers most susceptible to drought.

The most common changes in irrigated production during 2002 related to acreage adjustments. The most common decisions reported were fallowing and abandoning a growing crop. The number of irrigators who chose each of these options is discussed below.

Previous studies have found that the most common short-run response to drought is fallowing (Sunding et al., 1997). Our survey responses among Colorado producers confirm this

general finding. Among survey respondents involved in irrigated crop production, approximately 30 percent indicated that they had responded to the drought by fallowing acreage. Nearly half of these acres were fallowed late in the spring, typically in April, May and June. However, the proportion of total on-farm acreage fallowed generally was rather small. Among producers who fallowed irrigated acreage, most

indicated that they had fallowed only between 10-30 percent of their irrigated acreage.

In addition to fallowing, irrigators also abandoned growing acreage. Nearly 30 percent of all irrigated producers in the sample indicated that they had

abandoned growing crops, generally in the summer months of June, July and August. Most of the abandoned acres were relatively high water consumption crops, typically alfalfa and corn. Abandoning a growing crop is comparable to fallowing acreage because water usage is stopped completely rather than attempting to reduce water usage in other ways. Given the number of irrigators who reported having no water deliveries at all, these responses were not surprising.

**The most common changes in irrigated production during 2002 related to acreage adjustments. The most common decisions reported were fallowing and abandoning a growing crop.**

**What irrigators did not do is almost as telling as what they did do.**

What irrigators did not do is almost as telling as what they did do.

While slightly over 20 percent of all irrigators reported deficit ir-

rigating their crops, relatively few irrigators attempted to grow irrigated acreage as dryland. Less than 7 percent of survey respondents indicating that they had converted irrigated acreage to dryland. As mentioned previously, it appears that irrigators instead chose to abandon this acreage. Irrigators also did not change crops in expectation of drought conditions. Only 4.5 percent of irrigators indicated that they had changed crops to cope with the drought. Most of those individuals were moving away from corn and toward a less water-intensive crop, typically sorghum. However, approximately 13 percent of respondents indicated that they would change crops if drought conditions continued in 2003. This behavior suggests that while irrigators did not opt to change their cropping rotations due to last year's severe drought conditions, they are willing to change their cropping patterns if drought persists.

Few irrigators chose either to adopt a new irrigation system or to make upgrades to existing irrigation systems. Only about 11 percent of all irrigators indicated that they had changed or modified their irrigation systems to increase their technical efficiency. About half of these changes were modifications of existing systems rather than investment in entirely new irrigation technology. The low number of irrigators who altered their irrigation systems may be attributable to a combination of a lack of financial capital, uncertainty about future water supplies, and/or expectations of low returns on the investment. However, in this preliminary assessment it is not possible to identify which

if any of these likely reasons explain the low adoption rates observed during the drought. An in-depth assessment of the low adoption rates for improved irrigation technology will be a point of critical interest in future analysis of irrigators' responses to the 2002 drought.

A relatively large proportion of irrigators reported making no changes at all in their production practices. The proportion of irrigators who reported making no changes is similar to the number of irrigators who either fallowed acreage or abandoned a growing crop.

Almost 20 percent of respondents indicated that they had not altered acreage or production practices in any way as a result of the drought. This relatively unaffected group corresponds roughly to the proportion of irrigators who reported being at 80 percent or more of their annual water supply last year. On the whole, it appears that irrigators either were severely impacted by the drought, or not affected at all.

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What Colorado producers did not do during the 2002 drought is sell water. Less than 1 percent of all respondents reported making permanent water sales, while slightly over one percent indicated that they had leased water for the growing season. Coupled with the response rates for seeking off-farm income or reducing farm living standards, these decisions suggest that most irrigated producers intend to remain in agriculture and are not selling their water assets.

Irrigators confirmed this perception through their responses to a question identifying how likely they were to exit agriculture as a result of the drought. Essentially, producers were asked to identify on a percentage basis how likely they were to leave agriculture within the next year if drought conditions continued. This response, with 100 percent indicating that a farmer or rancher absolutely intended to leave agriculture and with 0 percent indicating a firm commitment to continued production, was only about 20 percent for all

Many agricultural households responded to lower incomes caused by the drought by pursuing off-farm income, reducing family living standards, and pursuing federal assistance...it appears that Colorado producers tried to keep their operations in business mostly by finding money from non-agricultural sources and by sacrifices in the home. In the long run, these decisions may have consequences for both rural labor supplies and standards of living.

**Preliminary Assessment of Changes in Farm Finances**  
From a social perspective, it is critical to translate changes in on-farm production practices into financial impacts for the farm. While no definitive answer is yet available from the survey data, basic trends do emerge. These trends relate to off-farm income, reduction in family living standards, pursuit of federal assistance, sales of water, and the rate of exit from agriculture.

Many agricultural households responded to lower incomes caused by the drought by pursuing off-farm income, reducing family living standards, and pursuing federal assistance. Nearly 19 percent of all survey respondents indicated that they had taken off-farm employment to compensate for reduced incomes caused by the drought. Additionally, 25 percent reported making reductions in household standard of living because of the drought. Almost 25 percent reported seeking federal assistance, although the types of assistance vary widely across operations. Based on these response rates, it appears that Colorado producers tried to keep their operations in business mostly by finding money from non-agricultural sources and by sacrifices in the home. In the long run, these decisions may have consequences for both rural labor supplies and standards of living. These indirect impacts will be an additional point of concern for further analysis.

producers. However, nearly 60 percent of all producers indicated that they had no intention of leaving agriculture regardless of water supplies in 2003. This response indicates that the majority of agricultural producers are committed to continuing production.

Unfortunately, almost 25 percent of all producers indicated that they have a greater than 50 percent probability of leaving agriculture if drought conditions persist beyond 2003. While over half of these producers indicated only a 50 percent likelihood of exiting agriculture, the remaining 50 percent typically indicated a likelihood of exit over 75 percent. Consequently, while it appears that the majority of agricultural producers are committed to continued operation, a sizeable number will end production if drought conditions persist multiple years into the future. The impact of multiple-year drought on long-term commitment to agricultural production is another point for future analysis that is not answered by these preliminary assessments.

#### Summary and Conclusion

The summer of 2002 drought in Colorado was arguably one of the worst in the state's recorded history. Statewide survey results indicate that this drought led to major changes in agricultural production. For irrigated producers, these changes were primarily through either fallowing acreage or through

abandonment of existing crops. Relatively few producers indicated either selling water, modifying irrigation systems, or planting less water intensive crops. At the farm level, the drought caused reductions in household incomes that were offset either through seeking off-farm employment or through reductions in the standard of living. Despite these changes, most producers expressed a fairly strong intention to continued production.

The initial findings emerging from the 2002 "Weathering Tough Times" drought survey indicate that most agricultural producers in Colorado had to alter short-term production practices; however, long-term expectations were to continue production. While these results are indicative of general responses, they do not demonstrate either correla-

The initial findings emerging from the 2002 "Weathering Tough Times" drought survey indicate that most agricultural producers in Colorado had to alter short-term production practices; however, long-term expectations were to continue production.

tion or causality. The next stage in assessing the effects of the 2002 drought is to build on these preliminary results to determine how the changes in production practices and financial management discussed here translate into farm survival rates. Once these relationships are known, it will be possible to identify both what decisions helped Colorado producers survive the drought and which producers are at

greatest risk if drought conditions persist or return. We will also analyze the role of climate and weather information in various responses to the drought as part of an effort to identify alternative types of information that would be of use to agricultural producers. Ultimately, the full assessment of the impact of the 2002 drought on Colorado agricultural producers should provide useful information leading to more successful management in inevitable future droughts.

#### Citations:

- Salant, Priscilla and Don Dillman. *How to Conduct Your Own Survey*. New York: John Wiley and Sons, 1994.
- National Agricultural Statistics Service. *Cattle Outlook on January 1, 2003*. United States Department of Agriculture, Washington, D. C., 2003.
- National Agricultural Statistics Service. *Crop Production 2002 Summary (Cr Pr 2-01)*. United States Department of Agriculture, Washington, D. C., 2003.
- Pielke, Sr., R. A., N. Doesken, and O. Bliss. "Climate of Colorado". *Climatology Report 60*. Dept. of Atmos. Science, Colorado State University, Fort Collins, CO, 2003.
- Sunding, D., D. Zilberman, R. Howitt, A. Dinar and N. MacDougall. "Modeling the Impacts of Reducing Agricultural Water Supplies: Lessons from California's Bay/Delta Problem," in D. Parker and Y. Tsur, eds., *Decentralization and Coordination of Water Resource Management*, New York: Kluwer, 1997.



#### RESEARCH PAPERS TO BE INCLUDED IN INTERNATIONAL LIBRARY OF ECONOMICS AND POLICY PUBLICATION

The research papers listed below, co-authored by Professor Emeritus Robert A. Young, Department of Agricultural and Resource Economics, Colorado State University, are scheduled to appear in:

K. William Easter, ed, (forthcoming 2004) "Economics of Water Resources: Institutions, Instruments, and Policies for Managing Scarcity". (A volume in the International Library of Environmental Economics and Policy) Ashgate Publishing, Aldershot, Hampshire, UK.

1. Daubert, J. T. and R. A. Young. 1981. Recreational Demands for Maintaining Instream Flows: A Contingent Valuation Approach. *American Journal of Agricultural Economics* 63, No. 4, pp. 666-76.
2. Young, R. A., J. T. Daubert and H.J. Morel-Seytoux. 1985. Evaluating Institutional Alternatives for Managing an Inter-related Stream-Aquifer System. *American Journal of Agricultural Economics* 68, No. 4, pp. 787-97.
3. Booker, J. F. and R. A. Young. 1994. Modeling Intrastate and Interstate Markets for Colorado River Water Resources. *Jour. Environ. Econ. and Management*. 26 (1: 66-87).

Cont'd on page 17



MANAGING A LIMITED WATER SUPPLY

by

Joel Schneekloth, Extension Specialist  
Montezuma County, CSU Cooperative Extension

During the three-year drought, Colorado State University Cooperative Extension has been working with crop producers to help them manage and make the most profitable decisions when faced with shortages of water. Many of these difficult decisions involve determining the best crops to grow and how much water to apply to each crop.

When producers cannot apply water to meet the crop's evapotranspiration (ET), they realize that yields and returns from the irrigated crop will be reduced with typical management practices. To properly manage the water for the greatest return, an understanding of how crops respond to water, how crop rotations can enhance irrigation management, and how changes in agronomic practices can influence water needs is critical.

There are several important "pieces to the puzzle" that help facilitate limited irrigation strategies. Many of these principles come from dryland water conservation management. They include: the relationships between grain yield and water use (evapotranspiration), crop residue management for water conservation, plant population management, crop rotations to balance water use, and irrigation timing. Putting all of the "pieces" together is important for maximizing the use of the water.

Use of crop rotations is critical for both limited amounts of water and reduced system capacities. By using crops that require less water and that have different time periods of critical water needs, yields and irrigated acres grown during

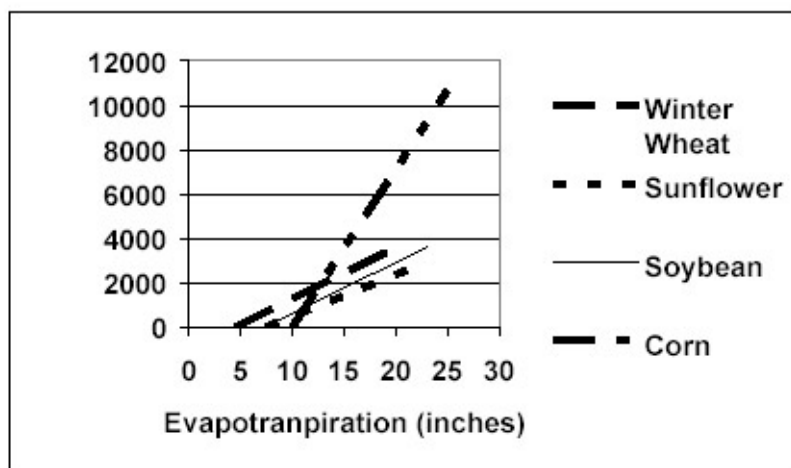


Figure 1. Yield vs. ET relationship for several irrigated crops.

drought can be greatly increased. With limited amounts of water, growing crops that use less water allows producers to save water by growing a portion of acreage to that crop. The "saved" water can then be applied that to a crop that requires more water. This will allow producers to achieve higher yields for both crops.



Figure 2. Center Pivot irrigation of bean crop.

When producers are faced with low-capacity systems, systems that cannot meet crop water needs, they are faced with either reduced yields when average rainfall doesn't occur or reducing the number of irrigated acres that they can grow. Another option is to plant a portion of the field to crops that have a different critical time period for water. For example, if a producer wants to grow corn but has inadequate capacity to meet the needs of the corn, growing a crop such as winter wheat under a portion of the acres reduces the number of acres of corn and net effect is the ability of the current system to meet the needs of the corn. Both crops can be irrigated since both crops need water at different time periods.

One important aspect of limited water management is the acceptance of stress at appropriate times. Most crops can withstand some water stress. The key time period for stress is during the vegetative growth stage

of most crops. In some regions where water delivery will be limited to a short time period, stressing the plant during the vegetative growth stage and saving the water for the reproductive growth stage is an important strategy. Research has shown that stress during this growth stage has little impact upon crop yields. Water during the vegetative growth stage has little impact upon grain yields if water is limited during the reproductive growth stages.

County Extension Educators have reported an increase of irrigated winter wheat acres in many areas of the South Platte and High Plains region. With these observations, farmers have increased the flexibility of their irrigation management with limited water for 2003.



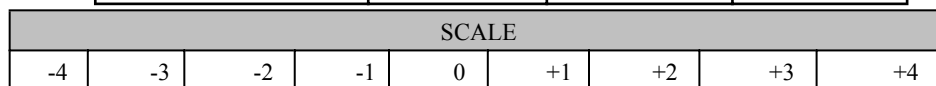
**WATER SUPPLY**

A wetter February boosted the SWSI and snowpack values over most of the state. The March 1 statewide snowpack is 83 percent of average. The Colorado River basin has the highest value at 93 percent of average, and the Rio Grande basin has the lowest at 73 percent of average.

All seven major drainage basins have a higher SWSI value than they had at this time last year, but six out of the seven still have negative values and the drought is not over, especially for the southwest areas of the state. The near average to even slightly above snowpack in the northern mountains trends to below average snowpack as one looks south, with the Rio Grande basin and the southwest corner of the state still in very dry conditions. Statewide the May 1 snowpack averaged 87 percent of normal. April precipitation helped slow snow melt, reduce demand for early season irrigation water, and bolstered stream flows for reservoir filling in the north of the state, but not in the south. Concern is expressed about the loss of snowpack to dry soil moisture and sublimation in the southern mountains, without benefit to stream flow. Most all reservoirs in the state contain less water than they typically do at this time of year.

The Surface Water Supply Index (SWSI) developed by the State Engineer's Office and the USDA 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 May 1, 2003, and reflect the conditions during the month of April.

Basin	5/1/03 SWSI Value	Change From Previous Month	Change From Previous Year
South Platte	-0.6	+0.8	+1.9
Arkansas	-1.8	-1.4	+1.1
Rio Grande	-3.2	-2.1	+0.4
Gunnison	-1.7	-1.2	+1.4
Colorado	+0.4	-0.3	+3.4
Yampa/White	-1.3	+0.2	+2.6
San Juan/Dolores	-3.0	-1.2	+0.7





## WATER-SIPPING TREES FOR COLORADO LANDSCAPES

by Keith Wood, assistant staff forester  
Colorado State Forest Service

The height of the busy spring planting season is here, and the drought, damaging spring snowstorms and watering restrictions have left many landowners wondering if they should plant trees this year. The answer is a resounding yes, with a caveat that landowners strive to plant drought-tolerant trees.

When deciding what to plant, it's important to remember that Colorado is still in a drought—and that drought is a recurring event—so it's best to plant trees that will conserve water and withstand Colorado's rigorous climate and harsh environmental conditions.

Trees that can withstand dry conditions are often termed drought tolerant. However, it may be more appropriate to say that a majority of tree species that escape damage during dry periods are drought avoiders.

Some trees truly are drought tolerant, which means they are able to withstand significant water depletion in their leaves and stems before damage occurs. However, most species possess some genetic adaptation to survive drought by retaining water within their leaf and stem tissues. Adaptations include the ability of roots to extract large amounts of water from the soil due to a higher root-to-shoot ratio; reduced leaf surface due to rolling; folding and shedding leaves; limited transpiration from the leaf surface during dry conditions; and a thick, waxy cuticle on the leaf surface that minimizes transpirational losses of water vapor.

When replacing trees or adding new trees to the landscape, the Colorado State Forest Service recommends the following tree species, which have demonstrated the ability to avoid and tolerate dry conditions.

### Drought-tolerant Species

Hackberry  
Hawthorn  
Kentucky Coffeetree  
Black Walnut  
Upright and Spreading Junipers  
Bristlecone Pine  
Pinyon  
Limber Pine  
Mugo Pine  
Ponderosa Pine  
American Plum  
Hoptree  
Ornamental Pears (avoid Bradford)  
Gambel Oak  
Bur Oak

### Moderately

### Drought-tolerant Species

Amur Maple  
Tatarian Maple  
Wasatch Maple  
Ohio Buckeye  
Horsechestnut  
Serviceberry  
Western Catalpa  
All Green Ash Cultivars  
All Honeylocust Cultivars  
Golden Raintree  
Apples and Crabapples  
Colorado Blue Spruce  
Austrian Pine  
Southwestern White Pine  
Scotch Pine  
Chokecherry  
Canada Red Cherry  
Mayday Tree  
White Oak  
English Oak  
Japanese Pagoda Tree



Bigtooth Maple



Catalpa

## Water-Sipping Trees for Colorado Landscapes

Keith Wood, assistant staff forester,  
Colorado State Forest Service

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Golden Raintree



Kentucky Coffeetree



Hawthorne



Limber Pine

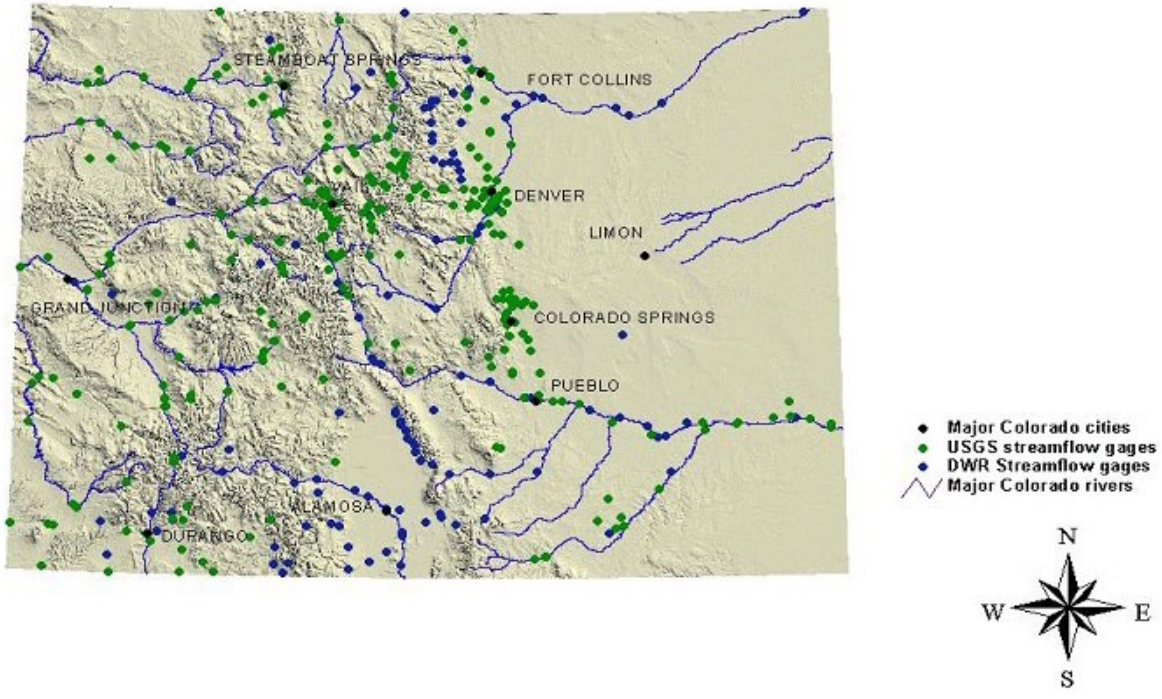
For a complete list of drought-tolerant species and cultivated varieties and advice on how to manage woody plants before, during and following a drought, visit [www.watersaver.org](http://www.watersaver.org) or <http://www.ext.colostate.edu/>

## MEETING BRIEFS



### COLORADO STREAMGAGING SYMPOSIUM 2003

# COLORADO STREAMFLOW GAGES



Map courtesy of the Colorado Division of Water Resources and the U.S. Geological Survey.

Snow greeted the flow data collectors and users at the Beaver Run Resort on May 8, 2003, as they arrived for the Second Colorado Streamgaging Symposium. The Symposium is a joint effort of state, federal and university organizations – organizations very concerned with the data upon which our understanding of Colorado’s water resources are based. Cosponsors of the 2003 symposium were: the Colorado Water Conservation Board, the Division of Water Resources, the U.S. Geological Survey, and the Colorado Water Resources Research Institute.

The purpose of the Streamgaging Symposium was to share information about:

- The major Streamgaging programs in Colorado.
- The uses of flow data – current and proposed.
- Coverage of flow gages, and thus, flow data availability.

- Opportunities to collaborate in enhancing flow data Colorado.



John Henz (left), HDR Engineering, here with Bill Horak, U.S. Geological Survey, was the symposium luncheon speaker .





Eric Oppelt (Left), Colorado Water Quality Division, and Doug Cain, (Right) U.S. Geological Survey, enjoy a break at the symposium.



Jana Riedesel, Colorado Division of Water Resources, discussed high-flow rating extension.

Organizations that collect flow data in Colorado operate over 700 gages, most of which now transmit data via satellite. Increasingly, this data is readily available via the Internet and supports the ability of Colorado citizens, from a wide array of economic endeavors, to share benefits from multiple uses of Colorado's water resources. Since the first Streamgaging Symposium in 2001, a number of gages, in critical stretches of Colorado Rivers, have been 'hardened' against flood flows – the gages are better able to record high flows without damage. New satellite telemetry is being installed to speed up the data transmission rates. Studies aimed at reducing redundancy in gaging efforts and increasing the accuracy of winter flow measurements were reported. Post-fire burn measurements, as well as debris flow studies, were described. Many of the above efforts to improve flow data acquisition represent enhanced collaboration among water organizations in Colorado.

During an open discussion session at the end of the meeting, the use of flow data in water-quality management decision-making (e.g., discharge permit and TMDL calculations) as well as the increasing use of water quality data in water exchange agreements, were noted as representing increasingly important water data interfaces in Colorado. With strong pushes toward efficiency, as well as accuracy, in water data collection and use, there appears to be a growing desire to further enhance the ability to readily share water data among organizations and individuals. This need, in turn, suggests development of a water 'data commons' – where organizations and individuals can readily determine what data exists – thus greatly increasing the efficiency of water data acquisition funds. It was noted that this is a topic needing additional discussion and, in particular, additional dialogue among those collecting water data and those using the data, as it is not clear who would be responsible for creating and maintaining a water 'data commons.'



Cont'd from page 11

4. Taylor, R. G. and R. A. Young (1995). Rural-to-Urban Water Transfers: Measuring Direct Foregone Benefits of Irrigation Water under Uncertain Water Supplies. *Journal of Agricultural and Resource Economics* 20, No. 2, pp. 247-62.

The aim of the volume's editor is to collect a wide range of important and influential essays on the economics of water resources. The volume will contain 29 papers.

CWRRI, the USGS State Water Institute Program, and the CSU Experiment Station helped fund the research now being recognized for its contribution to the field of economics of water resources.



## 'CAN DO' LANDSCAPE DROUGHT CONFERENCE

On April 15, 2003, an overflow crowd gathered in the Hall of Education at the National Western Stock Show to hear speakers discuss the impact of drought watering restrictions on Colorado's landscape industry and possible options for stretching urban water supplies in the future. The conference theme was "Dealing with Drought: Saving Water Now, Planning for the Future."

Attorney General Ken Salazar began the meeting by stressing the need for water efficiency and outlined ways to stretch Colorado's urban water supplies. He identified the need for: additional water management flexibility during times of drought; increased use of reclaimed water; enhanced water education; 'retrofitting' old water systems; and evaluation of new water pricing structures. Other speakers addressed the variability of Colorado's precipitation, underscored the need to plan for the invariable uncertainty present in Colorado's weather, presented examples of urban water conservation efforts in other states, recommended better data on urban water



John Pinder, Little Valley Wholesale Nursery in Brighton, Colorado, spends a moment with Attorney General Ken Salazar prior to his opening presentation

use, and provided examples on how Colorado's landscape industry is addressing the need to make landscapes more drought-resistant.

The conference speakers articulated and examined a number of issues that, during times of drought, can cause conflict between Colorado's Green Industry and Colorado's water providers. The focus of the meeting, however, was on a number of options for community-wide approaches to urban water and landscape management – options that



Sharon Harris of GreenCO visits with Milan Rewerts, Director of Cooperative Extension at Colorado State University



From left: Jim Klett, Horticulture Department, CSU, Jim Heird, College of Agricultural Sciences, and Steve Wallner, Horticulture Department, CSU share their thoughts on water management flexibility during times of drought.

can move Colorado toward a more sustainable urban landscape and urban water supply both balanced and interconnected in a way that is adapted to the invariable droughts that visit and revisit the State.

The Conference was organized by Colorado State University's Department of Horticulture and Landscape Architecture, College of Agricultural Sciences; and Cooperative Extension in collaboration with CSU's Water Center and the Green Industries of Colorado. Lunch was provided by Hardy Boy Plants.



## DROUGHT IMPACTS ON SOUTH PLATTE AQUATIC ECOSYSTEMS AND WATER QUALITY DISCUSSED AT CSU CONFERENCE

Over 100 scientists, water managers, public officials, students, and the public met on the CSU campus April 3-4, 2003, to examine the impacts of drought on aquatic ecosystems and water quality in the South Platte River. The conference was sponsored by the U.S. Environmental Protection Agency's Office of Global Change.

The objectives of the conference organizers, Jill Baron (USGS and CSU) and Alan Covich (CSU), were to share scientific understanding of the consequences of severe drought, develop awareness and possibly preparedness for future drought, and build collaboration and trust among participants. Judging from the liveliness of the discussion and debate, the conference readily met its objectives.

A broad range of presentations explored direct and indirect effects of drought on species, ecosystems, and water quality, and the social and economic ramifications of drought to communities. A number of innovative planning and modeling tools were presented as ways to explore the consequences of different management approaches on municipal, agricultural, and environmental parameters.

Several talks on managed groundwater recharge, termed "smart storage" by one speaker, were presented to illustrate innovative partnerships that can enhance instream flow, wildlife habitat, while meeting water rights obligations.

Conference participants were reminded that drought exacerbates and accelerates problems associated with continued population growth. For example, drought highlights tensions in water management, such as the direct connection between water supply and water quality that is sometimes overlooked in times of water abundance. Issues of current concern, mentioned during the meeting, include the impact of tributary groundwater pumping on stream flows, the continued movement of water from agriculture to cities, the search for additional trans-basin diversions, the 'Big Straw,' and growing pressure to pursue significant water conservation measures. Water quality and environmental issues were



Ben Alexander, Fort Collins Water Utilities (Left), Alan Covich, Department of Fishery & Wildlife Biology, CSU, and Jill Baron, Natural Resource Ecology Lab, share thoughts during conference break.



Jim Loftis (left), Civil Engineering Department, CSU, greets Tod Harris, Metro Wastewater Reclamation District.

noted as often viewed as constraints limiting water development and management options, not as having value as sources of important environmental goods and services. Ultimately, the greatest environmental impact of drought may be in how it influences the political environment, and the long-term, statewide legacy of decisions made during periods of crisis. Communication and dialog among scientists and water managers, scholars and citizens, as occurred on April 3-4, 2003, are essential to the constructive debate over the future of Colorado's water resources.

More information, including background material and abstracts of presentations, can be found at

<http://www.nrel.colostate.edu/projects/drought>.



## HYDROLOGY DAYS - 2003 EDITION

The 23<sup>rd</sup> annual Hydrology Days was celebrated March 31-April 2 on the CSU campus. Besides annually honoring an outstanding hydrologist, a new Borland Lecture Series was initiated as part of the Hydrology Days program. The Borland Lecture Series, endowed by Whitney Borland, brings nationally and internationally recognized hydrology-related speakers to Hydrology Days.

Seventy-one oral and 25 poster presentations were authored by scientists and students from around the world and across the United States, in addition to numerous faculty and students from Colorado State University, the Colorado School of Mines, University of Northern Colorado, and the University of Colorado at Boulder. Sessions addressed a wide range of topics including 'Drought, Fire, and Forests'; 'Advances in Stream Restoration'; 'Snow Hydrology' and 'Ground Water.'



Neil Grigg, Civil Engineering Department, presents Hydrology Days Honoree Plaque to José (Pepé) Salas.

The 2003 Borland Lectures were presented by Prof. José Salas from Colorado State University and Prof. John Dracup from the University of California at Berkeley. Prof. Salas presented a lecture entitled "Characterizing the Dynamics of Drought."

In his presentation, Prof. Salas summarized the techniques employed to understand how droughts evolve over time and space, particularly those based on stochastic models. Prof. Dracup presented a lecture entitled "Linking Drought Research to Water Resource Management Actions." He described a multivariate, principal component-based index that has been developed to quantify the severity of droughts. Named the Aggregate Drought Index (ADI), it describes the meteorological, hydrological,



John Labadie (Left), Civil Engineering Department, chats with John Dracup, Labadie's mentor from UC days.

and agricultural aspects of drought on a climate-divisional basis, using fluctuations in the values of five variables associated with the hydrologic cycle and available water: precipitation, evaporation, streamflow, reservoir storage, and soil moisture. Additionally, the ADI considers the snow-water content of snowpack reserves.



Robert Ward, CWRI Director, presents Borland Lecture plaque to John Dracup, UC, Berkeley.

Prof. José Salas was also recognized as the 2003 Hydrology Days honoree. He was recognized for his contributions to flood and drought risk assessment calculations as well as modeling and simulation of stochastic hydrologic processes.

Whitney Borland, an employee of the Bureau of Reclamation from 1930 to 1972, worked on many of the Bureau's major water projects, including the building of Hoover Dam, Grand Coulee Dam and the Colorado-Big-Thompson Project. He specialized in sedimentation issues surrounding the large projects. He began his Bureau career performing sedimentation studies at the hydraulics lab on the campus of Colorado State University. During WWII, Mr. Borland served as a lieutenant colonel in the Army's 10<sup>th</sup> Mountain Division. Mr. Borland died October 2, 2001.

As usual, the hydrology-oriented conversations, presentations, and debates during Hydrology Days were challenging and extremely educational – the purpose of the annual event. Hydrology Days Proceedings are available at: <http://hydrologydays.colostate.edu/Proceedings.htm>.

Join us next year for another exciting and educational dialogue from the cutting edges of hydrological sciences. Watch the Hydrology Days website for announcements: <http://hydrologydays.colostate.edu/>

CWRRI  
CSM water news



International Ground-Water Modeling Center  
Colorado School of Mines  
Golden, Colorado, 80401-1887, USA  
Telephone: (303) 273-3103 / Fax: (303) 384-2037  
Email: [igwmc@mines.edu](mailto:igwmc@mines.edu) / URL: <http://typhoon.mines.edu/>

#### 2003 Short Course Schedule

#### INTRODUCTION TO ARCGIS: ENVIRONMENTAL DATA FOCUS August 7-9, 2003 -- Instructors : Kyle Murray and Samantha Tokash

This three-day course provides an introduction to the fundamental concepts and techniques for displaying, manipulating, and analyzing spatial data in Geographic Information Systems (GIS). Concepts and data structures commonly encountered when using ArcGIS are explained in brief lectures, and followed by extensive hands-on exercises. The instructors focus on basic terminology and concepts that will allow students to quickly understand the capabilities, techniques, and limitations of implementing environmental data into GIS. The fundamentals learned in this course provide the tools for students to explore more complex spatial data and sophisticated analyses that are specific to their field. No previous training or experience in GIS is required.

#### CALIBRATION AND UNCERTAINTY OF GROUNDWATER AND OTHER MODELS September 10-12, 2003 -- Instructors : Mary Hill, John Doherty, and Claire Tiedeman

This course teaches methods of nonlinear regression and associated statistics, and a set of fourteen guidelines that describe how those methods can dramatically improve how data are used to calibrate and test models. This course presents a unique opportunity to learn a variety of approaches to the calibration and predictive uncertainty analysis of groundwater models from leading experts in the field. Attendees will gain a much better appreciation of the importance of calibration in model deployment, the limitations of models in many real-world settings.

#### MODFLOW: INTRODUCTION TO NUMERICAL MODELING September 13-16, 2003 -- Instructor : Eileen Poeter

This course is designed for the hydrogeologist and environmental engineer familiar with ground-water flow concepts, but who have limited or no experience with ground-water flow modeling. Basic modeling concepts: conceptual model development, definition of boundary and initial conditions, parameter specification, finite-differencing, gridding, time stepping, and solution control using MODFLOW-2000 and UCODE. Basic modules of MODFLOW are explained and concepts are reinforced with hands-on exercises. Calibration is presented via the public domain universal inversion code, UCODE.

#### POLISHING YOUR GROUND-WATER MODELING SKILLS September 14-16, 2003 -- Instructors : Peter Andersen and Robert Greenwald

This course is designed to provide significant detail on practical ground-water flow modeling concepts and techniques. It will explore development of conceptual models for complex sites or regions, how to convert these conceptual models to appropriate ground-water flow models, and how to apply supplemental MODFLOW modules to effectively solve such problems. This course takes the user beyond topics covered in introductory modeling courses and beyond courses that teach the mechanics of applying various pre- and post-processing software.

#### UCODE: UNIVERSAL INVERSION CODE FOR AUTOMATED CALIBRATION September 15-16, 2003 -- Instructor : Eileen Poeter

If you have a working knowledge of ground-water flow modeling and some knowledge of basic statistics, you will benefit the most from this short course. This course introduces to ground-water professionals to inverse modeling concepts and their use via UCODE, relying heavily on hands-on exercises for automatic calibration of ground-water models to promote understanding of UCODE and avoid "black-boxing". If you would like to spend more time being a hydrologist and less time as a "number tweaker", please join us in the ucode course.

#### ADVANCED MODELING OF WATER FLOW & SOLUTE TRANSPORT IN THE VADOSE ZONE September 15-16, 2003 -- Instructors : Rien van Genuchten and Jirka Simunek

This course begins with a detailed conceptual and mathematical description of water flow and solute transport processes in the vadose zone, followed by an brief overview of the use of finite element techniques for solving the governing flow and transport equations. "Hands-on" computer sessions will provide participants an opportunity to become familiar with the Windows-based RETC,

STANMOD, HYDRUS-1D and HYDRUS-2D software packages. Emphasis will be on the preparation of input data for a variety of applications, including flow and transport in a vadose zone, variably-saturated flow through a dam, flow and transport to a tile drain, and two-dimensional leachate migration from a landfill through the unsaturated zone into groundwater.

#### SUBSURFACE MULTIPHASE FLUID FLOW AND REMEDIATION MODELING

September 19-21, 2003 -- Instructor : John McCray

This course covers subsurface multiphase fluid flow modeling concepts and techniques using the multi-dimensional multiphase flow code TOUGH2/T2VOC (with a new graphical user interface for input/output manipulation and visualization). Topics include the development of conceptual models for vadose zone flow and transport, flow and interphase partitioning of nonaqueous-phase liquids (NAPLs) mixtures in the saturated and unsaturated zones, NAPL-contaminated sites, simulation of remediation techniques, and how to apply the models to effectively solve realistic problems associated with these conceptual models.

#### PHREEQC MODELING: THE BASICS

September 19-21, 2003 Instructor : Geoffrey Thyne

This course will provide a review of theoretical background and practical experience in the use of the PHREEQC computer code. We will work with the recent version of PHREEQC program and the accompanying Windows interface using progressively more complex simulations to build user ability. Class exercises will include speciation of water analyses, equilibrium with gas and solid phases, acid-base and redox reactions, sorption reactions, kinetic reactions, mass balances (inverse modeling) and the advection-dispersion-reaction module, time permitting.

#### MODEL CALIBRATION AND PREDICTIVE UNCERTAINTY ANALYSIS USING PEST-ASP

September 19-21, 2003 -- Instructor : John Doherty

This intensive short course will instruct participants on the application of nonlinear parameter estimation techniques to the calibration of environmental simulation models of all kinds, particularly groundwater flow and transport models, and on the analysis of the predictive uncertainty associated with such models. The course will be based on the use of PEST-ASP; "ASP" stands for "Advanced Spatial Parameterization". Its advanced regularization and predictive analysis functionality allows models to be used in more flexible and powerful ways (and with greater scientific integrity) than has hitherto been possible. PEST-ASP is complemented by MODFLOW-ASP, a special version of MODFLOW2000 that works best with PEST-ASP.

#### EVALUATING PREDICTIONS OF MULTIPLE CONCEPTUAL MODELS

September 20, 2003 -- INSTRUCTOR David Anderson

Which model might be "best" and what is meant by "best"? Simple methods will be explained to allow the models to be ranked, from best to worst. Once multiple models with acceptable calibration, each model provides predictions and associated confidence intervals related to the question of concern. The next question is whether one model is better than the others, or should all models be considered. If you are interested in the Model Simplicity vs. Complexity issue OR interested in methods for evaluating results of alternative models of the same site, then you should consider taking this course.



John McCray, Associate Professor of Hydrogeology, Department of Geology and Geological Engineering, Colorado School of Mines will teach a short course on multiphase fluid flow and remediation modeling using the codes TOUGH2 and TMVOC this fall. The course will be held at the International Ground Water Modeling Center in Golden, Colorado September 19-21 (Friday through Sunday noon), 2003.

TMVOC is a new version of T2VOC which can simulate multiphase transport of NAPL mixtures. McCray plans to use the new Graphical User Interface for the TOUGH codes called Petrasim. The codes and the Petrasim are not included in the price of the short course.

The codes are useful for modeling such problems as NAPL spills and remediation, vapor transport in the vadose zone, pollution from agricultural or domestic wastewater sources, radioactive chemical transport, and more. The code can handle saturated and unsaturated problems, and also has a means of simulated flow in fractured rocks.

An academic discount for students will be offered that is not described on the web page.

For details on the course, please see the following link: <http://typhoon.mines.edu/short-course/multi.htm>.

## MODFLOW and More 2003: Understanding through Modeling

September 17-19, 2003

Ice-Breaker Evening of September 16

International Ground Water Modeling Center (IGWMC)  
Colorado School of Mines, Golden, Colorado USA

Co-sponsored by  
US Geological Survey  
United Kingdom Environment Agency  
National Groundwater & Contaminated Land Centre  
International Association of Hydrological Sciences

The MODFLOW conference series has become a tradition for the presentation of cutting-edge practical application of ground water models in all aspects of hydrologic work. MODFLOW, the USGS modular three-dimensional finite-difference, ground-water flow model, has become an international standard for ground-water modeling. MODFLOW serves as a centerpiece for the recurring conference, but we anchor on MODFLOW only because of its widespread use and its status as a community model. The conference organizing committee needs and encourages participation by users of all types of models in all kinds of applications, including those for which MODFLOW is not suitable, so that the modeling capability of our profession will evolve. MODFLOW is a basis from which other models can be considered. The advantages and disadvantages of alternative codes can be reflected from MODFLOW with which nearly all modelers are familiar.

Many registrants were disappointed by the travel problems in September of 2001, so the next conference is scheduled after only two, instead of three, years. The conference will include keynote speakers on a wide range of topics, contributed oral presentations and poster sessions (both oral and poster papers will be published in a proceedings volume), exhibitors, short courses, and software demonstrations. The purpose of this conference is to bring together model users and developers to exchange ideas on the latest innovations in model applications, discuss the capabilities and limitations of currently available codes, and explore the needs and directions for future developments.

Panel Discussion: Complexity or Simplicity? -- Should Ground-Water Models Strive to include Field Complexity or Maintain Simplicity? Please offer your thoughts, opinions, and questions, and get involved in the discussion.

A panel discussion session is planned for Thursday afternoon. The topic will be whether ground-water models should strive to include the field complexity or maintain simplicity. We encourage the audience to be actively involved in this discussion. Jaime Gomez-Hernandez will make a presentation that sets the stage for the complexity view and Mary Hill will set the stage for the simplicity view. Panel members include: Jaime Gomez-Hernandez, Mary Hill, John Doherty, Chunmiao Zheng, David Hyndman, and Bill Woessner, with Eileen Poeter as the moderator.

Conference attendees are encouraged to make a short (100 words or less) statement, comment, or question related to the complexity/simplicity issue on their registration form. These will be organized and printed for distribution to the panel and conference attendees. This input will facilitate understanding of the viewpoints and issues, thus stimulating an interesting and productive session.

Location -- The Conference will be held on the Colorado School of Mines Campus in Golden, Colorado, U.S.A. September 16-19, 2003. There are many hotels in the nearby Golden and Denver areas in which reservations can be made. Golden, Colorado is located at the foot of Lookout Mountain, 13 miles west of downtown Denver, on the majestic Front Range of the Colorado Rockies.

Organizing Committee -- Eileen Poeter, IGWMC, Colorado School of Mines, Mary Hill, US Geological Survey, Chunmiao Zheng, University of Alabama, and John Doherty, Watermark Computing, Australia

John McCray, Department of Geology and Geological Engineering, Colorado School of Mines, has been named the 2002 outstanding Associate Editor for Vadose Zone Journal (VZJ). This annual award is presented to one associate editor in recognition of outstanding professional contributions in the handling of papers submitted for publication in VZJ.

## CWRRI

### *DU water news*

#### PhD Fellowships Available to work on

Sustainable Urban Infrastructure Engineering Projects (USIEP)  
At the Civil Engineering (CE) Department  
University of Colorado, Denver (CU-Denver)

Six fellowships, awarded by the Department of Education GAANN Program, include full tuition support and a stipend of (up to) \$21,500 per year for 3 years, based on financial need. Eligibility for the GAANN fellowships is limited to US citizens and permanent residents.

Fellows will evaluate technological factors that impact the development of sustainable urban infrastructure by working on inter-disciplinary projects that integrate water, energy, environmental, transportation, built facilities and geographic information systems. Projects may cover topics such as alternative energy, hybrid vehicles, transportation planning, phytoremediation, disaster management, and green buildings, evaluated in the context of urban systems. Applicants must have a BS or MS degree in Civil Engineering or a closely related field (e.g., Systems Engineering, Environmental Biotechnology, Mechanical Engineering), an excellent academic record, strong

interpersonal skills, and a strong interest in working on inter disciplinary projects intersecting at least two of the domains listed above.

To ensure timely review of applications for Fall 2003, completed application materials (found at <http://www.cudenver.edu/~aramaswa/usiep.htm>) must be received no later than July 1, 2003, to the attention of: Dr. Anu Ramaswami, Project Director, USIEP GAANN Fellowships, Department of Civil Engineering, Campus Box 113, PO Box 173364, Denver, CO 80217. Applications will be reviewed continuously until all positions are filled. CU Denver is an equal opportunity educator and employer committed to excellence through inclusiveness. Women and minority candidates are encouraged to apply. Alternative forms of this announcement are available for people with disabilities. For further information, call: (303) 556-4734.



### *UNC water news*

The History Department of the University of Northern Colorado, in partnership with the National Park Service, has agreed to undertake a second phase of oral interviews for the "Cache la Poudre Oral History Project." Phase One will be completed in September 2003, and will consist of 20 interviews with a wide range of water users, policy makers, and water administrators from northern Colorado and the Denver metro area. Phase Two (to be completed by September 2004), will expand the interview base to include more longtime users whose memories of life on the Poudre will be useful for water managers, students of Colorado's natural resources, and the citizenry of the state. Each phase utilizes the talents of three graduate research assistants in the UNC History Department, and includes the development of skills in oral interviews and transcribing of tapes.



#### Call for Papers Small Flows Quarterly Magazine

MORGANTOWN, WV-Papers are now being accepted for the peer-reviewed articles section of the Small Flows Quarterly magazine, the only national magazine devoted specifically to small community wastewater issues. Published by the National Small Flows Clearinghouse, the Small Flows Quarterly's mission is to present and disseminate ideas and methodologies for solving wastewater issues for small communities (i.e., communities with populations under 10,000 or communities handling less than one million gallons of wastewater flows per day).

Papers in the following categories will be considered for peer review:

- technology/research,
- operation and maintenance,
- regulations,
- management,

- finance, and
- public education.

For more information about research topics, submission guidelines, and publication deadlines, please contact Cathleen Falvey, juried articles editor, at (800) 624-8301 or (304) 293-4191, ext. 5526, or e-mail [cfalvey@wvu.edu](mailto:cfalvey@wvu.edu)

The Small Flows Quarterly is published by the National Small Flows Clearinghouse located in Morgantown, WV. Authors are encouraged to call the editor to discuss their manuscripts or ideas between 9:00 a.m. and 5:00 p.m. Eastern Time. Manuscripts can be e-mailed to [cfalvey@wvu.edu](mailto:cfalvey@wvu.edu) or mailed to Cathleen Falvey, National Small Flows Clearinghouse, West Virginia University, P.O. Box 6064, Morgantown, WV 26506-6064.





## RESEARCH AWARDS

A summary of research awards and projects is given below for those who would like to contact investigators. Direct inquiries to investigators c/o indicated department and university. The list includes new projects and supplements to existing awards. The new projects are highlighted in bold type.

### COLORADO STATE UNIVERSITY, FORT COLLINS, COLORADO

Awards for Jan. 26, 2003 to May 26, 2003

PI	Dept.	Sponsor	Title
Thilmany Dawn	DARE	GreenCO Fdn.	Economic Contribution of Colorado's Green Industry
Kondratieff Boris	BSPM		Inventory of Aquatic Invertebrates of the Valles Caldera National Preserve, Jemez Mountains, NM
Sale Thomas C.	Chemical Engr.	DOD	Electrically Induced Redox Barriers for the In- Situ Treatment of Contaminated Groundwater
Reardon Kenneth F.	Chemical Engr.	NSF	Redirecting Cellular Metabolism for the Biodegradation of Mixtures of Chlorinated Solvents
Reardon Kenneth F.	Chemical Engr.	EPA	Remediation of Mine Drainage in a Microbially Active Permeable Barrier Reactor
Stephens Graeme	Atmos. Sci.	NASA	CloudSat
Pielke Roger A.	Atmos. Sci.	NASA	Multiscale Convergence of Cold Land Process Representation in Land Surface Models...
Randall David A.	Atmos. Sci.	NASA	Comparison of Cloud Resolving Model Simulations to Remote Sensing Data
Stephens Graeme	Atmos. Sci.	NASA	Validation & Enhancement of AMSR-E Cloud & Precipitation Products
Kummerow Christian D.	Atmos. Sci.	NASA	The Extension of the TRMM Microwave Rainfall & Vertical Structure Algorithm to Other Radiometers
Montgomery Michael T.	Atmos. Sci.	NASA	Energy & Water Cycles within Hurricanes Determined from High-Resolution Simulations
Kummerow, Christian D.	Atmos. Sci.	NASA	Risk Mitigation Studies for Evolving Data & Information Systems Related to Rainfall Missions
Rutledge, Steven A.	Atmos. Sci.	NASA	Analysis of Data from Tropical Rainfall Measuring Mission to validate Tropical Rainfall Measuring Mission...

FEDERAL SPONSORS: BLM-Bureau of Land Management, COE-Corps of Engineers, DOA-Dept. of the Army, DOD-Dept. of Defense, DOE-Dept. of Energy, DON-Dept. of the Navy, DOT-Dept. of Transportation, EPA-Environmental Protection Agency, HHS-PHS-Public Health Service, NASA-National Aeronautics & Space Administration, NBS-National Biological Survey, NOAA-National Oceanic & Atmospheric Admin., NPS-National Park Service, NRCS-Natural Resources Conservation Service, NSF-National Science Foundation, USAID-US Agency for International Development, USBR-US Bureau of Reclamation, USDA/ARS-Dept. of Agriculture, Agricultural Research Service, USDA/NRS-Dept. of Agriculture, Natural Resources Service, USFS-US Forest Service, USDA-USFS-RMRS-Rocky Mountain Research Station, USFWS-US Fish & Wildlife Service.

STATE/LOCAL SPONSORS: CDA-Colorado Department of Agriculture, CDNR-Colorado Dept. of Natural Resources, CDPHE-Colorado Dept. of Public Health and the Environment, CDWL-Colorado Division of Wildlife, NCWCD-Northern Colorado Water Conservancy District.

OTHER SPONSORS: AWWA-American Water Works Assn., CID-Consortium for International Development.

UNIVERSITY DEPARTMENTS, INSTITUTES AND CENTERS: Colorado State: BSPM-Bioagricultural Sciences & Pest Management, CBE-Chemical & Bioresource Engr., CFWLU-Cooperative Fish & Wildlife Unit, CSMTE-Center For Science, Mathematics & Technical Education, CIRA-Cooperative Inst. for Research in the Atmosphere, DARE-Dept. of Agric. & Resource Economics, ECE-Electrical & Computer Engineering, ERHS-Environment & Rad. Health Sciences, FWB-Fishery & Wildlife Biology, HLA-Horticulture & Landscape Architecture, NREL-Natural Resource Ecology Lab, NRRT-Nat. Resources Recreation & Tourism, RES-Rangeland Ecosystem Science, SCS-Soil & Crop Sciences. University of Colorado: ACAR-Aero-Colorado Center for Astrodynamics Research, AOS-Atmospheric & Oceanic Sciences, CADSWES-Center for Advanced Decision Support for Water and Environmental Systems, CEAE-Civil, Environmental, and Architectural Engineering, CIRES-Cooperative Institute for Research in Environmental Sciences, CRCMAST-Cooperative Research Center for Membrane Applied Science & Technology, EPOB-Environmental, Population & Organismic Biology, IAAR-Institute for Arctic & Alpine Research, IBS-Institute of Behavioral Science, ITP-Interdisciplinary Telecommunication Program, LASP-Lab. For Atmos. And Space Physics, PAOS-Program in Atmospheric and Oceanic Sciences.

PI	Dept.	Sponsor	Title
Montgomery, Michael T.	Atmos. Sci.	NSF	Tornadoes with Secondary Circulations
Rutledge Steven A.	Atmos. Sci.	NSF	The Colorado State University CHILL Radar Facility
Stephens Graeme L.	Atmos. Sci.	NSF	On the Maintenance of the GLOBE Atmosphere Investigation Protocols & Application of These Protocols...
Cotton William R.	Atmospheric Science	NSF	Numerical Simulation & Analysis of Mesoscale Convective Systems & Severe Storms
Gates Timothy K.	Civil Engr.	CDPHE	Assessing Irrigation-Induced Selenium & Iron in the Stream-Aquifer System of the Lower Arkansas River Basin, CO
Loftis Jim C.	Civil Engr.	NPS	Guidance & Technical Support to the Natural Resource Program Center
Salas Jose D.	Civil Engr.	USDA-ARS	Quantifying Space-Time Variability in Agricultural Landscapes
Sale Thomas C.	Civil Engr.	DOD	Sequential Electrolytic Degradation of Energetic Compounds in Groundwater
Gilbert David M.	Civil Engr.	COE	Influence of pH on the Electrolytic Degradation of TNT & RDX in Groundwater
Watson Chester	Civil Engr.	DOD	DEC Monitoring 2003
Gates Timothy K.	Civil Engr.g	USBR	Identification of Public Awareness & Solution of Waterlogging & Salinity in the Arkansas River Valley
Ramirez Jorge A.	Civil Engr.	NSF	Research Experiences for Undergraduates Program in Water Research at Colorado State University
Garcia Luis	Civil Engr.	DOE	Framework for Decision Support System for Rocky Flats
Labadie John W.	Civil Engr.	USBR	MODSIM Enhancement and Maintenance
Loftis Jim C.	Civil Engr.	NPS	Inventorizing & Monitoring National Resources Status & Trends in National Park Service
Sanders Thomas.	Civil Engr.	City of Fort Collins	Deicer Test Proposal, Phase III
Thornton Christopher I.	Civil Engr.	McLaughlin Water Engr.	American River Model Study
Vonderhaar Thomas	Cira	NOAA	Air-Sea Interaction Remote Sensing Processes
Vonderhaar Thomas	Cira	NOAA	Environmental Applications Research Project
Vonderhaar Thomas	Cira	NOAA	Enhanced Communications at CIRA for the Development of Real-time Evaluation of Advanced Microwave Sounder
Vonderhaar Thomas	Cira	NOAA	CIRA Activities & Participation in the GOES I-M Product Assurance Plan
Wang Ning	Cira	NOAA	Development of Efficient Satellite Data Compression Techniques: Transmission of GOES Imagery to NOAA
Kidder Stanley Q.	Cira	NOAA	CIRA's Cross-Sensor Products for Improved Weather Analysis and Forecasting
Connell Bernadette	Cira	NOAA	A Satellite Hydro-Meteorology (SHyMet) Training & Education Proposal
Omi Philip N.	Forest Sci.	BLM	Colorado Workshop on the 2002 Fire Season
Binkley Daniel E.	Forest Sci.	USGS	Structure & Function of Northern Ecosystems & Their Response to Global Change
Romme William H.	Forest Sci.	Nature Conservancy	Temporal & Spatial Variation of Fire Regimes in the Low Elevation Douglas-Fir Forests of the Centennial Valley
Rideout Douglas B.	Forest Sci.	USDA-USFS	Estimating the Efficacy of Fuels Management on Wildlife Frequency & Intensity on the Black Hills National Forest
Reich Robin M.	Forest Sci.	USDA-USFS-RMRS	Development & Test of Fuel Loadings Disturbance & Fire Spread Models Based on Satellite Imagery & Field Surveys
Fausch Kurt D.	FWB	USBR	Research for Mitigation for Lost Production of Naturally Reproducing Salmonids in the Sacramento River
Johnson Brett M.	FWB	USBR	Provenance & Trophic Roles of Non-Native Fishes
Johnson, Brett M.	FWB	USBR	Ecological Effects of Reservoir Operations on Blue Mesa Reservoir
Clements William	FWB	NPS	Assess Ecological, Hydrological & Geochemical Effects of Dome Fire Capulin Watershed
Fausch, Kurt D.	FWB	DOI	Colorado River Cutthroat Trout Translocation Research

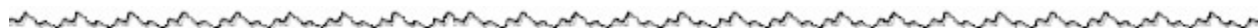
PI	Dept.	Sponsor	Title
Snyder Darrel E.	FWB	USBR	Identification & Curation of Larval Fish by CSU Larval Fish Laboratory
Bestgen Kevin R.	FWB	USBR	Abundance Estimates for Colorado Pikeminnow in the Middle Green & Yampa River Systems
Bestgen Kevin R.	FWB	USBR	Interagency Standardized Monitoring Program Assessment of Endangered Fish Reproduction...
Bestgen Kevin R.	FWB	USBR	Verification of Stocked Razorback Sucker Reproduction in the Gunnison River via Annual Collections of Larvae
Bestgen Kevin R.	FWB	USBR	Population Estimates of Colorado Pikeminnow in the Lower Green River
Bestgen Kevin R.	FWB	USBR	Effects of Flaming Gorge dam Releases on Lodore/ Whirlpool Canyon Fish Community
Hawkins John A.	FWB	USBR	Yampa River Nonnative Fish Control: Translocation of Northern Pike from the Yampa River
Hawkins John A.	FWB	USBR	Middle Yampa Smallmouth Bass & Channel Catfish Studies
Myrick Christopher A.	FWB	World Wildlife Fund	Potential Impacts of Global Climate Change on Freshwater Fisheries
Fausch Kurt D.	FWB	USDA-USFS	Recruitment Bottlenecks Hampering Restoration of Native Cutthroat Trout
Cooper David J.	Earth Res.	NPS	Restore Snake River Gravel Pit...
Macdonald Lee H.	Earth Res.	USDA-USFS	Monitoring Runoff & Erosion in the Upper South Platte Restoration
Wall Diana H.	NREL	Winslow Foundation	International Workshop on Soil & Sediment Biodiversity & Ecosystem Functioning
Garcia, Luis.	CWRRI	Various Sponsors	SPMAP Support System for the South Platte Basin
Berrada Abdelfettah	SW CO Res. Ctr.	USBR	Research & Education Activities to Enhance Water Management & Conservation in SW Colorado
Waskom Reagan M.	Cooperative Ext.	USDA-NRCS	High Plains Irrigation Guide

UNIVERSITY OF COLORADO, BOULDER COLORADO  
Awards for Jan.-Mar. 2003

PI	Dept.	Sponsor	Title
Nerem, Robert S.	ACAR	Jet Propulsion Lab	An Investigation of Very Low Frequency Sea Level Change Using Satellite Altimeter Data
Emery, William	ACAR	Jet Propulsion Lab	Merging Infrared Sea Surface Temperature with Satellite Altimetry to Map Ocean Currents in Two Coastal Domains
Leben, Robert	ACAR	LA State Univ.	New Remote Sensing Methodologies for the Gulf of Mexico
Nerem, Robert S.	ACAR	Jet Propulsion Lab	Using Global Terrestrial GPS Measurements to Unravel the Emerging Altimetric Record of Global Sea-Level Change
Hamill, Thomas	CIRES	NSF	Incorporating the Uncertainty of Atmosphere-Land Interactions into Ensemble Forecasts
Frodeman, Robert	CIRES	NSF	Climate Modeling and Societal Impacts: Scientific, Political, and Philosophic Themes
Mapes, Brian	CIRES	NSF	Climatological Studies with Doppler Radar
Scharfen, Gregory	CIRES	NASA	Global Land Ice Measurements from Space
Zagona, Edith	CADSWES	DOA	Analysis and Implementation for Support for Various Water and Environmental Systems
Zagona, Edith	CADSWES	DOI	Upper Colorado Research, Development, and Support for Riverware
Zagona, Edith	CADSWES	USBR	Watershed and River System Management Program – Decision Support for Truckee Carson
Serreze, Mark	CIRES	NSF	Characteristics of Cyclone Development in the Arctic and Their Hydrologic Impacts
Scharfen, Gregory	CIRES	NSF	An Archive and Data Distribution System for Glaciological and Cryospheric System Data from the U.S. Antarctic Program...
Peckham, Scott	IAAR	Univ. of Alaska	Conversion of Hydrologic Model from Fortran to GUI

UNIVERSITY OF COLORADO, BOULDER COLORADO  
Awards for Jan.-Mar. 2003

PI	Dept.	Sponsor	Title
Sievering, Herman	IAAR	Tulane Univ.	Nitrogen Flux and Carbon Sequestration at Coniferous and Mixed Forest Ameriflux Sites
McKnight, Diane	IAAR	Ohio State Univ.	McMurdo Dry Valley Long-Term Ecological Research
Woodhouse, Connie	IAAR	Denver Water	Dendrochronological Work
Gupta, V.K.	CIRES	NSF	Designing a Pilot System for Floods in the Walnut River Basin, KS Using a Scaling Framework
Evans, K. Franklin	PAOS	NASA	Retrieval and Validation of Cirrus Cloud Properties with the Far-Infrared Sensor for Cirrus...



# Water Resources Archive



at Colorado State University Libraries

The Colorado State University Water Resources Archive is a joint project of the University Libraries, the Colorado Water Resources Research Institute and the Colorado Agricultural Archives. Formally begun in 2001, the Archive consists of collections from individuals and organizations that have been instrumental in the development of water resources in Colorado and the West. The Water Resources Archive has collections of the following individuals and organizations available for research.

Morton W. Bittinger  
Whitney M. Borland  
Colorado Association of Soil Conservation Districts  
Eric Eidsness  
Ival V. Goslin  
National Water Resources Association  
James L. Ogilvie

Rocky Mountain Hydrologic Research Center  
Herbert Vandemoer (Colorado Water Conservation Board)  
David Walker (Colorado Water Conservation Board)

Document types within the collections are numerous, ranging from meeting minutes, reports and correspondence to maps, photographs and audio tapes. These primary materials relate to all aspects of water in Colorado and to contributions made by Coloradoans to water activities. Subject areas include engineering studies, legislative matters, water resources management and more.

What's New: 21 April 2003 - Full text finding aids for the collections are now online. View them through the [collection list](#) or perform a [keyword search](#) through them all simultaneously. The electronic searching techniques allow the user to find words in documents as long as 100 pages.



## WATER NEWS DIGEST

by Marian Flanagan

Conservation/Water Restrictions

### Boulder ends water limits

While Boulder City Council undid its year-old mandatory water restrictions, the city is still encouraging residents to voluntarily reduce water use, hoping to cut consumption to 10 percent below normal. Boulder was in a better position to back off than many other cities because it saved a great deal of water last year by instituting water restrictions earlier than most. That helped prevent the reservoir levels from dropping as low as they might have.

The Denver Post / May 8, 2003

### Aurora reduces curbs on water-tap allocations, allows minimal lawn-watering this summer

Aurora officials backed off dire water restrictions for this summer, allowing a small amount of landscape irrigation. Residents are encouraged to hand water trees and shrubs but such watering must be done with a hose that has a spray nozzle or deep-root watering mechanism attached to it. Planting trees and shrubs are prohibited, while planting xeriscape plants as well as vegetables and flowers are allowed under the city's new watering schedule. Car washing at private homes will be allowed as long as customers use a shut-off nozzle and bucket. Privately owned residential pools may not be filled and restaurants will be required to serve water upon request only. Hotels and motels will be required to display water conservation materials provided by the city. City leaders also backed off a plan that would have significantly curbed new development by reducing water tap allocations, citing potential lost revenues. Utilities Director Peter Binney said the more than \$20 million developers annually pay for tap fees is used to buy more water, secure storage and build dam and pipe systems to prepare for future drought years. Those fees were recently increased to \$10,711 from \$6,846 for a single-family home. Councilwoman Kathy Green, who introduced the amendment, said it was necessary to ensure that existing residents, businesses and new development bore the brunt of conserving water where reservoir levels have dropped to 27 percent.

The Aurora Sentinel / April 15, 2003; Denver Post / May 13, 2003

### Wiser users to be exempt

For 17 years, Castle Rock has implemented water restrictions. Now it will end those restrictions for homeowners who complete the town's Water Wiser Workshop as part of a pilot program. Based on a theory that water restrictions don't really conserve water, the workshop will teach homeowners how to conserve water with methods other than the three-day watering schedule, said Ron Redd, director of utilities for the town. "The theory, based on observation, is that if it rains the day before a watering day, I'm going to water on my day anyway," Redd said of one of the reasons he thinks watering restrictions are ineffective. "I think if we lift the three-day watering schedule and water when it's needed, we're going to save water."

Douglas County News Press / May 17, 2003

### Broomfield, E. Cherry Creek Valley ease water rules

The city and county of Broomfield has gone to a voluntary lawn-watering program. "We still are asking people to pay attention and maybe add only one day a week of watering," said Broomfield spokeswoman Roseann Doran. "And we are advising people to avoid installing new lawns during July and August." Starting Sunday, June 1, customers of the East Cherry Creek Valley Water and Sanitation District may increase their lawn watering to two days a week. The water district, which serves about 50,000 customers in the city of Centennial and unincorporated Arapahoe County, will continue to enforce violations.

Rocky Mountain News / May 31, 2003

### Denver Water eases drought restrictions / Sod, city parks and large lawns will benefit

Denver Water has agreed to provide extra water for new sod, city parks and people with large lawns. But the agency stood firm on maintaining a two-day-a-week watering schedule and banning outdoor watering daily between 10 am and 6 pm. and altogether on Mondays. Denver Water's reservoirs are about 63 percent full, and are expected to reach 80 percent in four to six weeks, according to Ed Pokorney, director of planning. The drought surcharge will stay in place. Homeowners are allowed to use 18,000 gallons of water bimonthly before surcharges kick in. The fees start at 80 cents per thousand and soar to \$11.85 per thousand for customers who use more than 61,000 gallons in a two-month period. Instead of the eight lawn zones watering restriction, homeowners can now water an unlimited number of zones for an average of 15 minutes each. A zone is the amount of lawn served by one automatic sprinkler system section or one sweep of a manual lawn sprinkler. Instead of issuing special permits, Denver Water is requiring that homeowners show a receipt indicating their sod has been newly purchased. Homeowners who want to install sod will be allowed to water every day, including Monday, but not between 10 am and 6 pm. They can water the sod for 14 days. Then, they must follow the two-day-a-week watering schedule for their address.

### Thumbs down for fake grass / Thornton enforcing ban on artificial turf

Just four months after spending \$9000 to replace his natural grass with AstroLawn Turf, a Thornton homeowner must rip out his water-free turf. Thornton officials voted to uphold the city's ban on artificial turf. Thornton city leaders are concerned with probable standards for replacement of faded or worn out turf, vandalism, and a potential lack of access to underground utilities. A homeowner in Aurora has agreed to have artificial turf installed in her backyard as a "test plot" for city officials wrestling with whether to lift a ban similar to Thornton's. The cities of Broomfield and Northglenn allow it. Denver does not have restrictions prohibiting artificial turf and are using two test plots for public comment. Liz Gardner, Denver's water conservation manager said, "There is no perfect maintenance-free and water-wise solution." "(Artificial turf) does conserve water, but for how long?" she asked. "Would people leave it in place, or is it a temporary solution that would end up like an old carpet in a dumpster?"

The Denver Post / April 29, 2003

### Drought, Fire and Flood

### San Luis Valley still in the grip of record drought / Snowpack goes into ground, not streams

Things might be looking up northern Colorado, but the "drought of the century" still grips southern Colorado's San Luis Valley and the Upper Rio Grande Basin. Spring sunshine is quickly melting the snow, but the Rio Grande's 4,700-square-mile watershed is so dry that much of the water soaks into the ground before it reaches the river. This marks the third year in a row that the Rio Grande's flow is below average, but the state will still provide enough water to fulfill the Rio Grande Compact. Three years of drought also have diminished the San Luis Valley's vast underground aquifer, which nourishes thousands of acres of natural wetlands and a half-million acres of farm and ranch land. John Allen Davey, engineer for the Rio Grande Water Conservation District, who has measured the valley's aquifer since 1976, recorded a drop of as much as 20 feet in places in the past three years. Many thousands of acres of wetlands will be dry for the second summer in a row.

Special to the Denver Post / May 2, 2003

### Floods won't mean end of 3-year drought

Even floods this summer will not mean the drought is over, say members of the state's drought and flood task forces. State experts claim that while the dry weather appears to have subsided, at least temporarily, the hydrological, agricultural, economic and water-storage aspects of the drought will linger for months, if not years. "Water managers and consumers should not toss aside conservation measures," said state climatologist Roger Pielke Sr. Statewide, reservoirs are at only 60 percent of their average storage of 6.5 million acre-feet. Meanwhile, floods are the product of timing and temperature. The cool, wet spring so far is keeping upper-elevation snowpack from melting or evaporating. "When temperatures heat up, some areas, especially those barren from last summer's wildfires, could get a deluge of runoff in a short period, spurring flash floods and landslides," said drought task force member Klaus Wolter, an atmospheric scientist with the Climate Diagnostic Center in Boulder. The flood threat is not unique. Floods have partnered with drought many times in Colorado, according to Larry Lang, chairman of the state flood task force and flood-prevention division chief of the state Water Conservation Board. But assistant state engineer Jack Byers said that although the statewide snowpack peaked at 94 percent, it would be 30 to 45 days before he feels confident about how much of the melting snow will make it into reservoirs. Melting snow can evaporate or soak into the ground, and reservoirs are more than 1.4 million acre-feet below normal. "As a whole, this state has a long way to go, in general, before we get back to normal conditions," Byers said.

The Denver Post / May 15, 2003

### On Trail Ridge's high road, plows take the snow road

Crews in Rocky Mountain National Park have been busy getting Trail Ridge Road cleared of record-breaking amounts of snow in time for its opening. "This year, our road crews said the snow was the most they've seen in 10 years," said Kyle Patterson, spokeswoman. Completed in 1932, the elevation of Trail Ridge Road ranges between 12,183 feet and 8,500 feet. It is the highest continuously paved road in the country. Snowdrifts at the Alpine Visitors Center on May 15 (at an elevation of 11,796 feet) were 15 to 20 feet high.

Rocky Mountain News / May 21, 2003

### A river runs through it

The South Platte River is flowing despite fears that parched riverbeds and water drainage would suck up much of the runoff this year. "That's 100 percent better than last year," said Kenny Bohl, superintendent of Jackson Lake and manager of Fort Morgan Reservoir and Irrigation Co. Since April 10, the ditch company has let water flow directly into irrigation from the river, leaving precious reserves for the dry days of summer. Many growers elected not to plant this year with the fate of wells along the river still uncertain. But for those who have planted, steady rain has meant no need to use irrigation reserves for crops to germinate. It is a big savings compared to last year when a big part of Jackson Lake went to the start of crops.

Fort Morgan Times / May 22, 2003

### Summer water picture coming into focus / Despite high runoff, shortages coming

Water managers watching current conditions have concluded that water shortages will return to the Gunnison Basin as early as mid-June. The most recent report from the National Weather Service Climate Prediction Center predicts that the drought is likely to “persist or intensify” in Western Colorado through August, with temperatures expected to be above average for the same period. “Quick runoff like that is kind of double-edged sword,” said Ed Warner of the Bureau of Reclamation. “It is good for storage, but doesn’t do the irrigators and other users any good.” That means that senior downstream users will most likely place a call on the Gunnison River within two-to-four weeks. Junior water rights holders, including some homeowners, will be forced to shut off their water or find a replacement for what they use. The Upper Gunnison River Water Conservancy District (UGRWCD) has purchased two sources of augmentation water to be sold to homeowners; one from Blue Mesa intended to protect against downstream calls, and the other from Long Lake above Crested Butte. However, both the volume of water needed and the cost make the plan unworkable for irrigators. Also, the call on the river will have a more immediate effect than last year - when many agricultural users lost irrigation water for the bulk of the summer. UGRWCD was able to use water stored in Taylor Reservoir last year, but that water is not available now.

Gunnison Country Times / May 29, 2003

### Arkansas River running deep, to everyone’s delight

Last year on June 3, the Arkansas River through Pueblo was running at only 350 cubic feet per second, far below the average for the date of about 2,000 cfs. On June 4, 2003, the river flow through Pueblo was 4,400 cfs, running deep and muddy. The river call stood at an 1896 priority date, meaning almost all the rights were being satisfied. Bud O’Hara, water resources manager at the Pueblo Board of Water Works said the water board has been receiving questions from drought-weary citizens who wonder “why we can’t hold some of that water in the reservoir instead of letting it all go down the river.” The answer is that the river’s flow is appropriated for downstream users, and it can be held back only during the winter storage period from Nov. 15 to March 15. The level at Twin Lakes is rising because the owners of Twin Lakes water are still able to store their water until they need to move it. The rising river also raises the spirits of city planners who are working on the Arkansas River Corridor Legacy project. The project, which will be done by the Army Corps of Engineers under contract with the city and various other agencies, may be ready to go to bid in a few months so that construction can begin in the late fall.

The Pueblo Chieftain / June 4, 2003

### Rain brings slides / Boulder warns of flood dangers

“Of anywhere in Colorado, Boulder is most at risk for injuries and damage because of flooding,” said Lt. Larry Stern, emergency manager for the city and county of Boulder. More than 103,000 people live in Boulder, and the heart of the city hugs Boulder Creek. “Any water that comes down there is going to come into Boulder,” Stern said of Boulder Canyon. “We have a one-in-three chance this year of having some kind of flooding,” he added. The mountain streams in Boulder County are running just above the normal rate for spring - 100 to 300 cubic feet per second. “It would require a lot more water to get to the level of a 100-year flood with 12,000 cubic feet per second flowing into Boulder,” Stern said. The last 100-year flood of Boulder Creek was in 1894.

Rocky Mountain News / May 17, 2003

### Poudre levels under watch

A string of hot days has the mountain snowpack dwindling, the Poudre River running high and local emergency personnel on the lookout. The Poudre River is expected to reach around 4,000 cfs at its peak flow -- which, depending on the weather, probably will come sometime in the next two weeks. Locally, the greatest flooding risk would come from a run of unseasonably hot days and nights, coupled with heavy rains in the foothills and high country. Larimer County and Fort Collins personnel are watching for debris in area rivers to make sure it doesn’t build up to form makeshift dams behind bridges and in other spots.

The Coloradoan / May 31, 2003

### Flood fears rise / Hayman streams black with ash go over their banks

Heavy rains blackened streams with ash from last summer’s Hayman Fire and turned several miles of the South Platte River smoke-brown with silt. Flash flooding caused no property damage but raised fears that storms could trigger severe erosion and flooding. Two inches of rain fell in about two hours. Flood alerts were in effect until 6 p.m. for Larimer, Boulder, Routt and Clear Creek counties because the week’s warm weather had caused more snowmelt, which pushed streams and rivers into bike trails, pastures and parking lots. National Weather Service said that flooding, in the next few weeks, will depend on the severity of storms and whether cool days will slow snowmelt. On the Western Slope, flood warnings remained in effect for the Yampa River near Steamboat Springs and the Crystal River between Carbondale and Redstone.

Rocky Mountain News / May 31, 2003

#### Car-size pit forces closing of highway; water floods city

A sinkhole the size of a car opened up under Interstate 70 east of Vail on the first day of June after an underground culvert failed. It forced the highway to be closed in both directions, and hundreds of homes were evacuated as water roared through town. Residents of East Vail were ordered to evacuate their homes as rain and runoff caused Bighorn Creek to roar over its banks. There were no reports of injuries. Engineers worked through the night to get to the cause of the disaster. Stacey Stegman, a spokeswoman for the Colorado Department of Transportation, said that a constant flow of water overnight from Bighorn Creek, on the north side of the highway, overwhelmed an 8-foot culvert with sediment and mud. Stegman said repairs could take "two days, a week or more" because once the water is drained, the earth under the highway will remain unstable for some time. The Western Slope's tourism economy, which is swinging into high summer gear, could suffer ill effects if the interstate remains closed for very long.

Rocky Mountain News / June 2, 2003

#### Endangered Species

#### Student project helps rare fish recover in Colorado

A group of Steamboat High School students released a batch of native razorback suckers into the Yampa River at The Nature Conservancy's Carpenter Ranch last week. The event marked another step toward recovering a fish population that has existed in the region for millions of years. "Similar releases are planned in Telluride, Crested Butte, Ignacio and Grand Junction," said Stan Johnston, an education and outreach coordinator with the Colorado Division of Wildlife.

Special to the Denver Post / May 11, 2003

#### Fishing: mud and ash give cutthroat trout another shot

The mud and ash that swept down the Florida and Los Pinos rivers after last summer's Missionary Ridge Fire devastated fish populations. However, the loss offered a rare opportunity to restock the streams with Colorado cutthroat trout, a native species that hasn't been seen in the San Juan Basin in 100 years. According to Mike Japhet, an aquatic biologist with the Colorado Division of Wildlife, the Florida River is completely depleted of fish and the Los Pinos River lost 90 percent of its fish population. Japhet calls the restocking a trial project with no guaranteed results. It will take place in late August and during the next two summers in stretches of the Florida and Los Pinos Rivers that run through private property. The restocking effort has the support of the private property owners, who have pledged not to stock other game fish. The absence of the non-native rainbows and browns will afford the young cutthroat a protected environment in which they might reproduce. Japhet said that the Division of Wildlife has an abundance of cutthroat brood stock at its hatcheries in Durango and Glenwood Springs so restocking the two rivers won't be done at the expense of other areas. Japhet believes that without heavy rain that would wash more ash and mud down from hillsides, the young cutthroat have a good chance for survival.

Durango Herald / May 18, 2003

#### Recreation

#### Camping in forest? Pack in some drinking water

If you plan on going to any of the designated campgrounds and day use areas on the White River National Forest, you are encouraged to bring your own drinking water, as numerous sites may not have potable water this summer. Some of the drinking water unavailability is due to the drought and wells going dry. In other cases, tests indicate that water does not meet current state safe drinking water standards. Until upgrades and repairs to water systems can be made, the Forest Service cannot provide safe drinking water.

Glenwood Springs Post Independent / May 20, 2003

#### River levels, rafting spirits rise / Outfitters look to make rebound

Colorado River water levels are up substantially over last year, and so are rafters' spirits. According to Glenwood Springs Chamber Resort Association, whitewater rafting is a \$15-million-a-summer industry for Glenwood Springs. Last year business was down as much as 30 percent due to low water on the Colorado River and June wildfires that kept tourists away. "At this time of the year in 2002, the Colorado River was flowing at about 2,000 cubic feet per second (cfs)," said Lloyd Moore at the Shoshone power plant in Glenwood Canyon. On May 19, the river was flowing at 4,100 cfs.

Glenwood Springs Post Independent / May 21, 2003

#### Technology

#### NOAA gives 'infrasound' network a whirl in pursuit of better tornado warnings

The same ultra-low-frequency sound waves that whales and elephants use to communicate have been harnessed in a tornado-detect-





tion network being tested by Boulder researchers. By the end of May, three tornado-detection stations in Colorado and Kansas will be listening for acoustic waves called "infrasound," below the range of human hearing. "A tornado's violently rotating column of air resonates like a ringing bell at infrasound frequencies, emitting sound waves that can be detected hundreds of miles away," said physicist Alfred J. Bedard Jr. of the National Oceanic and Atmospheric Administration in Boulder. "The average tornado warning time is 12 minutes, and the goal is to push that out further, to improve detection and warning and to reduce false alarms," said Bedard. "But first, we have to show that it actually helps forecasters," he said, adding, "The burden of proof is on us to demonstrate that this works." The equipment for each station costs about \$50,000. During the early May tornado outbreak in central plains, many of the tornadoes were spawned by massive, long-lived, rotating thunderstorms called supercells. According to Bedard, infrasound tornado detection may be able to reduce the false-alarm rate associated with supercell storms. For reasons that remain unclear, supercell storms with the potential to produce tornadoes are noisy at infrasound frequencies, while supercell storms that generate hail but no tornadoes are quiet.

Rocky Mountain News / May 26, 2003

#### Water Legislation

##### Controversial water bill passes legislature

Concerning Colorado's serious water shortage, the most significant piece of legislation that emerged from the recently completed legislative session was Senate Bill 236; a controversial measure that many say has made it easier than ever for big water projects to be built in Colorado. The bill gives the state the power to raise as much as \$2 billion for new water projects and directs the governor to select one, and to ensure that construction begins by 2005. The new spending authority will have to be approved by the voters in a statewide initiative in November. Environmentalists had recently opposed the bill, because it could create a fund for huge, environmentally damaging dams and projects.

The Coloradoan / April 16, 2003 / Gunnison Country Times / May 15, 2003

##### Whitewater case reflects the importance of tourism in state

On May 19, the Colorado Supreme Court, with a 3-3 tie, let stand a District 1 Water Court Decision allowing the City of Golden to appropriate water for a white water course on Clear Creek. Two decisions out of Colorado's District 5 Water Court granting similar rights to the communities of Vail and Breckenridge were consolidated with the Golden case for the Colorado Supreme Court's review. After the case was filed, but prior to a water court's decision, the Colorado Legislature passed SB 216/HB1344. Among other changes, it directs that local governments considering a recreational in-channel diversion submit the application to the Colorado Water Conservation Board (CWCB) for review. Applications filed since January 1, 2001 are subject to CWCB review.

Western States Water / May 23 and May 30, 2003

#### Water Rights

##### Gunnison River named one of nation's most endangered

American Rivers listed the Gunnison River as the fourth most endangered river in the United States in its report, [America's Most Endangered Rivers of 2003](#). Colorado's Rio Grande and Platte Rivers were also on the list. The American Rivers report cites unnatural flows as one of the threats to the Gunnison River. On April 2, the National Park Service and Colorado officials agreed to transfer any rights for Gunnison River flows above 300 cfs in the Black Canyon from the NPS to the Colorado Water Conservation Board. Colorado water court still has to approve the proposed water rights before the agreement is final. American Rivers reported that agricultural and municipal diversions claim almost 95 percent of the Rio Grande's annual flow, and the river failed to reach the Gulf of Mexico for the first time in 2001.

Montrose Daily Press / April 10, 2003 / The Associated Press / The Coloradoan / April 10, 2003

##### Users reach tentative agreement on San Juan River allocations

San Juan River users have reached a tentative agreement on how to share its water for the rest of the year. The recommendations will be sent to the Bureau of Reclamation for consideration. Farmers, American Indian tribes, electric-generating plants and residents in four states rely on a 224-mile stretch of the river. "The users began meeting in September when it became evident that water could be in short supply this summer," said Pat Page, USBR's water-management team leader in Durango. Numerous long-standing water issues, still unresolved, include Navajo claims to San Juan River water, the administration of the river by the State of New Mexico and various legal issues probably won't be settled for years.

Associated Press / The Coloradoan / April 24, 2003

## Water Supply and Development

## Stocking up for growth

Aurora water official Peter Binney announced at the May 19 city council study session that he wants to reorganize the Utilities Department and recruit seven high-level, highly-paid employees. The new positions will form a core team of experienced water experts capable of building a water infrastructure equivalent to that of other cities the current size of Aurora. The city has asked the Utilities Department to double the capacity of the water system by 2020, and the budget will grow to \$80 million per year. Binney said more terminal storage, such as the Aurora Reservoir and others along the West Slope, is “absolutely” a major part of the long-term plan. In other water-related news, the city council approved leasing 4,000 acre-feet of water from the Climax Molybdenum Company for the next two years. Aurora will pay \$1.2 million for the water, which would be available this year. The water will be used to replenish Aurora’s depleted reservoirs.

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The Aurora Sentinel / May 22, 2003

## Owens signs study of water project proposal

Gov. Bill Owens has signed a bill authorizing a \$500,000 study of a proposal to pipe unused Colorado River water across the Continental Divide to Front Range communities. Opponents argued the study of the Big Straw proposal was a waste of money on a project that would be too costly to build. Estimates range from \$5 billion to \$15 billion. Supporters included bill sponsor Sen. Lew Entz, R-Hooper, who said the study is needed to determine some way to keep water that the state is entitled to but lacks storage for.

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Associated Press / Boulder Daily Camera / May 23, 2003

## Springs plans water pipeline

Colorado Springs plans to build a 45-mile, \$900 million water pipeline to draw water from the Arkansas River below Pueblo Reservoir and deliver it north to the city. The Colorado Springs pipeline is one of several Front Range projects identified as “smart” in a recent report by the Sustainable Water Caucus; a partnership between Trout Unlimited and the Colorado Environmental Coalition. “This will virtually double our water supply,” said Jerry Heimlicher, newly elected city councilman. The pipeline will eventually deliver 68 million gallons of water per day to Colorado Springs and 10 million gallons per day to Fountain. The project also will include two new reservoirs in El Paso County and several pump stations. The pipeline project will be up for a series of public reviews this summer. Although lawmakers are asking voters to approve a new \$2 billion state financing authority for water projects this fall, Colorado Springs plans to issue its own bonds for the project, using tap fees and water fees to pay off the bond debt.

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Rocky Mountain News / May 27, 2003

## County commissioners endorse special domestic water district

County commissioners endorsed a plan for residents to form their own special district to provide domestic water in southeastern La Plata County. The county does not want to form a county-managed system, but it will support residents who want to form a water district with a board of directors and a taxation system. The district could serve about 3,500 residents. The district service plan must be approved by county commissioners and a district court judge before residents in the district can vote on it. It could be 20 years before the water system is completed.

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Durango Herald / May 28, 2003

## Feds host water talks

The Bureau of Reclamation will start a series of conferences in Denver on June 6, 2003 to discuss water supplies. But no new federally funded dams are on the agenda. In the last century, the Bureau of Reclamation dammed rivers to irrigate arid lands and generate electricity to settle the West. John Keys, commissioner of the Bureau of Reclamation, said the mission now is to find ways to conserve water. For more information, see [www.doi.gov/water2025/conference](http://www.doi.gov/water2025/conference).

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Rocky Mountain News / May 31, 2003

### ADMINISTRATION UPDATE

#### Water 2025/Western Water Initiative

On May 2, Interior Secretary Gale Norton announced an Administration proposal to concentrate existing federal and technical resources in key western watersheds to address chronic water supply problems. The President’s FY2004 budget included an \$11 million Water Initiative, which the Secretary called an initial investment in “Water 2025: Preventing Crises and Conflict in the West.” Norton said, “Crisis management is not an effective solution for addressing long-term systematic water supply problems. She specifically referred to the Klamath Basin and

Middle Rio Grande. "Water 2025 recognizes that states, tribes, and local governments should have a leading role in meeting these challenges. The department of Interior should focus its attention and resources on areas where scarce federal dollars can provide the greatest benefits to the West and the Nation."

"Water is the lifeblood of the American West..." Water 2025 recognizes that explosive population growth in western urban areas and growing needs for water for municipal and industrial, environmental and recreation uses, as well as irrigation demands for food and fiber, are driving an increasing number of conflicts over scarce water resources. In some areas, existing water supplies are - or will be - inadequate, even under normal climatic conditions. The continuing drought magnifies the problems, which include over-allocated watersheds and aging water supply infrastructure. Water 2025 is designed to provide a framework to focus on future challenges and stretch or increase water supplies to meet environmental and economic demands through a balanced, practical approach to water management.

Four key tools for proactive management are: (1) conservation, efficiency and market improvements; (2) collaboration; (3) technology; and (4) raising interagency cooperation, while removing institutional barriers. Six principles are listed: (1) recognize and respect state, tribal and federal water rights, contracts, and interstate compacts or decrees of the United States Supreme Court that allocate the right to use water; (2) maintain and modernize existing water facilities so they will continue to provide water and power; (3) enhance water conservation, use efficiency, and resource monitoring to allow existing water supplies to be used more effectively; (4) use collaborative approaches and market-based transfers to minimize conflicts; (5) improve water treatment technology, such as desalination, to increase supplies; and (6) get more benefits from existing water supply facilities to meet existing and emerging needs.

Among the areas where the potential for conflicts is high, due to inadequate supplies for existing demands, are California's San Joaquin Valley, Lake Tahoe, the Reno/ Sparks area in Nevada, Las Vegas and the Lower Colorado River to the border with Mexico, the Lower Rio Grande and Texas Gulf Coast, Albuquerque and Santa Fe in northern New Mexico, as well as the Middle Rio Grande above Elephant Butte Reservoir, Denver and Colorado's Front Range, Salt Lake City and Utah's Wasatch Front, and much of Arizona, including Tucson, Phoenix, Flagstaff and communities along the Mogollon Rim, as well as the Navajo and Hopi Reservations.

The proposal opines, "America's strength has always depended on the great wealth of her natural resources and the ingenuity of her people. Water 2025 will enable our nation to continue to prosper and grow well into the 21<sup>st</sup> century and leave the legacy of a healthy environment, community strength, and economic self-reliance for generations to come." For more information, visit [www.doi.gov/water2025](http://www.doi.gov/water2025).

Source: Western States Water newsletter / May 9, 2003

## HOMELAND SECURITY REPORT – WATER SECURITY SINCE 9/11 SHOWS UNPRECEDENTED MOBILIZATION OF EFFORTS, RESOURCES AWWA report outlines progress, challenges in securing water supply from terrorism

WASHINGTON – According to a new report issued by the American Water Works Association, (AWWA) America's water utilities' immense focus on homeland security since the terrorist attacks of 9/11 has resulted in an unprecedented mobilization of effort and resources to protect America's water supply. The new report, *Drinking Water Security in America After 9/11*, identifies the extensive new security measures water utilities have undertaken since 9/11. It also describes the new culture of security that water utilities now operate under and the challenges they still face in protecting the nation's water supplies from terrorism. For a copy of the full report, go to <http://www.awwa.org>

Working together with the Environmental Protection Agency (EPA), water utilities have ramped up security efforts at water supply systems throughout the nation. Background checks on new employees have become common, as have intensive employee training, security audits, assessments and emergency response and communications plans. A nation-wide information sharing system has been developed for water utilities. Utilities are identifying their most vulnerable traits and are working with local emergency first responders to coordinate planning.

Taken together, this mobilization of effort and resources is vir-

tually unprecedented. It has resulted in the development of:

- The EPA's "Baseline Threat Report" describing likely modes of terrorist attack and outlining the parameters for vulnerability assessments by community water systems. This is sensitive information provided only to water utilities;
- Risk assessment tools for utilities to identify and evaluate their own security risks. Such analyses, called vulnerability assessments, are required by the Bioterrorism Act;
- Training programs on vulnerability assessments, used by several thousand water systems, to help utilities prepare accurate and detailed assessments;
- Security protocols to assure that vulnerability assessments are safeguarded after they are sent to EPA, as required by the Bioterrorism Act;
- Guidance and technical assistance for utilities to use in revising emergency response plans as required by the Bioterrorism Act;
- Development of information on "best practices" and technical assistance on matters such as security hardware technologies;
- An inventory of past security threats to community water systems and the lessons learned from them;
- Analysis of the lessons learned by community water systems through the vulnerability assessment process;

- Guidelines that water utilities may use to guard against terrorists and security threats, correlated with the Department of Homeland Security's color-coded advisory system; and
- The Water Information Sharing and Analysis Center (WaterISAC), which provides a secure portal for the communication of sensitive security information among utilities, law enforcement, and intelligence agencies.

The drinking water community, in partnership with EPA and others, actually began to prepare for terrorist threats before September 11, 2001. In 1998 President Clinton signed Presidential Decision Directive 63 and thereby identified water as part of America's critical infrastructure. Under that Directive, EPA was assigned lead responsibility for the water sector and, in turn, designated the Association of Metropolitan Water Agencies (AMWA) as the lead for this sector. At the same time, the American Water Works Association (AWWA) began to prepare technical materials and publications for water utilities relating to water system security. These efforts went into high gear immediately after the terrorist attacks on New York and Washington.

Title IV of the Bioterrorism Act, which was signed into law last June, amended the Safe Drinking Water Act (SDWA) and required specific actions to improve water security, with specific deadlines and requirements for both water utilities and the EPA.

The Bioterrorism Act mandated significant new security requirements for all community water systems serving more than 3,300 people. Collectively these approximately 8,000 utilities serve over 240 million people, or about 90% of the nation's population served by community water systems. The Bioterrorism Act requires community water systems serving more than 3,300 people to do the following:

- Conduct a vulnerability assessment;
- Certify to EPA that the vulnerability assessment was completed by a date specified in the law;
- Submit a paper copy of the assessment to EPA;
- Prepare or revise their emergency response plan based on the results of the vulnerability assessment; and
- Certify to EPA that the emergency response plan has been developed or revised by a date certain.

Deadlines for submission of vulnerability assessments to EPA depend on the size of the water system:

Systems serving 100,000 or more people—March 31, 2003;  
 Systems serving between 50,000 and 99,999 people—December 31, 2003;  
 Systems serving between 3,300 and 49,999 people—June 30, 2004.

Six months after submission of the vulnerability assessment, utilities are required to certify to EPA that they have developed or revised an emergency response plan based upon the results of the vulnerability assessment.

Under the Bioterrorism Act, both vulnerability assessments and emergency response plans have to focus on terrorist attack or

other intentional acts intended to disrupt the ability to deliver a safe and reliable supply of drinking water or otherwise present a significant health concern. That stands them apart from the assessments and plans that most utilities have had for years for dealing with natural disasters, vandalism, etc. While the assessments and plans that existed before September 11 may serve as a very good starting point, the focus of the Bioterrorism Act is purposeful destruction or contamination, and water utilities must alter their emergency response plans to meet these new threats.

EPA has its own set of deadlines in the Bioterrorism Act. Congress required that by August 1, 2002, EPA complete a baseline threat report with information on likely threats for utilities to consider in the development of a vulnerability assessment. EPA completed the Baseline Threat Information for Vulnerability Assessments for Community Water Systems and provided this sensitive report to water utilities in the fall of 2002.

The law also required EPA to develop a protocol for protection of the submitted vulnerability assessments by November 30, 2002. In response, the Agency has completed a robust protocol with multiple levels of protection to safeguard vulnerability assessments within a controlled-access facility at EPA headquarters.

EPA is also required to conduct research on prevention, detection, and response to contamination and supply disruption, and a research plan is under development. Finally, the law requires EPA to develop guidance for small systems serving less than 3,300 people. While these systems are not required to conduct a vulnerability assessment and revise an emergency response plan under the Bioterrorism Act, many are implementing plans to protect their customers.

Virtually all of the largest utilities – those with the earliest deadline of March 31, 2003 – submitted their vulnerability assessments to EPA on or before the deadline. They are now revising their emergency response plans to reflect what they learned in the vulnerability assessment. In addition, utilities are conducting prevention and response training to anticipate and prepare for issues surrounding a potential terrorist attack that impacts the water supply. Medium and smaller sized utilities across the nation are in the process of developing their vulnerability assessments, and they too will develop or revise effective emergency response plans. Both the utility community and EPA are giving security the serious attention it deserves.

Since the terrorist attacks of September 11, 2001, water utilities have been assessing their systems. AWWA has estimated \$1.6 billion is needed for the first steps towards greater physical protection, to include better fences, locks, lights, and alarms at critical utility assets. The cost of other necessary utility security upgrades is highly dependent on local factors such as the level of water security upgrades needed. Such costs have not been estimated at this time, but will be substantial. Barring additional local, state, or federal funding, these costs will be passed on to the customer.

ALAN COVICH TO BECOME DIRECTOR,  
INSTITUTE OF ECOLOGY,  
AT THE UNIVERSITY OF GEORGIA

Alan P. Covich, Professor and former Head of the Department of Fishery and Wildlife Biology at Colorado State University (1993-1998), will become the director of the Institute of Ecology, in July, 2003. The Institute is part of the new College of the Environment and Design at the University of Georgia-Athens.

Long-term effects of drought on species-specific regulation of stream food-web dynamics and the ecological integrity of riparian communities are major areas of Covich's research. Covich was awarded the Icko Iben Award for Excellence (in interdisciplinary work) by the American Water Resources Association in 1997, and elected a Fellow of the American Association for the Advancement of Science in 1999.

In 2000 Covich served as president of the American Institute of Biological Sciences (AIBS). Previously he served as chair of the Aquatic Ecology Section of the Ecological Society of America, President of the North American benthological Society, and currently serves on the INTECOL Board of Directors. He co-edited two editions of the Ecology and Classification of North American Freshwater Invertebrates (Academic Press) and published a review on "Water and Ecosystems" in Water in Crisis: A Guide to the World's Freshwater Resources (Oxford University Press).

Covich participated in several international workshops on biodiversity and ecosystem function in Holland, Finland, Denmark, and Switzerland and in two EPA-sponsored workshops on effects of climate change on freshwater ecosystems. The latest EPA workshop was focused on drought effects in the South Platte watershed and was co-organized with Jill Baron through the Natural Resources Ecology Lab.

The University of Georgia's Institute of Ecology has emerged as a leading center for ecological research. Faculty, graduate



students, and professionals who are members of the Institute represent a cross-section of departments and schools across the University's campus - including anthropology, botany, crop and soil science, entomology, forestry, geography, genetics, and microbiology. Members off-campus include ecologists stationed at the Savannah River Ecology Laboratory in Aiken, South Carolina, the University's Marine Institute at Sapelo Island, the Coweeta Hydrologic Laboratory in Franklin, North Carolina, the Skidaway Institute of Oceanography in Savannah, Georgia, and the Joseph W. Jones Ecological Research Center in Newton, Georgia. Some scientists working in state and federal agencies are also Institute members. More than 120 students are enrolled in graduate programs in the Institute. They conduct research with faculty on the UGA campus, with faculty at the Savannah River Ecology Laboratory, with partnering faculty at the Coweeta Hydrologic Laboratory, Joseph Jones Ecological Research Center, and at the Tifton and Griffin Agricultural Experimental stations, among others. Each of the facilities that faculty are associated with offer extensive access to a variety of ecosystems and the equipment needed for research studies.

The Institute's research projects are diverse from geographic, ecosystem, and 'issues' perspectives. Research is currently being conducted in Costa Rica, Ecuador, Brazil, Puerto Rico, Belize, Madagascar, the Ukraine, China, and many parts of the U.S. This research focuses on salt marshes, coral reefs, agroecosystems, mountain streams, large rivers, soil ecosystems, pristine, disturbed and urban systems. Of particular interest in the Institute is coupling research efforts with [service](#) to provide answers to today's environmental problems. Examples of these research and outreach activities include the Center for River Basin Science and Policy and the Center for Biodiversity Research that are interdisciplinary groups within the new College of the Environment and Design.

## MEETINGS and CALLS FOR PAPERS

THE 14TH ANNUAL  
SOUTH PLATTE FORUM  
PLANNING FOR UNCERTAINTY  
Oct. 22-23, 2003  
Raintree Plaza, Longmont, Colorado



### Keynote Speakers

Ken Salazar, Colorado State Attorney General  
Dave Robbins, Hill & Robbins, PC  
Rod Kuharich, Colorado Water Conservation Board  
Robert Ward, Colorado Water Resources Research Institute

#### Rural Economics - Thirsting for Water

Rick Dykstra, Progressive 15  
Erick Schuck, Colorado State University  
Alan Foutz, Colorado Farm Bureau

#### We're All Tapped Out

Sharon Harris, Green CO  
Leslie Parker, Denver Water  
Dick Parachini, Colo. Dept. of Public Health & Environment

#### Crispy Critters - Past, Present & Future

Kurt Fausch and Kevin Bestgen, Colorado State University  
Boris Kondratieff, Colorado State University  
Ellen Wohl, Colorado State University

#### Planning For an Uncertain Future In the South Platte

Don Ament, Colorado State Agriculture Commissioner  
Peter Binney, City of Aurora  
David Merritt, USDA Stream Systems Technology Center

#### Just How Abrasive IS Gravel?

Melissa Young, Colorado Rock Products  
Glenn Rodriguez, US Environmental Protection Agency  
Margaret Langworthy, US Corp of Engineers

#### Will You Take a Rain Check From the Water Bank?

Leroy Mauch, Lower Arkansas River Conservancy District  
James Broderick, Southeast Colorado Water Conservancy District

#### And More...

Julie McKenna, Brandeberry & McKenna Public Affairs - State Legislative Update  
Nolan Doesken, Assistant State Climatologist - Climate Update

### Call for Posters

You are invited to submit a one-page abstract to the organizing committee by Aug. 1, 2003. Selected posters will be displayed throughout the forum with a staffed session from 3-7 p.m., Wednesday, Oct. 22. Authors whose posters are selected for presentation will be notified by Sept. 1, 2003. All accepted abstracts will be published in the conference proceedings.

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US Geological Survey

To submit abstracts or request additional information, CONTACT:

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28TH COLORADO WATER WORKSHOP  
 IN HARD TIMES: WATER ALLOCATION AND USE IN TIMES OF SCARCITY  
 WESTERN STATE COLLEGE, GUNNISON, CO  
 JULY 23-25, 2003

The drought of the past several years has been a wake-up call for the people of the arid West. Even if the drought is lessening this year (and that seems to vary from basin to basin), it is increasingly clear that the West's water economy is caught in a "supply-demand vise," with the moving jaw of the vise a growing demand that is tightening down on a water supply that is, practically speaking, fixed at best, and maybe destined to diminish in coming years.

Western State College's 28th Water Workshop this summer will look at the responses that are emerging to these "Hard Times" in Colorado and the Southwest. The first day of the conference, water leaders from the Upper Colorado Region will present "Strategies for Hard Times" - Greg Walcher from Colorado's Department of Natural Resources on the state perspective, Dan Luecke from an environmentalist perspective, Mike Applegate of The Applegate Group from an engineering perspective, Chris Treese on the "Ten Principles for Water Development," and others.

The second day of the conference, Colorado Supreme Court Justice Grew Hobbs will give some historical perspective on the evolution of Colorado Water Law, followed by a panel analyzing the 2003 General Assembly's water legislation in terms of what water law was made and why. That panel will include Colorado Senator Jim Dyer, Representative Greg Rippy, Melinda Kassen of Trout Unlimited, and Gunnison water attorney John McClow.

The afternoon session will look at examples from around the state where people are attempting to work collaboratively and often creatively to deal with "Hard Times." A general session on the physical and legal challenges facing the Upper Rio Grande basin will be followed by breakout sessions discussing situations from nearly every part of the state.

The final morning of the session will be devoted to consideration of the Colorado River region and its foundational legal infrastructure, on the question: "In hard times, is the Colorado River Compact still part of the solution, or is it beginning to be part of the problem?" David Getches of the University of Colorado Law School will lead the discussion, with participants from both the Upper and Lower Basins of the Colorado River - and the Indian Nations in between.

The complete schedule is posted on the college's website, along with registration information, at [www.western.edu/water](http://www.western.edu/water), or can be obtained from Water Workshop director George Sibley at 970-943-2055.



COLORADO WATER CONGRESS WORKSHOPS

The following workshops are planned for Fall - 2003: They will all be held in the Colorado Water Congress Conference Room, 1580 Logan Street, Suite 400, Denver, Colorado.

Initiatives - What You Should Know  
 Water Quality  
 Groundwater  
 Legislative Process - Advocacy  
 News Media Relations  
 Wetlands  
 Federal Environmental Laws  
 Water Financing  
 Ethics

An Advance Course in Water Law by the Veterans (or the School of Hard Knocks in Water Law)

The Colorado Water Law Seminar is scheduled for September 8 - 9, 2003. Program and Registration will be posted on the CWC Website when available at <http://www.cowatercongress.org>.

Colorado Water Congress - Summer Convention -- August 21-22, 2003  
 Steamboat Grand Resort Hotel & Conference Center, Steamboat Springs, Colorado

The 2004 46th Annual Convention will be January 29-30, 2004

## CALENDAR



June 29- July 2	American Water Resources Association 2003 International Congress, WATERSHED MANAGEMENT FOR WATER SUPPLY SYSTEMS, New York. Contact: AWRA, 4 W. Federal St., Middleburg, VA 20118-1626, Call AWRA at 540/687-8390 or see Website at <a href="http://www.awra.org/meetings">http://www.awra.org/meetings</a> .
July 23-25	IN HARD TIMES: COLLABORATION OR CONFLICT? COOPERATION OR CONTENTION? 28TH COLORADO WATER WORKSHOP, Western State College, Gunnison, CO. Contact: George Sibley, Western State College, Phone 970/943-2055, E-mail <a href="mailto:water@western.edu">water@western.edu</a> .
Aug. 21-22	COLORADO WATER CONGRESS Summer Convention, Steamboat Springs, CO. Contact: Dick MacRavey, Executive Director, at Phone 303/837-0812, FAX 303/837-1607, E0mail <a href="mailto:macravey@cowatercongress.org">macravey@cowatercongress.org</a> . Website: <a href="http://www.cowatercongress.org">www.cowatercongress.org</a> .
Sept. 17-20	SUSTAINABILITY ISSUES OF ARIZONA'S REGIONAL WATERSHEDS, Mesa, AZ. Contact: Dr. Pete Kroopnick at Phone 602/567-3850, FAX 602/567-4001, or E-mail <a href="mailto:PKroopnick@brwncaid.com">PKroopnick@brwncaid.com</a> or Julie Rutkowski, Symposium Committee Chair, at 602/771-4411 or <a href="mailto:rutkowski.julie@ev.state.az.us">rutkowski.julie@ev.state.az.us</a> . Website: <a href="http://www.azhydrosoc.org">http://www.azhydrosoc.org</a> .
Oct. 12-15	10TH ANNUAL CONFERENCE ON TAILINGS AND MINE WASTE, Vail, CO. Contact: Linda Hinshaw, Coordinator, Dept. of Civil Engr., CSU, Phone 970/491-6081, FAX 970/491-3584, E-mail <a href="mailto:lhinshaw@enr.colostate.edu">lhinshaw@enr.colostate.edu</a> .
Oct. 22-23	14th ANNUAL SOUTH PLATTE FORUM, PLANNING FOR UNCERTAINTY, Longmont, CO. Contact Jennifer Brown at (970) 213-1618, <a href="mailto:jennifer@jibrown.com">jennifer@jibrown.com</a> . Website: <a href="http://southplatte.jibrown.com/">http://southplatte.jibrown.com/</a> .
Oct. 29-30	GETTING IT DONE: THE ROLE OF TMDL IMPLEMENTATION IN WATERSHED RESTORATION, Stevenson, WA. Contact: Kelly Newell at 509/335-5531, E-mail <a href="mailto:watercenter@wsu.edu">watercenter@wsu.edu</a> . Website: <a href="http://www.swwrc.wsu.edu/conference2003">http://www.swwrc.wsu.edu/conference2003</a> .
Nov. 3-7	7TH BIENNIAL CONFERENCE, INTEGRATING SCIENCE AND MANAGEMENT ON THE COLORADO PLATEAU, NORTHERN ARIZONA UNIVERSITY, FLAGSTAFF, AZ. Contact: David Mattson, Phone 928/556-7466 x245, <a href="mailto:David.Mattson@nau.edu">David.Mattson@nau.edu</a> ; David Fiss, Phone 928/523-7087, <a href="mailto:David.Fiss@nau.edu">David.Fiss@nau.edu</a> . Website: <a href="http://www.usgs.nau.edu/conf2003/">http://www.usgs.nau.edu/conf2003/</a> .
Nov. 4-8	NALMS 2003: PROTECTING OUR LAKES' LEGACY, 23rd International Symposium, Mashantucket, Ct. Co-Chairs: Amy Smagula, Phone 603/271-2248, E-mail <a href="mailto:asmagula@des.state.nh.us">asmagula@des.state.nh.us</a> ; Neil Kamman, Phone 802/241-3795, E-mail <a href="mailto:neilk@dec.anr.state.vt.us">neilk@dec.anr.state.vt.us</a> .

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