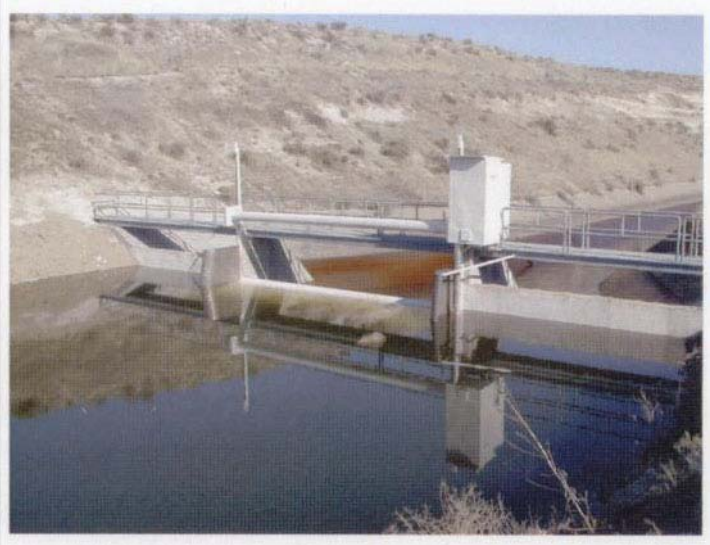
Colorado Water

Newsletter of the Water Center at Colorado State University

April 2006

Canal Modernization articles inside:



Langemann gate controls canal water flow.

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COLORADO WATER

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EDITORIAL

Research and Tech Transfer Help Modernize Colorado's Ditches and Canals

Reagan M. Waskom, Colorado Water Resources Research Institute

Supervisory Control and Data Acquisition (SCADA), coupled with advanced decision support systems, is transforming water management across the West. This issue of *Colorado Water* takes a look into how ditch companies and water districts are working with industry, government, and university researchers to modernize canals with these new tools to increase operational efficiency.

Colorado has a rich history of ditch and canal development, and has been a leader in canal innovation and measurement technology. Irrigation in the modern era of Colorado started in the late 1850's along the bottomlands adjoining streams, as settlers diverted water. Hardy farmers quickly learned that irrigation ditches were going to be essential to profitable agricultural enterprises, but building ditches was no minor task! Pioneers with oxen and shovels worked cooperatively to construct virtual rivers across previously arid plains, but not without difficulties. In 1872, the banks of Union Colony Ditch Number Two failed to hold, causing a minor disaster. After this experience, the colonists realized they needed competent water engineers to design, install and maintain canals. It is remarkable how many of the early Colorado ditches have stood the test of time.

Once Colorado's water pioneers had the ditches built and flowing, the tricky but essential process of measuring and distributing the water began. Weirs were first employed to measure flow volumes, but had to be properly designed and installed to give reliable measurements. The "Max Clark Box", invented by and named after a Union Colony member, slowed the velocity of water approaching a weir, making it easier to measure. Later, engineers such as Elwood Mead and Ralph Parshall devoted their research to developing methods for accurate measurement of flowing water. Research on methods to improve water measurement and distribution continue to this day.

There are hundreds of ditch companies and literally thousands of miles of ditches and canals in Colorado, moving millions of acre feet of water annually. Most agricultural ditches in Colorado are owned by the water users themselves, with maintenance and oversight often performed by volunteer members. Larger canals are most often owned by shareholders of a mutual ditch company, led by a Board of Directors, and managed by a paid staff. Many ditch companies operate as private nonprofit organizations with small budgets. For many years ditch riders have allocated ditch water according to share ownership and their personal knowledge of system intricacies, using division boxes to divide and measure flow. While demand for these services is as great as ever, more accurate, centralized monitoring and control is needed as population growth and new water demands take the slack out of Colorado's water system.

Water managers are increasingly under pressure to tightly control flows and deliveries, and to account for every foot of water in their systems. Guest authors Steve Smith and Don Magnuson provide *Colorado Water* readers with a great introductory article on SCADA fundamentals and examples of ditch modernization (see page 4). The recent drought has accelerated a modernization trend already underway across the West.

SCADA offers significant promise to help water managers, but raw data alone does not meet the information requirements of complex management systems. To be useful, data must be transformed into information that can be employed to make better decisions. New decision support software helps water managers make real time decisions, integrating data and expert knowledge of the system. An article by Professor Oad and graduate student Kristoph Kinzli, on page 10, describes one effort to develop and implement a decision support system. Until recently, these tools have been too expensive for most small water districts. Several ditch companies and districts in Colorado have recently benefited from the Bureau of Reclamations' Water 2025 cost-share program, which Tom Gill describes in his article on canal modernization projects on page 14.

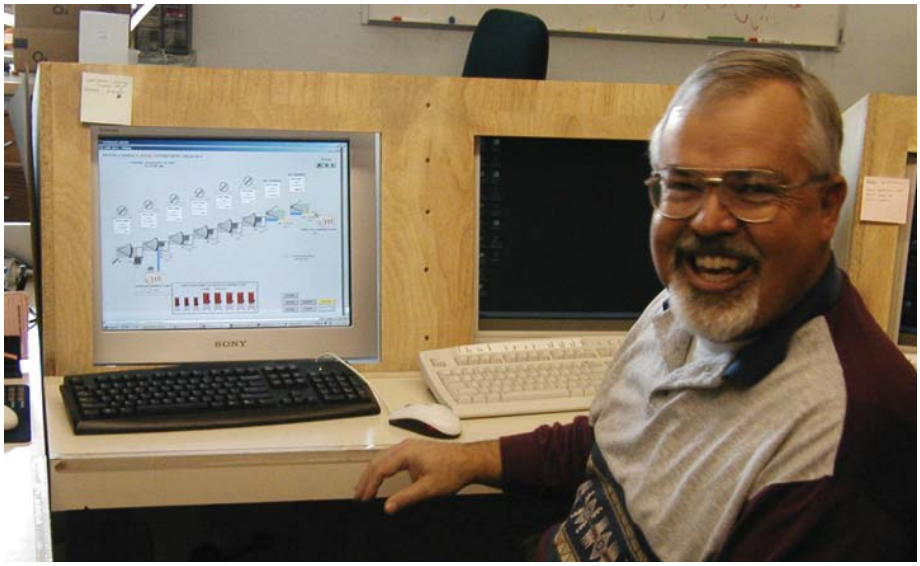
The goal of canal modernization is to achieve increased operational efficiency and tighter control of water resources, resulting in greater conservation and water security. The research efforts to develop modern canal systems are an excellent example of partnership between industry, government, higher education, and the water management community.

On another note, input from readers of *Colorado Water* is always accepted and appreciated. This month we ask our readers to take a little extra time to help us in our effort to continue providing a relevant newsletter that serves as a linkage between higher education and water managers and water users. On page 35 you will find a simple one-page survey that we ask you to take a few minutes to complete and fax back to us. We greatly value your input and look forward to hearing from you soon.

SCADA Adapts to Irrigation and Canal System Needs

Stephen W. Smith, Aqua Engineering, Inc.
and
Donald O. Magnuson, New Cache La Poudre Irrigating Co.

Supervisory Control and Data Acquisition (SCADA) has been with us a long time but mostly with industrial process control and monitoring circumstances that could afford the technology. Irrigation, for many years, was not an industry that warranted the steep hardware cost until some irrigation manufacturers began to develop a specialized type of SCADA from their own proprietary hardware and software. In the mid-1980s we began to see adapted SCADA systems that were specifically intended for irrigation projects that could afford it -- golf irrigation, in particular. In landscape irrigation, we referred to these systems as "centralized irrigation control." These early control systems were further adapted to accommodate distributed sites such as school districts or municipal park departments. In 1986, the City of Pueblo became the first city in the country to implement centralized irrigation control for distributed park sites. During this period, specialized SCADA systems found a niche in irrigation and those systems, by a myriad of different proprietary names, have been with us for almost 25 years.



Chuck Lurvey sits in front of the SCADA central computer for the Dolores Project. Radial gate icons on the HMI screen indicate the water surface level in the canal and the gate positions of the radial gates at checks along the canal.

Where was agricultural irrigation to be found in this picture? There were a few irrigation central control systems to be found in agriculture, but comparatively few. Agriculture could generally not afford the rather steep cost of the SCADA systems of the past. During the early 1990's, the cost of implementing SCADA on a per site basis was in the range of $5,000 to $10,000 per site without gate actuation hardware. This cost was quite high in comparison to the cost of a classic chart recorder installation on a weir or flume, or for that matter, the cost of manual actuation of valves, headgates, and checks by the canal company's ditch rider.

The current cost of SCADA implementation has decreased in recent years to a price point where SCADA is affordable to mutual irrigation companies. Often smaller mutual irrigation companies do not have an office or a staff per se, but a SCADA central system can be located anywhere that is practical. SCADA can provide smaller companies many cost effective features which result in significantly improved canal operations, improved deliveries to shareholders, and reduced liabilities.

SCADA concepts

Generic definitions are appropriate to help describe basic SCADA concepts. The "central system" is microcomputer based and interface software is used to communicate with remote sites. The software that provides an umbrella over everything is called a "human-machine interface" or HMI. The key hardware at remote sites is a "remote terminal unit" or RTU.

The HMI software can be proprietary and published by the manufacturer of the hardware or it can be more generic and published by software companies that write HMI programs that are compatible with the hardware of many manufacturers. Flexible and broadly compatible programs are known as Wonderware, Lookout, and Intellution, as examples.

Communication can be via wire line (hard wired), telephone, fiber optics, or radio. Radio for most canal operations is preferred although the canal easement does present the potential for easy fiber optic installation. (The Dolores Project in Cortez, Colorado utilizes fiber optic communication.) The SCADA industry has standardized largely on a communication protocol called "Modbus" which is quite flexible but also considered antiquated by many because it was developed for wire line applications and not the higher communication speeds that are now possible.

This rated canal section is remotely monitored using a SCADA system. RTU equipment is 12-volt DC powered from a solar panel that maintains a charge on a battery. Communication with the site is by radio.

Remote terminal units are essentially a small computer that can be programmed for the specific requirements at individual sites. The RTU is also the point at which sensors are connected. A site with only one requirement, e.g. monitoring the water surface elevation in a flume or weir, would have a water level sensor wired to it. The RTU then communicates to the central system or conversely, the central system can initiate a call to the RTU. The preferred communication is two-way communication. In other words, the central can call the RTU or the RTU can call the central. It is important to note that the RTU can be monitoring one or more sensors and perform logical operations and even create an exception report or alarm. If flows or water levels exceed a pre-set limit at a point in the canal system, an alarm can be raised or action can be taken in the form of gate or check adjustments. Alarms can appear at the central computer or even be transmitted to a cell phone or pager.

Four levels of SCADA implementation can be described by their respective function and utility to the canal company.

- Monitoring (only)
- Remote manual operations
- Local control
- Fully automated operations

Each level results in increasing capability within the SCADA system, but each level costs more. The additional cost is largely at the remote sites, not at the central workstation. The central workstation becomes a fixed cost except for HMI upgrades and the inevitable computer hardware upgrades.

A simple SCADA monitoring site is installed in a rated canal section historically used by the New Cache la Poudre Irrigating Company

(NCLPIC) in Lucerne, Colorado. For many years, water surface elevations have been monitored at this location using a Steven's recorder and by manually reading the gauge twice per day by the ditch rider. With SCADA, data is transmitted by radio to the central computer on a frequent basis. At the central computer, the data is reported continuously on the HMI screen. NCLPIC is currently investigating full SCADA for improving canal operations and monitoring and reporting of the company's well augmentation plan.

The HMI screen can be, and should be, unique to the user and the circumstance. The screen is simple and intuitive in nature. Radial gate (check structure) positions are depicted graphically, each in a somewhat lower position in the HMI screen, to indicate the canal itself. The operator may raise or lower gates, and therefore water surface elevations in canal pools, by using very small incremental gate movements. Interestingly, Dolores Project staff can and do make changes in their own HMI software interface without assistance from an outside consultant or system integrator.

With simple monitoring using a SCADA system, sensors are installed that meet monitoring requirements such as water level sensors. Data is collected on the central system and can then be directly viewed by a system operator or plotted depending on needs and functional requirements.

This check structure is controlled by Rubicon gates which are integrated with the SCADA system and used for water surface level control or flow control.

With remote manual operations, as the name implies, the operator can raise or lower gates and thereby effect the canal operation from the central computer. This is called remote manual because gate movements are implemented by the canal company staff, just as if they were at the gate or check. But gate adjustments can be made much more frequently and therefore canal operations, overall, can become more real time and precise.

With local control, the RTU at a particular site is programmed to maintain a set upstream water surface level or to open a gate if a water surface level increases beyond a set point as with a storm event.

Full canal automation is possible. This ultimate benefit of SCADA has been widely discussed for two decades but there are actually very few canals operated under what would be called full automation. One note is important here. Some would refer to a canal as being automated with any SCADA implementation, but what they often mean is that the canal is operated under a remote manual scenario using SCADA equipment. For the purposes of this paper, full canal automation means a system in which computer programs control processes from irrigation order inputs through algorithm-driven gate adjustment schedules for some future timeframe. This level of automation is not an easily programmed or implemented process.

Case Studies

Central Arizona

The Central Arizona Irrigation and Drainage District (CAIDD) has implemented SCADA over much of the district's 60 miles of canal. CAIDD has utilized SCADA for many years but it is noteworthy that they have in recent years upgraded their old SCADA system at a relatively

An operator at CAIDD near Phoenix monitors primary flows and water surface elevations in the 60-mile canal. This SCADA system was implemented at relatively low cost using affordable RTU equipment and spread spectrum radios for communication.

low cost. With the upgrade, using the existing gates, actuators, and other infrastructure, the district staff installed new SCADA equipment on 108 sites for an equipment cost of approximately $150,000.

Most of the district's checks are operated in remote manual mode. The central system simultaneously displays the upstream water surface elevation at all 108 check structures on three side-by-side computer monitors. Using SCADA, gate adjustments can be made in increments of 1/8th inch which coincidentally equates to a change in flow of roughly one cubic foot per second through the check.

Additionally, a 15-mile lateral reach of the CAIDD sister district's (Maricopa Stanfield Irrigation and Drainage District or MSIDD) canal system is operated by Water Conservation Lab staff under full automation using a program that was developed by the Agricultural Research Service (USDA-ARS), Water Conservation Laboratory, in Phoenix, Arizona. SacMan, which stands for Software for Automated Canal Management, has been under development for approximately five years. SacMan runs in parallel with the HMI software and interface and is used to operate a key MSIDD canal in a fully automated mode.

This SCADA system uses spread spectrum radio which does not require federal licensing. The spread spectrum radio is housed in the white enclosure and the directional antenna shown has a line-of-sight range of approximately 5 miles.

A key approach to affordable SCADA for CAIDD was spread spectrum radios. These radios do not have a federal licensing requirement. The radios look for a clear frequency, use that frequency if it is unused, or proceed to another frequency if necessary. The line of sight range for a spread spectrum "loop antenna" is two miles and the line of sight range for a "directional antenna" is five miles. Of particular note, any one antenna can serve as a "repeater" radio to other radios. So, with a linear project like a canal system, communication can be achieved by using the radios in a daisy-chained fashion to increase the effective communication distance.

New Cache La Poudre

New Cache La Poudre Irrigating Company (NCLPIC) operates one of the larger canal systems in northeastern Colorado which is known as the Greeley #2 Canal. The company holds decrees on the Poudre River and diverts approximately 600 CFS when all the de-

crees are in priority. In recent years, NCLPIC has also initiated a well augmentation plan for more than 100 member wells within the company's historic service area.

In 2003, the company commissioned an initial demonstration of SCADA for monitoring with one of the key rated sections on the Greeley #2 system. This demonstration showed clearly that real time data could be effectively used, and that improved monitoring was a significant help in managing day-to-day operations as well as annual reporting of flows.

After considerable study, including tours of CAIDD, the Dolores Project near Cortez, and Imperial Irrigation District in California, the company elected to implement SCADA for further monitoring of flows as well as gate actuation at key checks and outlet gates. Rubicon gates were selected because of suitable flow measurement accuracy that is possible along with gate actuation. One existing radial gate was actuated with a Limitorque actuator. A UHF radio frequency was licensed to the company and the communications for the entire system are facilitated using a repeater on a water tower near the company's offices near Lucerne, Colorado.

Because Rubicon gates were selected, the Rubicon TCC (Total Channel Control) HMI was evaluated and ultimately selected for implementation. The system currently consists of five Rubicon gates, one actuated radial gate, and monitoring of one rated section. A key gate outlet used to waste excess water in storm events allows for continuous monitoring of canal water surface elevations. Storm flows can be dumped to avoid increased liability and risk of a canal breach.

In 2006, the company is adding Rubicon gates at the outlet of Kern Reservoir near Windsor and is actuating the existing river diversion on the Cache la Poudre River.

Riverside

Riverside Irrigation District located in Fort Morgan, Colorado operates a canal that is more than 100 miles in length. The company delivers water to well recharge structures which must be monitored to meet the required reporting demands for flows and volumes associated with recharge. Automata RTU equipment, specifically the Automata Minisat, was used and linked to satellites. Data is accessed through an internet web page. Although there is an annual recurring cost for satellite communication, this approach allows a very low SCADA entry cost and minimal capital investment to meet the requirements of the site without having to travel to individual recharge sites for data collection. Currently six sites are in operation. Riverside Irrigation District has invested approximately $18,000 to date since early 2004 and expects to gradually expand the system as may be warranted and afforded.

Affordable implementation

Table 1 contrasts SCADA implementation costs at varying levels and compares those costs to collection of flow data using a Stevens recorder device, as might have been most common in the past. So, for example, if it were necessary to replace an existing Stevens recorder at a flume or weir at $2,450 (second column), the existing equipment might be replaced with an RTU using satellite communication at a cost of approximately $3,000 plus annual costs of $435 (third column). This incremental additional cost is likely quite palatable given the ease of data collection.

Additionally, assuming a central computer is already in place, the cost of real time assess to the additional site would be approximately $3,000 as well (fourth column). If the added features and sophistication of alarm condition reporting is desirable, then this cost increases to approximately $4,000 (fifth column).

SCADA has become more affordable in recent years and is quite useful to mutual irrigation companies for monitoring, remote manual operations, or even for full canal automation in the

Table 1. Cost Comparison for Various Means of Recording Flow Data at a Measurement Structure

Costs	Stevens Type Chart Recorder	Log data and upload to Satellite via an Automata Mini-Sat device with a satellite uplink, no central computer; data accessed via web site	Log data and upload to local computer using existing SCADA implementation based on Automata equipment using spread spectrum radio communications	Log data, upload to local computer using existing SCADA backbone installation and Motorola MRTU with either spread spectrum or UHF licensed radio communications, and create Alarm Condition
Equipment	$2,200	$2,500	$2,500	$3,500
Installation	$ 250	$500	$500	$500
Total Installed	$2,450	$3,000	$3,000	$4,000
Monthly Recurring	$0	(per year) $435 (per month) $36	$0	$0

not so distant future. The technology has changed rapidly and can be expected to continue to change and become more flexible, more intuitive, and more affordable. This will encourage mutual irrigation companies to change to these technologies and adapt them to the increasing demands of canal operations.

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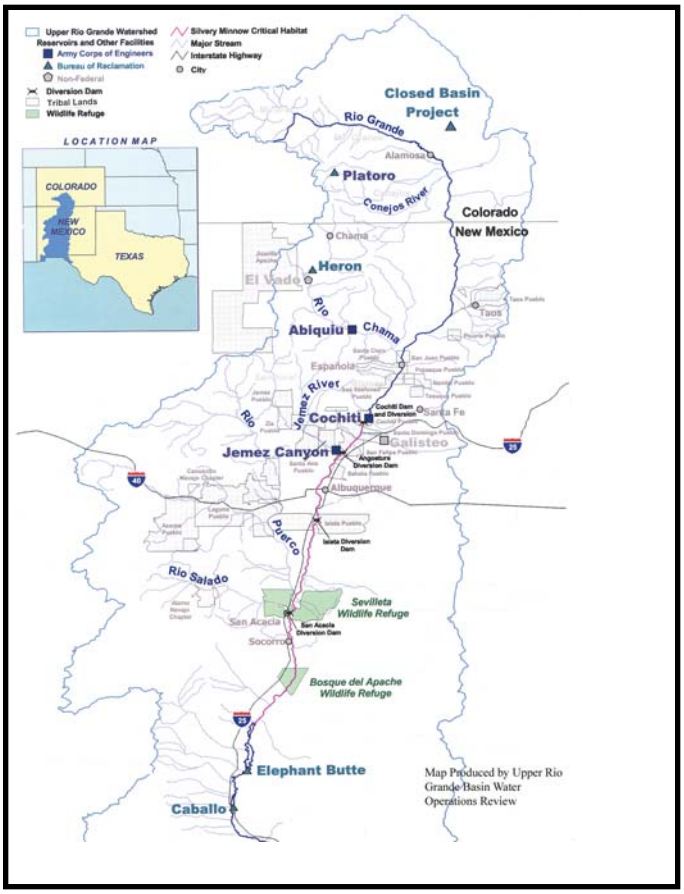
SCADA Employed in Middle Rio Grande Valley to Help Deliver Water Efficiently

Ramchand Oad, Colorado State University
and
Kristoph Kinzli, Colorado State University

During the last few decades water has become an ever more sought after commodity in the arid West. Water use has increased in urban and industrial sectors, while environmental concerns for fish and wildlife habitats call for steady or increased water supplies. Since irrigated agriculture uses large quantities of water – about 85% of available water supplies in the western United States – it is increasingly being asked to become a more efficient water user. In order to do so, irrigated agriculture has turned to improvement and modernization. Many irrigation systems in the United States were built during the 1920s and 30s and have become inefficient due to canal degradation and deterioration of flow control and measurement structures. Modernization has consisted of dredging and lining irrigation canals to restore the original capacity and prevent excessive seepage losses, and installing of modern water regulation and measurement structures. These modern flow control structures can be automated and remotely controlled through telemetry. In addition, computer decision support systems (DSS) have been developed and implemented to help better manage water supplies and demand. The Middle Rio Grande Conservancy District in the Middle Rio Grande Valley, described below, is one example where irrigation system modernization is being implemented currently.

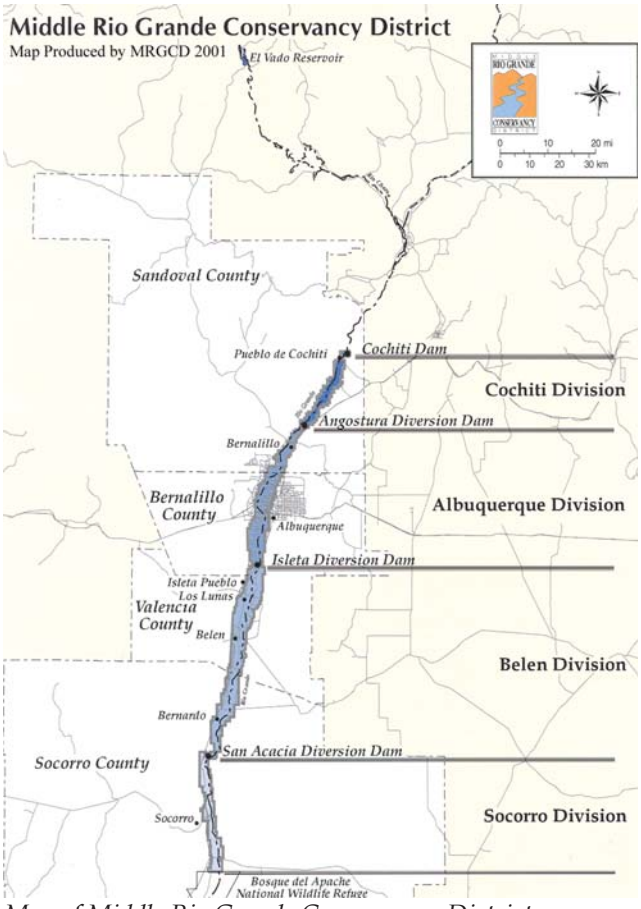


Map of the Middle Rio Grande Valley

Middle Rio Grande Valley

The Middle Rio Grande (MRG) Valley runs north to south through central New Mexico from Cochiti Reservoir to the headwaters of Elephant Butte Reservoir, a distance of approximately 175 miles. The valley is narrow, with the majority of water use occurring within five miles on either side of the river. The City of Albuquerque and several other communities are located in and adjacent to the MRG Valley. Although the valley receives less than 10 inches of rainfall annually, it supports a rich and diverse ecosystem of irrigated farming, riverside forests and fish and wildlife habitats.

Water supply available for use in the MRG Valley includes native flow of the Rio Grande and its tributaries, allocated according to the Rio Grande Compact of 1938; San Juan-Chama (SJC) project water, obtained via a trans-mountain diversion from the Colorado River system; and groundwater. Water is fully appropriated in the MRG Valley and its utilization is limited by



Map of Middle Rio Grande Conservancy District

the Rio Grande Compact. The Compact sets forth a schedule of deliveries of native Rio Grande water from Colorado to New Mexico and from New Mexico to Texas.

Water demand in the MRG Valley includes irrigated agriculture, municipal, and industrial consumption. In addition to these demands, there are significant consumptive uses associated with riparian vegetation, wetlands, river and reservoir evaporation. Superimposed on these demands are river flow targets associated with two federally-listed endangered species, the silvery minnow (hybognathus amarus), and the southwestern willow fly catcher (Empidonax traillii extimus).

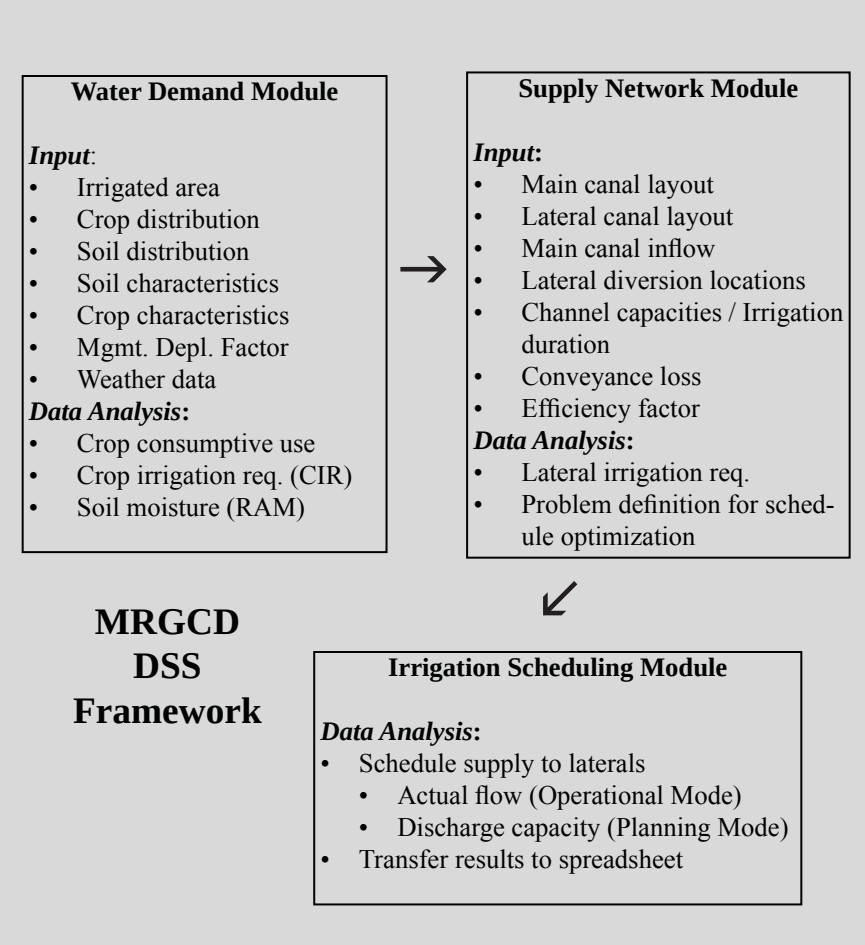
MRGCD

The Middle Rio Grande Conservancy District (MRGCD) was formed in 1925 in response to flooding and the deterioration of irrigation works. In 1950, MRGCD entered into a contract with the USBR to receive financial assistance for its system rehabilitation (the Middle Rio Grande Project). System improvements occurred until 1975, when MRGCD resumed operation and maintenance of the system. Water diverted by the MRGCD originates as native flow of the Rio Grande and its tributaries, including the Rio Chama.

The MRGCD services irrigators from Cochiti Reservoir to the northern boundary of the Bosque del Apache National Wildlife Refuge. Irrigation facilities managed by the MRGCD divert water from the river to service agricultural lands, which include small urban parcels and large tracts that produce alfalfa, pasture, corn and vegetable crops. The MRGCD supplies water to its four divisions -- Cochiti, Albuquerque, Belen and Socorro -- through Cochiti Dam and Angostura, Isleta and San Acacia diversion weirs, respectively. In addition to direct diversions at these weirs, all divisions except Cochiti receive return flow via drains from divisions upstream.

Efficient Water Delivery

During the recent drought years, the MRGCD has taken a proactive approach to improving its water delivery operations and its management of available water. Towards this end, aging infrastructure has been replaced with automation capable structures and the division managers and ditch-riders are increasingly practicing rotational water delivery, which is an effective way to fulfill demand with reduced available water.
Rotational Water Delivery (RWD) is used in irrigation systems worldwide to improve water delivery and to support water conservation. In RWD, lateral canals receive water from the main canal by turns, allowing water use in some laterals while others are closed. In addition to this water rotation among laterals, there can be rotation within laterals whereby water use is distributed in turns among farm turnouts or check structures along a lateral. By distributing water among users in a systematic rotational fashion, an irrigation district can decrease water diversions and still



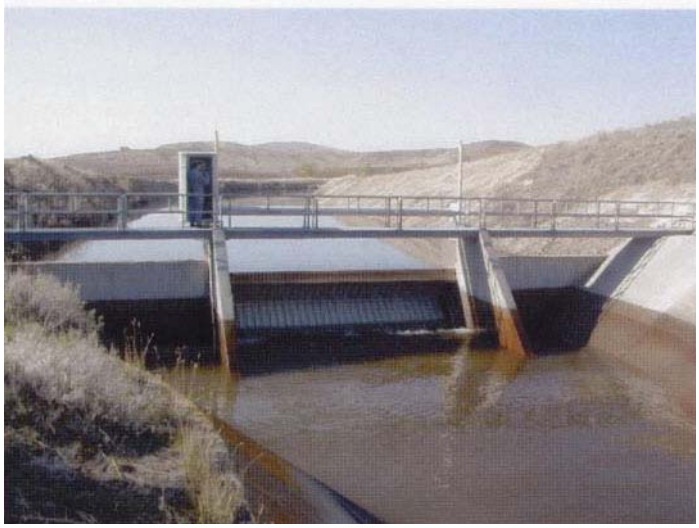
The Lopac gate controls water surface elevation upstream, serving as an automated check structure.

meet crop water use requirements. A well-managed program of rotational water delivery is able to fulfill seasonal crop water requirements in a timely manner, but requires less water than continuous water delivery.

Decision support systems for RWD

Colorado State University researchers have formulated a decision-support computer model to assist implementation of rotational water delivery in the MRGCD. A DSS combines intellectual resources of individuals with capabilities of computers to improve the quality of decision-making. It is a logical arrangement of information including engineering models, field data, GIS and graphical user interfaces, and is used by managers to make informed decisions. In irrigation systems, a DSS can organize information about water demand in the service area and then schedule available water supplies to efficiently fulfill the demand. The conceptual problem addressed by a DSS for an irrigation system, then, is: how best to route water supply in a main canal to its laterals so that the required water diversion is minimized. The desirable solution to this problem should be "demand-driven", in the sense that it should be based on a realistic estimation of water demand.

The DSS was designed to improve understanding of how the water supply can be best scheduled to meet the crop water demand; and, specifically, to aid in the implementation of rotational water delivery practices within the MRGCD. The DSS consists of three elements; a water demand module, a supply network, and a scheduling program. A Graphical User Interface (GUI) provides a means for



Langemann gates have the capability to maintain constant upstream water level or a pre-determined constant flow rate to downstream users.

linking the three elements of the DSS. This GUI constitutes a framework for the DSS that provides the user with the ability to access data and output for the system. The three DSS model components are termed modules. The project GIS and databases are used to develop input for both the water demand and the supply network modules.

Modernization of Canal Structures

Along with the DSS, the MRGCD has been replacing antiquated diversion and measuring structures to become a more efficient water user. Traditional wheel type check structures have been replaced by Lopac gates and canal diversion structures have been replaced by Langemann gates.

Lopac gates are a type of automated check structure that can control the water surface elevation upstream. Lopac gates are based on a saloon door style design and maintain upstream water surface elevation by opening or closing to account for variations in flow rate. By opening when flow rate increases the gate spills the excess water but retains the desired upstream elevation. In the case where the flow rate decreases the gate closes and stores more water upstream to maintain the water surface elevation. Lopac gates feature manual or remote electrical operation and are equipped with solar panels. Each gate comes with a NEMA 3 electrical panel which can be integrated to include an AMI electronic gate controller and SCADA ready software.

The Langemann gate was developed by Peter Langemann through a cooperative effort between the St. Mary's Irrigation District, Peter Langemann and Aqua Systems 2000 Inc. The Langemann Gate has the capability to maintain a constant upstream water level (used as a check structure) or it can provide a pre-determined constant flow rate to downstream users (used as a turnout structure). The Langemann gate is analogous to a hinge placed perpendicular to the flow and functions using a chain drive that lifts the leaves of the hinge either up or down. The Langemann gate is equipped with solar panels for power and the same telemetry and controller units as the Lopac gate. Langemann gates can be used as irrigation check structures, turnout structures, spillway structures, diversion structures, variable weirs in water and sewage treatment plants, and storm water management flood control structures

By installing automated canal level and flow regulating structures, the MRGCD is gaining real time control of their irrigation system. Control resulting from the installation of automated structures has been accompanied by the development of a decision support system for better water allocation. These two modernizations (decision support system and automated control structures) will enable MRGCD to manage water efficiently and sustain irrigation concurrently with wildlife, urban and industrial demands.

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Bureau of Reclamation Provides Financial, Technical, and R&D for Affordable Canal Modernization

Tom Gill, Bureau of Reclamation

Since it's inception in 1902, the emphasis of the Bureau of Reclamation's mission has gradually evolved from development to management of water resources in the western United States. Up through the 1960s and into the 1970s, tasks related to new project construction were a major part of Reclamation's activities. Since the 1970s, much of Reclamation's focus has shifted to issues associated with operation, maintenance, and improvement of existing facilities. These efforts often include minimizing project impacts on habitat and enhancing the ability to manage and conserve water to better meet the needs of all stakeholders. Canal modernization represents an important aspect of Reclamation's efforts to improve water management and conservation.

Monitoring and control devices using radio communication such as this one are becoming more affordable.

Reclamation activities related to canal modernization could be categorized into three areas: providing financial assistance; providing technical assistance and information; plus research, development, demonstration and deployment (referred to as RD3 by Reclamation's Science and Technology Program) of appropriate/affordable flow measurement and canal control technologies. Often, Reclamation's involvement in a particular project will include two or even all three of these areas.

Financial Assistance

Reclamation's Water 2025 initiative, through which funding was first made available in Fiscal Year 2004, was set up with the goal of "preventing crisis and conflict in the west". Water 2025 Challenge Grants provide ". . . 50/50 cost share funding to irrigation and water districts and states for projects focused on water conservation, efficiency, and water marketing." These competitive grants are awarded based on a merit-based review process. Priority is given to projects that will be completed within 24 months from the date of award, and that will decrease the likelihood of conflict over water. More detailed information on the Water 2025 Initiative may be obtained at the Water 2025 website: http://www.doi.gov/water2025/.

Colorado recipients of Water 2025 Challenge Grants include: FY 2004 – Mancos Water Conservancy District, Mancos; Lower South Platte Water Conservancy District, Sterling; FY 2005 – Grand Valley Irrigation Company, Grand Junction, Groundwater Management Subdistrict, Greeley, and the West Divide Water Conservation District and Silt Water Conservation District, Silt. Activities in the funded proposals include canal infrastructure improvements, rebate cost assistance for installation of flow monitoring equipment, construction of new facilities to enable delivery and marketing of water between neighboring districts, and installation of canal lining.

Financial assistance has also been provided through Reclamation's Water Conservation Field Services Program (WCFSP). Funding through this program is administered through Reclamation's Regional and Area Offices. Examples of canal-related projects in Colorado that have recently received assistance through the

WCFSP include a diversion structure replacement at the Silt Water Conservancy District, Silt, and installation of a long-throated (ramp) flow-measurement flume at the Florida Water Conservancy District, Durango. The web link for Reclamation's Water Conservation Field Services Program is: http://www.usbr.gov/waterconservation/.

Technical Assistance and Information

Reclamation provides technical assistance through both Regional and Area Offices, and from Reclamation's Technical Service Center (TSC) located in Denver. Reclamation's Western Colorado Area Office (WCAO) is part of Reclamation's Upper Colorado Region and is located in Grand Junction. The WCAO has recently been an active partner in providing technical assistance for the Grand Valley Irrigation Company's modernization project on the Government Highline Canal. The Eastern Colorado Area Office (ECAO), located near Loveland, is part of Reclamation's Great Plains Region. The ECAO is currently a partner in efforts by the Northern Colorado Water Conservancy District to establish demonstration sites for canal monitoring and data telemetry technologies.

Reclamation's Water Resources Research Laboratory (WRRL) which is part of the TSC in Denver is closely involved in providing technical assistance and information in support of canal modernization projects. The WRRL annually offers training opportunities such as the five-day "Modern Methods in Canal Operation and Control" and the three-day "Basic Principles and Developments in Flow Measurement" workshops utilizing a model canal-simulation facility. Both courses integrate classroom instructional sessions with "hands-on" experience with the laboratory's canal model. Information on these classes can be accessed at: http://www.usbr.gov/pmts/hydraulics_lab/workshops/

Information sources related to canal modernization available from the WRRL include:

• *Water Measurement Manual, Third Edition*. This 1997 update was produced by the WRRL staff in cooperation with both the Agricultural Research Service and the Natural Resources Conservation Service of the USDA. It is available from the US Government Printing Office, or may be downloaded in .pdf format at: http://www.usbr.gov/pmts/hydraulics_lab/pubs/manuals/WMM_3rd_2001.pdf.

• *WinFlume*, a Windows-based software for designing long-throated flumes and for calibration of "as built" long throated flumes. WinFlume may be downloaded at: http://www.usbr.gov/pmts/hydraulics_lab/winflume/.

• *USBRWeir.xls*, an Excel spreadsheet-based program for creating ratings tables and simplified weir equations for common sharp-crested weirs. The simplified weir equations are more easily incorporated into canal automation programming than previously available weir relationships. USBRWeir.xls is currently available for beta testing. It can be downloaded at: http://www.usbr.gov/pmts/hydraulics_lab/usbrweir/index.html.

Members of the WRRL staff, working through agreements with Reclamation Area Offices are conducting on-site assessments and providing technical assistance to canals seeking improved flow measurement capability and/or automated control in the Belle Fourche and Angostura districts in South Dakota, the Pioneer district which spans the Colorado/Nebraska border, the Carlsbad district in New Mexico, the Truckee-Carson district in Nevada, the Yuma Mesa district in Arizona, and the Moon Lake Water Users Association in Utah.

RD3 of Appropriate/Affordable Technologies

WRRL staff members are active in numerous areas of canal operating technology development and demonstration, supported both by Reclamation's Science and Technology (S&T) Program, and in partnership with Reclamation Area Offices. A key focus has been identifying and developing technologies that are affordable for

A low-cost flow measurement device using pressure differences on the inside and outside of a pipe elbow bend to determine flow rate.

agricultural water systems. An example project supported by the S&T program involves development of an improved calibration methodology for using radial gates as flow measurement structures. This capability can enable districts to measure flows with suitable accuracy for monitoring canal operations using existing radial gate control structures. The calibration method is being coded into a software package that will soon be available for download from the WRRL website.

A "self-assembled" electronic flow monitoring system known as the Continuous Flow Meter (CFM) has been developed by researchers at the WRRL. Demonstration sites for this concept are being established for the upcoming irrigation season on the Pioneer Ditch (in cooperation with the Nebraska Kansas Area Office), at the Angostura district (in cooperation with the Dakota Area Office), and at the Yuma Mesa district (in cooperation with The Yuma Area Office). The "self-assembled" system is capable of monitoring both instantaneous and cumulative discharge and features a low-cost (~$100) programmable logic controller equipped with a 4 X 20 LCD display and a 4 X 4 keypad. This unit is installed in a NEMA 4 enclosure and runs on 12 volt DC solar charged power. It is compatible with a wide range of water level sensors that output an analog (voltage or current) signal. Programming for the units has been developed at the WRRL. After a period of demonstration/field testing with these units, an instructional aid for component acquisition and system assembly as well as the program code will be available from the WRRL website.

Accurate knowledge of flow rates at key points in a system is a necessity for improving canal operations. Enhancing flow measurement capability is typically an appropriate first step in adoption of a canal automation system. The WRRL has worked to help agricultural water systems identify opportunities for low-cost means of measuring flow that can provide suitable accuracy for administering system operations. An example is seen in the photo at right where flow is determined by measuring pressure difference between pipe taps on the inside and outside of a pipe elbow bend. At the site pictured on the Pioneer Ditch near Haigler, NE, differential pressure can be observed and measured using water columns on a manometer. A CFM installed at this site utilizes an electronic pressure transducer (seen at the bottom of the manometer) to sense the pressure differential. This information is processed to calculate differential head, discharge, and totalized volume which are shown on the CFM display.

Venturi flumes such as this one can also measure flow.

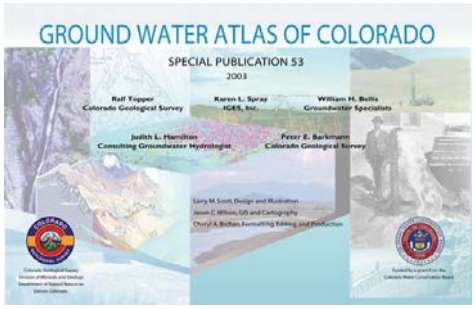
In other ongoing studies, WRRL staff members are looking at using a Venturi flume for measuring flows under conditions of high submergence. A Venturi flume as referred to in this study is a flat bottomed structure with a prismatic upstream section, a gradual contraction to a prismatic throat section and a gradual expansion back to the downstream channel. Flow is determined by measuring flow depth at both the upstream and throat sections, then using this information to simultaneously solve the energy and continuity equations. In a laboratory test flume (shown

at right), discharges measured with a submerged Venturi have been obtained with accuracy similar to discharge measured over a critical-flow long-throated flume. Currently, a bubbler sensor is being configured to monitor the two water levels needed for measuring flow in a submerged Venturi flume. The submerged Venturi flume is seen as an affordable technology that will enable flow measurement at sites with insufficient head for a critical-flow measurement structure.

During the current water season, the WRRL staff is working with the Colorado Water Conservation Board, the State Engineer's office, Northern Colorado Water Conservancy District, Lower South Platte Water Conservancy District and local irrigation companies in demonstrating flow monitoring and control technologies linked by radio communications. The photo at right shows an installation on the South Platte Ditch Company's recharge system near Merino, CO. Costs of equipment that has recently become available are approaching an affordability threshold that can make centrally-controlled canal automation cost effective for smaller agricultural water systems. These demonstration projects will enable cooperating districts the opportunity to gain a sense of the range of benefits that the technology can offer for their system. They will also provide interested parties with the opportunity to interact with local cooperators to sense both the types of issues encountered as well as the improvements that are possible with the technology.

The range of options for both canal modernization hardware and operational methodologies that are available for agricultural water entities to consider is evolving rapidly, both in terms of capability and affordability. Districts that have embarked on canal modernization programs frequently note that one of the most costly aspects of integrating new technologies into their operations is "finding out what works". Frequently, as districts move forward with canal modernization projects, they will experience a shift in mindset as personnel become more familiar with the capabilities and the limitations of the technology, and as improved data flow makes impacts of canal hydraulics become more apparent. Through financial and technological support, workshops and training, and active research and demonstration efforts, Reclamation is seeking to shorten the learning curve for agricultural water systems and facilitate improvements that enhance water conservation and management.

Award Winning Groundwater Atlas Now Available At Colorado Geological Survey Website



The Ground Water Atlas of Colorado, published by the Colorado Geological Survey, earned the Geological Society of America's 2005 E. B. Burwell, Jr. Award for it's authors, Ralf Topper, Karen L. Spray, William H. Bellis, Judith L. Hamilton, and Peter E. Barkmann.

A synopsis of the Ground Water Atlas is now available online. Like the original publication, the web site contains introductory chapters on the state's ground-water resource, as well as specific discussions on each of the state's major aquifers. The web site version consists of 3-4 pages of text and graphic materials for each of the original 7 chapters of the publication. In addition, the web site contains the complete glossary, and download capability of high-resolution graphic files displayed as figures on the web pages. The synopsis of the Ground Water Atlas of Colorado can be viewed at http://geosurvey.state.co.us/wateratlas/.

Sociology Water Lab at CSU Provides Social and Economic Information For Local Canal and Ditch Companies

The Sociology Water Lab, founded in 1995 as an adjunct to the Department of Sociology at Colorado State University, focuses on practical research in service to canal companies and irrigation districts in the western United States. This includes research on social and economic issues facing these two kinds of irrigation enterprises. Urban growth throughout the West has increased the complexity and cost of operating traditional irrigation enterprises. The Sociology Water Lab has generated more than $1.2 million of research and educational funds since 1995. These funds include grants from the U.S. Bureau of Reclamation, the U.S. Department of Agriculture, the Colorado Water Conservation Board, the Colorado Agricultural Experiment Station, and other sources.

More information on Sociology Water Lab activities can be found at http://waterlab.colostate.edu.

Sociology Water Lab Projects

- assisting ditch companies in Colorado with grant applications for new technologies, such as GIS and SCADA
- conducting institutional strengthening programs for water user associations in the Navajo Nation
- conducting workshops on urban encroachment issues facing canal companies and irrigation districts
- assisting old drainage districts in the Arkansas Valley to rehabilitate their tile line infrastructure
- conducting study tours and workshops for canal companies in Colorado
- assisting canal companies with developing risk assessment tools to improve water supply forecasting
- conducting research and organizing workshops for canal companies in ways to improve cooperation between these entities and to strengthen their position in the economy

Colorado School of Mines Faculty Receives DoD Award

Robert Siegrist, Michelle Crimi, Junko Munakata-Marr, and Tissa Illangasekare of Colorado School of Mines were honored with a DoD Project of the Year award. Their $750,000 project, *Reaction and Transport Processes Controlling In Situ Chemical Oxidation of DNAPLs,* was selected from a pool of 60 projects.

Activities and accomplishments of the project include:

- Applied varied experimental and modeling approaches to advance the understanding of in situ chemical oxidation (ISCO) for degradation of chlorinated organics presence in soil and groundwater as dense nonaqueous phase liquids (DNAPLs)
- Developed an improved understanding of ISCO for degrading DNAPLs in groundwater as affected by water chemistry and porous media properties
- Batch and flow-through reactor and 2D tank experiments revealed ISCO can achieve a target contaminant mass destruction if engineering parameters such as oxidant type, concentration, and delivery mode are chosen correctly
ISCO can be effectively coupled with pre-ISCO surfactant-cosolvent flushing or post-ISCO bioremediation to achieve cleanup goals at DNAPL sites
- Analytical and numerical modeling studies were completed to enhance ISCO engineering and site-specific decision-making
- The project supported two Ph.D students, four M.S. students, and four B.S. students, as well as producing 32 publications including journal papers and conference presentations/papers in the USA and abroad, and one patent application.

Economist Explores Risk Management in Crop Production and Economic Impacts of Changes in Irrigatigated Cropping in

James Pritchett

James Pritchett joined the Department of Agricultural and Resource Economics at Colorado State University in May of 2001. Pritchett served as an Assistant Professor in Agricultural Economics at Purdue University in from 1999 to 2001 where primary research, extension, and teaching efforts were in grain production economics, and grain product marketing, with a particular emphasis in specialty grains and oilseeds. He received a doctorate in Agriculture and Applied Economics from the University of Minnesota in 1999.

Pritchett currently advises one of the CWRRI fellows, Jennifer Thorvaldson. They are working on the project "Colorado's Evolving Irrigated Agriculture: Economic Accounting and Impact Analysis." Water is a natural resource of limited supply and many competing uses – and irrigated agriculture is only one of the uses. Pritchett and Thorvaldson are working to model specific cropping scenarios that might occur if water is not available for irrigation. The economic impacts of converting from irrigated agriculture to dryland cropping systems and fallowing programs are just a few of the possibilities they are exploring.

Dr. Pritchett's primary research and extension efforts are focused on risk management in crop production with specific interest in managing limited irrigation water supplies, the economic contribution of irrigated agriculture to local regions, and the use of real options analysis in everyday agribusiness investment decisions. Examples of Pritchett's work include unpublished studies concerning the economic impacts of complying with the Republican River Compact, the economic contribution of wells under the Groundwater Appropriators of the South Platte (GASP) and published studies regarding the risk management effectiveness of various marketing strategies and crop insurance products, a vegetable processing case study and the economic impacts of invasive animal disease. Dr. Pritchett also teaches EA 428 Agribusiness Management, EA 310 Agricultural Marketing, EA 308 Agricultural Finance, EA 305 Enterprise Analysis as well as ACC 192 Introduction to Agricultural Systems and EA 510 Agricultural Product Marketing at Colorado State University

Originally from southeast Colorado, Dr. Pritchett attended Colorado State University and obtained a B.S. in Agricultural Business and an M.S in Agricultural Economics from the Department of Agricultural and Resource Economics.

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Water Table Whets Appetites and Raises Funds for the Water Resources Archives

The research room was anything but quiet when nearly one hundred members of the water community poured into the Archives and Special Collections Department of Morgan Library on January 28, 2006 for Water Tables: An Evening with the Experts. A benefit for the Water Resources Archive, Water Tables featured a vibrant display of archival collections and an array of water experts, who hosted conversations about the past, present and future of Western water concerns, accompanied by a gourmet meal. Sponsors and participants raised nearly $8,000 in support of the Archive and proceeds will help the Archive to acquire, preserve and promote additional and existing collections significant to Colorado's water history.

(From top)

Mary Lou Smith (back) visits with Dave Stewart and Mary Stewart during a break in the discussions.

Bennet Raley (left) and Mike Applegate listen during discussions.

Greg Smoak provides his opinion.

Dave Stewart serves as master of ceremonies.

Guests mingled around displays of archival materials from the Water Resources Archive's extensive collections. "It was wonderful to see the reading room filled with so many people engaged in vibrant conversation and examination of our archival materials," said Janet Bishop, Coordinator of Archives and Special Collections. "While many people think of archives as dusty and dull places with no relevance to their lives or the modern world, it's important to emphasize that a good archive is a 'living collection' and our Water Resources Archive is an excellent example of this."

Materials on display included Delph Carpenter's briefcase, lantern slides from the Ralph Parshall Collection, the ground water survey books of W. E. Code, and photographs, papers, maps and films. The displays offered a historical glimpse to those industry professionals, historians, and scholars that joined CSU Libraries for the evening's events. "There is so much to learn from the materials preserved in the Water Resources Archive. What future generations of water professionals can learn from the past should help create a much better future. There is no better acknowledgement of the contributions of our predecessors than preserving their work and using it to shape our future," said Webb Jones, a member of the event's planning committee.

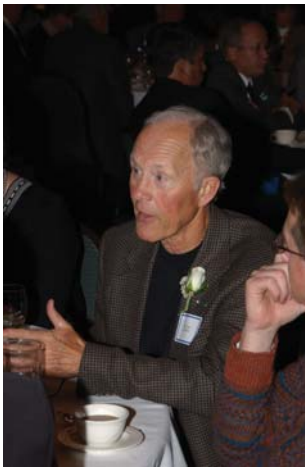
After perusing the materials of the water experts of the past, guests were escorted across the plaza to the Lory Student Center for a sumptuous meal and dynamic conversations led by today's experts in the water field. "We had some of the best minds in the subject of Western Water all sitting in one room. It was one of those heady evenings where you got to rub elbows and converse with some really good people that have made significant contributions to their community," said Mike Applegate of Applegate Group, Inc. one of the event's sponsors and a member of the event planning committee.

(From top)

Michael Ryan explains his perspective.

John Keys provides the finishing touch to his point of view.

Dan Tyler posits a discussion item.



Benet Raley visits with Kenneth Wright and Ruth Wright at the end of the evening.

Conversations ranged from discussions on the role of climate on Colorado and Western Water Institutions to little known trivia regarding the transformation of Colorado from the Great American Desert. (A complete list of hosts and their topics are listed on page 22).

Dave Stewart of Stewart Environmental Consultants, Inc., a sponsor and planning committee member, was the creative force behind the event aimed at raising funds to support the growth of the Water Resources Archive. Inspired by Tables of Content, the Libraries' annual benefit banquet for a variety of its collections and services, Stewart wanted to help the Libraries host an event that could help make the CSU Water Resource Archive the best in the Western US. "As a member of the engineering community, the water community in Colorado and as an alum of Colorado State," said Stewart, "I feel that it is important to have this type of resource to be able to provide water for our future generations…We need to keep this history intact, grow the Archives with additional history and let people know of its existence. This will only enhance our ability to work with water issues, such as our drought that we have today."

Water Tables would not have been possible without the generous help of the Water Tables Planning Committee and our dedicated sponsors. Those sponsors include Applegate Group, Inc., Harrison Resource Corporation, Northern Colorado Water Conservancy District, Stewart Environmental Consultants, Inc., Aqua Engineering, Inc., Ayres Associates, Boyle Engineering Corporation, CDM, Leonard Rice Engineers, Inc., New Frontier Bank, Black and Veatch, the Hilton Fort Collins and Hydro Construction Company, Inc.

2006 Water Tables Hosts and Topics

Jack G. Byers, Deputy State Engineer for State of Colorado, and **Dick Wolfe**, Assistant State Engineer: *Historical and Future Perspectives of the Colorado Division of Water Resources.*

Craig Harrison, Harrison Resource Corporation: *The Meek Shall Inherit the Earth . . . But Not The Water Rights: Buying, Selling, and Exchanging Water Rights*.

Justice **Gregory J. Hobbs**, Jr., Colorado Supreme Court Justice:
T*he Role of Climate on Colorado and Western Water Institutions.*

Commissioner **John W. Keys, III**, 16th Commissioner of the Bureau of Reclamation: *Managing Water in the American West*.

Susan Kirkpatrick, former Colorado State Director for Audubon Colorado: *The Federal Endangered Species Act and its Importance for Water Policy*.

Roger K. Patterson, President of Patterson Consulting, Inc.: *The Republican River Compact.*

Bennett Raley, former Assistant Secretary for Water and Science for the U.S. Department of Interior: *Water Policy Issues Facing Colorado*.

Michael J. Ryan, Bureau of Reclamation's Great Plains Regional Director: *Water Marketing.*

Gregory E. Smoak, Assistant Professor of History at Colorado State University: *Tribal Sovereignty and Water Rights in the American West*.

Dick Stenzel, former Division One Engineer for the Colorado Division of Water Resources: *Little Known Trivia Regarding the Transformation of Colorado from the Great American Desert*.

Dan Tyler, Emeritus Professor of History at Colorado State University: Conflict and Compromise: *How Do You Get a Deal When No One Wants to Budge an Inch?*

Ruth Wright, former House Minority Leader of the Colorado State Legislature: *Colorado Water Issues with Respect to Legislative Action*.

Virtual Exhibit Documents Delph Carpenter's Role in Western Water

Colorado State University Libraries' Water Resources Archive is proud to announce the launch of a virtual exhibit documenting Delph Carpenter's influential role in western water policy. "Carpenter and the Compacts" features digital images and information from the Water Resources Archive's Delph Carpenter Collection.

Carpenter, often referred to as the "Father" of the Colorado River Compact, was a Greeley water lawyer who identified the compact clause of the U.S. Constitution as a way to resolve water conflicts among western states. Carpenter's papers provide a wealth of information on interstate water treaties, prior appropriation, water-rights adjudication, the role of the federal government, and state sovereignty.

The new virtual exhibit offers an important glimpse into Carpenter's contributions. With photographs, digital images of important documents, as well as other materials that highlight Carpenter and his historic work, the Water Resources Archive virtual exhibit now offers world wide access via the Colorado State University Libraries' Web site. Log on for a visit today (http://lib.colostate.edu/archives/water/compacts/)

Colorado Water Supply Issues –Today and Tomorrow

Friday, April 14th, 2006

Mount Vernon Country Club

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Papers of Carl Nordin Saved From Shredder to Join Archives

Boxes of old papers gathering dust in an attic or taking up needed office space just might be priceless hidden treasures when gifted to an archive where they become essential primary research materials. Researchers find evidence of events and ideas of the past that are critical to historical interpretation of that past. The potential impact of these materials is impossible to gage, therefore, the mention of an appointment with a paper shredding company sends shivers down the spine of any archivist.

Beating the blades of the shredder, the Water Resources Archives acquired the Papers of Carl F. Nordin, a part-time professor and consultant of engineering at Colorado State University. During his long career as a hydraulic engineer, Nordin worked on research projects for the U.S. Army Corps of Engineers and the Federal Highway Administration. He also served as project director for the Water Resources Division of the U.S. Geological Survey. His work on water took him to places as far away as China, Egypt, and the Amazon.

Patricia Nordin had stored her late husband's papers in a garage storage room for some time. When it was time to move, she made an appointment with a company to shred these materials. A few days before the appointment with the shredding company, Mrs. Nordin heard about the Archive's quest for materials. After surveying the materials, Archivist Patty Rettig knew that Carl Nordin's papers would make an excellent addition to the Archive.

The Nordin collection—which consists of slides, photographs, reports, correspondence, maps, graphs and other papers—documents Nordin's work on water in Colorado and all over the world. Water concerns highlighted in Nordin's papers include his work on alluvial river flows in Colorado. Author and co-author of more than 100 hydraulic and hydrology reports, his papers now call the Archive home.

As part of the Archive, Carl Nordin's papers will be carefully preserved under controlled conditions, while at the same time be available for pubic study. The Archive will process the collection in the coming months and develop a finding aid. To view the collection and study Carl Nordin's valuable contributions to water around the world, visit the Archive in Morgan Library.

Law of the Colorado River
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Mark Limbaugh
Assistant Secretary for Water and Science

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Joench-Clausen, CSU Alum, Receives International Water Award

Dr. T. Joench-Clausen, DHI Director for Development and Innovation has been awarded the prestigious King Hassan II Great World Water Prize. The price was presented by the Moroccan Prime Minister on March 16th at the opening ceremony of the 4th World Water Forum in Mexico City.

The King Hassan II Great World Water Prize was established as a joint initiative of the World Water Council and the Government of Morocco and is awarded every third year. The award ceremony of the second King Hassan II Great World Water Prize was carried out during the inaugural ceremony of the 4th World Water Forum, and was awarded to Dr.Torkil Jonch Clausen, Director of the Water and Environment Institute of Denmark and Chair of the Danish Water Forum, for his outstanding action to improve the integrated water resource management at the global scale. He has worked in the sphere of water management for 35 years in more than 40 countries.

The general theme of the Prize is cooperation and sound management in the development and use of water resources, in memory of his Majesty King Hassan II. With the Prize comes a check of US $ 100,000, which Dr. T. Joench-Clausen has decided to donate to a new fund, which will support 3rd world women's education and training within integrated water resources management.

Joench-Clausen

Dr. T. Joench-Clausen received his PhD at Colorado State University working under Hubert Morel-Seytoux. He returned to Denmark after receiving his PhD and worked with the Danish Hydraulics Institute (DHI). He worked for the Danish agency for international development and spent several years in Bangladesh. He served as Director of the Danish Water Quality Institute before taking on a major leadership/organizational role in the World Water Council's Technical Advisory Committee.

Further information is available at: http://www.worldwatercouncil.org.

Research Experiences for Undergraduates Program in Water Research at Colorado State University

Summer 2006

Fifteen select undergraduate students will undertake individual research projects in water research, under the supervision of a CSU faculty member, over the course of 8 weeks. Participation includes weekly workshops, seminars, field excursions, and discussion on water research topics. Students will present results at the end of program symposium.

REU students will receive stipend of $3,000 for participation. Housing will also be provided.

Eligibility Requirements

* At least a junior standing in appropriate major at time of application with good academic standing
* Must have at least one semester left prior to graduation as of June 1, 2006
* Complete and submit online application form with a copy of transcripts and two letters of reference
* One to two page essay describing student's interest in water research

For more information or to apply online go to: http://WaterREU.colostate.edu/

USGS Water Related Publications Available

The U.S. Geological Survey has recently published several reports of interest to Colorado water experts. Copies are available for inspection at the Water Resources Research Institute library in E122 Engineering Bldg, CSU, Fort Collins. They may be ordered from the USGS, Federal Center, Box 25286, MS 517, Denver, CO 80225. You may call 1-888-ASK-USGS for price information or go to www.usgs.gov.

Effects of Emission Reductions at the Hayden Powerplant on Precipitation, Snowpack, and Surface-Water Chemistry in the Mount Zirkel Wilderness Area, Colorado, 1995-2003 by M. Alisa Mast, Donald H. Campbell, and George P. Ingersoll
(USGS Scientific Investigations Report 2005-5167)

Precipitation, snowpack, and surface-water samples collected during 1995-2003 were analyzed to evaluate environmental effects of emission reductions at the Hayden powerplant on the Mount Zirkel Wilderness Area. The Hayden powerplant, one of two large coal-fired powerplants in the Yampa Valley, was retrofitted with control systems during late 1998- and 1999 to reduce emissions of sulfur dioxide and nitrogen oxide-the primary precursors of haze and acidic precipitation. Concentrations and deposition rates of selected constituents were compared for the periods before and after emission reductions at the Hayden powerplant. The trend of decreasing sulfur dioxide emissions throughout western North America over the past 20 years is reflected in reduced concentrations of sulfate in lakes that were part of this study, as well as other lakes in the Rocky Mountains. However, detection of the surface-water response to changes in deposition requires a sufficiently long record to minimize effects of climate variability and to allow for lag time as sulfate moves through storage in soil, ground water, and lake reservoirs.

Historical Perspective of Statewide Streamflows During the 2002 and 1977 Droughts in Colorado by Gerhard Kuhn
(USGS Scientific Investigations Report 2005-5174)

Because the drought of 2002 had a substantial effect on streamflows in Colorado a study began in 2004 to analyze statewide streamflows during 2002 and develop a historical perspective of those streamflows. The purpose of this report is to describe an analysis of streamflows recorded throughout Colorado during the drought of 2002, as well as other drought years such as 1977, and to provide some historical perspective of drought-diminished streamflows in Colorado.

Water Conservation Workshops and Forums Planned

A Water Efficiency Grant from the Colorado Water Conservation Board will enable three organizations to promote water conservation and water efficiency. The three organizations, Great Western Institute, Colorado WaterWise Council and Western Resource Advocates will provide technical workshops and forums throughout the state suring the spring and summer of 2006. Sixteen local water users, water providers, and other water stakeholders in six of the seven major river basins endorsed the project.

Great Western Institute is a Colorado non-profit whose mission is to promote water resource conservation through education, research and policy. The professional organization Colorado WaterWise Council promotes the efficient use of Colorado's water. Western Resource Advocates works to protect and restore the land, air and water resources of the Rocky Mountain States.

Ogallala SymposiumVenue for Discussion of Shared Interests

Lori Brunswig, Colorado State University

We are all tied together by a dependence on our water resources, according to Jim Goeke, hydrogeologist with the University of Nebraska's West Central Research & Extension Center. This dependence can bring us together and did at the Ogallala Aquifer Symposium held on February 20, 2006 at Wray, Colorado, which was attended by about 250 participants.

The continuing depletion of the Ogallala Aquifer and the declining levels of the Republican River have been the subject of much discussion, research, and debate. The dispute Kansas had over shares of the Republican River began in 1988 with Nebraska and then included Colorado in 2000 continuing until 2002 when a final settlement was reached. The amount of water Colorado and Nebraska can pump from the Republican River basin is now defined. What is not so clear is how the two states will comply with the settlement.

(Above)
Jim Goeke (University of Nebraska) answers questions between presentations.

(Right)
Conference organizers Alan Helm and Dennis Kaan of CSU Cooperative Extension take a break during the proceedings.

Dave Barfield (Kansas Division of Water Resources) reported that Kansas and Colorado stopped well development by 1980 but in Nebraska 20,000 high capacity wells were developed since 1984, which added to the 100,000 wells already existing before that time. The level of the Ogallala Aquifer under Nebraska has changed very little over the years making it difficult for Nebraskans to understand their role in creating the reduced flows of the Republican and other rivers. According to Jim Goeke, Nebraska is just beginning to understand the connection between groundwater pumping and surface water flows. Carol Angel (Colorado Attorney General's office) stated that Colorado is currently in debt to Kansas for taking more water than the allotted amount in part due to the drought. Colorado has two years to get their water debt covered. This dept is cumulative and must be made up or a non-voluntary program will implemented.

Mike Thompson (Nebraska Department of Natural Resources) said that there are currently 37,000 acres in CREP and 10,000 acres in EQIP in Nebraska. They are working on a long-term strategy to reduce water pumping by using new technologies, land retirement, and riparian vegetation management to comply with the compact. According to Thompson, there is a need for research to help farmers understand how to deal with the water shortage.

Scott Richrath (Colorado's Division of Water Resources) and Dennis Coryell (Colorado Ground Water Commission) brought participants up to

speed on the activities of the Republican River Conservation District (RRCD). In order to comply with the settlement with Kansas, the RRCD starting charging a fee as of January 1, 2005, of $5.50 per irrigated acre. Coryell stated that the CREP sign-up for 2005 was good but did not result in the retirement of many wells. A full time water commissioner will begin working with the district to monitor acreage and pumping.

Luis Garcia (Colorado State University) explained his research on remote sensing of evapotranspiration and crop stress reduction as it applies to applications for water resources, irrigation, and drainage. Through this research, Garcia can identify the impacts of salinity on crops and determine the efficiency of irrigation systems using technologies such as GIS, numerical modeling and, and databases. David Nielson (USDA) talked about increasing residue to capture moisture and reduce evaporation rates. He gave the example that no-till wheat stubble can capture about twice the amount of water as conventional tillage. He showed the audience slides of two fields adjacent to each other with one having stubble and the other tilled. Snow had fallen on each field but evaporated or blew off the tilled field, while the stubble field was covered with snow.

Nolan Doesken (CSU Climate Center) said the 1980s and 90s were moist, but since that time we have been experiencing a wide-spread drought coupled with high temperatures, resulting in a decline in ground water.

CSU Extension Water Resources Specialist and conference organizer, Joel Schneekloth, talked about different options to reduce pumping from the Republican River basin such as reducing crop evapotranspiration by changing to crop types that use less water, reducing the amount of irrigated acreage and a rotation from high to low water use crops. He also said that alternate crops should be

(Top)
Rob Wawrzynski (Colorado Department of Agriculture) and Troy Bauder (CSU) were among the many exhibitors present.

(Left)
Patti Rettig (Water Archivist at CSU Morgan Library) and Reagan Waskom (interim director of CWRRI) pause for a moment of conversation.

(Above)
Ron Meyer (CSU Cooperative Extension) and Dennis Coryell (Colorado Groundwater Commission) discuss the new conservation district.

RESEARCH AWARDS

Colorado State University, Fort Collins, Colorado
Awards for February 06 to March 2006

Waskom,Reagan M--CWRRI--DOI-USGS-Geological Survey--*Technology Transfer & Information Dissemination CWRRI* --**$48,735.00**

Waskom,Reagan M and James Pritchett--CWRRI--DOI-USGS-Geological Survey--*Colorado's Evolving Irrigated Agriculture: Economic Accounting Impact Analysis*--**$16,000.00**

Waskom,Reagan M--CWRRI--DOI-USGS-Geological Survey—*CWRRI Program Administration Project* --**$26,800.00**

Niemann,Jeffrey D--Civ Eng--DOD-ARMY-ARO-Army Research Office--*Scaling Properties & Spatial Interpolation of Soil Moisture*--**$100,000.00**

Garcia,Luis—Civ Eng--DOI-Bureau of Reclamation--*Subsurface Drainage Research* --**$14,053.00**

Carlson,Kenneth H—Civ Eng--CH2M Hill--*Aquifer Recharge and Recovery (ARR) Testing* --**$102,600.00**

Kummerow,Christian D--Atmospheric Sci--NASA - Natl Aeronautics & Space Admin.--*A Physical Validation Approach for Precipitation* --**$27,462.00**

Hicke,Jeffrey A--Natural Resources Eco Lab--DOI-USGS-Geological Survey--*Western Mountain Initiative: Response of Western Mountain Ecosystems to Climatic Variability & Change*--**$191,457.00**

Bauder,Troy A--Soil Crop Sci--Colorado Department of Agriculture--*The Training and Education for Agricultural Chemicals and Ground Water*--**$55,000.00**

Binkley,Daniel E--Forest Rnglnd Wtrshd Stwdshp--Oregon State University--*Connecting History with the Future Forests of Colorado*--**$11,000.00**

Welch,Bradley A--Forest Rnglnd Wtrshd Stwdshp--NASA - Natl Aeronautics & Space Admin.--*Using NASA's Invasive Species Forecasting System to Support NPS Decisions on Fire Management Activities and Invasive?*--**$82,650.00**

Johnson,James Bradley--Biology--Colorado Department of Natural Resources--*Reference Conditions in Rocky Mountain Wetlands*--**$11,499.00**

Poff,N LeRoy--Biology--EPA - Environmental Protection Agency--*Linking Watershed Characteristics with Flow Regime & Geomorphic Context to Diagnose Water Quality Impairment* --**$273,262.00**

Sommers,Lee E--Ag Experiment Stn--Utah State University--*Drip Irrigation as a Means of Reducing the Rate of Dewatering of Groundwater Aquifers in Baca County, Colorado*--**$9,353.00**

Kathlene,Lyn--CO Pub Policy Inst--Colorado Department of Natural Resources--*Water Basin Negotiaion Charter* --**$21,945.00**

Ramirez,Jorge A--Civ Eng--DOD-ARMY-ARO-Army Research Office--*Quantifying the complex hydrologic response of an ephemeral desert wash*--**$84,469.00**

Gates,Timothy K--Civ Eng--Southeastern CO Water Conservancy Distr.--*Part 2, Monitoring and Modeling Toward Optimal Management of the Lower Arkansas River*--**$100,000.00**

L'Ecuyer,Tristan S--Atmospheric Sci--NASA - Natl Aeronautics & Space Admin.--*New Satellite Energy Balance and Water Cycle Products for the Study of Interactions* --**$161,026.00**

Schneekloth,Joel--Coop Ext--Republican River Water Conservation Dist--*Crop Rotations and Limited Irrigation* --**$29,016.00**

Norton,Andrew P--Bioag Sci & Pest Mgmt--State Board of Land Commissioners--*Monitoring Saltcedar (Tamarix) Biological Control (Diorhabda elongata) Insectary Establishment in Adams County*--**$9,100.00**

Thornton,Christopher I--Civ Eng--SNWA-Southern Nevada Water Authority--*Hydraulic Study of Sloped Rock Structures* --**$232,911.00**

Carlson,Kenneth H--Civ Eng--CH2M Hill--*Aquifer Recharge and Recovery (ARR) Testing* --**$95,660.00**

Wilkins-Wells,John Reese--Sociology--University of Colorado--*Western Water Assessment - Providing Increased Focus on the Crucial Agricultural Sector*--**$48,913.00**

Fausch,Kurt D--Fish & Wild Bio--Fisheries Conservation Foundation--*A Documentary Video on Interconnections between Forests and Streams: Segment III*--**$35,000.00**

Johnson,Richard H--Atmospheric Sci--NSF - National Science Foundation--*Study of Monsoon Processes Using Sounding Data from North American Monsoon Experiment*--**$125,509.00**

Randall,David A--Atmospheric Sci--DOE - US Department of Energy--*Use of ARM Data to address the Climate Change Problem*--**$400,000.00**

Bledsoe,Brian--Civ Eng--NSF-GEO-Geosciences--*CAREER: Stream Restoration, Ecological Engineering and Nutrient Retention of Streams in Urban and Agricultural Settings*--**$97,042.00**

Salas,Jose D--Civ Eng--DOI-Bureau of Reclamation--*Phase II: Development of Stochastic Hydrology for the Colorado River System*--**$165,278.00**

Culver,Denise R--Fish & Wild Bio--Colorado Department of Natural Resources--*Survey of Critical Wetlands in Hinsdale County, Colorado*--**$63,507.00**

Rocchio,Joseph F--Fish & Wild Bio--Colorado Department of Natural Resources--*Vegetation IBI for Wetlands in Colorado - Phase III*--**$77,586.00**

Johnson,James Bradley--Biology--Colorado Department of Transportation--*Development and validation of the Functional Assessment Method for Colorado Wetlands*--**$44,783.00**

Johnson,James Bradley--Biology--Colorado Department of Transportation--*Development and validation of the Functional Assessment Method for Colorado Wetlands*--**$45,217.00**

Knapp,Alan Keith--Biology--Kansas State University--*Effects of altered rainfall timing and warming on soil processes and plant responses in a grassland ecosystem*--**$27,933.00**

Roesner,Larry A--Civ Eng--Water Environment Research Foundation--*Guidance for Stormwater-Borne Solids* --**$74,999.00**

Abt,Steven R--Civ Eng--USDA-USFS-Rocky Mtn. Rsrch Station - CO--*Bedload Transport in Gravel-bed Rivers & Channel Change*--**$69,624.00**

University of Colorado, Boulder, Colorado
Recent Research Awards

Siegrist, Robert, Michelle Crimi, Tissa Illangasekare, Junko Munakata-Marr, Tom Simpkin (CH2MHill), Tom Palaia (CH2MHill), and Mike Singletary (Navy) --Department of Defense-- *Environmental Security Technology Certification program (ESTCP) In Situ Chemical Oxidation for Groundwater Remediation Technology Practices Manual.* **$995,619** .

Siegrist, Robert and Michelle Crimi-- DoD Strategic Environmental Research and Development Program (SERDP) --*Improved Monitoring Methods for Performance Assessment during Remediation of DNAPL Source Zones* -- **$162,296.**

Research awards from institutions of higher education in Colorado other than Colorado State University are provided by self-report of the Principal Investigator. If you have water related research awards to report, send them to Gloria.Blumanhourst@colostate.edu.

MEETINGS

Innovative Approaches to Water Leasing and Canal Company Cooperation in Face of Municipal Demands for Agricultural Water Supplies

April 25, 2006

Gobin Community Center
105 North Main Street,
Rocky Ford, CO

- How to protect and maintain agricultural water supplies while improving water equity valley for agricultural landowners
- Issues and problems surrounding water leasing option and water banking
- Strategies for improving cooperation between canal companies and their water supplies
- Policy issues

Reegistration fee $5, payable at entrance. Please preregister by sending name, organization affiliation, address including city, state, and zip, and phone number to John Wilkins-Wells at fax (970) 491-5635, johnww@lamar.colostate.edu, or by mail to Sociology Water Lab, Dept of Sociology, Clark Bldg B258, Colorado State University, Fort Collins, CO 80523

31st Water Workshop at Western State College of Colorado: The Developed Resource

July 26-28, 2006
Gunnison, CO

"We are no longer developing a resource. We are learning how to share a developed resource." Justice Greg Hobbs, at 20th Water Workshop.

Is the resource "fully developed," or is there still water to develop? Is augmentation a plausible possibility? Or are we entering a new era of "challenging choices"?

What are the implications of a "developed resource" in a cultural environment of usufruct appropriation from the commons? Is the appropriations doctrine flexible enough to adapt to a "finite West," or are we moving toward new layers of compacts and agreements among users?

For more information including registration, go to http://www.western.edu/water/ .

StormCon '06

July 24 to 27, 2005
Adam's Mark Hotel
Denver, Colorado

- 216 Presenters from 35 states and 5 countries
- Proven techniques for solving community, construction site and industrial storm-water pollution
- 175 vendors, contractors, and consultants exhibiting equipment, product, and services

Topics covered:
- BMPs in Practice
- Managing the Stormwater Program
- Research and Testing of BMPs
- Comprehensive Water Quality Management

StormCon is presented by Forester Communications, publisher of Stormwater magazine.

For more information including how to register, go to: www.stormcon.com

Climate Change and the Future of the American West

June 7-9, 2006

The Natural Resources Law Center
University of Colorado School of Law

"Global warming exists and we have to do something about it."
John H. Marburger III, Science Adviser to President George W. Bush
Princeton University, Spring, 2005

The Natural Resources Law Center's 2006 summer conference will explore a wide range of issues from climate science, to the impacts of climate change on water resources and ecological systems. It will consider the implications of climate change on land use and transportation, energy resources, and the business community. This will set the stage for an exploration of the legal and policy dimensions of climate change, with attention focused on all levels of government. The conference will conclude with two panels that look toward the future. The first will consider what we in the West might do to confront climate change, and the second will look more broadly at the future of the American West in a world facing climate change. Please join us for what promises to be an outstanding program for lawyers, resource professionals, and policymakers. Continuing legal education credit will be available.

Who Should Attend? This is a conference for people who face decisions relating to climate change, and for the lawyers and others who advise the decision-makers. It is also for people who are interested or involved in the law and policy of climate change, including government policymakers, academics, and representatives from affected industries and non-governmental organizations.

What Should I Expect from the Conference? Many aspects of our lives will ultimately be affected by climate change. It will impact how and where we live, how we recreate, how we get from place to place, and it will dramatically impact the types of energy available to us to do all of the things we do. The conference is designed to provoke discussion about the consequences of climate change and the choices we face. The conference will conclude with a discussion about how we, as a community, can "do something about" climate change.

If your organization is interested in becoming a sponsor of the conference, or if you would like additional information about the program please contact the Center at nrlc@colorado.edu.

Registration information, the agenda, and speakers, as they become available, will be posted at: http://www.colorado.edu/law/centers/nrlc/summerconference/

NCES 8236: Introduction to Floodplain Management

Thursday and Friday, April 27 and 28, 2006
Thursday, 8:00 a.m. - 5:00 p.m. and
Friday, 8:00 a.m. - 12:00 noon

More info and registration form located at www.cudenver.edu/engineer/cont

Nonpoint Source Forum 2006
More than Brochures -- Real Change

One Workshop, Choice of Days
September 6 or 7, 2006
PPA Event Center, Denver, CO

Most people know that to protect the environment they should recycle more, water their lawns less, get out of the car and take a multitude of other steps to reduce their ecological footprint. This is the starting point.

However, research indicates that each form of sustainable behavior has its own set of barriers and benefits. Our workshop presenter, **Doug McKenzie-Mohr**, has been working to incorporate scientific knowledge of behavior change into the design and delivery and evaluation of community programs.

A professor of environmental psychology at St. Thomas University, New Brunswick, McKenzie assisted in the development of Canada's public education efforts on climate change, served as a member of the Canadian National Round Table on the Environment and Economy, and presented science-based community programs around the world.

The workshop covers four key areas:

►How to identify the barriers to a desired behavior, such as reducing lawn watering or pesticide use,

►How to use behavior change "tools" to design more effective programs,

►How (and why) to pilot test a program, and

►How to evaluate the impact of a program once it has been implemented.

For more information and registration, go to http://www.npscolorado.com/

CALENDAR

Apr. 20-21	**A Hundred Years of Change: Arkansas River Basin Water Forum.** Poncha Springs, CO. For more information visit www.arbwf.org
Apr. 25	**Innovative Approach to Water Leasing and Canal Company Cooperation in Face of Municipal Demands for Agricultural Water Supplies.** Rocky Ford, CO. Registration fee of $5, payable at entrance. For more information regarding location and how to register contact John Wilkins-Wells at johnww@lamar.colostate.edu .
Apr. 27-28	**NCES 8236: Introduction to Floodplain Management.** For more information and to register visit www.cudenver.edu/engineer/cont
May 4-5	**Third Annual Water Law, Science and Policy Conference: Adaptive Management for Resilient Water Resources.** Nebraska City, NE. For more information go to: http://snr.unl.edu/waterconference/.
May 4-5	**Nondetects and Data Analysis.** Hotel de Anza, San Jose, CA. For more information go to: http://www.mines.edu/igwmc/short-course/
May 5-9	**River Network's National River Ralley 2006. Bretton Woods, NH.** For more information, go to www.rivernetwork.org/rally.
May 7-9	**2006 West Regional Conference, Overland KS.** For more information go to www.damsafety.org
May 8-10	**American water Resources Association 2005 Spring Specialty Conference: Geographic Information Systems and Water Resources IV.** Houston, TX. For more information go to http://www.awra.org/Houston2006/index.html
May 11-12	**Law of the Colorado River.** Tuscon, AZ. Keynote speaker: Mark Limbaugh, Asst. Secretary for Water & Science. For more information or to register online go to http://www.cle.com
May 15	**Deadline for paper submissions for 2006 AWRA Annual Conference Call for Abstracts,** Baltimore, MD on November 6-9, 2006. For more information, go to http://www.awra.org
May 17-19	**9th Inter-Regional Confrence on Environment – Water: Concepts for Water Management and Multifunctional Land-Uses in Lowlands.** UNESCO I.H.E., International Institute for Infrastructural, Hydraulic and Environmental Engineering, Delft, The Netherlands. For more information go top http://www.wau.nl/rpv/isomul/envirowater2006 .
May 17-19	**Rocky Mountain Section, Geological Society of America, 58th Annual Meeting,** Western State College, Grand Gunnison, CO. For more information go to www.geosociety.org.
May 19-21	**Polishing Your Ground-Water Modeling Skills. Colorado School of Mines, IGWMC Short Course.** Golden, CO. For information on registration deadlines, fees, or to register online, go to http://www.mines.edu/igwmc/short-course/
May 19-21	**Introduction to ArcGIS. Colorado School of Mines, IGWMC Short Course.** Golden, CO. For information on registration deadlines, fees, or to register online, go to http://www.mines.edu/igwmc/short-course/
May 19-21	**Finite Element Ground Water Modeling using FEFLOW. Colorado School of Mines, IGWMC Short Course.** Golden, CO. For information on registration deadlines, fees, or to register online, go to http://www.mines.edu/igwmc/short-course/
May 19-21	**Analysis of Surface Water-Groundwater Flow Systems Using Integrated Codes, Colorado School of Mines, IGWMC Short Course.** Golden, CO. For information on registration deadlines, fees, or to register online, go to http://www.mines.edu/igwmc/short-course/
May 21-24	**MODFLOW and MORE 2006: Managing Groundwater Systems.** Golden, CO. For information and registration, go to http://typhoon.mines.edu/events/modflow2006/modflow2006.shtml
May 24-26	**Modeling Water Flow and Contaminant Transport in Soils and Groundwater Using the HYDRUS Computer Software Packages. Colorado School of Mines, IGWMC Short Course.** Golden, CO. For information on registration deadlines, fees, or to register online, go to http://www.mines.edu/igwmc/short-course/
May 24-26	**Subsurface Multiphase Fluid Flow and Remediation Modeling. Colorado School of Mines, IGWMC Short Course.** Golden, CO. For information on registration deadlines, fees, or to register online, go to http://www.mines.edu/igwmc/short-course/
May 24-26	**Phreeqc Modeling: The Basics. Colorado School of Mines, IGWMC Short Course.** Golden, CO. For information on registration deadlines, fees, or to register online, go to http://www.mines.edu/igwmc/short-course/
May 24-26	**GIS for Water Resources. Colorado School of Mines, IGWMC Short Course.** Golden, CO. For information on registration deadlines, fees, or to register online, go to http://www.mines.edu/igwmc/short-course/

May 24-26	**UCODE-2005 and Pest: Universal Inversion Code for Automated Calibration. Colorado School of Mines, IGWMC Short Course.** Golden, CO. For information on registration deadlines, fees, or to register online, go to http://www.mines.edu/igwmc/short-course/
Jun. 7-9	**Climate Change and the Future of the American West.** Natural Resources Law Center, University of Colorado School of Law, Boulder, CO. For more information go to www.colorado.edu/law/summerconference .
Jun. 26-28	**Adaptive Management of Water Resources, American Water Resources Association 2006 Sumer Specialty Conference.** Missoula, Montana. For more information, go to http://www.awra.org .
Jul. 18-20	**2006 UCOWR Annual Conference: Increasing Freshwater Supplies.** Santa Fe, NM. For more information, go to http://www.ucowr.siu.edu/.
Jul. 22-26	**Annual Meeting of International Soil and Water Conservation Society**. Keystone, CO. For more information go to: http://www.swcs.org/en/swcs_international_conferences/2006_internationalconference/
Jul. 24-27	**5th Annual North American Surface Water Quality Conference and Exposition.** Denver, CO. For more information, go to http://www.stormcon.com/sc.html.
Jul. 26-28	**31th Colorado Water Workshop: The Developed Resource.** Western State College of Colorado, Gunnison, CO. For more information contact George Sibley at 970-943-2055 or gsibley@western.edu or go to http://www.western.edu/water/
Sep. 6 or 7	**Nonpoint Source Forum 2006: More than Brochures—Real Change.** Denver, CO. For more information and registration, go to http://www.npscolorado.com
Sep. 10-14	**Dam Safety '06. Boston.** For more information, go to www.damsafety.org or call 859-257-5140.
Sep. 18-20	**Wetlands Restoration Dialogue,** Fort Lauderdale, FL. For more information go to http://www.awra.org/meetings/
Sep. 26-28	**3rd International Symposium on Integrated Water Resources Management.** Ruhr-University, Bochum, Germany. International Commission on Water Resources Systems. For more information go to http://conventus.de/water/
Oct. 25-28	**Ground Water and Surface Water Under Stress: Competition, Interaction, Solutions**. Boise, Idaho. For more information go to www.uscid.org/
Nov. 1	**Deadline for paper submissions to Fourth International Conference on Irrigation and Drainage: Role of Irrigation and Drainage in a Sustainable Future**. Sacramento, CA. for more information go to http://www.uscid.org/
Nov. 6-9	**American Water Resources Association 2006 Annual Conference.** Baltimore, MD. For more information go to www.awra.org/meetings/Baltimore2006/.
2007	2007
Jan. 25-26	**Colorado Water Congress 49th Annual Convention.** Denver, CO. For more information go to: www.cowatercongress.org, or phone 303/837-0812, or email macravey@cowatercongress.org .
Sep. 30 to Oct. 5	**Fourth International Conference on Irrigation and Drainage: Role of Irrigation and Drainage in a Sustainable Future**. Sacramento, CA. for more information go to http://www.uscid.org/

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Colorado Water Newsletter Reader Survey

I read the newsletter *Colorado Water*
___ every issue ___most of the time ___depends on theme ___sometimes ___rarely ___never

When I read the newsletter *Colorado Water*, I read
___cover to cover
___more than half the content
___about half the content
___less than half the content
___headlines and first paragraphs only
___headlines and only articles I'm interested in

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Colorado Water presents timely and important information.
___Definitely agree ___ Mostly agree ___Mostly disagree ___Definitely disagree

Colorado Water is important to my ability to perform my job/studies/etc.
___Definitely agree ___ Mostly agree ___Mostly disagree ___Definitely disagree

Colorado Water provides (choose as many as apply)
___an authoritative source of water information
___ more information than I need on some topics
___too much focus on some topics
___interesting updates on research and current issues
___a good variety of topics
___not enough information on some critical topics

cut here

Comments on this question to help us understand your needs, preferences, etc.

I prefer *Colorado Water*'s focus on one theme in each issue
___Definitely agree ___ Mostly agree ___Mostly disagree ___Definitely disagree

Colorado Water provides more information than I need.
___Definitely agree ___ Mostly agree ___Mostly disagree ___Definitely disagree

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Tell us which topics or features have too much coverage:

Please rank the five (5) most important features in the *Colorado Water* newsletter, where 1 is the most important.
___News digest
___Calendar of water events
___Meeting notices
___In-depth research updates (4 or more pages)
___Requests for proposals
___Faculty profiles
___Research award lists
___Meeting briefs
___Brief research updates (1-2 pages)

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Other comments (including address corrections and updates):

Thank you for your feedback and your time!

Return completed survey to Gloria Blumanhourst, Fax: 970-491-1636,
Email: Gloria.Blumanhourst@colostate.edu Mail: CSU - CWRRI, Fort Collins, CO 80523-1033

The **Calendar,** usually found here, is inside on **pages 34-35.**

Help us provide the best newsletter we can!

On the back of this page is a survey
which will help us understand your needs and preferences.

Please take a few minutes to fill out the survey,
and then fax or mail it back to us.

Your time, effort and answers will help us as we organize and design a new look
for the future of *Colorado Water.*

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

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