



COLORADO WATER

Newsletter of the Water Center at Colorado State University

APRIL 2004



The Department of Interior's Assistant Secretary for Water and Science, Bennett Raley, joined the National Institutes for Water Resources meeting in Washington D.C. to discuss FY2005 appropriations for state water institutes. See page 13.



Dr. James Moncur, President of NIWR, and Bennett Raley at NIWR Meeting, March 1, 2004.

INSIDE: SPECIAL ISSUE
Conjunctive Management of Colorado's Ground and Surface Water Resources

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Colorado Water Resources Research Institute
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Writer: Marian Flanagan

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Colorado Water Resources Research Institute
Colorado State University, Fort Collins, CO 80523
Phone 970/491-6308 FAX: 970/491-1636

E-mail: CWRRI@ColoState.EDU

INTERNET SITES

Colorado Water Resources Research Institute: <http://cwri.colostate.edu>
CSU Water Center: <http://watercenter.colostate.edu>
Colorado Water Knowledge: <http://waterknowledge.colostate.edu>
Hydrology Days: <http://hydrologydays.colostate.edu/>
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<http://watercenter.colostate.edu/frdwc/frdwc.htm>



The Colorado Water Resources Research Institute (CWRRRI)
Colorado State University

Cordially invites you to a reception recognizing
Shirley A. Miller

For her 30 years of service to CWRRRI
and the 'water' community of Colorado

Monday, May 3, 2004
4:00 to 6:00 pm

Longs Peak Room, Lory Study Center
Remarks at 5:00 pm

If you have any questions, contact
Bernie Shepard at (970) 491-7425

RECOGNITION

The CSU Water Center and the Colorado Water Resources Research Institute (CWRRRI) are lean organizations, employing only one full time person – Shirley Miller. Shirley edits the Water Center/CWRRRI newsletter, Colorado Water; manages the Water Center/CWRRRI budget, including many research projects; processes personnel paperwork for CWRRRI project-related employees; ensures that CWRRRI submits timely and complete annual reports and 5-year evaluations to the USGS (per requirements associated with CWRRRI's Federal funding); handles numerous requests for water information; manages the Water Center/CWRRRI office; and, in general, has been the steady hand behind the Water Center/CWRRRI core operations for 30 years.

Shirley is retiring May 31, 2004! A reception has been organized to recognize Shirley's many contributions, not only to the water programs at CSU, but, also, through CWRRRI, to the water programs in Colorado's higher education system, to water users and managers across the State, and to the national water institute program. The reception will be held May 3, 2004, from 4:00-6:00 p.m. in the Longs Peak Room, Lory Student Center, CSU. You are invited to join us as we recognize Shirley's outstanding service to higher education's water programs in Colorado.

Having worked with Shirley for many years, I find her strong commitment to the successful operation of CWRRRI and the CSU Water Center inspiring. There have been many times when the pressure of trying to connect higher education's

extensive water expertise with the evolving research and education needs of Colorado's water managers put me in a difficult, almost frenetic, situation. In such situations, it could be easy to let a newsletter deadline slip or an annual report lag. It is usually Shirley's clear view of the core operations of the Water Center and CWRRRI that keeps the organization moving steadily ahead, fulfilling its obligations in a highly competent manner. When you recall the regular appearance of Colorado Water in your mailbox over the years, you are witnessing Shirley's strong commitment to the CSU Water Center/CWRRRI.

During Shirley's tenure with higher education's water programs, there have been many changes – not only in higher education and society in Colorado, but also in the technology employed to produce a newsletter, to be accountable to the U.S. Geological Survey, our federal sponsor, and to perform the duties of managing a budget, processing personnel paperwork, making travel arrangements for CWRRRI project staff and communicating with CWRRRI clients. Shirley has always been resourceful – you have to be to perform the breadth and number of tasks she does by herself. She navigates the people side of the Water Center/CWRRRI's operations with sensitivity and provides a welcoming human face to those approaching higher education's water expertise.

We all thank Shirley for her many, many contributions; recognize her commitment to excellence in her work; and wish her, and her husband (Wes), an enjoyable and long retirement. It is extremely well deserved.



CONJUNCTIVE MANAGEMENT OF GROUND AND SURFACE WATER

Introduction by Representative Diane Hoppe

Chair, House Agriculture, Livestock, and Natural Resources Committee

Colorado established its water rights system and signed most of its Compacts with downstream states prior to the technological developments that permitted large-scale ground water pumping. Integrating ground water pumping rights into the priority system for surface rights has been a challenge facing Colorado, and other western States, for a number of years. Colorado was a leader among other states when, in 1969, it formally incorporated ground water pumping into the water rights priority system. The goal was to make maximum use of surface and ground water resources.

Ground water resources are complex and challenging to manage. First, the resource can be contained in deep formations that are not readily recharged (e.g., Denver Basin Aquifers) or contained in alluvial aquifers that are hydrologically connected with river flows (e.g., Lower Arkansas Valley). Second, the amount of water available is not as readily quantified as surface water. Third, the impact of ground water pumping on surface water flows can be quantified in a number of ways, thus creating differences of opinion on how such quantification should take place.

Further complicating the issue, Colorado experienced almost 50 years without a multi-year drought which, in some ways, shielded the water users from the reality that during a multi-year drought ground water may be readily available (albeit at greater depth) while surface water may not be available. Thus, those with senior surface water rights may not have water while those with junior ground-water rights may still have access to ground water resources.

This potential situation exists in four river valleys in Colorado - Republican, Arkansas, South Platte, and Rio Grande. The Republican and Arkansas water users are currently adjusting water use to comply with settlements/decisions rendered on recent lawsuits. In the South Platte and Rio Grande, the recent drought and the Colorado Supreme Court's Empire Lodge decision exposed conflicts between surface and ground water users that are still being sorted out.

This issue of Colorado Water magazine examines the history and need for new water knowledge that surrounds efforts to refine conjunctive ground and surface water management in ways that satisfy the prior appropriation system and Colorado's compact obligations, and yet, ensures maximum utilization of water resources during a time of drought.

In this issue of Colorado Water Justice Greg Hobbs outlines for us some of the history behind the current situation. Ray Wright, Tom Cech and Jim Broderick describe the issues facing the Rio Grande, South Platte and Arkansas basins, respectively. The article on page 15, summarizing the recent Ogallala Aquifer Symposium, briefly describes the nature of conjunctive ground/surface water management problems facing the Republican River water users.

Luis Garcia describes how science can help develop 'tools' that allow water managers and users to 'see,' in a transparent manner, the conjunctive movement of ground and surface water within a river valley.

The magazine's articles point out some of the difficulties and questions surrounding conjunctive ground and surface-water management during a time of drought. The questions are not easy to answer, and efforts to provide answers consume considerable time in the Colorado legislature.

As is pointed out in remarks presented to the Ogallala Aquifer Symposium, water managers and users are realizing the inevitable - use of water, on average, exceeds that available under the Republican River Compact. Adjustments required to live within the limits are being formulated in fair and equitable ways.

Meeting the increasing demands for water in Colorado is no easy task in view of increasing population and the expectation that there will be water available to meet the state's river compact requirements, produce food, and fulfill endangered species requirements. The Colorado Legislature's challenge is to set the legal framework for the successful integration of surface and ground-water rights within the system of prior appropriation.

Whenever Colorado must adapt its water management system to new realities, as it has constantly done since the 1850s, there is a need for new information and education. Higher education has considerable expertise to bring to bear during the current adjustments and stands ready to offer its assistance where needed and welcomed, as witnessed by the theme of this issue of Colorado Water.

DID YOU KNOW -- There is the same amount of water on Earth today as there was 3 billion years ago.

1. What percent of Earth's water is freshwater?
2. What percentage of Earth's freshwater supply is available for consumption?

Answers on page 11.



WHERE WE ARE, WHERE WE'VE BEEN

by Justice Greg Hobbs

A Few Words About Context

The conveners of this written forum on ground water asked me to review where we are and where we've been. I'm glad they didn't ask me where we're going. I honestly couldn't speak about that, as in my judicial capacity I await the next case and can do no other.

The strength of the judicial method—and of our merit selection system for judges—is that the water judges of this State aren't persuaded to engage in politics. The law, judicial ethics, and common sense prohibit us from making decisions based on political considerations. This is a very good thing, as we'd be very bad at that. There's plenty of opportunity for the General Assembly and the Governor to account for public policy and the synergy of politics; they're structured for that purpose.

The Canons of Judicial Ethics, nevertheless, allow judges to teach and write. And, since the invitation I accept is to review the state of the law bearing on this Forum's examination—briefly, as best I might—I am privileged to join this educational context.

I am naturally reluctant to depart from the written text of case opinions and articles that deal analytically, in much more detail, about the subject. So this article appears in two parts. The second part consists of a twenty-nine page Appendix, which I ask the conveners to place on the Institute's web page for public access, along with this first part article. This Appendix contains excerpts from the Colorado Supreme Court's opinions in Park County Sportsmen's Ranch, Empire Lodge, and Simpson v. Bijou. The fourth excerpt is from an article I did for the University of Denver Water Law Review about Colorado's 1969 Adjudication and Administration Act.

I have arranged the Appendix, so the reader can see the case-on-case,

statute-on-statute, progression that marks Colorado water law—in this instance, the progression of the tributary ground water principles—since the seminal Yunker v. Nichols opinion of the Territorial Supreme Court in 1872.

What's Uncommon About Colorado's Common Law

As Prescott Webb points out in his wonderful book of the western migration, *The Great Plains*, the people coming west in the mid-nineteenth century were radicals when it came to public land and water law. The aridity of this mountain/plains environment drove their audacity to invent a set of legal principles that differed markedly from the English and eastern American common law. Their insistence gained Congressional acceptance of these new principles, finding expression as the "Colorado Doctrine."

Nonetheless, these principles flowed directly from the western experience shared by Native Americans, Hispanos, Anglos, and African-Americans alike, in their order of western American progression: that the waters of the natural stream are a public resource to be conserved and carefully used.

The 2002 Park County Sportsmen's Ranch opinion contains a detailed discussion about the derivation of the "Colorado Doctrine" from the public lands experience (and, also, of tributary ground water hydrology, see the Appendix). So, I do no more than to re-state its basic principles, as seen through Colorado's historical lens:

(1) water is a public resource, dedicated to the beneficial use of public agencies and private persons wherever they might make beneficial use of the water under use rights established as prescribed by law;

(2) the right of water use includes the right to cross the lands of others to place water into, occupy

and convey water through, and withdraw water from the natural water bearing formations within the state in the exercise of a water use right; and

(3) the natural water bearing formations may be used for the transport and retention of appropriated water.

This new common law established a property-rights-based allocation and administration system which promotes multiple use of a finite resource for beneficial purposes.

The term "natural stream" contained in the prior appropriation provisions of Colorado's 1876 Constitution include tributary groundwater, the pumping of which can affect the supply of the surface stream within one hundred years. The 1951 Safranek decision of the Colorado Supreme Court announced this principle quite clearly.

Where We've Been

The Safranek opinion coincided with the unregulated drilling of numerous unregulated tributary ground water wells, most notably in the South Platte and Arkansas River Basins. The advent of the high efficiency pump, rural electric cooperatives serving farmers, and the "Eureka" like discovery of a huge ground water treasure apparently available for the taking—without interference—left a dramatic marker on Colorado's future.

Plenty of agricultural production came from this, and many families came to depend on a water supply that, in many ways, was for-a-time seemingly firmer than far-senior surface diversions.

Nevertheless, the bedrock constitutional, statutory, and case law principles of prior appropriation remained the current by which Colorado flows to the future. Equally as important, the natural

science of hydrology and the tools of applied engineering—nature being the constant underpinning of these arts, for water is the stuff of dream, reality, and community consanguinity—continued to shape our understanding of the connection between the surface stream and the tributary aquifers.

The Out-Of-Priority Pump Comes Home, Alas

A State committed to prior appropriation, vested water use rights, security, reliability, and flexibility in the use of its scarce water resource—as Colorado is—could not escape the inevitable intersection of the natural sciences and the legal artifice we know as the ground water law. Quite plainly, the law could not defy nature's way.

Maintenance of the stream conditions, as they existed on the date of the appropriation of unappropriated water, is a necessary corollary of any water use right, to be respected in order of priority.

Other States, like Arizona, California, and Texas, ignore the surface/ground water interconnection and the injury that junior well pumping can cause to senior surface or ground water rights. They allow any land owner to punch a well and possess the ground water without regard to the effect of this on a neighbor's senior water use.

But, from the outset, Colorado law—with Congressional approval—severed the water from the land, keeping the water always as a public resource, subject to the creation of use rights in water wherever water might appear, in mountain stream or within the deepest aquifer.

Empire Lodge and Simpson v. Bijou set forth the ground water law's progression quite clearly. The General Assembly introduced the augmentation plan provision of the 1969 act to assist the integration of surface and tributary water into the adjudication and administration of water rights. Again, this was a radical western innovation pioneered by Coloradans.

The operative principle is that one is free

of priority administration, even though junior, if he or she replaces—by means of an approved augmentation plan—the depletions that would otherwise occur to the seniors' water supply due to the out-of-priority diversions.

The General Assembly adopted these conjunctive use principles in the 1969 Act and refined them through subsequent amendments, as stated in Park County Sportsmen's Ranch:

- (1) a natural stream consists of all underflow and tributary waters, § 37-92-102(1), 10 C.R.S. (2001);
- (2) all waters of the natural stream are subject to appropriation, adjudication, and administration in the order of their decreed priority, § 37-92-102(1)(a) & (b);
- (3) the policy of the state is to integrate the appropriation, use, and administration of underground water tributary to a stream with the use of surface water in such a way as to maximize the beneficial use of all of the waters of the state, § 37-92-102(2);
- (4) the conjunctive use of ground and surface water shall be recognized to the fullest extent possible, subject to the preservation of other existing vested rights in accordance with the law. § 37-92-102(2)(b).

While the State Engineer had temporary authority for the approval of augmentation plans in the early 1970s, the General Assembly repealed that authority after a brief time. The State Engineer then used the exchange statute, which contained authority for administrative approval of substitute supply plans, to approve out-of-priority depletions by surface and well users.

This practice amounted to the annual approval of what the Colorado Supreme Court in Empire Lodge and Simpson v. Bijou recognized to be augmentation plans, which the General Assembly by statutory amendment in the mid-1970s had deprived the State Engineer of authority over—in favor of the water court application,

notice, water-user participation, and decree process. One need not see any malevolence in the actions of three State Engineers in this regard. Another principle of water law expressed in the 1969 Act is maximum utilization. Tracking, accounting, and quantifying the impact of ground water depletions on senior water rights are sophisticated, resource-intensive efforts, replete with less than totally accurate predictions and results. But, as it turns out, the job is requisite.

When the water years are good, every body gains. It took the early 21st Century drought to bring the truth of the prior appropriation doctrine back out: it's still first in time/first in right.

Where We Are

Where we are is where we began. When faced with the opportunity again to reiterate its long-standing commitment to prior appropriation and the integrated administration of tributary groundwater and surface water, the General Assembly by 2002 and 2003 legislation granted the State Engineer annual substitute supply authority. Getting approval of one of these annual substitute supply plans is contingent on replacing injurious depletions and the filing of long-term augmentation plan applications with the water court.

The General Assembly in the 2003 legislation (S.B. 2003-73) approved the State Engineer's Arkansas River well rules, resulting from the Kansas v. Colorado U.S. Supreme Court Compact litigation, and it gave the South Platte out-of-priority well operators three years in which to file their augmentation plan applications.

What is needed appears to include a fair and reliable method for calculating depletions and their effect on senior water rights, and the use of all available legal means to supply a firm supply of replacement water to those in need. But, at this juncture, I must yield to others.

Thank you for the invitation to participate.



GROUND WATER ISSUES IN THE SOUTH PLATTE BASIN

by Tom Cech¹

Central Colorado Water Conservancy District

The dramatic water events of 2002-2003, both atmospheric and legal, forever changed the use of alluvial ground water along the South Platte River. Colorado's Doctrine of Prior Appropriation was severely tested, and well owners were forced to comply with the system of strict surface water rights administration.

The year 2002 began with far below average snow pack. As the year progressed, unprecedented drought – the driest year in possibly more than 300 years – gripped the state and much of the western United States. Both municipal and agricultural water users saw severe watering restrictions and shortages. This multi-million dollar natural disaster led to increased scrutiny of tributary ground water use in Colorado, particularly in the South Platte River Basin, where more than 4,500 alluvial irrigation wells irrigate tens of thousands of acres of productive farmland.

Colorado water law operates under the Doctrine of Prior Appropriation – “first in time, first in right” – that was established in the 1800s. Guided by this principle, Coloradans have developed an extensive, long-standing, surface water supply system to serve farms, industry and households. However, Colorado's arid climate can severely limit water availability, particularly in dry times. Drought during the 1930s and 1950s led to the drilling of thousands of shallow irrigation wells in the South Platte Basin to supplement surface water from rivers and reservoirs. These shallow wells are known as alluvial wells since their water source is connected to nearby river flows.

Well pumping continued basically unrestricted until 1969 when the Colorado Legislature enacted the Water Rights Determination and Administration Act. The 1969 Act incorporated alluvial “junior” ground water wells into the priority system with existing “senior” ditch and reservoir companies. The Act also required that all out-of-priority well pumping depletions had to be mitigated, or “augmented”, before pumping could continue during dry summer months. This law was severely tested in 2002 and 2003.

In 2002 the Colorado Supreme Court ruled in *Empire Lodge Homeowners Association v. Moyers* (Case No. 00SA211, Colo. Dec 17, 2001) that alluvial ground water pumping must be curtailed by the State unless a decreed augmentation plan was obtained from a Water Court. The Colorado Legislature responded in 2003 with SB73, and authorized the State Engineer to approve alluvial well pumping for only a three-year interim period. However, this approval could only be given if senior water rights were not injured. Well owners were in a quandary – would they have irrigation water to finish the season, and would they be able to pump their junior wells in the future? In 2003, the State Engineer ordered approximately 250 alluvial wells to cease pumping due to inadequate augmentation water supplies.

Crop consumptive use calculations have been the cornerstone of determining on-farm well depletions for augmentation plans for years, but well metering is gaining favor as a method to verify actual pumping quantities. Research will be needed to integrate the accepted practice of consumptive use analysis with well meters to better determine crop water requirements. In addition, more research is needed on the use of satellite imagery to determine crop water usage. Currently, consumptive use calculations assume a full crop water supply at all times, but irrigators know that does not regularly occur. Improved crop consumptive use data, with verifications from well meters and aerial imagery, will provide a more accurate figure for stream depletions caused by out-of-priority well pumping.

The future of alluvial ground water irrigation in the South Platte River Basin has changed forever. However, our challenge today is to continue ground water irrigation in a way that protects all water users. Research in the areas noted above could assist with the difficult task ahead.

¹ Tom Cech is Executive Director of the Central Colorado Water Conservancy District in Greeley, Colorado. The organization has two subdistricts to provide augmentation services – the first was formed in 1973 and has 960 well members with a water portfolio of approximately \$75 million. The second subdistrict was formed in January 2004 and has 450 wells included. The new subdistrict intends to issue a \$20 million bond in 2005 to purchase water rights. The original subdistrict obtained approval from voters for a similar bond issue in 2002.

2nd Edition of Tom Cech's Textbook in Print -- Publisher John Wiley and Sons, Inc. has announced the new Second Edition of Tom Cech's *Principles of Water Resources: History, Development, Management, and Policy* (ISBN: 0-471-48475-X). This comprehensive text was written specifically for students in non-technical majors. It integrates a wide variety of water resources topics all under one cover. Contact John Wiley & Sons, Inc. at Phone 201/748-6000, FAX 201/748-6728, or see the website www.wiley.com/college/cech.



THE RIO GRANDE BASIN – A VALLEY PERSPECTIVE

by Ray Wright, President
Rio Grande Water Conservancy District

The Rio Grande basin in Southern Colorado's San Luis Valley is blessed with bountiful ground water resources that are both easily recharged and extracted. Of the 600,000 acres of irrigated lands, approximately half are irrigated either supplementally or solely by ground water from over 6,000 irrigation wells. While the Water Rights and Determination Act of 1969 required the incorporation of ground water usage into the water rights system, no rules for ground water administration have been adopted in Division 3 and ground water pumping remains, for the most part, unregulated.

The ground water system is generally divided into three parts: confined, or artesian, wells which are generally deep and considered tributary to streams; shallow alluvial wells whose connection to streams is acknowledged; and shallow wells in the Closed Basin area which are generally considered to not be tributary to the Rio Grande. A moratorium on the drilling of new confined and alluvial wells was instituted by the State

Engineer in 1972. A similar moratorium on shallow Closed Basin-area wells was put in place in 1981, but in the intervening 10 years nearly 30,000 acres of irrigation without any supporting surface rights was permitted.

Nature has not been kind to the Valley's water supply. While the historic average flow of the Rio Grande at Del Norte has been nearly 650,000 af/yr. since 1988 the river flow has averaged only about 560,000 af. The historic drought of 2002/3 brought us the driest year on record followed by the 6th driest year on record. A continuing study funded by the Rio Grande Water Conservation District shows that ground water storage in the Closed basin area declined in those two years by 600,000 af.

The terms of the Rio Grande Compact, with its inflow/outflow-based schedules of delivery, prevent Colorado from enjoying the great benefits of above average snowpacks. This means that refilling our aquifers will be difficult to accomplish without substantial reductions in consumption.

The drought and overdraft of the aquifers has resurrected the debate over the effects of well pumping on the river systems, and surface-water users increasingly are calling for well regulation. The Rio Grande Water Conservation District and concerned water users have begun efforts to create water management sub-districts which would use market-based approaches to reduce water consumption and hopefully obviate the need for state-ordered regulations.

While the water interests of the Valley have been proactive in research and data gathering, and the Rio Grande Decision Support System is nearing completion, knowledge gaps still exist. Research that attempts to analyze and quantify the lineal extent and quantity of confined-aquifer recharge would greatly aid our efforts in designing a sustainable ground water economy. Additional research of the sources, timing and quantification of native flows into the Closed Basin region would similarly aid in management efforts.



ISSUES FACING THE ARKANSAS BASIN

by Jim Broderick, General Manager
Southeastern Colorado Water Conservancy District

The struggle over water resources in Colorado always has been a contentious subject. However, at this time in our history the catalyst has to do with climate; precipitation, whether rain or snow, and resulting runoff (or in this case lack of). The drought conditions of the past six years brought to light conflicts over water rights in Colorado that are no less pervasive than they were in the 1800's. Water issues are alive and well in the 21st century in the Arkansas Basin.

The prior appropriation doctrine ("first in time, first in use"), seemingly harsh, has been the law of Colorado for over 100 years. In fact the doctrine entitles the senior user to divert and use water with no consideration for the right or needs of junior users. In the Arkansas Basin we have been seeking more efficient ways to meet water demands with limited water supplies. At the same time striving to protect valid in-state water rights and deliver water to other states as required by interstate water compacts.

The pressure to regulate ground water pumping came first, not from Kansas, but from holders of downstream surface diversion rights in Colorado. Thus in 1965 new state legislation required the State Engineer to administer wells along the Arkansas River in accordance with the doctrine of prior appropriation. That is, to subordinate new wells to prior surface diversion rights. Further legislation resulted in a comprehensive study of both surface diversions and ground water pumping. Colorado then

enacted the Water Rights Determination and Administration Act. The major impact has been augmentation plans or replacement plans and sources of replacement water.

The coordinated and integrated management of the basin's surface and ground water resources, under a conjunctive use management program, would aim to optimize the joint use of all water resources in the basin. This approach to water planning requires a comprehensive consideration of regional basin-wide water objectives. This is accomplished by matching the characteristics of different supplies (such as quality, availability cost, and reliability) to the requirements of different water demands as conditions change inside and outside the basin. In general, greater benefits from the conjunctive management of all water supplies together can be achieved over the isolated management of each individual supply system.

While conjunctive use of surface and ground water supplies is occurring in the Arkansas Basin, the coordinated and integrated management of these two supply sources within the basin is working (although with its share of growing pains). By conjunctively managing the basin's surface supplies with the management of the ground water, specific ground water overdraft-related problems have been addressed. The reliability and role of ground water supplies during droughts for agricul-

tural and urban users could be enhanced. Conjunctive use management can concurrently address the ground water depletion concerns of the present water supply system, strengthen the basin's position for managing water transfers, and ensure the adequacy of the basin's ground water resources for periods of drought and surface water shortages. One important component of conjunctive ground water management is the use of wet-year excess surface water supplies to artificially recharge ground water in order to sustain ground water yield and recover lost storage after periods of drought.

Improvements in institutional arrangements, the sophistication and orientation of technical capacity, data collection and analysis, and process for public participation may all be needed to support a new emphasis on a balanced perspective encompassing the water needs of all the participants in the basin's water system.

Water use in the Arkansas Basin is a chief driver of agricultural development. The region is currently in the sixth year of a significant drought, which makes it difficult to sustain annual crop cycles. In the context of increased agricultural reliance on a scarce resource, research will be needed to answer the following questions:

- What economic and environmental impacts are likely to result from increased climate variability, crop substitution/subsidy changes, or increased

ground water use, under the current water regulations and economic behavior?

- What are the likely hydrological and economic effects of changing irrigation technologies, crop rotations, or drainage infrastructure? What possibilities exist for more efficient use of ground water and surface water given our compact compliance?
- How vulnerable are water resources in the basin to climate change? Can multi-year planning horizons by government authority engender more sustainable and efficient water use?
- What are the appropriate allocation decision rules to sustain the water resource and water-associated activities? What are the real costs of placing environmental constraints on water use and allocation?

The adoption of an integrated river basin management approach for elaborating policies and strategies of water resources development, management and conservation would help consider the water resources as one system. This approach also facilitates the management of the resource itself, allowing a better understanding, by water users, of the hydrological issues involved.

New Nonpoint Source Information

Cooperative Extension's Nonpoint Source Outreach Coordinator, Loretta Lohman, has developed a new website, "NPS Colorado -- Nonpoint Source Information." Website contents include: "What is Nonpoint Source Pollution?", Current News Stories, Nonpoint Source Database, Outreach Grants, Colorado and Other Resources, Funding Opportunities, and Colorado NPS News. Check out the website at <http://www.npscolorado.com>.

DECREE: An official document issued by the court defining the priority, amount, use and location of a water right or plan of augmentation. When issued, the decree serves as a mandate to the state engineer to administer the water rights involved in accordance with the decree (Rice 1991). <http://cdss.state.co.us/glossary.asp>.



EMPLOYING 'SOUND SCIENCE' TO CONJUNCTIVELY MANAGE SURFACE AND GROUND WATER

by Luis Garcia
Civil Engineering Department
Colorado State University

There is increased scrutiny of the amount of ground water depletions caused by well pumping in alluvial aquifers. The impact of these depletions on river flows has prompted renewed interest in the methods used to calculate the quantities of water involved. As can be seen from the articles in this issue of Colorado Water, the three river basins in the eastern plains of Colorado (South Platte, Republican and Arkansas) where significant amounts of alluvial pumping take place are, or have been, involved in litigation. The conflict revolves around the desire to make use of the large amount of storage in alluvial aquifers while protecting Colorado's Doctrine of Prior Appropriation and more senior surface water rights.

For the last eight years I have been working closely with a group of water users in the Lower South Platte Basin developing tools for determining augmentation requirements. This experience, along with work in which I am currently involved in the Arkansas River Basin and prior experiences, form the basis for my views on this issue. In order to manage conjunctive surface and ground water there are four components that need to be evaluated: 1) water demands, 2) water supplies, 3) depletions of ground water, and 4) impacts to rivers and augmentation requirements. I believe that in each of these components there are opportunities to employ new (or update existing) software tools to assist water managers in making fair, transparent, and equitable decisions regarding augmentation flows.

Quantification of Demands

In most instances, alluvial ground water is used as a supplemental water supply to meet shortages due to lack of surface supplies. Therefore, the first step in modeling a ground water/surface water system is calculating the water demand for the system. In agricultural systems, the demand is normally determined using a crop evapotranspiration (ET) method. In the past, this demand has been computed using monthly evapotranspiration (ET) equations, with the most commonly used being the Blaney Criddle method. However, since more complete weather stations were installed around the state in the 1990's, additional data has become available to support using daily reference crop ET methods such as the Penman-Monteith or the new ASCE standardized reference evapotranspiration equation (the December issue of Colorado Water has several articles on this topic). The daily methods are becoming more popular.

The incorporation of remote sensing techniques, as a way to confirm cropping patterns, needs to be evaluated and included

in the process where appropriate. Water users need to have access to computer tools that make it easy to use both daily and monthly ET methods as well as compare the impacts of using different methods. Users should be able to calibrate monthly methods based on daily methods, which are generally agreed to be more accurate. Models should have the ability to do a water budget to show users when crops might be water-short or stressed. Models should also include the ability to compute the reduced ET based on water-short conditions. In addition, in some parts of the state crops are impacted by salinity and waterlogging. Models should include the ability to reduce ET based on saline or waterlogged conditions.

Quantification of Supplies

Water supplies are normally from two sources: 1) surface water supplies, and 2) ground water pumping. The canal systems for delivering surface water to farms in Colorado have been in existence for many decades. In an increasing number of canals and laterals, automated measuring devices (dataloggers and flumes) continue to be installed for the purpose of measuring the surface water supplies as accurately as possible. Models should allow users to calculate system losses in both space (along the canal) and time (losses might be different during different times of the year). In the ground water supply area, there is a move to install more well flow meters and/or to use power records. Models should have the capability to allow users to use well pumping records from either well meters or those derived from power records.

Quantification of Depletion of Ground Water

After obtaining an estimate of the demands and supplies, models can compute depletions of both surface and ground water. Models should have ways to allow users to evaluate the impacts of the depletions of ground water based on using a "Presumptive Depletion Factor (PDF)," or well efficiency, as well as calculated depletions based on whether the ground water is a primary source of water or is supplemental. The models should also have the ability to compute ground water depletions based on a water budget. The models should allow users to compare the two results to evaluate if they are in general agreement.

Quantification of Augmentation Requirements

The amount of ground water depletion needs to be routed to the river in order to determine the timing and magnitude of the depletions. Historically, in Colorado the Stream Depletion Factor (SDF) (Jenkins, 1968) methodology has been used

to determine the impact of the depletions of ground water on a particular stream. However, the SDF methodology is an analytical technique, based on several boundary assumptions. Although analytical techniques are convenient and, if properly calibrated, very valuable tools, they are not able to handle the heterogeneity of an aquifer. Models should allow users the ability to use other analytical techniques that have different boundary conditions (no flow boundaries, alluvial aquifers, etc.). Normally, the analytical techniques are calibrated using numerical models, and work should continue in the area of calibrating analytical solutions using numerical models. The standard for numerical modeling of ground water has been the USGS MODFLOW model; however, constructing a basin or sub-basin scale model using USGS MODFLOW is extremely data intensive and time consuming. There are newer software tools such as the Ground Water Modeling System (GMS) or the MIKE SHE models, which use sophisticated Graphical User Interfaces, Geographic Information Systems (GIS) and databases to expedite and help in the modeling process.

Development of Tools for Computing Augmentation Requirements

There is a great deal of work being conducted around the state to improve existing models, develop new models, collect additional data, and apply the models. For the past eight years I have had the opportunity to study the data and modeling needs of water users in the Lower South Platte River in Colorado. With the active participation of water users, we prioritized their data and modeling needs and collect or generate the data and modeling tools to meet their needs. This approach to Decision Support System (DSS) development is based on the premise that users have a very good understanding of their current and future management information needs. With this in mind, we have developed an interactive and dynamic development process in which the users play an integral part. I refer to this approach as a "User Centered DSS Development Approach."

Using this approach, we have developed several data-driven tools that are widely used in the South Platte and other parts of the state and even in other states. The tools are collectively called the "South Platte Mapping and Analysis Program" (SP-MAP) (www.ids.colostate.edu/projects/splatte). The project has been funded by water users, the Colorado Water Resources Research Institute, Colorado Cooperative Extension, the Colorado Agricultural Experiment Station, the State Engineer's Office and the United States Bureau of Reclamation. To date, the total funding for this project has been around \$500,000.

One of the SPMAP tools is a consumptive use model called the IDS CU model. The model enables water managers to estimate the consumptive use (CU) of ground water based on surface water supplies and crop consumptive use estimates. The model allows weather station and surface water supply information to be imported from the Colorado State Engineer's office database, HydroBase. Weather station information can also be imported from the Northern Colorado Water Conser-

vancy District weather stations or from the Colorado Agricultural Meteorological Network (Coagmet). The IDS CU Model has been enhanced to compute monthly CU using the SCS Blaney Criddle, Calibrated Blaney-Criddle, Hargreaves, and Pochop methods. Daily CU can be computed by the model using the Penman-Monteith, Kimberly-Penman, and new ASCE standardized reference evapotranspiration equation. The model calculates water budgets that take into account soil moisture and allows users to determine times when the crops are water-short. When pumping records are available, the application efficiencies of wells can be estimated, and these can be used for comparison with user-provided well efficiencies or to determine what PDF values should be established. The model also has the capability of comparing the CU calculated with different ET methods. Scenarios for forecasting CU can be created by repeating or averaging any sequence of historical years. We will be conducting a one day workshop in the use and capabilities of the IDS CU model on May 18th. To obtain more information you can visit the IDS website www.ids.colostate.edu.

Water managers have historically used stream depletion factors (SDF) to determine the lag time from when a well is pumped or water is recharged to a recharge site and when a depletion or accretion happens in the river. We have developed a model to calculate monthly depletions or accretions (in case of recharge sites) using the SDF methodology (SDF View – www.ids.colostate.edu/projects/sdfview). In the past year, due to additional needs expressed by water users, a new model based in the State Engineer's Office, Analytical Stream Depletion Model (Schroeder 1987), was implemented. This model is called the IDS Alluvial Water Accounting System (IDS AWAS – www.ids.colostate.edu/projects/idsawas). This new model has the capability of modeling different time steps (daily, monthly, and annually) and allows users to evaluate different types of boundary conditions.

Our work in the South Platte is one framework for the development and implementation of decision support tools to assist water managers address the complex issues surrounding conjunctive management of Colorado's ground and surface waters. SPMAP incorporates a number of options to ensure that water managers easily utilize the latest in scientific understanding as they calculate and manage augmentation flows. As the models are employed in the 'real world' of water management in Colorado, new opportunities arise to further enhance the capabilities of the software tools to better serve fair and equitable management of Colorado's limited water resources. That is the essence of the "user-centered" approach to developing software tools in support of improved water management.

Answers to questions on page 4:

1. 3%.
2. 1%.

Source: Clean Water Foundation



COOPERATIVE EXTENSION EFFORTS ADDRESS WELL AUGMENTATION AND DROUGHT CONCERNS

by Reagan Waskom
CWRRI Water Resources Specialist

As crop producers and ranchers struggle with uncertainty surrounding augmentation water supplies and drought, difficult decisions confront rural Colorado families. Should they purchase expensive additional augmentation water, install drip irrigation or center pivots, convert to dryland cropping systems, or even tougher – consider selling out? Many farm families are questioning what the future holds for irrigated agriculture in Colorado. In most cases these decisions impact several generations, making it difficult to approach these decisions strictly from a short-term economic perspective. To assist Colorado families facing these difficult issues, Colorado State University Cooperative Extension has offered several educational programs over the last year to help producers evaluate their options. This report outlines two recent programs conducted in Eastern Colorado – one program specifically on well augmentation and another designed for rural families on “Keeping a Positive Focus.”

Last year over 800 Colorado producers and family members participated in Cooperative Extension workshops designed to help producers understand the complex legal issues of ground-water pumping and surface-water augmentation requirements in the South Platte River Basin. These workshops brought Division Engineer staff together with University irrigation and crop production specialists to discuss the situation and potential options. Of the 800 producers attending these workshops, 83 percent reported increased knowledge about irrigation alternatives to fit their operations; 29 percent said they would use crop rotation and reduced tillage systems to raise farm profitability and sustainability; 14.5 percent indicated they were able to net excellent yields and profits from their irrigated crops as a result.

It is interesting to note that several South Platte Valley and Bijou Hill farmers have put their properties up for sale since these augmentation education programs were held last year. More are expected to take this route in the near future. The decision to sell out and not encumber further costs for what are most likely questionable returns in the short term must be balanced against future profits and value. One question that many are asking is will these farms with uncertain augmentation water sell at irrigated or dryland land prices? -- A difficult situation from either side of the equation; tough on the buyers if they buy at irrigated land prices or tough on the sellers if they sell at dryland prices. Realtors in the Fort Morgan area report that farmland realtors will market these farms with full disclosure of the current situation on water to prospective buyers.

A second group of Colorado State University Cooperative Extension agents in Eastern Colorado formed the “Keeping A Positive Focus” team to address the needs of families and individuals in Eastern Colorado as drought and economic concerns impacted rural communities. This team utilized seminars, small group workshops, one-on-one and the mass media (news articles, radio, local T.V., extension newsletters, web site) to share information on communication, decision-making, and mental and physical health. Workshops included: Home Alone (parenting), Passing Down the Legacy (estate planning), Passing Down the Legacy II (in-depth estate planning information), Legal Matters Matter – Wills and other Important Legal Documents, Sunflower oil production, Precision Ag, and others. Regular columns by Dr. Val Farmer were run in local newspapers across the Eastern Plains covering topics such as marriage, family conflict, farm stress, parenting and rural communities. Dr. Ron Hanson conducted positive focus seminars in three different locations (Lamar, Burlington and Sterling) in March of 2003. 4-H/Youth Development

programs offered projects/programs challenging youth to learn new ideas, learn to communicate, make decisions, learn life skills, learn leadership skills and practice resiliency through friendships and leisure time activities.

One of the goals of the “Keeping A Positive Focus” program was improved skills and behaviors in communicating, resolving conflicts and making effective decisions. Approximately 150 of the participants said they received useful information in helping them cope and deal with stress. The Positive Focus Team consists of Colorado State University Cooperative Extension staff from multiple disciplines – Agriculture, Family & Consumer Education, 4-H Youth Development and Technology working together to address issues that are of concern to individuals, families and communities on the Eastern Plains. This team continues to build collaborations with numerous community partners including local community colleges, members of the faith community, financial organizations, mental health organizations, local health organizations, news media, key state agriculture boards, local advisory groups. Although drought and water scarcity is still a key factor in the lives of the people of Eastern Colorado, the Colorado State University Cooperative Extension Positive Focus team has been able to provide information, skills and techniques to help individuals, families and communities cope during tough times.

If you would like to organize similar events in your community, please contact Reagan Waskom at (970) 491-2947 or Karen Brock at (719) 523-6971.

MEETING BRIEFS



WATER INSTITUTES SEEK TO RESTORE CONGRESSIONAL FUNDING FOR PROGRAM

The National Institutes for Water Resources (NIWR) held its annual meeting in Washington, D.C. February 29 – March 1, 2004. NIWR represents the 54 water institutes created and operated under the federal Water Resources Research Act. The Colorado Water Resources Research Institute (CWRI) is Colorado's institute under the federal legislation.



Congress annually appropriates approximately \$6.5 million for the national water institutes program, to be administered by the U.S. Geological Survey. A portion of the federal funds are directed to each institute to operate a state-based water research

competition – designed to assist local and state water managers in obtaining the science needed to solve water problems. A second portion of the federal funding supports a national water research competition to provide science in support of solving regional and national water problems.



John Scheffer (left), Chief, Office of External Research, USGS Water Resources Division, with John Letey, Director, Center for Water Resources, University of California.

The NIWR program included sessions on improving water institute management, water research trends and needs, and an overview of federally funded water research opportunities. The Universities Council on Water Resources (UCOWR) Board of Directors met during the NIWR meeting and joined a number of the NIWR sessions. In addition, the water institute directors were updated on new developments with NIWR.org software – the information technology employed by the USGS and water institutes to manage both the state-based and national research competitions, as well as institute reporting requirements and five-year evaluations (which are currently underway). NIWR.org also facilitates avoiding duplication of water research efforts and dissemination of research results generated as part of the national water institute program (via the USGS website: <http://water.usgs.gov/wrri/>).



Sharon Megdal, Director, Arizona Water Resources Research Center, with James Moncur, NIWR President and Director, Hawaii Water Resources Research Center.

The President's FY 2005 budget 'zeroed out' funding for the water institute program. The Department of Interior's Assistant Secretary for Water and Science, Bennett Raley, joined the NIWR meeting to discuss the situation with the water institute directors. Secretary Raley acknowledged the efforts of the water institutes to bring local, state, federal and university scientists and water managers together to incorporate sound science into efforts to resolve water conflicts, but he also noted the budget limits under which the Department of Interior must operate for FY 2005.

Beyond appropriations, the national water institute program is up for reauthorization by Congress in the 2005 session, thus, the institute directors had two reasons (appropriations and reauthorization) to visit their Congressional delegations during the NIWR meeting. Robert Ward, CWRRRI Director, and Reagan Waskom, State Water Resources Extension Specialist, pointed out to the Colorado Congressional delegation the CWRRRI water research efforts recently completed and currently underway, noting how university-based water science and technology is being made available to local and state water managers and users. For example, they pointed out the:

- Flow augmentation software that Prof. Luis Garcia is developing in close cooperation with water managers and users in the Lower South Platte and its growing use in quantifying augmentation requirements;
- Salinity mitigation efforts of Prof. Tim Gates and his colleagues in the Lower Arkansas Valley and the potential to improve agricultural profitability in the region (incorporating due respect for the Arkansas River Compact situation);
- Recently completed Forest and Water report (CWRRRI Completion Report 196) that summarizes the science at the interface between forest and water management.



Leroy Heitz (left), Director, Water and Environmental Research Institute of the Western Pacific, Guam, with Henry Smith, Director, Virgin Islands Water Resources Research Institute.



M. Karl Wood (left), Director, New Mexico Water Resources Research Institute, with B. L. Harris, Associate Director, Texas Water Resources Institute.

The report has been well received and is currently in its second printing (supported by research cosponsors and CWRRRI);

- CWRRRI Special Report 13 that summarizes options municipalities have to stretch urban water supplies through urban lawn water conservation; and
- Drought Conference proceedings in which CWRRRI documents the concerns and plans of water managers at the completion of the 2002 water year – a point in time when Colorado’s water supplies were at their lowest, up to this point, in the current drought.

A number of other CWRRRI studies were discussed during the conversations, such as the use of recycled wastewater on urban landscapes, the science behind Colorado’s efforts to establish EPA required nutrient standards, and the quality of urban water supply reservoirs. Robert and Reagan also pointed out that CWRRRI research funds are matched by funds from local, regional, state and federal agencies and organizations, indicating their confidence in research CWRRRI organizes and administers. Without the federal funds, there would be no CWRRRI water research program to glue these university-based, sound science efforts with the needs of Colorado’s water managers and users.

Congressional Hearing -- Water Supply Challenges in the West

On March 9, the Senate Committee on Energy and Natural Resources held a hearing on “Water Supply Challenges in the West,” with a focus on the effects of the multi-year drought. Chairman Pete Domenici (R-NM) opened the hearings, suggesting that the federal government may need to establish a major federal water program to assist communities, particularly small rural towns, in building infrastructure required to ensure adequate water supplies. Sen. Domenici also urged additional efforts to further technology initiatives, including water desalination and eradication of non-native species. The hearing featured witnesses representing various federal agencies, and included Craig Bell, Executive Director, Western States Water Council, and Tex Hall, President, the American Congress of American Indians. Assistant Secretary of Interior Bennett Raley acknowledged the significant challenges facing the West with regard to water supply, particularly in light of the extended drought. He referred to the Administration’s 2025 Initiative as an effort to respond to these challenges.

(Cont’d on page 18)



REPUBLICAN RIVER SETTLEMENT HIGHLIGHTS 2004 OGALLALA AQUIFER SYMPOSIUM

Over 450 people squeezed into Wray High School's auditorium on February 23, 2004, to discuss water conservation over the Ogallala Aquifer and in the Republican River Basin, in the area where Colorado, Nebraska, and Kansas meet. Joel Schneekloth, chair of the Ogallala Aquifer Symposium Planning Committee, noted that the 2004 Symposium's theme -- water conservation as a way of saving water today, for tomorrow -- provides water users in the region food for thought about the protection of this valuable water resource.



Wray High School was the site of the 2004 Ogallala Aquifer Symposium, where an overflow crowd heard speakers talk about 'saving water today for tomorrow.'

Below, from left: Virginia McGuire, U.S. Geological Survey, Nolan Doesken, Atmospheric Science, CSU, and Kevin Dennehy, U.S. Geological Survey provided a water supply/water quality update for the High Plains Aquifer.

Sessions on water conservation discussed Farm Bill assistance programs, ET-based irrigation scheduling, and subsurface drip irrigation. A water supply update session discussed changes in High Plains aquifer water levels. Virginia McGuire, U.S. Geological Survey (USGS), indicated continuing water level declines, in general, with rates of decline accelerating during the current drought. Kevin Dennehy, USGS, provided an update on the High Plains National Water Quality Assessment study currently underway. In general, the quality of water obtained from domestic wells is good; however, the aquifer is vulnerable to human activities. Dissolved solids concentrations exceeded the USEPA secondary maximum contaminant level in about 25 percent of the ground-water samples in the central High Plains.



Hal Simpson, Colorado State Engineer; Dave Barfield, Chief Engineer, Kansas Division of Water Resources; and Ann Bleed, Deputy Director, Nebraska Department of Natural Resources, reviewed the Republican River settlement. They noted that the compact was not changed by the settlement, only the ways to measure and comply were updated. They described the modeling and assessment efforts that

led to an agreement and indicated that each state is developing ways to comply with its obligations.

As Kent Askren, Kansas Farm Bureau noted, water users in the High Plains are realizing the inevitable -- there are limits to water availability. Don Batie, representing the Nebraska Farm Bureau, added that the key question revolves around determining how far over appropriated is the Republican River Basin. Answering this question is the

key to seeking solutions and living within the limits. As changes are required, it is hoped that the adaptations to living within the limits occur gradually to avoid economic catastrophe.

From left: Dave Barfield, Chief Engineer, Kansas Division of Water Resources, Ann Bleed, Deputy Director, Nebraska Department of Natural Resources, Hal Simpson, Colorado State Engineer, and Bill Orendorff, Session Moderator, prepare for the Republican River Settlement Session.



HYDROLOGY DAYS 2004: A CELEBRATION OF WATER SCIENCE

Over 300 water scientists and engineers, students and faculty shared their experiences and insights in the science of hydrology during the 24th annual Hydrology Days held March 10-12, 2004 in the Lory Student Center on the Colorado State University campus. More than 85 oral presentations and 17 poster papers constituted a busy three-day program.

A special session on the Hydrology Days program was devoted to Personal Recollections of Whitney Borland, whose donation to CSU financially supports Hydrology Days each year. A paper recalling the personal and professional accomplishments of Whitney Borland is contained in the Hydrology Days Proceedings which can be found at: <http://hydrologydays.colostate.edu/Proceedings.htm>.

While papers presented at Hydrology Days address both theoretical concepts and applications around the world, there were papers that discussed Colorado water issues such as selenium levels in the Lower Gunnison Basin, Big Thompson phosphorus conditions, ground and surface water interaction in ephemeral wetlands in the San Luis Valley, effectiveness of PAM treatments in reducing post-fire erosion on the Schoonover fire, water storage policy for Colorado, sediment impacts from unpaved

forest roads in the Upper South Platte Basin, new capabilities of the South Platte Mapping and Analysis Program to estimate consumptive use in the South Platte Basin, basin-scale stream-aquifer modeling of the Lower Arkansas River Basin in Colorado, mountain block recharge from snowmelt runoff in the Colorado Rocky Mountains, and a geomorphic assessment of the Eagle River at Camp Hale. While not all authors submit papers for the proceedings, those that are available can be viewed at: <http://hydrologydays.colostate.edu/Proceedings.htm>.



Borland Lecturer Dr. Jerson Kelman, Director President of the National Water Agency of Brazil, accepts plaque from Sandra Woods, Chair, Civil Engineering Department, CSU.

The 2004 Hydrology Program highlighted several keynote speakers. Jerson Kelman, Director of the National Water Agency of Brazil, described Brazilian hydropower planning experiences in recent years. With 90 percent of the electricity of Brazil coming from hydropower, a complex network of dams and power lines has resulted. During the 1990s, there was an effort to incorporate more market forces into Brazil's hydropower-based system, as had been done with a number of thermal-based electric supply systems in other countries. However, a drought in 2001 precipitated an energy crisis (a 20 percent shortage in available electric power). The energy crisis of

pointed out the need to continue a strong role for central government planning in developing and managing the complex hydropower-based electric grid in Brazil. Dr. Kelman described how Brazil employs water resources planning to ensure a balance between electric power security and environmental sustainability.

András Szöllösi-Nagy, Director of the Division of Water Sciences of UNESCO and Secretary of the International Hydrological Program of UNESCO, provided an overview of society's relationship with water and pointed out the need for hydrological science to contribute to solving looming water crises. Dr. Szöllösi-Nagy noted that 'water flows through society like money,' as he listed key issues facing society today – environment, food security, human health, industry and energy – all dependent upon water resources. He noted that in 2000, 47 percent of the world's population lived in cities/urban centers. By 2030 the figure is expected to rise to 60 percent, making water resources management big business.

Water is a major challenge of the 21st century, if not the challenge. In noting the potential for conflict that often surrounds water resource development and use, Dr. Szöllösi-Nagy also noted that with river systems 'water connects – it does not divide;' thus, the flow of water can become a basis for agreement. Regarding global climate change, he pointed out that 80 percent of the future stress placed on the world's ecosystem will come from population increases and development. Today, the U.S. spends 85 percent of its global change research funding on issues other than population growth and development. Dr. Szöllösi-Nagy closed his remarks by quoting President Kennedy – 'Anybody who can solve the problems of



From left: Robert Ward, CWRI Director, Prof. Dr. András Szöllösi-Nagy, Dr. Jerson Kelman, Neil Grigg, and Jorge Ramirez, Hydrology Days Chairman.



Neil Grigg, Civil Engineering Department, CSU, presents Hydrology Days Award to Prof. Dr. András Szöllösi-Nagy, Assistant Director-General of the Natural Sciences Sector of UNESCO, Director of the Division of Water Sciences of UNESCO, and Secretary of the International Hydrological Programme of UNESCO.



Left: John Stednick, Department of Forest, Range and Watershed Science, helps Eric Morway, Graduate Student, prepare for his presentation on quantifying waterlogging and salinization impacts in the Eastern Arkansas River Valley (a CWRI research project).

water will be worthy of two Nobel Prizes: one for peace and one for science.'

Dr. Paul Portney, President of Resources for the Future, presented a talk entitled "Numbers Tell the Tale: The Role of Data in Environmental Policy Making." Dr. Portney began his talk by asking the question, "Why should we care about the state of environmental data?" The answer: The economic stakes are high, the public cares, and misconceptions

about the status of our environment abound. To illustrate, he noted that the environmental improvement story is the greatest story of post WW II democratic society – a story not being told! There are, of course, caveats -- we still clear a lot of land for development, thus reducing natural habitat, and CO₂ emissions continue to be of concern.

Dr. Portney suggested that the U.S. does a good job of measuring the status and trends of air quality and energy supplies; however, it does a poor job with water quality status and trends. To make matters worse, budget cuts are threatening existing environmental data collection efforts as well as those of such agencies as the Bureau of Labor Statistics and the Bureau of Economic Analysis. There are efforts to describe

status and trends in environmental conditions by such organizations as the Heinz Center and the World Resources Institute.

Picture at right: From left, Dr. Jerson Kelman; Darrell Fontane, Civil Engineering Department, CSU; and H.J. Morel-Seytoux, Professor Emeritus of Civil Engineering, CSU and founder of Hydrology Days.



Dr. Portney concluded his talk by noting that Rep. Doug Ose (R-CA) has introduced legislation (the 'Department of Environmental Protection Act') that would elevate the U.S. Environmental Protection Agency to a cabinet department and create within it a Bureau of Environmental Statistics (BES). The BES would be authorized to assemble and disseminate environmental data and information, including assessing ambient conditions and trends.

Picture at right: John Loomis (left), Department of Agricultural and Resource Economics, CSU; and Paul Portney, President, Resources for the Future, who presented "Policy Making and Data."



More information about Rep. Ose's bill can be found on the Resources for the Future webpage: <http://www.rff.org/Documents/RFF-Resources-151-Enviroacctng.pdf>

Planning for Hydrology Days 2005 is underway, so mark your calendars for the 2nd week of March.

Congressional Hearing – Water Supply Challenges in the West (Cont'd from page 14)

Senator Domenici underscored the Bureau of Reclamation's important role in responding to water supply challenges, indicating that a new paradigm is needed, again referring to the need for a program for rural communities in particular. Floyd Gaibler, Deputy Undersecretary for the Department of Agriculture, referred to the establishment of the Interim National Drought Council in partnership with other entities (including the Western Governors' Association) as a successful effort to improve response to drought. The Interim National Drought Council was formed in September 2000 to establish a more comprehensive, integrated and coordinated approach toward reducing the impacts of drought through improved preparedness, protection and risk management. Creation of the Council was one of the recommendations in the May 2000 report of the National Drought Policy Commission, created by Congress in July 1998 to provide advice on how to improve federal drought policy.

Craig Bell expressed the vital interest of western states in water supply conditions, and explained the impacts generally of the drought in the West over the past several years. While acknowledging that the drought was comparable to the droughts of the 1930s and 50s, he also underscored the fact that the drought is more challenging in several respects because of the growth and increasing demands for water in the West. He also reiterated the support of the Western States Water Council and the Western Governors' Association (WGA) for the Drought Preparedness Act of 2003, S. 1454. He noted that the bill would "move the country away from costly ad hoc approaches to drought response in favor of proactive preparedness, improve delivery of federal drought programs, and provide new tools for drought preparedness planning. Through establishment of the National Integrated Drought Information System, the bill would create a vastly improved drought monitoring and forecasting system."

Copies of Mr. Bell's statement may be obtained by contacting the Council at (801)561-5300. The Senate Energy Committee will hold a hearing on March 25 to consider S. 1085 and S. 1732, both of which would provide for programs to assist in developing rural and small community water supply systems.

Source: Western States Water newsletter / March 12, 2004

Water Resources Archive

WATER IN BOXES: AN UPDATE ON THE WATER RESOURCES ARCHIVE

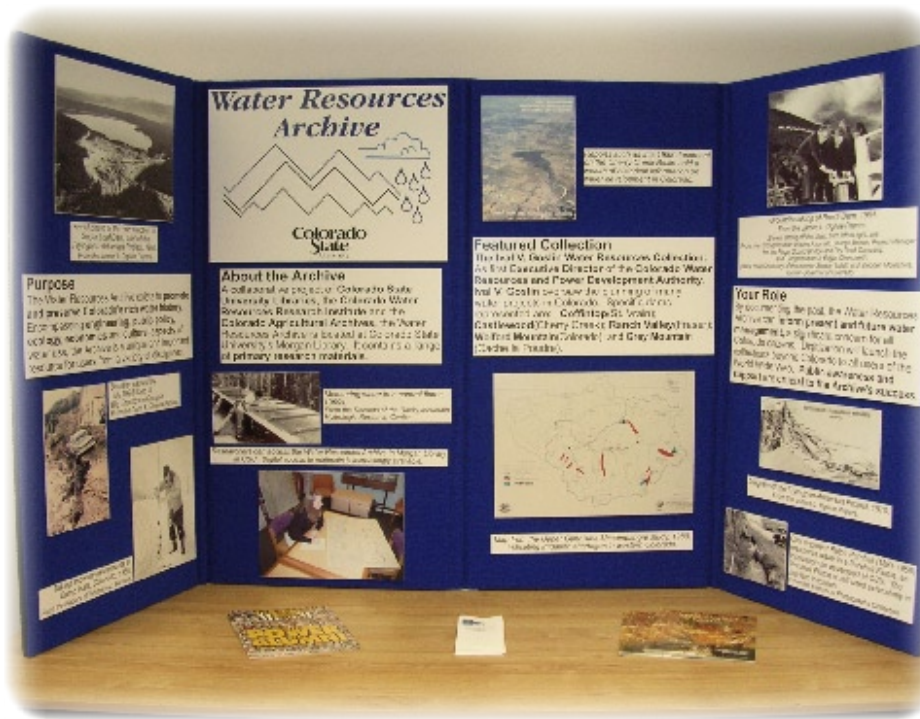
by Patricia J. Rettig, Head Archivist for Water and Agriculture Archives
Colorado State University Libraries

For an archive—which stores materials in perpetuity—three years is a very short time period. Yet the first three years of Colorado State University's Water Resources Archive show evidence of a firm foundation which will support growth far into the future. Over the past three years, the Water Resources Archive has gone from an abstract idea to a body of collections that is growing in depth and breadth, improved facilities for both researchers and storage, and heightened awareness about Colorado's water history across the state. The Water Resources Archive still has much work to do to match the vision that inspired its creation, but it has been consistently fulfilling its mission: to preserve, provide access to and promote the water heritage of Colorado.

Preserving

The Water Resources Archive started off strong, with collections of materials from prominent people and organizations, including Ival Goslin, James Ogilvie, Whitney Borland, the National Water Resources Association, the Rocky Mountain Hydrologic Research Center and others. The archive now holds nearly thirty collections contained in over 500 boxes as well as tubes and flat files. Predominant material types remain text-based—reports, minutes, correspondence and the like—but holdings of photographs, slides, audiotapes, films and especially maps are growing. Materials from the mid-1900s predominate, but older materials, extending back to the mid-1800s and early 1900s, have strengthened the holdings. The most widely represented subjects relate to engineering and policy, but information about irrigation structures and ditch companies has increased.

The two newest collections to be prepared for public use build



The Water Resources Archive is located in Morgan Library on the Colorado State University campus.

on these existing strengths. Made fully accessible last summer were the papers of CSU professor emeritus and internationally known engineering consultant Daryl B. Simons. The collection (with materials dated 1933-1995) includes documents from Simons' time at the U.S. Geological Survey, CSU, and his two consulting firms, Simons, Li and Associates, and Simons and Associates. The collection contains good documentation of projects Simons was

involved in, mostly related to the fields of hydraulics, hydrology, geomorphology, river mechanics, sediment transport and hydraulic modeling. A large addition to the collection from Dr. Simons is presently being inventoried and will be fully available at a later date.

Received last summer and made accessible in January are maps from the Larimer County District Court that primarily relate to irrigation in Larimer and neighboring Weld counties. The Larimer County District Court Map Collection (with materials dated 1884-1953) contains 304 maps discovered in the old county courthouse during relocation to the new building. The maps are of wells, ditches, reservoirs and other water-related structures and were used to establish water rights and settle water disputes in district courts.

Several collections are presently being prepared for full research access. These include the Groundwater Data Collection, the Records of the Colorado Water Resources Research Institute, and the Records of the Iliff and Platte Valley Ditch Company. Watch the Water Resources Archive website and this newsletter for additional details as processing is completed. New to the CSU Libraries is a resource that complements the water archive holdings and builds on another of the univers-

ity's research strengths. The Colorado Agricultural Archive, an important resource documenting the state's agrarian heritage, was transferred in January from CSU's history department. It developed over the years through the efforts of history professor James E. Hansen and contains over thirty collections in nearly 700 boxes. The largest collections are those of the Colorado Cooperative Extension Service and the Colorado Agricultural Experiment Station, both of which contain substantial amounts of water-related information. The Colorado Agricultural Archive is being integrated into the systems and services developed for the Water Resources Archive.



James Hansen and Patty Rettig -- Dr. Hansen's efforts led to development of the Colorado Agricultural Archive, which is being integrated with the Water Resources Archive.

Providing access

In the interest of having a space more amenable to researchers, a renovation of the archives reading room on the second floor of Morgan Library took place over the summer. The capacity for researchers was doubled by removing a wall, and a welcoming, professional reference desk was installed following carpeting and repainting. Having a comfortable facility for researchers is important, as none of the archival materials leave the vicinity of the reading room. A dedicated researcher might spend hours in the room poring over unique documents taking notes with paper and pencil or on a laptop computer. To facilitate the latter, wireless network access was installed in the archives, as it has been throughout the library. Additionally, discreet lockers were installed, because personal belongings must be kept separate from archival materials so accidental mix-ups of papers are prevented, not to mention theft. Many compliments about the renovation have been received, from researchers and library staff alike.

In addition to research space, the archives also acquired additional storage space. An annex to the Libraries' book depository was completed in January for the express purpose



Patricia J. (Patty) Rettig oversees the continuing development of Colorado State University's Water Resources Archive.

of housing Water Resources Archive collections as well as the Colorado Agricultural Archive. The annex is equipped with state-of-the-art security systems and environmental controls and has a capacity of over 5,000 boxes. This addition will allow for unfettered acquisition of archival collections for a number of years.

Beyond physical access, advances have been made toward virtual access. With full-text versions of the Water Resources Archive finding aids making their online debut last spring, a major step toward easier access occurred. The finding aids are detailed listings of each collection, and having them online allows for electronic searching. This is significant because it facilitates locating materials of interest, and it also provides universal access to information that was once only available locally as printed documents.

The next step toward increased digital access is to scan archival materials for posting to the Internet. Toward this end, the CSU Libraries is participating in a grant funded by the Institute of Museum and Library Services awarded to the Greater Western Library Alliance. The grant is to create a digital library of water resources information for the western United States. The two-year project will produce the Western Waters Digital Library, with an initial focus on the Colorado, Columbia, Platte and Rio Grande river basins. This is a wonderful opportunity for the Water Resources Archive to collaborate with other institutions to provide increased access to rare but important texts, photographs, maps and more. As materials are scanned and cataloged, the aggregation will be available through a single search interface on the project website (<http://www.westernwater.org/>).

Promoting

Last year, a traveling exhibit about the Water Resources Archive was created to take to conferences and meetings around

Colorado. It has recently been on display at the 2003 South Platte Forum, the second annual Ditch and Reservoir Company Alliance (DARCA) convention, and the 24th annual American Geophysical Union Hydrology Days. The purpose of the exhibit is to raise awareness about the water archive in order to attract potential researchers who could benefit from using the archive as well as potential donors whose materials could benefit from the care given by the archive. So far, response to the exhibit has been overwhelmingly positive.

Attendance by Water Resources Archive staff at the DARCA convention was significant, as capturing the history of ditch companies is an area of focus for the archive. The earliest ditch companies in Colorado have over 100 years of history to capture, which is crucial to understanding the development of water resources in the state. If their founding documents

and ongoing financial, maintenance and data records are stored away in barns or basements, that history could be lost. The Water Resources Archive is working with DARCA to inform ditch companies of the need to preserve these materials and the services the archive can provide. Since DARCA has chosen the water archive as the repository for its own records, this strong relationship can also serve as a model for other target groups with significant water documents.

Other modes of promotion have included newsletter articles, brochure distribution and of course a website. Visit the Water Resources Archive website (<http://lib.colostate.edu/water/>) for collection information and occasional updates. Also, input is always welcome, so feel free to contact the author at anytime (prettig@manta.colostate.edu ; 970-491-1939).



WATER SUPPLY



Statewide, the snowpack is 90 percent of average. The southwest corner of the state has the highest snowpack values with both the Rio Grande and San Juan/Dolores basins at 108 percent of average. These numbers are reflected in those basins having the only positive SWSI values. The South Platte basin has the lowest snowpack at 70 percent of average. The reservoirs graphed in this report are storing a cumulative 81 percent of their normal amounts. Stream flows remain below normal throughout the state.

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 streamflow, 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 March 1, 2004, and reflect the conditions during the month of February.

Basin	3/1/04 SWSI Value	Change From Previous Month	Change From Previous Year
South Platte	-1.2	+0.2	+1.4
Arkansas	-2.0	-0.1	+0.3
Rio Grande	+1.0	+0.6	-2.0
Gunnison	-0.3	+0.5	+1.1
Colorado	-2.2	-0.1	-1.2
Yampa/White	-1.7	-0.4	+0.1
San Juan/Dolores	+1.1	+0.9	+2.5

SCALE								
-4	-3	-2	-1	0	+1	+2	+3	+4

Severe Drought

Moderate Drought

Near Normal Supply

Above Normal Supply

Abundant Supply

CWRRI University Water News

University of Colorado

NATURAL RESOURCES LAW CENTER UPCOMING EVENTS



Best Management Practices and Adaptive Management in Oil and Gas Development May 12 and 13, 2004

Government agencies, industry and non-profits are all beginning to apply the concepts of best management practices and adaptive management to oil and gas development. This FREE workshop will examine what is going on in the Rocky Mountain Region with these innovative management approaches. This timely workshop will be kicked off with a presentation on the Western Governor's Association Coal Bed Methane Best Management Practices Handbook due out in April, 2004.

The workshop is designed for government agency employees, the oil and gas industry, conservation organizations, interested citizens, and attorneys working in the field (CLE credit will be applied for).

Groundwater in the West -- 25th Summer Conference June 16 – 18, 2004

The Natural Resources Law Center will be sponsoring its 25th summer conference June 16 -18, 2004 in the Fleming Law Building on the University of Colorado Boulder campus. This year's conference will explore ground water law, policy and management issues throughout the West.

- The conference will begin on Wednesday the 16th with a primer on ground water in the West focusing on science in the morning and law in the afternoon.
- Thursday's program will present case studies of ground water use and management, focusing on innovative solutions for the industrial West, transboundary issues, the High Plains and the Lower Colorado.
- Friday's program – available for separate registration – will focus on Colorado.

Wednesday evening's keynote presentation – Robert Glennon, author of "Water Follies: Ground water Pumping and the Fate of America's Fresh Water" – will be free and open to the public.

For additional information, please contact NRLC by phone 303-492-1286, fax 303-492-1297, email NRLC@colorado.edu, or see the NRLC website at <http://www.colorado.edu/law/centers/nrlc/events.htm>



NRLC ANNOUNCES NEW GROUNDWATER LAW SOURCEBOOK

The Natural Resources Law Center has announced the availability of a new publication. The Groundwater Law Sourcebook of the Western United States provides both an overview of the management and allocation issues that surround the use of groundwater in the West, but also provides a detailed explanation of groundwater law in each of eleven Western states. An extensive appendix provides links to the major groundwater laws in Western states so users can stay abreast of any changes in those laws. The states covered in this sourcebook include: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. Professor Gary Bryner, the principal author of the Sourcebook, said that "as the population of the American West continues to grow, one of the greatest challenges facing many communities is securing an adequate water supply." He added that "since the legal systems for managing groundwater resources are so complex, we think the Sourcebook will provide an indispensable tool for those looking for an explanation of how groundwater law works in each of the western states."

The Sourcebook is available free of charge in CD from the Natural Resources Law Center at the University of Colorado School of Law (303-492-1286). It also can be downloaded at no cost from the Center's web site at: <http://www.colorado.edu/law/centers/nrlc/pubs.htm>.

CU-DENVER

Training Class on URBAN FLOOD CHANNEL DESIGN
 UNIVERSITY OF COLORADO AT DENVER
 College of Engineering and Applied Science
 May 20 and 21, 2004 (Thursday and Friday) 8:30 a.m. - 4:30 p.m.

This course will be presented as an intensive computer aided design workshop in order to deliver hands-on working knowledge.

Tuition \$595.00 per enrollment Continuing Education Units: 1.4 units.

Location Auraria Campus in Downtown Denver

Course Topics

- | | |
|--|--|
| (1) Review of Hydraulic Principles | (2) Uniform Flow, Critical Flow, Rating Curve |
| (3) Introduction to UDCHANNEL Model | (4) Channel Grade Control --- Design of drops |
| (5) Grass Channel Design | (6) Riprap Protection |
| (7) Concrete Channel | (8) Back Water Profile |
| (9) Hydraulic Jumps | (10) Composite Channel Design |
| (11) Inlet/Outlet and Culvert Hydraulics | (12) Cross Waves at a Bend |
| (13) Transition Design | (14) Design of Curve Reach, |
| (15) Steep Channel Design, and | (16) Unsteady Flow-Waves Channel Routing Schemes |

Instructors

Ben R. Urbonas, P.E., MSCE is a professional civil engineer with a career spanning over 40 years that has included positions with the federal government, aerospace industry, consulting firms and, for the last 27 years, the Urban Drainage and Flood Control District, a regional drainage and flood control agency. At the District he has directed the development of over 115 watershed-level drainage and flood-remediation master plans and the design, construction and maintenance activities of the South Platte River Program. In addition, he has directed the District's technology development program and the expansion and the updates of the Urban Storm Drainage Criteria Manual and related computer computational tools.

James C.Y. Guo, P.E., and Ph.D., is a professor in the Department of Civil Engineering, University of Colorado at Denver. He has over 25 years of engineering experience in urban drainage planning and design. Dr. Guo has published 60 some technical papers, three technical books, many chapters, and more than 10 computer models in the area of storm water management and urban drainage designs. Many of Dr. Guo's research products have been converted into design criteria and accepted by Denver, Las Vegas, and Sacramento metropolitan areas.

Ken A. MacKenzie is a hydraulic engineer in the Urban Drainage and Flood Control District, Denver, Colorado. Mr. MacKenzie is experienced with the design procedures for urban drainage facilities. He reviews stormwater studies and also inspects construction projects in the field. Since 2001, he has participated in the development of computer models for urban drainage and flood control designs, including UDCHANNEL for channel design and UDCULVERT for culvert sizing.

FOR ENROLLMENT, VISIT <<http://www.cudenver.edu/ENGINEER/CONT>> CALL 303-556-2849 for more information.

*University of Northern Colorado*

The University of Northern Colorado will offer
 an online, graduate Earth Systems: WATER course
 in the summer as follows:

ESCI 575-970 Earth Systems: WATER (3 semester hours of graduate credit). June 7-July 30, 2004. Course instructor: Dr. Michael Taber. This is an online, problem-based course in earth sciences focusing on water resources. The course will fulfill Colorado Model Content Standards in Earth and Space Science, as well as serving as a model for problem-based, technology-based pedagogy. Students in the course should have a basic science background. For more information, contact Dr. Taber at michael.taber@unco.edu. Registration information may be obtained at <http://www.unco.edu/center/online.htm> after posting of the summer courses in February of 2004.

Colorado School of Mines

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 / URL: <http://typhoon.mines.edu/>



2004 SHORT COURSE SCHEDULE

Applied Environmental Statistics, June 7 -11
 by Dennis Helsel and Ed Gilroy

This five-day course develops hands-on expertise for all environmental scientists who interpret data and present their findings to others. The course emphasizes: when each method is appropriate; how to plot and present data; assumptions behind statistical tests, and their implications; how to build a good regression model, and trend analysis with common pitfalls. Our Goal: for you to make sense of your data. No requirement of previous training or experience in statistics. The fee for the short course is \$1495 before May 28 and thereafter \$1595.

Less than Obvious: Statistical Methods for Data below Detection Limits, August 18-19
 by Dennis Helsel

This two-day short course presents statistical methods for interpreting data below detection limits. The course examines up-to-date methods which are more appropriate for interpreting data than deleting less-thans, or substituting arbitrary values. Example problems are worked in class, so students can confidently take these methods back to their office. The course assumes a knowledge of basic statistics, including some familiarity with t-tests, linear regression, and simple nonparametric tests like the rank-sum test. The fee for the short course is \$895 before August 5 and thereafter \$995.

MODFLOW: Introduction to Numerical Modeling, November 4-6
 by 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, solution control, and calibration are presented using MODFLOW-2000. Basic modules of MODFLOW are explained and concepts are reinforced with hands-on exercises. The fee for the short course is \$995 before October 21 and thereafter \$1195.

Polishing Your Ground-Water Modeling Skills, November 4-6
 by 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. The fee for the short course is \$995 before October 21 and thereafter \$1195.

Modeling Water Flow & Contaminant Transport in Soils and Groundwater
Using the HYDRUS Computer Software Packages, November 5-6
 by 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. The fee for the short course is \$495 before October 21 and thereafter \$595.

UCODE: Universal Inversion Code for Automated Calibration, November 11-12
 by 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 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. The fee for the short course is \$795 before October 28 and thereafter \$995.

1st WEF/AWWA Student Conference
Colorado School of Mines
Golden, Colorado State University May 18, 2004

Co-Sponsored by
Rocky Mountain Water Environment Association
Rocky Mountain Section
American Water Works Association

CONFERENCE SUMMARY

The Colorado School of Mines AWWA/WEF Student Chapter invites students and professionals to join the 1st Student Conference of the Rocky Mountain Region on May 18, 2004 at the Colorado School of Mines in Golden, CO. The conference offers a new forum for undergraduate and graduate students in Wyoming, Colorado and New Mexico to present their research and design projects before a professional audience and to enhance networking between students and professionals in the region. The event is sponsored by the Rocky Mountain Water Environment Association and the Rocky Mountain American Water Works Association as well as environmental consultants in the Front Range. Student presentations will focus on research projects related to water, wastewater, water resources and groundwater remediation. The conference is open to all universities in the Rocky Mountain region and will be joined by students from CSU, CU, CSM and UW. Members of professional organizations, consultants, and design engineers are encouraged to attend and are invited to present their affiliations to students during the conference (e.g., in form of booths).

HOW TO REGISTER

To register for the RM WEF/AWWA Student Conference complete and send the registration form via mail or fax along with payment (student registration is free) to the CSM WEF/AWWA Student Chapter (see address on last page of flyer). Pre-registration deadline is April 15.

PROGRAM COMMITTEE

Prof. Dr. Jörg E. Drewes, CSM WEF/AWWA Student Chapter, Faculty Advisor, Colorado School of Mines
Prof. Dr. Ken Carlson, Colorado State University, Fort Collins
Eric Dickenson, CU Boulder (graduate student)
E. Heidi Bauer, Colorado School of Mines (undergraduate student)
Mery Beth Talty, Colorado State University (graduate student)
Kevin Bergschneider, Richard P. Arber Associates, Denver, CO
Karen de Fazio, P. E., Brown and Caldwell, Golden, CO

CONTACT INFORMATION:

For further information please contact the conference president:

Tanja Rauch, Ph.D. candidate
CSM WEF/AWWA Student Chapter
Environmental Science and Engineering
Colorado School of Mines
1500 Illinois St.
Golden, Colorado 80401

Email: trauch@mines.edu

Phone: 303-384-2445

Fax: 303-273-3413

Website: <http://www.rmwea.org/>

SCOPING REPORT COMPLETED

The U.S. Bureau of Reclamation (USBR) has completed the Public Scoping Report for the proposed Excess Capacity Contracts between the City of Aurora and USBR. The report includes a description of the public involvement process and a summary of the comments received during scoping. A copy of the document in .pdf format can be downloaded from the following websites:

<http://www.usbr.gov/gp/pubinv1.cfm> or http://www.eroresources.com/aurora_exchange/aurora.html

Hard copies are on file at selected libraries in Aurora, Buena Vista, Canon City, Colorado Springs, La Junta, Leadville, Pueblo, Rocky Ford, and Salida. If you have any questions or would like to request a hard copy of the Public Scoping Report, contact Kara Lamb at 970/962-4326 or klamb@gp.usbr.gov.

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 January 29, 2004 to March 26, 2004

PI	Department	Sponsor	Title
Culver, Denise	FWB	CDWL	Fremont County Survey for Critical Wetlands
Rocchio, Joseph	FWB	CDWL	Development of Vegetation Index of Biotic Integrity for the Southern Rocky Mountain Ecoregion Phase I
Culver, Denise	FWB	CDWL	Dolores County Survey for Critical Wetlands
Gates, Timothy	Civil Engr.	CDPHE	Assessing Irrigation-Induced Selenium & Iron in the Stream-Aquifer System of the Lower Arkansas River Basin, CO
Smith ,Danny	CIRA	Univ. of CO	Western Water Assessment - Providing Increased Focus on the Crucial Agricultural Sector
Vonderhaar, Thomas	CIRA	NOAA	Environmental Applications Research Project
Kidder, Stanley	CIRA	NOAA	CIRA's Cross-Sensor Products for Improved Weather Analysis and Forecasting
Pielke, Roger	CIRA	NOAA	An Evaluation of Ultrasonic Snow Depth Sensors for Est 6 & 12 Hr Snowfall Totals
Johnson, Brett	FWB	USBR	Provenance & Trophic Roles of Non-Native Fishes
Bestgen, Kevin	FWB	USBR	Development & Execution of a Biological Study Plan for Evaluation of Injury to Young Life States of Fish
Rathburn, Sara	Geosciences	NPS	Sediment Transport/Deposition within the Colorado River Resulting from the Spring 2003 Grand Ditch Failure
Poff, N. LeRoy	Biology	USGS	Compilation & Analysis of Macroinvertebrate Species Traits for the National Water Quality Assessment Program
Rutledge, Steven	Atmos. Sci.	NASA	Physically-based Observational Studies for Tropical Rainfall Measuring Mission & Concept Development ...
Randall, David	Atmos. Sci.	NASA	Comparison of Cloud Resolving Model Simulations to Remote Sensing Data

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.

OTHER SPONSORS: ADEC-American Distance Education Consortium.

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, FRWS-Forest Rangeland Watershed Stewardship, 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 Astrodynamic 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, EEB-Ecology & Environmental Biology, 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	Department	Sponsor	Title
Stephens, Graeme	Atmos. Sci.	NASA	Effects of 3D Cloud Morphology on Retrievals of Optical Depth
Randall, David	Atmos. Sci.	NASA	Large Ensemble Evaluation of Cloud Models and Super Parameterization Using EOS Satellite Data
Kummerow, Christian	Atmos. Sci.	NASA	Risk Mitigation Studies for Evolving Data & Information Systems Related to Rainfall Missions
Venkatachalam,C.	Elec./Comp. Engr.	NASA	Tropical Rainfall Measuring Mission Observations & Precipitation Microphysics...
Paustian, Keith	NREL	USDA-NRCS	Quantifying the Change in Greenhouse Gas Emissions Due to NR Conservation...
Binkley, Daniel	NREL	USGS	Support for Global Change Research Program
Ward, Robert	CWRRI	USGS	Description & Interpretation of Salinization in the Lower Arkansas River Valley
Ward, Robert	CWRRI	USGS	Enhancements to South Platte Mapping and Analysis Program (SPMAP)
Johnson, Richard	Atmos. Sci.	NSF	Midlatitude Mesoscale Convective Systems
Gray, William	Atmos. Sci.	NSF	Studies in Empirical Climate Prediction & Understanding
Stephens, Graeme	Atmos. Sci.	NSF	On the Maintenance of the GLOBE Atmosphere Investigation Protocols & Application of These Protocols . . .
Randall, David	Atmos. Sci.	DOE	Use of ARM Data to address the Climate Change Problem
Bestgen, Kevin	FWB	USBR	Evaluating Effects of Non-native Predator Removal on Native Fishes in the Yampa River
Snyder, Darrel	FWB	USBR	Identification & Curation of Larval Fish by CSU Larval Fish Lab
Bestgen, Kevin	FWB	USBR	Interagency Standardized Monitoring Program Assessment of Endangered Fish Reproduction...
Bestgen, Kevin	FWB	USBR	Verification of Stocked Razorback Sucker Reproduction in the Gunnison River via Annual Collections of Larvae
Bestgen, Kevin	FWB	USBR	Population Estimates of Colorado Pikeminnow in the Lower Green River
Bestgen, Kevin	FWB	USBR	Effects of Flaming Gorge dam Releases on Lodore/Whirlpool Canyon Fish Community
Qian, Yaling	CWRRI	USGS	Urban Landscape Irrigation with Recycled Wastewater, Phase 2
Cardon, Grant	CWRRI	USGS	Salt chem. Effects on Indirect Field Salinity Assessment, Arkansas River
Bestgen, Kevin	FWB	USBR	Annual YOY Colorado Pikeminnow Fall Monitoring
Snyder, Darrel	FWB	USBR	Publication of Supplemental Update to Larval Sucker Guide
Badertscher, Kerrie	Coop. Ext.	CO Garden Show	High & Dry Demonstration Gardens
Garcia, Luis	CWRRI	Various Sponsors	Developing a Decision Support System for the South Platte Basin
Bush, Carmel	Library	Greater West. Lib. Alliance	Western Waters Digital Library
Fontane, Darrell	Civil Engr.	Korean Water Res. Corp.	Development of Real Time Water Resources Management System
Thilmany, Dawn	ARE	GreenCO Fdn.	Economic Contribution of Colorado's Green Industry
Thornton,Christopher	Civil Engr.	USFS-RMRS	Hydraulic Modeling of Stabilization Techniques
Smith, Freeman	FRWS	USFS-RMRS	Mapping Snow Properties: A Multi-Scale Approach

UNIVERSITY OF COLORADO, BOULDER, COLORADO

Awards for December 1, 2003 to December 31, 2003

PI	Department	Sponsor	Title
Blanken, Peter	Environ. Studies	NSF	Extension of Surface Energy and Water Cycle Flux Measurements Beyond the International H2O Project...
Akmaev, Rashid	CIRES	NSF	A Theoretical and Modeling Study of Global Change in the Mesosphere and Thermosphere
Avallone, Linnea	PAOS	NASA	Improvements to In Situ Measurements of Ice Water Content Using Tunable Diode Laser Spectroscopy

PI	Department	Sponsor	Title
Konrad, Steffen	CIRES	NASA	Greenland Ice Sheet Melt Climatology Based on Passive and Active Satellite Data...
Konrad, Steffen	CIRES	NASA	Validation of AMSR Sea Ice Products in the Southern Hemisphere
Nerem, Robert	ACAR	Jet Propulsion Lab	An Investigation of Very Low Frequency Sea Level Change Using Satellite Altimeter Data
Zhang, Tingjun	CIRES	Tulane Univ.	Investigation of the Spatial and Temporal Variations of Seasonally Frozen Ground in the Contiguous US

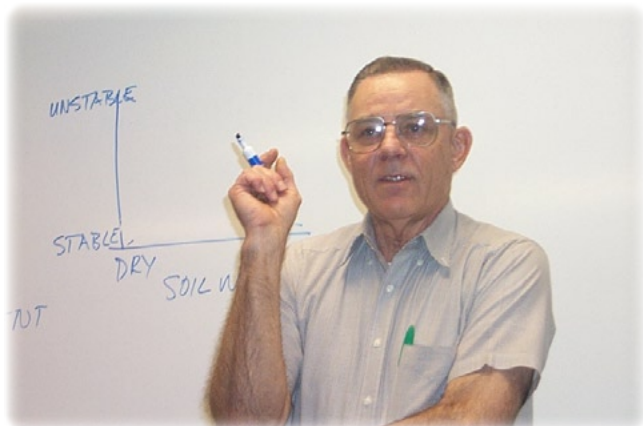


FREEMAN SMITH CHOSEN BEST TEACHER OF THE YEAR

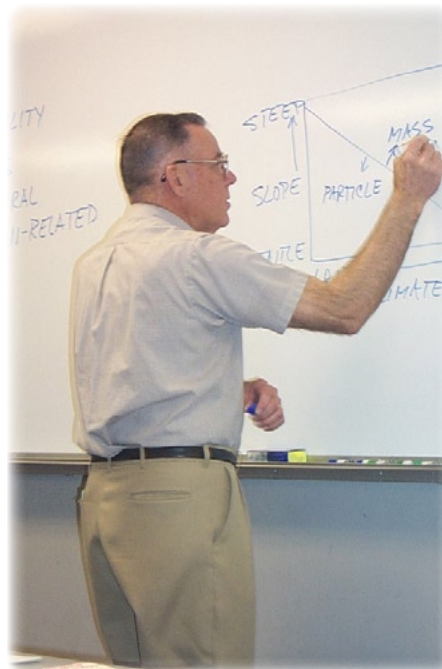
Freeman Smith, Professor, Department of Forest, Rangeland and Watershed Stewardship was honored at a dinner in the Lory Student Center Ballroom on February 20, 2004, as one of six professors chosen university-wide as Best Teacher of the Year. Smith is well-known by students in the College of Natural Resources for his open-door policy and for being a mentor and friend.

In addition to his teaching responsibilities, Smith also is director of the International School of Natural Resources, and has extensive international consulting experience in land-use hydrology, irrigation, and watershed management for hydropower. His research has dealt with individual hydrologic processes as well as those involving integrated watershed planning and management, and he has considerable experience in modeling watershed processes and watershed systems. Smith's current research interests include detecting change within natural hydrologic variability, environmental monitoring, global energy/water balance mapping, and Eigenvector analysis of hydrologic time series.

Freeman Smith initiated and supervised development of the Colorado Water Knowledge website, which is found at <http://waterknowledge.colostate.edu>.



"He's concerned with students learning the information, not just memorizing things for a test," say Smith's students.



Smith's students say he "brings in a sense of humor that appeals to all ages..."

The website has received numerous state, national and international awards and recognition.

Smith, who received his doctorate in 1971 from Colorado State, earned master and bachelor degrees from the University of Arizona in 1969 and 1961, respectively. He joined CSU in 1969.

Water conservancy districts were authorized for organization in the 1937 Water Conservancy Act⁴⁰³ as a legislative response to the need for water projects in Colorado...In addition, Colorado required water projects to transfer water within the state.

⁴⁰³ 1937 Colo. Sess. Laws 1311 (codified at COLO. REV. STAT. §§ 37-45-101 to 152. (1973 & Supp. 1985).

FACULTY PROFILE



DR. CHIH TED YANG NAMED BORLAND PROFESSOR

by Marian Flanagan

In January 2004, Dr. Chih Ted Yang joined Colorado State University faculty as the Borland Professor of Water Resources. The Department of Civil Engineering is developing a Hydrosience and Training Center, of which Dr. Yang will serve as Director. Although born in China, Yang grew up in Taiwan. In 1962, he received his B.S. in Civil Engineering at National Cheng Kung University in Tainan, Taiwan. Yang came to Colorado in 1963 to study at Colorado State University, where he earned both his M.S. and his Ph.D. in Civil Engineering in 1965 and 1968, respectively.

Dr. Yang's career began in Illinois, in 1968. He had a joint appointment as Associate Hydrologist and Principal Investigator for the Illinois State Water Survey and University of Illinois Water Resources Center. For six years he conducted basic and applied research in hydrology, hydraulics, sedimentation, and water resources engineering. Yang decided to resign from his academic position in 1974 to focus his energies on engineering. He went to Chicago to work as a Hydraulic Engineer for North Central Division of the U.S. Army Corps of Engineers, where he reviewed and directed flood control projects for the division's five districts.

In 1979, Yang returned to Colorado to serve at U.S. Bureau of Reclamation (Reclamation) until his retirement twenty-five years later. Yang said his top three accomplishments while working for Reclamation involved "three eras" or "three very different careers." His careers involved engineering, international and technical assistance and finally, management of sedimentation and river hydraulics studies.

In the mid 1970s, after the Teton Dam failure in Idaho, the Blue Ribbon Panel investigating the failure recommended that Reclamation perform an independent technical review of major projects. Dr. Yang was the first of three people, hired from outside, to be part of Reclamation's Technical Review Staff. This elite group consisting of Yang and five others, made important contributions to Reclamation by improving the design standard for dams and other hydraulic structures. The agency has not had a failure since.

Yang's credentials, capabilities and reputation earned him the title of International and Technical Assistance Program Manager for Reclamation in 1988. He initiated, coordinated, developed, and directed the International Technical Assistance Program and improved the standing of Reclamation in the international arena. Yang traveled to many different countries representing Reclamation. He provided expert consultation on institution building, water resources research, planning, design, operation, and management.

Once again, Yang shifted gears in 1994, with a third career at Reclamation. As Manager of the Sedimentation and River Hydraulics Group, Technical Service Center, Yang supervised, directed, and managed the Sedimentation and River Hydraulics Program at the Denver headquarters - a service agency with no budget and no base pay. The group formerly consisted of five people. It now has more than twenty, mostly hand-picked by Yang himself. Under Yang's leadership, the group received



Reclamation Commissioner's Work Force Diversity Group Award and is considered the best educated and most diverse in terms of national origin, gender and religion. The Group has produced three "Reclamation Engineer of the Year" and one "Woman in Science" national winners.

Prior to his retirement in January 2004, Yang was granted the prestigious Meritorious Service Award, which is one of the highest honors bestowed upon an employee by the Department of Interior. Yang received the award for his exceptional leadership, management and research accomplishments in the area of sedimentation and river hydraulics, and for his part in developing a series of computer models called "GSTARS" (Generalized Sediment Transport model for Alluvial River Simulation). Yang's vision and leadership led to the development and application of state-of-the-art technology in sedimentation and river hydraulics. GSTARS is available on Reclamation website and has several thousand of users around the world. The Meritorious Service Award, signed by Secretary of the Interior, Gale Norton, was presented to Dr. Yang along with a silver pendant and a lapel pin. In appreciation of his many contributions to Reclamation, Yang also received a Career Service Certificate from Reclamation Commissioner John Keys.

When asked what he considers to be his three most important international career activities, Yang said that there were many projects, however a couple of countries stood out. Above all,

Yang has been actively involved with Reclamation projects in Taiwan, contributing 15 years of technical assistance and cooperation programs. Since Taiwan and the United States have no diplomatic relationship, Yang acted as the Liaison Officer of Reclamation to Taiwan. Yang and Reclamation have helped Taiwan complete many projects including about a half-dozen dam designs and constructions.

China is another country where Yang has been actively involved. He worked on the Three Gorges Dam Project; a project to supply China with hydropower as a clean and renewable power source with capacity equivalent to 10 nuclear power plants. Yang was also invited to consult on an even bigger project called the South to North Water Transfer Project, to transfer water from the Southern (wet) region of China to the dry, Northern region. Yang may be invited back again, as he said, "There is much work to do in China."

The third most notable country where Yang and Reclamation have been active is Pakistan, where Yang taught irrigation engineers how to improve the design and operation of canals. For all of the above, Yang has been the Reclamation's International and Technical Assistance Program Manager.

"I've been blessed with lots of fortune in my career," said Yang. And he would like to share the experience he has gained with a younger generation. This year, Yang has come back to where he received his education, to 'pay his dues.' He is thankful for the opportunity he has been appointed as the Borland Professor of Water Resources. In addition to research activities, Yang is teaching a graduate course in fluvial

hydraulics and computer modeling this semester.

As Director of the Hydrosience and Training Center at CSU, Yang will establish a place for faculty to conduct research in interdisciplinary "hydrosiences" and water resources engineering with emphasis in erosion, sediment dynamics, river restoration, and computer model development and application. Yang hopes, he said, "...that faculty members can utilize the Hydrosience and Training Center as a center of synthesis to generate energy." The center will develop research projects and offer hydrosience related courses on national and international levels. Yang said that his job is not to direct, but to serve the faculty and act as a cohesive force to bond them together and to develop and conduct projects together.

There is an ancient Chinese philosophy that Dr. Yang says is still true today. It is: "The fundamental principle in river engineering is to follow the Mother Nature of rivers and to use potential energy wisely." The theory of minimum energy dissipation rate provides a mathematical way of describing the Mother Nature of rivers. Dr. Yang has received many honors and awards for his work over the years for the development and application of the minimum energy dissipation rate and unit stream power theories.

Chih Ted Yang is listed in Who's Who in Engineering, American Men and Women in Science, Who's Who in the West, Men of Achievement, and Personalities of America, just to name a few. Professor Yang's wife Eveline works for the Auraria Library in Denver. Ted and Eveline have two sons; Michael, who lives in San Diego and David, who lives in Singapore.



WATER NEWS DIGEST

by Marian Flanagan

Climate

Shorter, wetter winters lie ahead

If global warming grows at its current pace, skiers and snowboarders can expect to see shorter winters and a greater probability of rain, according to Daniel Lashof, science director of the Natural Resources Defense Council Climate Center. Computer models and research indicate that snowpack in alpine areas of the Northern Hemisphere will fall by up to 50 percent if current conditions persist. The ski season will end sooner because snowmelt will begin earlier and will occur more rapidly. Research indicates that peak runoff will be 30 to 40 days earlier in the year. Already, many major rivers are experiencing peak runoff five to 10 days earlier than they were 50 years ago. How quickly the climate changes will strike is being debated. It depends in large part, Lashof said, on how mankind reacts. The Intergovernmental Panel on Climate Change, sanctioned by the Bush administration, projects that average annual temperatures will rise between 2.2 and 10 degrees by the year 2100. That will mark a greater increase than has occurred in the last 10,000 years. The burning of fossil fuels for vehicles, to heat homes and businesses and to power factories generates 80 percent of the global carbon dioxide, according to the U.S. Environmental Protection Agency's (EPA) Web site on climate change. CO₂ emissions create greenhouse gases that capture the earth's heat. The United States produces about one-fifth of the world's greenhouse gases, according to the EPA. Lashof said global warming doesn't necessarily mean it will snow less. An oddity of the climate-change projections is that Colorado will receive more precipitation, not less, due to global warming. The EPA's Web site said research indicates temperatures in Colorado could climb 3 to 4 degrees in spring and fall and 5 to 6 degrees in summer and winter. Precipitation could increase by 10 percent in spring and fall and by up to 70 percent during winters. But, like Lashof, the EPA said more winter precipitation will come as rain.

Scientist: More funding needed

Warren Washington, senior scientist at the National Center for Atmospheric Research in Boulder, said scientists could not fully understand climate changes or global warming without extensive research. He estimated that the Climate Change Science Program needs considerable budget increases each year just to stay on track with its research. If the program does not get sufficient funding, it will take significantly longer to get scientific explanations for climate change. Washington said it is crucial to address climate changes sooner, not later. "If we don't start taking steps with global warming now, it'll be harder to deal with in the future," he said.

Boulder Daily Camera / February 19, 2004

Drought

Wildfire season likely to be above normal in interior West

Drought, warm temperatures and damaged vegetation have fire experts predicting a long and destructive fire season throughout much of the interior West this year. But the national outlook is better, with the National Interagency Fire Center expecting near or below average fire seasons in Eastern states, the South and Alaska. "One of the big factors that goes into the fire assessment is the ongoing drought in the West," said Rick Ochoa, national fire weather program manager for the Bureau of Land Management. The amount of vegetation damaged by drought and insects has been rising in the West, increasing the risk of wildfires.

Associated Press / Durango Herald / February 24, 2004

State snowpack in sorry shape

High country snowpack dropped alarmingly in March, pushing the state into its fifth year of drought and making strict summer watering rules almost a certainty for many communities. The statewide snowpack - a critical indicator of fresh water supplies - measured just 65 percent of average, well below the 94 percent of average recorded one year ago, according to the Natural Resources Conservation Service. "The message is grim," said Roger Pielke Sr., state climatologist. "Water managers need to plan now to conserve. We're in very poor conditions for water this summer." The precipitous decline in the snowpack since March 1 is one of the most dramatic melt-offs ever recorded in a single month, the Conservation Service said. March was the driest in Denver since 1908, according to the National Weather Service. Though statewide snowpacks are higher than they were in 2002 when they measured 52 percent of average on April 1, water officials are concerned because stored water supplies are lower.

Rocky Mountain News / April 2, 2004

Endangered Species

Official lukewarm on Platte River plan

The leader of the board that sets Wyoming's water policies is unenthusiastic about a proposed agreement with Nebraska and Colorado for using North Platte River water. But Mike Besson, director of the Wyoming Water Development Commission, nonetheless thinks it's the "best deal" for Wyoming. The Platte River plan proposes using 54,000 acre-feet of the river's upper basin to fill an expanded Pathfinder Reservoir. The water would be put in an account and released to Nebraska in phases of high water for the benefit of endangered species. Because Pathfinder Reservoir has lost capacity over the years, Wyoming's share of the water would be made up by raising the dam. Besson said he supports the plan because while raising the dam would cost about \$2.2 million, buying the water from other sources could cost much more. The agreement is an outgrowth of negotiations started in 1997 among the three states and the federal government. A final plan is due in April, and a final agreement due to be signed by June 2005.

Associated Press / Boulder Daily Camera / February 13, 2004

Recreation

Loss of manmade ice upsets climbing population

City officials in Colorado Springs shut down an ice-making system on a frozen waterfall in Cheyenne Canyon late last month in an effort to keep parks looking natural. Climbers were upset, saying the natural ice is not enough to sustain a growing number of climbers. "The parks department doesn't allow man-made structures in parks, including ice," said Kurt Schroeder, manager of park maintenance, trails and open space. Climbers said that Silver Cascade will still be used heavily because it is the only significant ice for 100 miles, and the ice climbing population is expanding. According to the Outdoor Industry Council, the number of people nationwide who climbed ice from 2001 to 2002 increased 120 percent.

Associated Press / Boulder Daily Camera / February 16, 2004

DOW strikes deal to preserve river access on Roaring Fork

Colorado anglers will keep access to prime fishing waters along the Roaring Fork River under an agreement between the Colorado Division of Wildlife and a valley landowner. Under the terms of the \$383,000 Burry Ranch access agreement, two trails leading to 1.25 miles of Gold Medal fishing waters between Glenwood Springs and Carbondale will remain open to the public in perpetuity, the DOW has announced. "Generations of anglers will benefit from Mr. Burry's generosity" said Pat Tucker, the division's area wildlife manager in Glenwood Springs. The Burry easement was funded by \$146,000 in Fishing Is Fun funds, financed with federal dollars; and \$237,000 in Great Outdoors Colorado money, funded with lottery proceeds. Alan Czenkusch, DOW area aquatic biologist, said "This is the best public access on the entire Roaring Fork. It's head and shoulders above any other." He said anglers who visit the easement site will have access to what the Colorado Wildlife

Commission has designated "Gold Medal waters," or fishing areas that offer anglers access to an abundant supply of large cold-water fish.

Aspen Times Staff Report, March 17, 2004

Sediment

Anglers, wildlife officials criticize dam cleaning

State wildlife officials and anglers are criticizing Xcel Energy's decision last fall to flush sand out of the reservoir behind the Shoshone Dam in Glenwood Canyon during the brown trout spawning season. A senior aquatic biologist on the Western Slope said it could take another year to determine the level of damage from last fall's sediment flush. Xcel promised to try to do future flushes in the spring rather than the fall. The Army Corps of Engineers is looking into whether it has authority under the Clean Water Act to require Xcel to obtain a federal permit before flush operations. Xcel Energy releases water about every four years to eliminate a sandbar that forms near the intake tubes of its Shoshone hydroelectric power plant.

Associated Press / Aspen Daily News / February 13, 2004

Tamarisk

Beetles to feast on tamarisk

The U.S. Department of Agriculture plans to release Asian beetles in 13 Western states next spring to combat the tamarisk shrub that is clogging riverbanks and sucking up water faster than any weed in the West. The *Diorhabda elongata*, otherwise known as the saltcedar leaf beetle, is a pencil-eraser-size yellow bug that gobbles its way through the thick vegetation of tough-to-kill tamarisk but does not eat other plants. The beetle is native to China and Kazakhstan, areas where tamarisk is native, and the beetles keep it in check. Bob Richard of the USDA's Animal and Plant Health Inspection Service announced the beetle-release plan Wednesday to about 300 land managers, politicians, scientific researchers, farmers and ranchers. Jack DeLoach, a USDA researcher, and Richard stressed that the beetles won't be a magic bullet that will eradicate tamarisk: The bugs are only expected to control it and be a less environmentally harmful tool than herbicides, which can also kill cottonwoods and willows. DeLoach said he doesn't know how long it might take beetles to kill a tamarisk that can grow in height and girth to the size of a tree. Some plants in the experiments have died in three years, he said. The beetles also aren't expected to halt other eradication efforts, which include everything from using goats to eat the weed, chain-sawing it down, and applying herbicides to the roots.

Denver Post / October 23, 2003

Water Conservation

Water use decreasing in Aurora

In 2003, Aurora cut its overall water use by 30 percent over 2002, but much of that was because of outdoor watering restrictions. Thanks to increased awareness and conservation programs, Aurora residents have reduced their winter water consumption by about 10 percent over the last two years, according to Natalie Brower-Kirton, senior water conservation specialist for the city. One successful program offers rebates for replacing water-wasting toilets and washing machines. The city also has handed out about 3,000 free water conservation kits to residents. Aurora residents may get a free water conservation kit by calling the hotline at 303-739-7195. For information on the toilet and washing machine rebate call 303-326-8879.

Rocky Mountain News / February 27, 2004

Permanent summer ban likely for Denver, even without drought

Drought or no drought, Denver residents likely will face a permanent summertime ban on lawn watering between 10 a.m. and 6 p.m., Denver Water officials said. Water conservation advocates have long argued that making such a restriction permanent, regardless of whether a drought exists, makes sense in Colorado's semi-arid climate. If the board votes to approve the daytime lawn-watering ban, customers who water during the day would be subject to fines and possible suspension of water service, said Rocky Wiley, Denver Water's manager of planning. Denver Water has asked homeowners to voluntarily refrain from lawn watering until May 1 in an effort to safeguard stored water supplies. Denver's mountain reservoirs are about 71 percent full, 10 percentage points below normal levels. Warm weather this month has melted substantial amounts of snow. Statewide snowpacks dropped to 75 percent of average this week, down from 94 percent on March 1.

Rocky Mountain News / March 26, 2004

Push to save water, money may loosen artificial-turf limits in Aurora

Although modern-day fiber grass has been around for a while, it's only just beginning to catch on in the metro area and across the nation. Denver Water displayed the turf at its headquarters to show residents alternatives to thirsty lawns. The city of Denver allows artificial grass. New York's parks department has been switching many of its ballfields to artificial grass for years, city officials there said. Faux grass is also popular in parts of California, Nevada and Arizona, wherever the elements make gardening a challenge, artificial turf retailers say. Artificial lawns would save water, time and money and do not require weeding, mowing or fertilizing. Several preschools across the metro area have already installed or will install faux turf on their playgrounds. The new turf is made of 2 1/2-inch blades of polyethylene fiber fashioned like real grass on a mat of granules of recycled tires. The turf mats are stapled into place over a drainage system. The upfront cost for artificial grass is not cheap. It can cost up to \$10 a square foot, retailers say. But artificial grass brings a return on the investment within a few years, they say.

Denver Post / March 29, 2004

Water Quality

EPA fears former explosives plant may pollute wells

Environmental Protection Agency documents show that owners of a former explosives plant near Louviers repeatedly tried to ignore or discredit a test showing explosives in deep groundwater and that the owners of the former Ensign-Bickford plant didn't test groundwater for explosives until the mid-1990s. Documents also show the owners haven't officially ruled out the chance that other toxic leftovers could drain from the plant into drinking water. Activists and some local residents worry the plant could have contaminated the water that flows to nearby drinking wells. Some oppose ending the cleanup without more testing. There are two levels of water beneath the site in Douglas County. The shallow water shows levels of several explosives - some that greatly exceed levels the EPA considers safe for cancer and other health problems. No one drinks the shallow water, but hundreds of feet below is an aquifer that feeds wells in Highlands Ranch, Louviers and other nearby communities.

Rocky Mountain News / February 21, 2004

EPA wants action soon

How hazardous is the lead contamination underlying Rico, Colorado's backyards? The Environmental Protection Agency said it's enough to warrant an almost immediate cleanup of the town. EPA officials handed the town an approximate six-week deadline to decide how it will approach its contamination problem before the agency makes the decision itself. Test results showed lead levels in residential soils well above EPA safety standards. EPA officials have said that, though Superfund is unlikely for the town, its duty is to protect the health of the local residents through whatever means it deems necessary.

Telluride Daily Planet / February 23, 2004

Water Supply/Development

Water ebbs, worry flows

Lake Powell, which has served Colorado as a crucial fail-safe for water deliveries throughout the Southwest during five years of hard drought, is now more than half empty. If the drought persists a year or two more, the 186-mile long reservoir in Utah and Arizona could be drained dry as early as 2007, federal officials say. That would propel Colorado - and 30 million other Westerners who depend on the Colorado River for their drinking water - into an uncertain future punctuated by recurring water shortages and decades of litigation, experts warn. The Bureau of Reclamation said it expects only 55 percent of the normal runoff to flow into Lake Powell between April and July. That guarantees the reservoir, already down to 42 percent of capacity, will recede even further by 2005. Under the Colorado River Compact of 1922, the states of Colorado, Wyoming, and Utah are required to allow an average of 7.5 million acre-feet per year to flow past a river gauge below Lake Powell for use by California, Arizona and Nevada. Drought is also draining Lake Mead, which is downstream and slightly larger than Lake Powell. During the past five years, the two vast impoundments have lost a volume equivalent to a full Lake Mead, officials say. "The moral is that if we think we have more Colorado River water that's developable, we'd better think again," said David Getches, Dean, University of Colorado Law School. "We may already be beyond the point of safe development of Colorado," he said. Experts warn that a call on the Colorado River has the potential to affect nearly everyone. If shut-offs proceed in a strictly chronological order, the losers could potentially include the Colorado Big-Thompson project; Denver Water transmountain diversions, including water from Lake Dillon and Fraser River Valley; water supply for the City of Colorado Springs including the Homestake Tunnel and the Frying pan-Arkansas Project; and a large majority of water users in the Gunnison Valley who draw water from Blue Mesa Reservoir. Summer mountain recreation, particularly rafting and golfing, would also be affected. Many water scholars point out that the laws governing the Colorado River, of which the 1922 compact is but one part, have never really been tested - legal tests may await the complex "law of the river."

Rocky Mountain News / April 4, 2004

Pueblo, Colorado Springs sign agreement on Arkansas River pipeline project

The Colorado Springs City Council and the Pueblo Board of Water Works have signed a historic agreement that ends months of controversy over Arkansas River water. The agreement will allow Colorado Springs' long-planned Southern Delivery System, a 66-inch-diameter pipeline that will carry water from the Arkansas to Colorado Springs, to move forward. The pipeline is expected by 2040 to pump 8 million gallons of water a day to Colorado Springs, Fountain and Security-Widefield.

Denver Post / February 12, 2004

Plan would create Front Range water conservation district

A Senate bill sponsored by Se. Jim Dyer, R-Littleton, would attempt to unify the fragmented water interests along the Front Range, particularly in the south metropolitan area, by creating a multi-jurisdictional board for metro-area water interests. "It would create a well-funded conservation district to provide for the people in the area," Dyer said. The areas of major population are the only part of the state represented by numerous water conservation districts, and individual municipalities are left to squabble over water rights and projects, while their nonrenewable water resources continue to dry up. "A regional conservation district would organize the different interests and allow them to bargain as one, which should help members acquire water more efficiently," Dyer said. But Western Slope advocates worry that the legislation would not do enough to protect the economic interests in the basin of origin - the area of a water source. Dyer said the district would be an "opt-in" program whose members would not have to be all in one area. "People from the Western Slope can join," he said. The bill summary lists Arapahoe and Elbert counties, northern El Paso County, portions of Jefferson County and the Parker Water and Sanitation District among interested groups.

Denver Post / April 2, 2004

Salazar says Arkansas River Valley needs to develop 1041 powers

Colorado Attorney General Ken Salazar has warned communities in the Arkansas River Valley that the metro area would be coming after their agricultural water, and they'd better start mounting a defense now. Specifically, Salazar said, counties in the region need to more fully develop their "1041" powers, a phrase linked to House Bill 1041, that gives counties the right to utilize land-use regulations to exact concessions from - or even stop - someone else's water project. Salazar said the Arkansas Valley has already seen roughly 60,000 acres of farmland dry up in recent decades by moving water from farms to cities, most of it to Pueblo, Colorado Springs and Aurora. Salazar also said that the effort to take water from the valley's massive Fort Lyon Canal could dry up an additional 32,000 acres of farmland. Salazar's family has farmed and ranched in the San Luis Valley for nearly 150 years.

Rocky Mountain News / February 11, 2004

Aurora to complete largest water lease in state's history

Aurora water officials are waiting for a federal permit from the Bureau of Reclamation that would allow the city to complete the largest water lease in the history of the state. This could mean the influx of 12,000 acre-feet of Arkansas River Valley water into Aurora's parched reservoirs. Water officials have proposed a "reservoir recovery surcharge" that could add anywhere from 65 cents to \$3.99 to the price of 1,000 gallons of water depending on the amount of water used. If approved by the full city council, it would be the first time Aurora has ever directly charged water users to refill the city's reservoirs. "We're trying to get ourselves out of the water restriction game at the earliest possible time," Utilities Director Peter Binney explained.

Aurora Sentinel / February 12, 2004

Water experts soak in demand data at Montrose roundtable

The Statewide Water Supply Initiative (SWSI) data shows that by the year 2030 Montrose County will grow by 103 percent, more than doubling the population from the current 33,666 residents to 68,304. Demands on the municipal and industrial water supply will double as well. The increase in population in the Gunnison Basin will likely be attributed to the "Front Range flight" syndrome, where residents of the Front Range move across the Continental Divide in search of water, said Kelly DiNatale, technical director for the consulting firm that compiled the data. "It will be especially apparent in the Montrose area." The Gunnison Basin is one of three river basins in the state that will show an annual increase in population of two percent or more. The other two basins, the Colorado and San Juan/Dolores/San Miguel, are also on the West Slope. The forecasted migration of Front Range residents came as no surprise to many of the roundtable members. The SWSI team plans to hold the third roundtable meeting for the Gunnison Basin on April 27 in Montrose.

Montrose Daily Press / February 18, 2003

Corps OKs Parker reservoir - Rare permit granted to build water storage project

For the first time in more than 20 years, the U.S. Army Corps of Engineers has permitted a new reservoir on the Front Range. The city of Parker hopes to begin construction of the \$103 million Rueter-Hess Reservoir project in a dry gulch 3 miles southwest of town later this year. Parker's current population of 30,000 is predicted to more than double by 2050, even as its groundwater supplies dwindle. Officials hope the new 16,000 acre-foot lake will help Parker solve two intractable problems: how to reduce pumping of limited groundwater during the peak summer season and how to maximize the use of water pumped from deep aquifers in the Denver Basin. In a transaction known as a "water exchange," the new reservoir will allow Parker to capture an amount of water equal to what it discharges from its wastewater plant. The water will be drawn from eight new wells to be drilled along Cherry Creek. Under state law, water pumped from deep underground can be used repeatedly until it is gone. By contrast, river water can be used only once before it must be released to flow downstream. The basin, which covers 6,700 square miles and reaches from Greeley to Colorado Springs, is made up of four unconnected aquifers arranged like stacked bowls. The Rueter-Hess Reservoir also would be filled with water that Parker already pumps from shallow wells along Cherry Creek, with seasonal water from Newlin Gulch, and with water diverted directly from Cherry Creek during wet years. The Army Corps estimates the amount of water that Parker could rely on from the reservoir each year would be just over 4,000 acre-feet - or enough to supply 8,000 families for a year. A big unknown is how long it will take for the lake to fill once the dam is completed - around 2007.

Denver Post / March 12, 2004

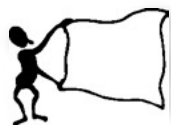
Wetlands

SMS students partner with Frisco on wetlands project

The town of Frisco wanted to explain the value of wetlands to locals and visitors at Willow Preserve, a piece of land recently acquired as open space with money from Great Outdoors Colorado. The town turned to Summit Middle School students, a class of English Language Learners, to develop a concept for interpretive signs along a proposed 1,500-foot gravel trail through the parcel. "We think they did a great job, and we were very excited to partner with Summit Middle School to do a collaborative project like this," said Jocelyn Mills, Frisco's senior planner.

Summit Daily News / February 12, 2004

(Denver, CO) - The Awwa Research Foundation, a non-profit organization dedicated to advancing the science of drinking water, announced today that proposals are requested for 21 research projects scheduled to be launched in 2004. The projects, with more than \$6 million in funding available, focus on a wide range of topics related to the drinking water community. The Requests for proposals (RFPs) for the projects are available on the Foundation's Web site at www.awwarf.org.



CALLS FOR PAPERS



INTERNATIONAL SALINITY FORUM
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Seawater Intrusion and Saltwater Encroachment	Salton Sea and Other Closed Basins
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Regional Watershed/Basin Management Strategies	Dryland Salinity
Rangeland Salinity	Brackish and Saline Waters – Use and Disposal
Waste Water (Sewage) Re-use	Reclamation of Saline/Sodic Soils
Plant Salt Tolerance and Breeding	Plant Crop Responses to Salinity
Environmental Impacts and Mitigation	

Abstract template and information available at this website: <http://www.waterresources.ucr.edu> Click on: News/Events

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MEETINGS

Integrated Decision Support Consumptive Use Model
 One Day Training Course
 May 18, 2004 Colorado State University

The Integrated Decision Support Group at Colorado State University will conduct a one day hands-on training course on the use of the Integrated Decision Support Consumptive Use Model (IDS CU). This model was developed as part of the South Platte Mapping and Analysis Program (SPMAP), a collaborative effort between IDS and water users in the South Platte. The model is completely data driven and is being used around Colorado. This training course will instruct users on how to create and use templates to develop data sets; create and use diversion records from HYDROBASE; and access weather data from HYDROBASE, COAGMET, and NCWCD. Participants will learn how to use the IDS CU Model's forecasting features to evaluate future scenarios. Participants will be shown how to create and use Access data tables to generate input for the model. Computing a detailed water budget with the model will also be explained. Other features of the model that will be discussed include: 1) the ability of the model to compare CU values computed using different ET methods, and 2) evaluating the application efficiencies of wells by comparing depletions of groundwater computed using a water budget with pumping records multiplied by a presumptive depletion factor. The training course will end with a brief introduction on how the depletions of groundwater can be exported to two models developed by IDS for calculating river depletions, SDFView and IDS AWAS. The training course will be conducted on May 18 at Colorado State University. The cost of the registration is \$125. You can obtain more information and register at www.ids.colostate.edu. Course registration will be limited due to the availability of computers for the hand-on training.



Register for the Upper Colorado River Basin Tour
June 23-25, 2004

Start the summer off right. Experience the Upper Colorado River firsthand. Listen to expert speakers discuss the latest issues in water management, and meet new peers and colleagues. Join the Colorado Foundation for Water Education as it presents the first Upper Colorado River Basin Tour, June 23 – 25, 2004. “Whether your job is in engineering, law, science, or politics, there is no substitute for getting out into the field and touring the river, talking to the people whose lives and livelihoods rely on these resources, and listening to their concerns,” says Karla Brown, CFWE executive director. “From the headwaters to the Utah line, this tour is designed to increase your technical knowledge and practical appreciation of this vitally important watershed.”

COSTS and REGISTRATION -- Tour registration costs are all-inclusive, covering tour transportation and lodging, meals, all activities and background materials.

Early registration (Friday, April 16, 2004):
\$495 single occupancy*
\$395 single occupancy*

Late registration (Monday, May 3, 2004):
\$550 single occupancy*
\$450 double occupancy*

For registration forms: Call the CFWE office at (303) 377-4433; or Download a printable form at www.cfwe.org. *As usual, membership discounts are available.

SCHOLARSHIPS -- The Colorado Association of Conservation Districts is sponsoring seven tour seats for state legislators. For details contact Callie Hendricks with CACD at (303) 232-6242, (970) 858-8560 or callie@cacd.us.

CAN'T ATTEND THE ENTIRE TOUR? -- Contact Young Hee Kim at (303) 377-4433 or youngk@cfwe.org to find out how to participate in our evening social events scheduled for June 23 in Keystone and June 24 in Glenwood Springs.

Upper Colorado River Basin Tour Sites and Topics

Wednesday, June 23 – Urban Water Supply

Dillon Reservoir
Farr Pumping Plant (Colorado-Big Thompson Project)
Wolford Reservoir
Town of Heeney and
Green Mountain Reservoir

Additional topics: Upper Colorado River Project, Northern Colorado Water Conservancy District programs, Middle Park Conservation District programs

Colorado River Water Conservation District programs
Rafting – Colorado River
Shoshone Hydropower Plant (optional)

Additional topics: Instream flows, Snowmaking, Recreational in-channel diversions, SnowTel sites, Mining and water quality

Thursday, June 24 – Recreational Water Use

Clinton Reservoir
Vail Whitewater Park

Additional topics: Noxious weeds, tamarisk removal efforts, Endangered fish habitat recovery program, Salinity and selenium water quality issues, Learn to set a siphon tube.

Friday, June 25 – Agricultural Water Use

Cross Orchards – Histories of Grand Valley agriculture
Colorado State University, Fruita Research Center

2004 WATER WELL TESTING CLASS -- May 5-7, 2004

The Colorado Division of Water Resources is planning a workshop/class on Water Well Testing intended for well drillers, pump installers and other persons interested in performing water well measurement tests pursuant to Well Measurement Rules of the State Engineer for the Arkansas River Basin, Designated Ground Water Basins, and for well measurement programs in other areas of the State. The class will be held in Pueblo May 5-7, 2004. The cost of the class is \$250 for three days of classroom instruction and field exercises. The class is designed to give an overview of groundwater hydrology, well hydraulics, water measurement methods, methods of collecting and analyzing data for determining power coefficients, well efficiency, system head considerations, reporting requirements, totalizing flow meter verification and more. Attendees will be allowed to take a test at the end of the class to obtain Division of Water Resources approval as a water well tester. Interested individuals may respond to be placed on the mailing list to receive the upcoming formal announcement and registration packet by writing Ms. Janet Kuzmiak, at the Colorado Division of Water Resources, 310 E. Abriendo Ave, Suite B, Pueblo, Colo. 81004 or by e-mail at janet.kuzmiak@state.co.us or by telephone at 719-542-3368 x 2101.



COLORADO WATER CONGRESS
Meeting Notices & Agendas

COLORADO WATER CONGRESS WORKSHOP SCHEDULE

The Colorado Water Congress prepares a series of six-ten workshops each year for the purpose of increasing and updating water knowledge both for the actively involved water community and general public knowledge. Workshops will all be held in the Colorado Water Congress Conference Room, 1580 Logan Street, Suite 400, Denver, Colorado. CLE credits are typically given for these workshops.

Colorado Water Law Seminar – September 20-21, 2004

2004 Summer Convention, August 26-27, 2004
Silver Tree Resort in Snowmass Village, Aspen, Colorado

For programs and registration forms in Word and PDF see the website at <http://www.cowatercongress.org>
or email macravey@cowatercongress.org

47th CWC Annual Convention, January 27-28, 2005
DIA Hotel and John Q. Hammonds Convention Center
15500 East 40th Ave., Denver, Colorado



2004 INTERNATIONAL SYMPOSIUM ON SOCIETY
& RESOURCE MANAGEMENT : Past and Future
Keystone, Colorado
June 2-6, 2004

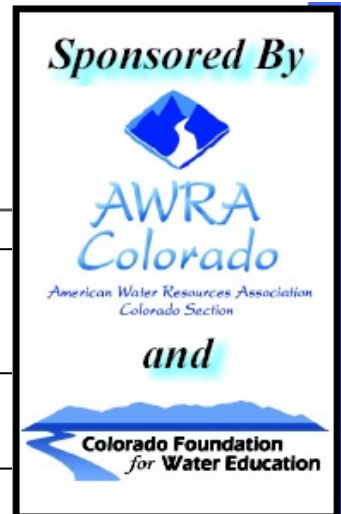
ISSRM will mark its 10th anniversary in 2004. Since the first ISSRM at Oregon State in 1986, this conference has emerged as the most prominent recurring international conference addressing the human dimensions of natural resource management. The 2004 ISSRM will be organized by subject themes that have appeared on a recurring basis during previous ISSRM meetings. To highlight each topic area, the symposium organizers have invited summary-of-knowledge papers from past symposia participants. These papers will be published as an edited book that will be distributed at the symposium. Furthermore, presentations of these papers will be presented at various times during the symposium.

Subject Themes / Summary of Knowledge Areas -- The 2004 ISSRM will build on work and research presented at previous ISSRM meetings, and coincide with a book that provides a summary of knowledge on each of the following themes:

- Social Sciences in Natural Resource Management: topics include philosophical perspectives, conservation psychology, global perspectives of natural resources, culturally diverse perspectives, changes in the profession, and others.
- Elements of Policy-Making, Planning and Management: topics include policy and planning frameworks, social impact assessment, environmental communications, recreation planning, and others.
- The Era of Participatory Democracy: topics include collaborative resource management, partnerships, and public involvement.
- Social Science Perspectives within the Multiple Resources: topics include social aspects of agriculture, coastal and watershed management, human dimensions of wildlife, human dimensions of fisheries, social aspects of forest and range management, and conflict.
- Enduring Conceptual Approaches and Methodological Issues: topics include human ecology, normative approaches to natural resource management, economics of natural resources, depreciative behavior, landscape aesthetics, community concept, wildland-urban interface and environmental psychology.

For additional information visit the website www.cnr.colostate.edu/2004ISSRM/.

Interstate Compacts and Treaties: Then and Now
 AWRA 2004 Annual Symposium
 Friday, April 30th, 2004
 Arvada Center, 6901 Wadsworth Blvd., Arvada



8:00 a.m.	Registration and Continental Breakfast
8:30 a.m.	Introduction and Welcome Beorn Courtney – President, AWRA Colorado Section Introduction of new officers and board members and opening remarks.
8:45 a.m.	Keynote Speaker -- Honorable Gregory Hobbs Justice, Colorado Supreme Court Brief history, introduction of compacts, and general background.
9:15 a.m.	PANEL DISCUSSION The Making of the Compacts and Issues Relating to Compacts Moderator: Jim Lochhead – Attorney, Brownstein Hyatt & Farber Panelists: Dan Tyler – CSU Professor Emeritus of History/Author of Silver Fox of the Rockies Hal Simpson – Colorado State Engineer, Colorado Division of Water Resources Rod Kuharich – Director, Colorado Water Conservation Board Carol Angel – Assistant Attorney General, Colorado Attorney General’s Office
10:30 a.m.	BREAK
Session A1 – Compact Administration -- Moderator: Don Carlson – Planning and Environmental Services, NCWCD	
10:45 a.m.	Arkansas River Basin – Where We’ve Been and Where We’re Going Steve Witte – Division 2 Engineer, Colorado Division of Water Resources
11:05 a.m.	Tribal Reserved Water Rights Scott McElroy – Attorney, Greene, Meyer & McElroy, P.C.
11:25 a.m.	Transbasin Diversions and Compact Compliance (Cameo & Shoshone Calls) Eric Kuhn – General Manager/Secretary, Colorado River Water Conservation District
11:45 a.m.	BUFFET LUNCHEON -- David W. Robbins – Attorney, Hill and Robbins, P.C. Overview of previous lawsuits, today’s relevant issues, and a glimpse into the future.
BREAKOUT SESSIONS	
Session B1 – Endangered Species and Water Quality -- Moderator: Peter Gowen – Attorney, Peter J. Gowen, P.C.	
1:30 p.m.	Colorado River Basin – Recovery Program and Salinity Control Program Dave Merritt – Chief Engineer, Colorado River Water Conservation District
1:50 p.m.	Rio Grande Basin – Interstate Compact and ESA Issues Steve Vandiver – Division 3 Engineer, Colorado Division of Water Resources
2:10 p.m.	South Platte River Basin – Three States Agreement Alan Berryman – Colorado Water Users Representative on the Platte River Recovery Program Governance Committee/Head of Engineering Branch, NCWCE
Session B2 – Water Supply and Development -- Moderator: Mike McHugh – Water Consultant, New West Environmental, LLC	
1:30 p.m.	Future Well Use in the Republican Basin Ken Knox – Chief Deputy State Engineer, Colorado Division of Water Resources
1:50 p.m.	Statewide Water Supply Initiative Progress Report Rick Brown – SWSI Project Manager, Colorado Water Conservation Board
2:10 p.m.	Water and Growth in Colorado Peter Nichols – Attorney, Trout, Witwer & Freeman, P.C.
2:30 p.m.	BREAK
2:45 p.m.	PANEL DISCUSSION AND WORKSHOP -- The Future in Light of the Compacts Facilitator: Karla Brown – Executive Director Colorado Foundation for Water Education Panelists: James Broderick – General Manager, Southeastern Colorado Water Conservancy Dist. David Getches – Professor and Dean, University of Colorado School of Law Russel George – Executive Director, Colorado Department of Natural Resources Jim Lochhead – Attorney, Brownstein, Hyatt & Farber Dan Luecke – Hydrologist and Environmental Scientist

Meeting Schedule -- Open to the Public
Rocky Mountain AWWA Water Conservation Committee
Colorado Water Wise Council

Date	Time	Location	Speaker(s)	Topic
Thurs., June 10	11:30 a.m.- 2:00 p.m.	TBD	Betty Solek, City of Boulder	Water Quality and Water Conservation Partnership
Thurs., Sept. 9	11:30 a.m.- 2:00 p.m.	Aurora Municipal Bldg., 15151 E. Alameda Pkwy., Aspen Conference Room (2nd floor)	Natalie Brower-Kirton, City of Aurora	City of Aurora's Xeriscape Demonstration Garden
Thurs., Nov. 4	11:30 a.m.- 2:00 p.m.	Denver Water Board Room (3rd Floor)	Larry Keesen, Keesen Irrigation	New Irrigation Technology: Benefits and Chal- lenges (sursurface irrigation, ET-Controllers, soil moisture sensors)

For information contact: Laurie D'Audney at ldaudney@fcgov.com

“Getting To Know Rural Properties”
& “Wells – Are They a Dependable Water Supply?”
Forthcoming Educational Programs – April 14 and May 11, 2004

The Colorado State University Cooperative Extension Offices in Adams and Boulder Counties, along with the Colorado Water Well Contractors Association, will host “Getting To Know Rural Properties,” a program designed for Realtors and Appraisers and others who work with rural properties. The primary rural property size to be addressed is 2.5 to 80-acre sites. The program will be held in Boulder at the Boulder County Clerk and Records Meeting room on April 14. Topics to be addressed include Colorado Water Law and History, Water and Your Right to Use it, Septic Systems and Well Maintenance, Mineral, Gas and Petroleum rights, Zoning Requirements in the two counties, Livestock Regulations, including Carrying Capacity and Fencing, and Weed Law and Regulations. Eight hours of Continuing Education will be offered for both Realtors and Real Estate Appraisers. The cost of this program will be \$100, which includes lunch, breaks, resource packet and certificate of completion. For further information regarding registration please contact Bob Hamblen at 303-776-4865 or Tom McBride at 303-637-8110. Registration will be limited to the first 100 registrants.

The May 11, 2004, program, “Wells – Are They a Dependable Water Supply?”, is sponsored by the Colorado Water Well Contractors Association (CWWCA), the Colorado Division of Water Resources (DWR) and the CSU Cooperative Extension Offices in Adams and Boulder Counties. This daylong educational program is designed for the North Denver Metro, Boulder and Longmont area. The emphasis will be on small-capacity wells serving domestic or household purposes. The meetings will provide a forum for well drillers, pump installers, engineers, geologists, realtors, planners, sanitarians, attorneys and DWR staff to discuss updated information on obtaining well permits, constructing wells in compliance with current rules and satisfying local county rules on the use of wells and septic systems. The meeting will be held in the Louisville Recreation Center in Louisville, Colorado. Attendance will be limited to 150 registrants on a first come basis. The anticipated cost will be less than \$100, including lunch, breaks and handout materials. The meetings will qualify for continuing education credits for realtors, appraisers, water treatment plant operators and lawyers. Mark your calendars now! For further information contact CWWCA at 8674 West Warren Drive, Lakewood, CO, 80227, phone 303-986-5035, fax 303-986-8375, e-mail office@cwvca.org.

CALENDAR



April 30	INTERSTATE COMPACTS AND TREATIES: THEN AND NOW, AWRA 2004 Annual Symposium, Arvada, CO. Contact: Beorn Courtney at 303/455-9589.
May 11	WELLS - ARE THEY A DEPENDABLE WATER SUPPLY?, Louisville, CO. Contact CWWCA at 8674 West Warren Drive, Lakewood, CO, 80227, phone 303-986-5035, fax 303-986-8375, e-mail office@cwvca.org .
May 12-13	BEST MANAGEMENT PRACTICES AND ADAPTIVE MANAGEMENT IN OIL AND GAS DEVELOPMENT, Boulder, CO. Free workshop. Contact: NRLC by phone 303/492-1286, email NRLC@colorado.edu , or see website at http://www.colorado.edu/law/centers/nrlc/events.htm .
May 12-14	ROCKY MOUNTAIN REGIONAL LAKE AND RESERVOIR MANAGEMENT CONFERENCE, “LAKES AND RESERVOIRS: THE AQUATIC ‘GOLD’ OF THE WESTERN LANDSCAPE, Sheraton Denver West Hotel, Denver, CO. See the website at www.clrma.org , or contact Sharon Campbell at sharon_g_campbell@usgs.gov .

May 17-19	AWRA Spring Specialty Conference, GIS AND WATER RESOURCES III, Nashville, TN. For information see the website at www.awra.org .
May 17-20	BUILDING AND SUSTAINING SUCCESSFUL MONITORING PROGRAMS, Chattanooga, TN. For information see the NWQMC website at www.nwqmc.org .
May 18	IDS CU ONE-DAY TRAINING COURSE, CSU, Fort Collins, CO. See the IDS website at www.ids.colostate.edu .
May 18	1ST WEF/AWWA STUDENT CONFERENCE, Golden, CO. Contact: Tanya Rauch, Conference President, at phone 303/384-2445, FAX 303/273-3413, or email trauch@mines.edu .
June 2-6	2004 INTERNATIONAL SYMPOSIUM ON SOCIETY & RESOURCE MANAGEMENT : Past and Future, Keystone, CO. For additional information visit the website www.cnr.colostate.edu/2004ISSRM/ .
June 10	WATER QUALITY AND WATER CONSERVATION PARTNERSHIP, Boulder, CO. Contact: Laurie D'Audney at ldaudney@fcgov.com .
June 13-17	AWWA ANNUAL CONFERENCE AND EXPOSITION: ONE WORLD, ONE WATER, Orlando, FL. For information on the conference and registration, visit www.awwa.org/ace2004 or call toll-free 1-800-926-7337.
June 15-18	EPA 2004 COMMUNITY INVOLVEMENT CONFERENCE AND TRAINING, Denver, CO. for information visit the website at www.epancic.org/2004 .
June 16-18	GROUNDWATER IN THE WEST -- 25TH SUMMER CONFERENCE, Boulder, CO. Contact NRLC by phone 303/492-1286, email NRLC@colorado.edu , or see website at http://www.colorado.edu/law/centers/nrlc/events.htm .
June 23-25	COLORADO FOUNDATION FOR WATER EDUCATION'S 1ST ANNUAL UPPER COLORADO RIVER BASIN TOUR, Keystone, CO. For tour details visit www.cfwe.org or contact Young Hee Kim at 303/377-4433, youngk@cfwe.org .
Aug. 26-27	COLORADO WATER CONGRESS 2004 SUMMER CONVENTION, Aspen, CO. See the website at www.cowatercongress.org , phone 303/837-0812, email macravey@cowatercongress.org .
Sept. 26-29	DAM SAFETY 2004, Phoenix, AZ. Assoc. of State Dam Safety Officials, phone 859/257-5140, FAX 859/323-1958, E-mail info@damsafety.org .
July 20-22	UCOWR/NIWR 2004 ANNUAL CONFERENCE, Portland, OR. Contact: Gary Johnson, Idaho Water Resources Research Institute, Phone 208/282-7985, E-mail johnson@if.uidaho.edu ; or Ari Michelsen, Texas A&M, phone 915/859-9111 or E-mail a-michelsen@tamu.edu . Website: www.uwin.siu.edu/ucowr .
July 28-30	29th COLORADO WATER WORKSHOP, Western State College, Gunnison, CO. See the website at www.western.edu/water/ .
Sept. 9	CITY OF AURORA'S XERISCAPE DEMONSTRATION GARDEN, Aurora Municipal Bldg., Aurora, CO. Contact: Contact: Laurie D'Audney at ldaudney@fcgov.com .
Sept. 20-21	COLORADO WATER LAW SEMINAR, Denver, CO. See the website at www.cowatercongress.org , phone 303/837-0812, email macravey@cowatercongress.org .
Sept. 26-29	DAM SAFETY 2004, Phoenix, AZ. Contact: Assn. of State Dam Safety Officials, Phone 859/257-5140, FAX 859/323-1958, Email info@damsafety.org , website www.damsafety.org .
Oct. 10-13	CONFERENCE ON TAILINGS AND MINE WASTE '04, Fort Collin, CO. Contact: Linda Hinshaw, Dept. of Civil Engr., CSU, Phone 970/491-6081, FAX 970/491-3584, email lhinshaw@engr.colostate.edu .
Oct. 13-16	WATER RIGHTS & RELATED WATER SUPPLY ISSUES, Salt Lake City, UT. See the USCID website at www.uscid.org/oridcall.html .
Nov. 4	NEW IRRIGATION TECHNOLOGY: Benefits and Challenges, Denver Water Board Room, Denver, CO. Contact: Laurie D'Audney at ldaudney@fcgov.com .

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

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**Appendix to Justice Hobbs Article,
C.S.U. Water Resources Institute Newsletter
Groundwater Forum Issue April 2004**

(Excerpts from *Park County Sportsmen's Ranch*, 45 P.3d 693 (2002); *Colorado's 1969 Adjudication And Administration Act: Settling In*, 3 U. Denv. Water L. Rev. 1 (1999); *Empire Lodge*, 39 P.3d 1139 (2001); *Simpson v. Bijou*, 69 P.3d 50 (Colo. 2003))

***Colorado Breaks From The Common Law
of Surface Water and Groundwater
(from Park County Sportsmen's Ranch)***

Colorado law differs fundamentally from the English common law it replaced. The English case of Acton v. Blundell, 12 Mees. & W. 324, 152 Eng. Rep. 1223 (1843) set forth the common-law rule of surface streams and ground water, based on Roman precedent. Enjoyment of the flowing surface stream was a riparian right of property owners whose land abutted the stream:

The rule of law which governs the enjoyment of a stream flowing in its natural course over the surface of land belonging to different proprietors is well established; each proprietor of the land has a right to the advantage of the stream flowing in its natural course over his land, to use the same as he pleases, for any purposes of his own, not inconsistent with a similar right in the proprietors of the land above or below; so that, neither can any proprietor above diminish the quantity or injure the quality of the water which would otherwise naturally descend, nor can any proprietor below throw back the water without the license for the grant of the proprietor above.

Acton, 12 Mees. & W. at 348-49, 152 Eng. Rep. at 1233. In contrast to the surface stream, so the court declared, ground water moves "through the hidden veins of the earth beneath its surface; no man can tell what changes these underground sources have undergone in the progress of time." Id. at 350, 152 Eng. Rep. at 1233. The court then held that ground water was not governed by the law that applies

to rivers and flowing streams; rather, it was subject to the *cujus* doctrine. The court asserted that ground water:

falls within that principle, which gives to the owner of the soil all that lies beneath his surface; that the land immediately below is his property, whether it is solid rock, or porous ground, or venous earth, or part soil, part water; that the person who owns the surface may dig therein, and apply all that is there found to his own purposes at his free will and pleasure; and that if, in the exercise of such right, he intercepts or drains off the water collected from underground springs in his neighbour's well, this inconvenience to his neighbour falls within the description of *damnum absque injuria*, which cannot become the ground of an action.

Id. at 354, 152 Eng. Rep. at 1235; see also Roath v. Driscoll, 20 Conn. 533, 541 (1850).

Advancing the national agenda of settling the public domain required abandonment of the pre-existing common-law rules of property ownership in regard to water and water use rights.¹ Reducing the public land and water to possession and ownership was a preoccupation of territorial and state law from the outset.² A new law of custom and usage in regard to water use rights and land ownership rights, the “Colorado Doctrine,” arose from “imperative necessity” in the western region.

This new doctrine established that: (1) water is a public resource, dedicated to the beneficial use of public agencies and private persons wherever they might make beneficial use of the water under use rights established as prescribed by law; (2) the right of water use includes the right to cross the lands of others to place water into, occupy and convey water through, and withdraw water

¹ Congress carved the Western states from property of the United States acquired through the 1803 Louisiana Purchase, the 1846 Oregon Compromise, and the 1848 Treaty of Guadalupe Hidalgo. Loren L. Mall, Public Land and Mining Law 7-8 (3d ed. 1981).

² For example, Colorado defined “any right to occupy, possess and enjoy any portion of the public domain” as “a chattel real possessing the legal character of real estate.” Act of November 7, 1861, § 1, 1861 Colo. Sess. Laws 168, 168; § 36-2-101, 10 C.R.S. (2001). This was a departure from the common-law concept of “naked possession” that the Colorado Supreme Court termed “remarkable.” Gillett v. Gaffney, 3 Colo. 351, 358 (1877); see Bd. of County Comm’rs v. Vail Assocs., 19 P.3d 1263, 1269 n. 8 (Colo. 2001).

from the natural water bearing formations within the state in the exercise of a water use right; and (3) the natural water bearing formations may be used for the transport and retention of appropriated water. This new common law established a property-rights-based allocation and administration system which promotes multiple use of a finite resource for beneficial purposes. Empire Lodge Homeowners' Ass'n v. Moyer, 39 P.3d 1139, 1146-47 (Colo. 2001).

When first announcing the Colorado Doctrine, we said that “rules respecting the tenure of private property must yield to the physical laws of nature, whenever such laws exert a controlling influence.” Yunker v. Nichols, 1 Colo. 551, 553 (1872) (Hallett, C.J.).

When the lands of this territory were derived from the general government, they were subject to the law of nature, which holds them barren until awakened to fertility by nourishing streams of water, and the purchasers could have no benefit from the grant without the right to irrigate them. It may be said, that all lands are held in subordination to the dominant right of others, who must necessarily pass over them to obtain a supply of water to irrigate their own lands, and this servitude arises, not by grant, but by operation of law.

Yunker, 1 Colo. at 555. Commenting on the 1861 Territorial Act, Justice Wells, in Yunker, confirmed this principle:

I conceive that, with us, the right of every proprietor to have a way over the lands intervening between his possessions and the neighboring stream for the passage of water for the irrigation of so much of his land as may be actually cultivated, is well sustained by force of the necessity arising from local peculiarities of climate But it appears to me that this right must rest altogether upon the necessity rather than upon the grant which the statute assumes to make. . . .

It seems to me, therefore, that the right springs out of the necessity, and existed before the statute was enacted, and would still survive though the statute were repealed.

Id. at 570 (Wells, J., concurring).³

We followed Yunker's lead with Coffin v. Left Hand Ditch Co., 6 Colo. 443 (1882), holding that an appropriator could capture water from a stream and transport it to another watershed, using streams in both watersheds to convey the appropriated water to its place of beneficial use:

The doctrine of priority of right by priority of appropriation for agriculture is evoked, as we have seen, by the imperative necessity for artificial irrigation of the soil.^[4] And it would be an ungenerous and inequitable rule that would deprive one of its benefit simply because he has, by large expenditure of time and money, carried the water from one stream over an intervening watershed and cultivated land in the valley of another.

Coffin, 6 Colo. at 449.

Accordingly, by reason of Colorado's constitution, statutes, and case precedent, neither surface water, nor ground water, nor the use rights thereto, nor the water-bearing capacity of natural formations belong to a landowner as a stick in the property rights bundle. Section 37-87-103, 10 C.R.S. (2001), for example, codifies this longstanding aspect of the Colorado Doctrine. It provides that water appropriated by means of a reservoir impoundment and then released for travel to its place of beneficial use shall enjoy the right of passage through the natural formation in the administration of water use rights.

In State v. Southwestern Colorado Water Conservation District, we cited the McCarran Amendment's Senate Report in support of the state's authority to depart from the preexisting common law in enunciating the principles of the Colorado Doctrine:

³ Commentators have noted the striking departure from the common-law riparian and *cujus* doctrines for surface and ground water which Colorado effectuated in contrast to the rule enunciated in Acton v. Blundell, 12 Mees. & W. 324, 152 Eng. Rep. 1223 (1843). See Charles E. Corker, Groundwater Law, Management and Administration 103 (National Water Commission October 1971); A. Dan Tarlock, Law of Water Rights and Resources § 3.3, at 3-4 to 3-6; § 4.6, at 4-6; § 5.8, at 5-12 to 5-14 (West 2001).

⁴ In 1903, Colorado extended its adjudication law to all beneficial uses. Empire Lodge, 39 P.3d at 1149.

[I]n the arid Western States, for more than 80 years, the law has been that the water above and beneath the surface of the ground belongs to the public, and the right to the use thereof is to be acquired from the State in which it is found, which State is vested with the primary control thereof.

State v. Southwestern Colo. Water Conservation Dist., 671 P.2d 1294, 1307 (Colo. 1983) (emphasis added); see also Roaring Fork Club, L.P. v. St. Jude's Co., 36 P.3d 1229, 1231-32 (Colo. 2002) (stating that “as early as the tenure of the territorial legislature, our lawmakers recognized that our arid climate required the creation of a right to appropriate and convey water across the land of another so that lands not immediately proximate to water could be used and developed”); Safranek v. Town of Limon, 123 Colo. 330, 336, 228 P.2d 975, 978 (1951) (stating that “[w]e have long since departed from the English common-law doctrine of ownership of percolating waters by the surface owner”); Southwestern, 671 P.2d at 1316 (overruling Whitten v. Coit, 153 Colo. 157, 385 P.2d 131 (1963), to the extent that Whitten had been previously understood to recognize in a landowner an interest in nontributary water coextensive with right of ownership of other interests in real property); Colo. River Water Conservation Dist. v. Colo. Water Conservation Bd., 197 Colo. 469, 474, 594 P.2d 570, 573 (1979) (stating that Colorado abolished the riparian water law doctrine).

Tributary Groundwater Hydrology

Legislators, administrators, and judges generally have a better understanding of surface water systems than ground water systems. See Robert Jerome Glennon & Thomas Maddock, The Concept of Capture: The Hydrology and Law of Stream/Aquifer Interactions, Forty-Third Annual Rocky Mountain Mineral Law Institute § 22.02, at 22-7 (1997). Some states that allocate their surface water by the principles of prior appropriation nevertheless allocate ground water by a rule of capture that permits overlying landowners to possess the ground water appearing under their land without regard to the effect

of its extraction upon other ground water and surface water users. However, such a rule of capture defies hydrologic reality⁵ and impairs the security and reliability of senior water use rights that depend on an interconnected ground and surface water system. Colorado law contains a presumption that all ground water is tributary to the surface stream unless proved or provided by statute otherwise.⁶ Safranek v. Town of Limon, 123 Colo. 330, 334, 228 P.2d 975, 977 (1951).

An aquifer is a subsurface water bearing formation. Hydrologic continuity exists if there is a hydrologic connection between a surface stream and the water table of an aquifer. Glennon & Maddock, supra, at 22-7 to 22-8. The water moves through a shared, permeable layer. Ground water, in an interconnected hydrologic system, provides a base flow⁷ for surface streams through the saturated layer of the water bearing formation. Water added to a ground water system can increase the flow of the surface stream; conversely, well pumping that results in lowering the water table can deplete the surface stream.

Aquifers consist of unsaturated and saturated zones. The unsaturated zone contains both air and water in the spaces between the grains of sand, gravel, silt, clay, and cracks within the rock. See Ground Water and Surface Water, A Single Resource, U.S. Geological Survey Circular 1139, at 6 (1999) [hereinafter USGS]. The movement of water in the unsaturated zone above the water table is controlled by gravity and capillary forces. Georg Matthes, The Properties of Groundwater 173 (1982). In the saturated zone, these voids are completely filled with water. USGS at 6. The upper surface of the saturated zone is the water table. Id. Water that infiltrates the land surface moves vertically downward through unsaturated areas to the water table to become ground water. Once

⁵ This is a common sentiment expressed by legal commentators. One article states:
The law in many states has not kept pace with the advances in the science of hydrology. Many states have developed entirely separate systems for regulating ground and surface water, even though there are often physical connections between the two and capture processes are occurring. The consequence is a set of legal rules that fails to conform to physical reality.

Glennon & Maddock, supra, § 22.02, at 22-14.

⁶ Pursuant to Colorado law, designated ground water, non-tributary ground water, and Denver Basin ground water are allocated and administered under a system that differs from the allocation and administration of the natural stream system. See generally Upper Black Squirrel Creek Ground Water Mgmt. Dist. v. Goss, 993 P.2d 1177 (Colo. 2000).

⁷ Base flow is “the slow time response component of streamflow.” Glennon & Maddock, supra, at 22-7.

the water has infiltrated the soil, its passage downward to join the ground water depends on the geologic structures and rock composition. See Elizabeth M. Shaw, Hydrology in Practice 124 (2d. ed. 1989). Storativity can be calculated for confined and unconfined aquifers. Id. at 128. The ground water typically moves laterally within the ground water system. USGS at 7. Well pumping creates a cone of depression, with the point of the inverted cone occurring at the bottom of the well pipe. This causes surrounding water in the aquifer to flow into the cone from all sides. See Fellhauer v. People, 167 Colo. 320, 331, 447 P.2d 986, 992 (1968).

The interaction between streams and tributary aquifers occurs in three basic ways: streams gain water from inflow of ground water into the surface stream, streams lose water to the aquifer from outflow from the stream, or do both by gaining water from aquifers in some reaches and losing it to aquifers in other reaches. USGS at 9. Without human intervention, the surface/ground water interconnected system “exists in a state of approximate equilibrium” which implies “a long-term balance between natural recharge and discharge processes in a groundwater basin.” Glennon & Maddock, supra, at 22-10.

“Recharge,” whether natural or artificial, is “the accretion of water to the upper surface of the saturated zone.” USGS at 6. “Discharge” is the contribution of aquifer water that migrates to the surface. Id. “Storage” is the retention of ground water in the aquifer for a temporal period. The length of the retention time depends upon the specific characteristics of the aquifer:

Aquifers have two main functions in the underground phase of the water cycle. They store water for varying periods in the underground reservoir, and they act as pathways or conduits to pass water along through the reservoir. Although some are more efficient as pipelines (e.g., cavernous limestones) and some are more effective as storage reservoirs (e.g., sandstones), most aquifers perform both functions continuously.

John C. Manning, Applied Principles of Hydrology 156 (1987). Hydrologists and commentators refer to the entire zone of saturation as a “groundwater reservoir”:

While the entire zone of saturation is referred to as the groundwater reservoir, it is seldom a single, homogeneous geologic formation. Usually a variety of rock types are present at any given location, and even though they may all be saturated, they often have widely varying hydrologic properties. Some would be called aquifers and others would not. The term aquifer comes from two latin words – aqua, meaning water, and ferre, to bear.

To be called an aquifer, a geologic formation must be porous and permeable. It must store, transmit, and yield significant amounts of water to springs and wells.

Id. at 148 (emphasis in original).

The extent of underground storage available for artificial recharge without interfering with the aquifer's natural recharge capacity or injuring senior ground or surface water rights is a central issue in any proposal to use an aquifer for artificial recharge and storage. See Ella Foley-Gannon, Institutional Arrangements for Conjunctive Water Management in California and Analysis of Legal Reform Alternatives, 6 Hastings W.-Nw. J. Env'tl. L. & Pol'y 273, 274-75 (2000).

Because the physical characteristics of groundwater basins vary greatly, the suitability of a particular basin to serve as an area for immediate storage and later extraction depends on its hydrological and geological features, as well as on the quality of the water stored within the basin.

Id. at 277. Some aquifers may be more suitable for storage of artificially recharged water than others. Id. at 278-79.

Integrating Ground Water and Surface Water (from 1969 Act Article)

Colorado water law has taken shape in the interaction between the water users, their advocates, the judiciary, the legislature, and the water officials. Opinions of the Colorado Supreme Court often planted the seed. How to address tributary groundwater in the

absence of legislative direction, for example, became a groundbreaking question. In 1951, the court established in *Safranek* a presumption that all ground water which finds “its way to the stream in the watershed of which it lies, is tributary thereto, and subject to appropriation as part of the waters of the stream.”⁸

In response to emerging groundwater issues, the General Assembly chose to focus first on the problem of aquifer depletion in the Eastern high plains. In 1957, it established a Ground Water Commission, required registration of existing wells with the state engineer, and required application for a state engineer permit for a new well or an existing well.⁹ Subsequently, the court: (1) determined that the Ground Water Commission was empowered to declare and regulate “critical ground water districts” in order to limit overdraft of aquifers; (2) restricted the state engineer’s authority to that of regulating the drilling and construction of wells to prevent waste; (3) determined that it had no authority to adjudicate rights to non-tributary groundwater; and (4) determined that the state engineer had no power to administer non-tributary groundwater.¹⁰

In a 1961 decision, the court observed the dearth of legislation governing the adjudication and administration of tributary groundwater. It nevertheless asserted a judicial responsibility to protect “relative priorities” of waters of the natural stream “whether visible or not” and “even though they have never been made the subject of a statutory adjudication.”¹¹ The case involved competing well users drawing water from the same tributary aquifer. The court held that each must effectuate a reasonable means of diversion and that no one could command the whole source of the supply merely to facilitate taking a fraction of the flow. But, it also held that junior users might be required to bear the expense of seniors whose historical diversions were reasonably efficient but whose wells must now reach deeper as a result of the junior’s use.¹²

In 1965, the General Assembly acknowledged and acted on the court’s cue that the state should administer surface water and tributary groundwater together. However, it did not revise the adjudication framework to assist in meeting this goal. Instead, it directed the state engineer to “execute and administer the laws of the

8. *Safranek v. Town of Limon*, 228 P.2d 975, 977 (Colo. 1951).

9. See Act of May 1, 1957, ch. 289, §§ 3, 5, 1957 Colo. Sess. Laws 863, 863-69.

10. *Whitten v. Coit*, 385 P.2d 131, 139 (Colo. 1963).

11. *City of Colorado Springs v. Bender*, 366 P.2d 552, 555 (Colo. 1961).

12. *Id.* at 556.

state relative to the distribution of the surface waters of the state including the underground waters tributary thereto in accordance with the right of priority of appropriation.”¹³ Further, the court authorized the state engineer to “adopt such rules and regulations and issue such orders as are necessary for the performance of the foregoing duties.”¹⁴

The General Assembly chose to focus on the problem of groundwater mining in areas with little surface water. It adopted the 1965 Ground Water Management Act (“the 1965 Act”) authorizing the Ground Water Commission to supervise the establishment of designated ground water districts where the principal reliable source of supply is groundwater.¹⁵ Withdrawals of designated groundwater could be made under a modified system of prior appropriation through the issuance of state engineer well permits pursuant to regulations of the Commission and the local ground water district to maintain “reasonable ground water pumping levels.”¹⁶ The 1965 Act also provided for state engineer review of applications for well permits outside of designated groundwater basins.¹⁷

Three activities precipitated the 1969 Act. First, the state engineer began to regulate tributary groundwater wells on a case by case basis. Second, the legislature directed the Natural Resources Department to conduct an investigation of the interrelationship of groundwater and surface water and recommend legislation.¹⁸ Third, in a contested groundwater case involving state engineer well regulation in the Arkansas River Basin, the Colorado Supreme Court urged the state engineer to take a more comprehensive approach by adopting regulations.

Exclaimed Justice Groves: “It is implicit in these constitutional provisions that, along with *vested rights*, there shall be *maximum utilization* of the water of this state. As administration of water approaches its second century the curtain is opening upon the new drama of *maximum utilization* and how constitutionally that doctrine can be integrated into the law of *vested rights*.”¹⁹ Thus, the court ratified the General Assembly’s recognition of the necessity to

13. Act of May 3, 1965, ch. 318, § 1, 1965 Colo. Sess. Laws 1244, 1244.

14. *Id.*

15. See Act of May 17, 1965, ch. 319, §§ 1-3, 1965 Colo. Sess. Laws 1246, 1246-68.

16. *Id.* § 148-18-10(1) 1965 Colo. Sess. Laws at 1254-55.

17. See *id.* § 148-18-36, 1965 Colo. Sess. Laws at 1265-66.

18. See Act of Apr. 19, 1967, ch. 175, § 1, 1967 Colo. Sess. Laws 249, 249-50.

19. *Fellhauer v. People*, 447 P.2d 986, 994 (Colo. 1968) (emphasis in original).

integrate the use, adjudication, and administration of tributary groundwater and surface water.

The very next year the legislature took the starring role with the adoption of the 1969 Act.²⁰

***Basic Tenets of Colorado Water Law
(from Park County Sportsmen's Ranch)***

Basic tenets of Colorado water law enunciated in the 1969 Act are: (1) a natural stream consists of all underflow and tributary waters, § 37-92-102(1), 10 C.R.S. (2001); (2) all waters of the natural stream are subject to appropriation, adjudication, and administration in the order of their decreed priority, § 37-92-102(1)(a) & (b); (3) the policy of the state is to integrate the appropriation, use, and administration of underground water tributary to a stream with the use of surface water in such a way as to maximize the beneficial use of all of the waters of the state, § 37-92-102(2); and (4) the conjunctive use of ground and surface water shall be recognized to the fullest extent possible, subject to the preservation of other existing vested rights in accordance with the law. § 37-92-102(2)(b).²¹

Other Colorado statutes foster ground water recharge and storage. See, e.g., § 35-70-103(6)(a), 10 C.R.S. (2001) (stating that one of the duties assigned to the state soil conservation board is to develop underground water storage projects). The General Assembly has attributed the statewide problem of soil loss and loss of irrigable acreage to a lack of aquifer recharge. See, e.g., § 35-70-102, 10 C.R.S. (2001) (stating that loss of irrigable and agricultural acreage in Colorado is a result of, among other problems, "increasing the rate of withdrawal from underground water reserves without adequate attention to recharging such reserves"); see also § 37-92-301(3)(d), 10 C.R.S. (2001). Another statute encourages the erection

20. See Robert F. Welborn, *Two Colorado Water Crises*, 1 U. DENV. WATER L. REV. 307, 308-11 (1998).

21 Storage of water underground in connection with conjunctive use projects has a number of advantages that implement the legislature's purpose to maximize the beneficial use of all of the state's waters. For example, water stored underground is not lost to evaporation; the water can be used as an emergency supply in the event of disruption to surface water systems; storing water in an aquifer raises the water table and can reduce energy demand and energy costs otherwise needed for well pumping; and storing water underground helps to reduce committing additional surface land to additional large reservoirs, conveyance systems, and stream modifications. Foley-Gannon, supra, at 275.

of suitable structures and the maintaining of facilities “to increase underground storage reserves.” § 35-70-103(6)(g), 10 C.R.S. (2001).

Out-of-Priority Diversions, Augmentation Plans and Exchanges (from Empire Lodge)

By the late 1960s, it became apparent to Colorado citizens and to the three branches of state government that principal river systems in Colorado, particularly the Platte and Arkansas Rivers, were reaching an over-appropriated status, and junior unadministered diversions, particularly wells depleting tributary groundwater, could be intercepting water necessary to fill senior decreed water rights. Strict application of the priority doctrine to overappropriated basins would restrict new water uses to changes of water rights. How to protect prior appropriation rights while also allowing new uses required a governmental response.

Fellhauer v. People contains this court’s response to these critical issues. See Fellhauer v. People, 167 Colo. 320, 336, 447 P.2d 986, 994 (1968)(“It is implicit in these constitutional provisions that, along with vested rights, there shall be *maximum utilization* of the water of this state. As administration of water approaches its second century the curtain is opening upon the new drama of maximum utilization and how constitutionally that doctrine can be integrated into the law of vested rights.”) (emphasis in original). The 1969 Water Right Determination and Administration Act (1969 Act) contains the General Assembly’s response. See Act of June 7, 1969, ch. 373 at 1200-1224. Both responses centered on: (1) reinforcing the adjudication and administration of decreed water rights in order of their priority; and (2) maximizing the use of Colorado’s limited water supply for as many decreed uses as possible consistent with meeting the state’s interstate delivery obligations under United States Supreme Court equitable apportionment decrees and congressionally approved interstate compacts. People ex rel. Simpson v. Highland Irrigation Co., 917 P.2d 1242, 1248, 1252-53 (Colo. 1996).

Augmentation Plan Approval

The General Assembly chose to implement a policy of maximum flexibility that also protected the constitutional doctrine of prior appropriation. Through the 1969 Act, the General Assembly created

a new statutory authorization for water uses that, when decreed, are not subject to curtailment by priority administration. This statutory authorization is for out-of-priority diversions for beneficial use that operate under the terms of decreed augmentation plans. See Act of June 7, 1969, ch. 373, § 148-21-3(12) at 1202; § 148-21-18(1) at 1207; § 148-21-20(6) at 1210; § 148-21-21(3)&(5) at 1211; § 148-21-23 at 1212, 1969 Colo. Sess. Laws. Plans for augmentation “were a creation of the 1969 Act.” David F. Jankowski et al., The 1969 Act’s Contributions to Local Governmental Water Suppliers, 3 U. Denv. Water L. Rev. 20, 29 (1999).

Plans for augmentation allow diversions of water “out-of-priority while ensuring the protection of senior water rights.” Farmers Reservoir & Irrigation Co. v. Consol. Mut. Water Co., 33 P.3d 799, 806 (Colo. 2001); Zigan Sand & Gravel Inc. v. Cache La Poudre Water Users Ass’n, 758 P.2d 175, 185 (Colo. 1988) (stating that, instead of being curtailed, “[t]he water user may choose to develop a plan for augmentation rather than discontinuing the diversion”). Decreed water rights receive a replacement water supply that offsets the out-of-priority depletions. Consol. Mut., 33 P.3d at 806 (citing § 37-92-305(5) & (8), 10 C.R.S. (2001)). We said in Midway Ranches:

Augmentation plans implement the Colorado doctrine of optimum use and priority administration, which favors management of Colorado’s water resource to extend its benefit for multiple beneficial purposes. Out-of-priority diversions can occur only when a replacement supply of water, suitable in quantity and quality, is made available to substitute for the otherwise diminished amount of water available to supply other water rights exercising their priorities. Depletions not adequately replaced shall result in curtailment of the out-of-priority diversions.

Midway Ranches, 938 P.2d 515, 522 (Colo. 1997) (citations omitted); see § 37-92-305(5) & (8). The replacement water can derive from any legally available source and be provided by a variety of means. § 37-92-103(9), 10 C.R.S. (2001).²² The augmentation plan decree

²² Section 37-92-103(9) provides that a plan for augmentation is:

a detailed program, which may be either temporary or perpetual in duration, to increase the supply of water available for beneficial use in a division or portion

identifies the structures, diversions, beneficial uses, and amount of depletions to be replaced, along with how the replacement water will be supplied and how the augmentation plan will be operated, so that the State Engineer can administer the diversions for beneficial use without curtailment.

As originally enacted in 1969, the augmentation plan statute required the water judge, not the referee, to hear applications for augmentation plans and required applicants to file their augmentation plans prior to July 1, 1971. See ch. 373, sec. 1, § 148-21-23(2), 1969 Colo. Sess. Laws 1200, 1212. The statute prohibited the filing of augmentation plan applications between July 1, 1971 and July 1, 1973 in anticipation of a rush to seek approval for this new type of water use. See ch. 373, sec. 1, § 148-21-23(3), 1969 Colo. Sess. Laws 1200, 1212. In 1971, the legislature amended the statute to repeal the suspension of the application period because the expected flood of filings had not materialized. See ch. 374, sec. 2, 1971 Colo. Sess. Laws 1334, 1334 (repealing § 148-21-23). After the repeal of the suspension, the filings began to appear in large numbers.

In 1974, in response to the desire of well users to obtain augmentation plan approval and to address the backlog created by the large number of filings, the legislature adopted Senate Bill 7 (S.B. 7). See ch. 111, sec. 1, § 148-21-23, 1974 Colo. Sess. Laws 440, 440-42, (originally codified at section 148-21-23 and recodified as 37-92-307). S.B. 7 allowed the State Engineer to grant temporary approval of augmentation plans if non-injurious to decreed vested water rights, provided that an application for an augmentation plan had also been filed in the water court. S.B. 7 also established State Engineer approval as prima facie evidence before the water court of a finding of non-injury, thereby affording considerable weight in determining the outcome of augmentation plan adjudication. See ch. 111, sec. 1, § 148-21-23(2), 1974 Colo. Sess. Laws 440, 440. This provision stated in part as follows:

Any person who has filed with the water clerk an application for approval of a plan for augmentation pursuant to section

thereof by the development of new or alternate means or points of diversion, by a pooling of water resources, by water exchange projects, by providing substitute supplies of water, by the development of new sources of water, or by any other appropriate means.

§ 37-92-103(9), 10 C.R.S. (2001).

148-21-18 may thereafter, at the applicant's option, submit such a proposed plan to the state engineer for his approval as a temporary augmentation plan. The state engineer shall approve such plan if he can determine with reasonable assurance that it will not injuriously affect the owner of or persons entitled to use water under a vested water right. If he determines that the proposed plan would cause such injurious effect, he shall afford the applicant or applicants an opportunity to propose protective terms or conditions. The state engineer may impose other protective terms and conditions including those specified in section 148-21-21(4). Wherever possible, the state engineer shall approve a plan for augmentation upon specifying protective terms and conditions which would permit the plan to be implemented without such injurious effect.

See ch. 111, sec. 1, § 148-21-23(2), 1974 Colo. Sess. Laws 440, 440 (emphasis added). The provision establishing approval of a temporary augmentation plan as prima facie evidence stated that:

[w]here the state engineer has approved a temporary plan for augmentation, the findings of the state engineer in support of such determination shall be prima facie evidence, unless challenged by competent countervailing evidence, that the augmentation water to be provided to the stream system is sufficient in quantity and time and that the protective terms and conditions are sufficient to prevent injury to the owner of or persons entitled to use water under a vested water right or a decreed conditional water right.

Ch. 111, sec. 1, § 148-21-23(5), 1974 Colo. Sess. Laws. 440, 441.

The General Assembly repealed the State Engineer's authority to approve temporary augmentation plans in 1977, in response to concerns about the provision's constitutionality for lack of notice to potentially injured water right holders. See ch. 483, sec. 6, 1977

Colo. Sess. Laws 1702, 1704; Kelly Ranch v. Southeastern Colo. Water Conservancy Dist., 191 Colo. 65, 550 P.2d 297 (1976).²³

In Kelly Ranch, Southeastern Colorado Water Conservancy District (SCWCD) objected in a water court proceeding to giving effect to the State Engineer's temporary approval of the augmentation plan because the court hearings commenced prior to the adoption of S.B. 7 and because the temporary plan statute did not provide for notice to holders of adjudicated water rights that might be injured by the augmentation plan. We agreed that the State Engineer's temporary approval of the plan should not be given the *prima facie* effect because the court hearings commenced prior to the adoption of S.B. 7. Accordingly, we did not address the constitutionality of the State Engineer temporary approval provision, reserving it for another case. Kelly Ranch, 191 Colo. at 75, 550 P.2d at 304.

The SCWCD had argued that "in the absence of provisions for adequate notice of the State Engineer's proceeding and with the possible result of his act of approval of the plan presenting the application with proof of a *prima facie* case, Senate Bill No. 7 is facially unconstitutional as a violation of due process." Id. at 76, 550 P.2d at 305. We invited legislative attention to the issue: "In the

²³ Kelly Ranch involved an augmentation plan application for three proposed subdivisions. The State Engineer approved a temporary plan for augmentation under the authority of S.B. 7 after hearings had commenced in the Water Court on the application for an augmentation plan decree. The source of augmentation water under the plan was an 1874 irrigation right which historically irrigated the Kelly Ranch. The plan proposed to remove lands from irrigation, store the historic consumptive use water, and release it as needed to replace the out-of-priority depletions resulting from subdivision water use. The Water Court ruled that the plan could not be approved because it did not add new water into the water system. Disagreeing with the Water Court, we held that "new water need not be injected to give life and validity to a plan for augmentation." Kelly Ranch v. Southeastern Colo. Water Conservancy Dist., 191 Colo. 65, 74, 550 P.2d 297, 303 (1976).

We observed that the statutory definition of a plan for augmentation, set out in section 37-92-103(9), included a number of alternatives for providing the necessary replacement water, such as water exchange projects, substitute supplies of water, development of new sources of water, or other appropriate means. Id. at 74, 550 P.2d at 303-04. We pointed out that our decision in Fellhauer and the General Assembly's enactment of the 1969 Act contemplated new methods of allowing water uses which could not occur under a strict regime of priority enforcement in over-appropriated watersheds:

The fact that the rivers involved are over-appropriated, rather than being an argument against the plans, is the very reason for the valid exercise of ingenuity of persons seeking to maximize the use of water, whether they are present or future owners of land and wells, developers, or, as characterized by the Water Court here, promoters, speculators or non-users.

Id. at 74-75, 550 P.2d at 304.

absence of intervening legislative amendment as to notice we well may have to cross that bridge some future day.” Id.

In response to Kelly Ranch, Senator Fred Anderson introduced Senate Bills 4 and 5 in 1977. S.B. 5 would have added procedures, including notice, to the State Engineer temporary augmentation plan approval statute, but this provision was not adopted. Instead, the legislature enacted S.B. 4, which, among other changes, repealed the authority for State Engineer approval of temporary augmentation plans. See ch. 483, sec. 6, 1977 Colo. Sess. Laws 1702, 1704 (repealing § 37-92-307).

Our fundamental responsibility in interpreting a statute is to give effect to the General Assembly’s purpose and intent in enacting the statute. People v. Martin, 27 P.3d 846, 851-52 (Colo. 2001). We should give effect to each word and construe each provision in harmony with the overall statutory design, whenever possible. See City of Florence v. Bd. of Waterworks, 793 P.2d 148, 151 (Colo. 1990). We also consider the General Assembly’s course of action and intent when enacting, amending, and repealing statutes. If different statutory provisions are in conflict or cannot be harmonized, the specific provision controls over the general provision. Martin, 27 P.3d at 852.

Specific inclusion in the statutes of State Engineer authority to approve temporary plans for augmentation, subsequent introduction of a bill to cure a potential constitutional problem of lack of notice to holders of decreed water rights who might be injured by temporary approvals, rejection of that bill, and adoption of a provision to repeal the statutory authority for State Engineer temporary approval of augmentation plans demonstrate legislative intent to consign the matter of authorizing out-of-priority diversions requiring an augmentation plan solely to the water courts.²⁴

²⁴ As a result of this action by the General Assembly, when the State Engineer subsequently approved Empire Lodge’s out-of-priority diversions in recognition that a “substitute supply” of water would likely prevent injury to water rights, the State Engineer was exercising enforcement discretion and not statutory approval authority under section 37-80-120 when the out-of-priority diversion required an augmentation plan. See, e.g., People ex rel. Simpson v. Highland Irrigation Co., 917 P.2d 1242, 1253 (Colo. 1996). Exercise of enforcement discretion does not alleviate the duty of those making such water uses to obtain a decree for an augmentation plan. It is the role of the General Assembly, not the State Engineer or the courts, to provide amendments to the current statutes if additional State Engineer administrative authority is desirable. See, e.g., § 37-80.5-104(1)(a)(IV), 10 C.R.S. (2001) (providing that, in compliance with rules promulgated for the Arkansas River water bank pilot program, leases, loans, and exchanges effectuated through the bank need not be adjudicated). We also acknowledge the State Engineer’s administrative

Accordingly, the current statutes do not contain a provision for State Engineer approval of out-of-priority diversions requiring augmentation plans.²⁵ A person desiring to divert out of priority through the device of an augmentation plan must file an application with the water court for approval. § 37-92-302(1)(a)(providing that “Any person who desires . . . approval of a plan for augmentation . . . shall file with the water clerk in quadruplicate a verified application”); see § 37-92-501.5 (stating that “[c]onsistent with the decisions of the water judges establishing the basis for approval for plans for augmentation” the State and Division Engineers shall have the broadest latitude to “encourage and develop augmentation plans and voluntary exchanges of water”) (emphasis added).

Substitute Supply

The purpose of augmentation plan adjudication is to fix the conditions under which the State and Division Engineers may allow out-of-priority diversion and depletion of the waters of a natural stream to occur consistent with the administration of decreed priorities. Midway Ranches, 938 P.2d at 522. Empire Lodge asserts that the State Engineer has broad authority to approve out-of-priority diversions in connection with a “substitute supply plan.” We disagree.

The term “substitute supply” appears in section 37-92-103(9), defining the term “plan for augmentation”; section 37-92-305(5), relating to quantity and quality of replacement water under a decreed augmentation plan; sections 37-80-120(2), 37-80-120(3), and 37-80-120(4), relating to quantity of exchange water; sections 37-90-137(11)(a)(I) and 37-90-137(11)(b), providing for a court-approved augmentation plan or State Engineer-approved substitute supply plan to replace depletions from sand and gravel open mining evaporation;

authority to regulate wells upon promulgation of rules for a river basin or aquifer, subject to a water court review proceeding, under section 37-92-501.

²⁵ Commentators have observed the effect of the 1977 repeal of the State Engineer’s temporary augmentation plan approval authority. See, e.g., James N. Corbridge, Jr. & Teresa A. Rice, Vranesh’s Colorado Water Law 157 (rev. ed. 1999) (“Prior to 1977, special procedures were provided for approval of plans for augmentation. Approval for temporary plans could be obtained from the state engineer if it were possible to devise terms and conditions that would allow the state engineer to determine, with reasonable certainty that the plan would not injuriously affect vested rights. However, plans for augmentation are now treated the same as any other water matter and are governed generally by the rules established for matters before the water court.”) (footnotes omitted).

and section 37-80-120(5), relating to sand and gravel open mining operations.

The common nexus of these provisions is a quantity and quality requirement applicable to replacement water; if a diverter meets these requirements and alleviates injury to decreed water rights, it may take an amount of water equal to the replaced amount. The terms “substitute supply” and “replacement water” are undefined by statute but are substantially equivalent. They refer to the water supplied to decreed water rights holders under an exchange or augmentation plan. See City of Thornton v. Bijou Irrigation Co., 926 P.2d 1, 96-97 (Colo. 1996); City of Denver v. City of Englewood, 826 P.2d 1266, 1274-75 (Colo. 1992). Section 37-80-120 contains no reference to a State Engineer program for the approval of substitute supply plans, with the exception of section 37-80-120(5) pertaining to sand and gravel open mining.

The words “substitute supply” appearing in the various statutory provisions do not of themselves confer upon the State Engineer authority to authorize an out-of-priority diversion in absence of adjudication. Rather, when the General Assembly so intends, the statutory language creating such authority appears expressly. For example, sections 37-90-137(11) and 37-80-120(5) recognize State Engineer approval authority in regard to sand and gravel open mining operations. Section 37-90-137(11) states:

No person shall, in connection with the extraction of sand and gravel by open mining as defined in section 34-32-103(9), C.R.S., expose ground water to the atmosphere unless said person has obtained a well permit from the state engineer pursuant to this section. A well permit shall be issued upon approval by the water court of a plan for augmentation or upon approval by the state engineer of a plan of substitute supply

§ 37-90-137(11)(a)(I) (emphasis added).

Section 37-80-120(1) allows the State Engineer to permit out-of-priority storage of water in an upstream reservoir, provided that the water remains available for release to senior downstream storage appropriators in the event the water is needed for their appropriations

due to insufficient supply.²⁶ See Purgatoire River Water Conservancy Dist. v. Kuiper, 593 P.2d 333, 339 (Colo. 1979). This provision states:

In every case in which the state engineer finds that water can be stored out of priority under circumstances such that the water so stored can be promptly made available to downstream senior storage appropriators in case they are unable to completely store their entire appropriation right due to insufficient water supply, the state engineer may permit such upstream storage out of priority, but such storage water shall be promptly released on demand of a downstream senior whenever needed by such senior for actual use.

§ 37-80-120(1) (emphasis added).

The plain language of sections 37-80-120(1) through 37-80-120(4) does not establish administrative authority that parallels or provides an alternative to the water court authority for approval of out-of-priority diversions that require an augmentation plan under the 1969 Act.²⁷

Our cases refer to section 37-80-120 in the context of exchanges. See City of Florence v. Bd. of Waterworks, 793 P.2d 148, 151 (Colo. 1990) (citing statutory language referring to “a proposed or existing exchange of water under section 37-80-120 or 37-83-104”); City of Thornton v. Bijou Irrigation Co., 926 P.2d 1, 91, 92, 96 (Colo. 1996) (referring to exchange water quality under 37-80-

²⁶ The 1897 Act authorized exchanges of water between reservoirs and ditches. See Act of Apr. 9, 1897, § 4, 1897 Colo. Sess. Laws at 177. This provision continued through subsequent enactments; its current form is contained in both sections 37-80-120(2) through 37-80-120(4) and 37-83-104.

²⁷ Consistent with the view we express in this opinion, a commentator has described section 37-80-120(1) as a water management tool involving storage appropriators:

The amendment allows the state engineer to permit out-of-priority, upstream storage of water, provided the stored water can be promptly supplied to downstream storage appropriators with an insufficient water supply. An adequate substituted supply is deemed by statute to satisfy the senior appropriative right—the essence of a physical solution.

Harrison C. Dunning, The “Physical Solution” in Western Water Law, 57 U. Colo. L. Rev. 445, 468 (1986).

120(3)); see also City & County of Denver v. City of Englewood, 826 P.2d 1266, 1273-74 (Colo. 1992) (discussing exchange responsibilities); accord Santa Fe Trail Ranches, 990 P.2d at 59 n.17 (“Nor does our holding affect the upstream storage and substitute supply provisions of section 37-80-120, 10 C.R.S. (1999). These provisions allow out of priority diversions under conditions statutorily designed to protect seniors against injury to their appropriations.”).

The General Assembly added section 37-80-120 to the statutes in 1969. See ch. 370, sec. 8, 1969 Colo. Sess. Laws 1192, 1196-97. Sections 37-80-120(2) through -120(4) describe the quantity and quality criteria for the substitute supply provided through exchanges under sections 37-80-120 and 37-83-104. These subsections also provide that the senior’s rights may be used for effectuating the exchange, see § 37-92-120(2); describe the water continuity and quality requirements for the substituted water, see § 37-92-120(3); and confirm that an exchange is an appropriative right. See § 37-92-120(4). The addition of section 37-80-120 in 1969 by enactment separately from the 1969 Act supplemented section 37-83-104, the pre-existing exchange statute.

In City of Florence, 793 P.2d at 151, we held that the General Assembly intended to differentiate exchanges from augmentation plans. Under section 37-83-104 and sections 37-80-120(2) through 37-80-120(4), an exchange is a water management practice the State Engineer administers between decreed points of diversion. When a junior appropriator makes a sufficient substitute supply of water available to a senior appropriator, the junior may divert at its previously decreed point of diversion water that is otherwise bound for the senior’s decreed point of diversion. See A-B Cattle Co. v. United States, 589 P.2d 57, 58-59 (Colo. 1979); City of Denver v. City of Englewood, 826 P.2d 1266, 1271-72 (Colo. 1992); Fort Lyon Canal Co. v. Chew, 33 Colo. 392, 403-05, 81 P. 37 (Colo. 1905). Four critical elements of an exchange are that: (1) the source of substitute supply must be above the calling water right; (2) the substitute supply must be equivalent in amount and of suitable quality to the downstream senior appropriator; (3) there must be available natural flow at the point of upstream diversion; and (4) the rights of others cannot be injured when implementing the exchange. See Casey S. Funk & Amy M. Cavanaugh, Basic Exchange 101, 1 U. Denv. Water L. Rev. 206, 207 (1998).

Justice Erickson, in his City of Florence concurring opinion, explained the primary distinction between an exchange and a plan for augmentation. The operator of an exchange may obtain a conditional or absolute decree with a priority for the exchange. The State Engineer may allow an exchange in absence of a decree confirming it. If the exchange is adjudicated, it receives the priority date of its appropriation, without application of the postponement doctrine, pursuant to section 37-92-305(10). Adjudication of an exchange assigns it a priority vis-à-vis other exchanges operating in the affected stream reach.

In contrast, an augmentation plan operates to replace depletions to the water supply of the natural stream upon which appropriations depend and allows a diversion outside of the priority system; an adjudication is required to authorize such a diversion and no priority results. As Justice Erickson said:

Although an exchange program may be adjudicated, water can be exchanged through a water exchange project administered by the state engineer without judicial approval. On the other hand, both plans for augmentation and changes of water rights must be approved by the water court.

Section 37-92-302(1)(a) separately provides for judicial approval of water exchanges apart from plans for augmentation and changes of water rights. A decreed exchange is given a priority date and is operated within the prior appropriation system. A plan for augmentation allows the operator of the plan to take water outside of the prior appropriation system and therefore a plan for augmentation does not require a priority date. A change of water right retains the priority date of the original decree subject to terms and conditions for the prevention of injury to vested water rights.

City of Florence, 793 P.2d at 156 (Erickson, J., concurring) (emphasis added; citations omitted).

***Out of Priority Pumping of South Platte Wells Lacking Augmentation Plans
(from Simpson v. Bijou)***

Groundwater Management Act of 1965

By the early 1940s, in the South Platte River basin and elsewhere, agricultural activity was causing huge increases in the withdrawal of tributary groundwater, which was in turn beginning to deplete the surface flows of the major rivers.²⁸ See Lawrence J. MacDonnell, Colorado's Law of "Underground Water": A Look at the South Platte Basin and Beyond, 59 U. Colo. L. Rev. 579, 585 (1988). By the 1960s, the conflict this created between surface and groundwater users had become readily apparent, as had the dearth of legislative guidance and administrative authority necessary to address the problem.

In 1965, the General Assembly enacted the Groundwater Management Act, which provided that the State Engineer was to administer both surface and groundwater of the state in accordance with the priority system. Ch. 318, secs. 1-2, § 148-11-22, 1965 Colo. Sess. Laws 1244, 1244-45. Interpreting the constitutionality of that Act in Fellhauer v. People, 167 Colo. 320, 447 P.2d 986 (1968), this court held that any regulation of wells must: (1) be in compliance with written rules and regulations; (2) cause a reasonable lessening of material injury to seniors; and (3) provide for conditional use of wells if water can be withdrawn and put to beneficial use without injury to seniors. Fellhauer, 167 Colo. at 334, 447 P.2d at 993. The court also articulated the need for maximum utilization of both the surface and subsurface waters of the state, and the necessity of determining "how constitutionally that doctrine can be integrated into the law of vested rights." Fellhauer, 167 Colo. at 336, 447 P.2d at 994.

Water Right Determination and Administration Act of 1969

The implicit invitation extended in Fellhauer prompted the General Assembly in 1969 to take further action with respect to

²⁸ Tributary groundwater is by definition hydrologically connected to the surface water of a stream. Therefore, groundwater pumping can deplete water that would otherwise be available for withdrawal directly from the surface of the stream. In recognition of this fact, absent a showing to the contrary, Colorado law presumes that (1) groundwater is tributary to the stream, Board of County Commissioners v. Park County Sportsmen's Ranch, 45 P.3d 693, 702 (Colo. 2002), and (2) that where surface water is over-appropriated, groundwater depletion through well pumping causes material injury to senior appropriators. Alamosa-La Jara Water Users Prot. Ass'n v. Gould, 674 P.2d 914, 931 (Colo. 1984).

groundwater administration in the state. The Water Right Determination and Administration Act of 1969 was the most comprehensive water legislation ever enacted in the history of the state. See ch. 373, sec. 1, §§ 148-21-1 through 148-21-45, 1969 Colo. Sess. Laws 1200, 1200-1219. The purpose of the Act was “to integrate the appropriation, use and administration of underground water tributary to a stream with the use of surface water, in such a way as to maximize the beneficial use of all of the waters of this state.” Id., § 148-21-2(1) at 1200 (currently codified at § 37-92-102(1)(a), 10 C.R.S. (2002)).

The Act ushered in a host of changes to the state water law administrative scheme. It established the current system of water divisions and courts, id., sections 148-21-8 through 148-21-11 at 1202-05 (currently codified at sections 37-92-201 through 37-92-204, 10 C.R.S. (2002)), and set forth detailed administrative duties of the State and Division Engineers, particularly with regard to the integration of groundwater into the water law system. Id., §§ 148-21-17 through 148-21-45 at 1205-19 (currently codified at §§ 37-92-301 through 37-92-504, 10 C.R.S. (2002)).

As a result of the Act’s stated policy of conjunctive use,²⁹ wells were required to be integrated into the priority system, although unadjudicated wells in existence prior to 1969 were allowed to continue. See id., § 148-21-2(2)(a) at 1200-01 (“Water rights and uses heretofore vested in any person by virtue of previous or existing laws, including an appropriation from a well, shall be protected subject to the provisions of this article.”) (emphasis added) (currently codified at § 37-92-102(2)(a), 10 C.R.S. (2002) in slightly modified form).³⁰ The Act nevertheless encouraged the adjudication of existing wells by allowing well owners who filed an application by July 1, 1971, to receive a water decree with a priority dating back to their original appropriation date. Id., § 148-21-22 at 1212.

The 1969 Act also introduced the concept of augmentation plans into the water law adjudication and administration scheme. Augmentation plans were the primary means provided by the Act for

²⁹ The term “conjunctive use” refers to the combined priority administration of ground and surface waters of the state. James N. Corbridge, Jr. & Teresa A. Rice, Vranesh’s Colorado Water Law 16 (rev. ed. 1999).

³⁰ The current version reads:

Water rights and uses vested prior to June 7, 1969, in any person by virtue of previous or existing laws, including an appropriation from a well, shall be protected subject to the provisions of this article. § 37-92-102(2)(a), 10 C.R.S. (2002).

integrating groundwater into the state priority system, and were defined as follows:

“Plan for augmentation” means a detailed program to increase the supply of water available for beneficial use in a division or portion thereof by the development of new or alternate means or points of diversion, by a pooling of water resources, by water exchange projects, by providing substitute supplies of water, by the development of new sources of water, or by any other appropriate means.

Id., § 148-21-3(12) at 1202 (currently codified at § 37-92-103(9), 10 C.R.S. (2002) in slightly modified form).³¹ An augmentation plan is essentially a water court decreed means by which a junior appropriator or undecreed well user can replace his out-of-priority depletions of groundwater in a manner that prevents injury to senior rights. Therefore, when decreed by the water court, an augmentation plan allows the water user to divert out of priority without threat of curtailment by the State Engineer, so long as adequate replacement water is, in fact, supplied to the senior.³²

Approval of augmentation plans was expressly vested in the water courts for augmentation plan applications received prior to July 1, 1971. Ch. 373, sec. 1, § 148-21-23(2), 1969 Colo. Sess. Laws 1200, 1212.³³ Notably, a proposed but unenacted version of the 1969 Act would have granted the State Engineer, instead of the water courts, the authority to approve augmentation plans. S.B. 81, 47th Gen. Assemb., Reg. Sess. at 12 (Colo. 1969). The bill was defeated, however, in large part because of fierce opposition to the

³¹ There are two modifications to the current version of 37-92-308(9), 10 C.R.S. (2002). First is the addition of a clause to the first sentence: “Plan for augmentation’ means a detailed program, which may be either temporary or perpetual in duration, to increase the supply of water available . . .” (emphasis added). Second is the addition of a new sentence at the end of the statute which excludes from use in augmentation plans any water resulting from the eradication of phreatophytes, or from runoff created by rendering a previously permeable surface impermeable.

³² The augmentation plan decree identifies the structures, diversions, beneficial uses, amount of depletions to be replaced, the source of replacement water, and an explanation of how the augmentation plan will be operated. Empire Lodge, 39 P.3d at 1150-51.

³³ In expectation of an overwhelming number of applications, the 1969 Act prohibited any new filings between July 1, 1971, and July 1, 1973, § 148-21-23(3) at 1212; this restriction was rescinded in 1971 when the anticipated rush did not materialize. See ch. 374, sec. 1, § 148-21-23(2), 1971 Colo. Sess. Laws 1334, 1334; Empire Lodge, 39 P.3d at 1151. Subsequent approval of augmentation plans was vested in the water referee, § 148-21-19 at 1208, but subject to judicial review. § 148-21-20 at 1208-11.

considerable amount of power the proposed bill would have vested in the State Engineer, and the fear of creating a “water czar” on the river. David L. Harrison & Gustave Sandstrom, Jr., The Groundwater-Surface Water Conflict and Recent Colorado Water Legislation, 43 U. Colo. L. Rev. 1, 23-24 (1971).

The 1974 and 1977 Amendments

In response to the large number of augmentation plan applications which had been filed, in 1974 the General Assembly vested the State Engineer with the authority to grant temporary approval of augmentation plans. Significantly, however, a precondition to even temporary approval by the State Engineer was that the water user had an augmentation plan application pending in water court. Ch. 111, sec. 1, § 148-21-23(2), 1974 Colo. Sess. Laws 440, 440 (later codified at § 37-92-307); see also Empire Lodge, 39 P.3d at 1151.

In an effort to address the concern expressed by this court about the constitutionality of the 1974 amendments in Kelly Ranch v. Southeastern Colorado Water Conservancy District, 191 Colo. 65, 75, 550 P.2d 297, 304 (1976),³⁴ however, the General Assembly in 1977 repealed the State Engineer’s authority to approve temporary augmentation plans. Ch. 483, sec. 6, 1977 Colo. Sess. Laws 1702, 1704 (repealing § 37-92-307). Before passage of the 1977 Act, the legislature considered, but rejected, an alternative bill that would have retained the State Engineer’s temporary augmentation plan approval authority while adding additional notice provisions to cure the perceived procedural shortcomings of the statute. S.B. 5, 49th Gen. Assemb., Reg. Sess. (1970); Empire Lodge, 39 P.3d at 1152. The rejection of the alternate bill was at least partially motivated by concern over the potential overlap of administrative and adjudicative functions it would have created in the State Engineer.³⁵

³⁴ In Kelly Ranch, the conservancy district argued that the 1974 Act violated due process because it provided inadequate notice of the State Engineer’s actions and decisions to senior water users. This court did not reach the district’s argument because it found that the appellant’s application predated the 1974 Act, but noted that “[i]n the absence of intervening legislative amendment as to notice, we well may have to cross that bridge some future day.” Kelly Ranch, 191 Colo. at 76, 550 P.2d at 305.

³⁵ This intent is evident in the following excerpt from the Senate hearings:

I would recommend Senate Bill 4 [the enacted bill] as an improvement in the procedures which I think may have gotten the State Engineer more involved than he should be, ... perhaps from the standpoint that it is best that he not have to wear too many hats, and if

Simultaneous with its repeal of the State Engineer's temporary augmentation plan approval authority, the legislature added two other significant statutory provisions indicating its clear intent to vest the water courts with augmentation plan approval authority. The first section provides, in part, that:

Consistent with the decisions of the water judges establishing the basis for approval for plans for augmentation ... the state engineer and division engineers shall exercise the broadest latitude possible in the administration of waters under their jurisdiction to encourage and develop augmentation plans

Ch. 483, sec. 5, § 37-92-501.5, 1977 Colo. Sess. Laws 1702, 1704 (emphasis added) (currently codified at § 37-92-501.5, 10 C.R.S. (2002)). The second significant statutory addition of the 1977 Act provided in relevant part as follows:

In reviewing a proposed plan for augmentation and in considering terms and conditions which may be necessary to avoid injury, the referee or the water judge shall consider the depletions from an applicant's use or proposed use of water, in quantity and in time, the amount and timing of augmentation water which would be provided by the applicant, and the existence, if any, of injury to any owner of or persons entitled to use water under a vested water right

Ch. 483, sec. 4, § 37-92-305(8), 1977 Colo. Sess. Laws 1702, 1703 (emphasis added) (currently codified at § 37-92-305(8), 10 C.R.S. (2002)).

The 1996 Act

A lawsuit filed by the state of Kansas against Colorado claiming violations of the Arkansas River Compact, see Kansas v. Colorado, 514 U.S. 673 (1995), prompted the General Assembly in 1996 to

he's wearing the hat of a judge on a temporary plan for augmentation, then maybe it's some inconsistency there as compared with his entering an appearance before the water judge.

Hearing Before the Senate Committee on Agriculture, Natural Resources and Energy, 49th Gen. Assemb., Reg. Sess. (Colo. 1977) (testimony of Sen. Fred Anderson).

enact another statute adding provisions intended to strengthen the State Engineer's administrative enforcement powers. See ch. 7, secs. 1-7, 1996 Colo. Sess. Laws 19, 19-24. Those provisions pertinent to the instant case included: (1) the imposition of fines against any water user who violated rules or regulations adopted by the State Engineer "to regulate or measure diversions of ground water" or any "plan approved pursuant" to such rules and regulations, id., § 37-92-503(6)(a) at 21 (emphasis added); and (2) the imposition of fines against any water user who, by violating an order or rules issued by the State Engineer "to replace depletions caused by diversions of ground water ... and whose failure to replace such depletions" caused the violation of an interstate compact, id., § 37-92-503(7) at 22 (emphasis added). These sections, particularly the highlighted portions, are relevant because the State Engineer cites them as proof of legislative intent to grant him the authority to approve the "replacement plans" at issue in the instant case. We address this argument infra in Section IV(A)(3)(d).

The 2002 Act

In response to this court's holding in Empire Lodge and in order to "establish some additional authority for the state engineer to approve substitute water supply plans," section 37-92-308(1)(a), the General Assembly in 2002 enacted section 37-92-308, 10 C.R.S. (2002). To that end, the statute provides that "the state engineer is authorized to review and approve substitute water supply plans that allow out-of-priority diversions only under the circumstances and pursuant to the procedures set forth in this section." § 37-92-308(2). The statute then sets out four limited circumstances under which the State Engineer may grant temporary approval of substitute supply plans:

(1) If an applicant had a substitute supply plan approved prior to January 1, 2002, the State Engineer may approve one additional year of use. After that year, applicants are required to seek an augmentation plan decree from the water court. § 37-92-308(3).

(2) If an applicant has filed an application with the water court for approval of an augmentation plan upon which the court has not yet ruled, the State Engineer, after providing sufficient notice to other water users and making a finding of no injury, can temporarily approve the augmentation plan for up to one year. This approval is

annually renewable for up to three years, with a showing of justifiable delay necessary for extensions beyond three years. § 37-92-308(4).

(3) If an applicant's use will not exceed five years, the State Engineer, after providing sufficient notice to other users and making a determination of no injury, may approve the plan annually for up to a total of five years. § 37-92-308(5).

(4) If the State Engineer determines that an emergency situation exists and has made a finding of no injury, he may grant temporary approval of a substitute supply plan for up to ninety days. § 37-92-308(7).

Conclusions Drawn From Legislative History

This review of legislative history convinces us of the General Assembly's intent to consign the matter of approving ongoing out-of-priority groundwater diversions using replacement water exclusively to the water courts. In 1969 and again in 1977 when it repealed the State Engineer's short-lived temporary augmentation plan approval authority, the General Assembly rejected the idea of granting the State Engineer such approval power due to concern over overlapping administrative and judicial authority and the inordinate amount of power this would have vested in the State Engineer. Even when the State Engineer was given temporary approval authority during the period between 1974 and 1977, that approval was conditioned upon the water user having filed an augmentation plan application in water court. Those bills which were enacted into law in 1969 and 1977 evidence a steadfast legislative intent to make augmentation plan approval an adjudicatory function of the water courts as opposed to an administrative task of the State Engineer. See Empire Lodge, 39 P.3d at 1153.

Any lingering doubt as to this intent was conclusively put to rest with the enactment in 2002 of section 37-92-308, 10 C.R.S. (2002), which unambiguously provides that it is the province of the water courts to approve and decree augmentation plans, except in the four limited circumstances set out in subsections (3), (4), (5), and (7) of the statute, which allow the State Engineer to grant temporary substitute supply plan approval pursuant to the express provisions of those subsections.