

# WATER IN THE BALANCE

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**“Water research is more important today than it has been at any point in recent history.”**

*Colorado Water Resources  
Research Institute*

**Colorado  
State**  
University

## An Institute Runs Through It!

### Thirty Years of Vital Water Connections

*A 30-year celebration of the  
Colorado Water Resources Research Institute*



#### NEW CHALLENGES FOR A 30-YEAR OLD IDEA!

*by Robert C. Ward, Director, CWRRI*

The Colorado Water Resources Research Institute (CWRRI) will celebrate its 30th birthday in 1995. The National Water Institute Program (of which CWRRI is a part) was born during a period when water management was being asked to provide more water to meet municipal/industrial/agricultural needs (as a result of the growth following World War II) and at a time when the impacts of this growth and industrialization on water quality were increasingly being recognized. New management tools, many developed during WWII, were being applied to improve the efficiency and effectiveness of water management. For example, the Harvard Water Program, in the late 1950s and early 1960s, was adapting many of the

evolving mathematical modeling and optimization techniques to water resources management.

The mid 1960s was a time when the contributions of economists, sociologists, mathematicians, computer scientists and political scientists were being added to those of disciplines that had traditionally served water management (e.g., hydrologists, agronomists, engineers and lawyers). It was also a time when the means of integrating the disciplines, for enhanced water management, was not clear. Many felt, as described in the following article, that a new approach toward supporting water resources research was needed. It was at this time that the National Water Institute Program was born.

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Has the water institute program become obsolete? Have the reasons for its creation passed to the point where we no longer need such a program? Let's look closely at the situation today.

Public concern for sustainable ecosystems has brought the field of biology into defining water needs for ecosystem health. The fact that many of today's Colorado residents have only recently arrived to live in the state suggests that the role of history in explaining past developments in water management will be critical to making informed future water management decisions, especially those made at the ballot box.

The control of many point sources of water pollution has revealed the need to carefully examine the contribution and control of nonpoint sources of pollution. This fact is bringing our agricultural industry into a much more active role in water quality management than it has had in the past.

The increasing water needs of Colorado's tourism and recreation industries are bringing professionals from those fields into the realm of water management in a much more active manner than in the past. In other words, more disciplines are being brought into the water management picture today.


The decade of the 1990s is witnessing a situation similar to that of the 1960s - many new factors are impinging upon water management in ways not traditionally encountered. Is there a continuing need for an institution like CWRRI, or is it an organization that has outlived its usefulness?

The purpose of this publication, while celebrating 30 years of contributions to water resources research, education and service, is to also critically examine the current status of CWRRI (and its national

program) and to examine its future.

This is a critical time in the life of CWRRI and the issues being raised need to be addressed. For example, during 1995 Congress will address the reauthorization of the National Water Institute Program and future funding for the program (which took a 20% budget cut in 1994). As the state of Colorado continues to fund more studies of water management problems, what is an appropriate role for higher education?

To help CWRRI look both backward and forward, a number of authors have been invited to provide their perspectives on CWRRI -- both its past contributions and future potential.

Please join CWRRI in reviewing its past, its current status, and its future potential. We hope you enjoy the thoughtful and educational articles that follow. 



## THE BIRTH OF AN INSTITUTE

*by Jill Marsh*

In 1959 Montana Senator Mike Mansfield told a group of fellow western senators that water was the greatest resource problem facing not only the West, but the entire nation. He proposed that they sponsor an investigation of the nation's water situation and the problems that would

The committee report released in 1961 said that, based on medium projections of population increase,

have to be faced to the year 2000.

That year, as a result, the United States Senate Select Committee on National Water Resources was formed to assess the management of the Nation's water resources. It was the first national water supply and demand study that focused on specific demands on the nation's water resources would double by 1980 and triple by the year 2000. Colorado

regions. The Committee found that while water demands were increasing rapidly, there was a widening gap between the requirements for water and its availability in the amounts and quality needed.

Senator Gordon L. Allott, in a speech at the Western Resources Conference of 1963, stated that "It is from the

field of research that our hopes really spring...as our society becomes larger and in turn places greater demands upon this limited water resource, only research can be counted on to provide the answers which we must and will have for America."

The Select Committee also recognized that decision making concerning water management belonged at the source, and that problems were directly related to the particular area involved. The control, disposition, and use of natural resources would be attained more effectively if policies originated with the states.

To provide more effective coordination of the Nation's water research programs, in July, 1961, New Mexico Senator Clinton Anderson, along with others, drafted legislation to create a national Water Resources Research Program. The bill consisted of three parts to provide for river basin planning, a water supply demand inventory, and state-aid. The bill was studied and revised by the executive branch and submitted to Congress as a Kennedy Administration proposal. Title 1 of the bill authorized \$75,000 increasing to \$100,000 a year for the establishment of water resources research institutes at land grant colleges or state universities in each state.

The proposed water research program received widespread support from Congress and the university community. William E. Morgan, president of Colorado State University

and chairman of the Water Resources Committee of the National Association of State Universities and Land Grant Colleges at the time, played a key leadership role. Congress passed the bill and on July 12, 1964 President Lyndon B. Johnson signed into law the Water Resources Research Act of 1964. At the signing, Johnson said,

*"The Water Resources Research Act of 1964, which I have approved today, fills a vital need...it will create local centers of water research. It will enlist the intellectual power of universities and research institutes in a nationwide effort to conserve and utilize our water resources for the common benefit".*

The Act authorized the establishment of Water Resources Research Institutes in each of the 50 states and Puerto Rico. Later, Institutes would be formed in Washington D.C., Guam and the Virgin Islands. The Institutes were created to fulfill 3 main objectives:

1. To develop through research new technology and more efficient methods for resolving local, state and national water resources problems
2. To train water scientists and engineers through on-the-job participation in research

3. To facilitate water research coordination and the application of research results by means of information dissemination and technology transfer

The federal-state Water Institutes Program (SWIP) provides the unifying focus for the 54 Water Resources Research Institutes. Initially authorized in 1964, the program currently is conducted under the provisions of the Water Resources Research Act of 1984, as amended in 1990. The Act of 1984 incorporated the water resources research programs under the US Geological Survey through its Water Resources Division, within the Department of the Interior.

Although it remains accountable to the Federal Government through the USGS, the Colorado Water Resources Research Institute received statutory authority from the Colorado General Assembly in 1981 to operate as a unit of Colorado State University, with the authority being extended through 1997. The Institute operates under the supervision of Colorado State's Vice President for Research.

A Research Planning Advisory Committee that includes representatives from state and federal agencies and the private sector identify Colorado's high-priority water problems. A Technical Advisory Committee, comprised of faculty from the State's research universities, evaluates research proposals and offers advice on technical approaches.

## *The Future of University-Based Water Research:*



### **REFLECTION ON THIRTY YEARS OF WATER RESOURCES RESEARCH INSTITUTE EXPERIENCE**

*by Charles W. Howe,  
University of Colorado-Boulder*

The year 1965 was an exciting year in the field of water resources. The federal Water Resources Council was just setting up shop to assist in long-range water planning for the nation. Under the same legislation, river basin commissions were being established to coordinate state and federal agencies in planning the futures of some of our major rivers. In that same year, the 48 states were preparing to set up state water resources research institutes to stimulate research and training of water professionals.

We now have 30 years of experience to reflect upon and evaluate. The Water Resources Council was decommissioned in 1981, along with the river basin commissions established under the 1965 act. These were substantial losses to the effectiveness of the U.S. national water program. However, the Water Resources Research Institutes have continued their vital programs of research and training. What does the record show?

Let me paraphrase from the 1994 report of the USGS-appointed evaluation panel (of which I was a member) for the WRRI (Section 104) Program:

*Our panel has reviewed the 54 Water Resources Research Institute programs for the 5-year period ending in 1991. The Institute program is highly effective, which is particularly significant considering the small federal funding. For a modest investment each year, an effective program of multi-disciplinary research, education, training and information transfer occurs in each of the 54 institutes. Our panel's study gives a clear sense of a vigorous nationwide program resulting in substantial accomplishments.*


Over the 30-year period, I have had close contact with a dozen leading Institutes and have been tremendously impressed with the "multiplier" effects of the seed money provided by those Institutes. Small grants of a few thousand dollars have enabled young researchers and graduate students to get started on applied research of great relevance to their states.

In many cases, these initial effectors led to much larger funding from public and private sources. The average "multiplier" effect is about ten dollars of additional

research money raised for every dollar of federal money.

Research results are then communicated to the relevant publics through public information programs and easily accessible publications. The Institutes have often become the major focal point for water policy discussions, debates and conferences in their states.

Here in Colorado, we can identify many contributions of lasting value: integrated surface water/groundwater models that assist in the administration of the South Platte; response mechanisms to drought that were identified in studies of the 1976-77 drought and are now incorporated in the state drought response plan; evaluation of alternative programs of water conservation that have provided background for numerous town water conservation programs. The list could go on for a long time.

This vital WRRI program may lose federal funding. In a state that is highly dependent on water and that prides itself on the beauty and utility of its water resources, there is now a great opportunity -- indeed necessity -- for the State to pick up the funding of CWRRI. 

## *Water Research as Viewed by Water Users/Managers:*



## MEETING WATER MANAGEMENT CHALLENGES WITH SOUND INFORMATION

*by Ralph Curtis, General Manager  
Rio Grande Water Conservation District*

There are four major rivers that originate in the State of Colorado, all of which flow out of the state, giving Colorado its reputation as the “headwaters state.” All of these streams have interstate compacts which equitably apportion the waters of these streams between the State of Colorado and downstream states. The water to which Colorado is entitled under these compacts is then administered under Colorado’s Constitutionally adopted “Doctrine of Prior Appropriation.”

At the time Colorado became a state and until just recently, the development of the state’s water resources has focused on providing water for agriculture, industry, and domestic and municipal water. Because of an exploding population, the need for more domestic and municipal water is growing. The dilemma is where it will come from.

In developing an ever-expanding economic base for the state, the evolution of Colorado water law has been based on legal and engineering principles that do not allow injury to occur to senior water rights. Very little thought was given to the use of water for environmental purposes

In most cases water research projects, whether focused on water quantity or water quality, have a narrow goal and can be conducted by one or two researchers. However if a research project is conducted with a

until 1973 when the Colorado State Legislature enacted a “minimum stream flow” law. This law allows only one entity, the Colorado Water Conservation Board, to appropriate instream flows to protect the environment of the stream to “a reasonable degree.” Scientific research, other than engineering, had never been used in determining water rights decisions in the water courts until recently, and even then its use was not successful.

Colorado now has a portion of the public clamoring for a reallocation of the state’s water resources to include non-traditional uses and the use of so-called “saved” agriculture water for the growing municipalities. The great majority of the public doesn’t understand Colorado’s water laws and how the state’s water resources are managed and administered under these laws. They may not understand that if a major upheaval of our present water law is allowed to occur, it could result in untold economic hardships on those using water already developed and for those who have conditional decrees for the further development of it in the future. If reallocation of the State’s water resources ever becomes a reality, it will be critical that scientific focus on a much larger scale, then perhaps a “task force” composed of research personnel, economists, educators, engineers, biologists, and water users and managers could be an effective approach. This “task force”

research other than just engineering be considered.


It seems as though we are now in an era of learning how to manage our resources using an ecosystem approach. It is my belief that at the present time there is some confusion as to the definition of ecosystem management. Some say it is managing our natural resources through an understanding of how each resource interacts with the other. Others add to this definition people, economics, culture, etc. As we struggle to identify this new management concept it is pertinent that we better understand what happens to one part of the ecosystem when manipulating other parts of it. To fully understand this interaction will no doubt entail gathering or collecting various data. Therefore, research projects focused on the various aspects of water quantity and water quality must continue. In my estimation, the best resource we have for continuing this research exists in already established programs such as those promoted by the Colorado Water Resources Institute.

brings to the table more of an ecosystem management style by bringing together all of the various disciplines which have a stake in the research project.

An area of concern to me is the dissemination of information gained by a research project. Again, considering that a substantial portion of the public does not understand Colorado water law or how water is administered under the law, extreme care must be taken how the results of the research projects are reported to the public. Misinformation is very difficult to counteract. All parties involved in a research project must understand that the results of the project can be very specific and the

effect those results might have on Colorado's water laws can become quite complicated. Therefore, the reporting of results of any research project on water must be done from the perspective that most of the populace is not well-informed regarding water matters.

In closing, it is my firm conviction that water research is more important today than it has been at any point in recent history. Water research in higher education could and should be

the result of a process of water education beginning at the earliest level of a child's educational highway. We have challenges ahead of us that will require not only more information but sound scientific research based on the concept of ecosystem management. The information must then be used wisely and courageously to lead us into the next century prepared to meet those challenges. 



## REFLECTIONS FROM THE DIVISION OF WATER RESOURCES

*by Hal Simpson, State Engineer  
Colorado Division of Water Resources*

The Division of Water Resources (Division) has had a long and useful relationship with the Colorado Water Research Institute (CWRI). The CWRI has provided research that focuses on practical solutions to real-world problems versus university-level theoretical research with little practical application. Of course, there are exceptions to this conclusion, but, in general, I strongly believe the evidence supports this opinion.

Probably the best example of applied research that is still used worldwide is the Parshall Flume, which was developed at Colorado State University by Ralph Parshall. This simple measuring flume, used

Once a research project is underway, it is extremely important that CWRI establish an advisory group to reach agreement on the goals of the research and to have a clear understanding of the end product. In the past, there have been instances where the end product was not clearly understood and some parties were

throughout the agricultural world, measures flow in open channels to determine the amount of water diverted from a stream and the amount used for growing crops. Without this measuring device, water resources could not be properly managed nor would data be available for input to models and decision support systems.

Although CWRI has provided similar research that has been useful as the Division strives to achieve its mission, there have been instances where research has not been as useful as hoped for by the Division and water users. As CWRI celebrates 30 years, it must continue to improve how it serves the citizens and water disappointed in the results, especially those supporting the research. The principal investigator of the research project must realize the importance of communicating progress and providing interim reports. Finally, the work must be done in a timely manner, which has not been the case in a limited number of projects.

users of the state.

The CWRI must strive to better inform the research community of the "real-world" issues and problems encountered by water users. The Research Advisory Committee established by CWRI is one way these "real-world" issues can be identified and discussed and priorities for research established. Other possibilities must be explored to bring the research community and the professional water resources community together to identify specific research needs.

A major challenge facing the CWRI is the possibility that the National Water Institute Program, funded by the federal government through the USGS, will not be reauthorized. If this does come about, the State of Colorado must determine if it wants to support the CWRI

program in its current format or possibly through some other arrangement. I strongly believe that applied research that emphasizes solutions to “real-world” practical problems and issues will be needed in the future, probably even more than in the past, as we deal with increasing water demands related to population

growth, recreation, and the environment.

The investment of \$200,000 to \$300,000 per year could provide the funds to maintain the CWRRI and allow it to use matching grants and other sources to provide limited but very specific applied research

opportunities. This investment appears most beneficial to the State of Colorado. It not only provides needed research but also provides mechanisms to improve educational-related opportunities by producing conferences and seminars on important water resources topics. ●



## **WATER RESEARCH VIEWS FROM THE COLORADO WATER CONSERVATION BOARD**

*by Chuck Lile, Director  
Colorado Water Conservation Board*

The Colorado Water Conservation Board is the State agency charged by State law to develop and protect Colorado’s water resources for present and future generations. The agency is involved in the protection of all interstate compacted appropriations, the development of water projects, the protection of instream flows to preserve the environment to a reasonable degree, the prevention of floods, and the conservation of Colorado’s most important resource, water. In our view, the role for University water-related research is to provide the data and management tools to address the complex water challenges facing Colorado to ensure the wise use of the resource.

The definition of research lends itself to the concept of one working in

a laboratory to solve a detailed micro-problem. However, we cannot continue to look at water in a micro-context, but must expand our understanding of basin-wide systems and our knowledge of how river basins interact. It is difficult to look at basin wide research, since the parameters are varied, numerous, and overwhelming in complexity. The mere application of water to a farmer’s field or to a municipality’s water supply system cannot be the limit of our research efforts nor the limit of our understanding. The interrelationship between surface water uses, groundwater, the hydrological cycle, water quality and associated environmental impacts need to be fully analyzed on the broad perspective. Old myths about water-use efficiency and conservation must

be challenged and redefined to better understand system interactions.

The opportunity for future water research is greater than ever, and at the University level, where we are teaching our future water managers, we need to seize upon the opportunity to expand their understanding of the complex system that has developed in the West regarding water use. Our systems are diverse and complex, use of water has been built upon years of tradition which incorporates the need of man as well as the needs of other species. Research projects that integrate all aspects of water needs in the West should be encouraged. We at the state government level support the continuing efforts of water-related research. ●

## ***Water Research as Viewed by Researchers/Former CWRRI Directors:***



### **AGRICULTURAL WATER RESEARCH**

*by Dan Smith, Professor*

*Department of Soil and Crop Sciences, Colorado State University*

On the occasion of the 30th anniversary of the Colorado Water Resources Research Institute, I am pleased to offer my perspective on water resources research. Water resource problems are inherently complex, involving many interacting forces and groups that often have conflicting interests. Therefore it seems likely that the best possible technologies and methodologies should be pursued using direct input from diverse disciplines that have at least some appreciation for the conflicting interests involved. Water institutes represent a unique structure for pursuing solutions to problems using this approach.

For most of us involved in applied science disciplines, we have been trained to solve problems with hard technology by bringing to bear the various elements of technical expertise that provide the best apparent solution. The mode of action here is interdisciplinary, but narrow in

Much of this research conducted prior to 1980 was located at sites in South Park and emphasized fertilizer, soil management, and water management studies. The results

its scope because of the emphasis on technology.

This approach works best when the problems are purely technical and the solutions do not produce impacts that are in conflict with existing institutional constraints. Unfortunately, formal training in the recognition of these potential conflicts is not available; we are much more likely to recognize a technical barrier than social or legal barriers to solutions

This becomes especially troublesome when working with water problems, because this resource is so important and pervasive in our lives that nontechnical institutional considerations often are more important than technological factors.

In view of the complex of issues normally involved in problems related to water, a more diversified interdisciplinary research strategy allows technical clearly demonstrated that ranchers could significantly increase the yields and quality of hay produced from mountain meadows by increasing substantially cultural and labor inputs. Adoption of

and nontechnical disciplines to work together to identify the limits to technological solutions to problems. The following two examples are given to illustrate these points.

The South Park region is typical of the high-elevation mountain meadow agricultural system in Colorado. Most of these meadows became agriculturally important only after irrigation water was appropriated by the early settlers and used to enhance the productivity of native vegetation. In the early 1950's the USDA established a research center near Gunnison, CO to conduct research on agricultural problems in irrigated mountain meadows. Colorado State University later joined this effort and, even though the USDA discontinued their work in the 1970's, still maintains an active research program headquartered in Gunnison.

these practices requiring more intensive management was minimal, however, which indicated that the "improved" management systems were not cost-effective or not compatible

with the conventional systems being used.

At the same time that the management studies indicated above were being conducted in South Park, the early phases of a significant transition in land use were observed in this region. The transition occurred in the form of the first large-scale transfers of water from irrigation use in South Park to municipal use by cities on the front range. These early and subsequent water transfers would eventually produce significant impacts on the landscape, economy, and social culture of this region. Virtually none of the mountain meadow research on intensive hay pasture management was useful in providing insight into agricultural land management after removing the irrigation water.

The first research to determine the impact of water transfers on vegetation and soils in South Park was not conducted until the early 1980's, when the rate of acreage conversion from irrigated to dryland systems was occurring at its most rapid pace. Additional research on this topic, sponsored by the Colorado Water Resources Research Institute, was initiated in 1993 because of continued interest in long-term effects of water transfers in this region.


Both of these latter studies have provided some answers to the many relevant questions arising from the tremendous change in land and water use in this region. Even so, the expenditures in research dollars and technical effort have been minimal compared to the 30-year effort to promote intensive hay management in the area. Earlier research using a diversified interdisciplinary approach on the potential impacts of water transfers on the landscape and economy could possibly have identified a better institutional structure for absorbing these impacts.

A second example of the limits of technological approaches in water resources problems comes from recent efforts by a task force convened by the Water Resources Research Institute to study the issue of agricultural water conservation. This task force was composed of faculty from Colorado State University and representatives of various water agencies from around the state.

Even though most of the members of the task force were trained in technology-related disciplines (engineering, agronomy, etc.), discussion of

technological approaches to agricultural water conservation was minimal as compared to discourse on the institutional forces limiting the adoption of conservation practices.

This created significant discomfort for those of us on the CSU faculty representing technical disciplines, because, once again, we were reminded that purely technological approaches to problem-solving can be futile. In this case, our knowledge of a wide array of potentially useful technical strategies for improving agricultural water use efficiency on a single-farm basis was confronted by the reality of existing water delivery systems and institutional arrangements governing water rights.

Both of the examples given above validate the approach to research on water resources problems sponsored by state water institutes. The diversified interdisciplinary approach brings the perspective of technical and nontechnical disciplines together to identify the limits to technical solutions and the best possible path to development of appropriate technologies to solving water resource problems. 



## URBAN WATER SYSTEMS REVISITED

*by James P. Heaney, Professor*

*Department of Civil, Environmental, and Architectural Engineering,  
University of Colorado at Boulder*

A major justification for the original water institute program in the 1960s was the need to take an integrated look at urban water resource systems. Federal agency programs were, and remain, fragmented with each agency only able to evaluate a sub-system of the problem. However, this fragmentation was recognized and widespread support existed for supporting university based integrated research on urban systems with significant funding from non-mission oriented agencies.

The primary sources of funding were the newly created Office of Water Resources Research, the National Science Foundation through its program titled Research Applied to the Nation's Needs (RANN), and the U.S. Public Health Service. Also, a large federally supported traineeship program was created to attract top young people into the field. Many of today's leaders in the field were supported by these research programs. Concurrently, very active research was underway in evaluating urban systems in general and urban

Beginning about 1980, support for Institute Program was greatly curtailed as was the NSF and EPA support in these areas. Thus, university research was reduced to very small research projects in the \$10,000 - \$20,000 range, hardly enough to support

water systems in particular.

The interest in urban systems was related to the "Great Society" initiatives which sought to improve the standard of living for all citizens. Researchers on urban systems tried to develop and integrate land use, transportation, water supply, stormwater, wastewater, and economic models of the entire urban system including its watershed(s).

Within the urban water field, significant progress was made under the leadership of M.B. McPherson, a Professor at the University of Illinois, who established the ASCE Urban Water Resources Research Council (UWRRC). He established a strong network of researchers to integrate their individual efforts. The Colorado WRRI played a very active role in these early activities. M.L. Albertson, L.S. Tucker, and N.C. Taylor (1971) edited an influential publication titled "Treatise on Urban Water Systems" which summarized the results of the early years of these activities.

interdisciplinary research. Also, environmental and water resources management programs adopted much stronger command and control approaches. Thus, lacking research support and with little management interest in integrated water management,

The theme of the UWRRC was that we should look at the urban system in an integrated manner with water as a subsystem of the metropolitan and associated watershed systems. They cautioned against dividing our attention into water supply, flood control, wastewater collection and treatment, etc. since the same unit of water may serve several purposes as it moves through an urban area. They also stressed the need for taking a watershed approach.

Much progress was made during this time. Computer models were developed that are still in use today, e.g., the EPA Stormwater Management Model (SWMM), and the Hydrologic Engineering Center (HEC) models. However, we did find that our computer tools were less powerful than we had anticipated and that databases to provide meaningful output were very limited. Thus, a period of disenchantment set in and active research on integrated urban water systems was curtailed.

many of the best university researchers moved to better funded areas such as hazardous waste management. A by-product of this shift in priorities was that students were not being educated in the area of urban water systems. Thus, we have about a

15 year gap in continuity in educating the younger generations of scholars in this critical area.

In the early 1990's, we began to see a renewal of interest in watershed management and urban water systems with a focus on integrated, sustainable, and cost-effective systems. Several catalysts for these changes can be cited (Heaney 1993):

1. Disenchantment with the command and control approach as being too fragmented and piecemeal.
2. Concern over the cost of federal regulations and associated unfunded mandates.
3. Interest in using benefit-cost-risk analysis techniques to help prioritize where resources can be most effectively utilized.
4. Interest in developing sustainable infrastructure systems that will serve the long-term needs of society.
5. Interest in demand side management as an alternative


to costly supply side expansion.

6. Recognition of tradeoffs between urban and nonurban water management at the watershed scale.
7. Recognition of the need to develop management models that can show the interactions among the water infrastructure and urban systems in general because of the continuing urbanization within the United States and throughout the world.

Can we resurrect the urban water systems programs that were initiated in the 1960's? During the past year, the ASCE UWWRC has initiated efforts to secure research support for those programs. The most encouraging sign of rejuvenation is the recent NSF/EPA \$10,000,000 initiative to encourage interdisciplinary research on watershed systems. Also, some versions of the revisions of the Clean Water Act have provisions for major funding for urban stormwater research. Thus, the next decade can be an

exciting time in urban water systems.

At the University of Colorado, we are cooperating with numerous agencies to use the Boulder Creek Watershed (BCW) as a case study to evaluate promising approaches. BCW is a textbook watershed which contains virtually all aspects of water management with a focus on urban water systems. In November 1994, a Symposium on BCW was held. If current funding trends continue, the next decade will allow us to generate important research results and to educate the next generation of leaders in this important field. A more complete description of the history of urban water systems and some proposals for rejuvenation of these activities are presented in Heaney (1995).

The Colorado Water Resources Research Institute has made major contributions to urban water systems during the past 30 years. This important work needs to be continued and expanded. 

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## PERSPECTIVES ON PROBLEM SOLVING RESEARCH

*by Norman A. Evans*

*Director Emeritus, 1967-1988*

Colorado State University was an acknowledged leader among U.S. universities in several fields of water related research when PL 88-379, the Water Resources Research Act was enacted on July 17, 1964. Hydrology and Hydraulic Engineering, Economics and Agronomy were widely recognized for applications to irrigation of the arid west. Important technologies had been developed for water measurement, groundwater pumping, soil water management and crops management. Economic research at the farm production level in conjunction with agronomic research had, to a limited extent, introduced the concept of interdisciplinary research under the auspices of the Colorado Agricultural Experiment Station. This leadership position had attracted a substantial number of federal agencies to locate irrigation-related research and management units in Fort Collins.

When the Water Resources Research Act was signed into law by President Lyndon Johnson, CSU was prepared to incorporate the State Water Resources Research and Technology Institute authorized by the Act into the Natural Resources Center, which had been organized in 1963 by university faculty to facilitate communication and coordination among federal, state and university researchers in the broader field of natural resources. Dr. Stephen Smith,

All except one of these purposes can feasibly be met within the organizational framework of CSU, and I believe they have been accomplished reasonably well given the limited funding made available.

Chairman of the Department of Economics, was appointed NRC director on a quarter-time basis to manage the water research program. He resigned after two years and it was my privilege to serve as director for over two decades from 1967-1988.

Since CSU was designated the home for the PL88-379 institute and CWRRI had been created by administrative action within the University, there was no authority for a coordinating function involving other universities in Colorado. It was clear to me that a legislative mandate was needed if the State was to take advantage of its exceptional scientific manpower resource in all its research universities.

Colorado General Assembly leaders in both the House and the Senate agreed, and, through their initiative in 1981, H.B. 1498 authorized the CWRRI as a state agency. Unfortunately, the Legislature was unwilling to appropriate state funds for the institute because, as I understand it, undesignated research funds are regularly appropriated to the universities and it was expected that they would reallocate some of those funds to water research. While the legislative authorization has strengthened the institute in its coordinating function, the absence of state funds specifically for statewide The one partial exception is the management of research projects. The organizational structure of universities is characterized by disciplines organized into departments. Faculty members are employed by and

problem solving water research is a serious constraint to its full effectiveness.

### ***Mission - Campus Perspective***

Colorado is fortunate to have in its research universities outstanding experts in all the disciplines contributing to water problem-solving research. My opinion is that no other state can claim a more complete and well-qualified roster of water resources scholars. They are an invaluable resource for the state but are underutilized because of the lack of a coordinating mechanism. Coordination should link the university researchers with: (1) state and federal water management agencies; (2) industrial/municipal water providers; and (3) private-sector water managers.

The mission of the CWRRI flows out of its chartering instruments - PL 88-379 and H.B. 1498, the federal and state legislative actions. They call for an organization which will facilitate and stimulate problem-solving research, identify priority water problems, plan and manage research projects, disseminate the results of research to users, and prepare men and women for careers in water resources fields.

accountable to departments and the Institute, therefore, has no authority in the allocation of time and effort of its researchers and may find research time preempted for departmental assignments. This leaves a weak spot

in the Institute's ability to "manage" its research projects. However the sincere commitment of a large majority of faculty members as well as departments to making significant contributions to water problem solutions has generally offset this lack of management authority.

One of the significant highlights of CWRRI from the CSU perspective has been that the federal funds made possible "seed" grants to faculty in disciplines in which water-related research previously had been nil. Notably, faculty in Sociology and in Political Science were encouraged to undertake research on institutional behavior and water policy. As a result CSU built up a strong cadre of researchers in both disciplines and produced graduate students in those disciplines well prepared for water related careers.

The Institute has accomplished very well the felt need of faculty for a linkage to the users of water-related research. Because of the Institute's efforts, faculty are up-to-date in the problems being faced by water users and managers in both public and private sectors.

### ***Mission - Water User Perspective***

In some cases the problem solution calls for technology development, e.g., water quality monitoring instrumentation. In other cases it calls for analytical information needed to resolve conflicting interests, e.g., economic or ecological impacts of water supply development. A problem solution for one interest group might be seen as a "problem"

for the conflicting interest group, even though the product of research may be completely objective and unbiased. Strong criticism of research can arise; the disaffected interest group may conclude that no research is better than an adverse result.

A substantial number of these conflicting-interest situations characterizes today's water problems.


The Institute has successfully provided research products in many such cases which have been accepted and used. In those cases the conflicting-interest groups were actively brought into planning the research and were given the opportunity to assess the quality of relevance of data being used and the limitations which that might impose on the results.

An example of this case was a regional project to evaluate the economic cost penalty to the water users of the lower Colorado River basin due to the addition of salt load from proposed water development in the upper basin. Obviously the upper basin states were extremely sensitive to what the results might show. The research plan was carefully developed by the Institute and the U.S. Bureau of Reclamation in close consultation with state government representatives of all seven basin states. The data to be gathered and the methods of analyses were specified in detail in the plan and were critiqued by the state representatives. In addition the researchers who were selected to do the component studies were the most experienced and well-recognized in their fields among the seven states. This was an extremely challenging

project with conflicting interests which successfully produced the research product needed to meet its problem solving purpose.

### ***The Future***

The outlook in water resources management and related public policy issues is for increasing complexity and intensive conflict among interest groups. Certainly the need for problem solving research will become even more urgent than it is today, and the need for systematically linking the State's research professionals with the problems to be solved will remain. This means that the Institute's mission to facilitate and coordinate (and manage) problem-solving research will continue to be important to the state.

The Institute's full potential for applying the scientific expertise of Colorado's universities to problem solving research has not been reached and, in my view, rests on its ability to initiate and manage large-scale, interdisciplinary research. Complex projects require substantially greater funding than has been available to the Institute through the federal grant and limited voluntary contributions from CSU, CU, and CSM. The Institute has successfully demonstrated that it can manage large interdisciplinary projects which have been financed by contracts with federal agencies through competitive proposals. Unfortunately, that kind of funding is not a dependable foundation for the sustained, problem-solving research Colorado needs. 



## **COLORADO WATER RESEARCH, 1988 - 1991**

*by Neil Grigg, Head*

*Department of Civil Engineering, Colorado State University*

*Director Emeritus, 1988 - 1991*

My task is to describe Colorado water research during 1988-1991, when I was director of CWRRI. I would like to take advantage of the opportunity to provide a perspective of Colorado water issues and of the overall water institute experience. These two perspectives illustrate how the nation and the state have grappled over many years with the complexity and the conflict of water management, and institute research has made, in my opinion, important but under-appreciated contributions to resolving both the complexity and conflict.

While I argue that institutes played an important role in the past, I would also like to argue that now it is time for their role to change, along with the roles of government agencies, higher education in general, and the private sector. I became Director of CWRRI in 1988, after Norm Evans retired. Norm had compiled a long record of success and was respected both in Colorado and around the nation as a leader in water resources research. He laid a firm foundation for the Institute, although he had to struggle, as I did, with trying to keep CWRRI financed. This was easier in the 1960's and 1970's when the national grant programs were more responsive to the needs than they were later.

### ***Background of Water Resources Research Act***

To set the context for the passage of the Water Research Act, I would like to quote Ted Schad who in speaking of the 1940's and 1950's recently said: "In those days we didn't know as much about the problems and the issues..." Imagine the time, about 1950. The nation was recovering from World War II and could see a long period of prosperity, if we  
Numerous students have been motivated to pursue careers in water

could solve basic problems such as highways, city-building, water supply, etc. The attitude was "can do." The biggest worry was the Russians, not overpopulation, crime in the streets, or environmental quality. The Water Research Act was really part of the "New Frontier" and the "Great Society" and those eras have clearly passed. Now we are dealing with a fresh dose of realism.

Some saw the 1960's as an extension of the 1930's New Deal era. The water industry had started its period of self-organization about 1920. By then the nation was experiencing prosperity and had embarked on government-sponsored dam-building and other water development schemes. But by the 1930s, water development was a depression-era jobs program. This did a great deal, however, to stimulate water research and experimentation, including in universities such as CSU where our hydraulics lab flourished. After the war, the 1950s were a time of growth and expansion and brought the realization that the nation's water resources were finite. The Hoover Water Policy Commission of that era set the stage for the 1960s which featured the Water Resources Research Act and the Water Resources Planning Act. Neither of these achieved the goals of their creators but both made considerable contributions.

### ***Results of Water Resources Research Act***

The Water Resources Research Act has taken the nation, and water researchers, through several periods of experimentation with how to do research, and how to couple higher education, government, and the private sector. As a result, we have learned a lot about not and have received support and experience from CWRRI.

only water research but how to organize the nation's water industry.

The Act was launched with considerable fanfare, at least among university researchers, consultants and others in the water industry with an interest in water research. I benefited from it for the first time in 1965 when funds were allocated for an experimental open-channel flume at Auburn University where I received my M.S. degree. My next contact with the Water Research Act was during 1972-77 when I was investigator for several projects that kept me in touch with real world water development including combined sewer overflows, development of SCADA systems, and urban drainage in Colorado. In 1977 I became Director of the North Carolina Water Research Institute and had a experience with research and regulatory action in eastern water resources including estuaries. In 1988 I became Director of the Colorado WRRI and had a very satisfying three years of experience with research on Colorado water problems.

The water research issues that I worked on at CWRRI were quite diverse, reflecting the complexity of water management in the state. We supported South Platte River projects, projects on decision support systems and models, projects on economics of water in the state, and numerous conferences and workshops where we focused on a variety of Colorado water policy needs.

After my experience with CWRRI, I believe that the institute has made significant contributions such as the following:

CWRRI has compiled a most

impressive list of reports and research documents. The publications series is the only such set of documents available in Colorado.

CWRRI projects have resulted in knowledge and new technologies that have helped solve problems, develop computer software, educate officials, and generally contribute to the state's water resources management infrastructure.

Teamwork developed through CWRRI projects has helped to form relationships and to initiate important cooperative efforts. For example, a project organized about 1990 provided the nucleus for important work on South Platte models and data bases.

### ***A New Era For Water Research***

Taken in perspective, it is definitely a new era in water research. To highlight the current situation, I want to report on a meeting of water policy leaders that I organized in Washington on February 27, 1995. The basic purpose of the meeting was to comment on the current water scene and where water resources managers ought to be making contributions. The group of 25 included persons with experience ranging from New Deal era to today's international scene.

In historical perspective, they stated that the issues we face are the same as fifty years ago, when the professional practice of some participants was starting, or twenty five years ago when the environmental movement got going, but the issues are now more complex in spite of the fact that we know more about them. Thus, for researchers we have a dilemma: we know more, but things are more complex.

Fifty years ago water resources development was a much bigger item in

the federal budget - maybe 2% of the budget. Now it is much, much smaller, and the federal government is downsizing even more in its involvement. More focus is needed on state and local development to take up the slack. This has important implications for institutes because with the federal government withdrawing, states will have to do more.

There is much more emphasis on operating existing facilities than on building new ones, although in developing countries, and to respond to the "small systems" problem in the US, there is a need for practical systems to be built and operated. As we seek to make existing systems and facilities go further, there is a need for more management attention to water reuse, not as "add-ons" but as integral parts of systems.

Given the fragmentation of goals, values, programs, there is a strong need for leadership and bringing factions together. Communication skills are badly needed, as are skills such as interdisciplinary teams, improvements in negotiation and ADR, and the use of reinvented concepts such as partnering and privatization. The consensus is that being good technically is not good enough anymore - institutional problems must be solved. Water managers do not determine society's values, but to prepare the next generation to respond to them, water education must be realigned to respond to them. We should ask the questions: are society's needs being met, and what can we do to help meet them? One generalized response needed is to champion education at all levels, and advocate human resources development that is adequate to deal with the complexity and the responses and mandates needed in today's water scene. Thus emphasizes the continued need for CWRRI's student programs.

In spite of our best intentions, policy-setting is not science based, not in Colorado, the nation, nor the world. We need more informed public debates and sensible discussions in developing

countries. The public is not scientific and rational in its approach. CWRRI can help to inform people of their choices and to use information better.

To deal with financial and other realities, there is a need to focus on practical technology - to implement solutions that will work now, in 10 years, and on into the future. We should stress the integrity of solutions and look for ways to build systems that will serve society with high quality for decades.

Institutional fragmentation is an important issue. We need better and less confusing institutions. This is true nationally as well as in Colorado. The fact that the Mexicans chose to follow the French water management system rather than the US system should give us a wake-up call. Colorado has a big job to do in this area.

### ***Where to go with CWRRI?***

Given the above, what directions are needed for CWRRI? I am bullish on the need for research and the opportunities that can be provided through the institute, but with today's fiscal climate, it is going to remain difficult to fund programs at an adequate level. I forecast that a minimum level of support will continue from Washington, although the current scrutiny of the USGS budget itself suggests that Washington may cut even deeper into essential programs. It will be a tragedy if the water institute program was completely cut off from federal support. To me, the institute program is a good example of a proper role for the federal government to work with states and universities.

Regardless of the federal support, it will fall on the university and the state government to find a way to maintain a healthy and effective CWRRI. I hope this 30th anniversary CWRRI report will help to provide some perspective needed for the dialogue.

# About the Colorado Water Resources Research Institute and Water in the Balance

The Colorado Water Resources Research Institute (CWRRI) exists for the express purpose of focusing the water expertise of higher education on the evolving water concerns and problems faced by Colorado citizens. CWRRI strives to constantly bring the most current and scientifically sound knowledge to Colorado's water users and managers. For more information about CWRRI and/or the water expertise available in the higher education institutions in Colorado, please contact CWRRI

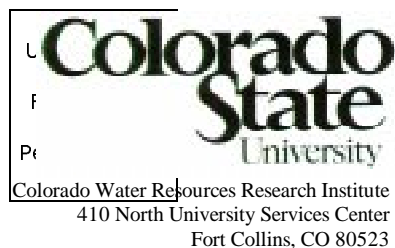
at the address below or by phone, fax, email, or internet as follows:

Phone: (970) 491-6308  
Fax: (970) 491-2293  
email: [cwis31@yuma.ACNS.ColoState.EDU](mailto:cwis31@yuma.ACNS.ColoState.EDU)  
internet: <http://www.ColoState.EDU:80/Depts/CWRRI>

“Water in the Balance” has been created in the spirit of informing the public about complex water management issues. This issue is intended to present different perspectives on University-based water research. With the uncertainty regarding

continued federal funding of such research, these perspectives hopefully will facilitate discussions which will lead to redefining how such research should be organized.

The contents of this publication do not necessarily reflect the views and policies of the Department of the Interior, nor does the mention of trade names or commercial products constitute endorsement by the United States Government.



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**“Water research is more  
important today than it  
has been at any point in  
recent history.”**