

Colorado Water

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

WATER ITEMS AND ISSUES . . .

October 1994

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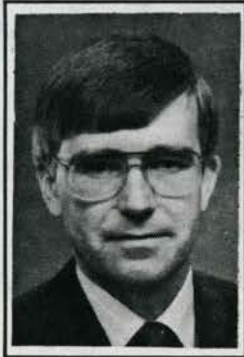
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WATER RESEARCH PRIORITIES FOR 1995/96

by Robert C. Ward



CWRRI's Research Planning Advisory Committee (RPAC) has completed voting on water research priorities for 1995/96, and the results are presented in the Request for Preproposals found on page 3 of this issue of *Colorado Water*. We also received a number of responses from *Colorado Water* readers -- I want to thank all the Colorado water managers/users who took the time to let us know the water issues they

would like CWRRI to address in its next cycle of water research efforts.

Before discussing the research priorities, I do need to point out that it appears the 1995/96 federal portion of CWRRI's budget will be reduced by 20 percent. This will necessitate a reduced number of projects as well as a reorganization in publication procedures. The goal is to continue to address high-priority water research issues and to get the research results into the hands of those who can use the information to improve Colorado's water management system. CWRRI will also seek matching funding to stretch its seed money grants further. Please contact me if you are interested in discussing water research on a topic that concerns you.

The 1995/96 CWRRI research priorities, in my opinion, reflect continuing concern on the part of many water managers/users about the increasing competition for water as well as the calls for new management structures to address the resulting conflicts. Addressing these concerns will require higher education faculty to integrate their disciplines in ways we are not normally called upon to do. The top research priorities, as shown on page 3, can best be addressed at the interface of academic disciplines and with the experience of current practice.

Beyond RPAC, CWRRI received a number of calls for research on how agricultural operations can be managed to improve water quality. Recently CWRRI, in cooperation with the Northern Colorado Water Conservancy District, published a guide to best management practices for irrigated agriculture (Completion Report No. 184 - see page 12). This year's research program includes a Task Force that is addressing agricultural water conservation in cooperation with Cooperative Extension. Furthermore, the Agricultural Experiment Station and USDA's Agricultural Research Service have a number of projects underway on this topic (see pages 6-7 of the June 1993 issue of *Colorado Water* for a complete list of water related projects). Thus, agricultural water conservation does not appear on the 1995/96 Request for Preproposals. It is well covered by other research efforts.

The 1994-95 research program also includes Task Forces on Colorado Sediment and Public Water Information. These task forces include a number of water managers/users, and I can

report that the conversations being held as part of these efforts are very exciting. If you want to be kept informed about the deliberations of these Task Forces, please contact the following:

Agricultural Water Conservation -- Dan Smith (303) 491-6371
Public Water Information -- Marilee Long (303) 491-6463
Colorado Sediment -- Steve Abt (303) 491-8203

You will be put on a "CC" list and receive copies of materials produced in the course of task force activities.

The report from the 1993-94 Task Force on Ecological Integrity is currently being finalized and should be available by the end of the year.

As you sum up the past, current and proposed future (in the Request for Preproposals) CWRRI efforts to address pressing Colorado water issues, you see higher education developing relevant information for Colorado water managers/users to help improve the decision making process.

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Robert C. Ward, Director

**COLORADO WATER RESOURCES RESEARCH INSTITUTE
REQUEST FOR PREPROPOSALS
Closing Date: January 10, 1995**

Preproposals are invited for the Colorado Water Resources Research Institute FY1995-96 water research program. CWRRI is especially interested in projects that feature collaboration between university researchers and water management organizations. Demonstrating collaboration in the preproposal stage will enhance the possibility of an award. Highest priority will be given to projects that address Colorado's most critical water problems as identified by CWRRI's Research Planning Advisory Committee:

- How much water is needed by endangered species and how do we get it to them?
- Integration of water quantity and quality management in Colorado - feasible? How?
- What is "Integrated Watershed Management?" How could it impact Colorado's water management system?
- Basin-of-origin protection - do the water courts need additional guidance in evaluating out-of-basin water transfers?
- Urban water conservation - where are we today?
- Hydro-modification - a source of pollution?
- What is the quality of Colorado's water?
- How can Colorado recognize a prospective drought and alert citizens, without creating a crisis mentality?

The Colorado Water Resources Research Institute (CWRRI) has, for many years, funded individual faculty to study rather specific and narrow research questions. The lack of basic knowledge about water behavior, movement, quality, and impacts led to this research strategy. More recently, there are indications that knowledge synthesis (integrating existing knowledge to answer broader management questions) is an increasingly important focus for water "research." These indications come from evolving shifts in water management that now employ such concepts as "integrated watershed management" involving "ecological integrity" goals. Within such concepts, information needs are developing around water needs for endangered species, basin-of-origin protection, integrated water quality and quantity management, and informing the public about Colorado's water quality.

During this next cycle of CWRRI's water research program, in addition to basic research proposals, proposals that involve a

number of faculty attempting to integrate knowledge that supports a better understanding of broader water management issues will also be sought. The goal is to have a blend of individual and group projects focused directly on high-priority needs of Colorado's water managers, users and citizens.

The proposals that attempt to synthesize knowledge must involve a group of faculty (and water managers/users) so that something like a "White Paper" on the topic can be developed. Such a product is designed to be readily useful to Colorado's water managers. Furthermore, it is desired that such groups of faculty, as part of their deliberations, also prepare a follow up proposal to seek additional funding from sources other than CWRRI. CWRRI monies are being used to direct faculty attention into those areas of investigation critically important to Colorado, realizing that CWRRI's funding levels cannot, of themselves, fund the level of research needed to adequately address the complexity of many of these issues.

Project Duration: Awards will be made for one year beginning July 1, 1995.

Funds Available: Current indications are that the number of 1995/96 awards will be reduced to 6 or 7 from the previous average of 8-10 per year. The funding range considered is between \$10,000 and \$25,000.

Indirect Costs/Cost Sharing: If additional funding for CWRRI's research program is obtained, cost sharing may be required of the principal investigator. Indirect costs must be provided as a contribution by the performing institution. Do not show indirect costs in this preliminary, direct-cost budget estimate. Financial arrangements for projects will be negotiated after successful preproposals have been identified.

Review Procedures: Preproposals will be evaluated by the Technical Advisory Committee (faculty of CU, CSM and CSU) and by the Research Program Advisory Committee (practitioners). Authors of preproposals judged to have a strong chance of final award will be invited to prepare full proposals. Criteria of selection include: (1) the ability of the proposed research "product" to be readily useful to Colorado's water users and managers; (2) relevance of research product to priority Colorado water problems; (3) scientific merit; and (4) performance record of principal investigator.

Eligibility: Open to regular, full-time faculty of Colorado State University, the University of Colorado and the Colorado School of Mines. For Instructions and Preproposal Format contact your Contracts and Grants office or call CWRRI (491-6308).

WATER RESEARCH

WINDY GAP: TRANSMOUNTAIN WATER DIVERSION AND THE ENVIRONMENTAL MOVEMENT

by
Gregory M. Silkensen

Editor's Note: The author recently completed his M.A. in history at Colorado State University. Greg's thesis has been printed by CWRRI, and is available through CSU's Bulletin Room (491-6198) at a cost of \$10.00. The title is Windy Gap: Transmountain Water Diversion and the Environmental Movement, Technical Report Series No. 61.

Setting

Water has played a major role in the history and development of the entire southwestern United States. Large portions of the region are either arid or semi-arid, receiving less than twenty inches of precipitation annually. Throughout the region this moisture deficit has necessitated irrigation to grow crops and the construction of large and intricate water diversion and storage projects to supply agricultural, municipal, and industrial needs. During the last century the region's population centers of Denver, Los Angeles, Phoenix, Salt Lake City, and San Francisco have all grown and developed due to major water diversions. This is also the case for irrigated agriculture in California's Central and Imperial valleys, west of Utah's Wasatch mountains, and along Colorado's Front Range and eastern plains.

Colorado, in turn, plays a crucial part in the hydrology of the Southwest; geography and climate patterns in part explain this importance. The state's topography can be roughly divided into thirds, with the eastern portion consisting of high plains, the middle of high mountains and valleys, and the western third of largely plateaus, mesas, and lower valleys. Four major river systems originate in Colorado's mountains -- the Platte, Arkansas, Colorado, and Rio Grande. Prevailing westerly winds of the mid-latitudes carry Pacific moisture east to Colorado where the mountains act as an orographic barrier, forcing the moisture to rise and literally wringing precipitation from the atmosphere. Thus, the state is a major water catchment basin for the entire Southwest.

This moisture, however, is not distributed evenly across the state. The windward or West Slope receives the bulk of precipitation, while the leeward or East Slope lies in a rainshadow and generally receives much less. The rivers which arise and flow from Colorado illuminate this imbalance. The Colorado River and its tributaries on the West Slope drain approximately one third of the entire state, but receive nearly 70 percent of the state's total precipitation. The Arkansas and Platte river systems together drain the entire eastern half of the state, yet receive only a third of Colorado's moisture. As a result, the average annual flow of the Arkansas and South Platte rivers is less than half of the Colorado River and its instate tributaries.

Colorado's unique topography -- its high mountains and continental divide running north-south roughly through the center of the state -- and human settlement patterns which occurred after 1859 are largely responsible for the transmountain diversion of water. From territorial times, the vast majority of Colorado's population has resided on the eastern side of the mountains. Thus, the highest demand for water has occurred on the East Slope while the largest supply exists on the West Slope.

Early Diversions

The first transmountain diversion of water in Colorado occurred near Fairplay in 1860. It was constructed for mining operations but was only used for a few years before being abandoned. The headwaters of the Cache La Poudre River provided the location for the first surge of transmountain water diversion activity. The Water Supply and Storage Company (WSSC), a Fort Collins-based local mutual irrigation company, began construction of the Skyline Ditch in July of 1891 to improve diversions from the Laramie River into the Poudre basin. Water from the Laramie River had been diverted to the Poudre basin through the Cameron Pass Ditch as early as 1881. When extension and improvement of the Skyline Ditch was completed in time for the 1894 growing season, farmers receiving water deliveries from it prospered, while many neighboring farms without additional water suffered foreclosures.

Construction of numerous other transmountain water diversion ditches in the upper Poudre basin followed. The Grand River Ditch, the oldest operating transmountain water diversion project and the largest to divert into the upper Poudre, was constructed beginning in 1890. This ditch collects high altitude runoff from the Never Summer Range in Rocky Mountain National Park and transports it from the West Slope across the continental divide via La Poudre Pass into the Poudre basin. The Grand River Ditch existed prior to the creation of Rocky Mountain National Park, and continues to operate within park boundaries. Water was first diverted in 1892 and extension of the ditch continued until 1936.

In the early 1920s the city of Denver filed for West Slope water rights and began to study the feasibility of diverting Fraser and Williams Fork river water from the West Slope to Denver via

the Moffat Tunnel. The Moffat Railroad Tunnel was under construction during this period by the Denver and Salt Lake Railroad. Completed in 1927, part of the construction effort included a pioneer bore, smaller in diameter than the main bore and used to excavate the larger tunnel. The city signed a 99-year lease for use of the pioneer bore tunnel and enlarged and lined it between 1929 and 1936. Completion of this project temporarily assured Denver an adequate supply of water. Fraser River water first reached Denver in 1936, but it was not until 1940 that an extension to the Williams Fork River added additional water to the Moffat Tunnel diversions. The system was further expanded and improved during the following two decades.

The Moffat Water Tunnel and the Grand River Ditch opened the floodgates to major transmountain water diversion projects in Colorado. Other water diversions undertaken by municipalities and water districts along the Front Range include the Homestake project which collects water from a tributary of the Eagle River and delivers it to the cities of Colorado Springs and Aurora. The Fryling Pan-Arkansas project was authorized in 1962 and completed by the U.S. Bureau of Reclamation in 1982 for the Southeastern Colorado Water Conservancy District. The largest transmountain water diversion in the state is the Colorado-Big Thompson project (CBT), which diverts water from the upper Colorado River basin to the Big Thompson, Poudre, St. Vrain, Boulder, and South Platte basins.

At present, nearly forty transmountain water diversions in Colorado have been constructed for the purpose of supplying agricultural, municipal, and industrial water to the East Slope. Most of these are small (a few hundred acre-feet). The half-dozen large-scale projects which exist in Colorado were constructed by either municipalities or water conservancy districts.

Windy Gap

Windy Gap is the most recent major transmountain water diversion project constructed in the state of Colorado. Utilizing the CBT's physical infrastructure, Windy Gap diverts water from the Colorado River basin eastward across the continental divide to the Front Range and East Slope. The idea for Windy Gap developed out of a 1950s U.S. Bureau of Reclamation report on the CBT. But it was not until the 1960s that construction of the project was seriously considered. By late in the decade, however, major water development projects were being increasingly questioned and criticized. The modern environmental movement was one source of this early opposition. It manifested itself in part through federal legislation such as the National Environmental Policy Act, the Endangered Species Act, and others. These environmental statutes and regulations joined forces with historic West Slope opposition to transmountain water diversion in Colorado and led to lengthy delays for Windy Gap. Legal challenges at each step added millions of dollars to the cost of the project and pushed its completion date to 1985, a full twenty years after the process began.

Water project development in Colorado has undergone monumental change over the last three decades. Prior to 1960, proposed projects regularly received federal funding and approval. Opposition, if it did exist, was concentrated in western Colorado and focused on the East Slope's "theft" of West Slope water. Today, resistance to further transmountain water diversion projects in Colorado is a multidimensional force consisting of environmentalists, traditional West Slope opponents, increasing demand for municipal water supplies in western Colorado, and escalating interstate pressures in the Colorado River basin.

Windy Gap was planned, pursued, and constructed during a time of monumental change in American society. Thus, it is a reflection of these times and the difficulty of building a modern transmountain water diversion project. Issues such as Colorado River salinity, endangered species, minimum streamflows, recreational and rafting water requirements, and protection of West Slope water rights all complicated Windy Gap immensely. In addition, the contemporary U.S. democratic process has many more participants today than fifty years ago when the CBT project was planned and constructed. Environmentalism, feminism, ethnic issues, and social upheaval have combined with startling technological advances to make Colorado, the United States, and even the world a much smaller and different place. The completion of Windy Gap during this period of history is remarkable considering the clash of values and ideas which has occurred.

Conclusion and Recommendations for Further Work

As the demand for clean, reliable water supplies grows across Colorado and the western United States, a comprehensive understanding of the history of transmountain water diversion in Colorado is critical. Managers and others in the field of water resources will be called upon to make important decisions about future water supplies for Colorado's citizens. These decisions should not be made lightly, and could benefit greatly from a better understanding of Colorado's water history. The last 130 years of water development in Colorado can provide important lessons for current and future decisions regarding water use in the state.

This investigation of Windy Gap and transmountain water diversion provides a springboard for further historical water research. Additional work is needed on the environmental movement's impact on water diversions. In particular, a more detailed analysis of the issues of salinity, endangered species, and water quality is required. The historic changes that aquatic environments have undergone due to water diversion requires further study as well. For example, how has the diversion of water from the Colorado River watershed changed the river's aquatic habitat during the past century? How has the addition of diverted water affected the watersheds of Colorado's East Slope?

There is also a need for an examination of transmountain water diversion from the unique perspective of the West Slope. Most

historical research on transmountain water diversion in Colorado has been written from the position of the East Slope, or only dealt with the West Slope in a perfunctory manner. Just as Dr. Daniel Tyler's *Last Water Hole in the West* details the history of the Northern Colorado Water Conservancy District, a corresponding history of the Colorado River Water Conservation District would provide a fascinating look at the West Slope's perspective and response to the construction of numerous transmountain water diversion projects during the past century. Other questions beg historical analysis: What effect would a prolonged drought (like that experienced by Colorado during the 1930s) have on water diversion, irrigated agriculture, or

municipal lawn watering within the state? What has the historical response been to severe drought in Colorado and the western United States?

This thesis provides a brief look at the history of Windy Gap and the issues of transmountain water diversion. Given the rapidly changing nature of western water management (from typically isolated water quantity and quality management procedures to a more holistic watershed management perspective), there is a definite need for additional historical analysis of water resources.

AGRICULTURAL TO URBAN WATER TRANSFERS IN COLORADO

by

Teresa Rice and Larry MacDonnell
Natural Resources Law Center
University of Colorado

Water supplies are becoming increasingly tight as environmental and cost concerns neutralize plans for new development projects while greater demands are placed by a growing urban sector and shifting public values for water. Agriculture accounts for a large amount of the water used today -- 80 percent of all water withdrawals in the West today go to agricultural uses. Not surprisingly, cities for several decades have looked to farms and ranches when seeking water for new or expanded uses.

At one time, the problem of meeting new water demands in the West was addressed through the development of new water supplies -- either by building water storage projects or by tapping groundwater. Surface streams are overappropriated in many areas of the West, and there has been a movement for over 20 years now to protect remaining undeveloped streamflows. Groundwater mining, the extraction of groundwater supplies below the amount annually replenished, is also a concern in some areas of the West. As a result, cities needing additional supplies have looked instead to opportunities to purchase water rights traditionally used in irrigation and transferring the water to urban uses.

Early transfers involved a simultaneous change in land and water use, so negative impacts from the transfers raised few concerns. Urban areas encroached onto adjacent agricultural lands, and either formally or informally, the water historically used for irrigation became part of the urban water supply. From a purely economic perspective such transfers make good sense, as the value of water used in agriculture is generally much lower than the value of water in urban uses. Especially when compared to the cost of developing new supplies of water, transfers of agricultural water are less costly to the cities in many cases.

Over the past several decades the nature of water transfers has changed, and impacts from the transfers have in some cases become more severe. In Colorado, we have seen cities purchasing water rights used on agricultural lands far removed

from city boundaries, and the purchases are of larger blocks of water and land. Many who live in Colorado front-range cities, rural southeastern communities and western slope towns would agree that we need to place some limits on water transfers while recognizing the growing urban population with its ever-enlarging straw. The problem, and the effort to address the problem, affects us all.

The Natural Resources Law Center, in 1989, was involved in a six-state study of water transfers in the West, and examined water transfer activity in Colorado during a ten-year period from the mid-1970s to the mid-1980s.¹ In this study, we looked in detail at areas in the state with significant water transfer activity including the lower Arkansas Valley, and South Park. Our results, and contemporary research on the effects of such transfer activity, reveal that, as water transfers involve more distance and larger amounts of water, the impacts on the local economy and resources can be dramatic, raising concerns in Colorado and other states in the West with similar water transfer patterns.

Concerns over these types of transfers led some states in the West to review their water transfer policies. Our research looked at water transfer experiences in Colorado and other western states. It examined strategies states are taking to adequately address concerns about traditional agricultural to urban water rights transfers, while ensuring that water be available for expanding urban needs.

As Daniel Kemmis, Mayor of Missoula, Montana and a visionary western writer, so eloquently argues, solving the West's problems today requires a return to our tradition in the West to get things done through cooperation. Many of the ideas discussed in this summary are small steps in this direction. They demonstrate the power of individual initiative at tackling, sometimes with risk and often with learning along the way, the question of how best to address our water supply concerns. Hopefully, they represent just a sampling of what can be done.

Water Transfer Experience in Colorado

In the late 1800s, the City of Colorado Springs needed to improve and expand its water supply from Fountain Creek and intended to do so by purchasing senior agricultural water rights and transferring their use to the city. The Colorado Supreme Court explicitly supported the right of the city to separate the use of the water right from the land on which it had been applied and to move it for use within the city.

Since this decision more than 100 years ago (if not before) water rights in Colorado have shifted from agricultural to urban use with some regularity. Most of these transfers have occurred in the rapidly urbanizing Front Range of the state. The rate with which this was occurring in the 1960s and 1970s caused some observers like Raymond Anderson to sound the alarm. Anderson and other colleagues at Colorado State University carefully researched the transformation of agricultural lands in the northern part of the Front Range at this time and noted the loss of high-quality agricultural lands and the weakening of the agricultural economy.

South Park

The South Park area of Colorado, referred to by some as Colorado's Owens Valley, is probably the earliest example in this state of cities buying up large areas of distant agricultural lands to transfer the water rights to urban uses. A high mountain valley averaging 9,000 feet in elevation, South Park contains the headwaters of the South Platte River which, on its way eventually to the Platte and Missouri Rivers, passes through Denver and other Colorado Front Range metropolitan centers. In the 1930s Denver began the process of buying large cattle ranches in South Park and transferring the irrigation water used to grow alfalfa and other pasturage to its urban water supply. In the 1970s and 1980s Aurora and Thornton acquired most of the remaining ranches and water rights. Irrigated acreage in South Park declined from 35,000 acres in 1969 to less than 4,000 acres in 1991.

Lower Arkansas Valley

Transfers of agricultural water from the Lower Arkansas Valley in Colorado have captured considerable attention in recent years. Agriculture continues to be a central part of the economy of this part of the state, but the loss of sugar beet processing facilities in the 1960s and 1970s (and thus the demand for production of sugar beets) noticeably weakened the agricultural economy in the area. Major purchasers of agricultural water rights in the Lower Arkansas have been the City of Pueblo and Pueblo West Metropolitan District, located upstream on the Arkansas River; the City of Colorado Springs, located upstream on a tributary to the Arkansas; and the City of Aurora, located east of Denver in the South Platte drainage.

Crowley County

Perhaps the most dramatic effects of agricultural to urban water transfers can be seen in Crowley County. Construction of the

Colorado Canal in the 1890s made possible the irrigation of much of the land in this area. Unfortunately, the water rights associated with the canal are relatively junior in priority on the Arkansas River, and the supply of water to those holding shares in the Colorado Canal varies dramatically from year to year. Most of the shares now are owned by Colorado Springs and Aurora, and irrigated acreage in Crowley County has declined from 68,000 to 4,000 acres.

Rocky Ford

The purchase and transfer of a majority of the shares in the Rocky Ford Ditch serving land near Rocky Ford, Colorado to Aurora provoked an aggressive response by other water users in the Lower Arkansas. Most of these shares had been owned by the American Crystal Sugar Company and were sold to a Canadian investment company after the sugar company closed its processing facility in Rocky Ford in 1977. As a condition of changing the water right Aurora agreed to establish a natural ground cover on all lands to be taken out of irrigation.

Fort Lyon Canal

In December 1991, a company wholly owned by Houston-based Coastal Corporation offered shareholders in the Fort Lyon Canal Company about \$2,200 per share of canal company stock on condition that it must acquire a majority interest in the canal company. Transfer of this amount of shares would mean the dry-up of at least another 48,000 acres of irrigated land in the Lower Arkansas — close to the total of 56,000 acres taken out of irrigation in the Lower Arkansas since the 1950s. The company's offer was unsuccessful, but it heightened awareness of the concerns raised by such transfers.

Thornton

Finally, the City of Thornton's purchase of 47 percent of the shares of the Water Supply and Storage Company in the Poudre Basin in northcentral Colorado prompted a strong reaction from water users in this area. Thornton purchased shares through private brokers who did not inform the sellers of the actual purchaser. Thornton is located 50-60 miles to the southeast of the lands irrigated by Water Supply and Storage, and the new water use will require construction of a pipeline to move the water out of the Poudre to the city. The change of water right proceeding involved 17 weeks of trial at a substantial cost to all parties.

Changes of water rights involving a change from irrigation to other types of use are common in Colorado. Between 1975 and 1984, 858 applications were filed seeking a change of water use. About 67 percent of this total involved a proposed shift in water use from primarily agricultural to primarily non-agricultural purposes. As of July 1988, 689 or 80 percent of the applications had been approved.

Colorado Water Transfer Law and Policy

Policy in Colorado in general supports the ability of a water right owner to sell that right to another and to make changes of use of the right, subject only to the condition that no other water rights are thereby injured. Several legal categories of water are distinguished under Colorado law, and the ability to transfer, and the rules that may condition or limit this ability, differ somewhat among the categories. For example, if groundwater is within one of eight designated groundwater basins within the state, it is legally classified as "designated groundwater," and its transfer must initially be authorized by the state ground water commission. Other legal categories that are important to a transfer of water in Colorado are imported or foreign water, salvaged water, conditional water rights, contract water, interstate water and tribal water.

A water right, under Colorado law, is a property right and, more specifically, a priority right to the use of water. Based in part on this view of water rights as property rights, in the late 1800s Colorado courts ruled that a water right can be transferred and changed so long as there is no injury to other water rights holders. In 1899, the ability to change a water right was recognized in a state statute.

Water rights contain a number of elements, most of which may be changed under Colorado law. Generally, there is a specific point of diversion. There is a specific rate of diversion in the case of direct flow rights and a volumetric quantity of water in the case of storage rights. Water rights are characterized by specified types of use and have an implied or express time and place of use. By statute, change may be made in the point of diversion, in the type, place, or time of use, or between direct flow and storage rights.

Historic Use

Historic use patterns provide a potential limitation on the transfer of a water right. In considering how much water might be changed or transferred, courts look behind the water right decree (court document recognizing the right) to the historical practice of diversion and beneficial use of the water. Many of the early decrees provided rates of diversion well in excess of the water actually diverted and used. To allow an enlarged use of water based on the decreed amount might result in injury to subsequent appropriators. In 1962, the Colorado Supreme Court clarified the characterization of this unused water in concluding that, regardless of the decreed diversion rate or amount, a water right exists only to the extent of actual beneficial use. Therefore, the unused quantity of water should not be called "abandoned," because it had never been legally perfected. Regardless of how it is characterized, water decreed but not historically used may not be transferred.

Duty of Water

Another consideration during review of change requests is how much water is sufficient for the purpose for which the

appropriation was made. This is called the "duty of water" and, under Colorado water law, diversions are limited to this amount even if this is less than the decreed rate of diversion. Duty of water, a term in use in several western states, has been defined by the Colorado Supreme Court as the amount of water, which, by careful management and use, without wastage, is reasonably required to be applied to any given tract of land for such period of time as may be adequate to produce a maximum amount of such crops as ordinarily grown. While the duty of water can work as a ceiling in calculating the transferable quantity of water, historic use could actually be less than the duty, in which case the amount historically used would become the ceiling.

In transfer proceedings, Colorado courts will consider the scope of the original water right, and how that right has been historically exercised. In many of the early decrees the elements of the water right were not clearly specified. Direct flow rights are commonly described in terms of a maximum flow rate with no volumetric limitation. Similarly, there is often no specified time of use, although a time of use might be implied by the type of use. For example, an irrigation water right is generally limited to the usual irrigation season in the area of use whereas domestic water use is assumed to be year-round. Where water rights are decreed for multiple types of use, which is not unusual in Colorado or other areas of the West, establishing a time, place, and quantity of use becomes more problematic, and will depend on actual use.

Injury to Other Water Rights

Once the water right is more completely defined, considering historic use and the duty of water, other provisions of Colorado law may further affect the amount of water that can be transferred, or otherwise condition the proposed new use of the water right. The most fundamental of all requirements is that the change not injuriously affect the owner of, or persons entitled to use water under, a water right. The issue of injury to other water rights is the most commonly disputed aspect of changing or transferring a water right. Injury can occur if the change of use of a water right causes an increase in depletion of the stream or a change in the timing of stream flows relied on by other water rights. Injury is inevitably a question of fact, and extensive engineering analysis may be involved in making such a determination.

But even if a proposed transfer would cause injury, the transfer may go forward. In order to encourage transfers, Colorado law specifically provides that injury to other water rights may be offset by imposing terms and conditions upon the transfer. These include setting parameters on the new use of water and relinquishing part of the right being changed or a related water right. Since the effects of a proposed transfer may not be known until implementation, Colorado law also allows the court to reconsider the question of injury for some specified period after approval.

Injury to Water Delivery Systems

Colorado law also protects water users from injury to their water delivery system in situations where the users share common water facilities and water is to be removed from the system for use elsewhere. Conditions will be imposed on the transfer to protect the remaining water users. For example, a shareholder in a mutual ditch company proposing a water rights transfer may be required to relinquish a portion of his water right to compensate for ditch losses resulting from the transfer. And the party seeking to sever his ditch company water right from his irrigated lands may be required to dry up his lands and take them out of the ditch company's system. These water delivery protections are common in other western states as well.

Mutual ditch companies may have valid concerns when water is transferred within or out of their system. Under Colorado law, these companies can impose reasonable restrictions on transfers in their by-laws, such as requiring transfer approval by the companies' Board of Directors, and limitations on the manner, type and place of use. For example, The Rio Grande Canal Water User's Association in southern Colorado limits the use of water to irrigation purposes, and makes the water appurtenant to the land. Other companies, like the San Luis Valley Irrigation District, allow transfers of water only to other lands within the district, and even then, subject to the approval of the Board of Directors. These types of restrictions, if reasonable, will generally be upheld by a court.

Conditioning Water Transfers to Prevent or Mitigate Third Party Impacts

Traditionally, western states have uniformly protected other water rights while considering a request for a change of use of an existing water right. In general, appropriators have a right to the continuation of stream conditions existing at the time of appropriation. Beyond this, many states examine impacts on water users sharing the same delivery system as that of the transferor. Other potential consequences of a transfer, such as degradation of water quality or effects on the local economy, typically were not considered during the transfer proceeding. State laws, however, have been changing, in recognition of these third party impacts. Increasingly, states are requiring that both injury to water rights and impacts on other values be addressed as a condition of water transfers. In addition, a few states are taking a more comprehensive view of potential impacts of water transfers, and have adopted, or are considering adoption of, a statutory scheme that sets out these broader concerns.

Water Delivery Impacts

In the West, where water sources are far apart and supplies often scarce, water supply systems have developed to move the water from where it is found to where it is needed. These systems, managed by a variety of public and private organizations, may involve an intricate web of canals radiating out from the main stream or source. From these canals many water users take water, including agricultural users who

Agricultural Water Transfers

When water is removed from agricultural lands, the impact on the land can be severe. Weeds can replace valuable crops and threaten a neighbor's productive fields. Additionally, in many parts of the West, exposed soils may be blown away, wearing down the topsoil of the land and possibly creating problems for adjacent farms and houses. For this reason, the Colorado Legislature recently enacted provisions authorizing the water court to require the revegetation of lands from which irrigation water is removed. Revegetation is defined as the establishment of a ground cover of plant life demonstrated to be, without irrigation, reasonably capable of sustaining itself under the climatic conditions, soils, precipitation and terrain prevailing for the lands. Since, generally, a portion of the water to be transferred is used to accomplish the revegetation, the water court retains jurisdiction over the transfer until the revegetation requirement is satisfied.

Water Transfers in Other Western States

Western states generally follow Colorado law in their recognition of water as a property right. They differ, however, in the way they encourage or deter the transfer process, and the factors considered in deciding whether, and under what conditions, to allow such transfers or reallocations to occur.

divert water for use on their farms. Water supply systems have developed so that users in the system are necessarily linked, sharing responsibility for the cost of maintaining the system and sharing water costs in terms of evaporation and seepage losses incurred in getting the water from its source to their farms. In situations where a low-volume flow of water in a ditch or lateral would quickly dissipate or evaporate, they rely on the larger flow related to the many users in the system to create an adequate "head" to carry water along the ditch to the headgates.

Because of this interconnectedness, transfers of water both within and out of the system raise concerns for the remaining water users. Reducing the amount of water that is delivered through a ditch may reduce the head of water so that some users' water no longer reaches their farm or, if it does reach the farm, cannot be taken out by the user's original diversion structures. A transfer may also affect evaporation and seepage losses; for example, where the velocity of the ditch or stream is significantly reduced by the transfer.

In general, the costs of operating and maintaining the system are not proportionately reduced and, in fact, may increase as a result of a transfer and resulting change in patterns of delivery because, for example, there are fewer parties to share ditch costs although the ditch costs are the same. As a result, although the transfer of a water right in appropriation states has been

traditionally limited only by the no-injury rule, several states now explicitly protect the remaining water rights holders when a transfer is proposed. In a few states, including Colorado and Nevada, the obligation to consider these types of water delivery impacts rests with the state entity charged with administering water transfers.

Other western states take a somewhat different approach to protect water delivery systems by requiring or allowing the water supply organization to consider the impacts. Idaho and Arizona *require* that the water supply organization consent to the transfer. In Idaho, no water right represented by shares of stock in a corporation may be changed or transferred without the corporation's consent. Standards have not been developed to clarify what may and may not be considered by the corporation in denying or conditioning a transfer. Arizona law requires prior approval and written consent by the water organization for all transfers of water rights from lands within irrigation districts, agricultural improvement districts, or water user associations.

Similarly, Wyoming law requires a party requesting a change of the point of diversion and means of conveyance to have the consent of the "other owners" of the ditch associated with both the old and new use. While Utah statutory law does not require the consent of the water supply organization for proposed transfers, such consent was required in a recent Utah Supreme Court case -- at least for mutual ditch companies. In a procedural variation, New Mexico allows ditch companies to object to the transfer of shares of its water in the transfer proceeding itself. In a New Mexico court case, two ditch associations filed protests to the proposed transfer of shares of their irrigation water supply to a large-scale commercial and residential development.

Regardless of which approach is taken by the states -- requiring the state administrator to consider harm to water delivery systems or leaving that decision to the district or company -- many states now specifically seek to protect the original water delivery systems from a range of adverse effects that might result from an out-of-system transfer.

The Public Interest

Several western states now address potential impacts, aside from injury to other water rights, during the water transfer process. They have developed limits on water transfers for the purpose of protecting a variety of non-water right interests such as harmful economic or environmental effects. These types of conditions all fall under the general "public interest" or "public welfare" heading; they are intended to protect public values and address public concerns as opposed to preventing injury to individual water rights.

Typically, state statutes provide little guidance to administrators in determining public interest. For example, a Nevada law requires the state engineer, in considering applications for changes of water rights, to determine whether the proposed change "threatens to prove detrimental to the public interest." Factors to be considered in defining the public interest are often

lacking. By comparison, Idaho law specifically defines local public interest as the affairs of the people in the area directly affected by the proposed use. Idaho also requires a finding that the proposed transfer would not change the agricultural base of the local area.

Idaho and Nevada are two of ten western states that require, by statute, case law, or administrative procedure, some type of public interest review for proposed water transfers. The types of concerns embodied by these provisions vary from state to state, but include (1) local economic impacts; (2) net benefit to the state; and (3) environmental impacts. In those jurisdictions requiring that transfers be conditioned or denied to protect the public interest, conditions have been as varied as the range of interests protected under this standard. States may require the transferor to submit data on the economic impacts of a proposed transfer. Transfer applications could be denied altogether if harm to the public interest cannot be adequately mitigated.

Given the legal authority to condition or deny transfers to protect public values, how have state water administrators exercised this authority to condition or deny requests to change water from agricultural to urban use? Several state administrators report that public interest concerns are increasingly raised during transfer proceedings. But, in fact, very few agricultural to urban transfers have been conditioned or denied for public interest reasons. Many of the public issues that are raised during transfer proceedings are not expressly incorporated into the final order approving or denying the application. Moreover, some public concerns may be addressed through outside negotiations that do not become a part of the transfer record. In the end, a court or state water administrator may base a decision to deny or condition a proposed transfer on the more traditional "no injury to water rights" standard. To a decision maker, the no-injury standard, if applicable, may provide a more legally defensible, and thus less likely to be challenged, foundation for conditional approval or outright denial of a transfer application. For whatever reason, administrative and court decisions to date may not accurately reveal the extent to which public interest factors are considered in agricultural to urban water transfers.

Pacific Power and Light Company--One example is the effort of Pacific Power and Light Company in Wyoming to obtain a water supply for its Dave Johnson Power Plant near Glenrock. In 1980, Pacific Power filed an application to transfer irrigation water rights from the North Platte River and one of its tributaries near Saratoga to its power plant, 223 miles downstream. In reviewing water transfer proposals, the Wyoming Board of Control must consider, in addition to issues of injury to other water rights: (1) the economic loss to the community and the state if the use from which the right is transferred is discontinued; (2) the extent to which such economic loss will be offset by the new use; and (3) whether other sources are available for the new use. Transfer applicants are required to provide data on the economic effect of a proposed water transfer whenever economic impact is a concern.

In 1981, the Board rejected Pacific Power's transfer application.

While the Board seemed most disturbed by the great distance the water right was to be moved, denial of the application was based on several reasons including the lack of adequate evidence to determine the transfer's impact (including those caused by the generation of electricity for possible out-of-state use) on the economy of Carbon County and an inadequate showing by Pacific Power that it had considered sources of water supply closer to the power plant.

Eleven years later Pacific Power was before the Board on a different transfer application, again involving a change of water rights from irrigation use to industrial use and, once again, involving a proposed use at the Dave Johnson Power Plant. The water rights in this proposal were from the Douglas Canal in Converse County, much closer to the power plant. As proposed, the diversion point would be moved from the canal 10.7 miles upstream to the intake system for the power plant. The Board approved the Douglas Canal transfer with little discussion of the economic impacts.

New Mexico's Sleeper Case--A second example of a state's application of public welfare considerations to proposed water transfers is the "Sleeper" case in New Mexico. A 1985 decision of a district court in New Mexico rejected a water transfer application because of the economic impact the transfer might have on a northern New Mexico community. The applicant, Tierra Grande Corporation, had purchased land and water for the purpose of creating a recreational lake as part of the development of a large ski resort near Enseñada, New Mexico. The new use would require the retirement of approximately 78 acres of previously irrigated land. Before the State Engineer, an irrigation user organization, the Enseñada Land and Water Association, protested the transfer, claiming that the proposed transfer would impair existing rights and be contrary to the public interest. Despite the Association's protest, the State Engineer approved the transfer.

The Association appealed the State Engineer's decision to the state district court, which focused on the impact the transfer would have on the local culture, rather than a strict balancing of economic benefit, and reversed the State Engineer. Evidence of various community and cultural impacts that would result from the transfer had been introduced. Further, it was argued that agricultural lands would be permanently dried up, and the remaining water users along the ditch would be burdened with an increased financial obligation for maintenance. The court concluded that the living culture of the northern New Mexico region is recognized as possessing significant value that cannot be expressed in monetary terms, and rejected applicant's assumption that increased economic benefits are better than preserving a cultural identity.

Reversing the district court, the New Mexico Court of Appeals found that state water law in effect at the time of the application

did not allow the court to consider any public interest factors during a transfer application proceeding. The only valid consideration under the controlling statute was injury to other water rights. Since the transfer would not harm existing water rights, the application could not be denied.

Las Sierras Development Project--More recent New Mexico cases involving the transfer of water out of agricultural use are subject to 1985 amendments to New Mexico water law allowing the State Engineer to consider public welfare. In 1992, the State Engineer denied an application to change surface irrigation water rights to groundwater rights for domestic, commercial and municipal uses. The water rights, once changed, were to be an integral part of the proposed Las Sierras development project, which included residential subdivisions and commercial enterprises. In denying the application, the State Engineer found that the amount of water that could be transferred would be less than the amount required for the full development of the project, and ruled that the public welfare is not well served by approval of only a portion of the water supply required for a proposed planned development project in which the ultimate water requirements are known. Fleshing out the meaning of New Mexico's public welfare criteria is thus left to future decisions.

Summary

As the foregoing examples illustrate, many western states provide some mechanism whereby potential impacts from water transfers can be considered and, in some cases, mitigated. In contrast to the traditional no-injury standard, however, these types of considerations are often subjective, guided by few or no standards, and may be time consuming to identify and evaluate. For these reasons and others, many state water administrators and judges remain hesitant to base water transfer decisions on public welfare considerations.

Both California and Kansas have taken a comprehensive, "big picture" view of water transfers. With some provisions, like those addressing conservation practices, these states are evaluating whether the transfer applicant in fact *needs* the water requested. With others, the provisions instead assume the water is needed, and focus on whether the social, economic and environmental consequences on balance are acceptable, considering the welfare of the state as a whole.

While some states in the West are attempting to encourage water conservation in the context of water transfers, other states are moving to directly mandate more efficient use of water.

NOTE: Part 2 of Agricultural to Urban Water Transfers in Colorado will discuss water conservation, water banking and dry-year options.

This article is a summary of CWRRI Completion Report No. 177, *Agricultural to Urban Water Transfers in Colorado: An Assessment of the Issues and Options*, by Teresa A. Rice and Lawrence J. MacDonnell of the Natural Resources Law Center, The University of Colorado. The report is available from the CSU Bulletin Room, 115 BRB Building, Colorado State University, Fort Collins, CO 80523. Phone: 303/491-6308. Price: \$7.00.

CSU STUDENT WINS NATIONAL AWARD FOR DISSERTATION

Dr. David G. Wagner's dissertation, "Consumptive Water Use by Remote Sensing and GIS Techniques for River Basins," has received the UCOWR award for best dissertation in the category of Engineering and Physical Science. The Universities Council on Water Resources (UCOWR) sponsors this annual national competition.



David Wagner

Professors Terence H. Podmore and Roger M. Hoffer were co-advisers for Wagner's Ph.D program of study at Colorado State University. Podmore, Professor of Agricultural and Chemical Engineering, described David's work as "...unique in that it couples for the first time remote sensing of irrigated areas with geographic information systems (GIS) to determine an estimate of basin water use. David was able to obtain a very close agreement (within 3 percent) between his remote sensing/GIS approach and a conventional water volume balance. Roger M. Hoffer is Professor of Forestry and Remote Sensing and

Director of the Remote Sensing and GIS Program at Colorado State. Hoffer says the results David obtained, when applied operationally, could have a tremendous economic impact, particularly in arid climates such as the American West and internationally in Asia, Africa and the Middle East.

David conducted his research at the USDA-Agricultural Research Service offices in Fort Collins. The model he developed, he says, is the first step toward a broader and more comprehensive goal that will provide a measure of evapotranspiration spanning multistate large river basins or continental-scale agricultural areas. The dissertation research correlated the Landsat satellite remote sensing technologies to evapotranspiration computation methodologies that are time-proven and legally acceptable for water rights adjudication within the U.S. judicial system. But Landsat data are relatively expensive and available only on 16-day repeat visit cycles. Now, with confirmation of the use of Landsat spectral data as a valid method of directly estimating evapotranspiration, the twice-daily revisit potential of the TIROS weather satellites can be correlated to the calibrated test river basin and the Landsat 5 TM satellite data.

The advantages of the TIROS-based AVHRR sensors and the large coverage will allow inexpensive, easily downloaded, spectrally compatible satellite data to be used for evapotranspiration estimation. The evapotranspiration model developed in this research is to be the test bed for calibration of the AVHRR daily weather satellite data to the Poudre River Basin. The ultimate goal for this research program is near-real time evapotranspiration forecasting using weather satellites for large-scale arid sections of the United States and other arid lands of the world wherever there is satellite coverage by the TIROS satellites.

BEST MANAGEMENT PRACTICES FOR IRRIGATED AGRICULTURE

by

Reagan Waskom and Grant Cardon

Department of Soil and Plant Sciences, Colorado State University
and Mark Crookston

Northern Colorado Water Conservancy District

The prevention of groundwater contamination is particularly important because, once polluted, groundwater is very difficult and expensive to clean up. Concern over the use of chemicals in irrigated agriculture led the Colorado legislature to pass the Agricultural Chemicals and Groundwater Protection Act (SB90-126) in 1990. This Act declares that the public policy of Colorado is to protect groundwater and the environment from impairment or degradation due to the improper use of agricultural chemicals, while allowing for their proper use.

Rather than legislate overly restrictive measures, however, Colorado has opted to encourage the voluntary adoption of Best Management Practices (BMPs). Voluntary adoption of these

measures by agricultural chemical users will help prevent contamination of water resources, improve public perception of the industry, and perhaps reduce the need for further regulation and mandatory controls.

Management practices for the use of irrigation water can help increase efficiency and uniformity, and reduce contamination of water resources. Due to the fact that each farm is unique, producers must evaluate their particular system and determine which BMPs are suitable for their operation. Irrigation management BMPs include: irrigation scheduling, equipment modification, land leveling, tailwater recovery, proper tillage and residue management, and chemigation safety.

Examples of BMPs by category

Source Controls

- * Voluntary restriction of a labeled pesticide by manufacturer
- * Mandatory label restrictions by EPA
- * Local restriction of nitrogen fertilizer application

Structural Controls

- * Sprinkler, drip, and surge Irrigation
- * Chemigation backsliphon devices
- * Irrigation tailwater recovery systems
- * Grass waterways and filter strips

Cultural Controls

- * Conservation tillage
- * Cover cropping
- * Crop rotation
- * Application techniques, such as split N application

Management Controls

- * Irrigation scheduling
- * Integrated pest management (IPM)
- * Soil and water analysis
- * Recordkeeping of pesticide and fertilizer use

Source controls are considered the easiest to regulate and implement. They include restriction or removal of a particular pesticide or nutrient source. Such controls are generally accomplished by the EPA for pesticides, or at the state or local level for fertilizers.

Structural controls usually require some capital outlay and maintenance, but are very effective in controlling water and sediment movement. Cost sharing of these types of controls is often available through the USDA.

Cultural Controls include cropping and tillage practices which either minimize pest problems and reduce the need for chemical controls or maximize nutrient use efficiency by conservation and crop rotations.

Managerial controls are management strategies and tools that minimize pollutant losses in surface or ground water. These methods are much more site specific than source or structural controls. A higher level of management enables producers to consider both environmental and economic impacts when choosing production methods.

BMPs for City Dwellers--In addition to BMPs for irrigated agriculture, the guide also offers helpful hints for urban water quality protection.

To obtain a free copy of *Best Management Practices for Irrigated Agriculture, A Guide for Colorado Producers* contact CWRRI at 491-6308 or Soil and Crop Sciences Department at 491-6517.

This publication is made available through the collaborative efforts of the Colorado Water Resources Research Institute, the CSU Soil and Crop Sciences Department, Cooperative Extension, and the Northern Colorado Water Conservancy District. The research was financed in part by the U.S. Department of the Interior, Geological Survey, through CWRRI.

What Can City Dwellers Do? BMPs for Lawn and Garden Care

Overapplication of nitrogen fertilizer and pesticides to lawns has been shown to cause groundwater contamination in some cases. If these chemicals are properly applied to turf at labelled rates, and no heavy rainfall or irrigation occurs shortly after application, research has shown that they cause little environmental hazard.

- * Apply all pesticides at the lowest effective labelled rate.
- * Time chemical application for optimum effectiveness. Do not apply pesticide immediately prior to irrigation unless specified by the label.
- * Apply only enough irrigation water to satisfy plant needs. Do not leach soils after pesticide or fertilizer application.
- * Store all pesticides and fertilizers in a safe, dry place with the labels intact.
- * Check with your county Department of Natural Resources prior to disposing of any lawn care chemical.

WATER RESEARCH AWARDS

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

Colorado State University, Fort Collins, CO 80523

- Summary of Economic Benefits of Endangered Species**, John B. Loomis, Agricultural & Resource Economics. Sponsor: USDA/U.S. Forest Service, Pacific SW.
- Assessment of the Relation of Mining to Water Quality**, John D. Stednick, Earth Resources. Sponsor: USDA/USFS Rocky Mountain Experiment Station (RMFRES).
- Partnerships for a Water Quality Workforce**, Neil S. Grigg, Civil Engr. Sponsor: Environmental Protection Agency (EPA).
- Effects of Sediment Contaminants on Macroinvertebrate & Fish Assemblages on Lower Lakes...**, William H. Clements, Fishery & Wildlife Biology (F&WLB). Sponsor: U.S. Fish & Wildlife Service (USFWS).
- Operation and Maintenance of Flood Control Channels**, Chester C. Watson, Civil Engineering. Sponsor: U.S. Army Corps of Engineers (COE).
- Population Modeling**, Gary C. White, F&WLB. Sponsor: Colorado Division of Wildlife (CDOW).
- Population Estimation**, Gary C. White, F&WLB. Sponsor: CDOW.
- Evaluation of Injuries Caused by Electrofishing**, Eric P. Bergersen, F&WLB. Sponsor: CDOW.
- Integrative Riparian Ecosystem Modeling Along the Yampa River, Colorado**, Ellen E. Wohl, Earth Resources. Sponsor: The Nature Conservancy
- Agricultural Pesticide Recovery**, Ronald F. Jepson, Cooperative Extension. Sponsor: Colorado Department of Health (CDOH).
- Pressure Flow Scour**, Steven R. Abt, Civil Engr. Sponsor: Colorado Department of Transportation.
- Mercury Deposition in Precipitation & its Movement in Upland & Peatland Ecosystems**, David S. Bigelow, Natural Resources Ecology Lab (NREL).
- Impact of Historical Landcover & Land Use Change on Weather & Climate**, Roger A. Pielke, Atmospheric Science. Sponsor: U.S. Geological Survey (USGS).
- Developing Partnerships & Identifying Research Priorities for the Colorado Ecosystem...**, Joyce K. Berry, Forest Sciences. Sponsor: RMFRES.
- ***Gas Phase Transport of Volatile Organic Compounds in the Vadose Zone**, David McWhorter, Agric. & Chem. Engr. Sponsor: University of Waterloo.
- ***Incremental Assessment of Habitat, Discharge & Modification for Low Flow**, Steven R. Abt, Civil Engr. Sponsor: COE.
- ***Water & Nitrogen Management to Protect Ground Water Quality**, Merlyn J. Paulson, Horticulture. Sponsor: USDA/ARS.
- ***Global Analysis of the Earth Energy Budget & Water Cycle Using Satellite Observations...**, Thomas H. Vonderhaar, Atmospheric Science. Sponsor: National Aeronautics & Space Admin.
- ***Subsurface Micro-Irrigation Using Buried Dripline**, Anm Mahbub-Ul Alam, Cooperative Extension. Sponsor: Colorado Water Conservation Board.
- ***Irrigated Agriculture Management Improvement Process**, Wayne Clyma, Agric. & Chem. Engr. Sponsor: USDA/ARS.
- ***Evaluating Log-Drop Structures as Habitat Improvement for Trout**, Kurt D. Fausch, F&WLB. Sponsor: CDOW.
- ***Training & Education for Agricultural Chemicals & Groundwater**, Reagan M. Waskom, Soil & Crop Sciences. Sponsor: Colorado Department of Agriculture (CDOA).
- ***Trophic Interactions in Colorado Reservoirs - Bioenergetics**, Brett M. Johnson, F&WLB. Sponsor: CDOW.
- ***Structural & Functional Roles of Course Wood Debris in Tropical Stream-Riparian- Upslope...**, Alan P. Covich, F&WLB. Sponsor: NSF.
- ***Mining & Water Quality: Abandoned & Inactive Coal Mines**, Denis J. Dean, Forest Sciences. Sponsor: RMFRES.
- ***Development & Application of Biological Assessment Techniques to Servicewide Water Resources...**, Glenn E. Haas, Natural Resource Recreation & Tourism. Sponsor: National Park Service (NPS).
- ***Long-Term Ecological Measurements in Loch Vale Watershed, Rocky Mountain National Park**, David M. Swift. Sponsor: NPS.
- ***Quantification of Federal Reserved Water Rights for National Park Purposes**, Thomas G. Sanders. Sponsor: NPS.
- ***Studies of the Influences of Land Use & Watershed Processes on Erosion & Stream Sediment...**, Lee H. MacDonald, Earth Resources. Sponsor: NPS.
- ***Modeling Techniques & Tools for Water Resources Management**, Marshall Flug, Civil Engr. Sponsor: NPS.
- ***Field Studies & Modeling of Cropping Systems & Their Impact on Water Quality...**, Gary A. Peterson, Soil & Crop Science. Sponsor: USDA/ARS.
- ***Razorback Sucker Larvae in Canyonlands National Park, Utah**, Robert T. Much, F&WLB. Sponsor: NPS.
- ***Stream Channel Processes at Squaw Creek & Related Technology**, Lee H. MacDonald, Earth Resources. Sponsor: USFS.
- ***Comparative Ecosystematics in Riparian Zones Along Regulated & Unregulated Rivers**, David J. Cooper, F&WLB. Sponsor: NPS.
- ***Hydraulic Assessment of Rangelands Using Rainfall Simulation**, Harold Goetz, Rangeland Ecosystem Science. Sponsor: USDA/ARS.
- ***Fish Habitat Structural Diversity Indices & the Reconstruction of Lake Basin at RMA...**, Eric P. Bergersen, F&WLB. Sponsor: USFWS.
- ***Hydraulic Model Study of Rock Creek & Crested Dam Sediment Management**, Albert Molinas, Civil Engr. Sponsor: Pacific Gas & Electric Co.

University of Colorado, Boulder, CO 80309

- ***Investigations of Natural Groundwater Hazards at the Proposed Yucca Mountain High-Level Nuclear Waste Repository**, Charles Archambeau, Physics. Sponsor: Technology and Resource Assessment Corp.
 - ***TOGA COARE Sea Surface Temperature Products**, William Emery, Aerospace Engineering. Sponsor: Univ. of California.
 - ***Late Quaternary Environments and Climate Change in the Eastern Canadian Arctic, Constructed from Sediment Cores**, Kerstin Williams, Institute of Arctic and Alpine Research (IAAR).
 - ***Eastern Arctic Climate of the Past 2000 Years: The Varved Lake Sediment Record**, Jonathan Overpeck, IAAR. Sponsor: NSF.
 - A Pale Lake Sediment Calibration Network for the Eastern Canadian Arctic**, Jonathan Overpeck, IAAR. Sponsor: NSF.
 - Comparative Response of Moist and Dry Arctic Tundra to Altered Snow and Temperature Regimes**, Marilyn Walker, IAAR. Sponsor: NSF.
 - Arkansas River Needs Assessment**, Lawrence MacDonnell, Natural Resources Law Center. Sponsor: BLM.
 - A Study on the Effects of Minimum Flows on the Metabolism of a Rainforest Stream**, William Lewis, Environmental, Population and Organismic Biology (EPOB). Sponsor: USFS.
 - ***Modeling for Design and Testing of Treatment and Remediation Technologies for Aquifers Contaminated with Organic Wastes**, Tissa Illangasekare, Civil Engineering. Sponsor: Kansas State University.
 - Carbon Balance in Global Arid and Semiarid Lands**, Carol Wessman, Cooperative Institute for Research in Environmental Sciences (CIRES). Sponsor: Colorado State University.
 - ***Effects of Climate Change in the Colorado Alpine: Ecosystem Response to Altered Snowpack and Rainfall Regimes**, Timothy Seastedt, IAAR. Sponsor: NSF.
 - ***Membrane Technology for Wastewater**, Robert Davis, Chemical Engr. Sponsor: NSF.
 - ***The Relationship Between Non-Methane Hydrocarbon Emission and Leaf Carbon Balance in the Boreal Forest: An Approach for Mechanistic Ecosystem Modeling**, R. Ray Fall, EPOB. Sponsor: NASA.
- *Supplement to existing award.

**Research Opportunity
USDA NATIONAL RESEARCH INITIATIVE
COMPETITIVE GRANTS PROGRAM**

The U.S. Department of agriculture has published the program description for the National Research Initiative Competitive Grants Program (NRICGP), 1995. Research areas include:

Natural Resources and the Environment;
Nutrition, Food Safety, and Health;
Animals;
Pest Biology, Biological Control, and Integrated Pest Management;
Plants; Market, Trade, and Rural Development;
Enhancing Value and Use of Agricultural and Forest Products; and
Agricultural Systems Research.

Project types will consist of standard research grants, conference grants, postdoctoral fellowships, and new investigator awards. Deadlines vary depending on the program, with the earliest being November 14 and the latest February 27.

Applicants **MUST** use the new NRICGP application kit, not the old CSRS application kit.

GOPHER access to the Program Description, Abstracts of Funded Research and the NRICGP Annual Reports is also available on the USDA Extension Service Internet Gopher on port 70 of zeus.esusda.gov.

The application kit is not available electronically. Contact your contracts and grants office for more information.

FEATURES

THE COLORADO WATERSHED PROTECTION APPROACH

by

*Paul Frohardt, Administrator
Colorado Water Quality Control Commission
Colorado Department of Health*

The watershed approach to water quality management has attracted a great deal of interest in Colorado and across the country over the last several years. The Colorado Water Quality Forum, in particular, has devoted considerable attention to this issue.

Colorado Water Quality Forum

The Colorado Water Quality Forum was created in 1992 to provide an opportunity for an ongoing informal dialogue among diverse parties representing a broad spectrum of stakeholder interests in water quality management. Participants include water suppliers, industrial and municipal dischargers, environmental groups, and federal, state and local governmental agencies. The adopted mission of the Forum is: To achieve solutions to Colorado water quality issues through communication and understanding, balancing use and protection of the resource.

Monthly Forum meetings are facilitated by the University of Colorado at the Denver Center for Public-Private Sector Cooperation, funded through participant contributions. To date, the Forum has experienced considerable success in improving communication among stakeholders and fostering a more cooperative approach in the administrative and legislative consideration of difficult water quality issues.

Watershed Working Paper

Over the past year, the Forum has focussed attention on watershed planning and management. Several considerations influenced this decision. First, in recent years there has been increasing interest nationally in a more holistic, integrated approach to environmental and natural resources management, such as that embodied in watershed management. Second, there was also a recognition that a number of local and regional watershed protection efforts had been initiated in Colorado. Third, Colorado's water quantity management system has always been organized around watersheds, and in recent years the Water Quality Control Division and Commission had begun to shift toward more of a watershed focus in the organization of the state water quality management system. Fourth, federal water quality program initiatives also have been moving toward an increased watershed protection focus, and watershed management is expected to be addressed in Clean Water Act reauthorization.

In addition, several federal resource management agencies are shifting their efforts toward an ecosystem management approach organized on a watershed basis. Finally, there was a recognition of the potential for watersheds as an appropriate and practical

scale on which to address the integration of water quality and water quantity concerns.

The Forum established a watershed working group that began its efforts by reviewing approximately twenty examples of watershed management approaches from Colorado and across the country. These included a number of local and regional watershed protection initiatives of varying scope, and a few legislative proposals regarding watershed management. The group developed a summary comparison of these examples to identify common elements that appear to be most critical to the success of watershed protection efforts.

This led to a decision to develop a "working paper" to advance communication regarding what was learned from this analysis, and to begin to work toward a consensus regarding an appropriate Colorado approach to watershed protection efforts. The working paper evolved through several drafts. Beginning with a focus on information regarding local and regional watershed initiatives, the paper was expanded to include a description of the statewide watershed management framework, from both a water quality and water quantity perspective.

The paper discusses the definition of "watershed." It suggests that the definition necessarily begins with hydrology: What land mass drains to a water body or water segment of concern? However, to define the appropriate scope of an area to be addressed by a watershed protection initiative, other considerations are also important. These include political boundaries, the nature of the uses sought to be protected, the nature of the problem or problems potentially impacting these uses, the need to identify an area of a manageable size for meaningful communication and coordination, the availability of resources to support the effort, and the extent of public interest in participation in a watershed protection effort.

Local and Regional Watershed Initiatives

The working paper presents the lessons learned from the Forum's review of local and regional watershed initiatives. The overall perspective offered is that voluntary, bottom-up watershed protection efforts are most likely to achieve successful long-term solutions to local and regional concerns. Several critical aspects of such initiatives are addressed. First, the importance of establishing clear goals and objectives is emphasized. Goals and objectives tend to fall into two broad categories: resource restoration and resource protection. Resource restoration efforts attempt to eliminate or mitigate problems that already exist. Resource protection efforts attempt to protect desirable uses or

values of a resource before an unacceptable adverse impact occurs. While such pro-active efforts logically seem desirable, in practice it appears more difficult to sustain stakeholder interest before a problem exists.

Several observations are offered regarding the organization and structure of local and regional watershed initiatives. Formal or informal program management and leadership, with adequate credibility, trust and resources, is noted as a critical element. The importance of an ongoing iterative process of stakeholder involvement and outreach is also emphasized. Unless all interested parties have an ongoing opportunity to participate, a local or regional watershed initiative is unlikely to be successful. Finally, the paper notes the need to integrate the watershed initiative efforts with the operation of existing local, state and federal programs relating to water quality management.

Several implementation tools -- the "nuts and bolts" of a watershed protection initiative -- are described. For example, water quality monitoring programs, the development of total maximum daily loads for critical pollutants, the identification of best management practices for nonpoint sources, and the establishment of point and nonpoint source trading programs are examples of specific tools that may be applied within a given watershed. Evaluating the progress of a watershed management effort on an ongoing basis is extremely important. Because the attainment of goals within a given watershed will typically take many years, ongoing evaluation is critical to a sustained, long-term effort. The paper also identifies key considerations in data collection efforts associated with watershed management.

To be successful, any watershed management effort in the arid west must address the need to integrate and balance water quality and water quantity considerations. The paper describes a best management practice process, developed as a part of Colorado's nonpoint source management program, for involving interested stakeholders in consideration of potential water quality impacts from hydrologic modifications.

The working paper also discusses the tradeoff between voluntary and mandatory approaches to watershed management. While most of the paper is intended to be descriptive rather than prescriptive, this section strongly advocates that voluntary, bottom-up efforts are more likely to achieve the cooperation and consensus necessary for long-term solutions in individual watersheds.

Finally, the need for adequate financial resources for local and regional watershed protection initiatives is addressed. Locating adequate resources even for organizational and planning support for such an effort presents a major ongoing challenge. Development of adequate resources for the implementation of watershed protection projects generally requires leveraging multiple funding sources and in-kind resources. The paper identifies some potential sources of funding which should be explored.

Statewide Watershed Management Framework

The working paper describes the degree to which statewide water

quality and water quantity management in Colorado are organized around watersheds. Colorado's water quantity management system has always been organized around watersheds, based on the prior appropriation system. This system is briefly described, and an overview of the principal roles of the State Engineer's Office and the Colorado Water Conservation Board is provided.

The state water quality management system operates on a cycle. Focused, site-specific ambient water quality monitoring is followed by revision of site-specific water quality standards. Revised standards then form the basis for development of total maximum daily loads and wasteload allocations for critical pollutants at a given location. This analysis is followed by an assessment of the adequacy of current controls to achieve the wasteload allocations necessary to attain the standards. If necessary, discharge permit limitations are revised. Finally, any necessary additional controls, such as improved point source treatment or additional nonpoint source best management practices, are implemented.

Until recently, each of the steps of this cycle occurred in various locations throughout the state on an independent and uncoordinated basis. The paper describes current efforts to apply each element in this cycle with a watershed-specific focus. Several benefits are anticipated from establishing a watershed focus for the various steps in this management cycle, including greater efficiency in allocation of state agency resources, improved public participation, greater effectiveness in achieving the appropriate level of water quality protection, and greater consistency in the requirements established for pollution sources within a given basin.

Finally, this section of the paper addresses the importance of coordination and integration of statewide water quality and water quantity management efforts. The current legal structure is described, as well as evolving efforts to improve communication and coordination in addressing water quality and water quantity management.

Future Challenges and Next Steps

The final section of the paper provides an overview of new directions in environmental and natural resources management that are developing at present. In addition, the paper identifies several questions and challenges posed by these new directions. Hopefully, this discussion will also help contribute to a common starting point as all stakeholders pursue efforts to address the challenges of the future.

The Water Quality Forum is currently disseminating copies of the working paper as broadly as possible. Although the paper is "final" for now, it is anticipated that ongoing developments and further public comment may warrant revision and updating over time. As noted above, one of these developments is Clean Water Act reauthorization. Whenever reauthorization is finalized, the outcome is likely to impact watershed management in Colorado. In the meantime, the Water Quality Forum and others will continue to work together to assure that watershed management efforts serve Colorado's needs and interests.

UNIVERSITY WATER NEWS

Recently Hired Faculty with Expertise in Water Resources

The following faculty with expertise in water resources have recently joined Colorado State University. They serve to exemplify Colorado State University's dedication to the study of water resources in traditional and non-traditional areas.

Mark Fiege

Mark has just been hired in the History Department. He is a 1994 University of Utah history Ph.D., with a specialty in environmental history. His dissertation addressed the changes which took place in the Snake River from the onset of irrigated agriculture to the present. Mark will be teaching an undergraduate course in environmental history, a seminar on the same subject for graduate students, and the United States history survey.

W. Marshall Frasier

Marshall was hired in December 1993 with a research and teaching appointment within the Agricultural and Resource Economics Department. His current research program focuses on policy evaluation with respect to water allocation and quality issues associated with irrigated agriculture in the western United States. Marshall's teaching responsibilities include undergraduate managerial economics.

Dana L. Hoag

Dana is currently responsible for environmental, natural resource, and conservation issues related to agriculture and the policy that governs it. His current interests include environmental indices, soil conservation, waste management, water quality, and sustainable agriculture. His most recent efforts have been focused on how to balance economic benefits from pesticide use with environmental risks. Dana's appointment to the Agricultural and Resource Economics Department is for both research and teaching.

Brett Michael Johnson

Brett was hired in 1992 in the Fishery and Wildlife Biology Department. He is developing an active research program focusing on trophic interactions in lakes and reservoirs. His teaching responsibilities include Fishery Science, Ichthyology, and a graduate level course. Brett's interests include trophic interactions in aquatic ecosystems, fisheries management, effects of angling on food webs, bioenergetics models, and fishery models.

John B. Loomis

A 1993 hire into the Department of Agricultural and Resource Economics, John was listed in the 19th edition of Who's Who

in the West. His areas of specialty include Natural Resource Economics, Public Finance, and Forest Economics. John has published 64 journal articles, 32 proceedings papers or book chapters, and 18 Experiment Station or Department Reports.

Fort Collins/CSU Weather Station Automated

The Fort Collins Weather Station, located near the Lory Student Center on the campus of Colorado State University, has been collecting detailed weather data for the past 106 years. The data collected become a part of the U.S. Historical Climate Network and are available locally from the Colorado Climate Center (and via Internet) and from the National Climatic Data Center. This function will continue, affording the most complete and consistent historical climate records in the Rocky Mountain Region. However, as automated weather stations replace human weather observers, by mutual agreement with the National Weather Service the Fort Collins station ceased taking around the clock (every two hours) aviation weather observations on August 31.

For the past 57 years, a team of well trained and federally certified weather observers, many of them CSU students, had been responsible for weather station operations. However, electronic weather stations now operate at the Fort Collins-Loveland Airport, the Greeley Airport and at Denver International. Cheyenne, Wyoming will get similar equipment in the near future. Human observations at Denver Stapleton will also be discontinued when Denver International Airport opens. The State Highway Department and other government agencies and private businesses have also been deploying weather stations. Pilots, weather forecasters and others will now be relying more on weather radar, satellite pictures and data from automated electronic weather stations.

Nolan Doesken, Assistant State Climatologist at CSU's Climate Center, sees the change as a sign of the times. He says, "The best solution is probably a combination of automation with human assistance, but that is too expensive for most organizations." For more information, contact Nolan Doesken at 491-8545.

Delta Extension Office Awarded Grant

The Cooperative Extension Office of Delta has received a \$37,620 grant from the Colorado Water Conservation Board to conduct research on subsurface irrigation using buried driplines. Several products developed to accomplish subsurface irrigation will be tested and the test crop will be strawberries. Ken Hines of Delta will be the cooperating farmer and the test will be conducted in his field. An advisory committee has been formed for the research project. For information contact Mahbub Alam, Extension Agent-Irrigation, CSU Cooperative Extension, Delta 303/874-5735.

Larry MacDonnell to Leave NRLC

Larry MacDonnell, Director of the Natural Resources Law Center since its beginning, has announced his resignation effective December 31, 1994. The Center is a research and public education program at the University of Colorado School of Law. Under MacDonnell's leadership, the Center grew to be an influential force in stimulating discussion of contemporary resource policy.

A Search Committee to fill the Director's position has been formed within the University of Colorado School of Law. Those wishing to obtain a job description or to send a letter of interest are invited to contact Professor Dale Oesterle, University of Colorado School of Law, Campus Box 401, Boulder CO 80309-0401.

Source: *Resource Law Notes*, Aug. 1994

Environmental Institute at Rocky Flats New Research/Education Consortium Formed

The University of Colorado, Colorado State University, Denver University and the Colorado School of Mines have formed the "Environmental Institute at Rocky Flats" for the purpose of rapidly (less than one month) funding environmental research projects dealing with Rocky Flats issues on each campus. All faculty will be eligible (there will be water-related research). Funding for the Environmental Institute is provided by DOE (administration) and EG&G (research). The contact at Colorado State is Ralph Smith, Associate Vice President for Research.

The Colleges of Engineering at both Colorado State University and the University of Colorado have new deans: Harold R. Jacobs at CSU and Ross Corotis at CU. See the next issue of Colorado Water for more information about them.

WATER SUPPLY

The Surface Water Supply Index (SWSI) developed by the State Engineer's Office and the USDA/SCS is used as an indicator of mountain-based water supply conditions in the major river basins of the state. It is based on snow pack, reservoir storage, and precipitation for the winter period (Nov.-April). During the winter

period snow pack is the primary component in all basins except the South Platte, where reservoir storage is given the most weight. The following SWSI values were computed for each of the seven basins on July 1, 1994 and reflect conditions during the month of June.

<u>Basin</u>	<u>Aug. 1, 1994 SWSI Value</u>	<u>Change From Previous Mo.</u>	<u>Change From Previous Yr.</u>
South Platte	+1.8	+1.6	-1.0
Arkansas	-0.3	+0.4	-3.2
Rio Grande	-1.9	-0.4	-4.8
Gunnison	-2.5	-0.5	-5.7
Colorado	-2.3	+0.7	-6.1
Yampa/White	-3.6	+0.1	-5.0
San Juan/Dolores	-2.5	-0.1	-5.0

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

State Engineer's Office Provides Dial-up Access to Streamflow Data

The Colorado State Engineer's Office provides a touch-tone telephone dial-up service for accessing information on streamflow measurements at gaging stations around the state. The time of streamflow information update varies for different stations, but all stations on the system report every four hours.

The system interacts with users through a set of codes, available from the State Engineer's office,

which are entered by the user via telephone. To obtain this list, call the State Engineer's office at (303) 866-3581.

To access the system, have the list of codes handy and dial (303) 831-7135. Follow the prompting of the system and enter the appropriate codes. The system will tell you current values for streamflow at the stream segments you select.

EDITOR'S IN-BASKET

ARIZONA PROPOSES WATER BANK

The following article appeared in the Fort Collins Coloradoan 9/16/94.

California and Nevada have their eyes on Arizona's hard-won but underused Colorado River water allocation, and a group of Arizona officials is pushing a plan that would protect this state's share while satisfying those states' thirst -- for a price.

The Arizona Water Bank, a proposed marketing agency for Arizona's Colorado River allocation, would sell the state's unused water to Nevada and California and administer the use of the rest within Arizona.

The proposal was announced Wednesday [9/14/94]. California already uses more than its share of Colorado River water, and part of Arizona's presently unused share. Nevada is expected to use its entire allocation in 11 years.

An article in the June/July, 1994 issue of Water Resource, newsletter of the Arizona Water Resources Research Center, describes the water bank idea. Following are excerpts from the article.

Present arrangements allocate 2.8 million acre-feet of Colorado River water to Arizona, 4.4 million acre-feet to California, and 300,000 acre-feet to Nevada. Arizona is using at most 1.6 million acre-feet of its annual allocation, while California uses its full share plus Arizona's unused portion. Rapidly growing Nevada expects to tap its full allocation within a decade.

California wants to continue tapping Arizona's allocation, and Nevada seeks to augment its share of the Colorado River, probably at Arizona's expense. Arizona seeks to control its allocation to ensure its full future use when needed. Despite the divergent goals, the states prefer to resolve the situation among themselves rather than accept a plan proposed by the Bureau of Reclamation. The federal plan calls for interstate leasing of unused water allotments to be authorized by the Secretary of the Interior. The Bureau has circulated a draft of its plan to the

Colorado River Compact states for comment. Reaction to the plan has been less than favorable, mainly because the federal government would gain control of how states manage and eventually sell their allotments of Colorado River water. Arizona Governor Fife Symington threatened to sue over the proposed new regulations.

In response to the Bureau of Reclamation proposal, Nevada and Arizona each have devised their own plans for managing Colorado River allotments. Nevada has proposed establishing a three-state commission of the lower-basin states. According to the plan Nevada, Arizona and California would have equal voice in determining strategies for gaining additional water to support economic development.

Equal voice among three states means Arizona would lose individual control over the management and sale of its unused Colorado River water. Arizona countered by devising its own plan to safeguard its water rights even while selling unused portions -- a "water bank proposal...The proposal would establish a water bank controlled by the state. The bank would acquire unused water allocations for sale to other states or for recharge. The Arizona Department of Water Resources (ADWR) would operate the water bank, with legislative action needed to authorize the bank to acquire water from those with rights to it. Unused water allotments that the bank acquires would be put into a special water category that statute allows to be marketed. Money to acquire the water could come from a legislative appropriation and be repaid by the water bank or from revenue bonds with water contracts for security.

Arizona's plan was presented to all seven members of the Colorado River Compact in July. A technical subcommittee was appointed to review the water bank concept and to report its results at a meeting in Phoenix October 11.

Ten tribes with Colorado River water rights also are meeting to develop a position on water banking. The tribes are expected to review a water banking proposal that recognizes the tribes as equal and separate entities from the states.

New Executive Director for CCEM

The Colorado Center for Environmental Management (CCEM) has a new Executive Director, David Shelton. Shelton was formerly Director of Hazardous Materials and Waste Management Division of the Colorado Department of Health. He has an A.B. degree in Geology from Harvard and a M.S. in Geology from the University of Colorado. CCEM has moved to downtown Denver and is located at 999 18th Street, Suite 2750, Denver, CO 80202. The telephone number is 297-0180; the FAX number is 297-0188.

The Eleventh World Food Day Teleconference Sharing Water: Farms, Cities and Ecosystems

The teleconference will be broadcast live from the studios of George Washington University in Washington, DC Friday, October 14, from noon to 3:00 p.m. Eastern Time. Continuing education credits for participation available in several disciplines. For additional information on the World Food Day Teleconference or other World Food Day resources, contact Patricia Young, National Coordinator, U.S. National Committee for World Food Day. Phone 202/653-2404; FAX 202/653-5760.

WATER UNITS

by Stacey Mellick

USDA-Soil Conservation Service, Cortez, Colorado

GPM, acre-feet, second-feet, miner's inches, how big is a share? Have you ever been asked about these terms, and thought, "I know, but can I define them for someone else?" What follows is a collection of definitions and conversions for water units commonly used by local irrigators.

Miner's inch is a term once used in hydraulic mining and in irrigating in the western United States. Miners were allotted water for sluicing based on the amount of water that would pass through an office one inch square under a head of 4 to 6 1/2 inches, based on locality. This system led to much confusion and was eventually fixed by statute this way:

50 miner's inches = 1 second-foot in
Idaho, Kansas, Nebraska, New
Mexico, North Dakota, South
Dakota, Utah, and Washington

40 miner's inches = 1 second-foot in
Arizona, California, Montana,
Nevada, and Oregon

38.4 miner's inches = 1 second-foot
in Colorado

The terms second-foot, cubic foot per second, and foot of water are interchangeable. Cubic feet per second (cfs) is a common measurement in pipes and ditches. To convert to gallons per minute (gpm), the common unit for sprinklers, multiply cfs by 448.8 to get gpm. One cubic foot per second (cfs) is also about one acre-inch per hour or two acre-feet per day. An acre-foot is the amount of water required to cover one acre one foot deep. In southwestern Colorado near Cortez, one share of Montezuma

Valley Irrigation (MVI) water is 1/80 of a cfs or 5.61 gpm. As a rule of thumb, 1.1 MVI shares per acre is needed to avoid deficit irrigation. One share of Summit water is 1/12 to 1/10 of a cfs or 37.5 to 45 gpm. 45 gpm is a full share.

So, how did one share of MVI come to be 1/80 of a cfs? In the 1880s the first irrigation company in the area set that figure, probably taken from research done by a Frenchman in the 1600s who published figures on how many acres one cfs would irrigate in differing climatic regions. For southwestern Colorado, it is 83 acres. This figure is very close to what is actually needed. As for the Summit system, the origin of their share size is unknown.

Measurements in ditches are usually done through a Parshall flume. The depth of water is measured in inches off a scale in the flume, then easily converted to cfs with the use of a chart. As more ditches are replaced with pipelines, flowmeters tend to replace Parshall and are read directly in gpm. Bureau of Reclamation flowmeters read in acre-feet. The conversion from acre-feet to gpm is acre-feet measured over a 24-hour period x 226.2 = gpm.

Why is water measurement such an important issue? Disagreements over irrigation water probably out-number marital problems as the leading cause of shouting matches in Montezuma County! The more you know about water measurement, the more constructive your discussions with ditch partners can be.

Source: *The Waterline*, No. 70, May 1994. Published by Colorado River Salinity Control Project, Cooperative Extension.

UPDATE -- FY95 ENERGY AND WATER APPROPRIATIONS

The Energy and Water Appropriations Act of 1995 (H.R. 4506) was signed by the President on August 26 (P.L. 103-316). The Act provides the following amounts for water programs.

\$3.4B -- Corps of Engineers for 528 projects. It includes \$181.2M for general investigations, \$983.7M for construction, \$1.65B for operation and maintenance work, \$152.5M for general expenses, \$101M for Corps regulatory programs, \$900,000 for oil spill research, \$10.1M for the 4-state Missouri River Mitigation Project, \$200,000 for construction, operation and maintenance of the Missouri National Recreation River Project, \$160,000 for the Lower Platte River and tributaries flood control study, and \$500,000 for engineering and design of water temperature control facilities at the Cougar and Blue River Projects in Oregon.

\$881.4M for planning and construction of 93 projects and operation and maintenance work on another 39 projects. It includes \$14.2M for general investigations, \$54M for general

expenses, \$432.7M for construction, \$284.3M for operation and maintenance, and \$9.6M for the loan program. Water management and conservation programs total \$6.2M. Funds of \$300,000 for a regional drought mitigation center, included in the Senate bill, were dropped. A sum of \$500,000 for USBR's Groundwater Recharge Demonstration Program was earmarked for Kansas. Another \$45.4M was appropriated for the Central Valley Project restoration fund and \$40.2M for the Central Utah Project completion account (\$22.8M for project construction and \$16.1 for fish and wildlife mitigation and recreation).

House/Senate conferees expressed concern that the establishment and operation of the Western Water Policy Review Commission has been delayed for nearly two years. The Commission is to submit its report to the President by October 30, 1995. The conferees urged the commission to hold its first meeting as soon as possible, and directed the Secretary of Interior to apprise relevant House and Senate Committees of the likelihood of the final report being completed by the statutory deadline.

WATER PUBLICATIONS, DATABASES, VIDEOS

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0-309-0-4534-7, \$39.95.

Water Transfers in the West, ISBN 0-309-0-4528-2,
\$34.95

Annual Report 1993, U.S. Department of the Interior, Water Resources Division, National Park Service, Natural Resources Report NPS/NRWRD/NRR-94/03. June, 1994. Copies are available from: National Park Service, Water Resources Division, 1201 Oak Ridge Drive, Suite 250, Fort Collins, CO 80525. Phone 303/225-3500.

USGS REPORTS

The following reports are available from U.S. Geological Survey, Box 25286, MS 306, Federal Center, Denver, CO 80225.

Summary of Selected Computer Programs Produced by the U.S. Geological Survey for Simulation of Ground-Water Flow and Quality, 1994, by Charles A. Appel and Thomas E. Reilly, U.S. Geological Survey Circular 1104, Free.

Bibliography of selected water-resources information for the Arkansas River basin in Colorado through 1985, by John M. Kuzmiak and Hyla H. Strickland, Open-File Report 94-331. Prepayment required. Call 303/236-7476 for price.

Hydrology and geochemistry of a surface coal mine in northwestern Colorado, by Robert S. Williams, Jr. and Gregory M. Clark, USGS Water-Resources Investigations Report 92-4197. Prepayment required. Call 303/236-7476 for price.

Hydrogeologic characteristics of the alluvial aquifer and adjacent deposits of the Fountain Creek Valley, El Paso County, Colorado, by Mary J. Radell, Michael E. Lewis and Kenneth R. Watts, USGS Water-Resources Investigations Report 94-4129.

WATER NEWS DIGEST

WATER ALLOCATION

Arkansas Study may go Another Year

A program to gather and study water quality and quantity data on the Arkansas River is expected to continue through next year. A committee of the Southeastern Colorado Water Conservancy District met last week with the U.S. Geological Survey, Water Resources Division, to consider a USGS-proposed cooperative program of data collection and interpretative studies for the coming year. The objective is to supplement state and federal stream gauging programs to meet both short- and long-term water management needs in the Arkansas River basin. USGS operates gauges that are a factor in the administration of the

Colorado-Kansas Arkansas River Compact. A salinity-monitoring component is built into the program.

Pueblo Chieftain 8/14/94

Water Users, Forest Service Compromise on River Flow

At the beginning of August, the Forest Service said it would require the city of Fort Collins to release water from a mountain reservoir into the Poudre River during the winter. At the same time the agency said such releases would not be required of two other reservoir owners--the city of Greeley and Water Supply and Storage Co. in Fort Collins. All three reservoir owners agreed to work together to add water to the river during the

winter, then recapture it downstream for later domestic and agricultural use. Even though the city of Fort Collins will have to spend \$200,000 to modify Joe Wright Reservoir for winter releases, the agreement was deemed worthwhile.

Colorado Springs *Gazette Telegraph* 8/14/94

Greeley to File Water Appeal

The Greeley Water-Sewer Board has unanimously agreed to file a "procedural appeal" on a July 29 decision by the U.S. Forest Service regarding the renewal permit for city-owned Barnes Meadow and Peterson Lake reservoirs. The board emphasized that it accepts the basic concept of the Forest Service decision, which calls for a joint operations plan rather than imposing bypass flows for both reservoirs. Winter releases of water from reservoirs, the board said, will benefit 50 miles of aquatic habitat in the Cache la Poudre Canyon during the critical flow period. The city had worried that the Forest Service would require bypass flows, requiring it to release large amounts of valuable water. Greeley is supportive of the joint operations plan, but city officials are worried that the language is vague and the Forest Service could implement other restrictions on the city's water rights when the details are released.

Greeley *Tribune* 9/13/94

Water Wars with Denver Have Ended, Official Says

Denver Water is changing its agency mission. It is rewriting contracts with nearly 80 agencies to which it provides water, concentrating on conservation and other measures. Those rewritten contracts will specify how much territory and how much water Denver will provide. That alone will give officials a better idea of how much Western Slope water they will need. However, those rewritten contracts may send outlying metropolitan regions to the Western Slope for their water.

Grand Junction *Daily Sentinel* 8/27/94

Platte River Flows Proposed

The U.S. Fish and Wildlife Service has announced its winter and spring water flow recommendations for conservation of the Platte River Valley ecosystem. In March, USFWS announced seasonal stream flow targets for wet, normal, and dry years in the valley, and said that pulse flows in late winter and late spring were the most important flows for conserving the Platte River ecosystem. Over a 10-year period, annual pulse flows in February and March should range between 2,000 and 16,000 cubic feet second. The flows during the same period for May and June should range between 3,000 and 16,000 cfs. The average pulse flow should fall between 8,300 and 10,800 to maximize benefits for the ecosystem and adjacent wet meadows, according to USFWS.

Montrose *Daily Press* 8/2/94

Water Worries Speed Research on Gunnison

The water flowing through the Black Canyon of the Gunnison National Monument was lowered to 300 cfs in late July so that researchers from the National Biological Survey could assess riparian areas and sediment movement. The first phase of the research was to take 10 days, but river outfitters, the Redlands Water and Power Co., and the Colorado Division of Wildlife expressed concerns about adequate water for rafting, power, and fish. To speed up the process, more researchers were brought in and, officials bumped the flows back to 400 cfs several days ahead of schedule. After a second phase of research at 400 cfs, river flows will be returned to 700 cfs, the level at which the river had been flowing before it was lowered.

Grand Junction *Daily Sentinel* 8/5/94

WATER PROJECTS

Federal Officials Oppose Mirror Lake Dam Plan

Federal officials are opposing a private company that wants to build a dam at Mirror Lake on the North End of Rocky Mountain National Park. Northern Colorado Properties, Inc., Fort Collins has a conditional right to 822 acre-feet of the lake's water, and has filed papers to convince the Water Court that it is diligently pursuing the dam building. The park has filed papers arguing against the dam. The water right dates back to 1958, before Mirror Lake became part of Rocky Mountain National Park in 1980. NCP bought the rights in 1970.

Grand Junction *Daily Sentinel* 8/28/94; Greeley *Tribune* 8/28/94

Federal Audit: Irrigation Water Misdirected

A federal audit has found farmers in Colorado and seven other Western states have received up to \$46 million worth of irrigation water they were not eligible for because of lax record keeping and management. The U.S. Interior Department's inspector general found stream flows from the Uncompahgre Project in western Colorado and about two dozen other delivery systems were used between 1984 and 1992 to irrigate more than 154,000 acres that did not meet federal guidelines. The auditors said the problem stemmed from a practice called "water spreading," where below-cost water is delivered to more commercial users than intended. The interior department's Bureau of Reclamation feeds water through delivery systems in 17 Western states. The use of water is supposed to be restricted by the amount of eligible land and by the amount of available water. At the Uncompahgre Project near Montrose, 12,884 ineligible farm acres received below-cost water from the Gunnison River valued at \$467,303.

Greeley *Tribune* 7/26/94

Reservoirs Undergoing \$70,000 in Improvements

The Trujillo Meadows and Road Canyon reservoirs on the Rio Grande National Forest have begun undergoing improvements.

The Forest Service and The Colorado Division of Wildlife are working together to build a new parking area and boat ramp at Trujillo Meadows near Cumbres in Conejos County. The project will cost about \$35,000. A similar joint project will be undertaken at Road Canyon Reservoir, below Rio Grande Reservoir in Mineral County.

Pueblo Chieftain 8/23/94

Project 7 Planning New Water Storage Reservoir

Initial plans are underway for a new 8 million to 10 million-gallon storage reservoir at the Project 7 water treatment plant east of Montrose. The estimated \$4 million project is scheduled for quick completion to meet rising demands for treated water in the Uncompahgre Valley. Construction could begin as early as November, and the reservoir may be ready for use by June 1995. The new covered facility would replace the existing 1.5 million gallon storage facility. A price hike may take effect January 1, 1995. Each member of Project 7 will decide whether to absorb the added expense or pass the cost on to its customers.

Montrose Daily Press 8/29/94

WETLANDS

Wetlands Workshop Held in Montrose

The Shavano Soil Conservation District sponsored an all-day workshop on August 10 addressing wetlands conservation and the impact it has on agriculture. According to the state Soil Conservation Board, there is a lot of interest in wetlands development among farmers and ranchers across Colorado. The conference focused on several wetlands projects undertaken by farmers and ranchers in the Uncompahgre valley and on the Western Slope.

Montrose Daily Press 8/11/94

WATER TRANSFERS

Springs' Surplus of Raw Water Tapped by River Rafters, Farmers

The city of Colorado Springs has made almost \$500,000 selling water to farmers and rafters left high and dry by a meager snowpack and a dry summer. During a wet year, there is little demand for the city's raw water surplus, but this year the Colorado Springs Water Department has sold over 45,000 acre-feet of water to help hard hit water users in the Arkansas River Basin. The city owns a good portion of the water in Twin Lakes, Pueblo Reservoir, Lake Meredith, and Lake Henry, but portions of the city's Arkansas water will not be tapped until the turn of the century.

Colorado Springs Gazette Telegraph 8/9/94; Montrose Daily Press 8/10/94

Aurora-Vall Water Agreement Reached

The city of Aurora has tentatively agreed to release 300 acre-feet of water from Homestake Reservoir into the Eagle River when the river is low, from September through the winter. The agreement, which begins November 1 and will end October 31, 1997, will supply enough water to take care of about 300 families of four. Vail Valley then would purchase 300 acre-feet of water from the Colorado River District and Green Mountain Reservoir to replace the water during the high runoff season.

Montrose Daily Press 9/6/94; Grand Junction Daily Sentinel 9/7/94

Louisville Seeking Windy Gap Water

The City of Louisville wants to purchase water from Greeley's Windy Gap Supply at a cost of \$788,000. The Greeley Water and Sewer Board has recommended selling Louisville three units of Windy Gap Water. The city still would have 64 units after the sale, and would use the revenue for water replacement.

Greeley Tribune 9/5/94

WATER QUALITY

EPA and Other Agencies Probe Smelter Health Hazards on the Arkansas River

Smelter industries are being recognized by various government agencies as sources of acidic and heavy metals pollution in the Arkansas River Valley around Salida, Cañon City, and Pueblo.

Salida--New and old industries pose a health hazard to the 100 residents who live in the Smelertown area just north of Salida. The EPA has been investigating contamination and prospects for cleaning up the 120 acre site for nearly four years. The federal Agency for Toxic Substances and Disease Registry is helping the EPA evaluate the site by focusing on health issues for residents. The site was home to an early 1900's smelting and refinery operation where workers separated impurities from lead, copper, silver, and gold. Molten slag was removed from furnaces and dumped on the ground near the Arkansas River. After the smelting operation closed in 1919, the site was used by various railroad tie-treating companies. The soil is also contaminated by creosote.

The EPA discovered that the well water of nearby residents contained high levels of zinc and ordered CoZinCo to supply drinking water to five residents who live near that facility. The Agency for Toxic Substances has outlined several recommendations in its public health assessment. Among the recommendations is to record levels of arsenic, lead, zinc, cadmium, copper, creosote, and other contaminants in soil and groundwater, especially in residential yards and play areas. The health assessment suggests that more data will help agencies better define the possibility of contaminants reaching public water supplies or the Arkansas River via runoff.

Pueblo--The first comprehensive testing for contamination on Pueblo's old smelter sites and surrounding soil and water will center around the reddish-orange sludge from an old smelter being released into the Arkansas River. Five surface-water samples will be in close proximity to the discharge. Representatives from the Superfund Environmental Response Compensation and Liability Information System will be in Pueblo collecting 62 samples in the project: fourteen from the historic smelter properties; thirty in the community; and background soil samples from outside Pueblo. The remaining samples are water quality-control samples.

Cañon City--EPA officials are conducting tests to determine pollution from a conducting mill and smelter near the industrial park south of Cañon City's Greenwood Cemetery. The tests are investigating impacts to groundwater and surface runoff to the Arkansas River. Limited sampling showed the presence of acidic water and heavy metals in relatively high concentrations. The tests started after a private company reported finding contamination on property in the industrial park.

Pueblo Chieftain 8/24/94; Colorado Springs Gazette Telegraph 8/18/94

Salinity Program Funding may be Slashed

Personnel with the Colorado River Salinity Control Program fear the federally funded project will lose a big portion of its money for fiscal year 1995. The House has earmarked \$5 million for the seven state program through the U.S. Department of Agriculture's 1995 appropriations bill. However, the Senate approved zero funding for the program, which is working to reduce salt levels in the Colorado River and its tributaries. The program, established under the Salinity Control Act of 1974, brought together the Soil Conservation Service, the Agricultural Stabilization Service, and cooperative extension services to battle salinity problems in the seven Colorado River basin states. Since it was first implemented in 1979, the program has reduced the salt loading to the Colorado River by 261,700 tons per year, and it is projected to remove 1.4 million tons by the year 2015. Under a reduced funding proposal, fewer farmers would receive cost-share dollars the program provides to install better irrigation facilities. It is also possible that the number of new contracts awarded to farmers would have to be drastically cut back.

Montrose Daily Press 8/15/94, 8/18/94, 8/29/94

Reservoir Contamination Found

Swimmers at Boulder Reservoir were warned to swim only at their own risk, when warm weather and low water levels caused relatively high levels of fecal coliform bacteria to be detected in the reservoir. Although the bacteria itself isn't harmless to humans--all warm blooded animals carry it in their intestines--it is an indicator that other more harmful bacteria and viruses may be in the water. The Boulder County Health Department put up signs at the reservoir warning swimmers not to take a dip.

Montrose Daily Press 8/22/94

Delta Prison Cited for Water Violations

State water quality officials have cited the state prison in Delta for 17 violations for discharges from its sewage lagoons over a six-month period last year, including releasing high levels of chlorine and algae into the Roubideau Creek drainage. In August suspended solids reached levels more than 100 times those permitted. Too many solids will deplete oxygen available in water, and if severe enough, can kill fish. The prison sits in the middle of the 4,000-acre Escalante State Wildlife Area, and Roubideau Creek flows into a stretch of the Gunnison River that is designated critical habitat for endangered species.

Grand Junction Daily Sentinel 9/4/94

Fire Runoff Fouls Water

Runoff from millions of gallons of water used to fight a fire in a pile of old cedar shake shingles fouled drinking water for about 30,000 Englewood residents. Firefighters had poured 6 million gallons of water a day on the shingles since the fire broke out. The water ran off into Big Dry Creek which feeds into the South Platte River only 100 yards from Englewood's main water intake valves. Extra chlorine was used to cleanse the water, and authorities said despite its foul taste it was safe to drink. The city shut off that South Platte water source over the weekend and began taking its water supply from the city ditch fed from Chatfield Reservoir.

Montrose Daily Press 8/22/94

MINING

Summitville Mine Drainage and Continuing Cleanup Efforts

Jeff Stern, technical advisor for Citizens for San Luis Valley Water, reported to local officials that despite the plugging of the Reynolds Adit at Summitville last January, acidic leaching continues and is polluting the Alamosa River. Stern has been involved in water testing for Conejos County for almost three years. Water backed up into the mountain and began to come out the Chandler Adit above, which was plugged in June. Stern reported that significant, smaller amounts of water continue to seep from both adits. The acidic water is not being treated and is entering Wrightman Fork, reaching the Alamosa River.

Additionally, Grant Cardon, Colorado State University agronomist, reports in a newly released study that there are minor problems with the crops in the Alamosa River Basin due to the drainage. The study noted possible contamination has raised concerns over the effects of low pH and metal-laden surface waters carried down the river. The study's purpose was to assess whether significant differences exist between the effects of two source waters (the Alamosa River and the Rio Grande) on the composition of potatoes and wheat and associated soils. With few exceptions, a review of the data generally found no difference between concentrations of metal levels in crops and soils irrigated by either water source, and no increases were high enough to cause a health risk.

The U.S. Environmental Protection Agency and the state of Colorado have released the proposed plans for additional cleanup of the Summitville Mine Superfund site. The plans propose interim remedial alternatives, to be added to the EPA and state cleanup work underway, for four sections of the site:

- * **Waste Piles:** Return an estimated 2.5 million cubic yards of mine wastes to the mine pits.
- * **Heap Leach Pad:** Dewater the pad, use biotreatment and cap with soil.
- * **Site reclamation:** Revegetate, using on-site topsoil which has been improved with a medium which will promote vegetation.
- * **Water treatment:** Continue treating contaminated waters, improving quality until treatment is required only in the summer months.

Pueblo Chieftain 8/5/94, 8/12/94, 8/24/94

Judge OK's Leadville Cleanup

U.S. District Judge Jim Carrigan has signed a consent decree that calls for the cleanup of more than a century's worth of mining pollution near Leadville. The Superfund cleanup of pollution from precious-metals mining by several companies and their successors is expected to cost tens of millions of dollars. Concerns include the impact of mine tailings in the Arkansas River Valley on surface and groundwater after the cleanup.

Grand Junction Daily Sentinel 8/28/94

Climax Project Closes; Cheney Reservoir's Fate Decided

A closing ceremony for the Uranium Mill Tailings Remedial Action Project in Grand Junction was held September 8 at the old Climax mill site along the Colorado River. Approximately 4.6 million cubic yards of tailings were removed from that site over the past four years. About \$445 million was spent cleaning up the Climax site, cleaning up tailings in 4,000 properties around the Grand Valley, and placing the tailings in a permanent disposal site known as Cheney Reservoir 10 miles south of Whitewater. The Climax site is one of 24 around the country designated for cleanup under the Uranium Mill Tailings Radiation Control Act of 1978. The 114-acre tract will become a state park once final cleanup and monitoring are approved.

U.S. Department of Energy officials presented a plan to keep a portion of the Cheney reservoir open for up to 20 years to accept uranium mill tailings from around the valley. As part of that plan, the energy Department would ask Mesa County to accept tailings from around the state, and a small amount from out of state, for disposal in Cheney. Grand Junction officials had worried that if the reservoir was closed now that the Climax project is completed, there would be no place to take tailings found around the community, such as when utility lines encased in tailings are repaired or replaced.

Grand Junction Daily Sentinel 8/20/94, 9/7/94, 9/8/94, 9/9/94;
Montrose Daily Press 9/9/94

Report Released on Fort Carson Waste Sites

Federal officials have identified some 180 solid- or hazardous-waste sites at Fort Carson, but say they pose no significant environmental threat. A report released by the Environmental Protection Agency recommends more testing and investigation of at least 35 sites as well as a groundwater monitoring plan and a review of environmental sampling. Fort Carson, already cleaning up various sites, will begin an intensive water monitoring program in October in cooperation with local water-quality agencies. It is also forming a citizens advisory board that will review the report and any cleanup activities. Fort Carson has requested a state permit to store its hazardous waste on the post. The state Health Department can use the EPA study or conduct its own to determine what needs to be cleaned up and how waste should be handled before it issues a permit.

Colorado Springs Gazette Telegraph 8/31/94

EPA, USDA Sign Pact on Pesticides

Under an agreement signed by the U.S. Environmental Protection Agency and the U.S. Department of Agriculture, the EPA will, within six months, list pesticides likely to be restricted or taken off the market, and renew this list each year. The USDA will determine whether any substitute pesticide or other method of pest control can be found. If no alternative exists, the USDA will work with commodity groups and research institutions to find alternatives, with some research financed by a new grants program to be budgeted in 1996. New pesticides, biological controls, or other substitutes will be given first consideration by the EPA, but the emphasis will be on finding safer alternatives to pesticides.

Montrose Daily Press 9/16/94

WILDLIFE

Division of Wildlife Prepares Two Reservoirs for Stocking

Biologists from the Colorado Division of Wildlife will treat two Grand Mesa Reservoirs, Young's Creek Nos. 2 and 3, to eliminate rough fish populations as the first part of a project designed to restock the reservoirs with Colorado River Cutthroat trout. Rotenone, a chemical derived from a South American plant which is often used to dust tomato plants, will be used to eliminate the existing fish. Potassium permanganate is used to detoxify the water once the existing population has been eliminated. It will be fall 1995 before the reservoirs will provide fishing opportunities. The Colorado River cutthroat is the only trout that is native to the Western Slope of Colorado.

Montrose Daily Press 9/12/94

Jackson Fish go to Sterling

The first of several fish salvages at eastern Colorado irrigation reservoirs was held at Jackson Reservoir in Fort Morgan. The fish were moved to North Sterling Reservoir. Jackson Irrigation

Co., representing a consortium of water owners with agricultural interests, announced plans to completely drain Jackson reservoir to provide water for area users. A construction improvement also is planned for the reservoir. A considerable amount of stocked rainbow trout were lost during the salvage due to warm water temperatures. About 250 rainbow trout were cleaned, packed in ice, and transported to the Larimer County Food Distribution Center, which provides food to the needy.

Greeley Tribune 8/6/94; Grand Junction Daily Sentinel 8/6/94

Colorado River Endangered Fish Program Implemented

For six years, scientists have researched the habits and habitat of the Colorado Squawfish, the Razorback Sucker, the Humpback Chub, and the Bonytail Chub, in the Colorado River basin. The U.S. Fish and Wildlife Service, the Colorado Division of Wildlife, and others have begun the work necessary to bring the four native fish species back from the edge of extinction. The cost, about \$86 million, will be paid for largely by the federal government. Contributions also come from Colorado, Wyoming, and Utah water users. The main factors influencing the demise of the fish are dams and reservoirs, water diversions, introduction of exotic, predatory fish, and dikes and levees that keep floodwaters out of bottomlands. The recovery program will concentrate on building fish passages around some dams, securing water rights for instream flows, removing exotic fish and limiting stocking for some stretches of river, finding places along the rivers where bottomlands can be flooded, and reintroduction of native fish from fish hatcheries.

Grand Junction Daily Sentinel 8/21/94

WATER RATES

Clifton WD Increases Water Tap Fee, Water Rates

The Clifton Water District, ten miles east of Grand Junction, has boosted its water-tap fees by \$1,000 and will raise its water rates in November. The tap fees, held at \$1,500 since 1981, are now \$2,500. Water rates, steady since 1989, will rise by \$1.20 for customers who now pay \$7.30 a month and \$2.40 for customers who now pay \$15.10 a month. The increases will generate about \$320,000 per year above current revenues, and are needed to meet rising costs of maintenance, construction, and new requirements of the Safe Drinking Water Act. The money will also help the district start to finance a new source of clean water. At present, the district's board and staff are weighing two options: building a \$5.2 million reverse-osmosis water-treatment plant, or making a deal to buy Grand Mesa water from the city of Grand Junction, which would require construction of a \$10 million pipeline.

Grand Junction Daily Sentinel 9/8/94

Windsor's Sewer Rates to Increase 90 Percent

On the recommendation of Western Consulting Inc. of Fort Collins, the Windsor Town Board voted to raise water rates and

sewer rates, and directed the town administration to write an ordinance for adoption at its next meeting. The sewer rate increase was blamed on a new \$4 million sewage treatment plant south of Windsor to be built in 1995. Board members said the federal government mandated that the town upgrade its sewage-treatment system. Under the proposal, the monthly sewer rate of \$10 per dwelling unit would increase to \$19 per month effective Jan. 1 in order to meet the town's debt service on the treatment plant project. Western Consulting Inc. recommended that water rates be increased an average of about three percent per year for three years to meet inflation.

Greeley Tribune 8/23/94

NATIVE AMERICAN WATER RIGHTS

Animas-La Plata Project Must be Revised

The U.S. Inspector General has issued a report stating that costs of the Animas-La Plata water project are far greater than benefits, and the water project should be revised. The report calls on the U.S. Bureau of Reclamation to seek congressional approval to restructure the project, limiting it to those parts that are financially viable or required under the terms of the Ute Indian Water Rights Settlement Act. The report suggests that the Dolores Project, which also failed the test for economic justification, has about 10,300 acre-feet of unused water that could be used by the two Ute tribes that are to get water from the project. At completion, the Animas-La Plata project would supply the tribes with 101,000 acre-feet of irrigation water and 32,500 acre-feet of municipal and industrial water.

Grand Junction Daily Sentinel 8/2/94

CONSERVATION

Surge Irrigation Touted as Major Water Saver

Several years of work by cooperators in the Patterson Hollow Hydrologic Unit have shown that surge irrigation can save between 20 and 30 percent of the water needed to grow a crop, and allows fertilizer to be better used in irrigation water. Surge irrigation has been a focal point of the project partly because it keeps run-off water from leaving a farm and eliminates nitrate and salt pollution problems. Surge irrigation uses a gated pipe and a computerized controller to send water to different parts of a field on a set schedule. Various parts of the field are irrigated for certain intervals to allow the water to reach the end of the field without soaking in too deep. The practice allows water to seep into the ground evenly over the entire field.

Pueblo Chieftain 8/6/94

DROUGHT

Drought Disaster Declared

Weld, Larimer, Jackson, Moffat, and Routt counties have been designated as natural disaster areas because of drought

conditions. Under the designation, farmers may qualify for Farmers Home Administration emergency loans due to damage and losses caused by drought conditions beginning May 15, 1994, and anytime since then. The five counties were contiguous to one or more of the 12 Wyoming counties that received the same designation due to drought conditions. Emergency loan applications will be received through April 10, 1995, for physical and productions. The FMHA can make emergency loans in counties where physical property loss or damage or severe production losses occur as a result of a natural disaster that substantially affects farming, ranching, or aquaculture operations.

Montrose Daily Press 9/2/94

LITIGATION

AWDI Asks U.S. Supreme Court to Review Case

American Water Development Inc., denied its request to annually sell billions of gallons of San Luis Valley Water, has asked the U.S. Supreme Court to review the case. Last May 9, the Colorado Supreme Court backed Division 3 Water Court Judge Robert Ogburn who in late 1991 denied AWDI access to 200,000 acre-feet per year of San Luis Valley water. The water development company wanted to sell outside the valley, perhaps as far away as California. Colorado's high court affirmed all of

Ogburn's rulings, which included his order for AWDI to pay \$2.7 million in costs and fees incurred by individuals and agencies in the valley that fought the plan. The state high court last June 6 also denied a request for a rehearing of the case. In a document filed with the U.S. Supreme Court, AWDI asked whether Colorado courts had improperly rejected its claim that it had historic rights to the water.

Pueblo Chieftain 9/7/94

Colorado Owes Water Damages to Kansas

An official overseer has confirmed his earlier finding that Colorado is violating a water agreement with Kansas and must release Arkansas River water and pay damages. The recommendation by Special Master Arthur Littleworth goes to the U.S. Supreme Court, which may accept or reject his findings. Littleworth is overseeing Kansas' 9 year-old lawsuit demanding hundreds of thousands of acre-feet of water and more than \$100 million in damages. Littleworth's finding agreed with Kansas' claim that wells in Colorado diverted part of Kansas' share of the Arkansas water under the 1949 compact. However, he found that Colorado reservoir management was not part of the problem.

Greeley Tribune 8/17/94

SEMINARS - Colorado State University

ENVIRONMENTAL ENGINEERING SEMINAR SERIES Department of Civil Engineering

Meetings are held on Mondays at Noon in the Senate Chambers, Lory Student Center.

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|---------|---|
| Oct. 31 | Pollution Prevention in Manufacturing
-- Dr. Harry Edwards, Professor of Mechanical Engineering, CSU |
| Nov. 7 | Design and Implementation of Integrated Water Quality Management Programs on Indian Reservations
-- Mr. Steve Johnson and Mr. Bill Schenderlein, Riverside Technology, Inc., Fort Collins |
| Dec. 5 | Legal Issues in Environmental Engineering: A Case Study
-- Mr. Dave Rau, Terracon Environmental, Inc., Fort Collins |

SEMINARS - Colorado State University**WATER RESOURCES SCIENCE AND ENGINEERING**

Department of Civil Engineering

Meetings are held in the Lory Student Center (LSC), Colorado State University, and begin at 12:10 p.m. Sponsored by Hydrologic Science and Engineering Program, Water Resources Planning and Management Program, and Groundwater Program, Civil Engineering Department; Watershed Sciences Program, Earth Resources Department. For information contact: Jorge A. Ramirez, Assistant Professor, Hydrologic Science and Engineering Program.

Oct. 27	Climatic Influences on Arroyo Dynamics in the Rio Puerco Basin, New Mexico -- Dr. Doug Fox, Director, TERRA Lab, Fort Collins, Colorado	LSC 208
Nov. 3	Rainfall Network Design in Tropical Flat Forest Land -- Dr. Edilberto Guevara, Professor, Universidad de Carabobo, Venezuela Visiting Professor, Earth Resources, CSU	LSC206
Nov. 10	In Search of Hydrologic Similarity: A Hawaii Case Study -- Dr. Gustavo Diaz, Research Assistant Professor, Civil Engineering Department, CSU	LSC208
Nov. 17	Potential Environmental Impacts of the Pangué Dam Project, Biobío River, Chile -- Mr. Claudio Meier, M.S. Student, Civil Engineering, CSU	LSC208
Dec. 1	Preliminary Investigations for Wadi Dayqah Dam Sites - Sultanate of Oman -- Dr. Carl Nordin, Research Professor, Hydraulics Program, Civil Engineering CSU	LSC208

BIORESOURCE ENGINEERING

Department of Agricultural Engineering

Meetings are held in the Lory Student Center (LSC), Colorado State University. Seminars begin at 3:30 p.m.

Oct. 21	Ground Water Remediation Technologies: Bioventing and Biosparging -- Dr. Thomas Simpkin, CH2MHill Inc., Denver	LSC 203-205
Oct. 28	Application of Biosolids in Range and Agricultural Land -- Dr. Ken Barbarick, Department of Soil and Crop Science, CSU	LSC 202-204
Nov. 4	Application of Bioremediation to Metal Contaminants in Aqueous Solution -- Dr. Linda Figueroa, Dept. of Environmental Science and Engineering Colorado School of Mines	TBA
Nov. 18	Nitrate Pollution Under Irrigated Agriculture: An Economist's Perspective -- Dr. Marshall Frasier, Dept. of Agricultural and Resource Economics, CSU	LSC 203-205
Dec. 2	Kodak's Ambient Air Quality Monitoring System -- Bill Burke, Environmental Services, Eastman Kodak Company, Windsor	TBA
Dec. 9	High Points in American Environmental History -- Dr. Mark Fiege, Department of History, CSU	LSC 203-205

NATURAL RESOURCE AND AGRICULTURAL ECONOMICS

Lunch-time Seminar Series, Wednesdays 12:10 to 1:10 p.m. Meetings are held in 110 Animal Science Building.

- Oct. 26 **A Dynamic Optimization of Policy Analysis of Controlling Nitrate Leaching in Colorado Irrigated Corn Production**
-- Mr. Steve Vickner, Agricultural and Resource Economics, CSU

DEPARTMENT OF FISHERY AND WILDLIFE BIOLOGY

Meetings are held in Room 133, Wagar Building, Colorado State University, from 3:10-4:00 p.m.

- Oct. 28 **Wildlife Management Within the Agricultural Context in Argentina: Building a Program**
-- Maria Elena Zaccagnini, PhD candidate, Department of Fishery and Wildlife Biology, CSU
- Dec. 2 **Catch and Release Survival of Rainbow Trout**
-- George Shisler, MS candidate, Department of Fishery and Wildlife Biology, CSU

INTERNATIONAL CONNECTION

This is a Noon Brown-Bag Lunch Program in the Lory Student Center, Room 165, Tuesdays at 12:10-12:55. An informal network for information sharing follows from 1:00 to 1:30.

Sponsored by Office of International Education.

- Dec. 6 **Social, Cultural, and Economic Dimensions of Changes to the Puerto Rican Rain Forest**
-- Diana Garcia, Forestry graduate student

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS

The following seminars will be at 4:00 p.m. in C-238 Clark Building

- Oct. 24 **On-Farm Management and Nitrate Leaching Under Irrigated Cropping Systems: An Economic Analysis**
-- Dr. W. Marshall Frasier, Agricultural and Resource Economics, CSU
- Nov. 9 **Economics of Sustainable Resource Use in the Gran Chaco of South America**
-- Dr. Paul C. Huszar, Agricultural and Resource Economics, CSU

DEPARTMENT OF ENVIRONMENTAL HEALTH

- Oct. 24 **Ergonomics**
-- Dr. Robin Herron, Department of Environmental Health, CSU
- Oct. 31 **Species Differences in Toxic Responses**
-- Dr. Sam Kacew, University of Ottawa

SEMINARS - The University of Colorado
HOT TOPICS IN NATURAL RESOURCES
A LUNCHEON PROGRAM SERIES

Meetings begin at 12:00 Noon, Holland & Hart Conference Room (except November - see note), 555 17th St., 32nd Floor, Denver. NOTE: November Hot Topic will be held at The Denver Club, 518 17th St., 17th Floor. Box lunches provided. One Hour of Continuing Legal Education. Prepayment required to hold space. \$13 if received 3 working days before program, \$16 thereafter. Cost includes lunch. Addition charge of \$5 for CLE credit, if desired. Limited scholarships. Register by phone or FAX with credit card or send check payable to the University of Colorado to Natural Resources Law Center, Campus Box 401, Boulder, CO 80309-0401. Phone 492-1288; FAX 492-1297. Kathy Taylor, Coordinator.

- Oct. 21 **JEFFERSON CO. PUBLIC UTILITY DISTRICT V. STATE OF WASHINGTON: WILL IT CHANGE THE 401 CERTIFICATION PROCESS IN COLORADO?** Colorado law prohibits the Water Quality Control Commission from requiring minimum flows under the 401 certification program. Attorneys **Barbara Green**, Hale Pratt Midgley Hackstaff & Goldberg, and **Marcia Hughes**, Marcia M. Hughes, P.C., will consider whether this summer's U.S. Supreme Court decision changes what the Commission can do under the 401 program. **Paul Frohardt**, Water Quality Control Commission, will consider recent changes to the agency's 401 regulations.
- Nov. 15 **WHAT COLORADANS SHOULD KNOW ABOUT DEVELOPMENTS IN THE LOWER COLORADO RIVER BASIN.** Innovative proposals for allowing more flexible use of Colorado River entitlements in the Lower Basin are under discussion. **Larry MacDonnell**, Director of the Natural Resources Law Center, will describe some of these proposals and **Jim Lochhead**, Executive Director of the Colorado Department of Natural Resources, will comment on them from Colorado's perspective.

ENVIRONMENTAL AND WATER RESOURCE ENGINEERING

The seminar meets on Fridays at 3:30-4:30 p.m. in the Engineering Center, Ground Level, Room 0-01.

- Oct. 21 **Distribution of Plutonium in Soils Around Rocky Flats Plant: A Compressive Approach**
-- Dr. Iggy Liator, Senior Researcher at Rocky Flats
- Oct. 28 **The Role of Analytical Commercial Laboratories in Engineering Research**
-- Dr. Huffman, President of Huffman Analytical Laboratories, Golden, CO
- Nov. 4 **Transport of Microorganisms in a Sandy Contaminated Aquifer**
-- Dr. Ron Harvey, U.S. Geological Survey
- Nov. 11 **General Framework for Corrosion Control**
-- Donna Dodrill, Ph.D. candidate, Environmental Engineering, University of Colorado
- Nov. 18 **The Impact of Best Management Practices in Reducing Unionized Ammonia Concentrations in a Treated Effluent Dominated 5th Order Stream**
-- Brian Murphy, Recent Graduate
- Dec. 2 **Fieldwork Update on Metal (Mercury) and NOM Complexation**
-- Dr. Mike Reddy, U.S. Geological Survey

SHORT COURSES -- Colorado School of Mines

**INTERNATIONAL GROUND WATER MODELING CENTER
GROUND-WATER MODELING SHORT COURSE 1995**
TENTATIVE SCHEDULE

International Ground Water Modeling Center
Colorado School of Mines
Golden, Colorado 80401-1887
Phone: 303/273-3103 FAX: 303/384-2037
e-mail: igwmc@mines.colorado.edu

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|----------------|---|
| Jan. 16-18 | Advanced Principles and Applications of the MODFLOW Ground-Water Flow Modeling System. Instructors: Andersen, Greenwald (GeoTrans, Inc.). Software: MODFLOW, MODPATH, MODFLOW add-on modules. |
| Jan. 30-Feb. 2 | Practical Modeling of Three-Dimensional Contaminant Transport and Remedial Action Designs Using MODFLOW and MT3D. Instructors: Zheng (University of Alabama), Neville (Papadopoulos, Inc.). Software: MODFLOWMT3D (Method of Characteristics). |
| Feb. 27-Mar. 3 | Statistical Methods in Ground-Water Pollution. Instructors: Helsel, Gilroy (USGS). Software: MINITAB (student edition). |
| Mar. 21-24 | Introduction to the MODFLOW Ground-Water Flow Modeling System. Instructors: Andersen, Greenwald (GeoTrans, Inc.). Software: MODFLOW, MODPATH. |
| May 8-12 | Principles and Applications of Chemical Reaction Modeling in Ground Water. Instructors: Parkhurst, Plummer, Glen (USGS). Software: PHREEQE, PHREEQEM, BALANCE, NETPATH. |
| June 5-9 | Characterization, Information Management and Modeling for Ground-Water Systems. Instructors: Kolm (CSM), Karanjac |
| June 19-21 | IGWMC Ground-Water Modeling Conference (Boulder) |
| June 26-29 | Practical Modeling of Three-Dimensional Contaminant Transport and Remedial Action Designs Using MODFLOW and MT3D. Instructors: Zheng (University of Alabama), Neville (Papadopoulos, Inc.). Software: MODFLOWMT3D (Method of Characteristics). |
| July 24-28 | Simulation of Saturated/Unsaturated Zone Flow and Contaminant Transport. Instructors: Bear (Technion), Yeh (Pennsylvania State University). Software: 3DFEMWATER, 3DLEWASTE, FEWA, LEWA, FEMWATER, LEWASTE. |
| Aug. 10-11 | Application of Geostatistics and Kriging to Spatial Estimation Problems in Ground-Water. Instructor: Hoeksema (Calvin College). Software: GEO-EAS, GEOPACK. |
| Sept. 18-22 | Parameter Identification for MODFLOW. Instructors: Hill, Cooley, Yager (USGS). Software: MODFLOWP. |
| Oct. 17-21 | Introduction to the MODFLOW Ground-Water Flow Modeling System. Instructors: Andersen, Greenwald (GeoTrans, Inc.). Software: MODFLOW, MODPATH. |
| Nov. 7-10 | 3D Saturated Zone Solute Transport Modeling. Instructors: Konikow, Goode (USGS). Software: USGS 3D-MOC/MODFLOW. |

ASCE'S DENVER CONFERENCE HAS CLOSE TO RECORD ATTENDANCE

Almost 600 people, a near record number, attended the 21st Annual Conference of the ASCE Water Resources Planning and Management Division (WRPMD) held in Denver in May 1994. The theme of the conference was "Water Policy and Management: Solving the Problems."

The conference featured a strong technical program with nearly 280 papers in eight concurrent sessions, which generated stimulating discussion and occasional friendly arguments. A display of 11 exhibits was also part of the conference.

Keynote speakers were Joe D. Hall, recently retired from the Bureau of Reclamation; Shannon Cuniff, Environmental Protection Agency official currently detailed to the Interagency Flood Plain Management Review Commission;

and Kyle Schilling, Director of the U.S. Army Corps of Engineers' Institute of Water Resources. Hall assessed the Administration's water policies while Cuniff and Schilling described studies by their agencies on floodplain management (the aftermath of the Midwest floods of 1993).

Colorado State University's Victor Koelzer, Professor Emeritus of Civil Engineering, was honored as a newly elevated Honorary Member of the American Society of Civil Engineers at the awards dinner. Koelzer was one of the Division founders.

The conference chair was Darrell G. Fontane of Colorado State's Civil Engineering Department and Managing Director, International School for Water Resources and Associated Programs.

MEETINGS

CONFERENCE ON TAILINGS AND MINE WASTE '95 AND SUMMITVILLE FORUM

January 17-20, 1995
Colorado State University
Fort Collins, Colorado

This event will provide a forum for members of the mining community, engineers and scientists serving the mining industry, regulatory groups, and other interest groups concerned with environmental issues related to tailings and mine waste management. Issues of mining, milling, environmental geotechnics, mining engineering, tailings management, geohydrology, geochemistry and other related topics will be covered in focused sessions.

For information contact Janet Lee Montera, Dept. of Civil Engineering, Colorado State University, Fort Collins, CO 80523. Phone 303/491-7425; FAX 303/491-7727.

1994 GROUNDWATER GUARDIAN CONFERENCE "Communities Leading Groundwater Protection" November 17-18, 1994, Washington, D.C.

This two-day conference will feature national and international authorities on groundwater, groundwater protection, and citizen and community mobilization. The keynote speaker is Gilbert M. Grosvenor, President of the National Geographic Society; the concluding address will be by Jim Elder, Director of the Office of Ground Water and Drinking Water, U.S. Environmental Protection Agency.

The first day will include an exposition of community groundwater protection projects and resources. On the second day, a series of workshops will acquaint you with organizations and resources which are available to help you and your community protect groundwater.

The *Groundwater Guardian* program supports, recognizes and connects U.S. and Canadian communities taking action to protect groundwater. During 1994 the program was tested in eight communities in the U.S. and Canada. You will hear first-hand about the program from these eight communities, which are being honored as Groundwater Guardians for 1994:

Boise, Idaho * Oxford, Michigan
Tillery, North Carolina * Seward, Nebraska
Warm Springs Reservation, Oregon
Yolo County, California * Watsonville, California
Wilmot Township, Ontario, Canada

Groundwater Guardian is a program of the Groundwater Foundation, P.O. Box 22558, Lincoln, NE 68542-2558. CALL TOLL-FREE: 1-800-858-4844.

**A RIVER OF DREAMS AND REALITIES--
ARKANSAS RIVER BASIN WATER FORUM**

Rafters want high water; people who fish want low. Boaters want full reservoirs; agriculturists need water for crops. Municipalities need water for homeowners and businesses; environmentalists want free-flowing rivers. Each has a dream for the Arkansas River; the reality is that users must work together to find ways to share the valuable resource.

A group of concerned river users currently is planning to hold the first conference of its kind that will focus on uses of the entire Arkansas Basin. Participants will explore "A River of Dreams and Realities" during the Arkansas River Basin Water Forum January 17-18, 1995, at the University of Southern Colorado in Pueblo.

Forum presentations will trace the Arkansas from its headwaters above Leadville to the Kansas border and will consider the varied uses of the river in Colorado. "We hope the Forum will encourage user groups to work together for the benefit of all," said Jim Valliant, Regional Irrigation Specialist at Rocky Ford. Representatives of agricultural, environmental, industrial, mining, municipal, recreational, and political and legal interests are on the Forum planning committee. "The Forum program will present the views of each interest group to give participants an opportunity to learn about problems, needs, and realities of other water users," said Charles L. "Tommy" Thompson, general manager, Southeast Colorado Water Conservancy District. Thompson is Forum program chairman.

For further information, contact:

Colorado State Cooperative Extension, South Central District, Pueblo at (719) 549-2049
Cooperative Extension in Otero County, Rocky Ford at (719) 254-7608
Southeast Colorado Resource Conservation and Development, Lamar at (719) 336-9421
Southeast Colorado Water Conservancy District, Pueblo at (719) 544-2040

**INTEGRATED WATERSHED MANAGEMENT IN THE SOUTH PLATTE BASIN:
STATUS AND PRACTICAL IMPLEMENTATION**

October 26-27, 1994 -- The Ramkota Inn, Greeley, Colorado

The fifth annual South Platte Forum will explore the practical implementation issues associated with an integrated approach to water management in the South Platte Basin. This year's agenda will look at several key basinwide issues, current physical conditions in the watershed, and tools that can be used to enhance an integrated approach to management of the resource. The final session will provide examples of strategies that are or could be applied in the South Platte Basin.

Keynote Speakers

Jim Lochhead, Executive Director, Colorado Department of Natural Resources
William Yellowtail, Regional Administrator, Environmental Protection Agency, Region VIII

Sessions

Incentives for Cooperation
Defining Integrated Watershed Management
South Platte River Basin Physical Setting
Implementing Integrated Watershed Management
Integrated Watershed Management Strategies
Integrated Watershed Management, Federal Perspective

For information contact:

Kathleen Klein, Conference Coordinator
CWRRRI, 410 University Services Center
Colorado State University
Fort Collins, CO 80523
Phone: 303/491-6308
FAX: 303/491-2293

*Sponsored by: Colorado Division of Wildlife, Colorado Water Resources Research Institute,
Northern Colorado Water Conservancy District, Denver Water, U.S. Geological Survey, U.S.
Environmental Protection Agency, U.S. Fish and Wildlife Service.*

CALLS FOR PAPERS

1995 National Conference of the American Water Resources Association, Nov. 5-9, 1995, Houston, Texas and Reconvened Conference Nov. 10-12, 1995, Cancun, Mexico--Submit three copies of 200-word abstract to appropriate conference or symposium technical program chairperson listed below. For National Conference, submit abstracts to: John S. Grounds III,

General Chairperson, Bechtel, 3000 Post Oak, Houston, TX 77252-2166, Phone 713/235-4921.

- For National Symposium on Water Management in Urban Areas, submit abstracts to: Mark L. Loethen, Symposium Chairperson, Pate Engineers, Inc., 13408 Northwest Freeway, Suite 160, Houston, TX 77040.
- For National Symposium on Advances in Model Use and Development in Water Resources, submit abstracts to: Theodore G. Cleveland, Symposium Chairperson, Dept. of Civil and Environmental Engr., University of Houston, Houston, TX 77204-4791.
- For National Symposium on North American Water Resources, submit abstracts to: Jerry R. Rogers, Symposium Chairperson, Dept. of Civil and Environmental Engr., University of Houston, Houston, TX 77204-4791.

Water Resources and Environmental Hazards: Emphasis on Hydrologic and Cultural Insight in the Pacific Rim, June 25-28, 1995, Honolulu, Oahu, Hawaii--Deadline: Oct. 28, 1994. Submit three copies of 250-word abstract to: Raymond Herrmann, Symposium Technical Program Chairperson, National Biological Survey, Colorado State University, Fort Collins, CO 80523, Phone 303/491-7825.

International Union of Geodesy and Geophysics, XXI General Assembly, July 2-14, 1995, Boulder, CO. For abstract instructions and information contact IUGG XXI General Assembly, c/o American Geophysical Union, Phone 202/462-6900, FAX 202/328-0566, e-mail iugg_xxiga@kosmos.agu.org. **Deadline: Feb. 1, 1995.**

Water Environment Federation 68th Annual Conference (Oct. 21-25, 1995) & Exposition (Oct. 23-25, 1995), Miami Beach, FL. **Deadline: Dec. 16, 1994.** Submit Abstracts to: Water Environment Federation, Attn: Conference Program, 601 Wythe Street, Alexandria, VA 22314-1994. Phone 800/444-2933. Fax submissions cannot be accepted for consideration.

FRESHWATER ECOSYSTEMS AND CLIMATE CHANGE IN NORTH AMERICA: A REGIONAL APPROACH

October 24-26, 1994 -- Leesburg, Virginia

Organized by American Society of Limnology and Oceanography and North American Benthological Society
Co-sponsored by U.S. Environmental Protection Agency and U.S. Geological Survey

Registration packets are available from the Office of Conference Services, Freshwater Ecosystems Symposium, Colorado State University, Fort Collins, CO 80523, Phone 303/491-6222, FAX 303/491-0667. For further information contact Diane McKnight, USGS-WRD, 3215 Marine St., Boulder, CO 80303, Phone 303/541-3015, FAX 303/447-2505; or Alan P. Covich, 303/491-2372, FAX 303/491-5091, e-mail alanc@picea.cfnr.colostate.edu.

Alan P. Covich, Head of the Department of Fishery and Wildlife Biology and member of the ASLO/NABS Steering Committee, received a grant from the U.S. Geological Survey to help organize this conference. He also is principal investigator of a CWRRRI project on ecological integrity and western water management.

CALENDAR

1994

- Oct. 19-22 13TH TECHNICAL CONFERENCE ON IRRIGATION, DRAINAGE AND FLOOD CONTROL, Denver, CO. Contact USCID, Phone 303/628-5430; FAX 303/236-5431.
- Nov. 6-8 107TH ANNUAL MEETING, NATIONAL ASSOCIATION OF STATE UNIVERSITIES AND LAND GRANT COLLEGES, Chicago, IL. Contact nasulgc AT PHONE 303/778-0850; fax 202/296-6456; Internet AM94@NASULGC.nche.edu.
- Nov. 6-10 AWRA NATIONAL SYMPOSIUMS ON WATER QUALITY AND NATIONAL WATER QUALITY ASSESSMENT (NAWQA), Chicago, IL. Contact AWRA, 5410 Grosvenor Lane, Suite 220, Bethesda, MD 20814-2192. Phone 301/493-8600; FAX 301/493-5844.
- Nov. 9-10 BOULDER CREEK WATERSHED FORUM, Boulder, CO. Contact Water Quality and Environmental Services, Phone 303/441-3251; FAX 303/441-4083; DISINGER%575TH@BOULDER.LIB.CO.US.
- Nov. 14-16 WATERSHED WISE: A WORKSHOP ON WATERSHED PROTECTION, Grand Junction, CO. Contact: Thorne Ecological Institute, Phone 303/499-3647; FAX 303/499-8340.
- Dec. 12-13 THE NATIONAL GROUND WATER STAKEHOLDERS CONFERENCE, Washington, DC. Contact Terrene Institute, Phone 202/833-8317; FAX 202/296-4071.
- 1995
- Mar. 5-8 CLEAN WATER-CLEAN ENVIRONMENT-21ST CENTURY, Kansas City, MO. Contact: ASAE Meetings & Conferences, Phone 616/429-0300; FAX 616/429-3852.
- Apr. 23-26 WATER IN THE 21ST CENTURY; CONSERVATION, DEMAND & SUPPLY, Salt Lake City, UT. Contact American Water Resources Association, Phone 703/904-1225; FAX 703/904-1228.
- May 23-25 WORKSHOP ON COMPUTER APPLICATIONS IN WATER MANAGEMENT, Fort Collins, CO. Contact L.R. Ahuja, USDA-ARS, PHONE 303/490-8300; fax 303/490-8310.
- June 26-28 WATER RESOURCES & ENVIRONMENTAL HAZARDS: EMPHASIS ON HYDROLOGIC & CULTURAL INSIGHT IN THE PACIFIC RIM, Honolulu, Oahu, Hawaii. Contact American Water Resources Association, Phone 703/904-1225; FAX 703/904-1228.

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