

Colorado Water

Colorado
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COLORADO WATER INSTITUTE

FIFTY
YEARS

RESEARCH | EDUCATION | OUTREACH



Colorado State University

Colorado Water

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Front Cover: CWI's housing university, Colorado State University, has a long history of involvement in water issues, and the institute has worked with many distinguished faculty over the years from all of the institutes of higher education in the state on a broad array of water issues. **Back cover:** CWI has worked with many students and faculty, such as Laurel Saito (top middle photo), who coordinated the first annual Student Water Symposium in 1997; Martina Gessler (now Martina Wilkinson, bottom left photo), who edited CWI publications in the early 1990s; and a student pictured with professor Freeman Smith who created CWI's first Water Knowledge website (bottom right). CWI makes efforts to connect with local water users and managers—local water manager Ralph Curtis talks to CSU professor Dan Smith in the bottom center photo—and supports youth education, such as the annual Children's Water Festival at top left. Photos Courtesy of CSU Archives & Special Collections, iStock.com



COLORADO WATER INSTITUTE

FIFTY YEARS

This year marks the 50th year of operation for the Colorado Water Institute. Formerly known as the Colorado Water Resources Research Institute, we are part of an enduring national network of 54 water institutes, with an institute in each U.S. state plus Guam, the U.S. Virgin Islands, Puerto Rico, and the District of Columbia. This issue of Colorado Water seeks to celebrate and capture a bit of our history as we mark 50 years in service to the water information needs of our changing society.

The water institutes have a unique mission, positioned between academic scholarship and the gritty world of water management and politics. The 1964 federal Water Resources Research Act sought to create long-term linkages between universities and state and federal agencies for the solution of the nation's water problems. A national network of water research institutes could focus locally on state problems, identifying research needs that could be filled at local universities. The national program is administered by the U.S. Geological Survey and provides a small annual base grant to each institute for research, coordination, outreach, and training. The Colorado Water Institute also has authorizing legislation by the Colorado Legislature, who changed the name from CWRRI during the last reauthorization in 2008. Research funds provided annually by the Colorado Water Conservation Board help fund faculty and students to work on high priority water issues.

The foundation and success of the Colorado Water Institute is attributable to the work of water faculty and their students over the past 50 years. Faculty at CSU, CU-Boulder, Colorado School of Mines, Mesa, UNC, CSU-Pueblo, Metro, Western State, and other public universities have collaborated with water managers in Colorado to identify and tackle the broad spectrum of contemporary water problems, including drought, flooding, groundwater, irrigation, drinking water, reservoir management, invasive species, water reuse and conservation, and many other

challenging topics over the years. The stability of the water institute program at CSU and the dedication of its prior directors—Steve Smith, Norm Evans, Neil Grigg, and Robert Ward—created an organization that is well known to water managers and decision-makers, building the trust needed to infuse academic scholarship into the high conflict arena of water policy and politics.

Looking ahead, the Colorado Water Institute is well positioned to continue serving the water information needs of Colorado. CSU Provost Rick Miranda has increased our base budget, allowing us to bring Brad Udall, the institute's first senior water and climate researcher and scholar, on staff this year. CSU Vice President for Engagement Lou Swanson has unified the CSU Extension water program with CWI, increasing our reach and impact through three regional Extension water resources specialists located in Grand Junction, Pueblo, and Akron: Perry Cabot, Blake Osborn, and Joel Schneekloth. Our advisory board is made up of top water managers from across the state and at key state agencies. And most importantly, the water research faculty at CSU and other universities in Colorado continue to gain momentum and relevance in their research and outreach endeavors.

I am humbled by the legacy left by the four previous directors of the Colorado Water Institute, and I am grateful for the opportunity to work in the challenging world of higher education, as well as with the remarkable array of water experts in Colorado who are managing this critical public resource. Water will always be a challenge in Colorado and our universities must continue to develop and extend the best available science in an objective manner. Future Coloradans are counting on us.

Reagan Waskom

Director, Colorado Water Institute

Maury Albertson (left) and Ray Chamberlain (center) were active in Colorado State University's involvement in water research and programs. Courtesy of the Water Resources Archive, CSU Libraries



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CWI Mission Statement

To connect all of Colorado's higher education expertise to the research and education needs of Colorado water managers and users.

COLORADO WATER INSTITUTE

FIFTY YEARS

OF RESEARCH, EDUCATION, AND OUTREACH

An Interview with
Norm Evans, Neil Grigg, Robert Ward,
and Reagan Waskom



Lindsey Middleton

Left to right: Four of the five current and former Colorado Water Institute directors—Reagan Waskom, Norm Evans, Neil Grigg, and Robert Ward.

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By Lindsey Middleton, Editor, Colorado Water Institute

Beginning with Stephen Smith in 1965, there have been five directors of the Colorado Water Institute, each interacting with local, state, and federal pressures and guiding the institute through a changing political and natural climate. In order since then, Norm Evans, Neil Grigg, Robert Ward, and Reagan Waskom have served as director.

Founding of the Institute

The institute was formed under the 1964 Water Resources Research Act (WRRRA), which had the goal of creating a national platform for water research, collaboration, and training. When the Colorado institute formed in 1965, the political climate was favorable of water development and research. “Things were very bright in the early part of that period,” says Neil Grigg, director from 1988-1991. “There was a lot of progressive legislation passed, and that’s what the WRRRA is—it has a role for government.”

Prior to the 1960s, there had been a push for developing the water resource—dams, canals, transmountain diversions, and irrigation infrastructure were built. Colorado State University was also well-positioned in terms of water research. “If you get the old-timers to talk about the 1950s, people like Bob Longenbaugh or those who worked on the experiment station and water programs with agriculture and engineering, they will tell you, in the most excited terms, about this groundbreaking work that they were doing, to identify these problems that Colorado had,” says Grigg.

As the university expanded and added new programs of study and research, water and agriculture became leading areas of focus. “If you think about the early problems that CSU was created for, it was the engineering type problems that related to farming on the frontier, so it was natural that those two disciplines would emerge,” says Grigg. Early institutions, like the Agricultural Experiment Station—formed in what was then the Colorado Agricultural College—exemplify this focus. “The Ag Experiment Station existed before most of us came around, but it has played a strong role in how this university kept up with the needs

of research,” says Norm Evans, who was director of the water institute from 1967 to 1988.

Water research was an early focus at CSU (see CSU’s Legacy of Involvement in Water Issues on page 36 by Robert Ward, director from 1991 to 2005). According to Ward, the university recognized that “it was important to get critical resources here in terms of people and faculty, and they made that effort.”

During the 1950s, CSU president Bill Morgan would campaign to change the name of then Colorado A&M to Colorado State University to lend a legitimacy to the degrees earned at the school—Norm Evans was among the first Ph.D. students to earn a degree under the auspices of the university’s new status. In addition to contributing to the university’s changing role and status, President Morgan also played a central role in the passage of the WRRRA by acting as a spokesperson to Congress for institutes of higher education.

Despite such strong support at the institute’s beginnings, there were challenges that water research would encounter and that water institute directors would face during their careers. “There were a lot of controversies between policies and the role of the university,” says Grigg. “And the institute director has always had a pivotal role in trying to sort that out and be a good coordinator.”

Challenges of a Changing Social and Political Climate

“Right after the WRRRA passed in 1964, you had the Federal Water Quality Act of 1965 that required each state to set up a commission of citizens to oversee the creation of water quality standards and apply them to all streams of the state for purposes of management,” says Ward. The institute’s director at the time, Norm Evans, was a founding member of Colorado’s commission, and Evans recalls an adversarial environment created locally because of the increasing role of the federal government in managing water quality during the 1970s.

During the 1970s and ‘80s, federal support for water research programs declined, and new regulations, originating from environmental legislation of the 1960s and ‘70s, came into play and changed the role of water research. There was now more of an emphasis on water quality issues.

In addition to contributing to the university’s changing role and status, [CSU] President [Bill] Morgan also played a central role in the passage of the [Water Resources Research Act] by acting as a spokesperson to Congress for institutes of higher education.

FIFTY YEARS OF RESEARCH, OUTREACH, AND EDUCATION

“As we got into the late ‘70s, with the Carter administration’s ‘hit list’ for new water projects, the water research programs began to fall out of favor. By the ‘80s you had the Ronald Reagan administration going, and they wanted to close up anything that had government involvement—water research, water planning—they shut down the Water Resources Council, so it was kind of like putting some of our programs into the ice box,” says Grigg.

The institute’s second director, Evans, was with the institute for 21 years, and saw much of the transition that went on in the 1970s and 1980s, which Grigg characterizes as a time when federal water research support began shutting down. “It was hard to get funding,” says Grigg. “You need funding—you need federal funding, you need state funding—to provide seeds for all of this, so I would say the period when I was director was maybe one of the toughest for the whole funding environment, both at federal and state levels.”

At times, the institute directors were able to, or even felt it necessary to, work with other organizations to get funding. “I viewed Extension and the Experiment Station as partners to try to leverage what money I had to

address key water problems,” says Ward. “One of the best examples was working with the Ag Experiment Station and Colorado State agencies to create the weighing lysimeter at Rocky Ford as part of implementing and managing the agreement on the Arkansas River Compact.” The partnership, says Ward, was a large-scale project that involved multiple collaborations. Despite this complexity, Ward says the project was a positive example of cooperation across research and management institutions. “I think it accomplished something that has been very beneficial to the state of Colorado,” he says.

Funding difficulties continued into the 1990s, and Ward discusses some of the issues he encountered trying to receive federal funding. Annually, water institute directors traveled from across the U.S. to Washington, D.C. to be accountable to Congress about how federal support of the WRRRI program was being used in their states. While Ward was director, regardless of the party, the President began removing water institute funding from his annual budget as presented to Congress. Thus, much of the time spent in Washington, D.C. during the 1990s and early 2000s was asking that water institute funding be restored

TIMELINE

1964

Water Resources Research Act

President Lyndon B. Johnson signed the act on July 17, 1964, establishing into law a Water Resources Research Institute in each state and Puerto Rico. There would later be institutes in the District of Columbia, the U.S. Virgin Islands, and Guam. The institutes, organized at land grant colleges and universities, were intended to provide a hub for water research and outreach that could tailor to meet the needs of local water communities.

1965 – Colorado Ground Water Management Act



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1966

Water Project Case Studies Begin

Director Stephen Smith initiated in-depth case studies of water bodies and man-made water projects relating to the Water Quality Control Commission, beginning with Chatfield Dam in 1966.



Norm Evans

1965-1967: Director Stephen Smith

1967-1988: Director Norm Evans



Stephen Smith

1965 Colorado’s Institute Forms

Colorado’s Water Resources Research Institute was initially formed as a division of Colorado State University’s Natural Resources Center (NRC), and many initial projects looked into the economic and legal aspects of water resources administration.

Blue Mesa Dam Completed – 1966



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1969 – Institute’s Housing Organization Changes Name

The NRC officially became the Environmental Resources Center (ERC) in 1969, and the Colorado Water Resources Research Institute (CWRRRI) remained a subset of this center.

by Congress. He recalls a frustration with this necessity. “My time with members of Congress was spent asking them to put us back into a budget rather than working with them and trying to find out what was important to them, and thinking about ways we could organize scientific teams to address emerging issues,” he says.

Lack of funding was not the only challenge the institute would face in its first 50 years. Events, perceptions, and policy changes also shaped how institute directors were able to carry out the institute’s mission. In 1989, during Grigg’s tenure, the Environmental Protection Agency vetoed the proposed Two Forks Dam, embodying tensions that had long undercut the interactions of various stakeholder groups invested in Colorado water management decisions.

Part of being institute director is learning to deal with these various interest groups. Ward, for example, talks about how water can be adversarial in Colorado by nature, since many decisions regarding water are argued in Water Court. When scientific findings align with one side or the other, opposing groups might try to disassemble the information presented,

says Ward. “As a water institute director, you have to appreciate that can happen and it’s not personal, it’s the nature of the way water is managed,” he says.

On a federal level, changes were being made to keep up with increased environmental awareness. The 1992 reauthorization of the Clean Water Act was an example of such federal changes—the draft bill’s declaration of purpose, when it came to Congress, was changed from protecting the “physical, chemical, and biological integrity of the nation’s waters” to “protecting the ecological integrity of the nation’s waters.” “When the Colorado water community here heard about that, they were very upset,” says Ward. “They wondered, what does ecological integrity in a semi-arid environment mean?” Other regions of the U.S.—the eastern states and the Pacific Northwest—had formulated a definition, but when Ward and his contemporaries organized a group to study the topic, they found that scientific definitions in the arid and semi-arid West were not well defined. A general resistance to the bill in this form meant that the Clean Water Act was not reauthorized in 1992.

**1972
Federal Water Pollution Control Act**

Better known as the Clean Water Act, this reauthorization of the 1948 Water Pollution Control Act reorganized and expanded the original purpose to include pollution regulation plans, permits for the discharge of wastewater into streams, water quality standards for contaminants in surface waters, and the recognition of the need to address nonpoint source pollution, among other changes. The institute became involved with committees, research, and outreach to implement the act in Colorado.

1972 – Report Highlights Social Science Representation in Institute Projects

Director Evans began reporting on significant institute projects, including 15 that were in progress in 1972. Of those, six included economics faculty, eight included political science faculty, and one included sociology faculty.



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**1975-1978
Urban Water Projects**

A number of the institute’s studies from 1975-1978 involved urban water.

**1972
Graduate Program Created**

The institute was selected along with institutes at the Georgia Institute of Technology and Stanford to create and implement a graduate training program for the Army Corps of Engineers from 1972-1981.

Endangered Species Act – 1973

1974 – ERC Affiliated With Colorado Agricultural Experiment Station

The ERC brought CWRRI along when it became affiliated with the CSU’s Colorado Ag Experiment Station. Collaborative projects arose from this partnership, including work on salinity, evaporation, and groundwater.

Big Thompson Flood – 1976

1977
Safe Drinking Water Act
Standards Take Effect

FIFTY YEARS OF RESEARCH, OUTREACH, AND EDUCATION

Fulfilling the Research, Training, and Outreach Mission

During the 1960s, '70s, and '80s, despite challenges, the institute worked to contribute in a meaningful way to the academic and greater water community, and that legacy has continued through the institute's 50 years.

The roles of the institute under this mission include communicating with water managers, government, and water academics in the state; funding the necessary water research and training new generations of water managers and faculty; and communicating research needs and findings among these various groups so that water issues can be supported with meaningful research.

Serving as a boundary organization between Colorado's collective higher education water community and the Colorado water managers and users, tensions developed over the years as CSU gained, lost, and eventually regained a university-centric Water Center. "There was a strain there between what the national water institute legislation demanded and what practically, we were expected to do being on the CSU campus," says Ward—when the CSU Water Center was founded on campus, Ward felt that the center would take on the responsibility

of promoting the institutional water interests of CSU, thus allowing the institute to reach out to the greater academic water community in the state as well as at CSU. As funding for the Water Center declined, the institute absorbed the center's roles within CSU, and Ward again felt the tension to promote and represent CSU's water research while also promoting and representing all of Colorado's academic water capabilities.

"The directors are between one of the most heavily endowed water higher education system in the world—that's the way I view it—and the water management organizations throughout our state," says Ward. "I've heard it reported that there are 700 water organizations for the South Platte alone. It's like the old expression, drinking water from a fire hose," he says. At the time, Ward was half time at the institute and half time as faculty, so he was advising students, teaching classes, conducting research, and attempting to fill his role of CSU, state, national, and international water representative at the institute. "My greatest challenge was simply trying to run both of those—I felt both of them were almost full time jobs—and try to do that within the time that I had."

TIMELINE

1978-1979 CWRRI Separation

CWRRI became an independent agency on the CSU campus, separating from the ERC and the Ag Experiment Station.

1980 Collaboration with EPA

The institute has a long history of collaboration with academia and public and private entities. One such collaboration with the Environmental Protection Agency (EPA) involved a 1980 informational brochure and educational film on the treatment of lands as a method of filtering municipal water supplies. Other significant partners over the institute's history have included the U.S. Bureau of Reclamation and the Colorado Department of Local Affairs, among others.

1981 Hydrology Days

CWRRI took part in organizing the first annual Hydrology Days and sponsored the event in following years until 1997, and again from 1992-2004.

1967-1988: Director Norm Evans

1978 – More than 300 Colorado Water Studies Catalogued

To make the 300+ water studies more accessible, reports were ordered and grouped into informational categories: Development, Policy; Development, Process; Project Feasibility; Project Operation; Project Planning; Regional Planning; Regulatory; Research, Applied; Research, Basic; and Resource Inventory.

1978-1980 Water Supply Projects

Many of the studies from the 1970s dealt with the topic of water supply. Ranging from 1974-1981, other topics included studies of river beds, salt and sediment loads in rivers, water efficiency improvements, and meeting municipal and agricultural demands.

1981 State Authorization of CWRRI

CWRRI's status as an independent university organization was recognized by the Colorado General Assembly under House Bill 1498, which tasked CWRRI with "developing, implementing, and coordinating water and water-related research programs in the state and transferring the results of research and new technologies to potential users."

Important partnerships within the state, local, and regional governments and at CSU have helped the directors and the institute along its mission. Ward recalls when he became institute director in 1991, former CSU Vice President Judson Harper, who oversaw the institute, was very concerned about statewide and national tensions surrounding water issues. Harper introduced Ward to important statewide water leaders to help him understand and address the tensions. “I think the Colorado Water leaders understood the limitations under which we operated, and they offered advice about how to engage them on contentious issues,” says Ward.

Recent partners, like Randy Fischer, and long-term partners like CSU presidents, vice presidents of research, provosts, deans, and Extension directors are all noted by Grigg as significant contributors and supporters through various parts of the institute’s history.

Grigg recalls that during his tenure, the institute’s projects dealt with many of the prevalent water issues still being researched today—groundwater development, consumptive use, transfer of water from farms to cities, and modeling projects were all taking place. One

of the most important projects he was involved in, says Grigg, was figuring out how to create a modeling environment to implement Colorado’s tributary aquifer laws.

During Ward’s tenure as director, several projects exemplified the changes that were occurring on a broader level. For example, a series of projects dealt with computing a balance between ecosystem needs and human needs—Ward recalls that this set of projects took place when, going back to the tension exemplified by the Two Forks denial, water managers were slowly coming around to the idea of welcoming university-based research to educate environmental decisions rather than seeing environmental concerns as an enemy of water management.

While many partnerships and initiatives took place on a state, national, or international level, the institute also contributed to CSU academics and research.

“I think that’s one of the things that I’ve looked back on with pleasure, that part of the result of our efforts at the time was the involvement of academic folks and as a result, we helped add to the rate of growth of several of the social sciences,” says Evans.

Ward similarly recalls working with social science

1984 – Oversight of Institutes Shifts to USGS

After the 1984 WRRR reauthorization, oversight of the water resources research program’s institutes moved from the Office of Water Research and Technology to the Water Resources Division of the U.S. Geological Survey (USGS), and USGS was authorized to officially operate as part of CSU.



Neil Grigg

1991 – Water Center Created on Campus

The Water Center at Colorado State University was established from a Colorado Commission on Higher Education (CCHE) Program of Excellence in Water Resources award. It replaced the Center for Water Resources Engineering and Science, which was established in 1990.

1996 – State-Based Funding Suspended

Until 1996, research funding was provided through a competitive, peer-reviewed process. This state funding was suspended in 1991 in favor of a regional funding program that provided a total of about \$800,000 for a 13-state Western region.

1990 – EPA Vetoes Two Forks Dam

1988-1991: Director Neil Grigg

1991-2005: Director Robert Ward

1984 Federal Reauthorization of WRRR

Additions were made in the reauthorization. In addition to maintaining environmental quality and social well-being, the act stated that water resources management is closely tied to “productivity of natural resources and agricultural systems.”

1988-1991 South Platte River Modeling

South Platte computer modeling project continuations were an important contribution under institute director Grigg’s tenure—the models depicted flow and deposits in the river system.



Robert Ward receiving the Warren Hall award.

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academics at CSU in his career. “One thing that I enjoyed when I first came to CSU in 1970 was water-oriented social scientists and lawyers who worked across campus. They added greatly to discussions of policy implications of applying science and engineering,” says Ward. “It created a dynamic that was really rich and exciting while giving future water managers from all disciplines an understanding of the social and legal environments they would work in during their careers.”

At times over the years, Ward notes that in an attempt to address budget shortfalls and still compete nationally in their specializations, some of the university’s departments would focus exclusively on research that took place at the cutting edge of their disciplines rather than participate in state-based, water-related, interdisciplinary research. But since interdisciplinarity has always been a part of water research at CSU, joining the social sciences with environmental sciences and engineering and many other disciplines, this type of work has been revived in recent years, and water projects will continue to cross such boundaries.

“The iWater program I think is a terrific example,”

says Grigg, of interdisciplinary projects. The program, funded by the National Science Foundation, provides Ph.D. support for students working on water issues, often linked to the environment and climate. “Right now, we’ve got 17 or more students in the program, and a lot of them are linking different departments,” he says. “It is an example, but we need a lot more of that type of work,” he says. Ideally, says Grigg, “we need to bring in more history, social sciences, and everything that people wouldn’t ordinarily think about in terms of setting the stage for the future.”

The Water Resources Archive

One important project that the institute helped get off the ground was the Water Resources Archive (WRA). Colorado is home to many important figureheads of hydrology and hydraulics, including Ralph Parshall, Elwood Mead, Delph Carpenter, and many others, and their historic documents and equipment often found temporary homes in the basement of a relative or in an unrelated archive, but no archives were dedicated to collecting water history documents in Colorado. Ward re-

1996-1998 Attempts to Restore Funding

Jud Harper and the CSU Water Center Board of Directors worked to reestablish CWRRI’s federally-funded, state-based research program to no avail. In 1997, Colorado legislature reauthorized CWRRI for 10 years and in the process, prohibited CWRRI from receiving state appropriations to fund water research, forcing CWRRI to seek research funding from other sources.



istock.com

1999 Institute Recognized Nationally

CWRRI was designated as one of five exceptional water institutes, of the 54 reviewed, by the national water institutes program review committee.

2004-2006 Gloria Bloomhurst Joins Institute

Bloomhurst filled the role of office coordinator, manager, and communications director after Miller’s retirement.

TIMELINE

1991-2005: Director Robert Ward

1998 Water Center Operation Merged with CWRRI

CCHC funding was discontinued for the Water Center in 1998, and the Water Center Board of Directors provided funding to continue operations. CWRRI Director Robert Ward would now oversee Water Center operations. The Water Center’s mission differed from CWRRI’s mission in that it only served CSU faculty and students, while CWRRI was a federal-state program that worked with all institutes of higher education in Colorado.

2002- Drought; Hayman Fire

2004 Shirley Miller Retires

CWRRI had only employed one full-time employee at a time to this point, and for 30 years, that employee was Shirley Miller. She edited the newsletter, managed the budget, processed and completed internal paperwork and annual reports, generally managed the office, and acted as a contact point within the institute.



members that about the time he became director, a call came into the institute that the basement of Judge Don Carpenter had been flooded.

“In that basement were all the family papers of the Carpenters, including Delph Carpenter, who’s considered the father of the Colorado River Compact,” says Ward. “Neil and I drove over there that one morning, and I remember walking into the lower level and you could not believe the damage to these papers. So I wondered, who do we call to take care of this?” Fortunately, Northern Water (the Northern Colorado Water Conservancy District) agreed to put the papers in their in-house archive—there was no one else to call.

“That [kind of thing] happened a number of times while I was director,” says Ward. He was asked if CSU wanted to house the papers of the Colorado Water Resources and Power Development Authority (CWRPD) and the papers of Robert Glover, whose equations are a part of the models supporting conjunctive management of ground and surface water on the South Platte. CWI stored the CWRPD papers, and Jim Hansen, a CSU historian, stepped in to house the Glover documents in a

small archive he held.

Recognizing the problem, CSU took advantage of recovery funding provided post-1997 floods for the library and with the support of CSU’s provost at the time, history professor Lauren Crabtree, the WRA was founded.

“By then, I had four collections stacked around in my office that I had accepted, not knowing what I was going to do with them, and the ERC was full of collections of original water research documents,” says Ward. Patty Rettig, now in charge of the archive, collects and sorts these documents, and digitization projects are underway that will help improve access to the documents. “It’s been very helpful to save a lot of these original documents of our history,” says Ward. For instance, Bob Longenbaugh, a member of CSU’s Department of Civil and Environmental Engineering for 19 years and assistant state engineer for 11 years until his retirement, came across original measurements of groundwater levels on the eastern plains that were about to be thrown away, and these records were among the first documents collected by the WRA.

2005 – Colorado Water for the 21st Century Act Establishes Basin Roundtables and Interbasin Compact Committee
2005 – Colorado Ag Water Alliance Formed



Reagan Waskom

**2008
Name Changed to CWI**

Colorado House Bill 08-1026 officially changed the name of CWRRI to the Colorado Water Institute (CWI), and the name change came with an updated and expanded mission.

**2010 – Extension
Specialists Work
Under CWI**

The Extension water program was reorganized under CWI to allow better coordination of CSU’s water outreach efforts.

2012-2013 – Drought, High Park Fire, Front Range Floods
2015 – Colorado Water Plan

2006-Present: Director Reagan Waskom

**2006
Nancy Grice Joins Institute**

Nancy Grice has been the Assistant to the Director for the Colorado Water Institute since 2006. Her roles include supervision of departmental operations, student internships, and budget management.



**2012 – CWI Tasked with
South Platte Aquifer Study**

Colorado House Bill 12-1278 tasked the institute with studying reports of high groundwater levels in the South Platte with the hopes of better administering the region’s groundwater. Findings were reported to the legislature in late 2013.

The Future of the Institute

Water is a strong connecting force in Colorado and the West. Academically, water research connects students and faculty from a broad range of disciplines; on a greater, statewide level, it connects agriculture, municipalities, business, energy, health, the environment, and many other sectors. Among the various groups involved in water in the state, the institute has upheld its role in outreach and communications. “It really lines up with what the land grant university should be doing, and I think we’ve done a terrific job of that over the years, through the institute,” says Grigg.

The institute directors tell a common story of the draw of CSU’s water programs—as a graduate student at North Carolina University in the 1960s, Ward recalls being told by an advisor that if he wanted to work in water, he “didn’t have a choice” among the offers he had—that CSU was by far the leading university in water. When Grigg similarly planned to study water resources in Colorado at the University of Colorado, an advisor quickly corrected him—“you mean Colorado State University,” the advisor said.

CSU’s reputation in water was representative of the state’s focus on water issues as a whole. “One of the things that I enjoyed the most about being water institute director was the fact that I got to work with wonderful students and a many great faculty members in the water field,” says Ward. “There’s a water community in this state that consists of highly talented individuals, who were not always agreeing on everything, working toward the common goal of a secure water future. And in that community is a lot of good will for the institute and higher education,” he says.

Various directors would hold different roles in the institute’s evolution to its current status in the water community. “If I had any legacy in running the institute,” says Grigg, “It would have been to keep it alive through a period of difficulty. My legacy was to help hold it together and keep our story being told down in Denver,” he says.

In speaking to his own legacy as director, Ward points to changes that came up during his tenure, like the introduction of the Internet to provide information to the greater water community, the evolving interest in aquatic health, and responding to the 2002 drought. He notes that an institute director is charged to keep on top of emerging water issues in order to tap Colorado’s higher education expertise in response, but sometimes the water issue does not emerge, and presents as an immediate crisis. For example, the water institute prepared a summary and explanation of drought in Colorado in 1999. “Once the drought hit [in 2002], I couldn’t reprint those reports fast enough,” says Ward. “One real advantage of the water institute is to look out at the horizon a little bit, and see what is coming, and organize and produce the science and understanding so that when it comes, we have a lot better ability to deal with it,” he says. “You can’t anticipate something like


the 2002 drought, but by doing our job all along, we had science and results we could bring forward and fit in,” says Ward.

“What I see when I’m out in the Colorado water community is a lot of good will and respect for CSU and respect for Norm, Neil, and Robert in particular and what they accomplished in their careers, and I think that bodes well for us going forward,” says current director Reagan Waskom. “When I look at where the institute is today, what I see is the foundation that the previous directors built, and it has a really firm foundation because of this work, but also the support from CSU right now is better than all of them experienced. I’m probably reaping the benefits of what they sowed,” says Waskom.

“What I see when I’m out in the Colorado water community is a lot of good will and respect for CSU and respect for Norm, Neil, and Robert in particular and what they accomplished in their careers, and I think that bodes well for us going forward.”

—Reagan Waskom

CWI currently stands with five full-time employees, between six and eight rotating and transitioning student employees, and a budget that outstretches the need for additional federal funding that was sought in the past. “The institute is extremely well poised,” says Waskom. “When I look at the young new faculty coming to CSU, I think our future is really bright.”

“As you think about the problems we have around the world, they’re not always so evident here in the U.S.—food, agricultural production, its impact on the environment, and managing water—and we’ve never needed programs like the Experiment Station, Extension, and the institute more than we’re going to need them in the future,” says Grigg. It will be important, he says, for people in the future to understand the vision that guided many of these institutions’ foundations, and at the institute, that includes the legacies of the hard work put in by its directors and staff. “I look to see what Robert and Reagan have built up, they have terrific support compared to what we had, and all we have to do now is to build an even better base and create a bigger support structure to put that forward as the centerpiece for Colorado water programs,” says Grigg. 

The Water Resources Research Institutes

A Discussion With John Scheffer and Jan Schoonmaker

Interview by Lindsey Middleton, Editor, Colorado Water Institute

Editor's note: The Water Resources Research Institutes (WRRI) require oversight and legislative representation, and for about two decades, John Scheffer and Jan Schoonmaker fulfilled these respective roles. John Scheffer, now retired, served as the Water Resources Research Act (WRRA) Coordinator and was the Chief of the Office of External Research at the U.S. Geological Survey (USGS). Jan Schoonmaker served as a legislative director for the U.S. House of Representatives and is a Vice President of Van Scoyoc Associates Inc. in Washington, D.C.

Could you describe your role with NIWR/USGS?



John Scheffer

I administered the Water Resources Research Act program for the USGS for 22 years, ending in December 2012.

The Act authorizes the State Water Resources

Research Institutes and a national competitive water resources research grant program. The Act also defines the purpose and mission of the institutes, requires a periodic evaluation of each institute, and has various provisions concerning the management and scope of the program.



Jan Schoonmaker

I was the legislative advocate for the National Institutes for Water Resources for 20 years.

More to the point: I was the organization's lobbyist. The U.S. Constitution in

the First Amendment guarantees the "right of the people...to petition the government." My job was to make certain the interests of the state water resources research institute directors were heard in the halls of Congress and within the Executive Branch of government.

Could you discuss the common mission of the Water Resources Research Institutes?

John: The Water Resources Research Act is quite explicit as to the mission of the institutes. It states that each institute shall conduct a program of water resources research, foster the education of new research scientists and engineers, and disseminate the results of research to water managers and the public. The institutes are to do this in cooperation with other colleges and universities in their state so as to develop a statewide program designed to "resolve State and regional water and land related problems." The institutes are also instructed to cooperate with other institutes and organization in their region so as to promote regional coordination. This is a tall order considering the small \$92,000 grant that the federal government has been providing to each institute and the required \$180,000 in matching commitments from the institute's university.

Jan: I like to remind the directors that their institutes are a service organization as well as a research, education, and information transfer center. The Water Resources Research Act intended to provide each state with the capability to conduct water resources research and education activities that respond to the particular needs of the individual states. These needs are expressed by state and local governments as well as stakeholders and the public. That's a tall order to accomplish with a limited amount of funds. It is essential for the institute directors to reach out and communicate with government, stakeholders and the public. These groups can, in turn, help advocate for support for the research, education and information transfer functions of the institutes.

How has the role of the institutes changed over the years? Does it vary regionally, or are there national trends?

John: The basic role of the institutes, as defined by the Act, has remained remarkably constant over the 50 years since the Act was first passed. There have been some changes in emphasis in some of the prescribed research areas over time, with an increased emphasis on water quality in the late 70s and 80s and an increased emphasis more recently on water supply and, especially, aquatic ecosystems. There seems to be much less emphasis on economic and institutional topics, such as water demand and water law, then there was in the earlier years of the Water Resources Research Act.

Though the Act defines the role and mission of the institutes, the emphasis on research, education, and information transfer varies among the institutes and often changes with the director of the institute. I would say that the relative emphasis varies more among the directors than it does either nationally or regionally. To the extent that there are national or regional trends, it is probably that there is relatively more emphasis on water supply in the arid West and perhaps some of the territories, such as Guam, and more on water quality elsewhere in the nation.

Jan: The Act recognizes that each state has different water resources research needs. The institutes are supposed to respond to the needs and priorities established within their sponsoring state. This results in significant differences in the role of an institute in the arid Western state versus an institute in an urban Eastern one. However, as demand grows, there is growing competition for water supply in regions of the country which wouldn't have experienced water conflicts decades ago.

What are some important topics or issues for the institutes?

John: These vary from state to state and depend to a great extent upon the milieu within which each institute operates: the specific issues within the state, state water law and regulations, water management agencies and practices within the state, other research programs addressing state water issues, historical practices and traditions, to name a few. It is for this reason, wisely I think, that the Act requires that each institute form and develop its program "in close consultation and collaboration with the director of that State's department of water resources or similar agency, other leading water resources officials within the State, and interested members of the public." Accordingly, most institutes have at least one state advisory committee, and many have two: one consisting of officials from state and local agencies and one of academics involved in water research and information transfer. The scope of water resource issues and research areas is too broad to be managed in a top-down fashion.

Jan: Congress has set forth priorities for water resources research in the WRRRA which include assuring water supplies in sufficient quantity and quality to meet the Nation's expanding needs for the production of food, materials, and energy; addressing practical solutions for water related problems, protecting the environmental and social values of water management and use; training the next generation of water scientists, engineers and managers, and encouraging long-term planning and research to meet future water needs.

What have been some challenges faced by the WRRR program?

John: I think that the institutes, as a whole, have always faced three main existential challenges:

1. Periodic congressional reauthorization of appropriations for the program
2. Proposals in the president's annual budget submission to the congress by virtually all administrations to either reduce substantially or eliminate funding for the program
3. Describing the results of the program to the administration and the congress such that their importance and relevance can be understood by non-academics and program managers

To a large extent, I think that the first two challenges are a function of the institutes' difficulties in addressing the third

Jan: I think the three biggest challenges are:

1. Meeting large expectations from the political/governmental sector with very limited resources
2. Explaining to government officials and the public the important function the institutes fill in helping government and the public in addressing problems and future needs
3. Making the case for continued funding for the WRRR program at a time of growing demands on limited federal and state financial resources

Also, academic researchers generally need to do a better job explaining to the public what they do. They need to be able to explain their research and the benefits of their research in a way that non-academics can understand.

How has the federal commitment to water research changed since 1964?

John: According to a 2004 report produced by the Water Science and Technology Board of the National Research Council and published by the National Academy of Sciences (Confronting the Nation's Water Problems: The Role of Research), total federal funding for water resources research nearly doubled between 1964 and 1973 and has remained approximately constant since the mid 1970s at about \$700 million when measured in constant 2000 dollars. The WSTB found that when funding for aquatic ecosystem research was subtracted from the total, it is "almost certain" that research funding for water supply, conservation, water quality management, and water resources planning and institutions has declined "severely" since the mid 1970s.

The federal funding under the Water Resources Research Act peaked in 1981 at around \$18 million and declined to around \$6 million in 1999 in nominal, current year, dollars, where it has remained ever since. In terms of constant 2006 dollars, funding peaked at about \$56 million in 1968 and has declined ever since, to about 10% of its peak value now.

Jan: Funding for the WRRR program has remained flat during the period of my association with the institutes. During this period of time the budget request submitted to Congress by the incumbent president has varied. Over the past 26 fiscal years the president's budget request has included funding to support the program 13 times and has included no funding for the WRRR program 13 times. On the other hand Congress has funded institutes in all 26 budgets. Congress pays attention to the institute directors, their allies, and supporters.

Funding for the water resources activities of the Corps of Engineers, EPA, the Bureau of Reclamation and other federal water resources agencies have been constrained as well. The fact is that water research has not been the high priority with the Executive and Legislative Branches of the federal government that it should be. When there are flooding, drought, or water quality crises government does respond in the short term, but a concerted focus on water research has been absent.

What have been some important successes and achievements?

John: The WRRRA program supports over 200 research projects nationwide each year. Some produce results with significant management implications in and of themselves and others produce results that contribute to subsequent projects that may have implications. Some, of course, produce little of immediate evident value; that is the nature of research. Also, that which one considers important depends in part upon one's role in the water resources community. That which is important to a municipal water supply treatment or a municipal waste treatment manager is likely to differ greatly from that which is important to a water irrigation district manager or a state water quality agency manager. That which is important to a hydrologist is likely to differ from that which is significant to a microbiologist or geochemist. As an economist, I think that the work on conjunctive groundwater-surface water management by Morel-Seytoux, Bob Young, and others ranks high in the accomplishments of the Colorado Water Institute and of those of the nationwide program in general. The USGS provides a memo report to Congress each year in which it describes what it considers to be significant accomplishments of the WRRRA program under specific topics. That report should be available from the Office of External Research of the USGS.

A major and significant accomplishment of the program is its contribution to the training of the Nation's future water scientists, engineers, and managers each year. The WRRRA program is a major source of this training.

Jan: It's a significant achievement that the water institutes continue to work together to serve the needs of their states and the nation.

In your opinion, how has the Colorado Water Institute grown or changed?

John: The institute has always had a strong and relevant program and ranked in the top tier of the 54 WRRRA institutes nationwide.

Jan: The Colorado Water Resources Research Institute has always been a good institute to work with. Two directors during my tenure, Robert Ward and Reagan Waskom, have served as president of the National Institutes for Water Resources (NIWR). Both did a very fine job. The CWRRRI has a good reputation with the Colorado congressional delegation for being responsive to needs for information and advice.

...I think that the work on conjunctive groundwater-surface water management by Morel-Seytoux, Bob Young, and others ranks high in the accomplishments of the Colorado Water Institute and of those of the nationwide program in general.

—John Schefter

How are the institutes positioned for the future, and what do you see ahead for water research?

John: The institutes have an active organization, the National Institutes for Water Resources, that has served them well, especially in maintaining their visibility in Washington. Though NIWR does a good job of positioning the program before the legislative and executive branches of the Federal government, the program will be much better positioned when and if the Water Resources Research Act is reauthorized. NIWR might be better positioned to make its case if it had a stronger national program for describing the relevance and importance of its research and information transfer activities. It might also strengthen its position by devising a means of better coordinating the programs of the individual institutes, both nationally and regionally.

As to the future of water research – I foresee increasingly difficult budget problems. The share of the federal budget (and state budgets) dedicated to our aging population is increasing and will continue to do so for quite some time. Given relatively small increases in the total budget, which is likely given the level of deficit spending we are experiencing, the share going to discretionary (as opposed to entitlement) programs will decline more and more over time. Water research is increasingly going to be in competition for federal funding.

Jan: The water resources challenges facing this country are growing each year and will continue to do so. Somehow Congress and the Executive Branch have to develop the commitment to provide the resources, coordination and long term vision to respond. The state water resources research institutes are well positioned to play a role if given the resources.

What are the Water Resources Research Institutes?

The Water Resources Research Institutes represent cooperative agreements between public universities and federal and state government that engender lasting partnerships among state universities; federal, state, and local governments; businesses and industries; and non-governmental organizations aimed at solving problems of water supply and water quality at local, state, regional, and national levels.

At the land grant university of each state, a small federal grant provides base support for a program that identifies water resources research needs, finds university researchers capable of conducting useful research, and leverages federal funds with state and other resources to sponsor the needed investigations. More importantly, the modest federal grant creates an environment that encourages the other partners to incorporate science into their efforts and fund additional research in ways that might not occur without the aegis of the federal grant. Some 40 percent of these programs are free-standing university institutes, some 35 percent are free-standing units within university colleges, and others are subunits within university departments or cross-discipline research entities. NIWR networks these separate institutes into a coordinated unit, represented by eight regional groupings and functioning through NIWR.

The State Water Resources Research Institute Program is administered by the U.S. Department of the Interior through the U.S. Geological Survey.

Source: niwr.info



Gilbert



Greene

Editor's note: John and Jan retired in recent years following dedicated and well-respected careers working with the institutes. Their roles are now occupied by: Leslee K. Gilbert, a Vice President of Van Scoyoc Associates, who now represents NIWR in Washington, D.C.; and USGS Hydrologist Earl Greene, the current USGS Coordinator of the Water Resources Research Act Program.

Clockwise from left: Robert Ward, Ken Wright, Reagan Waskom, Ruth Wright, and Norm and Jean Evans.



Wrights Honor Legacy of Former CWI Director Norm Evans

“Ruth and I long admired and respected Professor Evans, and over the years, we talked quite a few times as to how we might do something to honor him, because he was always such a great friend and inspiration.”
—Ken Wright



By **Lindsey Middleton**, Editor, *Colorado Water Institute*

Ken and Ruth Wright, both long-time active members of the water community both locally and abroad, recently gifted the Colorado Water Institute (CWI) with an endowment fund in the name of prior CWI director Norm Evans.

“Ruth and I long admired and respected Professor Evans, and over the years, we talked quite a few times as to how we might do something to honor him, because he was always such a great friend and inspiration,” says Wright. “We came up with the idea of an endowment to make sure that his name, his contributions, and his achievements are long remembered.”

The Evans Endowment sponsors an annual lecture on water management education and policy to be held by the institute in Evans’s name. The lectures would be “a contribution to science, education, and public service, all in the name of Dr. Evans and to honor his scientific approach to the handling and use of water and his good work for the Fort Collins community,” says Wright. “We look forward to the lectures,” he says, “As a way to keep up the Evans spirit and a desire for teaching and learning.”

Evans, a graduate of civil engineering at CSU, became head of the new Department of Agricultural Engineering in 1958 and took over from Stephen Smith as water institute director in 1967, two years after the institute’s establishment under the Water Resources Research Act. At that time, the institute was housed under the Natural Resources Center. In 1969, the name changed to Colorado Water Resources Research Institute (CWRRI) and later, CWI. Evans served as director for over 20 years, and was the longest running director of the institute over its 50 year history. Wright notes that Evans was loyal and dedicated to the institute, going to great lengths to secure funding. “He was certainly a champion for water research planning and programming,” says Wright. “He related well to other water use organizations and also to local, state, and federal government. He was well thought of at the state legislature, where he represented CSU with dignity.”

Among Evans’s other important achievements, Wright notes, was his commitment to historic preservation. After his retirement, Evans was very active with local groups, including the Poudre Landmarks Foundation, where he served on the board of directors. Evans took part in the preservation of several historic properties in the city of Fort Collins and nearby areas. Among the


many properties preserved by the foundation at that time were the Avery House and the 1883 City Water Works site, which is where the city of Fort Collins created its first water delivery system.

Wright notes that retiring faculty can find inspiration in this commitment, and dedicate time to pursuits like historic preservation, open space development, or other efforts that benefit the community. Young water professionals, says Wright, can learn from Evans’s commitment to promoting ideas they are passionate about—it is important, he says, to bring issues to public notice for action.

Wright notes that in upholding Evans’s legacy the institute should continue to focus efforts on the facilitation of dialogue among interested parties on water resources management issues and on the storage of data for use by state and local government.

“Our relationship [with Evans] goes back a long way,” says Wright. “We got to know him when he was heading up the CWRRI, and that was very important to us in those days, because our company [Wright Water Engineers, a water resources consulting engineering firm in Denver] and our colleagues were very interested in water resources research.” Wright says that the ’60s was a heyday for water research thanks to federal support, and he became acquainted with Evans through Colorado water research at the time.

Ruth Wright, Ken’s wife, served with Evans on the Water Quality Control Commission, and recalls that Evans upheld a public service commitment and helped keep the committee on the right track in terms of science and policy. Ken worked with Evans himself on a U.S. Army Corps of Engineers project in the 1970s to clean up Lake Erie—as an agricultural engineer, says Ken, Evans provided a valuable perspective on land treatment for sewage effluent in the Cleveland/Akron area. Later, the two worked together on local Fort Collins issues when Wright Water Engineers was working on a number of projects in the area and Evans was serving on a local water board.

“We had a long, rich background with Dr. Evans,” says Wright. “I think I would capulize it by saying his legacy is in public service and contributions to CSU, to which he always remained loyal, and also contributions to his community. We could sum it up by saying he was an outstanding citizen in all ways.” 

CWI Origins and Meeting Future Water Needs in Colorado

By Neil Grigg, Civil and Environmental Engineering, Colorado State University

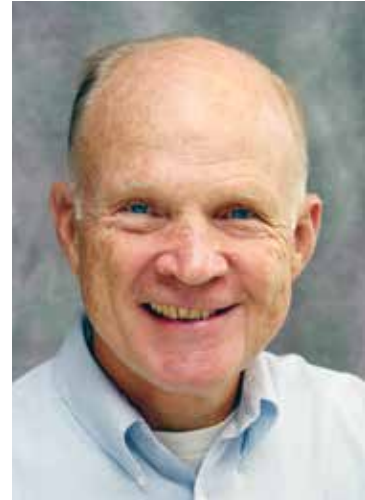
Looking back, we see that 50 years of service by the Colorado Water Institute (CWI) has been a period of growth and change, both for CWI and for Colorado State University (CSU) as it became a major research university. Now, CSU and CWI continue to evolve and work out their missions in a rapidly-changing world, and it is important to look at them together, because water research is hitched to the university's star. I've been involved with CWI or other institutes for many years, and I'll try to describe what CWI was like during my tenure as director and look ahead to its future.

My involvement with the state institutes started right after the 1964 Water Resources Research Act was enacted. In 1964, I was granted graduate student research funding from Auburn's institute to buy research equipment for hydraulic experiments. Later, I was appointed to be director of two state institutes (North Carolina in 1977-81 and CWI in 1988-91). I've also been involved with managing state water agencies and with national policy boards that were concerned with water, so all of these experiences give me a lot to think about related to water research.

When I became CWI Director in 1988, water management in the U.S. and in Colorado was in a shifting and reactionary mode. Gone were the 1960s heydays of rising expectations about the role of government in water management. Our highly-valued professor of political science Henry Caulfield even wrote a paper titled "Apostasy of a long-time water federalist." That's a long story, but it resulted from his shift from being a water-Hamiltonian to being a water-Jeffersonian at the same time that federal primacy was devolving to state and local primacy, at least to some extent.

Here in Colorado we had a battleground in water management, with the centerpiece being the struggle over whether the proposed Two Forks Reservoir would be built. In the 1970s, Colorado had turned thumbs-down on "state water planning," and the conflicts that caused that had only hardened. To make a long story short, all of this created a lot of difficulty in obtaining funding

for water research. Federal dollars for the institutes were being continually cut, and there was no state funding for the institute. I testified before the Joint Budget Committee and Interim State Water Committee about our need for funding, but in the climate of the time it did not seem clear to them why we need-



Neil Grigg

ed the funding. Vice President Jud Harper helped us explain the need for funding to the Governor and water stakeholders, but we were swimming against the tide. Subsequent directors have done much better in obtaining both state funding and favor for the institute's activities, and that record helps to set the stage for the future.

Even though the institute was having a hard time getting funding, some legacy work attracted a high level of interest. One project I recall was continuation of the work to develop a workable stream-aquifer model, which was needed to implement the new state water laws that integrated surface and groundwater management. There was also work on measuring evapotranspiration to inform water rights cases and work with the State Engineer's office to assess how flood potential varies with elevation in the mountains. During this period, we also published a brochure about the 25th anniversary of the institute and a booklet with the text of Governor Ralph Carr's 1943 tribute to Delph Carpenter. We had a number of student interns and published an active series of newsletters. There was a lot of activity, in spite of the lack of funding. These activities continued and were expanded under subsequent directors, who will write about them elsewhere.

As I see it, the larger issue is how to use water research to address major cross-cutting issues. As a connector between issues like food, energy, and urbanization, water management will be more and more important as the world comes under greater pressure.—Neil Grigg

Looking Forward

No one knows what will happen in the years ahead, but I think about the dramatic changes that occurred in the quarter-centuries from 1965 to 1991 and from 1991 to 2014. As we all know, the ongoing changes are across the board in technology, globalization, and in the social arena. With the political system in Washington experiencing deadlock, it seems that devolution to more state and local control is continuing, although existing federal law and influence will continue. This will require state governments to take more leadership, and the institute is poised to continue in its role as an impartial provider of quality scientific knowledge. In a sometimes-litigious environment of water management, this important role must continue to be exercised carefully, of course.


One issue for CWI is how it can be an effective state-wide institute and involve other universities as well as CSU when it has little money to grant for projects. There is no easy answer, although the institute's close relationship with state and federal agencies positions it well for other schools to coordinate some of their work. Another possibility is that the state will invest more in water research, and there will be a need to draw from the talent pool in other schools, as well as CSU.

As I see it, the larger issue is how to use water research to address major cross-cutting issues. As a connector between issues like food, energy, and urbanization, water management will be more and more important as the world comes under greater pressure. In this role as a connector, water management is not only about allocating water as a resource but also about linked goals, such as addressing poverty and having a healthy environment. With many complex problems like this, the institute's role as a coordinator of interdisciplinary work will continue to be important in addressing cross-cutting issues. However, it is hard to find ways to apply great science in the increasingly-political world where these issues are worked out.

This raises the question of the overall role of water research at the university. How can this applied field be

advanced in a setting where bright faculty members are not rewarded for working on practical problems? While water research has had some champions at CSU with our land grant and service missions and it seems that this will continue, there is an observable trend away from the service mission as faculty members respond to the university reward system that recognizes peer-reviewed journal articles more than it does service and outreach. A companion issue is that much service work is done by private sector firms, who often have staff with Ph.D.s and great capability to do integrated work. As an example of this issue, several decades back, CSU did a lot of international water outreach and research, but now the work is mostly by private companies.

At the same time, much progress has been made in the technical arenas of water management, where much of CSU's reputation in water was forged. While these remain important, the imperative to address socio-political issues of water management is becoming more intense. However, some faculty members in the social sciences tell us that they are not encouraged to work on applied problems while they strive for recognition by their peers in their sharply-focused academic disciplines. What will this mean for the future of interdisciplinary water research?

These are not easy questions to answer, but the university evolves and so does water research. Now, to address the need to forge more effective overall water programs, CSU has placed more emphasis on its Water Center, which is a companion program to CWI. The mission of the Water Center is: "The CSU Water Center catalyzes excellence in water research, teaching, and engagement by fostering interdisciplinary collaboration and creative scholarship." This is a visionary statement which seeks to bridge the worlds of academia and action, as they should play out on a global stage. Colorado and CSU are central players on this world stage, both in terms of university activities and the state's position in the global economy, and I look forward to seeing how CSU chooses to organize its programs to address critical water-related issues in the future. 

Fulfilling the Institute's Mission amid Changing Demands and Technologies

By Robert Ward, Professor Emeritus, Civil and Environmental Engineering, Colorado State University

When I first assumed the job as Director of the Colorado Water Resources Research Institute (CWRRI), the push back from the death of Two Forks was still actively reverberating through Colorado's water management community. The environmental movement, both nationally and Colorado-based, was confronting water managers on a number of fronts. Recreation interests were trying to establish water rights. New technology, in the form of improved computing technology, was enabling the development of more powerful river models. Addressing these, and other, challenges required the very best of the Colorado water management community as well as those preparing the next generation of water managers (i.e., Colorado's higher education community). CWRRI was well positioned to continue serving as an interface between the two communities. A review of the completion report titles on the CWI website provides a summary of the specific research topics addressed over the 50-year life of the institute.

While discussing water research needs with Colorado water managers in the early 1990s, I detected a desire, on their part, to be more directly involved in the research process. For example, they wanted to better understand the assumptions made during the course of research and were interested in how data were obtained and documented. In response, some institute funding was devoted to establishing committees of water managers and university researchers to work together on exploring issues at the forefront of science that had critical management ramifications. Examples of topics addressed in this manner were conjunctive management of surface and ground water in the South Platte River basin, exploring definitions of ecological integrity that might apply to Colorado's river corridors, and understanding water yield from forests where different logging strategies were employed.

The drought of 2002 was a major event for the entire water community in Colorado. The water institute

was also affected—we dropped most activities and focused on providing information about drought in Colorado, particularly to help the public understand the nature of drought and the history of its occurrence in Colorado. New research efforts were initiated to further explore the nature



Robert C. Ward

of drought in Colorado, given a new 2002 outlier in the record. One of the most popular pieces of information distributed by the institute was an informational report entitled "A History of Drought in Colorado: Lessons Learned and What Lies Ahead" (www.cwi.colostate.edu/publications/WB/9.pdf).

To help increase the number of well-educated future water managers, CWRRI made extensive use of students to conduct its water education and research activities as well as operation of the institute itself. One of the great pleasures I have today is the opportunity to attend Colorado water meetings and visit with former students (as well as those I advised and/or taught as an engineering professor), many of whom are now in the prime of their careers (some, gasp, are even retiring!).

During my tenure as director of CWRRI, rapidly evolving communication technology affected the operation of the institute itself. In the early 1990s, I recall trying to find space to store the large collection of CWRRI report reprints which permitted the institute to distribute copies to interested water managers, researchers, and the public. When I left in 2005, all CWRRI reports were available over the Internet—no reprint storage space was needed! I also recall the large number

Water institute directors are involved in a number of national water organizations which enhance sharing water knowledge and institute operational effectiveness.—Robert Ward


of phone calls we received wanting information about water in Colorado. When the Internet became firmly established, we could put most of this information on our website, and the number of calls for information dropped over the years as hits on the webpage surged.

University-based water institute directors have to deal with a number of issues not directly in their legal mandate, but which are very closely allied to it. For example, in the 1990s, there were a number of “watershed” organizations springing up around Colorado. They sought assistance in learning about Colorado’s water resources, and the institute responded as best it could. Efforts to initiate public school water education curricula and programs spread around the state, also wanting support from the institute. Funding for CSU’s international water program was reduced during the 1990s, and demands for the institute to work in the international arena increased. Water institute directors are involved in a number of national water organizations which enhance sharing water knowledge and institute operational effectiveness. I had the honor to serve as president of two of these organizations: The National Institutes for Water Resources and the Universities Council on Water Resources.

A major issue that emerged, during my tenure, was the growing concern among Colorado water professionals and some university faculty that there was no professional and systematic way to preserve, protect, and promote original documents related to Colorado’s rich water history. The issue was brought to my attention early in my tenure as a steady stream of issues related to the storage of historic documents continued to come to my attention, and funding opportunities led to the formation of a new Water Resources Archive (see page 10 of this issue for more back story). Finally, Colorado’s water community had a water-focused archive led by a professional archivist, Patty Rettig, with whom they could consult and entrust their valuable original documents. An annual celebration of Colorado’s water history, *Water Tables*,

is organized to help support the archive. Please join us during this most enjoyable and worthwhile event.

The federal legislation which establishes the national water institutes program, and provides limited federal funding for each state/territory’s water institute (54 in total), also requires regular reviews of the effectiveness of the program and institutes. After the 1999 review, CWRRI was designated as one of four “exceptional programs.” In particular, CWRRI was recognized as a model program for its ability to be very active in assembling and disseminating information to water managers while operating with limited funding. CWRRI was considered as being limited in its funding due to the fact that a number of other states chose to provide additional annual state funding in support of its water institute while Colorado did not. CWRRI functioned with a half-time director and one full-time employee, Shirley Miller. Shirley, serving as the CWRRI Administrative Assistant for many years, was a great contributor to the efficiency with which the institute went about its business. She served as the institute office manager, newsletter editor, personnel manager, and budget coordinator. Supportive higher education faculty, Colorado water organizations, and CSU administrators added to CWRRI’s ability to function in an award winning manner. In particular, the willingness of faculty to take on water institute projects, when CWRRI research support was small and uncertain from year-to-year, was greatly appreciated.

It was a great privilege to serve as director of CWRRI. I had the opportunity to work with a number of highly motivated and talented faculty who were more than willing to share their knowledge with me, water managers, and the public. I also had the opportunity to work with many outstanding Colorado water managers who appreciated obtaining new research insights as well as being able to hire well prepared new employees. Matching the practical need for water research and education with sources of water science within Colorado’s higher education system was both challenging and rewarding, and, ultimately, satisfying. 

The Water Resources Archive's CWRRI Collection



A researcher takes measurements from a river for a CWRRI project, 1978. Courtesy of the Water Resources Archive, CSU Libraries

This year, the Colorado Water Institute celebrates a half century of research and educational programs. The Water Resources Archive is also celebrating the twenty-fifth birthday of the institute's archival collection, which contains fifty years of accumulated data, reports, memos, photographs, and more.

Collection History

Founded in 1965, the Colorado Water Resources Research Institute (CWRRI) quickly amassed a variety of materials. Soon its employees found themselves with a dilemma: how to balance the need to protect and preserve previous work while also maintaining space to conduct new projects. In 1990, Director Neil S. Grigg found a solution to the storage problem by donating early project and administrative files to the Colorado Agricultural Archive as the Records of the Colorado Water Resources Research Institute. The collection was transferred to the Water Resources Archive in 2001.

Over the last 25 years, the institute's five directors—Stephen C. Smith (1965-1967), Norman A. Evans (1967-1988), Neil S. Grigg (1988-1991), Robert C. Ward (1991-2005), and Reagan M. Waskom (2006-present)—continued to create and then turn over materials to the Water Resources Archive. Files created by Evans, Grigg, and Ward, whose signatures appear on hundreds of letters, memos, and proposals, comprise the majority of the collection. Together, CWRRI directors Robert Ward and Reagan Waskom donated materials seven times between 2005 and 2009. Today, the 71 boxes that house the collection offer numerous research opportunities.

Research Opportunities

The CWRRI's records provide ample opportunities for interested individuals to learn about the institute's past. Contained within the collection is a plethora of information on the CWRRI's administrative history and research into water issues affecting the U.S. West. Highlights from the collection include:

- » internal files such as long-range plans, budgets, program reviews, reports, and correspondence with other organizations;
- » national and local conference and committee materials;

- » proposals and project files from collaborations with federal and state organizations, including the Environmental Protection Agency, U.S. Department of Agriculture, and the Colorado General Assembly's Legislative Council;
- » photographs and slides of CWRRI projects, meetings, and cooperative activities; and
- » a reference library full of water education curriculum and materials generated by Colorado's local watershed groups.

The CWRRI directed federal and state funding to water research and technology development. The organization then passed those findings on to specialists at the state and local level, which meant that directors needed to be skilled at communication and cooperation.

Records expose a vast, complicated network between the CWRRI and, by extension, researchers at Colorado State University (CSU) to irrigators in every corner of Colorado, instructors at every level of education, municipal employees on the Front Range, and federal officials across the U.S. The collection also contains important information on connected groups because CWRRI directors acquired and saved letters, publications, meeting minutes, and other materials on water-related organizations, individuals, and events. Documents uncover not only the flow of money but also ideas through the CWRRI and provide researchers with valuable insight into the water issues Coloradoans found most pressing during the last half century.

Environmental concerns are well represented in the CWRRI collection. For example, a large group of documents relate to Colorado's Water Pollution Control Commission (later Water Quality Control Commission), which was created to develop water quality standards for the state in the 1960s. Norm Evans served on the commission from 1966 to the early 1980s. During that time he collected meeting minutes, reports, correspondence, and data concerning the commission's attempts to con-

tain nuclear waste, determine allowable levels of municipal and agricultural water pollution, and find solutions for effluent treatment.

The CSU Water Coordination files hold more than thirty years of correspondence, data, maps, and reports about irrigation companies and structures in Fort Collins. The creator of these files, Norm Evans, sat on the board of several local irrigation companies. His prominence in the water community facilitated cooperation between those companies and CSU. The files document efforts to secure water for the growing university's changing needs from the 1950s to the 1980s. Furthermore, these records illustrate physical changes to CSU's campus and experiment farms.

CWRRI internal files also document the creation of the Water Resources Archive. Also included are details about the Archive's forerunners—a state fair exhibit and plans for a CSU Heritage Center than never materialized. In the 1990s, CWRRI directors joined other history-minded water colleagues at CSU in trying to create an on-campus center, museum, and archive that would focus on the school's contributions to water science. In 2001, their efforts culminated in the creation of the Water Resources Archive located at CSU's Morgan Library.

Online Availability

A small number of documents in the collection have been digitized and are available to researchers with internet access all over the world. These include studies that implemented the Stream-Aquifer Model for Management by SimulatiON (SAMSON). SAMSON allowed professionals to conduct comparative water allocation studies for several river basins throughout the 1980s and 1990s. Most of the information about SAMSON deals with studies implemented in the South Platte Basin. Also available are the majority of records in the CSU Water Coordination files concerning CSU's water interests in Fort Collins. Researchers can find all digital materials through links in the CWRRI collection finding aid, <http://lib.colostate.edu/archives/findingaids/water/wrri.html>.

Of course, the best way to learn more about CWRRI history is to visit the Water Resources Archive in Colorado State University's Morgan Library where you can comb through the collection yourself. For further information contact archivist Patty Rettig (970-491-1939; Patricia.Rettig@ColoState.edu).

A 1976 memo from CWI Director Norm Evans discusses the impacts of water research on legislation. Courtesy of the Water Resources Archive, CSU Libraries

*OWRTA: Update of
Research Results*

May 31, 1976

Ms. Lee Pilgrim, Editor
Water Research in Action
Texas Water Resources Institute
Texas A&M University
College Station, TX 77843

Dear Ms. Pilgrim:

In response to your telephone call of May 26 asking for specific instances where OWRT water research has resulted in new legislation, I have the following report.

The co-investigators of Project 8-113-COLO, "Urban Drainage and Flood Control Projects; Economic, Legal and Financial Aspects" include a University faculty member, a practicing civil engineer, a practicing lawyer and the director of an urban drainage and flood control district. Part of the problem to be solved by research is an equitable assessment of costs and benefits for urban drainage projects. The legal definition of benefits has been inadequate and, according to the investigators, the legislature should enact a broader definition than most state courts have followed as a step toward encouraging the construction of needed urban drainage improvements while at the same time affording protection to property to be assessed from irresponsible charges. As a result of this research, the Colorado State Legislature passed S.B. 52 on June 6, 1975 which accomplishes that purpose outlined above. The new legislation broadens the definition of "benefits" heretofore used by Courts to include (1) dominant owners discharging excess water onto servient property; (2) alleviation of health and sanitation hazards; (3) reduction in maintenance cost; (4) increase in convenience to property owners; and (5) additional improvements resulting from some drainage improvements.

with the same language five separate sections of

Organizational Rules, Technical Tools, and the Work of the Colorado Water Institute

By David M. Freeman,
Professor Emeritus, Sociology, Colorado State University

You cannot draw the same water from your tap twice—that's private use (although an important fraction will typically return to the river for downstream users and other living things). The plumbing that moves water from watershed catchments to your tap, and then to waste treatment is economic capital designed by a variety of engineers. The individuals with the range of skills to operate and maintain that plumbing represent human capital. Water organizations employ human capital, and use available tools within a web of law and administrative rulings. Those organizational networks are social capital. It is typically found in mutual ditch companies, irrigation districts, conservancy and conservation districts, municipal water departments, and Offices of the State Engineer and Attorney General. To touch water, it is necessary to touch all this socio-technical assembly.



Above: Ralph Parshall conducts a flume demonstration. Right: A lantern slide from the Ralph Parshall archive collection shows constructed flumes. Courtesy of the Water Resources Archive, CSU Libraries



By the time Ralph Parshall introduced his flume (1921), there had been an organizational evolution of social capital sufficient to empower water users and administrators to operate and maintain that technical device. In the context of organizational rules, the flume had a place and clear function to perform in managing ditch and river conflicts that had bedeviled people. The lesson was for all to see: technical tools must be enveloped by viable social capital governing tool use. Tools without effective application of organizational rules miss their design purposes; rules without tools cannot be implemented.

The water world does not come packaged within disciplinary boundaries nor does it reside within the halls of universities. When its history is written, the Colorado Water Institute's story must be one of grappling with the challenge of creating organizational space for university faculties to cross at least two types of boundaries—those dividing academic disciplines and those separating the academy from local water user communities. The mission of serving water-related information needs of Colorado citizens, water managers, and policymakers requires no less.

Within university halls, the tendency has always been toward increased disciplinary specialization with little regard for implications beyond the silo. There are compelling reasons for undertaking specialized teaching, research, and service encompassed within disciplinary cocoons. That it is the kind of work most rewarded in matters of salary, promotion, and tenure. Interdisciplinary teaching and research—linked to community water issues—is more difficult. A given set of faculty and students, when engaged in interdisciplinary effort, must

cope with the variables and relationships found within other domains of knowledge. That effort will always take more time, consume increased energy, and demand more intellectual investment.

Young faculty are typically advised to work within the disciplinary silos and to pump out work that will be rewarded within departments. But, if faculty do not learn the skills and habits of interdisciplinary collaboration when young, how will they develop the necessary competencies when older? How are the information needs of Colorado citizens and policymakers, in the water realm, to be served by universities?

The challenge of organizing cooperative efforts in the domain of water, and organizing linkages between the academy and water communities, is an old one. Over a century ago, Elwood Mead, a professor, penned this lamentation: “[Irrigators] needed training in...association [that] was lacking. They did not know how to work harmoniously together...” —(Irrigation Institutions, 1903: 50). Two thoughts come to mind: 1) Mead, an engineer, had to cross boundaries to address essential social capital reflected in his book's title, and 2) Mead's quote applies to contemporary faculty and students in water-related disciplines who find it challenging to climb out of their disciplinary silos to engage each other or citizen water users.

However, there has been—now for a half century—an organization serving Colorado campuses with a mission to promote the “habits of association” about which Elwood Mead spoke—to promote collaborative water research connected to the needs of water users across the state. The Colorado Water Institute has always pushed to enable the breaching of disciplinary and academy-community barriers in at least two major ways:

It has long provided a home for interdisciplinary and academy-community discourse when teams return to campus from fieldwork—domestic and foreign. For example, watercourse improvement, in the context of rising groundwater tables and massive salinity problems—in Pakistan's Punjab—required assessment of all forms of capital. The interdisciplinary and community-linkage competencies developed in that effort, among others in places such as Egypt, Sri Lanka, India, and Nepal, came to be employed in multiple Colorado river basins as well as in other Western states.

The institute has also provided a center for discourse within which faculty of all ranks and students representing many disciplines could find and develop connections and learn of efforts of others while simultaneously serving as an incubator for developing faculty-student research opportunities. It has always been the hope that modest financial seeding of small research projects will

R.F. Walter, Chief Engineer of the Reclamation Service, and Dr. Elwood Mead, Commissioner of the Bureau of Reclamation at the Hoover Dam site; September 16, 1930. Courtesy of Herbert Hoover Presidential Library



lead to larger multi-year contracts and grants for advancing knowledge and for building connections to water constituencies in the state and beyond.

Examination of virtually any water issue requires a deep appreciation of existing organizational rules and tools—our heritage of economic-physical, human, and social organizational capital. The Colorado Water Institute is essential to mobilizing faculty and student energies to comprehend what former generations of thinkers and doers have handed us, with which we adapt to address problems of our day. The institute provides an organizational space for the required discourse.

On the contemporary scene, a Colorado Water Plan—emergent out of years of discussion within river basin roundtables and the Interbasin Compact Committee—will be released to the public for discussion in 2015 (See: www.cwcb.state.co.us). This plan will center on ways to address a projected gap between water supplies and increases in municipal and industrial demand. Existing projects, now in some planning stage, are projected to fulfill about 80 percent of the increased demand. How will we think about addressing the gap? How will university faculties and students employ our institute's organizational capabilities to examine uses and limits of available options?

Options for increasing water supplies and re-shaping demands will require developing innovative adaptations of the organizational rules and tools that constitute our heritage. For example: many students of the subject see the importance of constructing alternatives to long-standing practices of “buying” and “drying” irrigated agricultural land with intent to shift water to municipal and industrial uses. Cities and industry add much value to an acre-foot of water; they have thereby been able to move significant portions of agricultural water to urban purposes. In the course of all this, cities have become intermediate watersheds, standing between mountain snowfields on one hand and, on the other, cities, farms, and the habitats of other living things.


At the core of the matter, the water that our civilization requires depends upon the uses to which urban and rural land is put. Whatever the merits of any given proposed water supply project, it will be essential for cities to become better watersheds—by constraining and re-organizing water consumptive land uses in the name of enhancing return flows to rivers and groundwater storage. For example, during many months of the year, cities impose low consumptive uses—most of what is diverted into the city returns to the river for other users and uses.

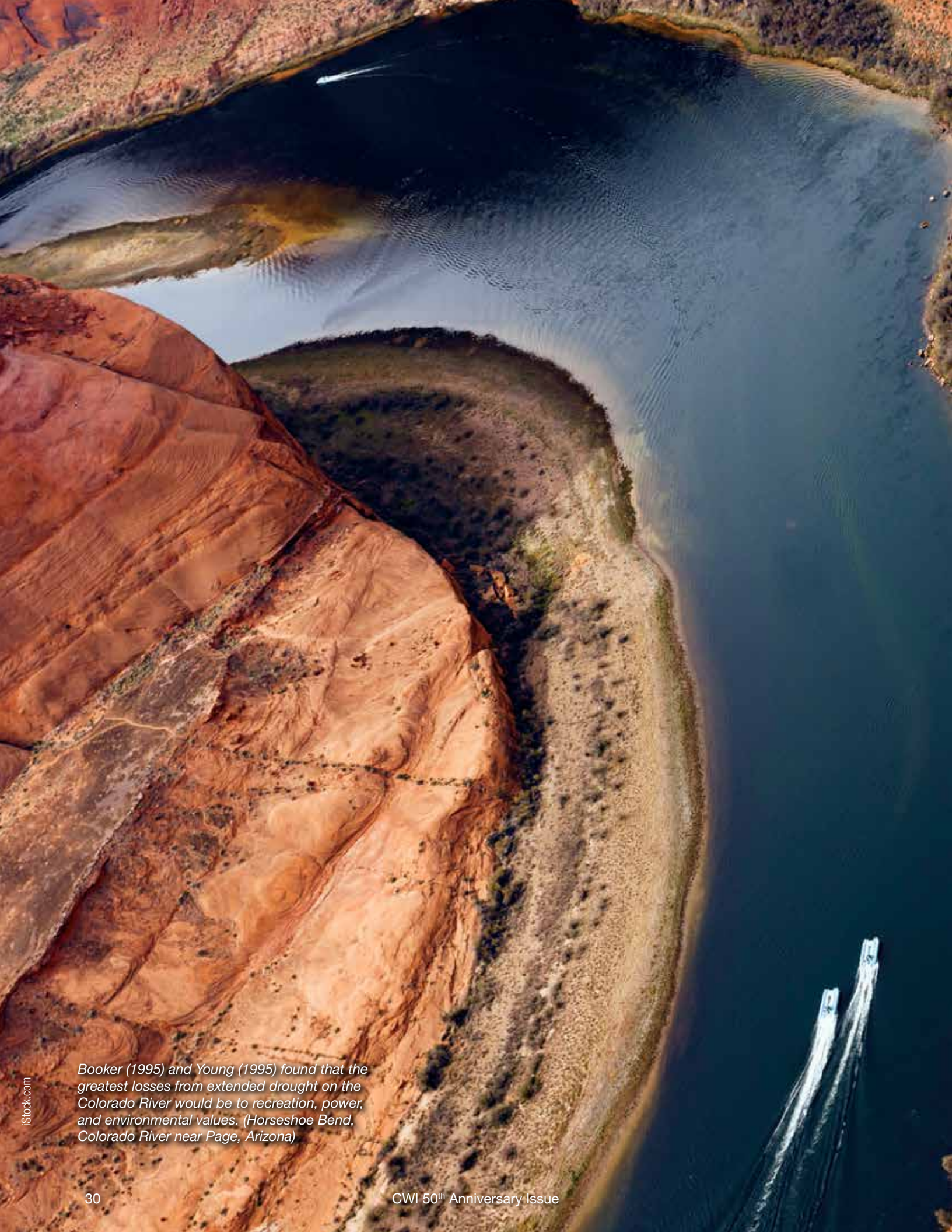
Our highly valued urban forests, gardens, and lawns markedly increase urban consumptive uses during dry summer months. Given feasible modifications of our economic and social capital, it is possible to reconfigure urban land-water uses so as to re-organ-

...the water that our civilization requires depends upon the uses to which urban and rural land is put. Whatever the merits of any given proposed water supply project, it will be essential for cities to become better watersheds...

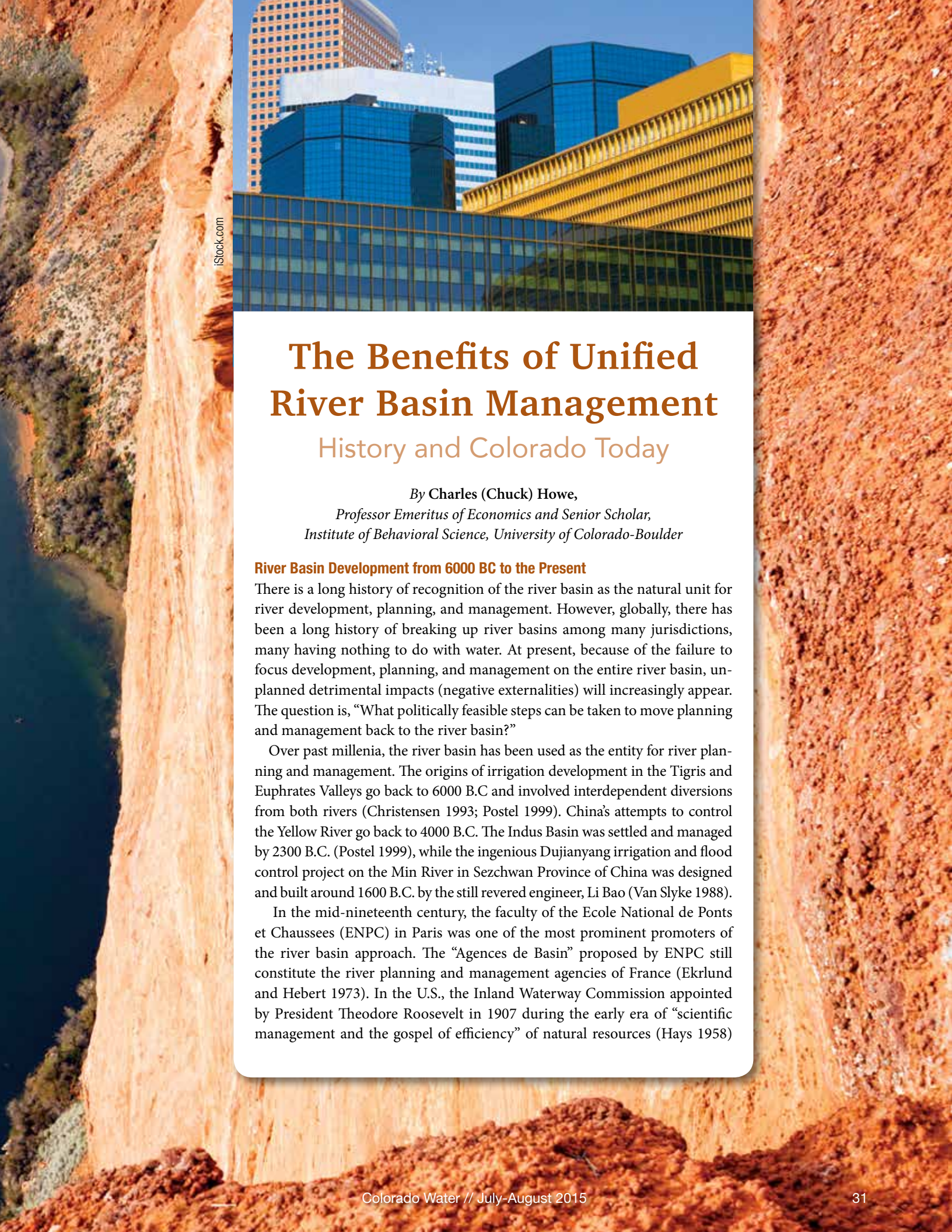
nize significant fractions of water demand in the urban sponge—keep it softer and more flexible in dry times while simultaneously serving the hard demands of industry and households. There will also be a need to address wastewater return flow quality issues. Municipalities can modify rules and tools to manage more productive intermediate watersheds and thereby expand opportunities for partnerships with local agriculture while also better sustaining the biotic communities to which we are all tethered.

To move in more water-sustainable directions while enhancing human productivity, innovative configurations of rules and tools will be required. When I was a young faculty member, I thought how great it would have been to be with John Wesley Powell down the Colorado, with Elwood Mead when he was leading struggling canal communities into more productive and sustainable patterns, to meet Ralph Parshall and have him teach me and my students how he came to design a flume the measurements of which were mathematically defensible and thereby stand up to inspection in a court of law. As the years have passed I have come haltingly to learn that, in our time, my generation, and the ones yet to come, have been and will be confronting society-shaping water issues of the highest order. There is no need to sentimentalize the episodes of years past; our contemporary opportunities to make a difference for better or worse are as great as those in the historical record.

As it enters its second half-century, the Colorado Water Institute is a place for the essential work. To do it, faculty and students must transcend their disciplinary silos, engage water communities beyond the academy, and contribute to an increasingly vibrant water policy discourse. After 50 years, with many worthy accomplishments on the record, the university community of scholars has only begun, through the good office of the Colorado Water Institute, to meet the challenges of Colorado, the region, the nation, and the world. 



Booker (1995) and Young (1995) found that the greatest losses from extended drought on the Colorado River would be to recreation, power, and environmental values. (Horseshoe Bend, Colorado River near Page, Arizona)



The Benefits of Unified River Basin Management

History and Colorado Today

By Charles (Chuck) Howe,
*Professor Emeritus of Economics and Senior Scholar,
Institute of Behavioral Science, University of Colorado-Boulder*

River Basin Development from 6000 BC to the Present

There is a long history of recognition of the river basin as the natural unit for river development, planning, and management. However, globally, there has been a long history of breaking up river basins among many jurisdictions, many having nothing to do with water. At present, because of the failure to focus development, planning, and management on the entire river basin, unplanned detrimental impacts (negative externalities) will increasingly appear. The question is, “What politically feasible steps can be taken to move planning and management back to the river basin?”

Over past millennia, the river basin has been used as the entity for river planning and management. The origins of irrigation development in the Tigris and Euphrates Valleys go back to 6000 B.C and involved interdependent diversions from both rivers (Christensen 1993; Postel 1999). China’s attempts to control the Yellow River go back to 4000 B.C. The Indus Basin was settled and managed by 2300 B.C. (Postel 1999), while the ingenious Dujianyang irrigation and flood control project on the Min River in Sezhwan Province of China was designed and built around 1600 B.C. by the still revered engineer, Li Bao (Van Slyke 1988).

In the mid-nineteenth century, the faculty of the Ecole National de Ponts et Chaussées (ENPC) in Paris was one of the most prominent promoters of the river basin approach. The “Agences de Basin” proposed by ENPC still constitute the river planning and management agencies of France (Ekrlund and Hebert 1973). In the U.S., the Inland Waterway Commission appointed by President Theodore Roosevelt in 1907 during the early era of “scientific management and the gospel of efficiency” of natural resources (Hays 1958)

strongly promoted centralized control of the major rivers and multi-purpose river development.


During the depression of the 1930s, the federal government of the U.S. developed the Tennessee Valley Project—the only U.S. attempt at basin-wide comprehensive development. (Trelease 1971). The 1965 federal Water Resources Planning Act created the Water Resources Council to coordinate federal water development and management activities (Rogers 1993) and also authorized the establishment of new river basin commissions to coordinate federal and state efforts of basin-wide planning.

From 1968 to 1973, the U.S. National Water Commission carried out an extensive set of studies leading to a landmark report, *Water Policies for the Future* (1973). The report strongly emphasized the importance of the basin approach. Under Commission sponsorship, a group chaired by Gary Hart produced a major study, *Institutions for Water Planning—Institutional Arrangements: River Basin Commissions, Inter-Agency Committees and Ad Hoc Coordinating Committees* (Hart, 1971) that emphasized the need for a whole basin approach. More recently, in 1998, the U.S. Western Water Policy Review Advisory Commission issued an incisive report, *Water in the West: Challenge for the Next Century* that emphasized the need to coordinate the numerous watershed initiatives with river basin goals. It should be noted that in

1982, the Reagan administration downgraded the Water Resources Council to a non-policy status and abolished the river basin commissions that had been established under the 1965 Act. This has left an uncertain, mixed picture of state versus federal water administration, especially across the western states.

In contrast to this long history of focusing on the river basin, many policies in the U.S. and elsewhere since the mid-19th century have had the effect of reducing federal control over water resources and reducing possibilities for basin-wide management (Trelease 1971). In the U.S., the 1877 Desert Land Act required that settlers make water claims under state law. The 1897 National Forest Act required those using forest lands to claim water under state laws. The 1902 Reclamation Act required authorized projects to proceed in conformity with state laws for claiming water, as did the Federal Power Act of 1920. The McCarran Amendment (1988) requires all federal agencies to pursue claims for water under state laws.

Many of the institutional arrangements that stand as impediments to comprehensive river basin planning were intended to achieve valid water- and non-water-related objectives, including the recognition of national sovereignty in the case of international rivers, the goal of stronger roles for the states in water and natural resources management, the safeguarding of basins of origin and states' water supplies through prohibitions



Basin-wide issues exist on the South Platte, from Chatfield State Park to the Nebraska line.

of inter-basin and/or interstate transfers, and the reluctance to recognize the newer, emerging uses of water. A major U.S. example is found in the Colorado River under the Compact of 1922 (Myers, 1966; Water Education Foundation 1997,1999) that divided the river's water between the four upper basin states and the three lower basin states. The rationale for the compact was to reduce the water supply uncertainty that was created for both basins by the upper basin commanding the origins of the river while the lower basin was growing much faster and rapidly establishing claims to the river's flow. This exhibits a trade-off between the basin-wide benefits that might be achieved through basin-wide management and subbasin equities. (The above materials taken from a paper by Howe, given at the World Congress of Environmental and Resource Economists, Montreal, September, 2009).

Conditions on the Colorado and South Platte Rivers Require Basin-Wide Approaches

It is well known that the Colorado River is under great stress, with deliveries to the Colorado River Delta in Mexico reduced to an occasional surge release from Lake Mead and greatly reduced flows in tributary rivers. The major reservoirs are at historic lows, posing the risk that the Upper Basin might not be able to release the required 10 year average of 7.5 MAF per year to the Lower Basin. This could result

in a "call" by the Lower Basin States on the Upper Basin in keeping with the Colorado River Compact of 1922, i.e., the possible curtailment of uses in the Upper Basin that would result in significant social and economic disruption.

It is clear that basin-wide approaches are needed to manage this risk. Since the origin of the River is in Colorado, Colorado would be heavily impacted by such a call. One measure that has been recommended is the establishment of a regional Compact Water Bank (Iseman, 2010) that would pay the owners of pre-1922 water rights that are not subject to the call to allow their water to be used in satisfaction of the Compact deliveries.

Basin-wide issues exist on the South Platte, from Chatfield State Park to the Nebraska line. Parts of Weld County are actually underwater with flooded basements and unworkable fields. This is due in part to the shutting down of hundreds of irrigation wells that are meant to irrigate the best soils in the state. The wells remain shut down since 2006 because of conflicts between our priority doctrine water law and the most effective ways of using our water.

Colorado also delivers more water from the South Platte to Nebraska than is required by compact. There must be ways in which these excess waters and those flooding Weld County could be utilized in place of further diversions from the Colorado Basin or the development of expensive, envi-



ronmentally costly projects. In the headwaters of the South Platte, proposals are moving ahead to increase storage in Chatfield State Park, the mostly heavily used of the state parks, storage that would inundate valuable recreational and natural areas that cannot be replaced. It is not clear that this project will produce any additional reliable water supply. Clearly, a basin-wide approach is needed.

“Virtual River Basins” as a “Second-Best Solution” to Basin-Wide Planning and Management

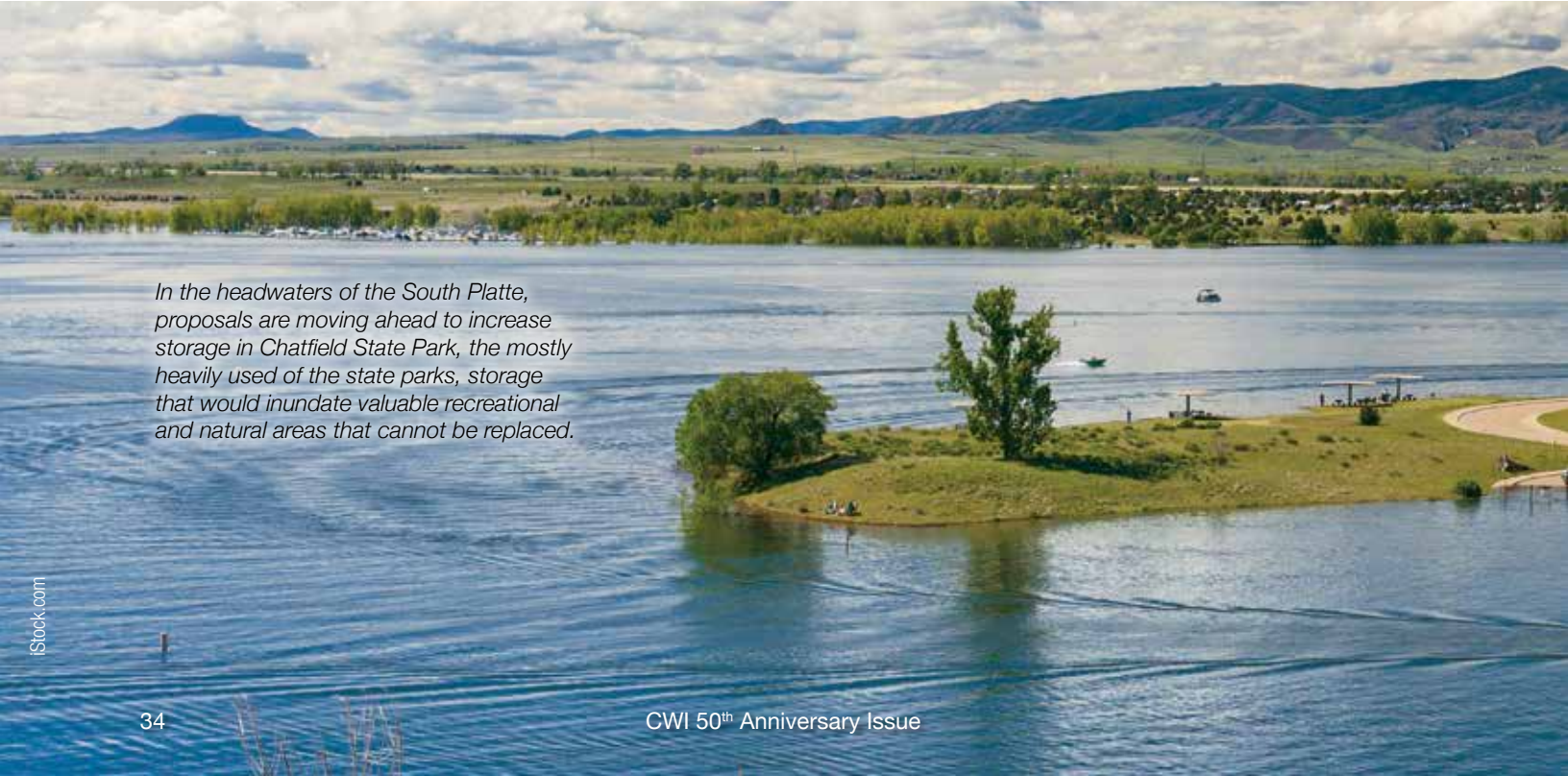
It seems unlikely that the states and all the special districts that currently have a say in water planning and management will simply surrender their prerogatives to unified river basin initiatives or new management institutions. Steps toward basin-wide integration will have to include rewards to all parties involved. Since institutional change always involves losers as well as winners, progress depends on devising ways of creating a “win-win” environment that effectively compensates the losers from the move to integrated basin-wide management. How can we proceed?

A *first step* would be the adoption of the principle of “benefit sharing” or parallel negotiations in place of restricting planning just to water. As an example of a move to international river basin integration, John Krutilla, in his analysis of the negotiations between the United States and Canada over Columbia River development, described the “benefit-sharing” (Krutilla 1967) incorporated in the treaty. Since the Columbia originates in the U.S., sweeps into the canyons of British Columbia, and then returns to the U.S., efficient development required

reservoir storage in the canyons of British Columbia to support power generation, navigation, and fisheries downstream in the U.S. The solution was to arrange monetary payments and the sharing of electric power from the lower river with British Columbia.

Similar arrangements can be envisioned on other rivers. The treaties between Mexico and the U.S. on the Colorado and Rio Grande Rivers in 1944 involved simultaneous negotiation over the two rivers, since Mexico provided a major portion of the water to the lower Rio Grande while the U.S. commanded all the water of the Colorado. This type of bargaining is referred to as an “interconnected game” (Folmer, *v. Mouche and Ragland*, 1993) and promises to play a role in getting back to the river basin. The potential gains may be sufficient to overcome the reluctance of nations and states to enter into more comprehensive river management arrangements.

Benefit sharing is most often accomplished through extra-market compensation. This is seen in payments to the basin of origin accompanying out-of-basin water transfers in the western U.S. The State of Colorado requires “compensatory storage” for any instate project that exports water from the Colorado River Basin to other basins in the state (Grigg 2003) to provide insurance against diversion-induced shortages in the state’s part of the Colorado River Basin. An example is found in Green Mountain Reservoir on the Blue River (tributary to the Colorado) built by the Bureau of Reclamation as compensatory storage for the Colorado-Big Thompson Project (C-BT, 1957) that diverts water from the Upper Colorado to the eastern side of the Rocky Mountains. Naturally, compensatory storage may not always be the most efficient form of compensation.



In the headwaters of the South Platte, proposals are moving ahead to increase storage in Chatfield State Park, the mostly heavily used of the state parks, storage that would inundate valuable recreational and natural areas that cannot be replaced.

A *second step* would be to take advantage of newly developed optimization and surveillance technologies that can facilitate basin-wide real time management. Technological developments have made basin-wide, real-time modes of river management practical. Tele-monitoring of streamflows is highly developed, while satellite imagery of weather and flood events now makes it possible to allocate water on a basin-wide, real-time basis rather than basing allocation on monthly or annual average flows. Kilgour and Dinar (2001) have shown that real time basin-wide river allocation rules are economically more efficient than administration based on periodic accounting with fixed or proportional allocations.

A *third step* would be to expand the geographical scope of water markets to an interstate (or even international) basis. Selling or even leasing water out-of-state has not been permitted by states in the West because of fear of losing the water and foregoing future development potential. These fears can be overcome by the establishment of continuous, low transaction cost water markets extending across jurisdictional lines. Recently, the states of Arizona and Nevada have entered into an interstate agreement under which Arizona will “bank” 40,000 acre-feet per year up to a total of 1.25 million acre-feet for Nevada from its currently unused portion of the Colorado River. When Nevada needs water, Arizona is to reduce its permitted diversions, allowing Nevada to divert an equivalent amount upstream. Arizona can then use the banked groundwater to meet its needs. Nevada paid the Arizona Water Banking Authority \$100 million “up front” to cover Arizona’s initial costs of groundwater recharge and will pay Arizona \$ 23 million annually for 10 years (Arizona Daily Star 2004).

Because of pervasive externalities, water markets must be supervised to avoid third party injury, in keeping with appropriations doctrine (Howe 2002). Water markets are often limited in their ability to protect non-consumptive instream benefits such as recreation, ecosystem maintenance, and hydro-power if they are not represented by water rights. Booker (1995) and Young (1995) found that the greatest losses from extended drought on the Colorado River would be to recreation, power, and environmental values.

The magnitude of transaction costs associated with transfers is crucial to the working of water markets. Transaction costs arise from the search for information about potential buyers and sellers and from the legal requirements imposed on transfers. The water court process used in Colorado guarantees orderly oversight of transfers but can be costly to buyers and sellers (Howe, Boggs and Butler, 1990). Greater reliance on oversight by administrative agencies like the state engineer office can reduce these costs and expedite market transfers.

Conclusions

The appropriations doctrine as practiced in the western U.S. has proven to be flexible in accommodating to changing economic conditions. Water markets, too, have evolved through experience with water banks, drought relief schemes, and rotating fallow schemes that have proven to be effective in allocating water flexibly and efficiently. These water institutions will undoubtedly continue to evolve in response to the pressures of demand, environment, and likely climate change.

Please contact CWI at cwi@colostate.edu for references list.



CSU's Legacy of Involvement in Water Issues

By Robert Ward, Professor Emeritus, Civil and Environmental Engineering, Colorado State University

As President Tony Frank notes in his remarks in this issue, Elwood Mead initiated a water education, research, and outreach tradition of excellence that CSU has sustained for 132 years. Mead gave CSU its water origins, as well as kept the university well connected to national and international water affairs for decades afterwards (after departing CSU in 1888 to become Chief Engineer of Wyoming, Mead went on to lead the Bureau of Reclamation in the 1920s and 1930s).

Louis Carpenter succeeded Mead in his leadership of water programs on campus. Carpenter, who also served as Colorado's State Engineer in 1903-04, continued Mead's emphasis on a strong scientific approach to resolving conflicts over water allocations and administration. Carpenter also led the effort to create a modern hydraulics laboratory in the basement of the new Civil and Irrigation Engineering Building on campus (completed in 1910).


Ralph Parshall graduated from CSU in 1904 and became a professor in 1909. In 1913 he joined the USDA Irrigation Investigations Unit located within the Civil and Irrigation Department. In the 1920s, in collaboration with CSU researchers, he helped design and construct a large hydraulics laboratory where the Lory Student Center (LSC) stands today. A plaque on the side of the LSC commemorates Parshall's development of the Parshall Flume in 1922.

In the 1930s, the Bureau of Reclamation was in need of a hydraulics laboratory to improve the science behind building large dams. A number of BOR scientists spent most of the 1930s on the CSU campus. Also, during this

time, CSU President Charles Lory was chair of a national committee established to resolve the repayment problems surrounding BOR projects. Lory's committee's work contributed greatly to solving the problem.

In 1947, a young Maurice Albertson joined the engineering faculty at CSU. It should be pointed out that through the earlier efforts of Mead and Carpenter, CSU was known around the world; however, with the addition of Albertson, CSU's international work increased greatly. CSU began offering Ph.D. degrees in the 1950s and a large new hydraulics lab was completed on the CSU Foothills campus in the 1960s.

As the environmental consequences of water projects began to be questioned, CSU faculty from a number of disciplines began to examine water resources in a more holistic manner. Henry Caulfield (Political Science), Evan Vlachos and David Freeman (Sociology), Robert Young and George Radosevich (Agricultural and Resource Economics), and Robert Dils and Jim Meiman (Watershed Sciences) are examples of the faculty that permitted CSU to create a strong interdisciplinary approach to water research, education and outreach in the 1960s and 1970s.

Thus, by 1965, CSU was well positioned to support a new, federally authorized and supported, water research institute. In addition, working relationships with 'water' colleagues at other Colorado universities, such as Chuck Howe at the University of Colorado at Boulder, facilitated the new Colorado Water Resources Research Institute (CWRRI) in meeting its mandate to be inclusive of all water-related higher education expertise. 

By Dr. Tony Frank, President, Colorado State University

“To Colorado belongs the credit of having been the first state to enact a code of laws for the public administration of streams, and these laws have directly and indirectly influenced more people than those of any other commonwealth.”

—Professor Elwood Mead (namesake of Lake Mead)

When Professor Elwood Mead arrived in Fort Collins in 1883 to teach at the state’s new agricultural college, the Poudre River flowed through a town of only about 2,000 people out to the arid farmland through a lace of irrigation canals. These canals, first dug by the Union Colony, incited an early but often repeated water dispute: Farmers dug their own canals to divert Poudre water, and always did so upstream. With the leadership of Mead and other faculty at the state’s land-grant campus who were skilled in the measurement and distribution of water, Colorado soon began to piece together the laws, policies, and practices to ensure a safe and reliable water supply for growing Colorado communities and agricultural producers.

Water has been the single, greatest factor in the growth of the American West—and its wise stewardship and management will be among the most significant factors in the West’s progress over the next century. As the premier source for unbiased, science-based research, data, and analysis on water-related issues, the Colorado Water Institute will be instrumental in this progress.

Colorado State University is extraordinarily proud to have served as the home of groundbreaking water research and outreach since the days of Elwood Mead—and we’re equally proud to have served as the home of the Colorado Water Institute for the past 50 years. The institute connects the water expertise of higher education to the needs of Colorado water users, managers, and policymakers. Thanks to the outstand-

ing leadership of several directors, including Stephen Smith, Norm Evans, Neil Grigg, Robert Ward, and now Reagan Waskom—and the unwavering support of the Colorado General Assembly and the U.S. Congress—CWI has become a vital resource and partner in Colorado water management.

Water and how it is used does not lend itself to consensus, and aspects of water use change through the years and decades—just like the rise and fall of river flows and reservoir levels. The challenges of today are different from those of decades and centuries past. In addition to continued work on water conflicts, allocation, and management, today’s water scholars are focused on the nexus of water and energy, the impacts of climate change, and collaborative conservation. That is why the full engagement of CWI—with its emphasis on sound, up-to-the minute scientific information, innovation, and

effective, transparent communication—remains essential to our state’s water future.

On behalf of the Colorado State University community—and the people of Colorado—I want to congratulate Reagan Waskom, the former directors, CWI staff, and CSU faculty on 50 years of making a difference in Colorado water issues. I also want to join with Reagan in looking toward the future and continuing to place high priority on effectively connecting the resources of Colorado’s land-grant university with the state’s water challenges. It’s been a strong and important partnership since the days of Elwood Mead, and CWI is committed to sustaining this effective partnership through a new era and a new century for Colorado water.



Dr. Tony Frank



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