Colorado Water

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

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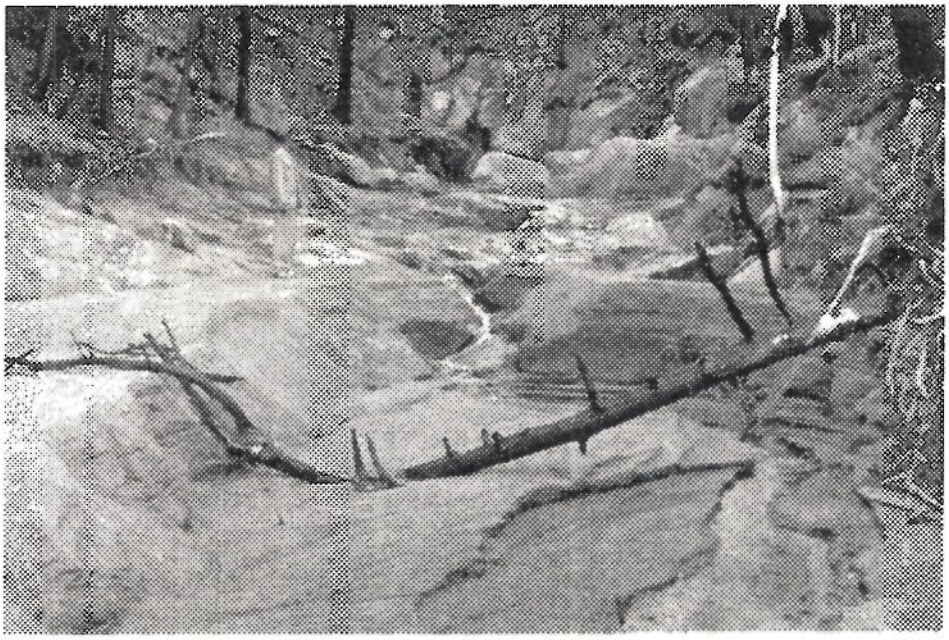

Buffalo Creek during the summer of 1996, following the forest fire and subsequent floods.

See page 4

INHERITING OUR PAST: RIVER SEDIMENT SOURCES AND SEDIMENT HAZARDS IN COLORADO

Colorado State University

WATER ITEMS AND ISSUES . . .

COLORADO WATER

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Editor: Shirley Miller
Writers: J.B. Bryant and Malle Ceridon

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Phone:970/491-6308
FAX:970/491-2293
E-mail:CWRRI@ColoState.EDU
Internet: Http://www.ColoState.EDU/Depts/CWRRI
Robert C. Ward, Director

EDITORIAL

SEDIMENT – WHAT DO WE KNOW? WHAT SHOULD WE KNOW?

Sediment's role in the behavior of watershed functions has received increased public attention in recent years. This attention stems from, among other things:

- Public debates on the sustainability of aging reservoirs perceived to be filling with sediment;
- The well-publicized release of water from Lake Powell to move sediment through the Grand Canyon as a means of restoring habitat functions;
- The controversial suggestion that some western dams be removed because they prevent sediment from moving downstream where it is needed to maintain healthy riparian ecosystems;
- The untimely releases of sediment into streams from reservoir operations, such as the Halligan Reservoir release, or natural disasters, such as forest fires in the Buffalo Creek drainage; and,
- The rising stream bed in the Arkansas River which may be disrupting drainage from some agricultural fields, and, in turn, reducing agricultural production.

As public attention is drawn to sediment issues, scientists and water managers are working together to synthesize our current understanding of the role sediment plays in a healthy watershed. This issue of COLORADO WATER contains a summary of a Colorado 'sediment' report prepared by Professor Ellen Wohl, Department of Earth Resources, Colorado State University, in collaboration with three Colorado natural resource managers — Robert McConnell with the Water Quality Control Division, Jay Skinner with the Division of Wildlife, and Dick Stenzel with the Division of Water Resources. The report is designed to explain what we currently know about sediment movement through a watershed and the impacts upon this movement caused by society's use of water and land.

The report ends by discussing what we do not know about sediment in Colorado's rivers and reservoirs. In the 'recommendations for the future,' the report recognizes the limitations society places on the management of sediment from land and its movement by water. The recommendations also point out the knowledge we need to sustain healthy Colorado watersheds. We need to know more about sediment movement under varying flow conditions, means to move sediment through reservoirs, a basin-wide overview of sediment management, and the interaction of sediment with a stream's chemistry and biology.

Thus, while we are gaining a better appreciation of sediment's role in Colorado's watersheds, we need to continue to improve our understanding of how to manage sediment. Sediment management, as a recognized component of land and water management, must provide a balance between sustainable human use of land and water resources and protection of natural sediment functions within a watershed. Continued cooperation between Colorado water and land managers and university scientists, as represented in the production of the Colorado 'sediment' report, is critical to developing the knowledge needed to achieve the balance we seek.

RESEARCH

INHERITING OUR PAST: RIVER SEDIMENT SOURCES AND SEDIMENT HAZARDS IN COLORADO

This is a summary of a report prepared by a task force created by the Colorado Water Resources Research Institute (CWRRI). The final report is being printed and will be available upon request in July.

by

Ellen Wohl, Department of Earth Resources, Colorado State University
with contributions from
Robert McConnell, Water Quality Control Division, Department of Public Health and Environment
Jay Skinner, Division of Wildlife, Department of Natural Resources
Richard Stenzel, Division of Water Resources, Department of Natural Resources

River channels are dynamic natural systems that are continually changing. A channel reflects to some degree all of the processes operating within its drainage basin. These processes are ultimately controlled by geology and climate, which together determine regional topography, soil development, the growth of vegetation, and the land-use practices of people living within the drainage basin (*Figure 1*). Hillslope features such as topography, vegetation, and land-use will influence the characteristics of water and sediment yield from the hillslopes to the channel. The movement of water and sediment along the channel will then depend on channel and valley-bottom geometry, but will also influence that geometry.

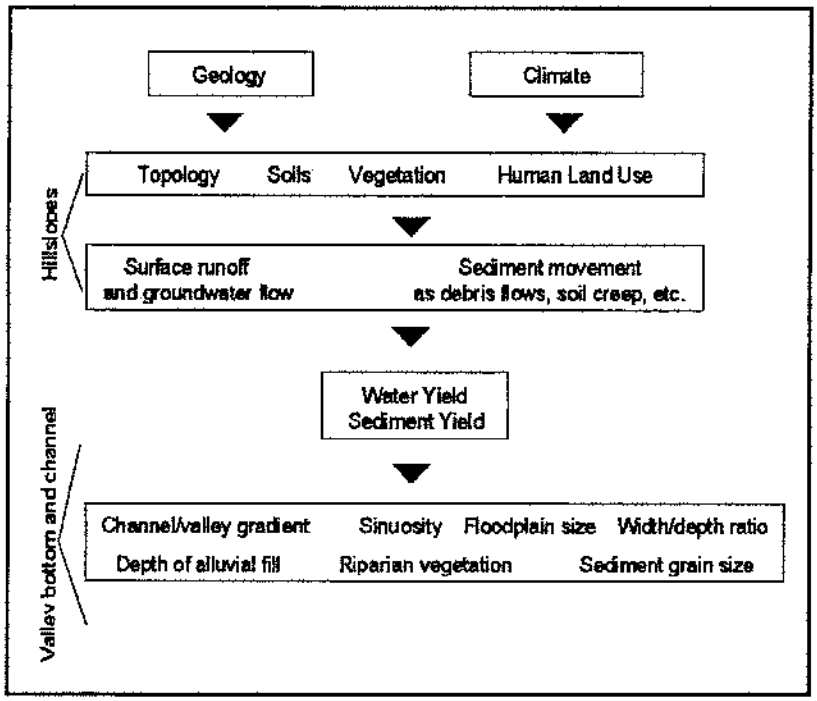


Figure 1. Schematic diagram of relationships among factors controlling sediment movement along rivers. Contaminants may move in association with water and/or sediment.

There are four basic processes by which sediment moves down a hillslope. Mass movements involve the rapid downslope motion of large aggregates of sediment. These movements include rockfall, landslides, debris flows, and slumps. Sediment may also move downslope as individual particles or small aggregates. Very intense rainfall on a slope of low permeability may create thin sheets of flowing water across the slope, and this water may carry sediment with it. The water may also concentrate into rills or gullies. The water's erosive force is greatly increased in these small channels. Both slopewash and rilling are particularly effective on sparsely vegetated slopes or on slopes that have been recently disturbed by something such as a forest fire. Finally, sediment may move very gradually downslope in cycles tied to freezing and thawing or wetting and drying. This process of soil creep may be effective even on densely vegetated slopes.

Once sediment enters a river channel, it may remain in place, or be transported downstream in dissolved, wash, suspended, or bedload. Dissolved load refers to material carried in solution in the water column. Dissolved load is high in drainage basins formed on rocks that are readily weathered and eroded, and in drainage basins where water moving slowly through the subsurface has time to react chemically with its surroundings before entering the stream channel. Wash load is composed of fine sediments that are carried in suspension and are deposited along the channel margins to only a limited extent. Suspended load is also carried in suspension, but these coarser silt, sand, and gravel particles move sporadically, being carried some distance and then stored for a time in the channel bed. Bedload is composed of the largest particles, which move by rolling, sliding, or bouncing, and always remain in contact with the channel bed. The grain size distribution and mode of transport of sediment will determine residence time within a river system: A clay particle that reaches a river from the hillslopes may be transported through the entire system in a few years, whereas a boulder that moves a short distance as bedload every few decades may remain in the river basin for millennia.

The relative importance of the different components in *Figure 1* varies with location in the drainage basin *(Figure 2)*. The upper portion of a drainage basin is primarily a source for water and sediment. The channels in this source zone tend to be steep and narrow, with bedrock or boulders forming the channel boundaries. Sediment introduced directly to the channels from the steep hillslopes is moved rapidly downstream, with relatively little sediment storage along the valley bottoms. In Colorado, this source zone is best represented by the Rocky Mountains.

The central portion of a drainage basin is primarily a transport zone for water and sediment. Channel gradient decreases in the transport zone, and the narrowly confined valleys of the source zone give way to broader valleys with well-developed floodplains and larger volumes of stored sediment. Sediment in storage throughout the transport zone has a longer residence time than sediment in the source zone, although the downstream sediment is periodically mobilized. Many of the channels on the plains of eastern Colorado and the plateaus of western Colorado have the characteristics of channels in the transport zone.

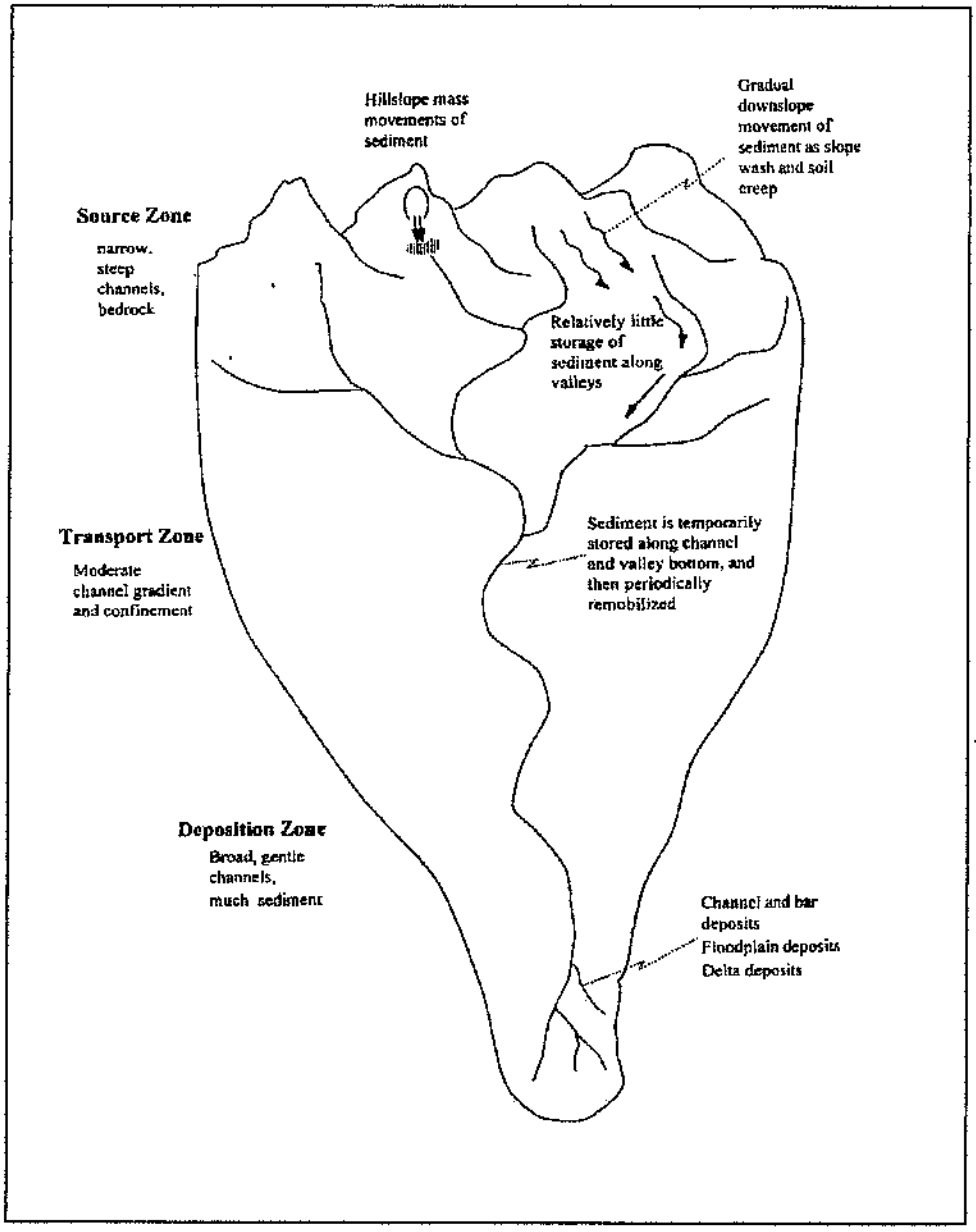


Figure 2. Schematic drainage basin illustrating natural sediment sources and sinks. This illustration may be applied to any scale of drainage basin.

The depositional zone at the downstream end of a drainage basin has very low-gradient channels flowing across very broad valleys. This zone is a sediment sink, where the finer sands, silts, and clays that have been transported from the uplands are stored for long periods of time along the valley bottoms. For many of the rivers originating in Colorado, this zone lies beyond the state borders, although some examples can be found in the San Luis Valley.

Hazards associated with sediment

The hazards associated with river sediment may be very local in scale, or they may affect a large portion of a river's drainage basin. Sediment hazards in Colorado take three basic forms: excess of sediment, decrease of sediment, and contamination of sediment.

Excess of sediment generally implies that flow in the channel is not capable of transporting all of the sediment supplied, resulting in a change of channel pattern, loss of specific channel features such as pools or spawning sites, filling of the channel and overbank flooding, or filling of a reservoir. Decrease of sediment implies that flow in the channel is capable of transporting more sediment than is being supplied. Consequently, the excess flow energy will be expended on channel erosion, resulting in bank collapse, bridge-pier scour, channel downcutting, and other changes. Sediments may be contaminated by materials toxic to humans and aquatic organisms, such as agricultural and urban pesticides or mining leachates. Sediments may also be contaminated by excessive levels of nutrients such as urban and agricultural phosphorus which create algal blooms that reduce dissolved oxygen and harm fish populations, a problem in many of the reservoirs in Colorado used for human recreation.

THE RIVERS OF COLORADO

The State of Colorado includes seven major water basins with 105,600 miles of rivers and 3,260 lakes, reservoirs, and ponds. The State can be divided into three physiographic provinces; the eastern plains, the central mountains, and the western plateaus and canyons (*Figure 3*).

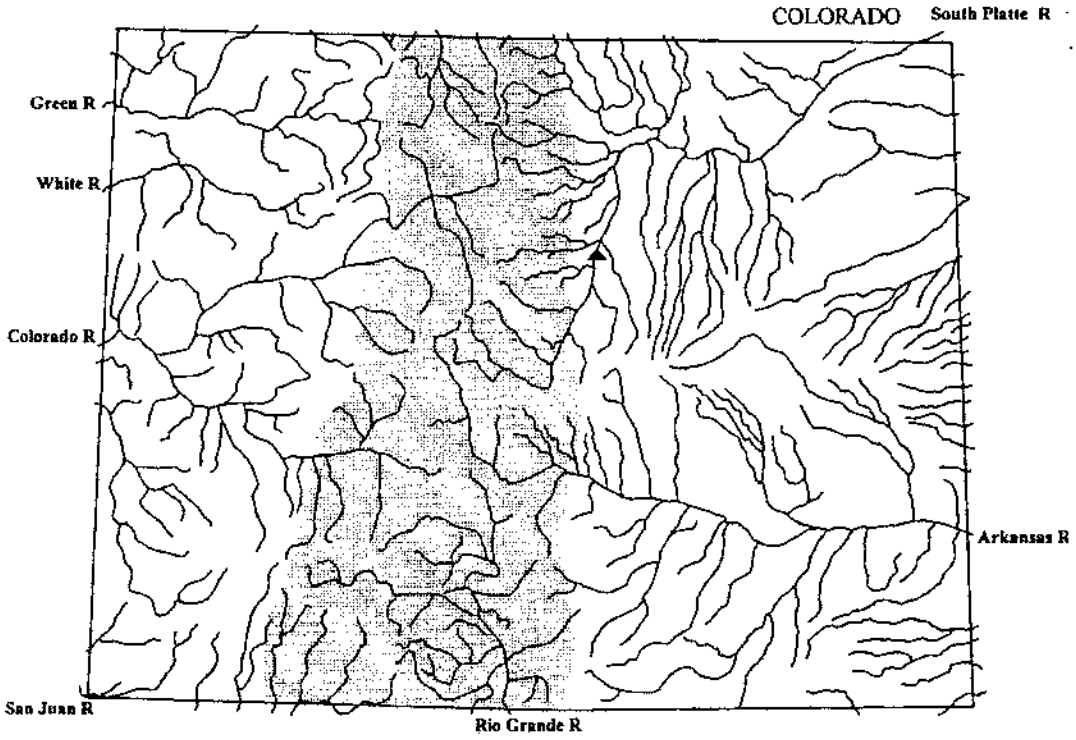


Figure 3. The State of Colorado, with major drainage networks and the three physiographic provinces. The eastern plains are the white band at the right of the figure; the mountains are indicated by the shaded band in the center of the figure; and the western plateau and canyon region is the white band at the left of the figure. The triangle at the western edge of the plains represents the city of Denver.

Each of these provinces has distinctive traits of geology, climate, soils, vegetation, topography, and land use that in turn produce distinctive types of river channels.

Many of Colorado's rivers have undergone substantial changes since 1800 as a result of human activities (Figure 4). In some instances, the effects of these activities completely dominate the natural controls on sediment movement into and along the rivers. However, there remain sediment issues that are unique to each of the three physiographic provinces because of the geologic and climatic characteristics of those provinces. The next section of this report highlights a series of examples of sediment hazards in Colorado.

Figure 4. The State of Colorado. Black dots indicate dams and reservoirs in the state, including very minor reservoirs.

SEDIMENT HAZARDS IN COLORADO

Human activities may indirectly affect river channels if the movement of water and sediment from hillslopes to channels is altered. Examples of such activities include timber harvest, crops, grazing, road construction, and urbanization. Human activities may also directly affect river channels by altering the flow of water and sediment along the channel, as results from dams, flow diversions, channelization, beaver trapping, or placer mining

Examples of hazards associated with excess sediment

North Fork Poudre River, Larimer County: The draining of Halligan Reservoir in late September 1996 was accompanied by the release of approximately 7,000 cubic yards of clay to gravel sized sediment that had accumulated in the reservoir. Flow from the drained reservoir was shut down immediately after the sediment was released, allowing the sediment to settle along more than 10 miles of river downstream from the reservoir. The immediate effect of the sediment release was a massive kill of aquatic organisms; the Colorado Division of Wildlife (CDOW) estimated 4,000 dead fish along the ten miles of channel immediately downstream from the reservoir. Over the longer term, the continuing presence of excess fine sediment along the channel has inhibited recolonization by aquatic insects and fish. CDOW is now proposing to re-stock fish along a river that had supported a self-sustaining population prior to the sediment release.

Buffalo Creek, Jefferson County: Following a forest fire that burned 2,000 acres of the Buffalo Creek drainage in May 1996, massive sediment yields came from the burned hillslopes during a series of rainstorms in June and July 1996 and 1997. The highly weathered granite underlying the hillslopes provided a source of abundant sediment once the vegetation was removed during the fire. The summer rainstorms caused 9 floods that were greater than the 100-year flood (pre-fire conditions), as well as numerous smaller floods (R. Jarrett, U.S. Geological Survey, unpub. report). Sediment associated with the floods and debris flows filled channels and culverts, buried houses and other structures along the channel banks, and caused several million dollars in public and private property damage. Two lives were lost during the 12 July 1997 flood. The combination of excessive sediment and large woody debris that accumulated downstream from the burned area, in Strontia Springs Reservoir, reduced water quality in the

reservoir and threatened reservoir operations to the point that the City of Denver flushed sediment from the reservoir three times between September 1996 and September 1997. Nutrients contained within this sediment introduced thousands of tons of nitrogen and phosphorus into Chatfield Reservoir, downstream from Strontia Springs, and affected water quality in Chatfield.

Examples of hazards associated with the decrease of sediment

- Bessemer Ditch, Pueblo County: This irrigation ditch takes water out of Pueblo Reservoir on the Arkansas River. Prior to construction of the reservoir, the ditch had a 15-18% water loss to infiltration. This increased to 45% water loss following construction of the reservoir. The change in infiltration rate has been attributed to the absence of fine sediment in the flow along the ditch; previously, this fine sediment accumulated in the cracks that form periodically along the ditch, filling the cracks and reducing water loss. Approximately 10 miles of the 35-mile long ditch have been lined with cement, following a $1 million lawsuit that forced the government to line the ditch.

- Elkhead River, Moffat County: Elkhead Reservoir was constructed along the Elkhead River outside of Craig, Colorado in 1974. Landowners along the river have subsequently alleged that excessive erosion has occurred along this sand-bed meandering channel as a result of sediment retention in the reservoir. Approximately 4 miles of channel below the reservoir are affected, and in some areas the channel has migrated 70 feet laterally during the past 30 years.

Examples of hazards associated with contaminated sediments

- California Gulch, Arkansas River basin, Lake County: The former mining area of California Gulch has been designated as a Superfund site by the U.S. Environmental Protection Agency. Concentrations of heavy metals (Mn, Fe, Cu, Zn, Pb, Mb, Cd) in the Arkansas River downstream from California Gulch are highly dependent on flow and tend to increase during high spring runoff. This suggests that these metals are abundant in the fine sediments that have traveled from the tailings piles to the river, and are now carried downstream in suspension during high discharges

- South Platte River, Adams, Weld, Morgan, Logan, Sedgwick Counties: The lower portion of the South Platte River basin in Colorado has been impacted by various human activities since the 1850s. Agricultural and urban land use in particular have produced contaminants carried into stream channels by surface runoff and subsurface flow. These contaminants are stored in river sediments for varying lengths of time, as well as being transported by stream flow and accumulating in the bodies of aquatic organisms. Concentrations of these contaminants increase in summer and during stormwater runoff, but persist year-round. In addition, approximately 7,000 tons of nitrogen and 860 tons of phosphorus enter streams in the basin each year. Nutrient loads are highest downstream from Greeley, which has extensive feedlots.

OUR OPTIONS FOR MANAGING SEDIMENT AND WATER

Our abilities to mitigate the types of sediment hazards outlined in the preceding sections of this report are constrained by societal and legal considerations, environmental considerations, and technical considerations. Ultimately, mitigating sediment hazards will mean (1) keeping sediment out of sites where it creates a hazard, or removing the sediment once it reaches those sites; (2) supplying sediment to sites where its absence creates a hazard; or (3) containing contaminated sediment, or removing that sediment from sites where it creates a hazard. Water is critical to each of these mitigation methods because water is the most common agent of sediment transport, and the ratio of water/sediment will govern whether there is an excess or absence of sediment.

Societal and Legal Constraints

Because the system of prior appropriation serves as the ultimate basis for water allocation in Colorado, the ability to use water to supply or remove sediment from a site will be governed in many cases by the ratio of water costs to sediment-hazard costs. For over-appropriated rivers, the water necessary to reduce sediment hazards simply may not be available on a regular basis. At present, we do not have well-defined legal connections between water quality and water quantity. Continuing trends of population growth in Colorado will also constrain our uses of water. As demographic balance in the state continues to shift from agriculture toward urban and industrial consumption, both the pattern of water use and the cost of water will change.

A final legal constraint on water use is the State's legal obligations to other groups of water users downstream. As one of the Upper Basin states in the 1922 Colorado River compact, the State of Colorado's use of that river's water is strictly confined. We also have other obligations to surrounding states such as Nebraska that are downstream along the South Platte River. Native American groups are arguing for water rights, as in the case of the Ute Mountain Ute Indian Tribe and the Animas-La Plata project, and federal land-management agencies are also legally requesting water rights related to the lands under their jurisdiction. Sediment removal that is not water-based will be subject to legal constraints in the form of state and federal permitting procedures for dredging and filling operations.

Environmental Constraints

Legislation designed to protect environmental qualities, as well as public demands for environmental protection, will constrain some options for mitigating sediment hazards. Environmental legislation includes specific federal measures such as the Endangered Species Act, the Clean Water Act, and the Wild and Scenic Rivers Act. These Acts may regulate water, and hence sediment distribution. Enforcement of measures such as the Endangered Species Act, for example, may involved specifying the instream flow necessary to maintain an endangered species. Federal regulations also govern activities in specially-designated public lands including the national parks, national forests, and wilderness lands administered by the Forest Service or the Bureau of Land Management. State regulations such as those governing Colorado's Clean Water Act, which includes narrative sediment regulations administered by the State Water Quality Control Commission with oversight by the U.S. EPA, pose additional potential constraints. The enforcement of these various Acts by regulatory agencies may be limited by other legal constraints, such as prior appropriation or private property rights, because water quality is often related to water quantity. (The legal connection of water quantity and quality remains vague, however.) With increasing public demand for habitat preservation and outdoor recreation, it is no longer considered acceptable to mitigate sediment hazards to human structures at the expense of river ecosystems, as indicated by the public indignation following the deliberate release of sediment from Halligan Reservoir in 1996.

Technical Constraints

Our ability to mitigate sediment hazards is also constrained by our limited knowledge of the physical and chemical processes by which sediments and contaminants move through a river drainage basin. Our ability to mitigate sediment hazards may also be constrained by difficulties in identifying the source of the hazard. There is geological evidence of decades-long cycles of sediment accumulation and subsequent erosion along these rivers, independent of human land-use, and these cycles seem to be inherent to rivers in arid and semiarid regions of the western United States. Because of this inherent variability in sediment yield, it may be difficult to determine the specific cause of an increase or decrease in sediment along a river. We also know far too little about the behavior of contaminants in natural environments. Some substances move downstream in solution, others are adsorbed onto particles of silt and clay and move only when the sediment moves. And, it has proven difficult to predict chemical changes in contaminants once they enter the environment. Legal, societal, environmental, and technical constraints pose numerous and complicated challenges for mitigating sediment hazards in Colorado as we enter the 21st century. Within these constraints, there are some basic steps that may be taken toward mitigating present and future hazards resulting from sediments.

RECOMMENDATIONS FOR THE FUTURE

We must begin by recognizing that we cannot restore the state's rivers to pre-19th century conditions, but we also cannot linearly extrapolate present patterns of water use without a serious degradation of the environment and our quality of life. Americans have always struggled to find a balance between individual freedom and property rights versus the duty of the government to protect the rights and quality of life for the public as a whole. This is exemplified by past treatment of sediment issues in Colorado, where flow regulation or land use by private individuals or small companies may clash with governmental protection of clean water. Too often, decisions between these competing interests have been decided on a case-by-case basis, with legal precedents given equal or greater weight than scientific understanding of the physical processes involved. We begin, therefore, with two broadscale recommendations:

♦♦ ***Sediment hazard issues must be considered at the scale of the entire drainage basin, rather than on a very site-specific basis.***

The loss of reservoir storage capacity may be a direct result of poor land-use and lang-management practices upstream from the reservoir, and the sediment release designed in an attempt to restore reservoir capacity may damage aquatic habitat downstream. The point is that the reservoir is not an isolated entity; it is closely connected to processes upstream and downstream. Therefore, any long-term plan to mitigate sediment hazards at the reservoir must also consider upstream and downstream controls. In addition, sediment generated at one point along a river may be carried miles downstream before it is deposited. In practice, such an approach to hazard mitigation will probably require government oversight rather than piecemeal individual control. Although state government agencies have an abundance of work with existing regulations, it seems apparent that unless a knowledgeable, interdisciplinary oversight body is charged with the task of drainage-basin-scale management, problems will continue to be addressed within an inappropriately confined scope.

- *The process of effective mitigation of sediment hazards would be facilitated by a decision-making process resting on scientific understanding of sediment dynamics rather than on legal precedents or court mandates.*

For example, following the 1996 sediment release from Halligan Reservoir, a group of state government employees, private water users, environmental activists, and research scientists was formed to develop protocols for reservoir sediment release that would avoid the environmental degradation associated with the Halligan release. This is a less divisive and costly approach than a lawsuit to compensate parties adversely impacted by the sediment release. If analogous groups could develop protocols for minimizing the types of sediment hazards outlined in this report, everyone in Colorado would benefit greatly. The development of such protocols depends closely on widespread recognition and understanding of sediment issues. The Colorado Department of Public Health and Environment's 1998 303(d) report (Water Quality Limited Segments Still Requiring TMDLs) lists 85 river segments with sediment problems, 12 river segments with metal-contaminated sediments, and 6 river segments with nutrient contamination. At the more specific level, there remain several issues that must be addressed before we can effectively manage sediment. Each of these requires basic and applied research into sediment movement.

- *Sediment accumulation in reservoirs*

This is one of the most widespread sediment hazards in Colorado. We must improve our understanding of how to limit sediment movement into, and accumulation in, reservoirs. Technologies exist for sediment dredging, bypassing, and flushing, but most of these are limited in application by cost or by downstream consequences such as possible water quality reduction from contaminants in the reservoir sediment.

- *Sediment transport along channels*

Whether the excess sediment comes from basin-wide land use, reservoir release, or flow diminution, sediment accumulation and consequent loss of water quality and habitat remain a problem along many rivers. We need to develop models that describe how various types and quantities of sediment are transported along different types of channels. Such models could specify, for example, the minimum flushing flow necessary to prevent downstream pool sedimentation during a reservoir sediment release.

- *Contaminant dispersion and disposal*

We are desperately in need of basic research on how individual contaminants combine with each other and with sediment along a stream channel; where they are stored and when they are mobilized; how they affect aquatic organisms and humans; and how long they remain biologically dangerous. We also need to develop basic protocols on how to remove contaminated sediments; how removal is accomplished; who pays for removal; and where the contaminated material is to be stored. The hazards posed by sediment along rivers in Colorado are complex. Mitigation of these hazards requires a carefully planned and integrated approach. We can continue to deal with each sediment hazard as it develops at a specific site. This approach is reactive and costly in that the situation is allowed to reach a hazardous level before action is taken, and that action is very limited in scope. Or, we can develop a proactive means of mitigating sediment hazards by designing basin-scale protocols for anticipating and preventing sediment-related hazards such as sediment releases from reservoirs or the downstream transport of contaminated sediments. Satisfactory resolution of these conflicts will require that everyone involved understands the basic processes of rivers and sediment movement, the history of river and land-use changes in Colorado, and the constraints that currently limit our abilities to mitigate sediment hazards.

WATER RESEARCH AWARDS

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

COLORADO STATE UNIVERSITY, FORT COLLINS, CO 80523

Title	PI	Department	Sponsor
Aquatic Studies	Eric Bergersen	Coop Fish & Wildlife Research	Colo Division of Wildlife
Whirling Disease PCR & Pepsin-Trypsin Development	Eric Bergersen	Coop Fish & Wildlife Research	Colo Division of Wildlife
Whirling Disease Transmission in Lakes	Eric BergersenP	Coop Fish & Wildlife Research	Colo Division of Wildlife
Piceance	Gary White	Fish & Wildlife Biology	Colo Division of Wildlife
Wetlands Initiative	John Sanderson	Fish & Wildlife Biology	Colo Dept of Natural Resources
Pond Analysis	**Eric Bergersen**	**Coop Fish & Wildlife Research**	**Colo Division of Wildlife**
Age & Growth of Rio Grande Sucker	**Brett Johnson**	**Fish & Wildlife Biology**	**Colo Division of Wildlife**
Evaluation of the Acid-buffering Capacity & Metal Mobility of Southwest San Luis Valley...	Grant Cardon	Soil & Crop Sciences	Colo Dept Public Health & Environ
Environmental Applications Research	Thomas Vonderhaar	CIRA	NOAA-Natl Oceanic & Atm Admn
Air-Sea Interaction Remote Sensing Processes	Thomas Vonderhaar	CIRA	NOAA-Natl Oceanic & Atm Admn
Simulations of the Interaction Between Deep Convection & the Ocean Mixed Layer...	William Cotton	CIRA	NOAA-Natl Oceanic & Atm Admn
Activities & Participation in the GOES I-M Product Assurance Plan	Thomas Vonderhaar	CIRA	NOAA-Natl Oceanic & Atm Admn
Funds for Satellite Data Reception & Analysis Support	**Thomas Vonderhaar**	**CIRA**	**NOAA**
Improving Manure Mgmt to Protect Water Quality in the Southwestern United States	Jessica Davis	Soil & Crop Sciences	Utah State University
Reducing Environmental Contamination from Feedlot Manure in the South Platte River...	Jessica Davis	Soil & Crop Sciences	Utah State University
Business Index Reporting Service for Irrig Districts & Canal Cos.	**John Wilkins-Wells**	**Sociology**	**USDA-Coop. States Res Service**
Colorado Pesticide Impact Assessment Program	Sandra Mcdonald	Bioagriculturl Sci & Pest Mgmt	USDA-Coop Extension Srv
Technical Assistance in Water Resource Investigations, Mod#1	Pierre Julien	Civil Engineering	DOI-Bureau of Reclamation
Inventory & Characterize Upland Water Resources in Dinosaur National Monument	John Stednick	Earth Resources	DOI-NPS-National Park Service
Water Vapor in the Climate System	Graeme Stephens	Atmospheric Science	Natl Aeronautics & Space Admin.
Coupling Atmospheric, Ecologic, & Hydrologic Processes in a Regional Climate Model	**Roger Pielke**	**Atmospheric Science**	**Natl Aeronautics & Space Admin.**
Snow Distribution & Runoff Forecasting, Kings River Basin, CA	Kevin Elder	Earth Resources	DOD-ARMY-Corps of Engineers
Characterize the Geomorphic Effects of the 1997 Flooding Along Yuma Wash, AZ	Ellen Wohl	Earth Resources	DOD-ARMY-Army Research Office
DEC Monitoring Sites 1996-1998	Chester Watson	Civil Engineering	DOD-ARMY-Corps of Engineers
Glenn-Colusa Irrigation District (GCID) Model Study	Steve Abt	Civil Engineering	Ayres Associates
Global & Regional Modeling of the Atmospheric Hydrological Cycle Using Water Vapor...	David Randall	Atmospheric Science	Calif. Inst. of Tech/Jet Propuls Lab
Tropical Rainfall Measuring Mission Ground Validation	**V. Chandrasekar**	**Electrical Engineering**	**University of Iowa**
Federal Flood Assistance	**David Anderson**	**Coop Fish & Wildlife Research**	**DOI-USGS-Geological Survey**
Water Resources Scoping Report for the Mojave National Preserve	Freeman Smith	Earth Resources	DOI-NPS-National Park Service
Ecological Effects of Reservoir Operations on Blue Mesa Reservoir	Brett Johnson	Fish & Wildlife Biology	DOI-Bureau of Reclamation

Modeling & Analysis of Convective Storms	William Cotton	Atmospheric Science	NSF-GEO-Geosciences
Simulations of Cloud/Radiative Responses to Variations in Cloud Condensation Nuclei	William Cotton	Atmospheric Science	NSF-GEO-Geosciences
Ice Formation Processes in Upper Tropospheric Conditions	Paul Demott	Atmospheric Science	NSF-GEO-Geosciences
Relations Between Ice Nuclei and Ice Formation in Clouds	David Rogers	Atmospheric Science	NSF-GEO-Geosciences
Interdisciplinary Approaches to Identification & Mitigation of NPS Water Quality Impacts	John Stednick	Earth Resources	University of Wyoming
Mitigation of Mountain-Channel Sedimentation Resulting from Reservoir Sediment Releases	**Ellen Wohl**	**Earth Resources**	**NSF - Engineering Grant**
Canal Seepage Reduction Demonstration	**James Valliant**	**Cooperative Extension**	**DOI-Bureau of Reclamation**
Colorado State-wide Riparian Inventory & Classification	Christopher Pague	Fish & Wildlife Biology	DOI-Bureau of Reclamation
Inventorying & Monitoring Natural Resources Status & Trends in the National Park System	Jim Loftis	Chemical & Biores Engineering	DOI-National Park Service
Restoration at Rocky Mountain Arsenal National Wildlife Refuge	Edward Redente	Rangeland Ecosystem Science	DO-Fish & Wildlife Service
Irrigation Enterprise Management Study	John Wilkins-Wells	Sociology	DOI-Bureau of Reclamation
Prepare a Water Resources Management Plan for the Chattahoochee River National Recreation Area	**Freeman Smith**	**Earth Resources**	**DOI-National Park Service**
Strategies to Reduce the Effects of Brook Trout on Cutthroat Trout Restorations	**Kurt Fausch**	**Fish & Wildlife Biology**	**US Department of the Interior**
A Physical Approach to Derive Integrated Water Vapor & Cloud Liquid Water from AMSR ...	Thomas Vonderhaar	Cira	Nat. Space Dev. Agency of Japan
Developing a Decision Support System for the South Platte Basin	Robert Ward	Colo Water Resources Res Inst	Various ""Non-Profit"" Sponsors
Effects of Fire Disturbance on Watersheds in Bandelier National Monument	William Clements	Fish & Wildlife Biology	SW Parks & Monuments Assoc
Fish Entrainment into the Fulton Ditch District	**Kevin Bestgen**	**Fish & Wildlife Biology**	**Metro Wastewater Reclam**
Development of an Integrated System of Flow Forecasting for the Maule R. Basin, Chile	Gustavo Diaz	Civil Engineering	Catholic University of Chile
Snow Monitoring in the Maule River Basin	**Gustavo Diaz**	**Civil Engineering**	**Colbun Machicura S.A.**
A Reg Assess of Land Use Effect on Ecosystem Structure & Function	Roger Pielke	Atmospheric Science	EPA-Environmental Ed Grants
Assessment of Sediment Quality Criteria for Heavy Metals	**William Clements**	**Fish & Wildlife Biology**	**Wright State University**
Cadmium & Arsenic QA/QC - ENSR/Globeville	John Tessari	Environmental Health	ENSR Consulting & Engineering
Radionuclides in Shallow Water Sediments at CANDU Nuclear Generating Stations	**David Rowan**	**Radiological Health Sciences**	**Atomic Energy of Canada Ltd**
Navigation Channel Widening at Crossings on Lower Mississippi	**Daniel Gessler**	**Civil Engineering**	**DOD-ARMY-Corps of Engineers**
Geomorphic Assessment in Vicinity of Old River Complex	Chester Watson	Civil Engineering	DOD-ARMY-Corps of Engineers
CORE A: Integrated Research on Hazardous Waste Chemical Mixtures - Administrative Core	**Raymond Yang**	**Environmental Health**	**Superfund Hazardous Substances**
The Influence of Previous Exposure to a Mixture of Heavy Metals on Tolerance...	**William Clements**	**Fish & Wildlife Biology**	**Superfund Hazardous Substances**
Integrated Research on Hazardous Waste Chemical Mixtures	**Kenneth Reardon**	**Chem & Bioresource Engr**	**Superfund Hazardous Substances**
Bedload Transport Processes in Gravel-Bed Rivers	Steve Abt	Civil Engineering	USFS-Rocky Mtn. Rsrch Station
Integrated Model for Optimization of Water Allocations	Gustavo Diaz	Civil Engineering	USFS-Rocky Mtn. Rsrch Station -

Integrated Modeling & Assessment for Balancing Food Security, Conservation, & Ecosystem Integrity	**Michael Coughenour**	**Natural Resource Ecology Lab**	**University of California at Davis**
Integrated Natural Resources Management Plans & Wetlands Action Management Plans	**Robert Shaw**	**Forest Sciences**	**USFS-Rocky Mtn. Rsrch Station**
Sustainable Irrigation Development in Indonesia	Ramchand Oad	Chemical & Biores Engineering	CID-Consortium for Inter. Development

UNIVERSITY OF COLORADO, BOULDER, CO 80309

Title	PI	Department	Sponsor
Hydrology, Hydrochemical Modeling and Remote Sensing of Seasonally Snow-Covered Areas	**Mark Williams**	**Inst of Arctic & Alpine Res**	**Univ. of CA at Santa Barbara**
Brumate Formation and Control During Ozonation off Low Biomide Waters	**Gary Amy**	**Civil, Env. & Arch Engr**	**Montgomery Watson**
Determination of Atmospheric Water Characteristics Using Advanced Microwave Scanning Radiometer (AMSR)	Judith Curry	Guosheng Liu	Natl. Space Development of Japan
Stratified Coastal Trapped Waves and Mean Flows	**Daniel Ohlsen**	**Atmos. And Oceanic Sciences**	**NW Research Associates**
An Integrated Approach for Examining the Large-Scale Interactions Between the Atmosphere and Oceans on Intraseasonal Time Scales	Peter Webster	Atmos. And Oceanic Sciences	National Science Foundation
Atmospheric Frontal Dynamics	William Blumen	Atmos. And Oceanic Sciences	National Science Foundation
High Resolution UK37 Alkenone Paleo-thermometry at Bermuda Rise: The Last Interglacial to the Littlee Ice Age	Scott Lehman	Institute of Arctic and Alpine Res	National Science Foundation
Expanded and Lengthened Dedroclimatic Reconstructions of Great Plains Drought	**Connie Woodhouse**	**Inst of Arctic and Alpine Res**	**National Science Foundation**
Meltwater Flow Through Snow From Plot to Basin Scales	Mark Williams	Institute of Arctic and Alpine Res	National Science Foundation
Ice-Core Analysis and Physical Glaciology of the Galena Rock Glacier, Wyoming	Eric Steig	Institute of Arctic and Alpine Res	National Science Foundation
Isotopic Analyses on the NGRIP Deep Ice Core	James White	Institute of Arctic and Alpine Res	National Science Foundation
Oceanic and Atmospheric Processes in the Formation and Maintenance of the Cosmonaut Sea Deep-Water Polyn'Ya and Their Relationship to Antarctic Climate	**Amanda Lynch**	**Cooperative Inst. for Research in Environ Sciences**	**National Science Foundation**
Climate Sensitivity of Thaw Lake Systems on the Alaskan North Slope	Tingjun Zhang	Cooperative Inst. for Research in Environ Sciences	Natl Aeronautics & Space Admin.
Potential Effects of Global Climate Change on Western River Basins Study	Edith Zagona	Advanced Decision Support for Water & Environ. Systems	DOI-Bureau of Reclamation
Analysis of Nitrogen Losses in a Constructed Wetland	Lesley Smith	Cooperative Inst. For Research in Environ Sciences	U.S. Geological Survey
A Circulation Model of the Western Pacific Marginal Seas	Lakshmi Kantha	Aero-Colorado Center for Astrodynamic Research	Department of the Navy

UNIVERSITY WATER NEWS

IGWMC — We're Changing

Most of you are probably familiar with the International Ground Water Modeling Center (IGWMC), but for those of you who are not..IGWMC is a research center at Colorado School of Mines (CSM) with the mission of stimulating the correct and efficient use of ground-water models while training and facilitating interaction of ground-water professionals. IGWMC conducts activities related to modeling methodologies, software, and management including information dissemination through the World Wide Web, mail, workshops; development of educational materials and courses; research on modeling methodology and functionality; development and testing of software; distribution and support of software; and organization of conferences.

From the late '70s until the early '90s IGWMC was strongly supported by the U.S. Environmental Protection Agency. About three years ago, governmental changes caused considerable cutbacks in funding for environmental work, resulting in termination of EPA support for IGWMC. The loss of federal funds also caused a slowdown in the environmental industry, which reduced software sales and short course attendance for the center. The State of Colorado and the Colorado School of Mines have not, and will not subsidize the center. With the advent of these changes, it became apparent that the IGWMC had to become a self-supporting center by offering services of value to all ground-water professionals at cost-effective prices. Also, Paul van der Heijde, who served as director from 1981 through April 1997, decided that it was time to pursue independent consulting projects. CSM retained Paul in a research faculty position and asked us, Eileen Poeter and A. Keith Turner, to co-direct the IGWMC as of May 1, 1997.

Our challenge is to structure a self-supporting center that will be valuable to you into the next century. The center continues to operate under tight financial constraints. We are pleased that many groundwater professionals appreciate the center's function and want to see it continue into the future.

Eileen Poeter and A. Keith Turner

For help with ground-water problems IGWMC provides a telephone service to advise professionals on generic modeling questions and site specific applications. See the IGWMC web page at http://www.mines.edu/igwmc/. ***See the MEETINGS section of this newsletter for the IGWMC conference and short course schedules.***

CSU CHOSEN AS SITE FOR CONSOLIDATED FEDERAL RESEARCH CENTER

Colorado State University has been selected as the site for a $65 million federal research center specializing in natural resources. The center will employ more than 1,000 scientists, engineers and specialists. CSU students will work closely with the researchers in areas including forest management, water quality, wildlife biology and animal diseases.

For a decade, CSU had been competing with other sites in Fort Collins to be chosen as the spot where seven federal agencies — spread over 13 locations nationwide — would consolidate. On March 26 the General Services Administration chose the CSU site, which offered the lowest price per square foot.

The center will be built on 30 acres on CSU's south campus, next to the veterinary teaching hospital. Five buildings are planned, with each costing $12 million to $15 million, according to Jud Harper, CSU's Vice President for Research and Information Technology. Major partners in the center include the U.S. Geological Survey, the Forest Service, the Natural Resources Conservation Service, the National Information Technology Center, the Agricultural Research Service, and the Animal and Plant Health Inspection Service.

Rocky Mountain News 3/28/98

NEW FACULTY IN WATER

Yaling Qian
Department of Horticulture and Landscape Architecture
Colorado State University

Yaling Qian is a new faculty member in the Department of Horticulture and Landscape Architecture at Colorado State University. Dr. Qian received her M.S. in Botany from Nanjing Agricultural University and her Ph.D in Horticulture from Kansas State University.

From 1996- 1997, she was an Assistant Research Scientist in the Dallas Research and Extension Center at Texas A&M University. For the past 5 years, she investigated turfgrass water use, irrigation management and mechanisms of turfgrass drought resistance.

Dr. Qian's areas of specialty include turfgrass-water relations, turfgrass stress physiology, minimum water requirements, and quality of irrigation water. She is currently establishing research projects related to environmental stress physiology of turfgrass, including selecting turfgrass which have the capacity to cope with salinity and drought conditions and developing approached to modify turfgrass's response to environments.

Dr. Qian teaches Turfgrass Science, a course that focuses on the turfgrass species and cultivar selection, addresses environment stresses that affect turfgrass growth, and discusses the cultural practices that can be employed to minimize damage from environmental stresses.

UNIVERSITY OF COLORADO WATER COURSES, 1997/98

The following courses offered through The University of Colorado at Boulder (at the senior level and above) are particularly relevant to water (e.g., water quantity, water quality, and the causes and management of both).

The following course letters refer to the department or college in which the course is taught:

ASEN	Aerospace Engineering Sciences
CVEN	Civil, Environmental, & Architectural Engineering
ECON	Economics
EPOB	Environmental, Population, & Organismic Biology
GEOG	Geography
GEOL	Geological Sciences
LAWS	School of Law

www.colorado.edu/geography/

COURSE	TITLE

Climatological Processes

GEOG 4211	Physical Climatology - Principles
GEOG 4221	Physical Climatology - Applied
GEOG 4331/5331	Mountain Climatology
GEOG 5951	Climatic Change Seminar

Economics

ECON 6535	Natural Resource and Environmental Economics
ECON 6555	Water Resources Development and Management
ECON 8535	Natural Resources Seminar
ECON 8545	Environmental Resources Seminar
ECON 8555	Water Resources Development & Management Seminar
ECON 6070	Applied Micro-Economic Theory

Groundwater

CVEN 4343	Groundwater Engineering
CVEN 5353	Groundwater Hydrology
GEOL 3030	Introduction to Hydrogeology
GEOL 5080	Advanced Hydrogeology and Modeling Concepts
GEOL 5280	Principles of Aqueous Geochemistry
GEOL 5300	Low-Temperature Geochemistry

Hydraulics

ASEN 4317	Computational Fluid Mechanics
ASEN 4517	Small Scale Processes in Geophysical Flows
ASEN 5011	Ideal Fluids
ASEN 5021	Viscous Flow

ASEN 5037	Turbulent Flow
ASEN 5051	Macroscopic Physics of Fluids
ASEN 5061	Microscopic Physics of Fluids
ASEN 5091	Quantum Fluid Dynamics
ASEN 5317	Computational Fluid Mechanics
ASEN 5327	Advanced Computational Fluid Mechanics
CVEN 3313	Theoretical Fluid Mechanics
CVEN 3323	Hydraulic Engineering
CVEN 4343/5343	Open Channel Hydraulics
CVEN 5363	Modeling of Hydrologic Systems
CVEN 5748	Design of Earth Structures
CVEN 7353	Hydraulic Design

Hydrology

CVEN 4333/5333	Engineering Hydrology
GEOL 4980/5980	River Basin Hydrology

Irrigation and Drainage

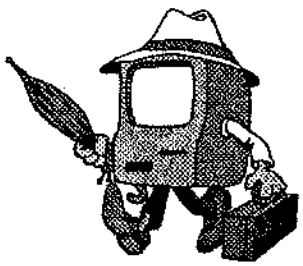
GEOL 5440	Morphology and Genesis of Soils

Law, Policy, History, Sociology

CVEN 5373	Water Law, Policy and Institutions
GEOG 6402	Comparative Environmental Studies Seminar
LAWS 6002	Public Land Law
LAWS 6302	Water Resources
LAWS 7154	Land Use Planning
LAWS 7202	Pollution Law
LAWS 7209	Natural Resources Litigation Clinic
LAWS 7307	Taxation of Natural Resources
LAWS 7402	Toxic and Hazardous Wastes
LAWS 7702	Conservation Philosophy and the Law
LAWS 8012	Public Land Law and Policy Seminar
LAWS 8302	Advanced Problems in Water Resource Management

Management and Planning

CVEN 5393	Seminar in Water Resources Development and Management
CVEN 5444	Municipal Design Project
CVEN 5367	Urban Problems
GEOG 4430	Conservation Trends: Urban Water
GEOG 4501/5501	Water Resources and Water Management of Western U.S.



Models/Computer Data Management/GIS

CVEN 5363	Modeling of Hydrologic Systems
CVEN 5454	Quantitative Methods
CVEN 5537	Numerical Methods

Oceans

ASEN 4125/5125	Physical Oceanography
ASEN 4215	Oceanography
ASEN 4519	Ocean Modeling

Sediment Transport

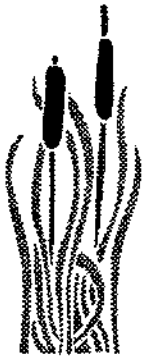
GEOG 4241	Principles of Geomorphology

Snow Hydrology/Glaciers

GEOG 4321/5321	Snow Hydrology
GEOG 5411	Topics in Snow and Ice
GEOL 4640/5640	Glaciology
GEOL 4360/5360	Glacial Geology

Stream and Riparian Zone Biology/Wetlands'

EPOB 4030/5030	Limnology
EPOB 4180	Ecological Perspectives on Global Change
EPOB 4380/5380	Respiratory Adaptations to the Environment
EPOB 4630/5630	Field Techniques in Environmental Science



Water Quality Management/Monitoring

CVEN 3454	Water Quality Laboratory
CVEN 5494	Environmental Pollutants

Water and Wastewater Treatment/Environmental Engineering

CVEN 3424	Water and Wastewater Treatment
CVEN 5414	Pilot Plant Laboratory
CVEN 5524	Advanced Wastewater Treatment
CVEN 5404	Environmental Engineering Chem
CVEN 4424/5424	Municipal and Sanitary Design
CVEN 4474	Hazardous and Industrial Waste Management
CVEN 5474	Hazardous and Industrial Waste Management

MEETING BRIEFS

HYDROLOGY DAYS 1998 — CELEBRATING ADVANCEMENTS IN THE SCIENCE OF HYDROLOGY

Hydrology Days is an annual forum for hydrologists and hydrology students to get acquainted and to share problems, analyses and solutions. The 1998 Hydrology Days was held on the campus of Colorado State University March 30- April 3, 1998. The blend of student and professional presentations and posters created an outstanding environment for students to meet professionals and for professionals to assist budding hydrologists. The exchange of insights into hydrological concepts, history and emerging developments stimulates all who attend the annual forum.

Hydrology Days 1998 was dedicated to individuals who were pioneers in the development of numerical techniques for ground-water modeling. Richard L. Cooley, Leonard F. Konikow, George F. Pinder, Thomas A. Prickett, and Robert A. Longenbaugh presented excellent overviews of developments in ground-water modeling over the past 40 years and were recognized for their contributions during the meeting. The historical overview was priceless for the students (and professionals) in the audience.

Bill Horak, Colorado District Chief for the U.S. Geological Survey, provided a sneak preview of the strategic plan for the U.S. Geological Survey's Water Resources Division during the luncheon on March 31, 1998. Chips Barry, Manager of Denver Water, provided a thought-provoking view of hydrologic modeling during the time of El Nino on April 1, 1998. Chips' talk is presented on page 22.

Winners of the student prizes for best oral presentations were John Pasch, Colorado State University, in the M.S. category and Mohammed Lahkim, Colorado State University, in the Ph.D category. Winners of the best poster presentations were Camille McEachern, University of Colorado, in the M.S. category and Tarek Saba, University of Colorado, in the Ph.D category.

Plans are already underway for the 1999 Hydrology Days. As these plans firm up, they will be announced in *COLORADO WATER*.

Hubert J. Morel-Seytoux, Professor Emeritus of Civil Engineering at Colorado State University, has been the driving force behind Hydrology Days since its initiation in 1980. For more information about Hydrology Days, contact Dr. Morel-Seytoux at E-mail address morelsey@usgs.gov, or Phone and FAX 650/365-4080.

Pictures on next page from left, clockwise:

Lory Student Center, Colorado State University, site of Hydrology Days 1998.

Steven Malers, Riverside Technology, with William F. Horak, Jr., Region VIII District Chief, U.S. Geological Survey, and Nolan Doesken, Assistant State Climatologist, Colorado Climate Center, Colorado State University.

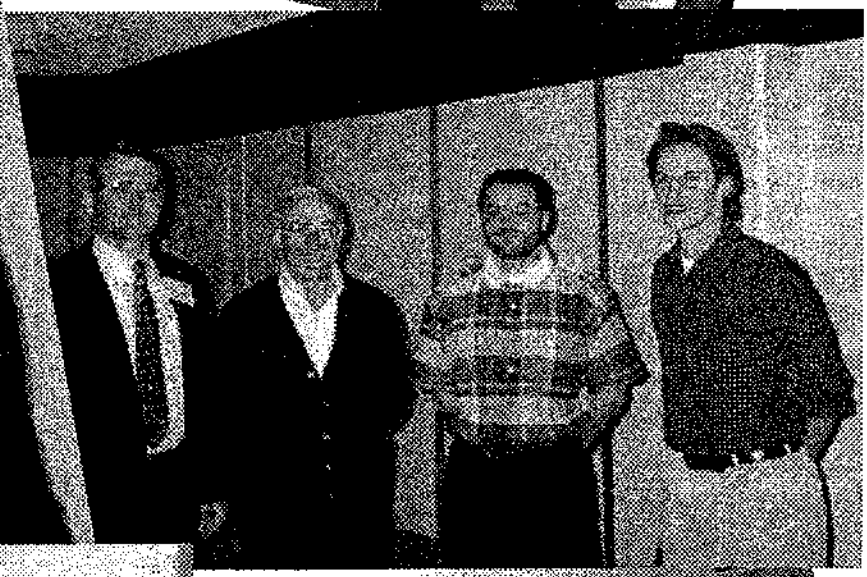
William F. Horak, Jr. and H.J. Morel-Seytoux pose with award winners Mohammed Lahkim, and John R. Pasch.

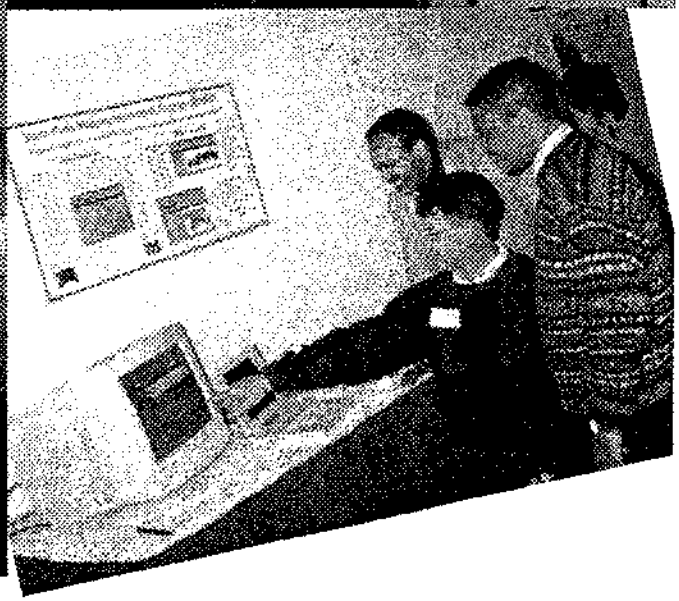
Hydrology Days attendees at the South Platte Mapping and Analysis Program (SPMAP) Demonstration presented by Brad Wind, Northern Colorado Water Conservancy District.

H.J. Morel-Seytoux with honorees Robert Longenbaugh, member of CSU's groundwater faculty from 1961 to 1980 until becoming Assistant State Engineer; Thomas A. Prickett, one of the earliest pioneers of numerical groundwater modeling in the real world; George F. Pinder, with the USGS from 1968 to 1972 and winner of 1969 Horton and 1975 Meinzer awards (with Dr. John D. Bredelhoeft); Leonard F. Konikow, instrumental in developing and documentingUSGS transport models and who applied the first transport model to the Rocky Mountain Arsenal; and Richard L. Cooley, with the USGS since 1975 whose contributions included groundwater flow modeling codes, numerical solutions for unsaturated flow and water table problems and parameter estimation and uncertainty analysis methods for groundwater models.

Honorees not pictured: John D. Bredehoeft, with the USGS from 1962-1994, called the "father" of modern groundwater modeling with applications; and Dr. Morton W. Bittinger, in charge of groundwater research at CSU from 1957-1966 and coauthor of the first publication to apply finite differences to groundwater modeling.

Hamlet J. "Chips" Barry, Manager, Denver Water





FEATURES

HYDROLOGY IN THE TIME OF EL NIÑO – A FOOL'S ERRAND?

by Chips Barry, Manager, Denver Water
Presented at Hydrology Days, Colorado State University, April 1, 1998

I have carefully reviewed the entire three-day Hydrology Days program in an effort to find clues as to the proper topic for lunch-time digestion today. Based on my review of this program, and on my own extensive experience as a trial lawyer and research hydrologist, it is clear that my topic for the day should be "Optimizing Variable Density Upscale Flows in Stochastic Virus Transport Models in the CSU Library flood of 1997." That title sounds pretty good, and I am ready to wager that if you couldn't see the twinkle in my eye, I could get it published.

Actually, as you have no doubt concluded by now, I'm a hydrology, science and computer moron. The titles of many of these papers elude me completely. Thus, it is only fitting that I should be the Manager of one of the largest and most sophisticated water systems in the entire country. It is no wonder that the employees hold their breath every time I get up to speak. I am as illiterate about computers as I am about hydrology.

Only now, by attending conferences such as this, am I learning the current language of research, hydrology and computers. I now know that beepilepsy is a disease that affects those with vibrating pagers, and it is characterized by sudden spasms, goofy facial expressions, loss of speech, involuntary muscle coordination and stopping of speech in mid-sentence. I now know that a "square-headed girlfriend" is your computer, and that "SITCOM" stands for single income, two children, oppressive mortgage. I now know that a "mouse potato" is the on-line generation's answer to a couch potato, and that the most knowledgeable, technically proficient person in my computer work group is known as the "alpha geek."

Actually, there is something to be said for the new vocabulary. It beats some of the old. For example, on the way up from Denver this morning, I went through a Burger King parking lot that had a particularly noteworthy sign: "Parking for Drive Thru Customers Only."

The alleged topic of this talk, "Hydrology in the Time of El Niño," is not actually meant as a joke. But the problems are not so much with El Niño as a scientific occurrence, as they are with the politics that surrounds hydrology and many areas of science today. In hydrologic terms, hydrology is becoming a tributary of politics. To me at least, politicizing something means using an otherwise non-controversial event or occurrence to further a political agenda. I see that occurring in many areas, and I am distressed by it.

There are plenty of examples in our recent history to illustrate this point. Birth and death are no longer simply natural occurrences. Dr. Kevorkian has politicized death, and the abortion and anti-abortion forces continually challenge each other on the rapidly developing politics of birth and abortion. Genetic research is no longer driven completely by science, because the cloning of Dolly now means that many politicians find it necessary to posture on the ethics, economics or demographics of cloning and genetic engineering. The previously clean line between science and politics has been blurred. For years, hydrology has simply means the scientific study of the flow and distribution of water. However, I now see some evidence that hydrology is becoming a branch of politics.

> ***. . . the problems are not so much with El Niño as a scientific occurrence, as they are with the politics that surrounds hydrology and many areas of science today. In hydrologic terms, hydrology is becoming a tributary of politics.***

Let me illustrate this point.

There is certainly ample evidence that both El Niño and global warming are fact. Clearly both have a dramatic short-term and long-term effect on climate, rainfall and fresh-water distribution. Although I have not surveyed much of the scientific literature, I believe it is unclear at this point as to whether there is a connection between the two. Does global warming cause El Niño? Does El Niño exacerbate global warming? I'm not sure we know the answer. But many think they know and see their political opportunity in advocacy of their answer.

There is also evidence to support the fact that both global warming and El Niño have occurred throughout history. A recent article ascribed mid-18th century crop failures and the plagues of the middle ages to past El Niños. Obviously ice ages of the past were followed by a period of global warming. The point is that both global warming and El Niño have occurred in the past. The critical question now is whether human activity is making El Niño and/or global warming worse. There are many who now believe that mankind is wholly or partially responsible for these events. To the extent that this allegation is believed (whether scientifically proven or not), we have succeeded in making hydrology a political issue. Let me repeat: If the world believes that human activity causes El Niño, with subsequent weather dislocations, storms, floods, mudslides and droughts, and that human activity drives significant increases in the rate of global warming, then the efforts to alter human behavior in response to this occurrence will, without question, result in political pressure on the field of hydrology.

El Niño and global warming have made apparent what is coming in any event -- the age of the innocent hydrologist is over. As we grapple with difficult questions of economics, development, demography and climate change, hydrology becomes just one more arrow in the quiver of someone with an agenda.

Presumably there was a time when hydrology was "pure science" — when no political judgments were involved in determining how much water was flowing, how much groundwater was in reserve, or what the relationship is between the two. However, if politicians now believe they must have a stake in altering human behavior because of their concerns about weather, climate, El Niño and global warming, the questions about water availability, water flow, stream flows, groundwater, etc. will be manipulated and used to serve an agenda that is either directed at limiting human activity or an agenda that is directed at allowing it to continue relatively unfettered. In this setting, hydrologic data is no longer neutral; it becomes a weapon for use by one side or another in the battle over the extent of allowable human activity. As an example, on the Yangtse River in China, flood events were overemphasized and exaggerated in order to gain support for Three Gorges Dam, which will control floods.

While I have described a theoretical and non-specific problem, I can begin to see its implication within the universe inhabited by the Denver water system. One of the questions now confronting Denver is the extent of flow required in the Upper Colorado River to preserve and/or recover four endangered species of fish. In the ideal world, the answers to this question would be difficult, but wholly based in science. Unfortunately, I find this no longer to be the case. The question of how much flow is needed in the so-called 15-mile reach of the Colorado River has become a political question. Because additional volumes of flow in the 15-mile reach will limit East Slope diversions and thus East Slope development, the questions are politically charged, and of significant economic importance. Similar issues exist on the South and North Platte Rivers through Colorado, Wyoming and Nebraska. The conclusions about how much water is in the river and how much water should be in the river are coming to depend more upon your belief about agriculture, development and water diversion than about hydrologic data.

I don't know that I am right about the politicizing of hydrology, and even if I am, I am not certain as to the implications. You all know that we have now reached the point where contending sides hire their own psychologists, accountants and doctors, each of whom is expected to present testimony or report supporting the view of whomever paid the expert. I don't look forward to the day when we also have "forensic hydrology" and each side in an important water dispute hires a hydrologist who will be expected to present a particular point of view which furthers the political agenda of the proponent.

Yet, that may be where we are going. If I have any message to this group of scientists and hydrologists, it is that you should be aware of, and careful about, the uses to which your work will be put. Do not be surprised if a nice, tight piece of scientific study of stochastic flow in the tributary alluvium of the South Platte River emerges as a newspaper headline signaling the death knell of irrigated agriculture on the High Plains.

El Niño and global warming have made apparent what is coming in any event — the age of the innocent hydrologist is over. As we grapple with difficult questions of economics, development, demography and climate change, hydrology becomes just one more arrow in the quiver of someone with an agenda.

THE CLEAN WATER ACTION PLAN

by Lloyd Walker

The Clean Water Action Plan is the Clinton Administration's vision for restoring and protecting America's waters. The plan was developed by a multi-agency federal task force in response to guidance provided by Vice President Gore. The impetus for the Plan is the unfinished business of reducing water pollution and restoring America's rivers, lakes and coastal waters. The Plan seeks to strengthen existing programs and embark on a new watershed-based approach to addressing issues.

One reason for the watershed approach is the predominant feature of the remaining water quality problem, i.e., polluted runoff. Polluted runoff is diffuse and site specific and includes contributions from agricultural lands, urban landscapes and forestlands. A watershed approach seeks to collectively address water quality problems from all sources through partnership of all watershed stakeholders. Such a partnership would be asked to assess the watershed's problems and develop a watershed restoration action strategy. Funding provided by the Clean Water Action Plan budget would then be used to implement these strategies.

The other aspect of the Clean Water Action Plan is to strengthen core clean water programs. The goals of this part of the Plan include:

- protecting public health;
- enhancing stewardship of natural resources;
- strengthening polluted runoff standards and controls, and
- improving information and citizen's right to know.

To protect public health, the Plan proposes actions to:

- improve assurance that fish and shellfish are safe to eat;
- ensure beaches are safe for swimming;
- ensure water is safe to drink; and
- reduce exposure to endocrine disrupting pollutants.

To enhance natural resources stewardship, the Plan proposes actions to 1) address stewardship of federal lands and resources; 2) restore and protect America's wetlands; 3) protect coastal waters; and 4) provide incentives for private land stewardship.

To strengthen polluted runoff standards and controls, the Plan proposes actions to:

- strengthen state and tribal polluted runoff programs;
- reduce nutrient over-enrichment;
- expand Clean Water Act permit controls; and
- eevelop incentives for reducing polluted runoff.

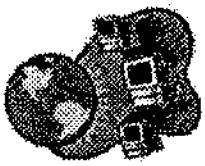
To improve information and citizens' right to know, the Plan proposes actions to 1) improve monitoring and assessment and 2) provide easier access to information sources.

The funding requested by the Clean Water Action Plan reflects the nonpoint source nature of water quality problems today. About 70 percent of the land in the continental United States is held in private ownership. Most of this land is held by agricultural producers. Precipitation on private land has the potential to created polluted runoff. Hence a significant part of the budget request would address curbing potential pollute runoff from these lands (FY 99 budget requests $200 million for Section 319 grants administered by EPA, $300 million for the Environmental Quality and Incentive Program [EQIP] administered by USDA-NRCS, $42 million for wetland restoration administered by US Fish and Wildlife Service, and $117 million for the wetlands program administered by the Army Corps of Engineers).

The federal government is also a significant landowner. In order to meet its natural resource stewardship responsibilities, the FY 99 budget requests $308 million to address water quality problems on forestlands by USDA Forest Service, $157 million to address Bureau of Land Management (BLM) lands.

The FY 99 budget represents an increase of $568 million of FY 98 spending. The total spending projection for the four-year life of the Clean Water Action Plan would be $10.5 billion. In this way, the administration is showing its commitment to water quality issues. However, as with any proposed administration plan, the Congress will have to debate it and decide on an appropriate budget. That debate is just beginning.

For more information on the Clean Water Action Plan, visit the Environmental Protection Agency website at www.epa.gov/cleanwater/action/overview.htm.



WWW WATER PATHS

Description	Website
Eco I.Q. provides internet publications, professional development resources, and consulting and client services designed to help communities and their local governments become more environmentally, economically, and socially sustainable. To accomplish this, EcoI.Q. focuses on helping programs and professionals -- in resource management, environmental management, and land use and transportation planning -- become more effective.	http://www.ecoiq.com/entry-hm -sections/hm_ecoiq.html
Eco I.Q. Water – This anthology includes 26 articles, essays, and longer documents on water.	http://www.ecoiq.com/electronicanthol/anth-10.html
Alternative Wastewater Treatment: Advanced Integrated Pond Systems-Shows how a new wastewater treatment technology may offer a solution for communities beset by intensifying cost constraints and water quality regulations.	http://www.eren.doe.gov/cities_counties/wastewt.html
Cities Cut Water System Energy Costs- Explains that by using Supervisory Control and Data Acquisition (SCADA) systems, cities can slash water utility energy costs.	http://www.eren.doe.gov/cities_counties/watersy.html
The Emerging Demand-Side Era in Water Management	http://www.sustainable.doe.gov/articles/emerging.htm
Sharing Colorado River Water: History, Public Policy and the Colorado River Impact	http://ag.arizona.edu/AZWATER/arroyo/101comm.html
Constructed Wetlands: Using Human Ingenuity, Natural Processes to Treat Water, Build Habitat	http://ag.arizona.edu/AZWATER/arroyo/094wet.html
Saving Endangered Species Poses Water Policy Challenge	http://ag.arizona.edu/AZWATER/arroyo/093save.html
Consumers Increasingly Use Bottled Water, Home Water Treatment Systems to Avoid Direct Tap Water	http://ag.arizona.edu/AZWATER/arroyo/081botle.html
Managing the Interconnecting Waters: The Groundwater-Surface Water Dilemma	http://ag.arizona.edu/AZWATER/arroyo/081con.html
Fountains—Water Wasters of Works of Art?	http://ag.arizona.edu/AZWATER/arroyo/073fount.html
Home Use of Graywater, Rainwater Conserves Water—and May Save Money	http://ag.arizona.edu/AZWATER/arroyo/071rain.html
Decision Variables, Standards, and Water Quality Models: Improving the Usefulness of Predictive Science	http://www2.ncsu.edu/ncsu/CIL/WRRI/news/jf98dirfor.html
Integrated Resources Mapping	http://h2o.ehnr.state.nc.us/wswp/SL/v2n5.html
Development and Evaluation of Analytical Procedures for Broad Spectrum Analysis of Synthetic Organic Chemicals in Source and Finished Drinking Waters	http://www2.ncsu.edu/ncsu/wrri/reports/report234.html
Identification of Mutagenic By-Products from Aquatic Humic Chlorination	http://www2.ncsu.edu/ncsu/wrri/reports/christ.html
Managing Public Water Supplies During Droughts: Experiences in the United States in 1986 and 1988	http://www2.ncsu.edu/ncsu/CIL/WRRI/reports/250.html
A History of Altering Wetlands	http://www.ianr.unl.edu/ianr/waterctr/wtlnd-29.html
The Dynamics of Wetlands	http://www.ianr.unl.edu/ianr/waterctr/wtlnd-26.html
What Is...Reverse Osmosis	http://www.wqa.org/Technical/What-is-RO.html
Treating The Water We Drink, When and Where We Drink It	http://www.wqa.org/Technical/Treating-the-Water.html
Aesthetic Water Quality Problems	http://www.wqa.org/Technical/Aesthetic-Problems.html
Improving the Quality of Water Through Disinfection	http://www.wqa.org/Technical/Improving-Water-Through-Disinfection.html
Nitrate Awareness: A Health Issue	http://www.wqa.org/Technical/Nitrate-Awareness.html
Radon: The Invisible Health Risk	http://www.wqa.org/Technical/Radon.html
Reducing Lead Levels in Drinking Water	http://www.wqa.org/Technical/Reducing-Lead.html

The Texas Water Resources Institute (TWRI) has created a World Wide Web site with extensive information about the onsite wastewater systems in Texas. In addition to a searchable subject index of 42 topics, the site also contains text, photos, and graphics from all 27 issues of the quarterly Texas On-Site Insights newsletter. The newsletter focuses on research in Texas pertinent to onsite wastewater, case studies of regional problems, innovative solutions, and meeting and publication announcements. A search engine, other site links, a form for e-mail feedback, and usage statistics are available. TWRI also operates and electronic mail list server, "TWRI WaterTalk." The site was funded by grants from the Texas On-Site Wastewater Treatment Research Council, a state agency that receives $10 for research, education, and training whenever an onsite wastewater system is installed in Texas.	http://www.towtrc.tamu.edu.
The League of Women Voters (LWV) Education Foundation has developed two new tools to help you with local drinking water protection. **The Tools For Drinking Water Protection** contains the new LWV WaterWEB, an Internet directory of people all over the United States working on local water issues.	http://www.lwv.org/drinkingwater/

PUBLICATIONS

COLORADO RIVER COMPACT SYMPOSIUM PROCEEDINGS PUBLISHED

The published proceedings from "Using History to Understand Current Water Problems," 75th anniversary Colorado River Compact Symposium, is available from the Water Education Foundation. The symposium was part of the Foundation's ongoing series of public education programs on Colorado River issues. Invited water leaders from the seven Colorado River states, environmental organizations and American Indian tribes gathered last May in Santa Fe, New Mexico, to commemorate the 75th anniversary of the 1922 signing of the Compact. The 204-page book contains a complete transcript of the symposium, with presentations by state water department heads on each state's historical perspective of the Colorado River Compact in 1922, and what they might do differently if they could roll back the years. For information contact the Water Education Foundation, 717 K St., Ste 517, Sacramento, CA 95814; 916/444-6240; FAX 916/448-7699.

U.S. Geological Survey Publications

Contact the U.S. Geological Survey, Earth Science Information Center, Open-File Reports Section, Box 25286, Mail Stop 517, Denver Federal Center, Denver, CO 80225 or call 303/236-7476 unless another source is provided

NOTE: In 1991, the U.S. Congress appropriated funds for the U.S. Geological Survey (USGS) to begin the National Water-Quality Assessment 9NAWQA) Program to help meet the continuing need for sound, scientific information on the real extent of water-quality problems, how these problems are changing with time, and an understanding of the effects of human actions and natural factors on water quality conditions.

The NAWQA Program is assessing the water-quality conditions of more than 50 of the Nation's largest river basins and aquifers, known as Study Units. Collectively, these Study Units cover about one-half of the United States and include sources of drinking water used by about 70 percent of the U.S. population.

The reports below are intended to summarize major findings that emerged from the water quality assessments of the Study Units and to relate these findings to water-quality issues of regional and national concern.

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Analysis of Ground-Water-Quality Data of the Upper Colorado River Basin, Water Years 1972-92, by Lori E. Apodaca. Water Resources Investigations Report 97-4240. 1998.

Water-Quality Assessment of the Arkansas River Basin, Southeastern Colorado, 1990-93, by Roderick F. Ortiz, Michael E. Lewis, and Mary Jo Radell. Water Resources Investigations Report 97-4111. 1998.

Water Quality in the Rio Grande Valley, Colorado, New Mexico and Texas, 1992-95, by Gary W. Levings, Denis F. Healy, Steven F. Richey, and Lisa F. Carter. U.S. Geological Survey Circular 1162.

Water-Quality Assessment of the Rio Grande Valley, Colorado, New Mexico, and Texas — Summary and Analysis of Water-Quality Data for the Basic-Fixed-Site Network, 1993-95, by Denis F. Healy. Water Resources Investigations Report 97-4212. 1997.

Shallow Ground-Water Quality of Selected Land-Use/Aquifer Settings in the South Platte River Basin, Colorado and Nebraska, 1993-95, by Breton W. Bruce and Peter B. McMahon. Water Resources Investigations Report 97-4229. 1998.

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Descriptions of the Program Changes (1987-97) and a User Manual for a Transit-Loss Accounting Program Applied to Fountain Creek Between Colorado Springs and the Arkansas River, Colorado, by Gerhard Kuhn, E.L. Samuels, W.D. Bemis, and R.D. Steger. Open File Report 97-637. Prepared in cooperation with the City of Colorado Springs, Department of Public Utilities, and the Southeastern Colorado Water Conservancy District. 1998.

WATER SUPPLY

Water supplies continue to be acceptable across the state with this spring's runoff and summer supplies looking like they will be normal or better at this point. May 1 snowpack is 106% of average statewide. Reservoir storage is generous with nearly all reservoirs full or expecting to fill. Streamflows are near normal levels.

The Surface Water Supply Index (SWSI) developed by the State Engineer's Office and the U.S.D.A. Natural Resources Conservation Service is used as an indicator of mountain-based water supply conditions in the major river basins of the state. It is based on stream flow, reservoir storage, and precipitation for the winter period (November through April). During the summer period stream flow is the primary component in all basins except the South Platte basin where reservoir storage is given the most weight. The following SWSI values were computed for each of the seven major basins for May 1, 1998 and reflect conditions during the month of April.

Basin	Mar. 1, 1998 SWSI Value	Change From Previous Mo.	Change From Previous Year
South Platte	2.2	+0.1	-1.0
Arkansas	0.1	-1.0	-3.1
Rio Grande	1.7	+1.2	-1.1
Gunnison	2.0	+0.8	-1.3
Colorado	0.1	+1.5	-3.2
Yampa/White	-1.6	-0.8	-4.9
San Juan/Dolores	0.1	+0.6	-2.5

SCALE

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

EDITOR'S IN-BOX

UPDATE ON THE COLORADO RIVER DECISION SUPPORT SYSTEM

The following update is abstracted from a memo received from the Department of Natural Resources-Colorado Water Conservation Board-Division of Water Resources dated April 1, 1998.

Colorado Water Right Administration Tool (CWRAT)
The Colorado Water Right Administration Tool is approximately 80 percent complete. A final is expected for release in May, 1998. Key deliverables include:

♦ Real time streamflow — presentations are available for all gages in the state's satellite monitoring program in both graphical and tabular format.

♦ Data Viewer — allows users to view nearly all of the information contained in the state's database (HydroBase) including water rights, diversions, streamflow, temperature, precipitation, etc.

♦ Water Information Sheet — Real time river administration that uses streamflow observations and gain/loss calculations to assist with daily river administration (diversions and reservoir operations) and record management.

♦ Special Projects — A mechanism to incorporate special, user-defined spreadsheets into the central database and Water Information Sheets.

♦ Database Synchronization — An automated procedure that ensures the information that resides on the central (Denver-based) database is the same as the information that resides on a local PC. Database synchronization is well suited for water commissioners and others who desire a local copy of selected information (e.g., all data for a water district or monthly data for a division) or do not have access to a high-speed connection.

♦ Daily StateMod Operation — To allow a call curtailment analysis to be performed and promote consistency between administration and planning activities of the state, the Water Resource Planning Model, StateMod, has been enhanced to operate on a daily time step. For additional information about the model's development and capability see the CRDSS web site crdss@state.co.us.

Database and Data Sharing
The CRDSS relational database conversion from Unix to Windows NT, that provides PC compatibility, is approximately 90 percent complete.

CRDSS data sharing issues are being investigated by the Attorney General's office. Current state thinking is that all CRDSS produces (except the proprietary Big River Model - RiverWare) will remain free in the foreseeable future. Access will be provided via the CRDSS FTP site, which is expected to be completed in May, 1998.

Water Resource Planning Model
Phase IIIa of the Water Resource Planning models, that allows 100 percent of a basin's CU to be included, have been calibrated for all basins on the western slope (Colorado, Gunnison, Yampa, White and San Juan). Models, data and documentation will be available on the FTP site in May, 1998.

Division 5 Worksheet
The Division 5 Worksheet, which will enhance and replace the Colorado River Accounting spreadsheet historically maintained by the USBR, is approximately 75 percent complete. Enhancements include new stream gages, new reservoirs, and new accounting procedures. An Excel application, the worksheet will provide 7 easy-to-use tabbed workbooks.

Study Period Extension and Stochastic Data Development
A study completed in January 1998 has concluded it is feasible to extend the available study period (1975 to 1991) back to the early 1900s and to develop stochastic data. The stochastic model developed by the USBR and CSU Professor Jose Salas et al, 1996, named SAMS, has been selected for application following the historic data extension. Both the historic data extension and stochastic model development are expected to be completed by June 1999.

Consumptive Use Model
Activities have been initiated to port the CRDSS Consumptive Use Model, StateCU, to a PC.

LEGISLATURE APPROVES RIO GRANDE DSS

The Colorado Legislature has authorized the Colorado Water Conservation Board "...to initiate design of a decision support system for the Rio Grande basin including data collection and development of the necessary data and databases, models, and user tools and to acquire, operate, and maintain the associated computer hardware and software." (H.B. 98-1189). The authorization also includes $2 million to retain a contractor to manage the design of the Rio Grande compact decision support system. A contractor is expected to be selected through a competitive bidding process and development activities initiated sometime after July 1, 1998. For additional information, contact Ray Bennett, CRDSS Project Manager, at 303/866-3585 x263 or E-mail ray.bennett@state.co.us.

WATER NEWS DIGEST

by Maile Ceridon and Jacklyn Bryant

ENDANGERED SPECIES

Two of the four endangered fish in the Upper Colorado River Basin — the Colorado squawfish and the humpback chub — are doing well enough to be downlisted from endangered to threatened, say state wildlife officials. But federal fish managers are reluctant to make a similar move, saying any change in state listing will not affect the federal listing. They want to look at the status and distribution of the fish throughout the region, including Colorado, Utah, New Mexico and Wyoming. Meanwhile, several environmental groups have petitioned the U.S. Fish and Wildlife Service to add three cutthroat trout subspecies to the list of threatened or endangered species. The Biodiversity Legal Foundation, American Wildlands and the Southwest Center for Biodiversity are seeking federal protection for the Bonneville (found in ID, UT and WY), West Slope (found in MT, WY and ID) and Rio Grande cutthroat (found in CO and NM).

Grand Junction Daily Sentinel 3/13/98, *Fort Collins Coloradoan* (Associated Press) 5/11/98

ENVIRONMENT

Upper Purgatoire Watershed Project Receives GOCO Funds
Great Outdoors Colorado will provide $500,000 of lottery funds toward the Division of Wildlife's $9.5 million purchase of a 30,000-acre future wildlife area west of Trinidad. The Upper Purgatoire Watershed project was authorized during the recent legislative session. GoCo's board awarded an additional $2.9 million to the DOW to work out additional land purchases in the lower part of the Purgatoire Basin. The project is considered one of the last opportunities to protect public access to recreation in Las Animas County, said to be 85 percent under private property ownership.

Pueblo Chieftain 5/26/98

WATER LEASING

Colorado River Water Conservation District to Lease Water
The Colorado River Water Conservation District has two buyers for Wolford Mountain water, each seeking a 40-year lease. The district can lease up to 10,000 acre-feet of water a year, and the current price is $105 to $155 an acre-foot per year. The district could earn $1 million to $1.5 million a year once the water is fully leased. In addition, the Denver Water Board owes the district $33 million for its share of Wolford water. District manager Eric Kuhn said Denver officials are considering retiring the 25-year payment soon in a debt consolidation move. If that occurs, Kuhn said the district would pay off its $15.5 million construction loan from the Colorado Water Conservation Board. Kuhn said profits from Denver and water leasing would be used to develop other water projects in western Colorado. One such deal is nearing completion. The Eagle Park Reservoir was created by Cyprus Climax Co. from an old tailings pond at the company's molybdenum mine between Leadville and Copper Mountain. A consortium of users including Vail Assoc., Eagle County water suppliers and the river district expect to close on the $12 million purchase this summer, once the new reservoir fills and tests clean. Consulting engineers expect the water from Eagle Park Reservoir to sell for $420 to $610 an acre-foot per year.

Grand Junction Daily Sentinel 4/24/98

WATER QUALITY

American Rivers Announces Most Endangered Rivers of 1998
American Rivers has announced its list of most endangered rivers in the country. The top ten most endangered rivers are:

Hanford Reach of the Columbia (Washington State) — Threat: Ag development, public land transfer, nuclear waste contamination
Missouri River — Threat: Dams, channelization
Pocomoke River (Maryland) — Threat: Factory poultry farms
Kern River (California) — Threat: Small hydropower dams
Blackfoot River (Montana) — Threat: Gold mine
Colorado River Delta (Mexico: Baja California, Sonora) — Threat: Overuse of water
Chattahoochee River (Georgia, AL, FL) — Threat: Development, polluted runoff, sewage overflows, competition for water supply
Lower Snake River (Washington) — Threat: Dams
Apple River (Wisconsin) — Threat: Factory hog farms
Pinto Creek (Arizona) — Copper mine

AR Says Fastest-Growing Threat to Rivers is Waste Produced by Hog/Chicken Farms
Among the fastest growing, most devastating threat to rivers, according to American Rivers' 13th annual report, is the vast amount of waste produced by factory hog and chicken farms springing up across the country.

Colorado Legislature Fails to Pass Hog Farm Bill

Colorado lawmakers adjourned in May without forging a compromise on Senate Bill 88. The bill would have required a permit system for factory hog farms, mandated water-quality monitoring, forced companies to buy bonds to cover the costs of any environmental damage that might occur, and required them to cover lagoons or take other action to reduce odor. But legislators could not agree on how to impose odor controls and the bill never was forwarded to the whole Senate. A debate goes on in Colorado over the future of mammoth hog farming operations. Traditional hog farming involved raising a couple of hundred hogs in outdoor pens. Today, farms producing over 100,000 hogs are common and production rates are growing. The National Pork Board says Colorado produced about 1.2 million pigs last year. There are about 100 pig farms in the state, with about 120,000 producing sows, according to the U.S. Department of Agriculture and the state director of the Colorado Pork Producers Council. Each hog produces 2.5 to 4 times the waste of a human. Some of the manure, which is often used as a fertilizer, can end up in groundwater and rivers through spills or runoff from waste-saturated fields.

The hog industry has boomed in Colorado largely due to the lack of laws governing how waste is handled. The Health Department has no control over practices on these farms, and county governments have been left to deal with this major pollution problem. This has resulted in a weak patchwork of regulations. Almost everyone, including the hog producers, agrees that regulations are needed, but the controversy revolves around how best to administer them, and the big sticking point appears to be odor. The issue of regulations has split communities, pitting producers and their supporters against environmentalists, ranchers and farmers who fear the huge farms may contaminate groundwater and destroy their way of life. Supporters of corporate hog farms say they have put new life into plains communities that were dying a slow economic death. Many communities on the Eastern Plains fear their economies would collapse without the production of pork. Others, backers of a ballot initiative that would impose strict environmental regulations on the operations, vowed to put the issue on the ballot for a statewide vote in November.

Hog farms are getting more scrutiny in southeast Colorado. Jeff Devere, an environmental health specialist, was hired with state money by Prowers County to regulate health issues in Prowers, Baca, Bent and Kiowa counties. Devere works with hog companies to make sure they aren't putting their farms in locations that are too close to people, that might flood, or that might contaminate groundwater. The hog companies like the extra oversight. Consulting with Devere while they are planning their projects saves them time, money and stress when it comes time to get approval from county commissioners. "...We can do lots of work on environmental impact up front," Devere says, before a hog farm is even built.

At the federal level, in March EPA initiated a proposal to regulate most livestock feedlots, requiring permits and waste control. The permits would automatically be necessary for any farm with more than 1,000animal "units" — which EPA defines as 1,000 cattle, 2,500 swine or 100,000 laying hens. A new proposal is scheduled for this summer. Agriculture Secretary Dan Glickman told a Senate forum in early May that he is searching for middleground in the nationwide battle over animal waste that has set environmental groups against farmers in dozens of states.

American Rivers Press Release dated 4/6/98, *Denver Post* 5/2/98, 5/5/98, 5/6/98; *Pueblo Chieftain* 4/10/98, 4/22/98

Alamosa River Downstream From Summitville Shows Dramatic Improvement

There have been dramatic improvements along the Alamosa River, downstream from the old Summitville Consolidated Gold Mine. The EPA took over the site in 1992, and it was declared a Superfund site on May 31, 1994. To date, it has cost taxpayers $117 million for the clean-up. At a long public meeting April 29 with the Colorado Department of Public Health and Environment and the U.S. Environmental Protection Agency, it was said the river, contaminated by heavy metals from the historical gold mine, has improved. However, when reclamation work begins next year, conditions on the river could get worse again. A state project manager for the DPHE said reclamation will begin in 1999 and should take about two years. Among aspects of the reclamation is the removal of a 15-foot deep peat bog. The peat may be used at the site. Needed for the reclamation is rock, and rather than open a quarry, negotiations are going on with the Colorado Department of Transportation to use waste rock from the Wolf Creek Pass highway project. Throughout the meeting, presenters were questioned about studies done in the past few years. Specifically mentioned was a lack of studies on manganese, the second most prevalent heavy metal in the Alamosa River. Howard Ramsdell and Brian Rimar, who were involved in a Colorado State University/U.S. Fish and Wildlife study of sheep and ducks along the river, insisted that manganese was not at high enough levels to be of concern.

Pueblo Chieftain 5/1/98

25 Sites in Colorado Candidates for the Superfund Program — 17 sites in Colorado are already on the federal Superfund list, and 25 additional polluted sites in Colorado are candidates for the program. The sites, placed on the list in the 1980s and 1990s, range from chemical-contaminated wells and groundwater to hazardous mine drainage into Western Slope rivers. The sites proposed for the program are listed and outlined below:

Industrial sites:

- ***Rocky Flats Industrial Park*** on Highway 72, two miles south of the former Rocky Flats nuclear weapons facility. The site has been home to a variety of chemical and recycling companies with suspected groundwater and soil contamination. A consortium of 10 to 12 companies has agreed to investigate the extent of the contamination.
- ***Aspen Park*** in Jefferson County. Carbon tetrachloride seeped into a water well used by a day-care center in 1994. The center used bottled water until contamination disappeared. EPA built a treatment plant to cleanse the area's groundwater.
- Former ***Centerline Circuits*** building in north Boulder. Organic chemicals got into nearby private water wells and into a wetland area used by Crestview Elementary School. The company is voluntarily cleaning up the site.

- *Twins Inn* at West 56th Avenue and Sheridan Boulevard in Arvada. Toxic chemical contamination found in water wells used by Twins Inn and two homes in 1995. The residents were provided with bottled water.
- *Sundstrand Aviation* facility at 2480 West 70th Avenue in Adams County—Chemical contamination was found nearby in water wells and soil. The site is on the "back burner."
- *Teller County Water and Sanitation District* near Woodland Park. A chemical by product of a now banned pesticide seeped into the district's water supply in 1994. The subdivisions served by the district were switched to Woodland Park's water system. A U.S. Forest Service facility is one of the suspected sources.
- *Larimer County Landfill*—Hazardous waste may have been buried and dumped in unlined septic pools in 1960s and 1970s. Contamination was found in the groundwater. The county and nearby cities are cleaning up and monitoring the site under an agreement with the state.
- *Leetsdale Shopping Center* area near Leetsdale Drive and South Holly Street in Denver. Gasoline and chemical byproducts seeped into a water well field used by the city of Glendale in 1994. The levels have since dropped off dramatically, and the site is on the back burner.
- *Hi-Tech Metal Refiners* southeast of Montrose—the site has changed hands several times since the late 1980s, leaving behind tanks full of hazardous metals from the recycling business. EPA earlier this year cleaned up the tanks.
- *Stapleton Airport* runways—Jet fuel, nitrates and cleaning agents have gotten into the ground water. The city of Denver is negotiating with the airlines over cleanup costs.
- *Ideal Basics* cement plant in LaPorte in Larimer County—the EPA investigated kiln dust from the facility; no major problems have been found.

<u>*Mining and Milling Sites:*</u>

- *Cedar Resources* mine near Platoro in Conejos County. The turn-of-the-century mining area is draining metals into the Conejos River and suspected of causing a fish kill in 1988. The owner is treating much of the water.
- *Wellington Ore* mine south of Breckenridge. Metals from the former mine are suspected of killing fish in French Gulch. EPA, the state and Summit County officials are working with the owner to devise a cleanup plan.
- *Bonanza Mining District* near Bonanza Saguache County. Various mines from the 19th century and mill tailings piles suspected of elevating metal levels in nearby creeks. The present mine owner is working with the EPA and state to treat the water.
- *Creede Mining District* near the town of Creede in Mineral County. Elevated metal levels have killed fish in Willow Creek and led to fish kills in the Rio Grande River. The Colorado Division of Mines has built a treatment system to remove the metals from the mining drainage.
- *Rico Argentine* mine and mill near Rico in Dolores County. Elevated levels of metals including arsenic and lead were found in the nearby Dolores River and Silver Creek.
- *Gold Hill* tailings site on the west side of Colorado Springs. Elevated metals' levels have been found in the soil of a mobile home park near the former gold and silver mill.
- *Upper Animas* water shed near Silverton. Drainage from the 19th century mining area has wiped out fish in part of the Animas River and nearby creeks. Last year, Sunnyside Gold Corp. agreed to treat the water, but EPA says there are other parts of the mining area that may pose problems.
- *Durango Lead Smelter* southwest of Durango. Lead and metals from the smelter that was closed in 1935 may have contaminated soil in a near residence and mobile home park. The Department of Energy may have exacerbated the problem in the late 1980s when it cleaned up uranium tailings on the site, but left the lead waste.
- *Climax Molybdenum* mine on top of Fremont Pass. EPA suspects arsenic and metals contamination in the groundwater and surface water from the early 20th Century mine and mill.
- *Santa Fe Bridge* area over the Arkansas River in Pueblo. Suspected high metals drainage from the sites of five turn-of-the-century smelters may have caused elevated arsenic levels in the yards of nearby homes. Blood tests on residents didn't find any health problems.
- *Captain Jack Mill* south of Ward in Boulder County. In 1992, Boulder County sheriff's deputies and state health workers found a worker dumping mill waste into the Left Hand Creek, turning it milky gray for almost six miles.
- *Silver Bell Mine and Mill* near Ophir in San Miguel County. Turn of the century mining site that could be draining metals into the Howard Fork. Residents have reported the river turning orange during heavy rains.
- *Wolf Tongue Mill* in Nederland. Initial testing showed possible mercury contamination from the old mill site, but subsequent investigations questioned the test results. It is on the back burner.
- *Golden Age* mine two miles northeast of Jamestown in Boulder County. Health investigators found high metal levels in the nearby Castle Gulch that drains into James Creek.

Rocky Mountain News 4/6/98

Rocky Flats — Rockwell Liability, Closure Schedule, and Proposed DOE Fine

The Supreme Court has rejected Rockwell International Corp.'s attempt to get out from under further federal liability for its past operation of the Rocky Flats nuclear plant. The justices, without comment, let stand rulings that allow the Clinton administration to pursue a false-claims lawsuit against Rockwell, which in 1992 paid an $18.5 million fine for hazardous waste and clean water violations at Rocky Flats. Rocky Flats officials said they don't expect their cleanup and closure schedule to be affected by Energy Secretary Pena's resignation. Pena, an advocate of accelerated closure at the Flats, predicted that the site could be closed as early as 2006. Other officials think a closing date of 2010 is more likely. The 2010 closure date is dependent on annual funding of $650 million over the next three years. And the USEPA wants to fine the Department of Energy $45,000 after a microscopic bit of plutonium was found in a creek that flows through the Rocky Flats site.

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wysiwyg://52/http://InsideDenver.com, Associated Press-Denver Post 4/28/98, wysiwyg://86/http://InsideDenver.com/news 5/1/98

Arkansas River Cutting into Sewage Lagoon
The channel of the Arkansas River is cutting a new path near Leadville and is threatening to cut into a sewage lagoon. Jo Clark, coordinator of the Arkansas River Restoration Project, said "EPA will be doing some work on the problem before it happens." The lagoon is on an 11-mile stretch of the river within the restoration project. Clark said the project is connected to the California Gulch Superfund Project to clean up toxic metals dumped into the river from ASARCO and Resurrection Mine. "This is the only river project of its kind in the nation," she said. "Instead of costly litigation, federal, state and local agencies are working together with the mines and ranchers whose land was contaminated by the polluted water from California Gulch."

Pueblo Chieftain 4/24/98

WATER RIGHTS

Well Water Beneath a Subdivision Can be Used Only With Consent of Landowners
The State Supreme Court has ruled that well water beneath a subdivision can be used only by consent of the landowners above it, ruling against the Chatfield East Well Co. The company had claimed ownership of the aquifer water beneath a 600-acre development near Chatfield Reservoir south of Denver under a quitclaim deed it received from Chatfield East Development Co., the developer of the subdivision in northern Douglas County. The State Engineer and the water court determined that the Arapahoe aquifer under the subdivision is not nontributary and the deeds did not withhold from the homeowners their right to use the water under their lots.

Fort Collins Coloradoan 4/21/98

WATER TRANSFERS

Irrigation District to Provide Water for Area Residents
The Pine River Irrigation District plans to provide up to 2,000 acre-feet of water from Vallecito Reservoir to the eastern third of La Plata County, an area where well water is scant and of poor quality. Central water service is largely unavailable. Vallecito Dam, completed in 1941, has for the last 27 years been operated by the district. U.S. Bureau of Reclamation officials said the district will be converting water historically used for farming to domestic supply and that it must have federal approval to do so. The irrigation district's three-man board said it doesn't need USBR approval — it has been running the dam for three decades, and it repaid its construction loan to the USBR in 1984. Members of the public are divided on the water system. Farmers see their landscape changing, and don't want to provide agricultural water for residential development. Area residents say the system is badly needed, with many having to haul water to their homes. The district's consulting water engineer said USBR could still attempt to block the district's plans, but if so, the district will divert its water below the dam, directly from the Pine River. Legislation to transfer 5/6 of Vallecito Reservoir from the U.S. Bureau of Reclamation to the Pine River Irrigation District was introduced in the U.S. House of Representatives and is scheduled to be brought before a Senate Committee June 9. The Bureau of Indian Affairs is in charge of the other 1/6. The legislation would allow the transfer of that 1/6 to the Southern Ute Tribe, but only if the tribe requests such a move.

Durango Herald 5/21/98, *Denver Post* 4/11/98

WETLANDS

Washington State Legislature Provides for Local Watershed Efforts
The Washington State Legislature recently adopted Engrossed Substitute House Bill (ESHB) 2514, which was signed into law by Governor Gary Locke. The bill provides a framework for local planning groups to assess water supply and use for Water Resource Inventory Areas (WRIAs), and begin to address specific strategies that include meeting instream flow needs. the planning process is to be initiated by specific governments, within the WRIA or watershed, including county governments, the largest city or town, the water utility obtaining the largest quantity of water, or tribes with reservations in the designated planning area. ESHB 2514 provides the Washington Department of Ecology (DOE) with $3.9M to provide grants to support local efforts authorized under the bill and $1.4M of this amount must be awarded during FY98, which ends on June 30th. Initiating governments may apply for up to $50,000 per WRIA or $75,000 for a multi-WRIA management area to organize a local watershed planning effort. Organized planning units may receive up to $200,000 for conducting watershed assessments, and up to another $250,000 for developing a watershed management plan. Applications must include proposals for developing the water quantity related component of a watershed plan. Water quality and fish and wildlife habitat components are optional, but DOE is required by ESHB 2514 to give preference to applications with all three components. For more information visit the website http://www.wa.gov/ecology.

On May 8, 40 years of efforts to bring West Slope water to farmers, towns and cities, and to provide flood control for the Arkansas Valley, via the FRYINGPAN-ARKANSAS PROJECT, were celebrated. The 15 current directors of the Southeastern Colorado Water Conservancy and 210 friends and family members met at the Pueblo Convention Center to honor Frank Milenski, a charter member of the District board, and the late Charles "Tommy" Thomson, district manager from 1966-94. Board chairman Ralph Adkins introduced a short video history of the district. FRYARK carries West Slope water from the Fryingpan via Ruedi Reservoir through Boustead Tunnel into Turquoise Lake west of Leadville. From there, the water flows through Twin Lakes and eventually down to Lake Pueblo, where it provides one of the top recreation areas in the state. Project water now irrigates more than 200,000 acres of farmland in the Arkansas Valley.

CALLS FOR PAPERS, POSTERS

PEAKS TO PRAIRIES:
A CONFERENCE ON WATER STEWARDSHIP
SUSTAINING COMMUNITIES AND THE ENVIRONMENT
Rapid City, South Dakota — September 27-30, 1998

Create a "toolbox" of methods, ideas and examples that provides answers for using the watershed approach to building community and sustaining the natural environment. You are invited to submit a poster for a poster session at the conference. Contact Thorne Ecological Institute by July 15. Phone 303/499-3647, FAX 303/499-8340, E-mail dir@thorneecoinst.org.

WATERPOWER '99 — Hydro's Future:
Technology, Markets and Policy
Las Vegas, Nevada — July 7-9, 1999

This conference will address the concerns that confront the hydro power industry and the future of hydroelectric generation. For information contact Liz Sigler at Phone 800/548-ASCE, ext. 6078 or 703/295-6078, FAX 703/295-6144, or E-mail lsigler@asce.org. You may submit your form and abstract via the new Waterpower home page at www.waterpower.org.

NOT IN MY WATERSHED!
Changes In Water and Land use In the South Platte Basin

First Announcement and Call for Posters

The 9th Annual South Platte Forum — October 28-29, 1998

Raintree Plaza Conference Center, Longmont, Colorado

The 9th Annual South Platte Forum will examine a variety of perspectives, including urban, agricultural, environmental, and municipal viewpoints. The forum will feature the following sessions:

Can't We All Just Get Along?
Instream Flows...Coming Soon to a River Near You
The Miracle of Fishes and Flows
Days of Swine and Roses
The ABCs of TMDLs
Models, Maps, and Modems

Poster abstracts are due by August 1, 1998. To submit abstracts or request information about the conference, call or write:

Laurie Schmidt
Colorado Water Resources Research Institute
410N University Services Center
Fort Collins, CO 80523-2018
Phone: 970/226-0533 FAX: 970/491-2293
E-mail: laurie1@lamar.colostate.edu

FIFTH BENCHMARK WORKSHOP ON NUMERICAL ANALYSIS OF DAMS
Denver, Colorado -- June 2-5, 1999

The U.S. Committee on Large Dams (USCOLD) has issued a call for papers for its 5th workshop. The workshop will provide an in-depth examination of the computational methods and software used for dam analysis, including concrete dams and embankment dams. The abstract deadline is September 30, 1998. For information contact Pasquale Palumbo, Technical Secretariat, Via Pastrengo, 9, 24068 Seriate (BG), Italy. Phone 39-35-307-111, FAX 39-35-302-999, E-mail ppalumbo@ismes.it.

See the U.S. Committee on Large Dams web page at **www.uscold.org/-uscold.**

CALL FOR ABSTRACTS
Second Annual Student Water Symposium
Colorado State University, November 3-6, 1998

The Second Annual Student Water Symposium will be held at Colorado State University on November 3-6, 1998. All CSU graduate and undergraduate students are invited to present ongoing or completed water-related coursework or research projects. For more information or an abstract submittal form, see the website http://lamar.colostate.edu/~watersym/ or send an E-mail to **watersym@lamar.colostate.edu.**

MEETINGS

24th Annual COLORADO WATER WORKSHOP
DISTANT WATERS AND THE CHALLENGES WE SHARE:
World Water Lessons for a Changing West on Management, Conservation and Public Education
Western State College, Gunnison, Colorado — July 29-31, 1998

This summer's conference will feature some of the best minds in international and local water, with a special appearance by former U.S. Bureau of Reclamation Commissioner and water legend Floyd Dominy. Later in the 3-day program, we'll turn the mirror on ourselves and our most pressing western water issues: The catch-22 of conservation and prior appropriation doctrine; the proposal for statewide water planning - with an intensive discussion of House Bill 1288; projections on growth trends in Colorado and our future water supplies and demands; and how we might better educate an increasingly diverse population which includes many newcomers who are often taken by surprise at what water means in the West. Concurrent session blocks will provide a variety of pertinent subject matter to allow attendees an opportunity to explore favorite concerns. For information, including sponsorship and exhibitor opportunities, contact: ***Robin Helken, Director, Colorado Water Workshop, 1181 County Road 20, Gunnison, Colorado 81230, Phone 970/641-6215/FAX 970/641-6219***

MODFLOW '98
INTERNATIONAL GROUND WATER MODELING CENTER (IGWMC)
COLORADO SCHOOL OF MINES, Golden, Colorado
October 4-8, 1998

The IGWMC, in cooperation with the Office of Special Programs and Continuing Education of the Colorado School of Mines, is organizing its 3rd international conference, MODFLOW '98 focusing on MODFLOW, its add-ons, extensions, plug-ins, spin-offs, interfaces, shells, etc. The conference will bring together the users and developers of MODFLOW and related modeling programs to present the latest innovations in model applications, discuss the capabilities and limitations of MODFLOW, and explore the needs and directions for future developments. The conference will include a series of keynote presentations on topics ranging from the history of MODFLOW to the visions for groundwater modeling in the 21st Century, demonstrations of the latest MODFLOW-related software products, and participation in workshops, seminars and poster sessions. The conference will be held on the Colorado School of Mines campus in Golden, Colorado, October 4-8, 1998. Conference registration is $545, which covers the conference proceedings, evening receptions, lunches and breaks. A reduction will be made for students registered for a degree. For more information, contact the Colorado School of Mines, Office of Special Programs and Continuing Education at 303/273-3321, FAX 303/273-3314, e-mail space@mines.edu. *Co-sponsored by U.S. Geological Survey and Waterways Experiment Station, U.S. Army Corps of Engineers.*

COURSES ASSOCIATED WITH MODFLOW98 CONFERENCE

Sept 29-Oct. 2 4.5 days 2@8am-5pm, 8am-8pm & 8am-60m	MODFLOW - Introduction to Numerical Modeling (Completely overlaps with UCODE course for calibration instruction)	Eileen Poeter William Wingle	$1295 w/MOD98 $1495 w/o
Oct. 1-2 1pm-8pm & 8am-6pm	UCODE - Universal Inversion Code - Automated Inversion of "Any" codes (Soon-to-be-released, jointly sponsored USDoD-IGWMC-USGS code)	Eileen Poeter William Wingle	$795 w/MOD98 $995 w/o
Oct. 4 8am-5pm	Applied Inverse Modeling: Why use anything less?	Evan Anderman	$395 w/MOD98 $495 w/o
Oct. 4 8am-5pm	MT3DMS WORKSHOP	Chunmiao Zheng	$395 w/MOD98 $495 w/o
Oct. 5 7:15-10pm	MODFLOW Trouble Shooting IGWMC via a panel of experts		$99 w/MOD98 $199 w/o
Oct. 8 8am-5pm	PEST - Parameter Estimation for "Any" Code (Automated Calibration of "Any" Code)	John Doherty	$395 w/MOD98 $495 w/o
Oct. 8-9 8am-5pm	SIMULATION/OPTIMIZATION (S/O) MODELING FOR OPTIMAL GROUNDWATER MANAGEMENT	Richard Peralta Aala Aly	$945 w/MOD98 $1045 w/o

IGWMC 1998 SHORT COURSE PROGRAM

June 22-25 8am-5pm	Advanced Ground-Water Modeling: Including MODFLOW96, MODPATH, MODFLOWP, MODMAN, ZONEBUDGET, utilities and graphics	Peter Anderson Robert Greenwald	$1395
Aug. 3-7 8am-5pm	Applied Environmental Statistics	Dennis Helsel Ed Gilroy	$1495
Aug. 10-11 8am-5pm	Less than Obvious - Statistics for Data Below Detection Limits	Dennis Helsel	$680
Aug. 24-27	Geochemical Modeling of Aqueous Systems	Wendy Harrison Suzanne Paschke	$1395
Sept. 14-15 8am-5pm	Wellhead Protection Modeling Using EPA's WhAEM (Analytical Element Modeling)	Jack Wittman Vic Kelson	$995
Oct. 22-23 8am-5pm	Windows Based HYDRUS 1D & 2D Software for Simulating Variably Saturated Flow and Transport	Rien van Genuchten Jirka Simunek Eileen Poeter	$995

Contact: IGWMC - International Ground Water Modeling Center, Colorado School of Mines, Golden, CO 80401, USA
Phone: 303-273-3103 FAX: 303-384-2037 WWW URL: http://www.mines.edu/igwmc/ E-Mail: igwmc@mines.edu

Colorado State University Alumni Water Symposium
June 20, 2000

Colorado State University Alumni working around the world in the water industry are making significant contributions, and to recognize them, the University proposes a one-day Alumni Water Symposium. The Water Symposium will focus on activities and roles in solving water problems and will blend Colorado State University and Alumni in this effort. Details will be announced in the near future. The Alumni Water Symposium will be held in conjunction with two other events entitled:

- International Conference "Challenges Facing Irrigation and Drainage in the New Millennium" June 21-24, 2000
- "Watershed Management 2000 Science and Engineering Technology for the New Millenium" June 21-24, 2000

Interested Colorado State Alumni and Friends of the University may contact:
Janet Montera Tosch
Department of Civil Engineering
Colorado State University
Fort Collins, CO 80523-1372, USA
USA Fax: (970)491-7727
E-Mail: jmontera@engr.colostate.edu

UCOWR 98
Sponsored by the Universities Council on Water Resources
Hood River Inn, Hood River, Oregon — August 4-7, 1998

Water will be the focus of epic 21st Century struggles for a resource essential to a population growing in number and prosperity. At the same time, the days of massive water development projects are over. This conference will explore the inherent conflicts between old water policies and new concepts of sustainable development. As examples of pressing policy issues in the region of the meeting, attention will be given to issues in the Western U.S., through discussion of the current Western Water Policy Review and examination of river management in the Pacific Northwest. Implications for university research and the education of future water professionals will be discussed. Contributed papers and posters will address contemporary issues in water policy and management, national, regional, or international, including:

- Legal and institutional reforms
- Incentive-based water policies
- Risk assessment
- River management
- Water quantity and allocation
- Interdisciplinary perspectives on water management
- Conflict resolution, including interstate issues
- Management of water quality and ecosystems, including hypoxia
- Integrating policy and technology

For information contact the UCOWR Executive Director, Phone 618/536-7571, FAX 618/453-2671, or email at ucowr@uwin.siu.edu. There is a complete listing of the Technical Program at the UCOWR website: http://www.uwin.siu.edu/ucowr

CALENDAR

July 5-9	BALANCING RESOURCE ISSUES, Soil and Water Conservation Society Annual Conference, San Diego, CA. Contact: SWCS, Phone 513/289-2331, FAX 515/289-1227, webpage http://www.swcs.org, or Email swcs@swcs.org/.
July 7-9.	MONITORING: CRITICAL FOUNDATIONS TO PROTECT OUR WATERS (National Water-Quality Monitoring Council), Reno, NV. Contact: GWPC, NWQMC Conference, 827 NW 63rd, Suite 103, Oklahoma City, OK 73116, FAX 405/848-0722, http://gwpc.site.net

Aug. 4-7	CROSS CURRENTS IN WATER POLICY — UCOWR '98, Sponsored by the Universities Council on Water Resources, Hood River, OR. Contact: Dr. Tamim Younos, Virginia Water Resources Research Center, 10 Sandy Hall, Virginia Tech, Blacksburg, VA 24061-0444, Phone 540/231-8039, FAX 540/231-6673, E-mail tyounos@ vt.edu.
Aug. 10-14	The 1998 U.S. Committee on Large Dams (USCOLD) 18th Annual Meeting and Lecture, MANAGING THE RISKS OF PROJECT DEVELOPMENT, SAFETY OPERATION, Buffalo, New York. Contact: Richard C. Harlan, Chair, 1998 USCOLD Lecture, FAX 415/288-9881, E-mail rcharlan@ email.msn.com.
Sept. 9-10	PRACTICAL APPROACHES TO BETTER GROUNDWATER MANAGEMENT, San Antonio, TX. Contact: The Groundwater Foundation, P.O. Box 22558, Lincoln, NE 68542-2558, FAX 402/434-2742, E-mail susan@groundwater.org.
Sept. 20-23	1998 GROUNDWATER, SOURCE WATER, AND UNDERGROUND INJECTION FORUM AND TECHNICAL EXCHANGE EXPOSITION, Sacramento, CA. Contact: Ground Water Protection Council, Phone 405/848-0690, FAX 405/848-0722, E-mail ben@ gwpc.site.net, WWW http://gwpc.site.net/meetings.htm.
Sept. 27-Oct. 2	GAMBLING WITH GROUNDWATER, Physical , Chemical, and Biological Aspects of Aquifer-Stream Relations, Las Vegas, NV. Contact: IAH/AIH Conference Las Vegas — Conference Headquarters, Attn: Helen Klose, 2499 Rice St., Suite 135, St. Paul, MN 55113-3724, Phone 612/484-8169, FAX 612/484-8357, E-mail AIHydro@ aol.com.
Oct. 8-9	FOURTH WESTERN REGIONAL INSTEAM FLOW CONFERENCE, Water for Fish vs. Water for People: A Real Conflict? Copper Mountain Resort, CO. For more information regarding the conference program, Contact conference director David Nickum at 303/837-9383.
Oct. 11-14	DAM SAFETY '98, Las Vegas, NV. Contact: Assoc. of Dam Safety Officials, Phone 606/257-5140, FAX 606/323/1958, E-mail damsafety@ aol.com.
Oct. 28-31	CONFERENCE ON SHARED RIVERS, River Basin Management to Meet Competing Needs, Park City, UT. Contact: Larry D. Stephens, Phone 303/628-5430, FAX 303/628-5431, E-mail: stephens@ uscid.org.
Nov. 10-13	18TH INTERNATIONAL SYMPOSIUM, NORTH AMERICAN LAKE MANAGEMENT SOCIETY (NALMS), Cooperative Lake and Watershed Management: Linking Communities, Industry and Government, Banff, Alberta, Canada. Registration information can be found at the NALMS web site http://www.biology.ualberta.ca/alms/1998/htm.
Nov. 15-19	34th ANNUAL CONFERENCE ON WATER RESOURCES 7 SYMPOSIUM ON APPLICATIONS OF WATER USE INFORMATION, Point Clear, AL. Contact American Water Resources Assoc., Phone 703/904-1225, FAX 703/904-1228, E-mail awrahq@ aol.com

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

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