COLORADO WATER

Newsletter of the Water Center at Colorado State University

OCTOBER 2002

Each annual COLORADO WATER WORKSHOP is distinctive -- and this year's event, held at Western State College in Gunnison, Colorado, July 31-August 2, 2002, celebrated the 100th anniversary of the U.S. Bureau of Reclamation plus the creation of the Colorado Alliance for Water Education. Above from left: Chips Barry, Manager, Denver Water; Rita Schmidt Sudman, Executive Director, California Water Education Foundation; Dick Bratton, Attorney and Co-Founder of the Colorado Water Workshop; and The Honorable Greg Hobbs, Justice, Colorado Supreme Court. See page 20.

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WATER ITEMS AND ISSUES . . .

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EDITORIAL

WATER, FORESTS AND DROUGHT

by Robert C. Ward, Director

Forestlands in Colorado are the source of a large fraction of Colorado's annual water supply. What happens on these lands is of considerable concern to water managers, from the standpoint of both quantity and quality of water. During a time of drought, as is currently gripping the state, a much more focused eye is cast by water managers upon forestlands regarding water yield. Recent forest fires have created water quality problems for drinking water systems. Recreation users are concerned about how trees and water are managed in protecting forest uses of value to them. In addition, wildlife interests seek to have forestlands managed in a way that successfully implements the Endangered Species Act. Several efforts of higher education to assist in providing new knowledge, in synthesizing existing knowledge, and in seeking agreements with forest plans are presented in this issue of Colorado Water.

Lee MacDonald, a professor of Watershed Sciences, with the help of a group of faculty and water managers, has prepared an analysis of the current knowledge that explains relationships between water and forest management practices. A summary of this report is provided on page 6. Phil Omi, a professor of Forest Sciences, provides an update on research related to forest thinning and prescribed fire programs on page 14. Karla Brown, Extension Specialist in Montrose, describes efforts to facilitate stakeholder input in developing forest management plans in the heavily utilized White River National Forest on page 16.

As faculty in higher education address scientific and practical information needs regarding drought, new interdisciplinary working relationships are being explored and new dialogues with water users and managers are being established. To better coordinate the emerging faculty drought activities, the CSU Water Center and the Colorado Climate Center established a joint initiative called DroughtLab (Drought Analysis and Management Laboratory). The main purpose of DroughtLab is to facilitate the conduct of basic and applied research on atmospheric, hydrologic, environmental, socio-economic, planning and management, and policy aspects related to extreme droughts. Education, technology transfer, extension, and communication are a critical part of the laboratory. The current focus of the DroughtLab is characterizing the vulnerability of the environment and the socio-economic infrastructure to severe droughts. More specifically, it will address:

- Drought Analysis and Characterization
- Drought Impacts and Consequences
- Drought Response and Management

Additional highlights on DroughtLab can be found on page 4 and on the following Websites:

http://droughtlab.colostate.edu

http://climate.atmos.colostate.edu/

http://cwrri.colostate.edu

The Colorado Drought Conference, announced on page 41, is a product of the new DroughtLab. The goal of the conference is to carefully examine the lessons learned during the 2002 drought and examine options available to Colorado as it prepares for a continuation of the drought into 2003. A proceedings of the conference will be published to document the various drought issues to be presented and discussed that may help water managers facing the uncertainty of water supplies in the unfolding drought.

China, with water scarcity reaching the critical stage in sprawling showcase cities like Beijing and Tianjin, has embarked on one of history's great water-moving projects. At huge cost and great risk to the environment, the government plans to rechannel vast rivers of water from the Yangtze basin to the thirsty north, over three pathways of nearly 1,000 miles each. The official price tage of $58 billion...is more than twice that of the Three Gorges Dam, China's most recent mega-prouject now nearing completion.

New York Times, 8/27/02

COLORADO STATE RESEARCHERS CREATE DROUGHT LAB

As Colorado's drought worsens, the state's water supplies diminish, and communities are uncertain about how to deal with prolonged dry conditions, Colorado State University researchers are responding by establishing DroughtLab. DroughtLab is a joint initiative of Colorado State's Water Center and the Climate Center, bringing together the knowledge of more than 100 researchers from 22 academic departments at Colorado State and labs and departments at the University of Colorado at Boulder. Disciplines contributing to DroughtLab's efforts include atmospheric science, civil engineering, watershed sciences, soil and crop sciences, rangeland science, forest science, ecology, sociology, political science, and agricultural and resource economics.

DroughtLab serves as a framework for researchers to collaborate and develop encompassing information that helps water managers reduce Colorado's vulnerability to drought. Outreach education, statewide Cooperative Extension efforts, technology transfer and the communication of drought knowledge to state and local officials and the general public will compliment the lab's research efforts. Research will be conducted on campus and across the state at the university's Agricultural Experiment Station research centers located in communities throughout Colorado.

Co-directors of the DroughLab are Professor Roger Pielke Sr., Department of Atmospheric Science and director of the Colorado Climate Center at CSU, and Professor Jose Salas, Professor of Civil Engineering at CSU. Building on renowned water and climatological research programs, the new collaborative drought analysis and management laboratory redirects current resources and establishes new studies to provide information to government leaders, businesses and individuals as they plan and/or manage drought events.
DroughtLab researchers are initially focusing on three key areas:

Drought analysis and characterization: Researchers are characterizing the initiation, evolution, termination and recurrence of drought and developing new methods for analyzing various types of drought.

Drought impacts and consequences: Researchers are identifying techniques for impact assessment and evaluation of consequences of extreme drought, including ecological and socio-economic impacts, and consequences to cities, rural communities, agriculture and industry.

Drought response and management: Researchers are developing new technological options for planning and managing the impacts of extreme drought, including analyses of water resources systems, the development of water supply forecasting techniques, developing associated policy, mobilization of institutions and mitigation options that could be useful for local, state and national level decision makers.

Current DroughLab research and community projects include:

a study about effective water management responses to the 2002 drought by Colorado agricultural producers

a study of the response of federal rangeland managers to the 2002 drought conditions,

co-sponsoring a statewide drought conference for water managers,

a drought-related precipitation analysis,

an analysis of the recurrence of extreme drought,

an in-depth study of the hydrology and erosion of burned watersheds during drought, and

an investigation of the impact of forest fires on erosion.

DroughtLab Co-Director Roger Pielke, Sr.

Professor Roger Pielke has been at Colorado State University since 1981. His research interests include Mesoscale Meteorology, Meteorological Modeling, Climate Change, and Air Pollution Meteorology. To investigate these topics, he developed the Regional Atmospheric Modeling System (RAMS). This nested grid meteorological model has been used in published studies of a wide variety of atmospheric systems. RAMS has been linked to an ocean model and to an ecosystem dynamics/hydrologic modeling system to evaluate feedbacks between these different geophysical systems. Professor Pielke's investigations include global, regional, and microscale studies.

Professor Pielke's research has led him, along with other scientists, to see the effect of land use change as an overlooked factor in global climate change.

The 1992 UN Framework Convention on Climate Change (UNFCCC) defines "climate change" as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere...". In contrast, the Intergovernmental Panel on Climate Change (IPCC) defines climate change more broadly and includes reference to land-use change.

Present mitigation strategies focus on the single factor of greenhouse gas concentrations and a single scale, global average climate. Pielke and his colleagues point out that while these provide a starting point for confronting climate change, humans and ecosystems reside in local climates, not in the global average climate.

Climate change is occurring at all spatial scales from local to regional to global. Human society is currently helping to produce a global climate for which there is no precedent in the historic or prehistoric records, and given the magnitude, duration, and diversity of environmental changes, there is no going back -- we must try to limit undesirable changes and to manage the changes that do occur.

The immediate question is how to minimize the vulnerability of ecosystems and human society to climate change and climate variability. To what extent do current climate-policy initiatives, focused on greenhouse gas concentrations, succeed in providing incentive for actions that reduce undesirable human influences on the climate system and increase resilience to climate change?

Source: The Climatic Impacts of Land Surface Change and Carbon Management, and the Implications for Climate-Change Mitigation Policy, by Gregg Marland, Roger A. Pielke Sr., et al. The paper was written as part of the output from a September, 2001 workshop at the Aspen Global Change Institute, funded by the National Aeronautics and Space Administration, Earth Science Enterprise.

For Colorado Climate Center resources and web links that discuss current drought conditions, go to the website at http://climate.atmos.colostate.edu/ and click on Drought.

NEW: Added 8/30/02 -- TOTAL PRECIPITATION ANALYSIS FOR SEPTEMBER - AUGUST YEAR SPANS. For Total Precipitation Analysis by Year, click one of the following stations to view September - August Year Spans and see how each year ranks. Climatic Divisions: Grand Lake 1 NW, Taylor Park, Grand Junction WSO A, Meeker, Montrose No. 2, Mesa Verde NP, Del Norte 2 E, Center 4 SSW, Colorado Springs

LATE NEWS: An October 1, 2002 NASA News Release: "Land Cover Changes May Rival Greenhouse Gases as Cause of Climate Change," focuses on Professor Pielke's research.

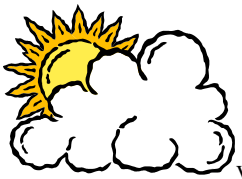
DroughtLab Co-Director Jose D. Salas

Professor Salas joined Colorado State University in 1976. His research interests include stochastic modeling and simulation of hydrological processes; hydroclimatic variability; flood prediction, forecasting and control; and drought analysis, prediction, and management.

From establishing a complex computer simulation model of the Nile River system in Africa to developing long range streamflow forecasting systems in Chile, Jose Salas has traveled the globe for more than 20 years collaborating with foreign nations on hydrologic and water resources projects.

Dr. Salas specializes in stochastic analysis, modeling, simulation, and forecasting of hydrologic systems. In collaboration with the U.S. Bureau of Reclamation he developed the software called SAMS (Stochastic Analysis, Modeling and Simulation) that generates "synthetic time series," which are used to design and manage water resource projects by considering the uncertainty of hydrologic processes, such as streamflow in rivers. Currently Dr. Salas and graduate students are studying the recurrence of extreme droughts in Colorado, particularly quantifying the severity of the ongoing drought.

Dr. Salas has been Program Leader of the Hydrology and Water Resources Program, Department of Civil Engineering at CSU, since 1986. The program's emphasis in water resources and hydrologic engineering focuses on the application of physical, stochastic, and systems and computing engineering techniques for estimation and control of extreme events such as floods and droughts, risk and uncertainty analysis in water and environmental systems, integrated hydrologic, ecological, and socioeconomic impact assessments of climate variability and change, conjunctive use of surface and groundwater systems, forecasting of precipitation, streamflow, reservoir levels, and groundwater levels, design of surface and groundwater reservoir systems, and design of surface and subsurface hydrologic gauging network systems. Computer models, geographic information systems, expert systems, decision support systems, and multimedia computing environments are used extensively.



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RESEARCH

EFFECTS OF CHANGES IN COLORADO'S FORESTS ON WATER YIELDS AND WATER QUALITY

by Lee H. MacDonald, Professor
Earth Resources Department, Colorado State University

The recent large wildfires and the ongoing drought have focused considerable attention on the role of Colorado's forests in generating runoff and controlling water quality. Key questions include:

1. How has past forest management affected annual water yields, low flows, and peak flows?
2. What is the potential for altering current streamflow regimes through forest management?
3. How is past and present forest management affecting water quality?
4. What are the risks to water quality posed by forest management, including the no-action alternative? and
5. What additional information is needed to guide public policy debates and future forest management decisions?

The role of forest management is of particular concern in Colorado, because the vast majority of the state's water supply is derived from forested areas. The effects of forest management on water quality are a major concern as a result of the severe problems observed after the 1996 Buffalo Creek fire, and the potential for similar adverse effects from the major fires recorded this past summer and future fires.

For the past two years a panel headed by Dr. Lee MacDonald has been addressing these issues. In addition to Dr. MacDonald, the panel includes water quality and forest ecology professors at CSU, a former U.S.Department of Agriculture. Forest Service research hydrologist, representatives of key water agencies such as Denver Water, the Colorado River Water Conservation District, and the Northern Colorado Water Conservancy District, and representatives of resource management agencies at both the state and federal level. Most of a draft report has been completed and reviewed by the panel, and a final report should be ready by the end of the year. The following article is an initial look at the key findings in the draft report, but the final report has yet to be reviewed and approved by the full panel.

Key Findings from Draft Report

The report summarizes existing knowledge on how changes in the density and composition of Colorado's forests can affect annual water yields, low flows and high flows, and the extent to which the results from small, experimental catchments can be applied to larger watersheds. In Colorado, we are particularly fortunate because we can draw from a large body of research from the Fraser Experiment Forest near Winter Park and other study sites in the Rocky Mountains. These studies have clearly shown that the removal of forest vegetation, particularly in the sub-alpine zone, increases annual water yields due to the reductions in winter (snow) interception rates and lower summer evapotranspiration. As long as the cut areas are not exposed to wind scour, water yield increases generally are directly proportional to the percent of the canopy that is removed rather than the pattern of harvest (i.e., whether the trees are removed in large patches, clumps, or as single trees scattered throughout the stand). The potential for increasing water yields is greatest on north aspects, as these areas have the densest vegetation and hence the highest rates of snow interception.

There are several important constraints on the potential for forest harvest to increase annual water yields.

- First, water yield increases are highly unlikely in areas that receive less than 18-20 inches (450-500 mm) of annual precipitation.

- Second, water yield increases are greatest in wet years and smaller in dry years. In the Fool Creek experiment, 40 percent of the basin area (50 percent of the forested area) was cut, and the water yield increase ranged from 1.6 inches in a dry year to 6.4 inches in an exceptionally wet year. An earlier experiment in south-central Colorado yielded an average annual increase in water yield of only 1.0 inch, as the mean annual precipitation in this area was only 21 inches as compared to the mean of nearly 26 inches at Fool Creek.

- Third, nearly all of the increase in water yield comes in May or June, on the rising limb of the annual snowmelt hydrograph. There is little evidence for any water yield increase from mid-summer until snowmelt begins in the following spring. This means that downstream storage is needed if this additional water is to be used for mid- or late summer irrigation and water supply purposes.

Another potential limitation is that forest regrowth will eventually eliminate the initial increase in water yields. In the case of Colorado, the slow growth rate in higher-elevation coniferous forests means that an increase in water yield may persist for 60 or more years. In contrast, the increase in flow from cutting an aspen forest might only persist for 15-40 years, and the increase in water yields from lower elevation forests is also likely to be substantially shorter than the estimated 60-year recovery period for the sub-alpine forests.

Another issue is the increase in peak flows after forest harvest due to more rapid spring snowmelt. As in the case of annual water yields, the increase in the size of peak flows is approximately proportional to the amount of canopy removed. As a

rough guide, clearcutting an entire basin would result in a 40-50 percent increase in the size of the mean annual peak flow, and a much smaller increase in the size of the largest instantaneous maximum flow. There should be little change in the timing of the peak flows, as the increase in winter snowpack roughly compensates for the increased rate of snowmelt. Finally, the results of a recent study on the 4100-acre Coon Creek watershed in southern Wyoming showed that the changes in the amount and timing of runoff observed in small, experimental watersheds can generally be extrapolated to larger forested watersheds.

Effects of Moderate- and High-Severity Fires on Runoff

The effects of moderate- and high-severity fires on runoff can be much greater than the effects of forest harvest, particularly in lower-elevation areas where peak flows are generated by summer thunderstorms rather than spring snowmelt. In these areas, high-severity, fires can increase instantaneous peak flows by 10 to nearly 100 times. This increase can be attributed to both the loss of soil cover and the development of a fire-induced water-repellent layer just below the soil surface. This water-repellent layer appears to break down within 1-2 years, and the development of ground vegetation means that increases in peak flows are of greatest concern in the first 1-3 years after burning.

Left: Panel members get a first-hand, on-site-look at the state of Colorado's forests.

There are virtually no data on the effects of high-severity fires on peak flows in higher-elevation zones, but the water repellent layer is not effective at limiting infiltration once a soil has wetted up from rainfall or snowmelt. Hence the effects of wildfires on runoff rates is a lesser concern for high-elevation forests where peak flows result from spring snowmelt rather than summer convective storms.

Effects of Forest Management, Roads and Fire on Water Quality

The next portion of the report reviews the effects of forest management, roads, and fire on water quality. In general, careful forest management practices should not result in a significant, adverse effect on water quality. Erosion from unpaved roads is usually the largest source of sediment in forested areas, and the placement of roads adjacent to stream channels is of particular concern because the eroded sediment is much more likely to reach the channel network.

The biggest water quality concern related to forest management is the degradation of water quality following high-severity wildfires. Data from the Buffalo Creek, Bobcat, and Hayman wildfires all indicate that large amounts of overland flow can be generated by rainstorms once the rainfall intensity exceeds approximately 0.5 inches per hour for about a 30-minute period. The lack of cover and the water-repellent layer act together to induce overland flow, and the combination of rainsplash, sheetwash, and rilling can increase erosion rates by several orders of magnitude relative to unburned conditions. Sediment concentrations in the runoff from burned areas can exceed 40 grams per liter. The increase in runoff rates can cause extensive incision in previously unchanneled swales or greatly increase the size of the smaller headwater channels.

The downstream deposition of the sediment eroded from hillslopes and headwater channels is of tremendous concern to downstream water users and aquatic resource managers. The sediment emanating from the areas burned in the 1996 Buffalo Creek fire temporarily dammed the South Platte River and reduced the storage capacity of Strontia Springs reservoir by approximately one-third. The high ash and sediment concentrations in storm runoff necessitated extensive and costly changes in water treatment procedures. In addition to sediment, other water quality concerns include potentially high levels of dissolved organic carbon, manganese, and iron.

Effects of Changes in Forest Cover Over Time

The next chapter of the report evaluates the changes in forest cover over time, and the possible effects of changes in forest cover on runoff. A variety of studies and historical photographs all indicate a substantial increase in forest density relative to the pre-settlement and early settlement periods (pre-1850 and approximately 1850-1900, respectively). The increase in forest density is probably greatest in the lower to mid- elevation ponderosa pine and mixed conifer forests, and these also are the forest types most susceptible to wildfires. The higher elevation forests have not been as extensively altered by human activities such as grazing, timber harvest, and fire suppression.

The increase in forest density probably has reduced annual water yields. The only quantitative estimates of this decrease are from a recent study of National Forest lands in the North

Platte River basin. This study estimated that annual water yields from the 1.34 million acres of National Forest lands has decreased by approximately 14 percent, or 185,000 acre-feet, since 1860, and that most of this decrease occurred from about 1900-1940.

Little or no data are available regarding forest management activities on private lands, but data from the National Forests show that only relatively small areas are being subjected to commercial timber harvests, prescribed fires, or forest thinning. The North Platte study suggested that sustainable timber harvests on all suitable lands could increase annual water yields by roughly 55,000 acre-feet per year.

The other important effect of changes in forest management and forest density is on the frequency and magnitude of wildfires. Historic records and tree-ring studies indicate that there have been fewer fires over the past 70-100 years than prior to European settlement. The combination of fire suppression, reduced grazing, and lower levels of timber harvest have all led to higher fuel loadings and hence a greater susceptibility to large fires under dry conditions. The combination of extended drought and increased forest density has resulted in the record number of large forest fires in the summer of 2002.

Left: Water professionals consider the impact of changes in forest cover over time.

Effects of Changes in Forest Density and Management on Water Quality

The effects of changes in forest density and management on water quality are the topic of the penultimate chapter of the report. The biggest threat to water quality in forested areas is the change in runoff and erosion that occurs after wildfires. High erosion rates and mass movements have already been observed in the areas that burned at high- and moderate-severity in the summer of 2002. At least for the Hayman fire, the relative lack of intense rainstorms has resulted in lower erosion rates and fewer water quality problems than occurred after the 1996 Buffalo Creek wildfire.

Other than wildfires, houses, roads, and recreational use pose the biggest threat to water quality in forested areas. As noted earlier, unpaved forest roads are typically the single largest source of sediment, and increased development is usually associated with increasing road density. Higher traffic loads and more frequent road grading both tend to increase road erosion rates. Poorly installed or maintained septic tanks can also degrade water quality. Intensive grazing in riparian zones by livestock or uncontrolled ungulate populations can reduce the streamside vegetation, directly and indirectly destabilize streambanks, and generally degrade water quality and aquatic habitat.

Given our current knowledge, the most difficult problem at this point is how to develop a consensus on managing forest lands in Colorado. Past management policies have resulted in lower water yields and an increased susceptibility to large wildfires. Efforts to reverse this situation through substantially higher rates of forest harvest may engender considerable public opposition. Larger-scale efforts to reduce fuel loadings may be quite costly, especially if there is no provision to offset some of the costs by harvesting some of the larger, more merchantable trees. Large-scale prescribed burns may be difficult to implement due to the limited number of days with suitable weather conditions, concerns over the degradation of air quality and release of hazardous particulates, and fears over the possible escape of prescribed fires.

In the absence of any changes in management, we can expect more large wildfires with the attendant risk to lives, property, water quality, and downstream resources. When initiating the debate on forest management policies, it is critical to recognize that the type and magnitude of problem will vary by location and forest type, and that different areas are likely to require different approaches and solutions. The hope is that this report can provide a solid, scientific foundation for this debate, and thereby contribute to the efficient development and implementation of sound forest management policies.

This research was conducted with the support and collaboration of the Department of the Interior, U.S. Geological Survey and the Colorado Water Resources Research Institute through Colorado State University Grant Agreement No. 01HQGR0077. Support was also provided by Denver Water, the Colorado River Water Conservation District, and the Northern Colorado Water Conservancy District.

DESIGN OF WATER QUALITY INFORMATION SYSTEMS FOR SOURCE WATER ASSESSMENT: A DENVER WATER CASE STUDY

by Justin C. Twenter, Brown and Caldwell, Seattle and
Jim C. Loftis, Professor, Civil Engineering Department, Colorado State University

The Denver Water Department, (now known as Denver Water), was formed in 1918 when it began planning and developing a water supply system to meet the needs of citizens of Denver and surrounding areas. The supply of water is presently obtained from an accumulated drainage area of 4,000 square miles (2.5 million acres) and a network of thirteen reservoirs. This vast amount of land covers eight counties of Colorado and is located on both sides of the Continental Divide. Within these counties, the population increase in the last 10 years has been relatively high. This flux of population usually accompanies a change in land use, which normally impacts water quality and creates a potential source of contamination. Although the water quality is known to be good in the source watersheds, Denver has identified the need to better track status and trends in the quality of its source water.

Questions that water quality information systems are called upon to answer are changing, as the management of water quality shifts from a historical point source control framework to investigation of non point sources of pollution. New emphasis is placed on the protection of current public drinking water supplies to diminish the risk of contamination.

The 1996 amendments to the Safe Drinking Water Act (SDWA) introduced information based programs that target the quality of source water. Large Public Water Systems (PWS), the providers of drinking water within large municipalities, have managed the quality of source water primarily at the intake to the treatment systems. The idea of moving farther up into the watershed for water quality management of drinking water supplies is presented by the U.S. Environmental Protection Agency (USEPA) in the Source Water Assessment and Protection (SWAP) program. This approach is logical from the quality standpoint, as potential problems can be identified earlier, rather than just prior to treatment. The Consumer Confidence Reporting (CCR) and SWAP, which were designed to involve and inform the public, both contain mandates to produce information on the source area from which suppliers obtain their water for consumption.

Although SWAPs are not considered to be a complete process in and of themselves they are the start of a continued Source Water Protection Program (SWPP) of which, source water quality monitoring is a critical part. Public water systems affected by a SWPP would need an effective method for combining the information needs of the program with legal and operational needs that they currently address. The method for doing this is not provided by the USEPA guidance document for the SWAP program.

This case study of Denver Water demonstrates how a large PWS can effectively implement a water quality information system to meet the regulatory requirements of programs presented in the SDWA amendments of 1996 while also providing essential general management information. Emphasis was placed on developing the solid framework for a successful water quality information system. The design focuses on the necessity to connect the information needs of management with the feasible products of water quality monitoring.

A key step in the design is identification of the information desired. In the case of Denver Water, information needs were identified through informal discussions and a meeting with management. Some direction with respect to information needs was gained from referencing implications contained in existing laws.

Because Denver Water is a public water system, it is regulated on a day-to-day basis by the SDWA. The 1996 amendments to the Act recognize that effective drinking water protection must be founded on government accountability and public understanding and support. Denver Water intends to use the legal implications of the SDWA programs to formulate information needs of a source water quality monitoring system. The desired product of such a system is information that enables management to make decisions or become informed on source water issues. An updated water quality monitoring design is presented which would enable Denver Water's information production to meet the needs of management for the entire source area.

An expressed interest of Denver Water is to associate any degradation of the water quality with a possible need for change in water treatment. Denver Water is interested in identifying a relationship between the quality of the source water and the associated cost of treatment.

The nutrients that are of the utmost concern for Denver Water's source area are nitrogen and phosphorous. Both are essential elements for the growth of algae and other aquatic organisms. The dynamics of nutrients entering, exiting, and residing in the systems reservoirs present a potential source of contamination to raw water supply. Denver Water recognizes that relatively simple control measures within drainages can be implemented to minimize nutrient loadings, and these actions are often more economical than treating degraded water supplies.

Growth within watersheds that are used as a source of drinking water, and subsequent land use changes, create a

a potential source of contamination to water quality. A focus of Denver Water is to identify land use changes within the source watersheds that involve the increase of small waste management systems (e.g. septic tanks), increased infrastructure (e.g. roads, utilities), and commercial /industrial applications. A summary of the information goals for the Denver Water watershed monitoring program and the information needs developed through examination of the goals is presented in Table 1.

The success of an information system design requires matching the information needs of management with information that can be produced by the monitoring system. The information needs of management are a composite of many topics including operational, planning, legal, public relation, and regulatory. Identifying the level of information that monitoring could produce was an important step in developing an accurate account of what the information system would yield. This step involved comparing monitoring capabilities with the identified information needs.

A complete monitoring system, based on the flow of information, is described by Ward et al. (1990) and summarized below. The system serves as the means to describe water quality conditions in the environment and provide information needed to support responsible decision-making. As shown in Figure 1, the system can be viewed as consisting of two parts: (1) data generation, and (2) information generation.

Table 1: Water quality information goals and associated needs identified for Denver Water.

	Information Goal	Information Need
1.	Source Water Quality: How it Affects Water Treatment	-Define the existence of a relationship between the quality of source water and cost associated with treatment. -Characterize the quality of source water over time.
2.	Nutrient Loading	-Identify the impacts of nutrients entering/exiting reservoirs over time. -Identify the effects of nutrient transport within rivers/streams. -Determine reservoirs to be either a source or sink of nutrients.
3.	Developing within Watersheds	-Associate a change in land use (as a result of development) with water quality levels. -For a given land use, identify a "baseline" water quality level.
4.	Due Diligence	-Produce adequate information to show reasonable diligence according to Colorado Water Law.
5.	Irrigation/Exchange	-Create a list of background water quality levels for known "agricultural" variables. -Track the change in water quality over time that could potentially contribute to the hindrance of irrigated agriculture.
6.	Colorado River Agreement	-Produce data on the water variables mandated by the U.S. District Court Findings.

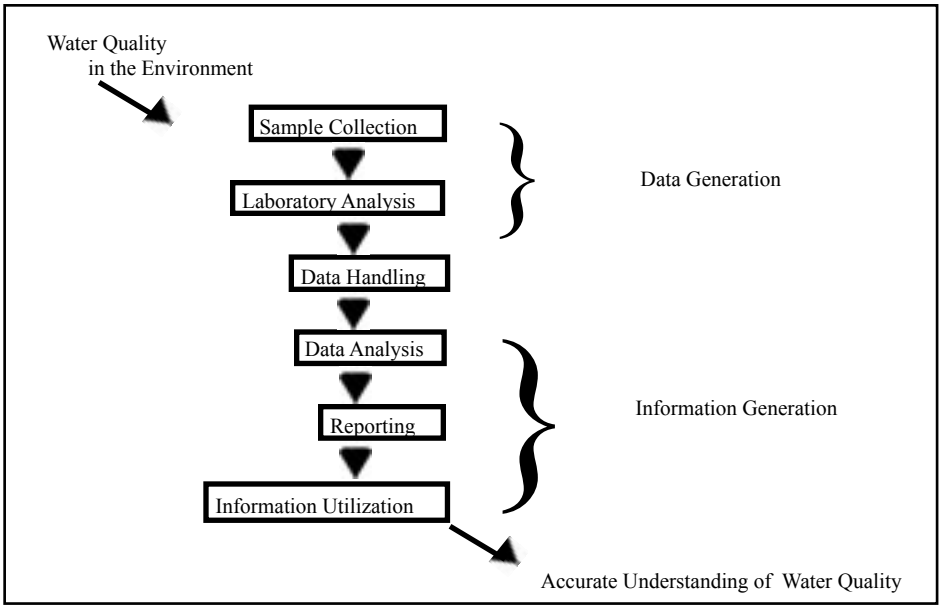

Figure 1: The definition of a complete water quality monitoring system by Ward et al (1990).

To be more proactive in supplying water quality information for the future, monitoring systems should be designed with an information product in mind rather than analyzing data as information needs arise to be more supportive of management decision-making. A design framework encompassing all components of a water quality monitoring system has evolved from the experience of various professionals working in the field (Ward et al., 1990).

Within this context, focus is placed on steps one through three of the framework listed below:

1) Define the surface water information needs of water utility management.
2) Define information that can be produced by monitoring.

3) Design a monitoring network.
4) Document data collection procedures.
5) Document information generating and reporting procedures.

The water quality monitoring network design includes three phases: water quality variable selection, sampling site selection, and sampling frequency determination. The water quality variables to be sampled for the watershed monitoring program are listed in Table 2. The selection of the variables was a function of their importance to information goals identified previously.

Analysis was conducted to determine reasonable sampling frequencies for estimation of mean concentrations, trends, and pollutant loads for physical and chemical water quality parameters.

Table 2: Water quality variables to be sampled by the Denver Water watershed monitoring program.

	Variable	Descriptor	Reason for Monitoring
1	Alkalinity, Total as CaCO3 (mg/L)	General	Drinking water standard. Indicator of Carbonate species concentrations; Acid neutralizing capacity (ANC) of water (buffering effect on pH)
2	Bromide (mg/L)	Ion	Total anion component.
3	Cadmium, Dissolved (mg/L)	Metal	Water Quality standard; Indicator of pollution from mining activity (at elevated levels).
4	Cadmium, Total (mg/L)	Metal	Drinking water standard; Indicator of pollution form mining activity (at elevated levels).
5	Calcium (mg/L)	Major Ion	Drinking Water Standard; Hardness indicator (imparts hardness to water); Typically in form of carbonate species.
6	Chloride (mg/L)	Major Ion	Drinking water standard; Water quality standard Indicator (at high concentrations) of industrial and sewage effluent; High levels render water unpalatable.
7	Coliform Total (/100mL)	Microorganism	Drinking water standard; Indicator of potentially harmful bacteria.
8	Escherichia coli (/100L)	Microorganism	Indicates presence of wastewater or fecal contamination.
9	Fluoride (mg/L)	Ion	Drinking Water Standard; Water quality standard; Found in wastewater due to use in industrial applications; Also occurs naturally.
10	Hardness, Total as CaCO3 (mg/L)	General	Treatment implications; Hard water causes scaling in water heaters/boilers, and soft water is considered corrosive.
11	Iron, Dissolved (mg/L)	Metal	Water quality standard; Affects treatment (can cause taste and discoloration).
12	Iron, Total (mg/L)	Metal	Drinking water standard; Water quality standard; Affects treatment (can cause taste and discoloration).
13	Lead, Dissolved (mg/L)	Metal	Drink water standard; Water quality standard; Indicator of pollution from mining activity (at elevated levels).
14	Magnesium (mg/L)	Major Ion	Hardness indicator (imparts hardness to water).
15	Manganese, Dissolved (mg/L)	Metal	Water quality standard; Undesirable impurity (aesthetic – taste and odor) in water supplies resulting from oxidation.
16	Manganese, Total (mg/L)	Metal	Drinking water standard; Water quality standard; Undesirable impurity (aesthetic – taste and odor) in water supplies resulting from oxidation.
17	Molybdenum, Dissolved (mg/L)	Metal	Indicator of pollution from mining activity (at elevated levels).
18	Molybdenum, Total (mg/L)	Metal	Indicator of pollution from mining activity (at elevated levels).
19	Nitrogen, Ammonia (mg/L)	Nutrients	Water quality standard; Aquatic life protection; Indicator of organic pollution by sewage or industrial effluent, agricultural wastes and fertilizers.
20	Nitrogen, Nitrate (mg/L)	Nutrients	Drinking water standard; Water quality standard; Potential health risk (especially infants); helps the assessment of the character and degree of oxidation in surface waters.
21	Nitrogen, Nitrite (mg/L)	Nutrients	Drinking water standard; Water quality standard; Indicator of microbiological quality of water (increased levels associated with unsatisfactory quality).
22	Nitrogen, Total Kjeldahl (mg/L)	Nutrients	Determination of total organic nitrogen; Increased levels of organic nitrogen indicate pollution of water bodies.
23	Oxygen, Dissolved (mg/L)	General	Water quality standard; Essential for aquatic life; Indicator of organic pollution, destruction of organic substances, and the level of self-purification in natural water (oxygen is involved in, or influences, all chemical/biological processes within water bodies).

Table 2: Water quality variables to be sampled by the Denver Water watershed monitoring program

	Variable	Descriptor	Reason for Monitoring
24	Organic Carbon, Total (mg/L)	Nutrients	Indicator of pollution; Arises form living material and water materials and effluents; Disinfection byproducts precursor.
25	pH (SU)	General	Drinking water standard; Water quality standard; Important variable in water quality assessment, as many biological and chemical processes involved in water bodies are pH dependent.
26	Phosphate (ortho), dissolved (mg/L as P)	Nutrients	High concentrations indicate pollution; Indicator of nutrient status (algal growth).
27	Phosphorus, Total (mg/L)	Nutrients	Indicator of nutrient status (algal growth).
28	Potassium (mg/L)	Major Ion	Indicator of pollution from run-off and discharges.
29	Sodium (mg/L)	Major Ion	Drinking water standard; Increased levels in surface waters may arise from sewage and industrial effluents (and road salts); Also can impact irrigation effectiveness.
30	Specific Conductance (æS)	General	Drinking water standard; provides relationship to concentrations of total dissolved solids in water and major ions.
31	Stream Flow (cfs)	Hydrological	Necessary for flow dependent analysis and load estimation (amount of suspended and dissolved matter in a water body depends on discharge).
32	Sulfate	Major Ion	Drinking water standard; Water quality standard; Treatment implications (taste and odor); Indicates industrial effluents and mine drainage at elevated levels.
33	Suspended Solids, Total (mg/L)	General	Amount of particulate matter in a water sample – implications for water treatment, stream habitat, and reservoir life.
34	Temperature (C)	General	Drinking water standard; Water quality standard; Affects chemical, physical, and biological processes – therefore the concentration of many variables.
35	Turbidity (NTU)	General	Drinking water standard; Indicator of biological activity in the water column.
36	Uranium (mg/L)	Metal	Water quality standard.
37	Zinc, Total (mg/L)	Metal	Drinking water standard; Indicator of pollution from mining activity (at elevated levels).
38	Zinc, Total (mg/L)	Metal	Drinking water standard; Indicator of pollution from mining activity (at elevated levels).

The organizational structure of the Denver Watershed monitoring program was further subdivided for sampling sets of specific sites, and consists of five collection systems designated within the watershed monitoring program. Each collection system contains the watershed(s) from which the water quality samples are taken according to the associated information goal that mandates monitoring.

Specific site sampling recommendations are as follows:

a) The site should be close to a stream gauging station so that loads can be calculated and relationships between water quality and flow could be analyzed,

b) The site should be accessible, safe, and within a reasonable distance from the laboratory, and

c) There should be some significance to the site, in particular, with respect to the information goals that were formulated.

The sampling selections for Denver Water's present monitoring system were used as a basis for selection of new sampling locations. In the end, the network of present sampling locations was deemed adequate for the new system. For sampling frequency calculations, a historical data analysis was required to gain an understanding of the statistical nature of the water quality population to be sampled. This analysis gave insight into the variability of the water quality and allowed for identification of seasonality present in the data. The historical data were taken from the United States Geological Survey's (USGS) Earth Info Quality of Water software (1996), and have since become available on the NWISWeb (USGS 2001) system offered by the USGS. The period of record for the data was from 1950 to 1997 and was arranged according to the 8-digit USGS hydrologic unit codes (HUC). Use of the HUCs allowed for the analysis of the Denver Water watersheds on a scale smaller than the entire system.

The Denver water source area is supplied by snowmelt/runoff. Season

designations corresponding to both the temperature and flow of water resulted from analysis of temperature and discharge data for determination of the sampling frequency. Combining statistical error estimates for each of three different sampling situations resulted in a recommended frequency of four samples (one sample every other month) during the low flow, low temperature season and four samples (one sample every month) during the high flow, high temperature season. The suggested sample frequency of eight samples on an annual basis is general for all watersheds and water quality parameters. It is important to point out that many of the sampling sites do not have the recommended eight samples per year due to management objectives dictating a different sampling frequency.

Water quality information system design is an iterative process that does not end upon the completion of the initial design. The following is a list of areas where Denver Water should direct future efforts in dealing with their source watershed monitoring system.

1. Data collection procedures: A well-designed network should include documentation describing the collection of data. Efficient design techniques and consistent data collection procedures help to minimize variance in water quality data. Areas of focus should be field sampling operations and procedures, laboratory analysis methods and operations, data storage and retrieval. Sound investment in the beginning will result in a quality program.

2. Data storage and retrieval system: Maintaining a complete record of data collected and analyzed as a part of the monitoring design contributes to the continued operation and productivity of an efficient information system.

3. Information generating and reporting procedures: Data analysis software such as Minitab, WQStat Plus, and Excel, exists to ease the transition to routine analysis and interpretation of data and reporting of information. Also, a documented agenda for reporting generated information should be constructed by developing the media by which the information will be transferred and gaining knowledge of the end use of the data.

For each sampling location, the mixing of a water body becomes important to describe the water quality. Where a tributary or outfall enters a water body, analysis should be completed to ensure mixing of the sampling site. Each micro sampling location should be well documented, so that samples are taken from the same site every time. Samples taken from differing locations add to the overall variability in the water quality data when, actually, the variability lies in the sampling technique.

The general forms that information from a water quality monitoring system can take are as follows: narrative, numerical, geographical, graphical, and statistical. Factors that can limit, or hinder the ability of monitoring to produce the desired information are many. Data limitations include multiple observations, outliers, changing sampling frequencies, missing values and censoring. Statistical limitations involve non-normality, seasonality and serial correlation. A benefit of a well-designed and documented monitoring system is the absence of impacts from data limitations.

Effective monitoring program operating procedures will minimize data limitations, while proper selection of data analysis methods will minimize the statistical impact of those data limitations that remain. The incorporation of a Geographical Information System (GIS) format as a data analysis information method is recommended. GIS technology is reliable and widely accessible and is thus a valid format for creating information associated with monitoring goals. The investigators propose that GIS technology be incorporated into any water quality monitoring system. Mapping sources of contaminants, pollution problem areas, and the display of other data is a key component of effective watershed protection.

A comparative analysis was performed for Denver Water's current and proposed monitoring system. The purpose of the analysis was to estimate the increased cost associated with the proposed monitoring system (a cost increase for the proposed system is inevitable as more samples will be taken at the same number of sampling sites). Specifically, the sampling and analysis costs for the present and proposed monitoring system were compared. Costs for equipment, maintenance, data analysis, and reporting were not accounted for, but are costs associated with all monitoring systems. The proposed monitoring system represents an 82% increase in cost for sampling analysis over the current system.

The investigators propose a process by which a large PWS can incorporate the existing knowledge concerning water quality monitoring into a practical application for production of usable, justifiable information in the management of water quality. It was created to serve as a reference for other large water purveyors, providing a practical approach to handling the effective gathering and production of information as shown in the Denver Water design.

This research was conducted with the support and collaboration of the Department of the Interior, U.S. Geological Survey and the Colorado Water Resources Research Institute through Colorado State University Grant Agreement No. 01HQGR0077. Support was also provided by Denver Water, theColorado River Water Conservancy District, and the Northern Colorado Water Conservancy District.

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This article is extracted from the full project report, which will be published as a CWRRI Open File Report and will be available by request in the future.

FIRE AND WATER

by Philip N. Omi, Professor
Forest Sciences Department, Colorado State University

Our Agricultural Experiment Station research project, Sustainability of Thinning and Prescribed Fire Programs to Improve Forest Condition along the Front Range, Colorado, examines pre-fire treatments aimed at mitigating wildfire severity. Our team (Assistant Professor Tony Cheng, Professor Doug Rideout, and Research Associate Erik Martinson, plus three graduate students) will combine field measurements, econometric analyses, and focus groups (managers and lay publics) to ascertain the ecologic, economic, and social feasibility of fuel treatments aimed at reducing wildfire severity. In the process, we will no doubt gain insights into the possible roles of prescribed fire and mechanical thinning in managing our precious water resources in Colorado, many of which originate in our forests.

The continuing drought and wildland fires wreaked havoc throughout the West during 2002. Colorado experienced two of the largest fires in state history with the Hayman and Missionary Ridge fires. The fires of summer begat fears of flooding, as land managers and downstream residents pondered the likelihood of future overland mudflows or sediment deposits in mountain reservoirs. Thus, once again we are reminded of the connections between fire management and water quality/quantity throughout Colorado. In the arid West, we can't forget drought-fire-flood threats.

Fire suppression initiatives of the 20th Century have contributed to unprecedented fuel loadings and subsequent wildfire severities throughout the western US. The fires of 20002 (and 2000, which was another major fire year) will be remembered for their social, economic, and ecological impacts, as well as the resultant presidential initiatives (i.e., of the Bush and Clinton administrations). While these initiatives are well-intended, many information gaps exist relative to the acceptability of the expanded thinning and prescribed burning programs to improve forest condition in Colorado and elsewhere.

To address these questions, we can look at the two key factors that have led to the severe fires this year: extreme climate/weather and an overabundance of fuel to burn. Since we cannot control the weather, we must focus our attention toward regulating the amount of fuel that is available to burn in our forests.

Fires have played an integral part in the life history of Colorado. However, our efforts to suppress fires during the 20th Century have inadvertently led to forest conditions that fall outside historic ranges of variability. Fires that periodically consumed much of the biomass that accumulates in the forest have not been allowed to burn as in the past. As a result, forest structure has changed significantly, including greater abundance of shade-tolerant understory tree species and closure of former gaps in tree canopy cover. The older, closed forest is also susceptible to insect and disease infestations. As a consequence, inevitable fires encounter greater fuel loads and burn more severely than in the past. Coupled with this summer's weather conditions, excessive fuel loads create the potential for devastating wildfires, clearly demonstrated by the loss of both property and lives during 2002.

To prevent catastrophic fires from occurring, we must attempt to restore forests to a semblance of their historical condition, including fires that generally burned with lower intensities. This will require the mechanical removal of both live trees and fuels atop the forest floor, as well as the use of prescribed burns to restore fire to the forest in a controlled manner.

Research is currently underway to determine the best way to manage forest fuels to reduce the severity of wildfires. The situation is complex, because we have crossed both ecological and social thresholds that do not allow us simply to revert back to historic fire regimes.

For a fuels management program to be sustainable over any significant period of time, it must be:

Photo by Kari K. Brown

* Ecologically sound and based on detailed scientific knowledge developed for the specific area in question;

* Within the bounds of what the public is willing to pay; and

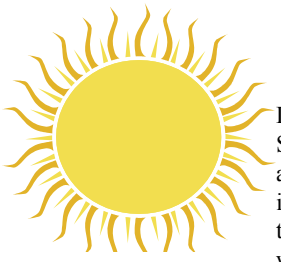
* Supported by the local publics.

The summer of 2002 brought wildfire management to the forefront of public awareness in Colorado. Fire exclusion has allowed the forests to gradually deteriorate.

Coupled with extremely dry weather, this has led to some of the worst fires in Colorado's history. A new, long-term attitude shift is required to not only reduce the continued loss of homes and lives, but also ensure the health and sustainability of our forests.

Although fire and water don't mix well, research suggests that both are essential to the sustainability of healthy forests. Attempts to exclude fire from wildland ecosystems have inadvertently created fuel accumulations that have led to today's larger and more severe wildfire episodes. Sustainability of healthy forests and water supplies will require that we create forest conditions that can survive future fires.

For further information, our the project website is http://www.cnr.colostate.edu/~fuel/mcintire-stennis/



WATER SUPPLY

Drought conditions continue statewide, as shown by the SWSI numbers. Conditions in the Arkansas River basin are worse than the SWSI value indicates. Scattered precipitation did occur during August providing limited moisture to a few areas in the state. Generally temperatures were warm during August. Streams continue to flow at record low levels, some being completely dry in spots. Many reservoirs, especially those used for irrigation, are empty. Many reservoirs, especially those used for irrigation, are empty. Statewide, average reservoir content is approximately 49 percent of normal.

Only the most senior water right holders are able to divert. Soil moisture and shallower ground water aquifers are being adversely affected. Many diverters relying on augmentation plans are being adversely affected because their sources of replacement water are drying up. While late summer and fall can be wet in southwest Colorado, with the climate in most of Colorado being dry in the autumn, we will have to wait to see whether the winter snows and spring precipitation events bring an end to the drought.

The Surface Water Supply Index (SWSI) developed by the State Engineer's Office and the USDA Natural Resources Conservation Service is used as an indicator of mountain-based water supply conditions in the major river basins of the state. It is based on streamflow, reservoir storage, and precipitation for the summer period (May through October). During the summer period, streamflow is the primary component in all basins except the South Platte basin, where reservoir storage is given the most weight. The following SWSI values were computed for each of the seven major basins for September 1, 2002, and reflect the conditions during the month of June.

Basin	9/1/02 SWSI Value	Change From Previous Month	Change From Previous Year
South Platte	-3.2	-0.3	-4.1
Arkansas	-1.9	-0.5	-2.1
Rio Grande	-3.6	+0.2	-4.1
Gunnison	-3.8	-0.3	-2.1
Colorado	-3.8	-0-	-3.2
Yampa/White	-3.8	-0.2	-2.4
San Juan/Dolores	-4.1	-0-	-5.4

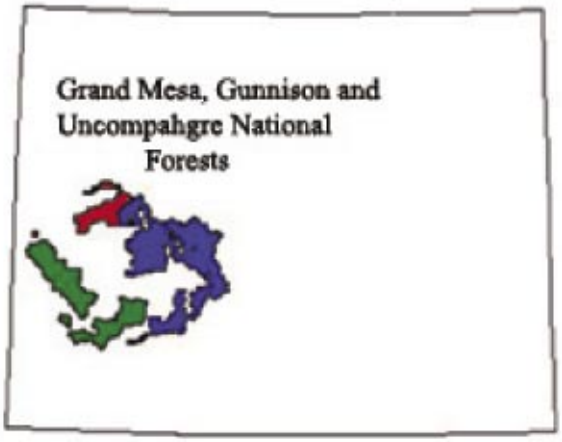
SCALE								
-4	-3	-2	-1	0	+1	+2	+3	+4
Severe Drought		Moderate Drought		Near Normal Supply		Above Normal Supply		Abundant Supply

Colorado State University Cooperative Extension

FACILITATING FEDERAL AND LOCAL PARTNERSHIPS ON THE WESTERN SLOPE: THE FOREST MANAGEMENT PLAN REVISION PROCESS

by Karla Brown, Tri River Area Water Quality Extension Specialist

The Grand Mesa, Uncompahgre and Gunnison (GMUG) National Forests, located in west-central Colorado, are currently in the process of revising their forest management plans. These revisions are completed every 10-15 years, and address all issues of forest management, including off-road vehicle use, grazing issues, and water management. The Forest Service is currently planning to issue a revised forest plan for the GMUG by 2004.



STATE OF COLORADO

There are some 3,500 miles of streams on the GMUG forests, and There are some 3,500 miles of streams on the GMUG forests, and water resource issues are becoming an increasingly important aspect of national forest management in Colorado. To address these concerns, during this round of forest plan revision the GMUG forests are attempting to develop a set of instream flow management guidelines. These guidelines will help provide sufficient water for the multiple uses of Forest water, including stock watering, critical fish habitat, downstream irrigation, and wetland areas.

To encourage community input and collaboration on this potentially contentious component of forest plan revision, the GMUG Instream Flow Pathfinder Project was convened in the spring of 2000. The Pathfinder Project is a local community-based group working to integrate stakeholder collaboration and science-based analysis. Their goals are to identify critical instream flow issues, and compile and recommend appropriate instream flow management tools available to GMUG forest planners. Local participants include federal agencies, state water management and fish and wildlife agencies, local water users, irrigation companies, conservationists, recreational users, and others with an interest in balancing healthy stream environments with human water needs.

A diverse steering committee forms the core group of the Pathfinder Project. However, gathering general community support and sharing information with the public was a potentially significant challenge. In the fall of 2001, Karla. Brown, Water Quality Specialist for CSU Cooperative Extension, was contracted to assist the group with its public outreach assist the group with its public outreach efforts. Since that time, CSU Extension has facilitated the design of the project's website, distributed an instream flow questionnaire to over 950 local stakeholders, published informational brochures, and held a series of public meetings to gather comment and explain the group's activities.

In the spring of 2003, the group is also planning a series of briefings on instream flow issues for legislators and other public officials, as well as local interest groups. Their hope is that this careful collaborative effort at the beginning of the forest plan revision process, will help avoid the litigation and controversy that recently engulfed the White River Forest Plan. That plan was only just released after a 22-month review period fraught with contention.

One particularly contentious issue, and a major concern expressed at the recent

Members of the Pathfinder Project Steering Committee tour a headgate in the Willow Creek drainage.

public meetings, had to do with bypass flows. "Public comments have leaned two ways," says Diana Leinberger, research assistant at Club 20 and Pathfinder Steering Committee member. "Environmental-oriented forest users want to ensure enough water is available to sustain fish and the forest ecology. Permittees and consumptive water users have expressed distrust about bypass flows." Currently, there are only two bypass flows on the GMUG forests, associated with snowmaking. However, the Forest Service requires those bypasses flows only to the degree necessary to maintain the Colorado Water Conservation Board's instream flow right.

The Pathfinder Project has also been focusing on identifying critical instream flow issues. This has included extensive evaluation of the technical information provided by the Forest Service, including a recent inventory of water resources, assessment of areas with heavy recreational use, and identification of prime cutthroat trout habitat. "We're really just looking for those places where there may be conflict and trying obtain balance", says John Almy, Forest Service hydrologist.

The Pathfinder group plans to make take its final set of instream flow management recommendations to the public and the Forest Service some time in the summer of 2003. "It is reassuring," says High Country Citizens Alliance representative to the Pathfinder Project, Steve Glazer, "that the Forest Service is reaching out in inviting stakeholder participation in the Forest Plan revision process."

NEW FACULTY PROFILE

Brian Bledsoe
Department of Civil Engineering
Colorado State University

Brian Bledsoe, who has been serving as a research associate with an appointment as research assistant professor, was recently appointed as a tenure-track assistant professor in the Department of Civil Engineering. Bledsoe says his new position enables him to place greater emphasis on balancing teaching, research, and outreach.

Bledsoe teaches in the general area of environmental river mechanics and nonpoint source pollution. He says he is excited about having more interaction with students and using difficult real world issues related to water quality as a context for teaching the fundamentals.

"I believe most people learn best by doing things that impact their life in some tangible way," he said. "The more we can bring applied research and outreach into the classroom, the more we're going to produce students who are better prepared to tackle complex problems that require applying technology with an awareness of long-term social and environmental consequences."

Bledsoe's research focuses on stream and watershed processes, in particular the interactions between hydraulics, geomorphic processes, and water quality. He says protecting and rehabilitating watersheds is the foundation of safe and reliable water supplies and healthy streams. "We are trying to develop a better understanding of the fundamental processes to improve the effectiveness of watershed management practices and rehabilitation strategies," said Bledsoe. "This ultimately involves collectively viewing water sheds and water treatment facilities as one system."

Bledsoe has active contracts with the US Environmental Protection Agency, US Army Corps of Engineers, USDOI Bureau of Reclamation, Water Environment Research Foundation and Three Forks Ranch Corporation. As he continues to develop new collaborations across campus and around the world, Bledsoe says he is looking forward to contributing to Colorado State's reputation for high-quality teaching and research.

Source: CSU Department of Civil Engineering Newsletter / Spring 2002

WATER TERMS

Hydrologic Cycle -- There is a finite amount of water in the world. It is never truly consumed, only used. Water is always in one stage or another, in one place or another, of the endless hydrologic cycle -- the cycle involved in bodies of water from which occurs evaporation, precipitation and runoff back to those bodies. The cycle has no fixed speed or distribution -- the only constant is the total amount of water on earth. Thus, water is not lost to evaporation; it is simply moved.

Minimum Stream Flows -- More accurately described as instream flow claims, this concept is a departure from the doctrine of prior appropriation in that it appropriates water for use in the stream to support fish and habitat.

Reserved Doctrine -- Reserves for the U.S. Government the right to water for federal land withdrawals. The amount is determined by the purpose for which the land was originally withdrawn and the priority date would be the same as the year the land was withdrawn. Three Supreme Court decisions directed the federal government to adjudicate its water claims through state courts to quantify those claims.

Colorado River Water Conservation District Water Terms

COLORADO'S 2002 FIRE SEASON CHALLENGES FOR MANY, OPPORTUNITIES FOR OTHERS

by Jan Hackett
Assistant Staff Forester, Colorado State Forest Service

The 2002 fire season was like one we've never seen before in Colorado. There were 2,012 fires recorded, burning more than 500,000 acres. One hundred forty-two subdivisions with 81,435 residents were evacuated. Most unfortunately, 384 homes and 624 other structures were lost.

Fighting fire is an expensive endeavor. The cost to suppress fires in Colorado this season totaled $152 million dollars. Thousands of firefighters assisted at the incidents while many others were involved indirectly to ensure communications, safety and stable operations.

Why has the 2002 fire season been one of the worst? Many factors contribute to this situation including an increase in population, an over abundance of fuels and dry fuels due to drought.

Fire is a natural phenomenon. It is one of nature's recycling agents and is key to maintaining natural processes in many wildland ecosystems. Fire has played a significant role in Colorado forests for many centuries, generating a healthy diversity of plant and animal species.

Historically, natural fire thinned Colorado's forests. Thinned forests recover faster and are more resistant to insect and disease attacks. American Indians burned thousands of acres every year to change vegetation patterns and to improve hunting grounds. In addition, they harvested many wood products.

By the late 1800s, fire suppression was organized and aggressive, and there was a drastic reduction in the number of acres burned. Today, fire suppression activities, along with interface urbanization, have prevented these frequent low-intensity fires from occurring. Add to this the lack of forest management activities and we find a forest condition vastly different from the forests of several hundred years ago. Our forests lack diversity of age classes and species distribution. Great amounts of dead, woody material have been allowed to accumulate. Increasing numbers of trees die from insects and diseases. Current mountain pine beetle infestations, also an indicator of forest condition, have increased the amount of hazardous fuel loading. Records indicate that current fires burn more intensely than those in the past.

So what can be done? Restoration of forest health is the ultimate goal. This will take years to accomplish and will require cross-boundary efforts. These efforts will also necessitate private, county, agency and other organizational partnerships. Education is an important tool in understanding and spreading FireWise messages. Landowners in urban interface areas will need to take responsibility and apply fuels management treatment for fire mitigation.

Many landowners have implemented fuels reduction treatments, and as a result there were several success stories in 2002. In August 2000, President Clinton addressed firefighting and fire mitigation efforts through the National Fire Plan, which established funding for fuels treatment projects. In Federal Fiscal Year 2002, Congress provided increased funding assistance to states through USDA- Forest Service State and Private Forestry Programs. The focus of much of the additional funding was on mitigating risk in wildland urban interface areas. In the West, $21 million of State Fire Assistance (SFA) funding was available and awarded through a competitive process with emphasis on hazard fuels reduction, information and education and community and homeowner action. This portion of the National Fire Plan was developed to help interface communities manage the unique hazards they find around them. Long-term solutions to interface challenges require informing and educating people who live in these areas about what they and their local organizations can do to mitigate these hazards.

Using this grant funding, Colorado has developed an incentives program that encourages landowners to implement various types of fuels reduction practices. Fuels reduction projects and vegetation treatments have been identified as a means of mitigating wildfire hazards. These are projects that remove or modify fuels in and/or adjacent to WUI development. Projects of this type include fuel breaks, thinning, pruning, landscape modifica-

tions, etc. The overall purpose is to modify or break up the fuels to reduce the risk of catastrophic fire and the resulting threat to public and firefighter safety and damage to property. Through the WUI Incentives Program, landowners pay for the cost of the work completed, and can receive up to 50 percent reimbursement. They can also receive reimbursement for doing the work themselves.

As a result, the 2002 WUI Incentives Program can show many accomplishments. Approximately 283 "sub" grants were awarded affecting more than 500 homeowners and groups. Almost 6,000 acres of forested land in the interface have been treated as a result. The grant has paid landowners $574,512 in incentives for implementing fuels reduction work. Work accomplished to date has totaled $1,325,688 in project costs. The difference reflects landowner time and expense. Many projects have cost landowners more than the allowable reimbursement, but their view is that the results are well worth it. From the Woodmoor Improvement Association, "On behalf of the Association, I can't thank you enough for the grant and the motivation you have given our community and the surrounding area. Much has been accomplished, but here is much more yet to do. We are pleased with the results and plan to continue."

These numbers are increasing as landowners continue to accomplish fuels treatment. There is still $267,342 of funding yet obligated for projects through 2002. Other State Fire Assistance grants under the National Fire Plan have accomplished comparable results in 2002.

It is anticipated that Congress will continue its support in FFY 2003 for programs in the WUI, although the level of funding won't be known until later this year. Landowners should contact their local Colorado Sate Forest Service (CSFS) District to receive an application. Proposed projects and completed projects are approved through the CSFS districts.

Homeowners and local government bear much of the responsibility for improving the defensibility of homes. Homeowners are encouraged to get involved with their HOAs, subdivision and neighbors. The most effective fuels treatment will be accomplished when implementation occurs across jurisdictional boundaries, on adjoining private lands or within the respective communities. CSFS encourages collaboration with adjacent public and county land officials to accomplish cross-boundary treatment. The goal is a fire-safe landscape, and as a result, improved forest condition.

OCTOBER 18TH MARKS 30TH ANNIVERSARY OF THE CLEAN WATER ACT

The 30th Anniversary of the Clean Water Act falls on October 18, a milestone iin efforts to protect the nation's water resources. America's Clean Water Foundation is serving as the primary sponsor and national coordinator for the Year of Clean Water, and is facilitating a number of related events to raise public awareness, celebrate our progress, highlight remaining challenges and solutions, foster a stewardship ethic, build support for watershed protection programs, and educate the nation's youth. For more information, visit http://www.yearofcleanwater.org.

October 18 has also been designated as National Water Quality Monitoring Day, and the public has been invited to join water quality professionals in sampling waters across the nation for water temperature, dissolved oxygen, pH, and water clarity. The data gathered will be entered into an online database by participating individuals, organizations and agencies to provide a picture of the quality of the nation's waters. Special participation kits needed to take and test water samples can be ordered online from the LaMotte Company foor $16.95. Just follow the links from the above website. The U.S. Geological Survey will also have a number of activities, reports and information on the monitoring. See http://water.usgs.gov/monitoring_day.

On September 18, U.S. District Court Judge James Parker ordered the Fish and Wildlife Service (USFWS) and the Bureau of Reclamation (USBR) to release water from storage to secure flows in the Rio Grande for the silvery minnow. Due to extreme drought, hydrologists predict that a 170-mile stretch of the Middle Rio Grande will dry up by month's end, unless USBR releases more water from the San Juan-Charma project. According to a September 12 Biological Opinion (BiOp), the USFWS was against releasing more water, even though not doing so would likely kill many silvery minnow. The USFWS argued that it was more important to have the water for next spring when the fish spawn. However, Judge Parker ruled that the BiOp was arbitrary and capricious, agreeing with environmental groups. John Horning of Forest Guardians said it would take an additional 20,000 to 60,000 acre-feet of water to sustain the species population, which is 5-25 percent of the water currently in storage. The water in storage is already under contract for delivery to farmers and municipalities, but Judge Parker ruled in April that USBR has the power to release the water to increase streamflow regardless of the contracts.

Source: Western States Water, September 20, 2002

MEETING BRIEFS

COLORADO WATER WORKSHOP CELEBRATES RECLAMATION AT THE CENTURY MARK

Two hundred people gathered on the campus of Western State College in Gunnison, Colorado, July 31-August 2, 2002, to review the achievements, problems, and remaining challenges facing the U.S. Bureau of Reclamation as it celebrates its centennial observation. The Colorado Water Workshop's program set the stage for the meeting as follows:

In 1902, after many decades of trial and error in the development of arid western lands, that effort became a federal matter through the Newlands Act and the creation of the Reclamation Service. The transformation since wrought in the West has been huge – most of it intentional and beneficial, some of it unanticipated, and most of it taken too much for granted by its beneficiaries today.

The workshop opened with a review of the Bureau's history presented by Brit Storey, Senior Historian with the Bureau of Reclamation. Brit's talk and photos can be found on the CWRRI web page (http://cwrri.colostate.edu/). A number of Bureau projects in Colorado were reviewed, including the Dolores Project by John Porter, Dolores Project Manager; and the Black Canyon and Gunnison Tunnel Project by Duane Vandenbusche, western historian and co-founder of the Colorado Water Workshop.

Ed Marston, Publisher, High Country News, provided an assessment of environmentalism and reclamation – his talk is reproduced on page 23 of this issue of Colorado Water. Randall Peterson, Manager, Adaptive Management & Environmental Resources, Upper Colorado Region, Bureau of Reclamation, presented an overview of how the Bureau is adapting its projects to multiple, evolving, and often competing uses of western water resources (see reproduction of talk on page 26).

In preparing the program of the 2002 Colorado Water Workshop, George Sibley, Workshop Coordinator and History Professor at Western State College, provided the following challenge to workshop participants:

"The concept of 'reclamation,' for Western Civilization, began in Europe where it mostly involved making land fit for cultivation by removing water from it, as was done for much of The Netherlands, which is about 40 percent below sea level. For people from those humid climates, and later from the humid eastern part of North America, the idea of aridity over much of the western half of the continent was so alien that they simply refused to believe it, until aridity had driven thousands of homesteaders off the land in Western America.

So the evolution of the idea of reclamation in America began with the realization that, to make land fit for cultivation, it was necessary to put water on it. This began primarily as a local agrarian phenomenon: a farmer would lead water out of a stream to irrigate a piece of bottomland, and other farmers downstream might enlarge and extend that ditch. Then groups of settlers established ditch companies to bring water from ever greater distances to irrigate mesas and other uplands that were fertile but dry. Sometimes these companies bit off a little more than they could chew, and their projects languished.

The federal Reclamation Service came into being in 1902 in large part as a progressive effort to encourage the settlement of small farmers on western lands as a deliberate effort to counter the growing power of ever larger corporations in an urbanizing and industrializing society, and most of the Service's early projects reflected that, picking up some troubled projects like the Gunnison Tunnel just downstream from here, and creating other local projects. This 'agrarian thrust' has remained an important thread in the weave of western reclamation.

But the urbanizing industrializing society also had needs – rather than spreading the water out onto the land, more along the lines of concentrating water, energy and food resources in centers. And by the time the 'Reclamation Service' had become the 'Bureau of Reclamation', this work also became a federal matter as the Bureau enlarged its scope to meet those needs, beginning with the boulder Canyon Project in 1928 that, by the beginning of World War II, had established the regional infrastructure for the phenomenon of Southern California.

The challenge for this Water Workshop is to try to imagine and envision what reclamation will be in the future of the West. We have learned too much about the consequences of engineering streams and rivers for a relatively narrow set of human needs and desires to ever proceed again with the naïve exuberance of the first two-thirds of the past century. But it seems equally naïve to think that a still-growing West, whose population grew from around 10 million to 90 million over the century just past, can step away from the idea of reclamation and 'the engineered environment.

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The Honorable Gregory Hobbs, in his closing presentation to the workshop, provided the following ten observations about the history and experience of men and women in the Americas regarding water:

(1) Water is a public resource. Speculation and waste at the expense of community deserve no respect;

(2) The construction and use of waterworks is a required adaptation to living in the Americas. Always has been, always will;

(3) The role of law in water resource policy is to allocate and administer the water by means of a fair system that promotes water planning and serves human and environmental needs;

(4) Public debate about water law and policy must be free and open. The rights of individuals and the community must be respected in the discussion. The discussion must be reflected in decisions that are implemented certainly and have flexibility for further adaptation, based on experience;

(5) At its core, prior appropriation is one of the most fundamental adaptations humans have made to living in the Americas. Prior appropriation is a drought-planning system. By study of the historic water data, planners and decision makers can determine what is available to a proposed community need, taking into account the use of others who have established their uses previously;

(6) In the third year of a drought, the summer of 2002 demonstrates how reservoirs are fundamental to life in the West. Saving in the ample time for the lean time is civilization at its best and most necessary. When the snow pack diminishes and storage water is not available to be released into the streams, so that water might run through the river channels to its place of use, humans and the environment suffer greatly;

(7) Our over-appropriated western and Colorado watersheds reveal the limits of our settlement. Now we must live with settling in. Local and state governments in all land use decisions must consider water use and its efficient availability. If not, the people will hold officials accountable for default in their elected and appointed community roles;

(8) We must allow our water officials to make sound decisions that involve curtailment of uses in priority and that forward efficiency of use. A system of fair allocation demands fair enforcement and respect for the enforcers;

(9) We must allow the market to function to redistribute water. We must employ reservoirs, including the storage opportunities available in our groundwater systems. We must negotiate and reach agreements that make Colorado's interstate water allocations available to as many needs for as many benefits, locally and statewide in Colorado, as possible. Ducks and people need water;

(10) We must pray for the blessing of insight, patience, and common sense-for what we must and must not do-as individuals in community. In scarcity is the opportunity for community. Civilized sacrifice is a sacrament.

As is usual, the 27th Colorado Water Workshop provided stimulating conversation about western water management and challenged all participants to reflect carefully upon our common 'water' future.

Pictures on page 21 from top left: John Keys, Commissioner of Reclamation and Seth Voyles, City of Colorado Springs; Justice Greg Hobbs and George Sibley, Colorado Water Workshop Coordinator; Dick Bratton, Attorney and Cofounder of the Colorado Water Workshop and Ed Quillen, Denver Post columnist and Editor of Colorado Central Magazine; Kathleen Curry, Manager, Upper Gunnison Water Conservancy District; State Senator Lewis Entz of Hooper and Ed Marston, Publisher, High Country News; Panel discusses the 'idea and reality' of the CBT and Fry-Ark projects (Ed Marston, Brian Person, USBR Great Plains Region; and William Jackson, journalist, Greeley Tribune).

RECLAIMING THE SPIRIT OF RECLAMATION

by Ed Marston, Editor, High Country News
Paonia, Colorado

It is astounding to me, watching the divided society we live in, that an earlier society situated on the same land could have come together to build Hoover, Glen Canyon, Flaming Gorge and scores of other major dams. We today are like barbarians left with something a higher order, or at least a more organized and cohesive society, built. The society that built those machines agreed on what they were for, and put them to work to produce food, fiber, and electricity and water for urban areas, with flat-water recreation thrown in.

Now, decades later, we have 50 ideas about what they're for. Some of us want them to be used exclusively for their original purposes. But others want them to be used to create floods to build beaches, and to provide water for rafters, raptors, or fish that are barely hanging onto their changed environments. And always, there is the tug of war between rural uses of water and urban uses of water. That rural-urban conflict does not include only the diversion of water away from irrigation and into cities' water treatment plants, but also includes the environmental uses of water.

So, the dams and Reclamation Era, which opened with the last century and declined well before the 20th century ended, is both a rebuke and a challenge to us: a rebuke for being so quarrelsome, without even having the excuse of being liquored up; and a challenge to come together and use these machines to serve our collective needs.

We are at the moment like the tribe in the movie "The Gods Must Be Crazy." The tribe found a Coca Cola bottle, which they found endlessly useful -- so useful that they fell to quarreling with each other over how to use it and who was to use it. Should it be a container to carry water? To store grain? To pound stakes in the ground?

We have found dozens of wonderful Coke bottles, left to us by a civilization that has all but disappeared, and whose vision and drive have certainly disappeared. We are fighting each other over those bottles. In case you didn't see the movie, at its end, the tribe's leader took the bottle, traveled a long way to a city, and returned this gift to whence it had come.

There are those who suggest that we, too, return the gift, which they see as a curse: that we breach the dams and let the rivers run through them. The most organized, cohesive and middle-of-the-road of these groups, the Glen Canyon Institute, has this as a mission statement:

> The Glen Canyon Institute's mission is to provide leadership toward restoration of a free-flowing Colorado River through Glen Canyon and Grand Canyon.

So far as I can tell from its web site, the keeper of the traditional vision, the U.S. Bureau of Reclamation, has this for a mission statement:

> Through leadership, use of technical expertise, efficient operations, responsive customer services and the creativity of its employees, Reclamation continues to manage, develop, and protect the water resources of the West for economic, social, and environmental purposes. Over the past 95 years, the Reclamation program has emphasized development of safe and dependable water supplies and hydropower to foster settlement and economic growth in the West.
>
> Reclamation will continue to increase productivity to carry out its mission more efficiently. This requires Reclamation to provide the opportunity and means for its employees to excel in their work, thereby ensuring that Reclamation can effectively and efficiently carry out its mission and provide high quality customer services at the lowest possible cost. Reclamation intends to achieve a diverse workforce to promote excellence, innovation and responsiveness to the needs of our various constituencies.

The Glen Canyon Institute may or may not succeed in implementing its audacious vision, but there is no doubt what its vision is. By comparison, it is clear that the US Bureau of Reclamation has no vision.

In a few places, dams have been dismantled, or steps toward such dismantling are well underway, as in Olympic National Park on the Elwha River in the State of Washington. I don't want to take sides on the question of wholesale dismantling of dams, because I don't think that's the core issue. I don't think the West would become a wonderful place if all of our dams disappeared tomorrow. Nor do I think our world would collapse. What we're up against is how to change our Hatfield and McCoy approach to water matters. Our challenge is how to achieve the unity of purpose that allowed the Reclamation Era to be an era.

I don't like everything the Reclamation Era achieved. I think it overshot, but I do admire its unity. I do admire the fact that the people of that time came together with a purpose they believed in, and they did it democratically, for that time. The Reclamation Era, I believe, was not a product of despotic forces. I think there was as much democracy in Reclamation as we can reasonably expect in this world. I think the evidence of that democracy came in the 1960s and 1970s, when the building

of dams in places that the nation held sacred – like Dinosaur National Monument and the Grand Canyon - was stopped. The nation's values changed, and dam building was stopped even though the top levels of government and most organized economic interests wanted to continue building dams.

The trouble is, we stopped Reclamation without replacing its vision with another. We were against, but we weren't clearly for something. What was Reclamation's vision? Initially, it was an agrarian, Jeffersonian vision: to make the desert bloom by putting water and tens of thousands of small farmers on the land. In places like these west-central valleys, that vision can still be seen in place today. It is what makes our areas special, I believe.

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But far more typical is a place like California's Imperial Valley, which uses something like 3 million acre-feet of water a year to raise a huge percentage of the nation's vegetables, as well as huge quantities of sudan grass, alfalfa and cotton. The Imperial Valley is being squeezed today, like a sponge, as California tries to figure out how to water its 33 million people while skinnying down to its 4.4 million acre-foot/year quota out of the Colorado River.

Imperial Valley agriculture has created as close to a feudal society as you can find in the United States today. The valley has a few large growers, tens of thousands of workers, 25 percent of its population living under the poverty level, and many, many workers migrating daily from the Mexican city of Mexicali to work in the fields. This poverty, these immense land holdings, and the drying up of the Colorado River Delta are all a result of the Reclamation vision gone awry. We built the Hoover Dam and the All American Canal so that the people who produce our food can live as if they were vassals of some knight in England or France. The desert is blooming in the Imperial Valley, but the society is not.

Reclamation completely abandoned the vision of small farmers creating a Jeffersonian society in the West after World War II. That vision was replaced by a vision of growth, progress, and technological mastery. It is the vision that is at work in Southern California as that region tries to meet its Colorado River Compact quota. California and the entire seven-state basin are proceeding as if they face only a technical problem of reallocating water. I think we face a deep social problem, which is easiest to express by pointing out that we have never replaced the lost visions of making the desert bloom, settling small farmers on the land, and, finally, creating growth and progress.

What we have today, if we have anything, is the latter vision: a vision of a smoothly running, ever-growing machine. I think people expect more from their society and even from their government than simply efficiency. America is a wonderful place because, periodically, we think and dream with large, impractical strokes. If we did not do this, we could not have built the Hoover Dam in the midst of the Great Depression. We could not have built Glen Canyon Dam, Flaming Gorge, or Blue Mesa. The West had a vision for itself, and the nation bought into that vision.

But that vision has played itself out, and we are living among monuments whose technical workings we understand, but whose spirit we do not understand. And so we divide into different camps: those who still want to keep the deserts and mountain valleys blooming; those who want to divert those waters to metropolitan areas to grow houses and malls, and those who want to tear down the dams and make the rivers live again.

I would like to see us recapture the Reclamation Era not by building more dams - where would we put them? and what would we put in them? - but by recapturing the spirit of Reclamation: a vision that would unite us in pursuit of a more fulfilling future. Much as I admire the simplicity of the mission statement of the Glen Canyon Institute – to breach Glen Canyon Dam – I don't think it's a sufficient vision for the society. We need and deserve more.

The future will require the merging of two large forces: environmentalism - which I define as a desire for a more natural and less paved world, and sprawl - which accepts as inevitable a paved world, but which demands a bit of fenced and private green space within that paved world. Both are intent on natural space, but they are after that space in different sizes.

The immediate tragedy – and you can see it here in the Gunnison area - is that caught between these two pincers are people who depend on large expanses of cheap land: ranchers, loggers, farmers, oil and gas drillers, and miners. They are people who depend on nature for their livings; people who experience nature in a much different way than environmentalists or suburbanites.

I should say here that if we Americans had a lick of sense we'd be perfectly happy with our material state, happy with our politics, and that we'd thank the Lord each day that we live here and not elsewhere. We'd bless our dams and dammed rivers, and we'd bless our undammed rivers, and we'd kiss our children and relax and cut our work weeks to 10 hours or so.

But we don't have a lick of sense. I know I don't. We live as if saber tooth tigers were still at our heels, and adrenaline still courses into our systems at the slightest provocation. And individually and as a society we're addicted to adrenaline, so we will keep on churning. We will keep busy. We will keep organizing. For whatever reason, we can't stop. I accept that. The only question is: in what direction should we try to direct our churning?

At my age, and at this point in my career, I feel like the Nez Perce Chief Joseph: I am tired of fighting ... from where the sun now stands, I will fight no more.

What I want instead of fighting are colleagues and allies, especially if they look at the world very differently. I am no longer a very good ideologue. I don't believe in large, overarching ideas or in the charismatic characters who preach those ideas. I don't believe in big technological fixes. I don't believe wind energy, or the hydrogen economy, or the fuel cell, or even the dismantling of dams will save us.

I believe instead in pragmatism. I believe in working away at a knot in many different ways, with many different hands and minds and approaches, until it finally unravels. I want to be involved with people who have the patience and temperament to work away at the many knots that confront the western United States: the cattle-and-public land knot; the dam and rivers knot; the logging and old growth forest knot. Those are my people. Those are my soul mates.

Chief Joseph came to his decision to fight no more out of honorable defeat. My war was against rural, extractive uses of the Interior West. I run an environmental newspaper, and for most of the 1980s, I ran that newspaper as if only the environmental movement could save the West from ranching, mining, logging and dam building. I consider that we, the green folks, have won that war. After all, we live in a state and in a region where urban uses now trump rural uses everywhere, including the most remote county.

But for me at least, the victory is proving hollow, for much of what I loved about the West was in rural nature. This isn't a new conclusion. For much of the 1990s, I tried to run as a vehicle of reform rather than of revolution. I became especially attached to the idea that ranching, properly done, could lead the way to a New West, and I've been appalled for years at the efforts some of my fellow environmentalists make to drive ranchers off the public land.

Where did this war within the West come from? I can describe it in terms of a personal evolution. We city people came here out of an alienation with how urban America was being run. We idealized the rural West, and we ran head on into the people who were living here, and who did not idealize the rural West. They understood it was a great place to live. But they knew it was also a tough place to make a living, and that it was a left-behind part of America, with everything stacked against it. They knew the rural West was living off the crumbs of the American economy, producing commodities at rock-bottom prices for relatively well-off city people.

Of course, they were enraged when the newcomers, and city people working through national environmental groups, interfered with the production of those commodities, and also interfered with the subsidies that larger economy chose to send to the rural West. Led politically by the environmental movement, and squeezed economically by free trade, by a reaction against subsidies and regulation, and by the increasing price of land and labor in rural areas, natural-resource based economies have come under increasing pressures.

What does this have to do with Reclamation? We should see Reclamation as a spirit rather than as a set of dams. The West came together - it buried enough of its differences to get a job done. Unless we can now adopt that spirit, we will be locked in endless warfare. Nothing will work well, and those things we care about: the land, wildlife, the economy and the things a healthy economy enables us to do will all deteriorate.

The following books are helpful in understanding the spirit, if not the purpose, of the Reclamation Era:

High and Dry: The Texas-New Mexico Struggle for the Pecos River, by Emlen Hall. A University of New Mexico law professor describes how Reclamation really works in the Southwest.

Against the Current: Essays in the History of Ideas, and The Hedgehog and the Fox: An Essay on Tolstoy's View of History, by Isaiah Berlin. What does a now dead Oxford philosopher have to tell us about the West? Plenty. Berlin is the apostle of a society which uses seemingly clashing ideas to find a workable middle.

Cadillac Desert, by Marc Reisner. A wonderful, from-the-heart book about the failures of reclamation. The wonderful thing about Reisner is that he went on to work with rice farmers and others to enhance rural economies. His death was a tragedy, for this was that rarity: a thinker and activist capable of growth.

Big Trouble: A Murder in a Small Western Town Sets off a Struggle for the Soul of America, by J. Anthony Lukas. If you like your history to be well plotted, this story of the murder of the former governor of Idaho, around 1900, is for you.

THE COLORADO RIVER STORAGE PROJECT IN THE 21ST CENTURY

by Randall Peterson, Manager
Adaptive Management and Environmental Resources Division
(also Program Manager, Glen Canyon Dam Adaptive Management Program)
Upper Colorado Region, Bureau of Reclamation

It seems such a simple question: Why have dams on the Colorado River? They are viewed by some as life-givers, and by others as intruders. Some perceive that we can't live without them; others perceive that we have somehow outgrown them, their necessity faded away. The past debated their existence. The past debated their existence. The present debates their operation, dividing the surplus; traditional water and power benefits, and instream flows. Like most societal issues, there can be no segregation of humans, their values, and their surroundings. As the West continues to press the boundaries of population growth, the future will debate our use of limited resources, particularly water. We will have to address the hard questions of why, how, and what's next.

Like most societal issues, there can be no segregation of humans, their values and their surroundings. As the West continues to press the boundaries of population growth, the future will debate our use of limited resources, particularly water. We will have to address the hard questions of why, how and what's next.

Why?

There can be no getting around it, we live in a desert. It took early settlers just one year to realize that this wasn't Ohio. Streams dried to a trickle. It would take some type of water storage to supply human needs during the parched summers. Early attempts were humorous; buckets, vats and tubs were scripted into service. For a settlement of just a few, small efforts might have worked. But for our current population, we speak in a language of water demands that the early settlers could never have understood. And the demands are still growing.

In the Colorado, Congress provided the Boulder Canyon Project and the Colorado River Storage Project (CRSP) as water resources to satisfy these life demands, about 30 million acre-feet of storage in both the Upper and Lower Basins. For the Lower Basin, the purpose was storage delivered directly to the thirsty states of Arizona, Nevada and California.

But upstream the purpose seems less clear. In truth, CRSP was a giant exchange agreement. Compact and potential treaty requirements would be delivered from the lower end of the Upper Basin, while depletions were allowed to develop upstream. Absent the storage to fulfill our Lower Basin commitments, upstream users would be forced to abandon, as the Anasazi, their water use during cyclic periods of drought. With CRSP, those threats were subdued. The Colorado is a system of extremes, with annual flows varying historically by a factor of five. Reservoirs smooth the extremes and society benefited from this certainty.

So the answer to "Why?" is simple: CRSP exists because we have chosen to live in this part of the West. Absent our existence in this basin, there would be no need for reservoir storage. We could point to others and their excessive water demands, but in truth the answer to "Why?" will be found in the mirror.

How?

Not only was CRSP designed to provide water; it also was a power generation project. Revenues from the sale of power not only were to repay the construction costs of the project (with interest), but also provided financial assistance for the development of irrigation projects in the basin. The irrigation subsidies designed to support farmers and keep food prices competitive came not from the federal government, but from the basin's power users. Initially, the projected power rates to accomplish all this were higher than the open market, and non-profit public power municipalities took some risk in signing contracts for CRSP power. In recent years this situation has reversed, and public power customers now enjoy CRSP rates lower than the open market.

The development and financing scheme developed during the 1950s has worked flawlessly. Much of the original construction cost has been repaid, and numerous water development projects are providing upstream water supplies. What wasn't completely foreseen was the change in society's expectations or the resource implications of constructing CRSP. River restoration and endangered species are now part of the demands that are placed on the reservoir system, necessitated by human demands on the water resources of the West.

What's Next?

The regulating nature of reservoirs reduced sediment load, spring peak flows and river temperatures, while increasing base

flows during the summer, fall and winter months. The natural functioning of watersheds and river systems has been altered, with declining native species the result.

It seems fair to ask the value of these natural resources; indeed, this question often frames the debate over the Endangered Species Act. What is sometimes lost in the debate is the recognition that there is something about the Intermountain West that either drew us away or keeps us from either coastal metropolis. We choose to live here. There is a premium that we place on the quality of life in the Colorado Basin. That premium is the currency that bridges human demands and human surroundings.

It's no surprise that there is a multitude of beliefs and positions on this issue, but perhaps it will be a surprise how we address these differences of opinion in the future. One emerging technique that may assist in this discussion is adaptive management. Adaptive management can be viewed as an admission of incomplete knowledge, which leads us to experiment to find solutions to current challenges. This incompleteness results from the extraordinary complexity of both ecosystems and our relationship to them. When CRSP is viewed through this filter, the debates over operational issues can change from polarization to solution-finding. It is inaccurate to assume that solutions only exist which result in winners and losers. Clearly we stand at a point in time when the possible universe of solutions has been only partially explored.

Future exploration depends on commitments to scientific rigor, respect for all needs, and a willingness to try. Litigation seems a failure of all three. The greatest creativity we can muster will be required, nurtured by trust. CRSP and its original purposes will continue to endure, but it will adapt as water use pressures continue to increase. That adaptation will bear the same marks of ingenuity as the early settlers, who not surprisingly were drawn here by the quality of life. Surely, that deserves our best efforts.

NEW FACULTY PROFILE

AMY PRUDEN
DEPARTMENT OF CIVIL ENGINEERING
COLORADO STATE UNIVERSITY

Amy Pruden joined Colorado State University as assistant professor of Civil Engineering and Environmental Engineering in August 2002. Amy just concluded her doctoral research at the University of Cincinnati, focusing on ways to optimize the biological degradation of MTBE (methyl tert-butyl ether). Due to the widespread use of reformulated fuels, MTBE has over the past decade emerged as a significant groundwater and drinking water contaminant. At Colorado State, Amy will work on developing applications of molecular tools, working with DNA and RNA analysis, in environmental remediation.

"With a more complete understanding of the microbes applied in environmental remediation we can put them to better use," Amy says. "I am particularly interested in the application of molecular tools, such as Polymerase Chain Reaction, Cloning, Denaturing Gradient Gel Electrophoresis, and Fluorescence In Situ Hybridization, environmental remediation and water treatment. Water quality is a pressing issue in Colorado and throughout the world, and developing these tools can help us better remediate and protect our precious water."

In addition to conducting research, Amy will apply her expertise in biotechnology and molecular methods to developing new and interesting courses for the civil and environmental engineering curriculum. She hopes to combine the focus of her teaching and research as much as possible, and has plans to develop a laboratory course integrating these concepts. "Professors have a very important responsibility in shaping the future, both in terms of research and education," says Amy. "I am very excited to be working with a group of talented individuals in a department with such a strong commitment to environmental quality, especially in the area of water resources. I am also looking forward to interacting with the students and helping them develop into successful professionals."

When she's not in the laboratory or the classroom, Amy spends much of her time, running, hiking, biking and weight lifting. She says staying active keeps the momentum going in life and helps her nurture a balance necessary for creative thinking.

Amy is looking forward to becoming a part of the Fort Collins and CSU community. "The town is beautiful, the people are nice, and both the dean and the department head have a strong and positive vision for civil and environmental engineering at Colorado State, which will offer a lot of opportunity for growth and development. Who could ask for more?"

Source: CSU Department of Civil Engineering Newsletter, Spring 2002

CWRRI CU water news

THE NATURAL RESOURCES LAW CENTER
University of Colorado School of Law

EPA HONORS KATHRYN MUTZ

Kathryn Mutz, senior research associate, lawyer, and full-time staff member at the Natural Resources Law Center, was presented the Environmental Protection Agency's "Environmental Achievement Award" by Michael Gaydosh, deputy to the assistant regional administrator of Enforcement, Compliance and Environmental Justice. She received the award at a ceremony during NRLC's summer conference on June 12, 2002. Mutz was recognized in particular for her work in the "Justice in Natural Resources" project. "Kathryn reframed the national debate about environmental justice to include issues of water development, timber harvesting, endangered species programs, wilderness and parks protection, and energy development activities," Gaydosh explained. Mutz organized the various phases of the project, which included sponsoring a two-day forum in Denver on environmental justice and natural resources; sponsoring and hosting a two-day Native American Sacred Lands Forum in Boulder and Denver; sponsoring a Chancellor's Community Lecture Series on environmental justice issues; and commissioning, contributing to and editing Justice and Natural Resources: Concepts, Strategies and Applications, a set of essays on a variety of natural resource and environmental justice issues from academics, practitioners and government representatives.

NATURAL RESOURCES LAW CENTER CELEBRATES 20TH ANNIVERSARY

The Natural Resources Law Center (NRLC) at the University of Colorado celebrates its 20th anniversary this month with a gala fundraising dinner on October 26 at the Oxford Hotel in Denver. According to Center Director Jim Martin, the event will launch the Clyde Martz Endowment for the Study of Natural Resources and Environmental Law, honoring Martz for a lifetime of service on behalf of natural resources. "For two decades, NRLC has engaged in research aimed at influencing the public debate and policy making concerning natural resources," notes Martin. "We have helped decision makers resolve conflicts surrounding resource development and preservation, and have brought constituents from all levels of government, community and environmental groups, attorneys, Native American Tribes, academics, students, and the general public together to consider the implications of resources policy and practice. We are proud of our legacy and look forward to continuing this vital work."

The Natural Resources Law Center is a non-profit program at the University of Colorado School of Law supported primarily through foundation grants and private donations. Its mission is to promote sustainability in the rapidly changing American West by informing and influencing natural resource laws, policies, and decisions through a comprehensive program of research, education, and advice. The Center originated from an informal program of law school-sponsored conferences that focused primarily on public lands and western water. In 1982, Professors James Corbridge, David Getches, and Stephen Williams, with the support of visionary practitioners such as Marvin Wolf, Ruth Wright and Guy Martin, created the Center to help organize and manage these conferences and to develop a natural resources research program. From those roots, NRLC has served its diverse audiences in a variety of ways, among them: sponsoring 27 major conferences; hosting the luncheon series, "Hot Topics in Natural Resources," at the Holland & Hart offices in Denver, focusing on current environmental and natural resource law and policy; publishing reports, books, dozens of conference proceedings and a semi-annual newsletter, which make available the Center's research and related work on a variety of natural resource law and policy topics; and bringing scholars, practitioners, and government officials to the Boulder campus as Distinguished Visitors or research fellows for a few days to a year or more to pursue their research, and engage with the Law School and the metro-Denver community.

As part of the effort to guarantee NRLC's financial health, and to honor Clyde Martz, former professor, dean, and mentor who is considered a giant in the field of natural resources law, Martin will announce the establishment of the Clyde Martz Endowment for the Study of Natural Resources and Environmental Law at the anniversary event. Says Martin, "In addition to Clyde's impact on the University of Colorado School of Law and on the Natural Resources Law Center, he served as assistant attorney general during the Johnson administration, as solicitor of the Department of the Interior during the Carter administration, and was one of the leading members of the private bar. Not only is he one of the Center's founders, he is also one of the Center's most stalwart supporters. We are honored to establish this endowment in his name."

For more information on the Natural Resources Law Center programs, to find out more about contributing to the Center and/or the endowment fund, or to be included in the anniversary dinner, please click on www.colorado.edu/Law/NRLC, visit the Center office in room 160 of the Fleming Law Building on the CU-Boulder campus, or phone 303-492-1287.

CWRRI CU water news

LEE J. ALSTON NEW DIRECTOR OF CU'S ENVIRONMENT AND BEHAVIOR PROGRAM

The Environment and Behavior Program of the Institute of Behavioral Science, University of Colorado, has a new Director. Professor Lee J. Alston came to CU from the University of Illinois, where he was Professor of Economics and Political Science as well as a member of the Institute of Environmental Studies. Professor Alston is a prominent member of the "new institutional economics" group and an expert on property rights and land use, including the authorship of the definitive study of property rights and land reform in the Brazilian Amazon.

The Environment and Behavior Program (E&B) supports interdisciplinary research on interactions between human populations and their natural and technological environments, with an interest in policy formulation and evaluation. Natural environmental include the entire set of natural resources, the environmental media, and natural hazards such as earthquakes and floods.

ENVIRONMENT AND BEHAVIOR PROGRAM
FALL, 2002 WORKSHOP SCHEDULE

The Environment and Behavior Program is off and running with a fine schedule of challenging workshops as shown below. All meetings will be held in the Conference Room of building IBS # 3 (second down Broadway from Starbucks Coffee), starting at 12:00 noon and lasting more or less until 1:30. Feel free to bring your brownbag lunch. Please mark the dates on your calendar.

October 21 — Exploring Social Capital Debates at the World Bank: Grounding Discourses in Practice, Professor Anthony Bebbington, Dept. of Geography,

November 4 — Context and Climate Change: Adaptation on the North Slope, Professor Ronald D. Brunner, Dept. of Political Science, of Alaska

November 18 — Privatization of Water Services in the United States: An Assessment of Issues and Experience, Professor (Emeritus) Chuck Howe, E&B Program,

December 2 — Social, Psychological and Behavioral Responses to the 1999 Earthquake in Turkey, Dr. Aytul Kasapo,lu, Professor of Sociology, Ankara; University and Visiting Fulbright Fellow, The Hazards Center.

CU SEMINARS

For listings of seminars scheduled at the University of Colorado, consult the following web sites.

http://instaar.colorado.edu/other/seminar_mon.html — Institute for Arctic & Alpine Research. INSTAAR Noon Seminars are held 12-1 PM Mondays, RL-3, 6th Floor Auditorium, Room 620. For directions to RL-3, see INSTAAR Map pages. These seminars are open to the public. All are welcome!

http://paos.colorado.edu/seminars.html — Program in Atmospheric & Oceanic Sciences. PAOS series seminars are on Wednesdays at 4:00 p.m. in the Duane Physics Building, 11th Floor, Gamow Tower Lounge. There is a short reception prior to the seminar, starting at 4:00 pm.. Food and beverages are provided.

http://bechtel.colorado.edu/web/grad/environ/seminars.htm — Dept. of Civil, Environmental and Architectural Engineering, Environmental Engineering Seminar Series. Seminars are held Wednesdays, 11 am to 12 pm, Engineering Center CE 1B41. Administered by Prof. JoAnn Silverstein.

http://www.colorado.edu/che/homepage/patten/seminar.html — Department of Chemical Engineering James and Catherine Patten Seminar Series meets Thursdays and some Tuesdays at 2:00 pm in ECCR 150 in the Engineering Center.

CWRRI MSC water news

NEW FACULTY PROFILE

GIGI A. RICHARD
ASSISTANT PROFESSOR OF GEOLOGY

Assistant Professor Gigi A. Richard is a recent faculty addition at Mesa State College in Grand Junction, Colorado, filling a newly created position for a surface water hydrologist. Mesa State wanted someone who could bridge the gap between the Environmental Science and Technology program and the Geology program, which are both in the Department of Physical and Environmental Sciences. The combination of these two programs takes advantage of her background in fluvial geomorphology and working with lateral movements of river systems and human impacts on rivers in New Mexico and New Zealand.

Richard's degrees include a Bachelor of Science in Civil Engineering from Massachusetts Institute of Technology, Cambridge, Massachusetts in 1989 and a Master of Science and PhD in Hydraulic Engineering from Colorado State University in 1997 and 2001, respectively. Her area of specialization is environmental river hydraulics and fluvial geomorphology. Richard's PhD research at CSU included a study of downstream impacts of Cochiti Dam on the Rio Grande in New Mexico. Her post-doc at CSU this year continued that research.

While on a Fulbright Fellowship, Richard spent a year (2001) in New Zealand, conducting postdoctoral research in the Natural Resources Engineering Department at Lincoln University, Canterbury, New Zealand. She studied the impact of lateral confinement on sediment transport capacity of gravel-bed braided rivers using a small-scale physical hydraulic model.

Richard's personal interests include parenting, SCUBA diving, running, hiking, backpacking, kayaking, modern dance, yoga and skiing. She has a lovely 7 and-a-half year-old daughter named Josie.

Hydrology Seminar Series
Mesa State College
Friday 4-5pm
Saccomanno Lecture Hall (SL 110)

The Mesa State College School of Natural Science and Mathematics, Department of Physical and Environmental Sciences, is offering a new seminar series to help students and the public understand water issues in western Colorado. The schedule of invited speakers is listed below.

1 Nov. Grand Valley Irrigation and Diversion, Bob Norman, US Bureau of Reclamation; Dave Merritt, Chief Engineer, Colorado River Water Conservation District

8 Nov. Selenium in Western Colorado, Mike Baker, US Bureau of Reclamation; Eileen List, Regulatory Coordinator, City of Grand Junction

15 Nov. Endangered Fish Recovery Program, Chuck McAda, US Fish and Wildlife Program

22 Nov. Geomorphology of the Colorado River, Grand Junction, Professor John Pitlick, University of Colorado, Boulder

6 Dec. Source Water Assessment and Coal Bed Methane Impacts, Bruce Smith, Principal Hydrogeologist, Western Water & Land, Inc.

CSM water news

Van Tuyl Lectures Fridays from 3:00PM to 4:00PM in Berthoud Hall room 108.

Nov 1	Perry Rahn	South Dakota School of Mines	Flood Hazards
Nov 8	Karl Karlstrom	University of New Mexico	Lithospheric Evolution of the Rocky Mountain Region: From the Basement Up
Nov 15	Eric Erselev and Vince Mathews	Colorado State University	Vertical and Horizontal Laramide Tectonics in the Rockies: Gladiatorial Battle or Scientific Progression?
Nov 22	Dr. Geoff Plumlee	US Geologic Survey	Summitville, Alamosa River and a comparison to Questa and the Red River

CWRRI CSM water news

igwmc International Ground-Water Modeling Center

SHORT COURSES 2002

Course Title	Instructors	Start Date No. of Days	End Date Times	Fee Late Fee/Date
Variable Density Modeling Workshop	Cliffort I. Voss Craig Simmons	Oct. 21 5 days	Oct. 25 8:00am-5:00pm	$1195 $1395/Oct. 1
Introduction to Numerical Modeling	Eileen Poeter	Oct. 23 4 days	Oct. 26 8:00am-5:30pm	$1195 $1395/Oct. 1
Universal Inversion Code for Automated Calibration	Eileen Poeter	Oct. 25 2 days	Oct. 26 8:00am-5:30pm	$795 $995/Oct. 1
PHREEQC Modeling: The Basics	Geoffrey Thyne	Oct. 31 2 days	Nov. 1 9:00am-5:00pm	$795 $995/Oct. 16
Advanced Modeling of Water Flow & Solute Transport in the Vadose Zone	Rien van Genuchten Jirka Simunek	Dec. 5 2 days	Dec. 6 8:00am-5:00pm	$495 $695/Nov. 22

SHORT COURSES 2003

Course Title	Instructors	Start Date No. of Days	End Date Times	Fee Late Fee /Date
Applied Environmental Statistics	Dennis Helsel Ed Gilroy	Summer 5 Days	Summer 8:00am-5:00pm	$1495 $1595
Calibration and Uncertainty of Groundwater and Other Models	Mary Hill Claire Tiedeman John Doherty	Sept. 10 3 days	Sept. 12 9:00am-6:00pm	995 $1195/Aug. 27
MODFLOW: Introduction to Numerical Modeling	Eileen Poeter	Sept. 13 4 days	Sept. 16 8:00am-5:30pm	$1195 $1395/Aug. 29
Polishing Your Ground-Water Modeling Skills	Peter Andersen Robert Greenwald	Sept. 14 3 days	Sept. 16 8:00am-5:00pm	$995 $1195/Aug. 29
UCODE: Universal Inversion Code for Automated Calibration	Eileen Poeter	Sept. 15 2 days	Sept. 16 8:00-5:30pm	$795 $995/Sept. 1
Advanced Modeling of Water Flow & Solute Transport in the Vadose Zone	Rien van Genuchten Jirka Simunek	Sept. 15 2 days	Sept. 16 8:00am-5:00pm	$595 $795/Sept. 1
Subsurface Multiphase Fluid Flow and Remediation Modeling	John McCray	Sept. 19 Fri. Eve.- Sun. Noon	Sept. 21 8:00am-5:00pm	$795 $995/Sept. 5
PHREEQC Modeling: The Basics	Geoffrey Thyne	Sept. 19 Fri. Eve.- Sun. Noon	Sept. 21 8:00am-5:00pm	$795 $995/Sept. 5
Model Calibration and Predictive Analysis Using Pest	John Doherty	Sept. 19 Fri. Eve.- Sun. Noon	Sept. 21 8:00am-5:00pm	$795 $995/Sept. 5

To register, contact:
Office of Special Programs and Continuing Education
Colorqdo School of Mines, Golden, CO 80401, USA
Phone: +1 303 273-3321
Fax: + 1 303 273-3314
E-mail: igwmc@mines.edu

For more information, contact:
International Ground-Water Modeling Center
Phone: +1 303 273-3103
Fax: +1 303 384-2037
E-mail: igwmc@mines.edu

FEATURES

NEW USGS FACILITY DEDICATED

Above: U.S. Senator Wayne Allard supported CSU's Natural Resources Research Center campus in Fort Collins.

Senator Wayne Allard, a key supporter of the project, Fort Collins City Manager John Fischbach, who was involved in the project for six years, and CSU President Al Yates joined in the dedication. President Yates spoke about the shared visions of federal and university researchers, and said their research will benefit the community, the state, and the nation. "The possibilities for collaboration are limitless," Yates said.

The dedication ceremony was followed by an open house featuring more than 50 exhibits that showcased a variety of FORT projects, including nationwide tracking of invasive species, monitoring nitrogen deposition in Front Range alpine lakes, evaluating the impacts of elk on plant communities, and the consequences of human population growth along the Front Range.

Left: CSU President Al Yates spoke of shared visions.

The new facility of the U.S. Geological Survey Fort Collins Science Center, known as FORT, was dedicated on August 23, 2002. Located on the Colorado State University campus, FORT is part of the Natural Resources Research Center, which is being developed to support and enhance natural resources research conducted by five federal agencies from the Departments of Agriculture and Interior.

FORT scientists conduct research and develop technical applications to help land managers understand and manage biological resources, habitats and ecosystems.

Adjacent to the USGS headquarters building is a 26,000 square-foot fabrication and light industrial shop, built jointly with the U.S. Department of Agriculture's Agricultural Research Service. These facilities and the USGS scientists will provide an integrated science capability in Fort Collins that will be able to conduct joint research with the co-located USDA agencies and with Colorado State University faculty and students When complete, the Natural Resources Research Center campus will house more than 1,200 natural resource professionals.

RESEARCH AWARDS

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

COLORADO STATE UNIVERSITY, FORT COLLINS, COLORADO
Awards for July 15, 2002 to September 25, 2002

Title	PI	Dept.	Sponsor
Training & Education for Agricultural Chemicals & Groundwater	Waskom, Reagan M	SCS	CDA
Possible Future Replacement of Sulfate by Nitrate in Aerosols on the CO Plateau	Collett, Jeffrey L. Jr.	Atmos. Sci.	"Land&Water Fund of Rockies"
Salmonid Disease Studies: Control of Whirling Disease Effects…	Anderson, David R.	CFWLU	CDWL
Whirling Disease Investigations: Quantification of Triactinomycin…	Anderson, David R.	CFWLU	CDWL
Status of Fremont Cottonwood Forests in the Upper Colorado River Basin	Cooper, David J.	Earth Res.	USGS
Pike/Trout Interactions in Colorado Reservoirs	Anderson, David R.	CFWLU	CDWL
Yampa River Northern Pike Exclusion Study	Anderson, David R.	CFWLU	CDWL
Zimmerman Lake Greenback Whirling Disease Project	Anderson, David R.	CFWLU	CDWL
1:24,000 Scale Hydraphic Coverage for the State of Colorado	Anderson, David R.	CFWLU	CDWL
TRMM Precipitation Radar & Microphysics: Interpretation & Precipitation Estimation	Venkatachalam, C.	ECE	NASA
Energy & Water Cycles within Hurricanes Determined from High-Resolution Simulations	Montgomery, Michael	Atmos. Sci.	NASA
DoD CG/AR Hydrometeorology	Vonderhaar, Thomas H.	CIRA	DOD
DoD CG/AR Cloud Structure, Dynamics & Climatology	Vonderhaar, Thomas H.	CIRA	DOD
DoD CG/AR N-Dimensional Data Assimilation & Fusion	Vonderhaar, Thomas H.	CIRA	DOD
DoD CG/AR Boundary Layer Atmospheric Chemistry & Aerosols	Vonderhaar, Thomas H.	CIRA	DOD
Biological Controls of Terrestrial Carbon Fluxes	Ojima, Dennis	NREL	NSF
Mapping Snow Properties: A Multi-Scale Approach	Smith, Freeman M.	Earth Res.	USFS-RMRS
Impact of Interactive Vegetation on Predictions of No. American Monoons	Denning, A. Scott	CIRA	NOAA
Air-Sea Interaction Remote Sensing Processes	Vonderhaar, Thomas H.	CIRA	NOAA

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

STATE/LOCAL SPONSORS: CDA-Colorado Department of Agriculture, CDNR-Colorado Dept. of Natural Resources, CDPHE-Colorado Dept. of Public Health and the Environment, CDWL-Colorado Division of Wildlife, NCWCD-Northern Colorado Water Conservancy District. OTHER SPONSORS: AWWA-American Water Works Assn., CID-Consortium for International Development.

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

COLORADO STATE UNIVERSITY, FORT COLLINS, COLORADO
Awards for July 15, 2002 to September 25, 2002 (cont'd)

Title	PI	Dept.	Sponsor
International Satellite Cloud Climatology Project Sector Processing and Analysis	Vonderhaar, Thomas H.	CIRA	NOAA
Variability & Trends in Global Precipitation	Kummerow, Christian	CIRA	NOAA
Quantifying the Change in Greenhouse Gas	Paustian, Keith H.	NREL	USDA-NRCS
Long-Term Ecological Measurements in Loch Vale Watershed, Rocky Mountain National Park	Parton, William J.	NREL	USGS
Responses of Hydrologic & Aquatic Ecosystem Processes to Potential Climate Change	Parton, William J.	NREL	USGS
Ecological Interpretations of the National Resources Inventory	Robinette, H. Randall	FWB	USDA-NRCS
Ecosystem Controls on C & N Sequestration Following Afforestation of Agricultural Lands	Paul, Eldor A.	NREL	DOE
The Response of the North American Monsoon to Boundary & Regional Forcing Mechanisms as Simulated by ClimRAMS	Pielke, Roger A.	Atmos. Sci.	NASA
Vulnerability of South Platte River Basin Aquatic Ecosystems & Water Quality to Severe Sustained Drought	Baron, Jill	NREL	EPA
The Influence of Climate-induced Alterations in Dissolved Organic Matter on Metal Toxicity & Ultraviolet …	Clements, William H.	FWB	EPA
Development & Operational Use of Fire Weather Forecast Support from a High-Resolution Mesoscale Forecast Model	Cotton, William R.	Atmos. Sci.	UCAR-NCAR
Restore Snake River Gravel Pit, John D. Rockefeller, Jr. Memorial Parkway, to a Self-Sustaining Riparian …	Cooper, David J.	Earth Res.	DOI-NPS
Rio Grande Channel Maintenance Mode	Abt, Steven R.	Civil Engr.	USBR
Influence of Flow Augmentation on Water Quantity & Quality in the South Platte River	Durnford, Deanna S.	Civil Engr.	USDA
History of the Water Delivery System on the Cache La Poudre River	Fiege, Mark T.	History	DOI-NPS
Economic Contribution of Colorado's Green Industry	Thilmany, Dawn D.	DARE	GreenCO
Landscape Characterization Over Time	Dean, Denis J.	Forest Sci.	USDA
Tools to Increase Translocation Success in Colorado River Cutthroat Trout	Fausch, Kurt D.	FWB	CDWL
Determination of the Role of Tropical Thin Cirrus Clouds in Climate Feedback through an Improved Cirrus Climatology	Stephens, Graeme L.	Atmos. Sci.	NASA
Soil Properties & Salinity Sample Collection & Analysis	Gates, Timothy K.	Civil Engr.	USBR
Land Development Over Time & Space: Economic & Hydrologic/Geomorphic Drivers of Ecological Structure	Poff, N. Leroy	Biology	Maryland University
Aquatic Ecosystem Responses to Streamflow Diversions	Poff, N. Leroy	Biology	USDA-USFS
Synthesis, Digitization, & Analysis of Clean Water	Loftis, Jim C.	Civil Engr.	NPS
Establishing the Status & Trends of Impaired, Threatened, & Outstanding National/State Resource Waters …	Loftis, Jim C.	Civil Engr.	NPS
Ensemble Simulations of Regional Climate Incorporating Explicit Vegetation Dynamics & Terrestrial …	Pielke, Roger A.	Atmos. Sci.	NASA
Improving Quantitative Precipitation Estimation Density	Cifelli, Robert C.	Atmos. Sci.	UCAR-NCAR
Land-Use Change in Temperature East Asia: Land Cover Changes Impacts on Carbon Fluxes & Land Productivity	Ojima, Dennis	NREL	NASA
Linking Geographic Water Utility Data with Study Participant Residences from the National Birth Defects Prevention…	Nuckols, John R.	ERHS	AWWARF
Fire Patterns in the Ponderosa Pine/Upland Shrub System	Savidge, Julie	FWB	DOI-NPS

COLORADO STATE UNIVERSITY, FORT COLLINS, COLORADO
Awards for July 15, 2002 to September 25, 2002 (cont'd)

Title	PI	Dept.	Sponsor
Monitoring of the Little Snake River & Tributaries	Bledsoe, Brian	Civil Engr.	3 Forks Ranch
Quantifying Space-Time Variability in Agricultural Landscapes	Salas, Jose D.	Civil Engr.	USDA-ARS
Winter Precipitation, Sublimation, & Snow-Depth in the Pan-Arctic: Critical Processes & a Half Century of Change	Pielke, Roger A.	Atmos. Sci.	NSF
Monitoring & Modeling the Effects of the Fires in the Colorado Front Range on Runoff & Erosion	Macdonald, Lee H.	Earth Res.	USDA-USFS-Pacific SW
Ecological Effects of Reservoir Operations on Blue Mesa Reservoir	Johnson, Brett M.	FWB	USBR
Monitoring the Effects of the Bobcat Fire	Stednick, John D.	Earth Res.	USFS-RMRS
Occurrence & Fate of Emerging Organic Chemicals in Onsite Waste-water Systems & Implications on Water Quality…	Ward, Robert C.	CWRRI	USGS
Water Yields in the United States under Climate Change	Ramirez, Jorge A.	Civil Engr.	USFS-RMRS
Regional Ecosystem-atmosphere CO2 Exchange via Atmospheric Budgets	Denning, A. Scott	Atmos. Sci.	DOE
Examination of the Linkages between the Northwest Mexican Monsoon & Great Plains Precipitation	Cotton, William R.	CIRA	NOAA
Stochastic Modeling & Simulation of the Great Lakes Net Basin Supplies	Salas, Jose D.	CIRA	NOAA
Establishment of Baseline Water Quality Conditions in the National Park Service	Hannah, Judith L.	Earth Res.	NPS
Assessing Ecosystem Response to Atmospheric Deposition in Western US Mountains & Select LTER Sites	Baron, Jill	NREL	EPA

WATER NEWS DIGEST

by Marian Flanagan

CLOUDSEEDING

Maybe we should make it snow / Water Board seeks OK for cloud seeding
Plans are in the works now to give nature a helping hand and increase the snow pack through "weather modification operations," or cloud seeding. The Denver Water Board made its case for the most ambitious cloudseeding project ever attempted in the state. "We feel the snowpack could be increased by 10 to 20 percent," said Chips Barry, manager of the Denver Water Board. He said they could, on the optimistic side, conceivably gain as much as 48,000 to 50,000 acre-feet of water from the project. Barry is seeking a state permit to allow Denver to operate 41 silver-iodide generators in the central mountains from November until March. The $700,000 project is an extreme measure warranted by the severity of the drought. Gauging the success of the program would be difficult, as precipitation produced by cloudseeding is indistinguishable from natural precipitation. Skeptics doubt the effectiveness of the technology, and other critics worry that a successful program could lead to avalanches, increases in traffic accidents on icy roads, and springtime flooding. Still others are concerned about potential harmful environmental affects, and criticize lack of conservation to address water shortages. Seeding is done by ground-based generators using a silver iodide solution, which is sprayed into a propane flame from the generators where it is vaporized into minute crystals. The crystals, which are lighter than smoke, are carried on the air currents to the bottom of the clouds. Once they reach the cloud's base and are drawn into the cloud, moisture collects on each artificial ice particle so that it resembles a snowflake. According to Western Weather Consultants manager Larry Hjermstad, once the snow melts, all that is left is the tiny piece of silver iodide, which is not a polluting substance.

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Denver Post / September 17, 2002; Leadville Herald Editor / September 5, 2002

EFFECTS OF DROUGHT

Colorado's trees dying
Drought is killing thousands of trees in Colorado forests and has triggered a false fall in urban areas, as thirsty trees change color early. Previously healthy ponderosa pines in the Manitou Experimental Forest, near Woodland Park, are dying from lack of water, said research forester Wayne Shepperd of the U.S. Forest Service. Weather records kept at the 26-square-mile experimental forest since 1937 report that the first seven months of 2002 were the driest on record. "Drought-stressed trees are being lost all over the state", said David Leatherman, a Colorado

State Forest Service entomologist. According to Leatherman, there is extensive mortality in pine along the southern Front Range east of the divide, from I-70 to the New Mexico border. Drought "scorch," another sign of water stress, is evident in Denver-area Norway, red and silver maples. Scorch occurs when the outer edge of a leaf dies and turns crispy brown, while the interior remains green. Carl Wilson, a horticulturist with Colorado State University's cooperative extension service reported that in Denver and other Front Range cities lack of water made the leaves of linden, aspen and cottonwood turn color several weeks early this year.

Rocky Mountain News / September 5, 2002

Drought intensifies beetle infestation of pinons

Severely weakened by the drought; piñon pine trees across Colorado are being killed off en masse by a growing epidemic of beetles. The native beetle feeds exclusively on piñon pine, boring into the bark to eat, breed and mature, then flies on to the next tree. Infected trees exhibit bored holes in the bark with red or yellow dust. The trees turn orange and die within weeks of the initial attack. According to forester Phil Kemp with the U.S. Forest Service, healthy piñons fight the invasion by seeping pitch, or sap, from their bark to push beetles away when they try to bore in. Severe lack of water has dried up the trees, stripping piñons of their defenses and rendering almost all of them vulnerable.

Durango Herald, Cortez Journal / September 5, 2002

Rains unleash flooding, mud slides in burned areas

Heavy rains unleashed mud slides and flooding in areas scorched earlier this summer by wildfires. The heaviest flooding was north of Durango in southwestern Colorado, where water, mud, large boulders and trees closed county roads in several spots. The area has been vulnerable to flooding and mud slides since a 70,000-acre wildfire stripped the slopes of trees and vegetation that would normally absorb the water. The mud was 5 to 6 feet deep in some spots. A few small mud slides were also reported near Glenwood Springs in Garfield County on mountain slopes burned by a 12,200-acre wildfire this summer. Again, on September 11th, mudslides caused by heavy rains sent trees and huge boulders crashing down charred hillsides near Durango blocking roads and threatening some homes. In some places, the debris fields were 10 feet deep, and boulders weighing several tons were on the roads and in driveways. It was the area's second major mudslide in four days. Experts have told residents living near certain drainages in areas prone to the slides that they may see problems for one to three years, until the vegetation has had sufficient time to regrow.

The Associated Press / September 7, 2002; Special To The Rocky Mountain News / September 12, 2002

Mud in the Animas choking aquatic life

Weekend rains washed mud and debris into the now-opaque Animas River, killing numerous fish, said Mike Japhet, aquatic biologist with the Colorado Division of Wildlife. The slides are a result of the Missionary Ridge Fire, which denuded the mountainsides throughout the forests north of Durango. In a 150-yard section along the river Japhet counted 100 dead fish, from tiny fish to 18-inch sucker fish. "The mud is so thick that they just can't breathe in the water," he said. Japhet was optimistic that as the river flowed faster as it moved south through Durango, there would be enough oxygen for the fish. If not, a section of the Animas River in south Durango could lose its status as a Gold Medal water, a designation given to waters with trophy-sized trout. The Animas River is one of 13 rivers nationwide to have such a designation. It would take several years for new trout to grow into the larger fish presently in the Animas. "I've never seen anything like it in my lifetime," he said. Japhet said the river will cleanse itself and the fish will return over time, migrating from unaffected areas.

Durango Herald / September 13, 2002

ENDANGERED SPECIES

Fish recovery effort aimed at keeping genetic link unbroken

What is believed to be one of the last 'remnant' (as opposed to stocked) populations of Colorado River Cutthroat Trout in the Gunnison Basin was running out of habitat in mid-August. Sections of West Antelope Creek that normally had a least a minimal amount of running water were going dry in 100-feet long sections, according to Western State College biologist Kevin Alexander, who's been closely observing the rare fish for a couple of years. Colorado Division of Wildlife biologist Dan Brauch and Alexander spearheaded an effort to rescue 50 Colorado River Cutthroats and transfer them into a "living stream" set up in Western's biology building, Hurst Hall, where at last count they continued to be "doing quite well." Brauch and Alexander hope that some stretches of the river will remain a viable home for the remaining fish through the winter. At least this way, Alexander explains, not all of their eggs are in one basket. "Our expectation is to return the fish to West Antelope Creek when conditions improve," Brauch said. "We hope that will be next spring, but if conditions are as bad, we may re-examine that plan. We could end up raising them for a brood stock of Colorado River Native Cutthroats."

Gunnison Country Times / September 5, 2002

RECREATION

Area rafting companies hit a low tide

Operators of area rafting companies hit rough water this summer with business plunging to new depths. Despite ideal conditions on the Colorado River, the general perception that the state was burning and was parched by drought, coupled with a lackluster economy, drove down visitor numbers. The Roaring Fork River did not play host to any rafting trips this season due to drought conditions, but the Colorado River in the Glenwood Springs area ran steadily all summer. Raft trips end in mid-October. Rafting companies on the Animas, Rio Grande, Blue and

Gunnison rivers reported 50 to 80 percent declines in business. Two Aspen rafting businesses have already finished operating for the season.

Aspen Daily News / September 6, 2002

WATER QUALITY

EPA concern centers on whether CWD prions can get into the water
EPA is scrutinizing laboratory practices at the Colorado Division of Wildlife, worried that infectious agents believed to cause chronic wasting disease could wash into public sewers and underground septic tanks. Water regulators with the Environmental Protection Agency could require wildlife officials to alter plumbing at CDOW laboratories in Fort Collins, Craig and elsewhere to ensure that the persistent protein - called a prion - doesn't accumulate in water supplies. Of most immediate concern is a special EPA permit needed for a Fort Collins laboratory where parts of the brain, tonsils and lymph nodes are removed from deer and elk heads. "They are taking precautions; we've asked them to take additional ones," said Steve Tuber, director of water programs for EPA's regional office in Denver. The federal agency's timing could make things tough for the CDOW as it gears up for a fall hunting season in which state workers are prepared to conduct up to 50,000 analyses on deer and elk heads to test for the presence of the disease. For the moment, the agencies are exchanging proposals on how to handle the matter.

Rocky Mountain News / September 6, 2002

Watershed group seeks tougher stream listing
The Eagle River Watershed Council has asked the Colorado Water Quality Control Commission to have the Black Gore Creek labeled "a sediment-impaired stream." As much as 300 million cubic yards of traction sand from nearly three decades of winter sanding on Interstate 70 is choking the stream next to the highway over Vail Pass and silting in reservoirs at the top of the pass. The initial cleanup has been estimated at $20 million or more, just to keep the problem from getting worse. The sand is slowly moving into Gore Creek, which is a high-quality Gold Medal trout fishery as well as the main water supply for Vail. Stream sedimentation is not a regulated pollutant under the federal Clean Water Act, so listing the stream as impaired will help convince Congress to fund it, explained Bill McKee of the Colorado Department of Health and Environment. The U.S. Forest Service (USFS) has pressed the state Department of Transportation (DOT) to develop a cleanup plan, because the USFS had issued the state an easement through federal land for the highway. One positive development over the years, according to the DOT, has been the use of liquid de-icers that diminished sand use on the pass. The cost of cleaning up the sand that already has moved farther toward and into the creek has not been established.

Vail Daily / September 2, 2002

WATER RIGHTS

GOCo seeks legal advice on water-rights projects
The Arkansas Valley Land Preservation Project is seeking a $4.5 million GOCo Legacy grant, to be matched by $1.5 million from Otero County, to lock up agricultural water before it is sold to Front Range interests such as Aurora, which has a growing interest in purchasing more shares in the Rocky Ford Ditch. Although GOCo has funded many land conservation projects, it has yet to consider farm irrigation water as possessing the natural and environmental values for which GOCo was created 10 years ago. Peter Nichols, director of the Colorado Water Trust, also encouraged GOCo to consider the value of water to conservation of open land. As a fallback safety measure, Nichols recommended that GOCo seek legislation next year to say explicitly in state law that a conservation easement constitutes a beneficial use of water. Colorado water law requires water rights to be put to beneficial use or be declared abandoned, and is therefore, subject to reappropriation to a different, more beneficial use.

Pueblo Chieftain Denver Bureau / September 6, 2002

WATER RECYCLING

Recycled water to irrigate golf courses, parks
University of Colorado Environmental Engineering professor JoAnn Silverstein said Broomfield is one of a relatively few communities that are instituting recycled water systems. Others in Colorado include Denver Water, the City of Aurora and Arapahoe County. A recycled water system, is expected to be finished next April and will provide water for most of Broomfield's golf courses and park lands. The project is designed to reclaim used water and save money on water rights. Currently, most courses use ditch and pond water for irrigation. Public Works Director Dorian Brown said that a series of parks along the pipeline's alignment would receive water by 2004. Some golf courses could receive the reclaimed water as early as next summer. The process for reusing water allows more nutrients to remain in water and would cut down on fertilizer costs. Although cost estimates for the system were not available, Professor Silverstein said technology that was developed 5-10 years ago is now becoming inexpensive enough for municipalities to use.

Boulder Daily Camera / September 21, 2002

WATER SUPPLY/DEVELOPMENT

Reservoir expansion still possible - two groups work together to increase water storage
A solid plan to enlarge Elkhead Reservoir is being researched, but even under the best circumstance, it would take five years before the project

is complete. The Colorado River District and the Upper Colorado River Endangered Fish Recovery Program have joined forces and finances to make the expansion happen. Several permits, including a wetland permit, must be obtained, as well as several easements onto private property before the proposal becomes reality. The current plan is to increase the reservoir's capacity by 8,500 acre-feet. The benefits of the expansion are increased water storage which will be used to augment river flows during low-flow periods, which are a danger to fish, including the four endangered species that have been identified in the Yampa River. Funds for the $20 million proposal would come from revenue generated by the sale of water from other reservoirs. The Colorado River District would also lease water to those in need, including farmers, ranchers and the city of Craig, if necessary.

Craig Daily Press / September 5, 2002

Golden's water cut

The city of Golden lost half its water supply Monday when a judge upheld a never before invoked drought clause in the agreement governing water rights on Clear Creek. Golden officials rushed to secure more water and dramatically reduce consumption, saying the city could run out of water next month if nothing is done. Even if use falls to the low levels seen in midwinter, Golden could run out by Oct. 10, according to City Water Engineer Gary Thompson. After a daylong hearing, Judge Jonathan W. Hays found that Golden violated a 1966 decree by continuing to take its full entitlement from Clear Creek while the Farmers Highline Canal was coming up short. Kelly DiNatale, the water resources treatment manager for Westminster and a vice president of the Farmer's Highline Canal, said that only recently was it discovered how much Golden had been taking during the drought. Golden was one of the few cities in the metro area that had not imposed mandatory watering restrictions. The state engineer issued an order for Golden to stop taking 3.4 cubic feet per second from Clear Creek, which the city has been doing for years. The order followed a complaint by Westminster, the canal's majority shareholder, and other neighboring cities that Golden was taking water to which the other cities were entitled.

Rocky Mountain News / September 10, 2002

Growth driving water decisions

Drought that has diminished local water supplies to unprecedented levels has water producers in the eastern half of Eagle County casting a wary eye on the demands of future development. Linn Schorr, head of engineering for Eagle River Water and Sanitation said, " Many of the big projects in Vail seem to be coming to fruition all once. It's going to be difficult." Eagle River Water and Sanitation and the Upper Eagle Regional Water Authority supply treated water to 22,762 single-family equivalents (SFEs), from Wolcott to Vail. An SFE is the amount of water used by 2.5 people occupying a dwelling of 3,000 square feet. Vail's projects will add more than 500 condos, townhouses and single family homes, as well as a net increase of 95,000 square feet of commercial space to Vail between 2003 and 2008. Developers are required to provide the water district with additional water or a payment that the district can use to purchase stored water. One of the water sources expected to become available in coming years is water stored in Eagle Park Reservoir, which holds slightly more than 2,100 acre-feet. But with a larger dam, as is planned, it could hold as much as 11,700 acre-feet. That's water enough for nearly 47,000 people. But not all the planned increase in stored water at Eagle Park Reservoir is for domestic consumption on the Western Slope. Vail Resorts will use up to 1,100 acre-feet for snowmaking on its mountains in Eagle and Summit counties. And nearly 50 percent of the increase in storage capacity will belong to Colorado Springs and Aurora under a memorandum of understanding with water users generated during the decade-long litigation over the Homestake II proposal.

Vail Daily / September 2, 2002

No new taps

Denver Water should stop issuing new water taps until the historic drought is over and reservoirs have been able to refill, according to a group of no-growth advocates. Darlene Colt, a Jefferson County resident, is spearheading a move to stop new developments in light of the current drought and water crisis. At a Jefferson County drought forum, Colt said Metro Denver, its suburbs and the state need to reassess growth policies and the issuance of new water taps. Denver Water, the largest municipal water supplier in the state with 1.2 million customers, is legally obligated to provide water taps to its customers, which include several suburbs. The agency would have to provide as much as five years notice to stop issuing new taps, under some of its contracts, and may look instead at simply restricting how any new taps could be used. One option is to prohibit watering of lawns at homes with new water taps. West side suburban residents and no growth advocates say the drought and this summer's water crisis are symptoms of overpopulation. "We're told over and over that we must conserve," said University of Colorado Professor Albert Bartlett. "And I would be happy to do this. But why should I if the water I save is going to be sold to a new subdivision."

Rocky Mountain News / September 14, 2002

State lacks the money for new water storage

Colorado can't afford to build more reservoirs, even if public opinion favors them, according to Senator Lewis Entz, head of the Colorado Water Congress. Earlier this year, the legislature eliminated $390 million from construction projects, and Governor Bill Owens also made $228 million in cuts and continued a freeze on capital construction. Local water suppliers would have to sell bonds to expand current reservoirs or build new ones, but a proposal to ask voters to approve issuing up to $10 billion in bonds for water projects died during this summer's special legislative session.

Rocky Mountain News / August 24, 2002

Denver seeks aquifer use
Denver Water plans to seek the legal rights to two aquifers under the city to serve as a backup water supply in future drought years. The project would take at least 5 years, with each well potentially costing $1 million. Denver would only be able to pump about 20,000 acre-ft of water per year, and the aquifers have no way to recharge, so this would be a temporary aid to the water supply.

The Coloradoan / August 24, 2002

MISCELLANEOUS

Experts: Tailoring aid key to saving lives, ending water conflicts
At the U.N. development summit's water conference held on August 31st in SOWETO, South Africa, experts and government officials from around the world said urgent steps are needed to solve water problems ranging from shortages to cleaning up contaminated streams. Jeremy Bird of the U.N. Environmental Program (UNEP), based in Nairobi, aid he fears the scope of the world's water crisis overwhelms local officials and those who endure the harshest living conditions. U.N. experts say more than 2.2 million people in developing countries, most of them children, die each year because they lack clean drinking water and proper sanitation. According to the UNEP, about half of the world's rivers are seriously depleted and polluted. Water shortages and contamination are closely associated with food scarcity, dismal job prospects and health threats; ravaging impoverished areas. Experts said that addressing pollution and limited resource problems can lead to huge gains. A British economist at the conference unveiled a Water Poverty Index to help local officials get water to more people, clean up pollution and avoid fights over scarce resources by tailoring projects to a community's most critical needs.

Associated Press / September 1, 2002

GS 592 WATER RESOURCES SEMINAR -- Tuesdays, 4:10pm, C-142 Clark Building
Fall 2002 theme: Cross Currents in the Arkansas River: Changing Values, Competing Demands, and Policy Reactions

October 29	"Strategies for Resolving Water Managament Problems in Colorado" – Dick MacRavey, Executive Director, Colorado Water Congress, Denver, CO
November 5	"Purchasing Water Rights to Improve the Environment to a Reasonable Degree: Ramifications of the Gordon Bill" – Dan Merriman, Chief, Stream & Lake Protection, Colorado Water Conservation Board, Denver, CO
November 12	Student Synthesis of changes in 'beneficial use' in Colorado (by student team)
November 19	"What do the Changes Taking Place in the Arkansas Valley Tell Us About the Future of Colorado's Water

Interested faculty, students and off-campus water professionals are encouraged to attend and participate.

COLORADO STATE UNIVERSITY SEMINARS

Department	Web Site
Agricultural & Resource Economics	http://www.agsci.colostate.edu/
Atmospheric Science	http://www.atmos.colostate.edu/dept/seminar/F02seminar.htm
Bioag. Sciences & Pest Mgmt.	http://www.colostate.edu/depts/bspm/Seminars/seminar_schedule.shtml
Biology	http://www.biology.colostate.edu/seminars.htm
Bioresource & Agricultural Engr.	http://www.engr.colostate.edu/cheme/seminars/
Chemistry	http://www.chm.colostate.edu/
Civil Engineering	http://www.engr.colostate.edu/ce/outreach/index.shtml
Graduate Degree Program in Ecology	http://www.colostate.edu/Depts/GDPE/Announcements/Seminars.htm
Earth Resources	http://www.cnr.colostate.edu/er/seminars/index.html
Environmental Health	http://www.cvmbs.colostate.edu/cvmbs/thiswk.html
Fishery & Wildlife Biology	http://www.cnr.colostate.edu/FWB/seminar2.htm
History	http://www.colostate.edu/Depts/Hist/events.html
Horticulture & Landscape Arch.	http://lamar.colostate.edu/~jcroissa/seminar.html
Natural Resources Ecology Lab	http://www.nrel.colostate.edu/events/seminar.html
Soil & Crop Sciences	http://www.colostate.edu/depts/SoilCrop/SeminarSchedFall2002%20.htm

MEETINGS

Who's Running This Ecosystem?
13TH ANNUAL SOUTH PLATTE FORUM
Oct. 23-24, 2002, Raintree Plaza, Longmont, Colorado

October 23
KEYNOTE PRESENTATION: Dan Luecke, Former Director, Environmental Defense Fund
SESSION TOPICS:
Integrating Habitat Protection with Agricultural Production
Understanding Colorado Climate Changes
Fouling Your Nest
KEYNOTE LUNCHEON: ROBERT E. ROBERTS, REGIONAL ADMINISTRATOR, U.S. EPA REGION 8
Special Award Presentation, Chuck GrandPre, South Platte Forum "Founder"
POSTER SESSION AND NETWORKING HOUR

October 24
STEVE SIMMS, STATE ATTORNEY GENERAL'S OFFICE
SESSION TOPICS:
Redefining Beneficial Use in the South Platte Basin
Protecting our Future

KEYNOTE LUNCHEON: Honorable Jonathan Hays, District Judge, Water Division 1
Sponsored by: Colo. Division of Wildlife, Colo. State Univ. Coop. Extension, Colo. Water Resources Research Institute, Denver Water, No. Colo. Water Conservancy District, US Bureau of Reclamation, US Environmental Protection Agency, US Fish and Wildlife Service, and US

GROUND-WATER DEPLETION AND OVEREXPLOITATION: A GLOBAL PROBLEM
The Geological Society of America 2002 Annual Meeting
October 27-30, 2002 -- Colorado Convention Center, Denver, Colorado

During the GSA Annual Meeting in October, the U.S. National Chapter of the International Association of Hydrogeologists (IAH) will sponsor a special session to focus on the magnitude and effects of ground-water mining, methods to quantify depletion, U.S. and international case studies, status and future trends, global impacts, and management solutions. John McCray and Tom Boving of the Department of Geology and Geological Engineering at CSM also are organizing a topical session on subsurface transport and remediation for this year's meeting. The session is titled, "Subsurface Characterization, Remediation and Natural Attenuation of Organic Contaminants in Heterogeneous Physical or Chemical Settings. For information about the GSA Meeting, go to their web site at: www.geosociety.org. For information about IAH, go to their web site at: www.iah.org.

International Workshop on Integrated Water Resource Management
April 7 - 11, 2003 -- Denver, Colorado

This workshop will review and analyze recent developments in integrated water resource management (IWRM) and tools. The speakers will be experts from the Bureau of Reclamation and specialists from other water resource management entities who will provide a comprehensive overview of IWRM theory and techniques with discussion on policies and practical management issues - - from river basin level to individual water resource projects. Discussion will focus on assessing and dealing with competing demands imposed on a limited water resource and, at the project level, means to better promote their efficient operation, maintenance, and management for multiple purposes including irrigated agriculture, flood control, hydropower, water supply and environmental purposes. Specific sessions in the Workshop will be devoted to a wide array of topics including IWRM theory, data collection, water quality, water conservation, drought management, adaptive management, decision support systems, and conflict management.

For information contact - Ms. Leanna Principe, E-mail: lprincipe@do.usbr.gov, International Affairs, D-1520, U.S. Bureau of Reclamation, P.O. Box 25007, Denver, Colorado, 80225, U.S.A. telephone: (303) 445-2127, Fax: (303) 445-6322.

FIRST ANNOUNCEMENT AND CALL FOR POSTERS

Colorado Drought Conference:
Managing Water Supply and Demand in the Time of Drought
December 4, 2002
Lory Student Center
Colorado State University
Fort Collins, Colorado

The current drought is forcing Colorado citizens to reflect more carefully upon their relationship with the State's water resources. At the same time, the drought is pushing water managers to the limits of their capabilities in meeting Colorado's many competing demands for water. As the drought continues to unfold, there is a need to reflect upon the drought mitigation efforts of 2002, from a water supply and demand perspective, and discuss options for addressing potentially critical water supply and demand issues if the drought continues into 2003.

While memories are still fresh in the minds of water managers and citizens, the purpose of the conference is to:

1. Examine efforts in 2002 to match water supply with water demand under rapidly developing drought conditions;
2. Critically examine the state-of-the-art of science that underpins management of droughts; and,
3. Broadly overview the options Colorado citizens and water managers may have to match available water supply with demand during 2003 and beyond.

The Drought Conference is organized in the tradition of the Governor's Flood and Drought Conference of 1999 and the Fort Collins Flood Conference of 1997 - to document current water management issues and explore future options to mitigate negative impacts of extreme hydrological events. Thus, a well-documented proceedings of the conference will be published.

The conference will be held in the North Ballroom of the Lory Student Center on the campus of Colorado State University. Poster papers are invited and will be displayed in the registration and break room during the day-long event.

Key topics to be covered are:

* Drought: A Recurring Atmospheric and Hydrological Event
* Lessons Learned while Managing Water in Colorado during the 2002 Drought
* Drought Mitigation Successes and Failures in 2002 - Plans for 2003
* Options for Short and Long-term Drought Preparedness

Sponsored by the

Colorado State University DroughtLab
Colorado Water Conservation Board
CSU Western Center for Integrated Resource Mgmt.
Colorado Water Congress
Colorado Division of Water Resources
U.S. Geological Survey

To submit a poster abstract or request information about the conference, please contact:

Marian Flanagan or Shirley Miller
Colorado Water Resources Research Institute
E-102 Engineering Building
Colorado State University
Fort Collins, CO 80523

E-mail: cwrri@colostate.edu
Phone: (970) 491-6308
Fax: (970) 491-1636

SEE NEXT PAGE FOR CONFERENCE PROGRAM

Colorado Drought Conference:
Managing Water Supply and Demand in the Time of Drought
December 4, 2002
Lory Student Center, Colorado State University
Fort Collins, CO 80523
(Draft Program)

8:00-8:30	Registration
8:30	Call to Order: Prof. Jose Salas, DroughtLab, Co-Director
8:30-8:40	Welcome Tony Frank, Vice President for Research and Information Technology, Colorado State University
8:40-8:55	Introduction Rep. Diane Hoppe, Co-chair of the Colorado Legislature's Water Resources Review Committee.
8:55-9:10	"We've Been Here Before!" – Michael Welsh, History Department, University of Northern Colorado
9:10-10:10	Drought: A Recurring Atmospheric and Hydrological Event Moderator: Marty Clark, Western Water Assessment, CIRES, NOAA, Boulder "Climate History Leading up to 2002 Drought" – Roger Pielke, Sr., Director, and Nolan Doesken, Research Associate, Colorado Climate Center, Colorado State University, "The Tree-Ring Record of Paleo Droughts in Colorado over the last 300-800 Years" – Connie Woodhouse, Jeffrey Lukas, and Robert Webb, NOAA, NCDC, Boulder "Colorado Climate Projections for the WY2003: Scientific Insights" – John Henz and William Badini, HDR Meteorological Services, Denver "Climate Projections: Assessing WY 2002 Forecasts and Developing WY 2003 Forecasts" - K. Wolter, NOAA, CDC, Boulder
10:10-10:30	Break (Poster Papers in Break Room)
10:30-12:00	Lessons Learned while Managing Water in Colorado during the 2002 Drought Moderator: TBA "Administering Water Rights During the 2002 Water Year: Lessons Learned" – Hal Simpson, Colorado State Engineer "Experiences of Water Conservancy Districts & Cities" - Alan Hamel, President, Southeastern Colorado Water Conservation District Board of Directors. - Rocky Wiley, Denver Water - John Porter, Retired Manager, Dolores Water Conservancy District - Tom Cech, Manager, Central Colorado Water Conservancy District
12:00-1:30	Luncheon (included in registration fee) Speaker: Governor Owens (Invited)
1:30-3:00	Drought Mitigation Successes and Failures in 2002 - Plans for 2003 Moderator: Bill Horak, USGS Agriculture – Ray Christenson, Ex. Vice President, Colorado Farm Bureau Municipal – Peter Binney, Aurora Utilities

Habitat/Minimum Flows – Dan Merriman, Chief, Stream and Lake Protection, Colorado Water Conservation Board
Recreation –Bob Aukerman, Natural Resources Recreation and Tourism Department, Colorado State University
Water Quality – Carl Norbeck, Water Quality Control Division, Colorado Department of Public Health and Environment; and Michael Lewis, USGS
General Discussion of Drought Mitigation Successes and Failures – What have we learned that will help in 2003?

3:00-3:30 Break (Poster Papers in Break Room)

3:30-4:45 Options for Short and Long-term Drought Preparedness
Moderator: Jack Byers, Assistant State Engineer, Colorado Division of Water Resources

Infrastructure Options for Colorado's Future Drought Prepardness - TBA
Legislative Options for Mitigating Drought – Dick MacRavey, Ex. Dir., Colorado Water Congress
Forest Practices and Water Yield: Options for the future – Chuck Troendle
Weather Modification/Cloud Seeding – Chips Barry, Denver Water

4:45-5:00 Concluding Remarks – Preparing for Future Droughts
Evan Vlachos, Dept. of Sociology, Colorado State University

5:00 Adjourn

WELLS – ARE THEY A DEPENDABLE WATER SUPPLY? Forthcoming Educational Programs

The Colorado Water Well Contractors Association (CWWCA) and the Colorado Division of Water Resources are sponsoring daylong educational programs for Durango on November 12 and Alamosa on November 13, 2002. The emphasis will be on small capacity wells serving domestic or household purposes. The meetings will provide a forum for well drillers, pump installers, engineers, geologists, realtors, planners, sanitarians, attorneys and Division of Water Resources staff to discuss updated information on obtaining well permits, constructing wells in compliance with current rules and satisfying local county rules on the use of wells and septic systems. Speakers will describe where and how to obtain well permits and data for existing wells. The limits on water usage to comply with permit and statutory conditions will be reviewed. Emphasis will be placed on proper well construction and well testing to develop a dependable supply. Local counties permit the septic systems and that may impact where wells can be drilled. Testing of wells for water quality will be discussed. The meetings will be informal and questions from attendees will be encouraged. For a brochure listing the speakers, their topics and a registration form, contact: CWWCA at 8674 West Warren Drive, Lakewood, CO, 80227, phone 303-986-5035, fax 303-986-8375, e-mail office@cwwca.org.

COLORADO WATER CONGRESS MEETING SCHEDULE

The 2003 45th Annual Convention will be January 23-24, 2003 in Northglenn, CO
The 2003 Summer Convention will be August 21-22, 2003 in Steamboat Springs, CO
The 2004 46th Annual Convention will be January 29-30, 2004 in Northglenn, CO

CONTACT: Dick MacRavey, Executive Director, at Phone 303/837-0812, FAX 303/837-1607,
E-mail macravey@cowatercongress.org. Web site: www.cowatercongress.org

CALENDAR

2002

Oct. 23-24	"WHO'S RUNNING THIS ECOSYSTEM? 13TH ANNUAL SOUTH PLATTE FORUM, Longmont, CO. Contact: Jennifer Brown, South Platte Forum, 513 N. Harding Ave., Johnstown, CO 80534, Phone 970/213-1618, E-mail conferenceplanner@msn.com."
Oct. 23-26	"USCID WATER MANAGEMENT CONFERENCE, Helping Irrigated Agriculture Adjust to TMDLs, Sacramento, CA. Contact: Larry Stephens at Phone 303/628-5430, FAX 303/628-5431, E-mail stephens@uscid.org. Internet: http://www.uscid.org/~uscid."

CALENDAR

2002

Oct. 27-30	"GROUND-WATER DEPLETION AND OVEREXPLOITATION: A GLOBAL PROBLEM -- THE GEOLOGICAL SOCIETY OF AMERICA 2002 ANNUAL MEETING, Colorado Convention Center, Denver, CO. For details see the website at http://www.geosociety.org/meetings/2002/."
Oct. 29-30	"COLORADO NONPOINT SOURCE FORUM, RESTORING IMPAIRED WATERS: TOOLS FOR TOMORROW, Colorado Springs, CO. For information contact Jennifer Brown at 970/213-1618 or email conferenceplanner@msn.com. "
Oct. 29-Nov. 2	"NORTH AMERICAN LAKE MANAGEMENT SOCIETY 22ND INTERNATIONAL SYMPOSIUM, Anchorage, AK. Registration information and forms only available on the Web at www.nalms.org. "
Nov. 3-7	"AWRA 2002 ANNUAL CONFERENCE, Philadelphia, PA. Registration information available at the AWRA web site at http://www.awra.org."
Nov. 11-12	"NASULGC 2002, 115TH ANNUAL MEETING, Chicago, IL. Call the Nat'l. Assn. Of State Universities and Land Grant Colleges at 202/478-6050, FAX 202/478-6046, or see the web site at http://www.nasulgc.org."
Nov. 12	WELLS – ARE THEY A DEPENDABLE WATER SUPPLY?, Durango, CO. For a brochure listing speakers, their topics and a registration form, contact: CWWCA at 8674 West Warren Drive, Lakewood, CO, 80227, phone 303-986-5035, fax 303-986-8375, e-mail office@cwwca.org.
Nov. 13	WELLS -- ARE THEY A DEPENDABLE WATER SUPPLY?, Alamosa, CO.
Nov. 18-20	"GROUNDWATER: THE FORGOTTEN ELEMENT OF WATERSHED PROTECTION, Eugene, OR. Contact: Cindy Kreifels at the Groundwater Fdn. at 1/800-858-4844, 402/434-2740 (Lincoln) or E-mail cindy@groundwater.org."
Dec. 4	COLORADO DROUGHT CONFERENCE: MANAGING WATER SUPPLY AND DEMAND IN THE TIME OF DROUGHT, Colorado State University, Fort Collins, CO. For information contact CWRRI at Phone 970/491-6308, Fax 970/491-1636, E-mail cwrri@colostate.edu, or see website at http://cwrri.colostate.edu.

2003

Jan. 23-24	COLORADO WATER CONGRESS 45th Annual Convention, Northglenn, CO. Contact: Dick MacRavey, Executive Director, at Phone 303/837-0812, FAX 303/837-1607, E-mail macravey@cowatercongress.org. Web site: www.cowatercongress.org
Feb. 13	LOWER SOUTH PLATTE SYMPOSIUM -- THE SOUTH PLATTE: LEARNING HOW IT WORKS AND HOW TO MAKE IT WORK. Contact: Joel Schneekloth, Phone 970/345-0508, E-mail jschneek@coop.ext.colostate.edu.
Mar. 27-28	Watering Your Future -- 2003 Arkansas River Basin Water Forum, University of Southern Colorado, Pueblo, CO. For information, call (719) 336-9421 or e-mail rappel@co.usda.gov.
Apr. 7 - 11	International Workshop on Integrated Water Resource Management, Denver, CO. Contact Ms. Leanna Principe, E-mail: lprincipe@do.usbr.gov,

Colorado State University
Colorado Water Resources Research Institute
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