

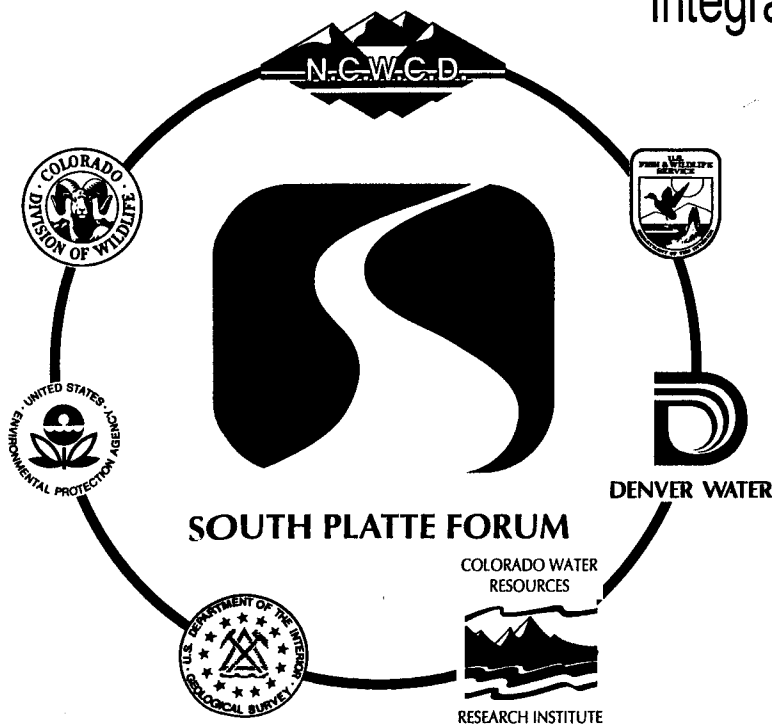
# Integrated Watershed Management in the South Platte Basin: Status and Practical Implementation

*Proceedings of the 1994  
South Platte Forum  
October 26-27, 1994  
Greeley, Colorado*

Kathleen C. Klein, Editor  
David J. Williams, Assistant Editor

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# **Integrated Watershed Management in the South Platte Basin: Status and Practical Implementation**

Kathleen C. Klein, Editor  
David J. Williams, Assistant Editor

## **Sponsored by:**

Colorado Water Resources Research Institute  
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**October 26-27, 1994  
Ramkota Inn  
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## Preface

The fifth annual South Platte Forum will explore the practical implementation issues associated with an integrated approach to watershed management in the South Platte Basin. Last year's conference laid the conceptual foundation; this year's agenda specifically addresses the status of integrated watershed management efforts, and tools for implementation.

Integrated watershed management initiatives are catching on in Colorado. In the South Platte Basin, watershed-based thinking is being driven by issues such as the threat of expanded water quality regulatory requirements, compliance with endangered species needs, increasing municipal demand, and federal lands management. As can be seen from the following abstracts, management strategies at the local, state and federal level are moving toward a watershed-based approach, and support tools are being developed to do the job.

One example of integrated watershed management at work is the growing watershed forum movement. Watershed forums are taking shape in the Arkansas River Basin, the Clear Creek Watershed, the Eagle River Basin, the Upper Animas River Watershed, and in the Upper Colorado River Basin. These forums have developed to meet different needs within each respective watershed. The dilemma common to all, however, seems to concern process and purpose - how do we actually integrate water management within a watershed, and to what end?

Development of tools such as the South Platte River decision support system, South Platte water rights management system, the Poudre River consumptive water use GIS, and the compilation of NAWQA data, provides us with the means to integrate management in the Basin. What we don't have, however, is a clearly defined set of objectives, or process, for responding comprehensively to changing water use needs.

Management of the South Platte River must continually evolve to meet these changing needs. The editor believes that the existing institutional system and arsenal of technical tools provides us with the means to integrate water management efforts, when we are ready to act collectively. The popularity of the South Platte Forum as an interdisciplinary gathering session underscores this belief.





# **Invited Speakers**

## **Colorado Watershed Management Initiatives**

Jim Lochhead, Executive Director  
Colorado Department of Natural Resources

## **Integrated Watershed Management, The Federal Perspective**

Bill Yellowtail, Regional Director  
U.S. Environmental Protection Agency

## **Complying with the Endangered Species Act**

Doug Robotham  
Colorado Department of Natural Resources

## **Forest Service Land Use Issues**

Elizabeth Estill  
U.S. Forest Service

## **Keeping up with Increasing Demands for Water**

Doug Kemper  
City of Aurora

## **Dealing with Water Quality Issues Comprehensively**

Paul Frohardt  
Colorado Water Quality Control Commission



# Forest Service Land Use Issues

**Elizabeth Estill**

U.S. Forest Service

Many existing water facilities are over fifty years old and operate under authorizations that have expired, will expire or will require substantial modification for public safety and operational efficiency. Some of the facilities predate the National Forests; almost all predate the environmental laws that now govern new or replacement authorizations. The laws include the National Environmental Policy Act, the Endangered Species Act, the Clean Water Act, the Federal Land Policy and Management Act, and the National Forest Management Act. They apply to continuing and new projects, and collectively they require analysis, disclosure of environmental impacts and permit terms and conditions to mitigate the impacts. Sometimes the only reasonable mitigation is leaving some amount of water in the stream.

Although public opinion of the "highest and best use" of water is expanding to include recreation, fish and aesthetics, State rules governing ownership have not changed. Of two sets of property rights, which prevail: the public's right to protect natural resources entrusted to the stewardship of Federal agencies or non-Federal property rights such as those administered under the State's water allocation system?

**Water facility uses are a welcome and legitimate use of National Forest Systems lands.**

Some suggest that efforts to require users to mitigate the environmental effects of their use is evidence that the Federal Government is trying to eliminate water facilities on National Forest Systems lands. To the contrary:

Several Federal statutes support use of National Forest Systems lands for water facilities.

The largest segments of the Colorado economy--agriculture, tourism and municipalities--depend upon the attributes of Colorado's Federal lands and the water produced on them. Thirty-six percent of Colorado's land base is managed by the Federal Government, and 96 percent of the State's average annual water yield comes off National Forests.

This region of the U.S. Forest Service has more authorized water facilities than any other. Demand, topography, Federal statutes and the public interest all dictate that these uses continue.

**Authorizations for water facilities on National Forest Systems lands will comply with law.**

In modern environmental laws, the Congress said there would be no further degradation of aquatic ecosystems; there would be some retrofitting of existing facilities to protect threatened and endangered species; and we would maintain the viability of vertebrate populations dependant on water. Congress requires that authorizations for new, modified or continuing water uses comply with those laws. In passing those laws, the Congress rejected the notion that a previous

authorization guarantees a new authorization or that environmental damage should continue without mitigation; the Congress, not unlike modern public safety and nuisance laws, expressed its commitment to avoid degradation of modern ecosystems.

**Both the Feds and the cities care about the public interest.**

The Feds and the cities share an interest in clean water, a sustainable supply of water, the recreational and economic benefits of tourism to local and national citizens, a legal commitment to protect the environment and the provision of certain resources and commodities. It is as much in the public interest to support an agrarian economy and provide domestic water for some of our citizens as it is to protect the public's lands upon which that water depends.

**Solutions will be sought collaboratively.**

So we have two parties trying to serve the public interest: one responsible for water for people, livestock, and crops in certain places and one responsible for providing suitable conditions for water supply while at the same time protecting ecosystems on behalf of all of the citizens of this country. When interests collide, we have two choices: we can negotiate some reasonable compromise, or we can ask the judicial or political Solomons to cut the baby in two. If a Solomon is summoned, you can bet that nobody's gonna get a slam dunk, and we'll all get some of what we want and some of what we don't want. If we ignore the facts of a particular operation and stand only on principle and themes, we will increase the chances of getting something we don't want.

It is not as though municipal facilities cannot be operated without damaging the environment; it is a question of our mutual commitment to collaborate in order to reduce our detriments and ignore irrational beliefs that any compromise will lead to the demise of either the environment or the State's system of water allocation. After all, Colorado's water allocation system has been a hardy institution. Conceived in 1870, it has been remarkable for its ability to protect the rights and interests of private property rights holders, and, if necessary, it can probably be modified to accommodate the mutual interests of Federal and non-Federal neighbors. That is, if we each step off our principles and absolutes long enough to seriously ponder it.

**Solutions will be scientifically sound, economically feasible, and socially acceptable.**

Jack Ward Thomas, new Chief of the Forest Service has said:

"Through science we can describe options and provide assessments of their consequences, but science is only a tool. ...Science simply will not give us 'the answer.' We live in a society that demands instant answers, but we manage a resource that responds to human activity over long time frames."

He also advises:

"Don't keep your eye on the impeccable correctness of your original position but on the

appropriateness of the ultimate compromise that will come."

**The expense of mitigating the effects of using the public's property is a cost of doing business.**

The law requires all users of the public's lands to mitigate the effects of their use.

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# **Colorado Watershed Protection Approach July, 1994**

**Paul Frohardt**

Colorado Water Quality Control Commission

The watershed approach to water quality management has attracted a great deal of interest in Colorado and across the country over the last several years. The Colorado Water Quality Forum, in particular, has devoted considerable attention to this issue.

## Colorado Water Quality Forum

The Colorado Water Quality Forum was created in 1992 to provide an opportunity for an ongoing informal dialogue among diverse parties representing a broad spectrum of stakeholder interests in water quality management. Participants include water suppliers, industrial and municipal dischargers, environmental groups, and federal, state and local governmental agencies. The adopted mission of the Forum is: To achieve solutions to Colorado water quality issues through communication and understanding, balancing use and protection of the resource.

Monthly Forum meetings are facilitated by the University of Colorado at the Denver Center for Public-Private Sector Cooperation, funded through participant contributions. To date, the Forum has experienced considerable success in improving communication among stakeholders and fostering a more cooperative approach in the administrative and legislative consideration of difficult water quality issues.

## Watershed Working Paper

Over the past year, the Forum has focussed attention on watershed planning and management. Several considerations influenced this decision. First, in recent years there has been increasing interest nationally in a more holistic, integrated approach to environmental and natural resources management, such as that embodied in watershed management. Second, there was also a recognition that a number of local and regional watershed protection efforts had been initiated in Colorado. Third, Colorado's water quantity management system has always been organized around watersheds, and in recent years the Water Quality Control Division and Commission had begun to shift toward more of a watershed focus in the organization of the state water quality management system. Fourth, federal water quality program initiatives also have been moving toward an increased watershed protection focus, and watershed management is expected to be addressed in Clean Water Act reauthorization. In addition, several federal resource management agencies are shifting their efforts toward an ecosystem management approach organized on a watershed basis. Finally, there was a recognition of the potential for watersheds as an appropriate and practical scale on which to address the integration of water quality and water quantity concerns.

The Forum established a watershed working group that began its efforts by reviewing

approximately twenty examples of watershed management approaches from Colorado and across the country. These included a number of local and regional watershed protection initiatives of varying scope, and a few legislative proposals regarding watershed management. The group developed a summary comparison of these examples to identify common elements that appear to be most critical to the success of watershed protection efforts. This led to a decision to develop a "working paper" to advance communication regarding what was learned from this analysis, and to begin to work toward a consensus regarding an appropriate Colorado approach to watershed protection efforts. The working paper evolved through several drafts. Beginning with a focus on information regarding local and regional watershed initiatives, the paper was expanded to include a description of the statewide watershed management framework, from both a water quality and water quantity perspective.

The paper discusses the definition of "watershed". It suggests that the definition necessarily begins with hydrology: What land mass drains to a water body or water segment of concern? However, to define the appropriate scope of an area to be addressed by a watershed protection initiative, other considerations are also important. These include political boundaries, the nature of the uses sought to be protected, the nature of the problem or problems potentially impacting these uses, the need to identify an area of a manageable size for meaningful communication and coordination, the availability of resources to support the effort, and the extent of public interest in participation in a watershed protection effort.

### Local and Regional Watershed Initiatives

The working paper presents the lessons learned from the Forum's review of local and regional watershed initiatives. The overall perspective offered is that voluntary, bottom-up watershed protection efforts are most likely to achieve successful long-term solutions to local and regional concerns. Several critical aspects of such initiatives are addressed. First, the importance of establishing clear goals and objectives is emphasized. Goals and objectives tend to fall into two broad categories: resource restoration and resource protection. Resource restoration efforts attempt to eliminate or mitigate problems that already exist. Resource protection efforts attempt to protect desirable uses or values of a resource before an unacceptable adverse impact occurs. While such pro-active efforts logically seem desirable, in practice it appears more difficult to sustain stakeholder interest before a problem exists.

Several observations are offered regarding the organization and structure of local and regional watershed initiatives. Formal or informal program management and leadership, with adequate credibility, trust and resources, is noted as a critical element. The importance of an ongoing iterative process of stakeholder involvement and outreach is also emphasized. Unless all interested parties have an ongoing opportunity to participate, a local or regional watershed initiative is unlikely to be successful. Finally, the paper notes the need to integrate the watershed initiative efforts with the operation of existing local, state and federal programs relating to water quality management.

Several implementation tools-the "nuts and bolts" of a watershed protection initiative-are described. For example, water quality monitoring programs, the development of total maximum



daily loads for critical pollutants, the identification of best management practices for nonpoint sources, and the establishment of point and nonpoint source trading programs are examples of specific tools that may be applied within a given watershed. Evaluating the progress of a watershed management effort on an ongoing basis is extremely important. Because the attainment of goals within a given watershed will typically take many years, ongoing evaluation is critical to a sustained, long-term effort. The paper also identifies key considerations in data collection efforts associated with watershed management.

To be successful, any watershed management effort in the arid west must address the need to integrate and balance water quality and water quantity considerations. The paper describes a best management practice process, developed as a part of Colorado's nonpoint source management program, for involving interested stakeholders in consideration of potential water quality impacts from hydrologic modifications.

The working paper also discusses the tradeoff between voluntary and mandatory approaches to watershed management. While most of the paper is intended to be descriptive rather than prescriptive, this section strongly advocates that voluntary, bottom-up efforts are more likely to achieve the cooperation and consensus necessary for long-term solutions in individual watersheds.

Finally, the need for adequate financial resources for local and regional watershed protection initiatives is addressed. Locating adequate resources even for organizational and planning support for such an effort presents a major ongoing challenge. Development of adequate resources for the implementation of watershed protection projects generally requires leveraging multiple funding sources and in-kind resources. The paper identifies some potential sources of funding which should be explored.

### Statewide Watershed Management Framework

The working paper describes the degree to which statewide water quality and water quantity management in Colorado are organized around watersheds. Colorado's water quantity management system has always been organized around watersheds, based on the prior appropriation system. This system is briefly described, and an overview of the principal roles of the State Engineer's Office and the Colorado Water Conservation Board is provided.

The state water quality management system operates on a cycle. Focused site-specific ambient water quality monitoring is followed by revision of site-specific water quality standards. Revised standards then form the basis for development of total maximum daily loads and wasteload allocations for critical pollutants at a given location. This analysis is followed by an assessment of the adequacy of current controls to achieve the wasteload allocations necessary to attain the standards. If necessary, discharge permit limitations are revised. Finally, any necessary additional controls, such as improved point source treatment or additional nonpoint source best management practices, are implemented. Until recently, each of the steps of this cycle occurred in various locations throughout the state on an independent and uncoordinated basis. The paper describes current efforts to apply each element in this cycle with a watershed-specific focus.

Several benefits are anticipated from establishing a watershed focus for the various steps in this management cycle, including greater efficiency in allocation of state agency resources, improved public participation, greater effectiveness in achieving the appropriate level of water quality protection, and greater consistency in the requirements established for pollution sources within a given basin.

Finally, this section of the paper addresses the importance of coordination and integration of statewide water quality and water quantity management efforts. The current legal structure is described, as well as evolving efforts to improve communication and coordination in addressing water quality and water quantity management.

#### Future Challenges and Next Steps

The final section of the paper provides an overview of new directions in environmental and natural resources management that are developing at present. In addition, the paper identifies several questions and challenges posed by these new directions. Hopefully, this discussion will also help contribute to a common starting point as all stakeholders pursue efforts to address the challenges of the future.

The Water Quality Forum is currently disseminating copies of the working paper as broadly as possible. Although the paper is "final" for now, it is anticipated that ongoing developments and further public comment may warrant revision and updating over time. As noted above, one of these developments is Clean Water Act reauthorization. Whenever reauthorization is finalized, the outcome is likely to impact watershed management in Colorado. In the meantime, the Water Quality Forum and others will continue to work together to assure that watershed management efforts serve Colorado's needs and interests.

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# **Technical Presentations**



# **Application of a Watershed Management Approach**

**Russell N. Clayshulte**

Denver Regional Council of Governments

## **ABSTRACT**

The regional Clean Water Plan developed and maintained by the Denver Regional Council of Governments (DRCOG) recognizes 18 hydrologic planning basins in the eight county region. These basins have been used to define water quality management planning areas. Designated management agencies in these basins have developed water quality management plans and implementation programs. These plans are summarized in the regional Clean Water Plan and they provide specific recommendations on wastewater facility siting, service areas, levels of treatment, nonpoint source control, stormwater management, stream standards, best management practices, as well as characterizing water quality within each basin.

Hydrologic features, geographical considerations and political designations were used to establish basin boundaries. Some basins define actual discrete hydrologic drainage areas or stream/river watersheds, while others are more complex hydrologic systems based on political realities. From a regional perspective, the water quality of each basin has some effect on downstream or contiguous basins.

Although a general watershed protection approach has been used in the DRCOG region for water quality planning and management programs, the process has not always applied an integrated, holistic strategy. Efforts are underway at DRCOG to revise the system of hydrologic basins and designate new water quality planning and management watersheds for the region. This change requires an extensive evaluation of existing management programs and could lead to a new water quality management system for the DRCOG region.

The goal of the DRCOG watershed protection approach is to apply an integrated, holistic strategy to protect or attain established beneficial uses of waters within regional watersheds, including protection of human health and aquatic ecosystems.

The first level of watershed designation was based on geographic areas where activities have significantly affected a waterbody or stream segment and control programs have been implemented. Different factors then taken into account to define or refine watershed boundaries in the DRCOG region include hydrology, political boundaries, uses to be protected, nature of the problem, manageability, available resources and existing management systems.

A preferred alternative watershed map has been proposed for the DRCOG region. There are nine proposed watersheds: St. Vrain, Boulder, Upper Clear Creek, Bear Creek, Upper South Platte, Cherry Creek, South Platte Urban, Box Elder and Eastern Plains. The Box Elder and Eastern Plains watersheds have not been well defined due to the extensive area outside the DRCOG region included in these watershed boundaries.

There are a number of political and management issues which will need resolution before an integrated, holistic watershed protection approach can be implemented in the DRCOG region.

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# **South Platte River Basin Study: Putting Data to Work on the Ground**

**Stuart N. Simpson**

USDA Soil Conservation Service

## **ABSTRACT**

When the USDA Soil Conservation Service and the Colorado State Soil Conservation Board first proposed to conduct a river basin study on the lower South Platte River, the question most people asked was why this effort was needed when the USGS had already embarked upon NAWQA.

The goal of a cooperative river basin study, as defined by USDA, is a logical next step to a major effort like the NAWQA. The ultimate goal of this study is to identify, develop and find funding for nonpoint source water quality improvement projects that address concerns on a watershed basis.

To accomplish this goal, SCS is working with local entities, such as soil conservation districts and water conservancy districts, to identify areas (watersheds) where there is local concern, interest and support for pursuing a project. The study uses data obtained from USGS and others to confirm the identified local water quality concerns. Acting as a facilitator, SCS will work with the local entities (in a collaborative process that includes all interested stakeholders) to develop alternatives for addressing the water quality concerns and identify potential sources of funding for the projects. Decisions for action are left in the hands of the local stakeholders.

Part of the presentation will address the areas of concern already identified to date, as well as an indication of the public perceptions of water quality, especially as related to agriculture. Understanding what the public perceives about any topic is the first step to encouraging action. The remainder of the presentation will briefly touch the "how to" of gaining decisions (consensus) at the local level, using principles often referred to as Coordinated Resource Management Planning.

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# **Collaborative Decision Making, Values and Goal Setting as a Participatory Grassroots Process To Build Public Ownership For a Natural Resource Allocation Decision**

**Bill Thompson**

## **ABSTRACT**

Citizens, taxpayers and special interest groups are increasingly more vocal on natural resource issues, and have "come to the table" prepared to involve themselves in the various decision making processes. These new presences will have a tremendous impact on how and why decisions are made in the future regarding resource allocation issues. What implications does this trend hold for the South Platte area?

These interest groups say that their presence enhances the dialogue and improves the outcome. Is that true of the current process, and if not, how do we make it so? How do we fashion a decision making process or methodology so as to include many constituencies, so that the resulting decisions are well crafted, have broad based support and can be implemented with a minimum of dissension?

There are several characteristics of such a process that are necessary if it is to be successful. The process must be participatory at the grassroots level. This means that it must be inclusive, and allow input of some form from each constituent or constituency that has a stake in the outcome. For public policy decisions, this is a key factor.

The process must involve collaborative decision making methods. All of us have seen, participated in and been frustrated with processes where we were chosen to "rubber stamp" a decision. This approach does not lend itself to a feeling of ownership of the decision, and thus naturally leads to a probable log-jam of dissension when the implementation comes.

In order to successfully combine the needs, desires and wishes of a broad based group of constituencies, a collaborative decision making process must begin at "first principles"--that is, with values and setting a goal. Using this methodology, and remembering the principle of "go slow to go fast", a consensus is developed from the bottom up, so that later debates and disagreements can be resolved by referral to previous agreements on values and goals.

This paper will examine the characteristics of such a decision making process, find some various models that are available, and draw some recommendations to be applied in the South Platte watershed management plan.

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# **Achievable Goals and Appropriate Tools For Integrated Watershed Management in the South Platte River Basin**

**Dr. F. Robert McGregor, P.E.**

Waste Engineering, Inc.

**Chuck R. Haines**

Wright Water Engineers, Inc.

## **ABSTRACT**

The South Platte River Basin is characterized by decentralized ownership of water rights and storage and delivery systems. Major investments have been made in achieving the current allocation of the South Platte's water resources under Colorado's appropriation system.

Colorado's system of water rights provides both security and flexibility. During 130 years of refinement, the prior appropriation doctrine has been successfully reconciled with changes and transfers of water rights, minimum stream flow rights, augmentation plans, and technical and institutional changes in the adjudication and administration of water rights. More recently, the development of advanced computer-based tools has created opportunities for better analysis and planning and more accurate administration.

Realistic plans to pursue integrated watershed planning within the South Platte Basin can build upon technology already available or under development. During the last four years, three major projects have been launched by public agencies within Colorado to develop advanced planning and analytical capabilities related to water resource management. These are the:

- South Platte Water Rights Management System
- Colorado River Decision Support System
- Denver Water Department's System Model

A comparative summary of the technical goals, designs and current capabilities of these systems is presented in layman's terms.

The techniques implemented in these modeling systems can be adapted by individual water providers or diverse groups to explore alternative management options to meet integrated watershed management goals within the context of the appropriation system. A hypothetical example of an application of these combined technologies to a problem in integrated watershed management, with emphasis on reservoir accounting and augmentation plans, is presented. The example illustrates how computer-based models can be used to foster integrated watershed management practices that are compatible with Colorado's appropriation system.

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# **Using the EPA Rapid Bioassessment Protocol III to Rank and Prioritize Areas on the South Platte River and Cherry Creek Impacted by Non-point Source Pollution**

**Todd A. Campbell, Tom Cowan, Maureen Dudley, and Amy Wiley**

Denver Public Health Department

## **ABSTRACT**

Denver Public Health Department's Environmental Protection Division was awarded a section 319 grant from the EPA, through the Colorado Department of Health, to study the effects of non-point source (NPS) pollution on Cherry Creek and the South Platte River in the City and County of Denver. Ninety-six sampling locations were selected with regard to substrate homogeneity and bracketing dry weather storm water outlets. The first year of the study consisted of collecting physical, chemical, and biological data using Rapid Bioassessment Protocol III (RBPS). This was done quarterly, in correlation with the changing of the seasons. Physical data collection centered on a habitat assessment at each monitoring location. The chemical parameters sampled included temperature, dissolved oxygen, pH, specific conductivity and phenols, while the biological component consisted of macroinvertebrates. In addition, total ammonia and fecal coliform analyses were conducted on a representative number of sample locations in order to assist in identifying potential areas impacted by those pollutants.

The first year's sampling data are currently undergoing analysis, and a preliminary effort has been made to identify and prioritize the most impacted stream areas in Denver. Future research will then focus on an intensive investigation into the cause(s) of the impact to several of the highest ranked sites. Six to ten of the sites are anticipated to be included in this investigative effort.

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# **Relation of Trace-Element Concentrations in Bed Sediment and Fish Tissue to Land Use in the South Platte River Basin**

**Janet S. Heiny**

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South Platte River Basin

## **ABSTRACT**

Bed sediments and fish tissues were collected from 23 stream sites representing various land uses in the South Platte River Basin at low flow during the summers of 1992 and 1993 as part of the U.S. Geological Survey's National Water-Quality Assessment Program. Bed sediments and fish livers were analyzed for selected trace-element concentrations.

Concentrations of most trace elements in bed sediments decreased with increasing distance from the mountains to the plains. Arsenic, cadmium, copper, iron, lead, manganese, and zinc concentrations were highest in bed sediments in mountainous mining areas. In the plains, concentrations of aluminum, selenium, and vanadium were highest in urban land-use settings, whereas arsenic, chromium, nickel, and silver concentrations were highest in mixed land-use settings. Concentrations of manganese and strontium were highest in bed sediments in agricultural land-use settings. Currently (1994), there are no national standards for trace-element concentrations in bed sediment to assess the environmental implications of these data.

Trace-element concentrations in fish livers exceeded the U.S. Environmental Protection Agency's suggested maximum levels for chromium, copper, selenium, and zinc at all sites in the basin, although these standards are based on whole fish samples. The suggested maximum level for cadmium was exceeded in 52 percent of brown trout and common carp, and vanadium concentrations exceeded the maximum level in 27 percent of the common carp.

Concentrations of aluminum, cadmium, chromium, copper, iron, manganese, and molybdenum were highest in brown trout (cold-water fish associated with mountain streams). Concentrations of aluminum, cadmium, vanadium, and zinc were highest in common carp (warm-water fish associated with plains streams) obtained from agricultural land-use settings, whereas in the mixed land-use setting, iron, molybdenum, and strontium were highest in carp.

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# **Development of a Point Source Analysis Tool for the Lower South Platte River**

**Bradley D. Wind**

Northern Colorado Water Conservancy District

## **ABSTRACT**

The expanding demand for waters flowing within the banks of the South Platte River coupled with the complexities and unknown ramifications associated with management strategies necessitates the need for refined water resources analysis tools. Prior to formulating enhanced management strategies it is crucial that the South Platte River 'system' be fully analyzed to better understand the many intricate links existing in both the spatial and temporal dimensions. A paramount step in understanding the river 'system' is performing a daily point flow study by examining in concert, 1) historical daily river gauge values, 2) historical daily river diversion values and 3) historical daily river inflow values. By applying elementary volume balance theory to such values on a daily time step basis, one can compute river gains (or losses) occurring within a defined reach. Such River gains (or losses) can be attributed to many factors including: influxes from underlying aquifers, unrecorded surface inflows, changes in riverbank storage and/or fluctuating river channel storage. Furthermore, by merging computed reach gains with known river diversions and known river inflow values, the flow within the river channel at locations directly above and directly below each defined river structure can be calculated. Although point flow studies have been performed on many reaches of the South Platte River they have been limited to a monthly time step basis.

In realizing the need for historical daily point flow values along the Lower South Platte River, the Northern Colorado Water Conservancy District (NCWCD) has initiated the development of a historical point flow analysis 'tool' (software program). In a user-friendly, menu-driven environment, the point flow analysis tool will utilize river reach gain values or river channel flow values that were computed from the point flow water balance for a specified location and time period and display them in both a graphical and tabular format. The point flow analysis tool will assist water administrators and water resource planners in locating points of minimum flow which will in turn help identify potential exchanges and potential new diversions. Deficits and surpluses in both river flows and diversion flows can also be illustrated readily with the point flow analysis tool. During periods of steady-state the computed river gains (or losses) should be used in part to calibrate groundwater water models for the Lower South Platte tributary aquifer. Utilizing accurate groundwater models will ultimately lead to the more efficient management of new and existing ground water recharge systems. In addition, the insight a point flow analysis tool provides to Lower South Platte hydrology will be invaluable to Recovery Program efforts as related to Platte River Threatened and Endangered Species issues.

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# **Comparison of Shallow Ground-Water Quality Between Urban and Agricultural Land-Use Settings, South Platte River Basin, Colorado and Nebraska**

**Bret W. Bruce and Peter B. McMahon**

U.S. Geological Survey, National Water-Quality Assessment Program,  
South Platte River Basin

## **ABSTRACT**

As part of the National Water-Quality Assessment Program's South Platte River Basin study, the U.S. Geological Survey has sampled shallow alluvial ground water beneath urban (Denver, Colo.) and agricultural (South Platte River alluvium from Brighton, Colo. to North Platte, Nebr.) land-use settings to determine the effect of land use on water quality. Thirty randomly distributed wells in each land-use setting were sampled for nutrients, trace elements and radon, pesticides and volatile organic compounds (VOC's).

Nutrient species concentrations generally were lower in the urban setting than in the agricultural setting. The median concentration of dissolved nitrite plus nitrate as nitrogen in the urban setting was 2.1 milligrams per liter. Preliminary results indicate a median concentration of 7.0 milligrams per liter for nitrite plus nitrate in the agricultural setting.

Trace-element and radon concentrations indicated no correlation with land-use setting. However, uranium and radon occurred at elevated concentrations in both land-use settings (median concentrations of uranium and radon were 25 micrograms per liter and 1100 picoCuries per liter). The distribution of uranium and radon in ground water probably was affected mostly by local geology rather than by land use.

Pesticide compounds detected in ground-water samples from both land-use settings generally occurred at low concentrations. Prometon, a nonselective herbicide, was the most frequently detected pesticide in the urban setting and atrazine was the most frequently detected pesticide in the agricultural setting. However, both of these compounds were detected in each of the land-use settings.

VOC's were detected in 86 percent of the urban wells sampled, and concentrations of specific compounds frequently exceeded National Drinking Water Standards. Preliminary results indicate that VOC's are almost nonexistent in alluvial ground water of the agricultural setting. The presence of VOC's affected redox conditions in the alluvial aquifer in the urban setting and, consequently, the chemistry of the urban ground water.

Data indicated that land use does have a measurable effect on the quality of ground water in the South Platte River alluvial aquifer and that ground-water quality differs between urban and agricultural land-use settings.



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# **Effect of Fuel Oxidants on the Degradation of Gasoline Components in Sediments of the South Platte River Alluvial Aquifer**

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## **ABSTRACT**

The Clean Air Act requires that beginning in 1995 selected major cities blend gasoline with fuel oxidants so that it burns more completely. Ethanol and methyl tert-butyl ether (MTBE) are the fuel oxidants most commonly used to produce cleaner burning gasoline. The debate over which oxidant should be used has focused on economic issues, however, certain environmental questions are of concern as well. For instance, MTBE is not easily degraded and tends to persist in the environment. A survey of the quality of ground water collected from 30 randomly distributed wells in Denver determined that more than 80 percent of the wells had measurable concentrations of MTBE. Ethanol is more easily degraded than MTBE but there are few data on ethanol concentrations in natural waters. Perhaps more important than the persistence of fuel oxidants in the environment is what effect they have on the degradation of gasoline components in the environment. For example, benzene is carcinogenic and commonly found in waters contaminated with gasoline. Readily degraded organic compounds such as ethanol are known to enhance the biological degradation of other organic compounds through cometabolic processes. However, it is not known what effect relatively nondegradable compounds such as MTBE have on degradation processes. The effects of MTBE and ethanol on the degradation of gasoline components in sediments of the South Platte River alluvial aquifer will be presented. Results from this study will provide policy makers with information that could be used in evaluating which fuel oxidant is more effective in producing a cleaner environment.

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# **Fish Communities of the South Platte River Basin**

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South Platte River Basin

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## **ABSTRACT**

Fish communities were sampled at 6 tributary and 5 main stem sites in the South Platte River Basin (about 300 river miles) in August 1993 as a part of the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program. The fish community structure of the South Platte River changed along elevation and temperature gradients from the mountains to plains. Mountain streams had fewer fish species than plains streams. Cool-water species, such as brown trout, rainbow trout, longnose sucker and longnose dace, were abundant at higher elevations (mountains), whereas warm-water species, such as common carp, white sucker and minnow and shiner species, were abundant in lower elevations (plains).

Of the six tributaries sampled, two were located in the mountains and four were located in the plains. Clear Creek at Golden, a site affected by upstream mining activity, had fewer fish species (2) and total fish (128) in a 150 meter reach than Cache la Poudre at the mouth of the canyon, a 179 meter reach, where 4 fish species and 297 total fish were collected. At Lonetree Creek near Greeley, a site affected by fluctuating agricultural return flows, no fish were present in a 191 meter reach compared to Lonetree Creek at Carr, an upstream rangeland site, where 4 species and 241 total fish in a 179 meter reach were collected. Cherry Creek at Denver, an urban tributary, had fewer species (5) and total fish (135) in a 157 meter reach compared to the main stem site, South Platte River at Denver, where 10 species and 2,005 total fish were collected in a 338 meter reach. The Saint Vrain River at the mouth near Platteville, a large plains tributary, had 11 species and 1,110 total fish in a 236 meter reach; this fish community was similar to the downstream main stem sites of the South Platte River.

The five sites sampled in the main stem of the South Platte River were located at Denver, Henderson, Kersey and Balzac all in Colorado, and at North Platte, Nebraska. In the main stem, the total number of fish species and number of individuals in a 230 to 300 meter reach increased in a downstream direction to North Platte. The number of fish species ranged from 9 at Denver and 7 at Henderson to 19 at North Platte. The total number of fish collected decreased in the South Platte River from Denver (2,005) to Henderson (178) and increased from Henderson to North Platte (2,536). White sucker and carp were present at all five main stem sites, whereas fathead minnow and creek chub were present at four of the five main stem sites. Cool-water species, such as longnose sucker and longnose dace, were abundant near Denver. Species associated with warm water, such as plains killifish, stoneroller, plains minnow, red shiner, shorthead redhorse and bigmouth shiner, were abundant at North Platte.

Fish community distribution was related to the natural elevational and temperature gradients characteristic of the South Platte River Basin. Land-use activities, such as mining and agricultural return flow, also seem to affect the fish communities in the basin.

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# **Pesticide Occurrence in a Small Urban and a Small Agricultural Basin, South Platte River Basin, April through December 1993**

**Robert A. Kimbrough and David W. Litke**

U.S. Geological Survey, National Water-Quality Assessment Program,  
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## **ABSTRACT**

A study of pesticides in surface water in a small urban and a small agricultural basin was completed by the U.S. Geological Survey's National Water-Quality Assessment Program, South Platte River Basin Study Unit. This study defined and contrasted the occurrence of pesticides in the two land-use settings. Although pesticide concentrations in surface water have been documented separately for urban and agricultural areas, little work has focused on comparing pesticides in the two environments using a common sampling and laboratory protocol.

Water samples were collected at the mouths of two tributary streams of the South Platte River in Colorado at least monthly during April-December 1993. The urban basin, located in the Denver, metropolitan area, had a contributing drainage area of 25 square miles with predominantly residential and commercial land use. The agricultural basin, located in Weld County, had a contributing drainage area of 78 square miles with predominantly irrigated land. Corn, alfalfa, pinto beans, sugar beets, and onions were the major crops grown in the agricultural basin. Twenty-one water samples collected from each basin were analyzed for 47 pesticides. In the urban basin, 24 pesticides were detected in one or more samples, and in the agricultural basin, 30 pesticides were detected in one or more samples.

The herbicide atrazine was the most frequently detected pesticide in each basin. Atrazine was detected in 20 of the urban samples and all of the agricultural samples. The concentrations of atrazine were greater in the agricultural basin where the median value was 0.12 microgram per liter (ug/L) and the maximum value was 2.7 ug/L. The median concentration of atrazine in the urban basin was 0.018 ug/L and the maximum concentration was 1.1 ug/L. The herbicide prometon was the second most frequently detected pesticide in each basin. Prometon was detected in 19 of the urban samples and all of the agricultural samples. Median concentrations of prometon were similar for each basin and equaled 0.063 ug/L for the urban basin and 0.066 ug/L for the agricultural basin.

In addition to atrazine and prometon, two herbicides in the urban basin and eight in the agricultural basin were detected in more than 50 percent of the samples. The compound DCPA had the highest concentration of any herbicide in each basin even though other herbicides, such as atrazine and prometon, were detected more frequently. Commonly used for weed control in urban lawns and in agricultural crops such as onions, DCPA had a maximum concentration of 3.2 ug/L in the urban basin and 40 ug/L in the agricultural basin.

Four insecticides in the urban basin and five in the agricultural basin were detected in more than

25 percent of the samples. Carbaryl, detected in 14 of the urban samples and 6 of the agricultural samples, had the highest concentration of any insecticide in each basin. Available to the public for use on trees and turf grass, and commonly applied to corn, pinto beans, and sugar beets, carbaryl had a maximum concentration of 2.5 ug/L in the urban basin and 1.5 ug/L in the agricultural basin.

Several pesticides were detected only during the growing season whereas other pesticides persisted through the fall after the growing season ended. Consistently present in water samples collected in October through December 1993 were atrazine and prometon (in both basins); simazine (in the urban basin); and cyanazine, DCPA, EPTC, and metolachlor (in the agricultural basin). Regardless of when pesticides detections occurred, the concentration of pesticides in both basins generally was higher in storm-water runoff compared to baseflow conditions.

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# **Nutrient Loads From Wastewater-Treatment Plants in the South Platte River Basin**

**David W. Litke**

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## **ABSTRACT**

To manage nutrient loads in rivers, point and nonpoint sources of loads need to be quantified. Point-source loads can be estimated using data from wastewater-treatment plants and then compared to instream loads measured at water-quality-monitoring sites. As part of the National Water-Quality Assessment (NAWQA) Program, data were collected during 1994 in an effort to improve estimates of nutrient loads in the South Platte River Basin.

Effluent nutrient data for 1993 were compiled from 30 wastewater-treatment plants in the basin. Ammonia routinely was measured at 96 percent of the plants, nitrite plus nitrate at 27 percent, and organic nitrogen at 11 percent. Total phosphorus routinely was measured at 19 percent of the plants and orthophosphate at 4 percent. Methods were developed for estimating nutrient loads for each nutrient species, and nutrient loads were estimated for each treatment plant.

During April 1994, samples were collected at 60 surface-water sites in the basin to determine nutrient species concentrations and to calculate instantaneous nutrient loads. Total nitrogen loads in the South Platte River ranged from 84 pounds per day (lb/d) to 18,000 lb/d; total phosphorus loads ranged from 10 to 3,200 lb/d. Highest loads were related to wastewater-treatment-plant discharges and agricultural land use. Loads decreased downstream from point sources due to diversion of water and instream processes.

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# **Integrated Information Exchange: Water Rights Administration Software for the South Platte River**

**Adam Light**

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## **ABSTRACT**

Developed by CADSWES (Center for Advanced Decision Support for Water and Environmental Systems) at the University of Colorado, under contract with Colorado Office of the State Engineer (SEO), South Platte Water Rights Management System (SPWRMS) software integrates the collection, exchange, organization and storage of information related to water rights administration in the South Platte watershed. SEO personnel maintain a detailed database through daily use of the SPWRMS application. In turn, through the application, the database affords decision makers the latest information on the state of the river. Analysis of collected data will lead to improved management strategies and greater equity in the day to day administration of the river. Feedback from quantitative and qualitative analyses of collected data helps software engineers and database designers to optimize the management system.

SPWRMS makes available basin wide information in real or near real time. Laptop PC's in the hands of Water Commissioners share information through workstations in Denver and Greeley. Water Commissioners fill out and transmit via modem a daily water information sheet for their respective districts describing diversions, exchanges, and flows. Anywhere in the South Platte drainage, an individual Water Commissioner can track on his/her personal computer the movement and use of water in any other district. At the same time, the Water Commissioner can view in either hydrograph or tabular form the latest readings from flow gauges that are part of the State Satellite Monitoring System. Calls can be set and released by authorized personnel, and the potential effects of changing a call on the river can be modelled and examined before such action is taken.

Over the past year, the process of designing and creating the SPWRMS software has itself fostered improvements in database design and creation. Knowledge gained from the implementation of the SPWRMS software by water management personnel in the State Engineer's Office will undoubtedly lead to further improvements in the software application and change in important ways, the nature of water management on the South Platte. Improved communication among administrators will lead to greater efficiency in the way water is allocated and budgeted. The latest phase of SPWRMS development focuses on information and its exchange on the South Platte, and sets the stage for innovative uses of that information in the years to come.



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# **Tools to Enhance Water Rights Administration in Division One: Implementation of the South Platte Water Rights Management System**

**Julie A. Kraus**

Colorado Division of Water Resources

## **ABSTRACT**

The South Platte Water Rights Management System was initiated and sponsored in June 1990 by many South Platte water users, the Colorado Office of the State Engineer, and the University of Colorado Center for Advanced Decision Support for Water and Environmental Systems (CADSWES). In June 1993 the Colorado Water Conservation Board provided \$350,000 towards development of this system. With this funding in place, CADSWES was contracted to develop the spatial and relational databases and applications to access and utilize daily water information. The tools will aid the Colorado Division of Water Resources in real time administration of water rights, enhance the transfer and exchange of data between agencies and water users, provide direct user access to the data, and allow spatial monitoring of water use in the South Platte basin.

In July 1994 Division of Water Resources staff began implementing the application. Implementation of the application will be an ongoing process that introduces change. The mere fact that we are introducing new technologies into the Division of Water Resources infers that some change will probably occur--perhaps the manner in which decisions are made, the way communications are transmitted or the way in which information is shared. What implementation issues must be confronted to make the South Platte Water Rights Management System successful? What did we do right? In retrospect, what could we have done better? The merits of the system and success of the project will certainly be dependent on:

- How the application and tools work,
  - How the tools meet the needs of the end user,
  - System response time and reliability,
- User involvement and training,
- Ability to keep the system dynamic (enhancing the system to meet future needs), and
- Long term support and maintenance of the system.

Since the project has evolved as part of the collaborative process between the project sponsors, Division of Water Resources staff, and CADSWES, we look forward to the first full year of system implementation.

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# **The Need for Comensurability in Values of Alternative Uses of Water in Integrated Watershed Management**

**John R. Loomis**

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## **ABSTRACT**

Integrated Watershed Management attempts to simultaneously consider all potential activities in a watershed so as to balance those uses for the benefit of all members of society. All sides in a water reallocation and water transfer discussions call for balance, but to date there has been difficulty in agreeing on how to determine the optimum balance between competing water uses and users. This has become more apparent as representatives of environmental uses of water have attempted to become partners in watershed management for non-commodity uses of water such as instream flow, fisheries, recreation, and aesthetics.

A Total Valuation Framework that has been adopted by Federal natural resource agencies for natural resource damage assessment would facilitate objective comparison of the value of water in competing uses. Total value can be defined to include traditional commercial uses of water (e.g., irrigated agriculture, M&I), recreation as well as the value the general public receives from knowing that rivers have adequate minimum flows and water quality to support fish, wildlife, and riparian ecosystems. This latter value can be motivated from simply knowing rivers in the state are functioning natural ecosystems or from knowing that such management today preserves options to future generations to have rivers that support fish and wildlife.

Since there are numerous estimates of commercial values of water this paper will summarize the recreation, existence and bequest values of water for fisheries, wildlife and riparian ecosystems in the Western U.S. developed using the Federally recommended Contingent Valuation Method. Resource values to be presented include those of whooping cranes, water quality along the Platte River, wetlands and instream flow.

An example of how such values can be used in a comprehensive benefit-cost analysis to address trade-offs between traditional water uses and these more environmental uses will be discussed.

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# Overview of the South Platte Urban TMDL/Watershed Project

**Cynthia Paulson**

Brown and Caldwell

## ABSTRACT

The purpose of the South Platte Urban Total Maximum Daily Load (TMDL)/Watershed Project is to develop a watershed management approach to guide the water quality decision-making process in the South Platte Urban Watershed. Specifically, the Project will provide a framework for NPDES permit limits and nonpoint source controls. A draft Work Plan has been prepared in the first phase of the Project to provide a proposed approach for stakeholder review and input. Two key issues for stakeholder discussion include development of an organizational framework to implement the Project and identification of key pollutants.

The South Platte Urban TMDL/Watershed project will be implemented in several phases, over a period of five to ten years. The first phase has been completed and the second phase will begin in late summer, 1994.

- **Phase 1 (6 months) - Draft Work Plan.** Steering Committee and consultant develop proposed draft Work Plan.
- **Phase 2a (18 months) - Organizational Framework and Evaluation of High Priority Pollutants.** Incorporation of watershed stakeholders, development of organizational framework, watershed monitoring program, database development, modeling of two high priority classes of pollutants (oxygen-demanding substances and metals recommended), evaluation of pollutant reduction alternatives and selection of recommended TMDLs, wasteload allocations (WLA) and load allocations (LA).
- **Phase 3 - Low and Medium Priority Pollutants.** Incorporation of other nonpoint source pollutants into the watershed management process as necessary, evaluation of medium and low priority pollutants for TMDL/WLA/LA development and evaluation of the relative importance of physical habitat factors.

The Project can provide several benefits for South Platte Urban Watershed stakeholders. The Project will build upon existing water quality studies within the watershed and help to integrate all stakeholder needs within a cohesive long-term program. In addition, the Project will provide a framework to evaluate alternative approaches and coordinate water quality decision-making within the South Platte Urban watershed.

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# Dowsing and Water Location

Gregory A. Storozuk

## ABSTRACT

There is not, as yet, any indisputable or generally acceptable scientific proof that dowsing techniques can be used to locate water and other subsurface objects.

It is also true that a majority of dowsers both here and abroad do not know with certainty the whys and hows of their craft. However, what they and their clients *do* know is that dowsing appears to work and produces verifiable results when other accepted means have failed. Judgement by result, then, becomes the gauge by which a dowser achieves his or her reputation and status among peers.

Following the Second World War, governments in Germany, Ukraine, and Russia funded research to study and also to develop dowsing. In Leningrad, now St. Petersburg, *Bioloakatsiya*, a scientific consulting bureau, was established to promote and develop dowsers. It possessed full legal status, including a bank line of credit and the right to make agreements and sign contracts.

In the United States, most studies have been privately funded. The late physicist Zabo J. Harvalik, Ph.D., conducted a succession of shielding experiments with Wilhelm De Boer, an acknowledged German *Rutenmeister* (master dowser), in which he concluded that the dowsing "sensors" are centered in the pineal/pituitary region and the adrenal region above the kidneys.

Conducting a further series of experiments, Dr. Harvalik had subjects walk through artificially-induced electromagnetic fields in a "double blind" experiment, concluding that "...a dowser reacts to magnetic gradient changes (as) weak as one millimicrogauss, or expressed another way  $10^{-9}$  or 0.000000001 gauss."

In another experiment, Dr. Edith Jurka, Diplomate of the American Board of Psychology and Neurology, used an electroencephalograph to study brain wave levels of seven American dowsers. She wrote, "Most of the time the beta and delta voltages were so high that they went beyond the 160 microvolts that the electroencephalograph could register."

Although the above studies may not offer conclusive proof, they do lend credence to the viability of dowsing as a method of locating water and other objects.

The question then, is whether to include dowsing as part of the overall development with regard to the Integrated Watershed Management in the South Platte Basin. Although scientific validity for a dowser's success remains in question, perhaps this ancient art could augment modern search techniques for pure water sources. The advantages are several, primarily low expense and minimal equipment requirements. In addition, a skilled dowser has the ability to explore large tracts of land in a short period of time.

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# **Farmers Independent Ditch Company Watershed Project**

**Connie Lance**

Central Colorado Water Conservancy District

## **ABSTRACT**

Farmers Independent Ditch (FIDCO) is southwest of Greeley, and it diverts water from the South Platte River. Groundwater in the area can have up to 40 ppm nitrate-nitrogen, and studies have suggested that water quality problems are the result of agricultural activities in the area. The major crops are corn, alfalfa, sugar beets, grains, potatoes, carrots, onions, and lettuce. Most of the crops are flood irrigated. There are also several large feedlots in the area. Central Colorado Water Conservancy District has a cooperative project with the ditch company to determine the nitrate levels in the ditch water and in various fields in the region. The FIDCO Watershed Project, partially funded by EPA Section 319, will build on previous analysis of other ditches, which found that nitrate levels were not as high as presumed. Although pesticide contamination does not appear to be a problem, the farmers have encouraged pesticide monitoring in the project. In February 1994, ten fields were selected based on representation of soil types of the area, and the soil in these fields was analyzed for nitrates and pH. Soil water samplers have been installed at three different depths in each of four fields. During the summer, water is being pulled from these samplers and analyzed. Ditch water monitoring began in 1991, and will continue. Soil analysis has shown that almost all of the nitrate in the soil is in the top few feet. However, the soils are very sandy below about ten feet, so there is little water in the soil to hold nitrate. Results will be presented on ditch water analyses conducted during the summer, as well as analyses of water from the underground soil water samplers. The results will help ascertain sources of nitrate-nitrogen in the area's groundwater.

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# **Climate Information to Support Integrated Watershed Management**

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## **ABSTRACT**

Historical climate data on temperature, precipitation, and snowfall date back more than 100 years at a small number of locations in the South Platte Basin in Colorado. Routinely updated, consistent historical data are essential for identifying and understanding long-term changes in the hydroclimatology of the basin. These stations must be preserved, but integrated watershed management requires much more than just historical perspective. Water resources planning, water distribution, use, conservation, and management, economic development, landuse planning, environmental protection, recreation and disaster planning and protection are just a few aspects of watershed management that often require considerable and specific climate information.

Manually-gathered temperature and precipitation data from a few sites combined with winter and spring measurements of mountain snowpack and measurements of streamflow were once deemed sufficient to address most watershed management questions. Three federal organizations, the National Weather Service, Soil Conservation Service and U.S. Geological Survey, gathered and maintained nearly all of these basic hydrometeorological data. This picture has changed rapidly during the past twenty years. Environmental regulations, the introduction of electronic data collection and a growing demand for hydrometeorological data to drive ever expanding computer models applied to a broad spectrum of management and planning problems has led to many organizations actively collecting weather data. Daily, hourly and sometimes even up-to-the-minute data with fine spatial resolution are now often demanded. Today we find weather stations in remote canyons, on mountain peaks, at sewage treatment plants, on feedlots, on golf courses, and everywhere in between, but can we find and use the data from these many stations? That becomes quite a different question. The original three Federal organizations continue to collect and share data, but their myriad of other hydrometeorological data is often difficult to obtain, varied in format, and questionable in accuracy. Integrated watershed management requires integrated climate data management. This has not yet been accomplished, but it is possible. Some steps toward this goal will be discussed.

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# **A GIS Model for Evaluation of Water Conservation Strategies**

**David G. Wagner**

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## **ABSTRACT**

Water management techniques for large river basins must account for temporal and spatial consumptive use patterns for a variety of vegetation, crop types, and soil/water surfaces for municipal, industrial and agricultural uses. The direct computation of evapotranspiration for non-agricultural vegetation has been limited due to the lack of crop coefficients for vegetation types other than for common irrigated agricultural crops. A model has been developed to estimate daily and annual evapotranspiration for all the vegetation, water and soil types spanning a river basin. The geographic information system based model uses remotely sensed satellite data and other GIS data layers.

The paper and conference presentation describe the model and the use of the model to apply and evaluate six different water conservation technology scenarios for the Poudre River basin. The application of water conservation technologies in the river basin is motivated by the increasing urbanization and the resultant conversion of agricultural land and agricultural water supplies to industrial and domestic use.

The water conservation technologies include urban consumptive and non-consumptive modeling under metered and non-metered conditions, agricultural water conservation techniques including taking land out of production, conversion of surface-to-sprinkler irrigation, SURGE irrigation implementation and changing crop types to more water-conserving crops. The GIS model can study the river basin on a farm-by-farm, irrigation district, ditch-head gate or urban growth area basis.

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# **The Maximum Utilization of Denver Basin Aquifers Through the Conjunctive Use of Surface and Ground Water Resources**

**Mary B. Rastall**

Denver Water

## **ABSTRACT**

Denver Water is participating as co-managers with Willows Water District in the U.S. Bureau of Reclamation's Denver Basin Aquifer Recharge Demonstration Project. The Colorado State Engineer's Office, U.S. Geological Survey and U.S. Environmental Protection Agency are also participants in this research project to evaluate the technical, economic and legal issues related to artificial recharge, storage and withdrawal of artificially recharged water in a nontributary Denver Basin aquifer.

The legal authority for artificial recharge was uncertain until the recent enactment of C.R.S. §37-90 137(9)(d), which states: On or before July 1, 1995, the state engineer shall promulgate reasonable rules which shall apply to the permitting and use of waters artificially recharged into the Dawson, Denver, Arapahoe, and Laramie-Fox Hills aquifers. The rules shall effectuate the maximum utilization of these aquifers through the conjunctive use of surface and ground water resources.

Although the legal authority for artificial recharge has been legislatively established, many issues remain concerning how the State Engineer's rules will maximize the conjunctive use of surface and ground water in the Denver Basin aquifers.

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# **Stormwater Quality Management Using Integrated Wetland and Bio-Remediation Techniques: A Demonstration Project at Coors Field in Denver, CO**

**J.E. Grove and D.L. Forcum**

Grove Constructed Wetlands

**D.I. Rosebrook**

Envirotech Laboratories

## **ABSTRACT**

Implementation of the Clean Water Act has significantly reduced point-source discharges to waters of the United States. Currently, the majority of pollution affecting surface waters is attributed to remaining non-point sources. As a result, water resource specialists are becoming increasingly concerned with management of stormwater quality as well as quantity. A new baseball stadium complex in Denver, Colorado will demonstrate the integration of bio-augmentation techniques with constructed wetlands to simultaneously enhance environmental protection as well as stadium revenue.

In 1992, the City of Denver, Colorado was selected to be the home of a new major league baseball expansion team, the Colorado Rockies. The Denver Metropolitan Major League Baseball Stadium District was established and the process of locating and planning for a new stadium was initiated. A site was chosen in the highly-urbanized downtown area.

The extensive area required for adequate visitor parking near the stadium eliminated much of the area available for the location of site storm drainage water quality elements. Both the stadium district and the local urban drainage authorities expressed a strong commitment that quality of the new sports facility should not come at the expense of water quality in the South Platte River or other environmental concerns.

Proposed stormwater retention volumes were approximately 40% less than existing guidelines. In an effort to reduce lost revenue from eliminated parking areas, it was proposed that the physical settling capacity of proposed retention basins be enhanced with natural treatment elements designed to ameliorate a wider range of urban pollutants. The stadium wash water and parking lot drainage system will integrate a number of traditional and innovative best management practices with bio-remediation and passive constructed wetland technologies. The intent is to create an ecologically compatible and economically feasible treatment system suitable for retrofit within the confined parameters of any traditional urban drainage system.

Best management practices (both structural and non-structural) will be implemented to improve the management of stormwater quality as well as quantity. Potential non-structural BMP's include source reduction, information/education, and the use of "environmentally friendly" enzyme or citrus-based sanitation products stadium-wide. Structural BMP's include construction

of sand filters, grease/oil separators, storage vaults, and constructed wetlands. The biological treatment capacity of the vault system will be enhanced via inoculation of custom-grown wastewater bio-remediation cultures isolated from natural wetland ecosystems. The microbial culture will be designed using a characterization of stadium discharge and injected on demand into the stadium stormwater system.

Constructed wetland treatment elements will be fitted within traditionally-designed linear detention basins. These components will perform physical, chemical, and biological wastewater treatment and transformation functions by harnessing the natural synergistic relationship between plants and microbes. Both free water surface (FWS) and vegetated submerged bed (VSB) wetlands will be constructed using a variety of locally-adapted wetland species. Following construction, wetland elements will be accelerated using cultured inoculum of high performance wetland microorganisms.

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# **The South Platte River From Denver to Nebraska: Monitoring Water Quality is Not a Simple Process**

**John D. Woodling**

Colorado Division of Wildlife

## **ABSTRACT**

An increasing awareness has developed over the last two decades regarding the importance of water in the South Platte Basin downstream of the Denver metropolitan area. Presently a variety of governmental and private entities are sampling various reaches of the South Platte in the eastern plains portion of Colorado. When the Colorado Division of Wildlife (DOW) instituted an intensive fish sampling program in this area a decision was made to obtain water quality data on a year round basis at many of the mainstem South Platte fish sampling sites. Instead of developing yet another individual sampling program the DOW contacted other entities and developed a multi-group, cooperative program that began operation in December of 1993.

By the early summer of 1994 the Colorado State Parks Department, the DOW, and nine schools from the Rivers of Colorado Watch Network began collecting samples at 14 sites from Denver to Julesburg on a predetermined schedule twice a month. All sites are samples on the same day. Flow data from the Colorado State Engineer's Water Talk Network is obtained the day of sampling at five locations by the schools. Samples are retrieved by the DOW on the day of sampling to allow for analysis of nitrate, which has a 24 hour holding time. The Denver Metro Wastewater Reclamation District and the Colorado Water Quality Control Division (319 nonpoint program) analyze the samples for nitrate and total phosphorus, respectively. All involved are benefitting. The schools can compare their results with the determinations of the Denver based laboratories. The DOW is obtaining information that will describe the year round chemical environment of the river's fish community. Lastly, a data base is being developed that any person or entity can utilize.

Initial observations show that the South Platte is actually several rivers as it flows from Denver to Nebraska. Most Colorado rivers can be compared to a continuum as they flow downstream. Dissolved salts increase, and, downstream of a point source, a contaminant may increase only to be diluted further downstream. Mainstem South Platte flow volumes change dramatically due to domestic wastewater effluents entering the river, agriculture diversions and irrigation, and subsurface return flows. As a result, various chemical constituents may actually decrease in a downstream direction during irrigation season only to dramatically increase further downstream. Temporally changing nitrate and ammonia concentrations at several sites indicate the river receives continual nitrogen loading (nutrient enrichment) from Denver to Nebraska.

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# **Optimizing Water Use Through Prior Municipal Use of Agricultural Priorities**

**Don P. Brown, Jr.**

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## **ABSTRACT**

The population of the State of Colorado has increased steadily during past decades and sharply over the last few years. As is typical throughout the West, the majority of this population increase has been focused in the rapidly expanding urban centers located primarily along the Front Range. This growth has transformed the West from an area dependant on a dispersed rural/agricultural economy to one that is increasingly reliant on a concentrated urban economy.

Typically, the two types of economies are viewed as being competitors for the limited water resources of the region. Accordingly, shifting water rights from agricultural to municipal uses has been the source of much tension. The established agricultural communities that typically control the senior water rights are concerned about the rapid pace with which their rights are being sold to the newly wealthy municipalities. Contrary to common belief, however, agricultural decline does not necessarily result from the transfer of water rights required to satisfy growing urban demand. Creative solutions are available that foster municipal growth without jeopardizing the existance of Colorado's agricultural communities.

Primary among these solutions is agricultural re-use of municipal wastewater, or, stated another way, municipal prior use of agricultural priorities. This solution allows municipalities to use agricultural water and then return it to the stream or ditch, after treatment, for subsequent agricultural re-use. Because municipal uses avoid the evaporative and other losses that normally usurp up to fifty percent of the agricultural water as it travels to the field, this solution is beneficial to both economies. Municipalities benefit by aquiring much-needed water to fuel growth, and agricultural users benefit by receiving a greater quantity of water than their historical share.

This paper will explore the concept of municipal prior use of agricultural priorities, explain in detail the specifics of a South Platte Basin project which was implemented in reliance on this concept, and suggest methods for applying this concept in other areas.

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# **The Use of Water Banks to Facilitate Short-Term Water Exchanges**

**Charles W. Howe and Lawrence J. MacDonnell**

University of Colorado-Boulder

## **ABSTRACT**

This paper will report on a recently completed project funded by the U. S. Geological Survey. A "water bank" is defined as an organization established at local, regional or state level to facilitate the short-term transfer of water. The objectives of having a formal organization are to legitimize short-term water transfers, to reduce transaction costs, to monitor economic and environmental impacts, and to compensate for damages that might occur to local economies and ecosystems.

The experiences of the two California water banks (1976-77 and 1991-92) and the Idaho water banks are examined in detail. Principles are drawn from economies concerning the implications of various water bank designs. The legal and organizational implications of these designs are investigated. Then recommendations are made about designs appropriate to the western United States.

These recommended design features are then compared with the intended structures of three new or prospective water banks: the Texas state water bank; the Fort Lyon Canal water bank (Colorado); and the Colorado River interstate water bank.

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# **Northern Colorado Water Conservancy District's Augmentation/Recharge Accounting Program**

**Jon Altenhofen**

Northern Colorado Water Conservancy District

## **ABSTRACT**

With more than 5,000 wells in the South Platte River Basin, ground water supplies are an important water resource to the constituents and economy of the Northern Colorado Water Conservancy District (NCWCD). NCWCD is committed to protecting and helping manage ground water through its Augmentation/Recharge Accounting (ARA) program. The ARA program provides the accounting required by Water Court decreed augmentation plans. Augmentation plans allow wells to be pumped out-of-priority. A major component of augmentation plans used in the South Platte River Basin is artificial recharge through surface basins. Recharge replaces the net groundwater extraction by wells and results in accretions to the South Platte River which cancel out depletions to the river caused by the well pumping. The ARA program helps manage the timing and location for recharge so that maximum groundwater return flows or accretions to the river are obtained.

NCWCD has provided the ARA program to decreed augmentation plans within the boundaries of NCWCD since 1985. Currently, the accounting is done for a total of 15 plans in the South Platte River Basin below Denver. Recharge projects have continued to expand because good recharge sites with adequate permeability and depth to water are plentiful. Net recharge has increased from less than an estimated 5,000 acre-feet in 1978 to 46,700 acre-feet as an average annual value for the 1985 to 1992 period for the 15 recharge projects involved in the ARA program.

The ARA program assembles and processes data collected by the augmentation plan operators and the Water Commissioners of the State Engineer's Office. This data consists of diversion records to recharge sites and well pumpage information. The network of 10 weather stations maintained by NCWCD is used to obtain crop consumptive use and pond evaporation values needed in the augmentation and recharge accounting procedure. The ARA program utilizes a groundwater model to determine the accretion or depletion effect at the river from the recharge or well pumping. Monthly reports summarizing the augmentation plan's operations are filed with the Division Engineer.

An increasing role for the ARA program is educating entities that artificial recharge of the ground water is essential for the long-term maintenance of adequate and reliable groundwater supplies. Managing recharge not only produces desired river returns, but also maintains and enhances aquifer water levels and supplies. The ARA program of NCWCD is beginning to encourage irrigation companies to consider recharge management objectives that would benefit surrounding municipalities. The ground water mounding that occurs under recharge sites can control local gradients for ground water flow thereby influencing the movement of compounds such as nitrates. These mounds or ridges could provide a higher quality groundwater for

municipal wellfields and be used to create hydraulic barriers which would keep pollutants away from the wellfields.

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# **Boulder Creek Instream Flow Program**

**Carol D. Ellinghouse**

City of Boulder, Colorado

## **ABSTRACT**

The City of Boulder, in conjunction with the Colorado Water Conservation Board, has developed an innovative program for the maintenance of streamflow within Boulder Creek and North Boulder Creek. The instream flow program will preserve fish habitat and enhance the aesthetics of the stream corridor. The instream flow program is a part of the water management program adopted by the City Council based on the September 1988 Raw Water Master Plan.

Under Colorado law, the Colorado Water Conservation Board (CWCB) is the only agency allowed to hold water rights decreed for instream flow purposes. The joint City/CWCB instream flow program was carefully designed to be in compliance with the state water administration system in order to assure that the water donated by the City would be used for instream flows and not diverted by other water users.

In the past, the holders of senior water rights, including agricultural interests and the City of Boulder, have had the legal right to virtually dry up portions of the creek through diversions during low flow periods. To alter this condition, Boulder's Raw Water Master Plan established goals for the City of achieving minimum streamflows in main Boulder Creek and its tributaries.

In July of 1990, an agreement was completed between Boulder and the CWCB and has been amended twice since that time. This agreement and the amendments provide for the deeding of ownership of a portion of Boulder's water rights to the CWCB. The agreement also provides for Boulder to release water that is stored by the City in the Silver Lake Watershed or in Barker Reservoir for fulfillment of the CWCB's junior instream flow right on Boulder Creek and the CWCB's new instream flow filings on North Boulder Creek and Boulder Creek. The City has deeded ownership of \$12 million of water and water rights to the CWCB so far. Boulder had previously depended on this water to meet municipal needs.

During severe droughts or emergencies, Boulder is allowed to call the water rights back and curtail storage releases for use within the utility system. This will protect reservoir levels in the Silver Lake watershed to preserve the native species of fish in the reservoirs. Boulder is also allowed to use the rights if they are not needed to satisfy the minimum streamflow requirements. At the downstream terminus of the instream flow reach, Boulder retains control of part of the water that had previously been consumed for municipal purposes.

The next step toward finalizing the instream flow program was to obtain a decree from the Colorado Water Court allowing use of these water rights and storage releases for instream flow. Boulder and the CWCB were joint applicants to the Water Court for a change in use in December 1990. A decree approving the change in use to instream flow was signed on December 20, 1993.

Through the joint CWCB/City of Boulder instream flow program, consisting of the City's dedication of water and water rights and the CWCB filings for new instream flow water rights, North Boulder and main Boulder Creeks now will rarely drop below the minimum levels needed for healthy fish habitat. The Creeks will continue to flow at much higher than the minimum levels during the natural high flow periods.

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# Clear Creek Watershed Forum Possibilities, Partners, and Projects

**Carl Norbeck**

Colorado Water Quality Control Division

## ABSTRACT

The Clear Creek Watershed Forum is an initiative sponsored by the U.S. Environmental Protection Agency (EPA) in cooperation with the Colorado Department of Health (CDH) under the "Watershed Protection Approach." The program focuses on watersheds such as Clear Creek (which stretches from Loveland Pass to the South Platte River) with mining related impacts. The agenda of the Forum is locally-controlled through a Planning Committee made up of representatives from throughout the watershed.

The initial role of the Forum was to bring people together from throughout the watershed to get acquainted and share information. In 1993 the Forum hosted two conferences. This led to another accomplishment: a public-private cleanup at the inactive McClelland Mine site near Dumont. The project consisted of several elements:

- A Superfund tailings pile south of Clear Creek was regraded, capped, and revegetated.
- The tailings pile was graded to accommodate a road to Clear Creek with a raft/kayak put-in ramp.
- Instream modifications were made to improve fishing.
- The right-of-way along I-70 north of Clear Creek was regraded, topsoiled, and revegetated.
- The centerpiece of the project is to be a two-part wetland, consisting of a bioreactor and an aerobic wetland treatment system to treat the acid drainage from the McClelland Mine.

The partners for this project included Clear Creek County, Coors Brewing Company, EPA, CDH, Colorado Department of Transportation, Colorado Division of Minerals and Geology, Colorado Division of Wildlife, and Clear Creek Rafting Company.

In 1994 the Forum will initiate a water quality data managers forum, a trail coordinators forum, open a storefront office, host a major watershed forum (Forum III), and conduct a public-private cleanup at the inactive Aorta Mine site near Empire.

The Forum is a unique partnership of agencies, industries, and communities. It represents a new tool for addressing water quality problems. Local citizens have been empowered, provided with information to enable them to make good water quality improvement decisions, and given access to the financial resources to solve problems.

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# **Technical Abstracts Received**



# **South Platte River Segment 15 Water Quality: An Historical Perspective**

**Suzanne C. Pass, Richard J. Thornton and Ronald D. French**

Camp Dresser & McKee, Inc.

## **ABSTRACT**

A review of the literature on the development of the South Platte River basin, with particular emphasis on Segment 15 water quality, was conducted as part of a series of scientific studies completed for the Metro Wastewater Reclamation District.

From its formation in the Mesozoic Era (100 mya) to the discovery of gold along its tributaries in the late 1850's, the flow of the South Platte River varied seasonally. Flooding in spring and early summer created a wide, braided river bed ; the drier conditions of fall and winter reduced the stream to little or no flow on the plains. Rapid development in the basin during the late 1800's and early 1900's stimulated the construction of massive irrigation and water storage projects for agricultural, industrial, municipal, and flood control purposes causing the hydrology of the South Platte River to change from an intermittent to a perennial stream.

The use of the South Platte River for disposal of untreated sewage and other wastes resulted in the rapid deterioration of water quality. Since the late 1800's, public health services studying water quality first in grains of putrid matter per gallon then progressing to micrograms per liter, reported coliform bacteria in certain parts of the river at times to be as high as 25,000 per milliliter. Standards for human contact recreation were exceeded; oxygen-demanding substances created nearly septic conditions; suspended and settleable solids destroyed aquatic plants; and groundwater water quality was degraded. Public outcry caused sewer lines and wastewater treatment plants to be constructed to deal with the pollution.

Over the almost century and a half that modern man has made an impact on the South Platte River wastewater treatment techniques have advanced from simple primary treatment, to nitrification/denitrification. Water quality control has progressed toward a total river management philosophy encompassing water quality, water quantity, aquatic and riparian wildlife, flood control and streambed stabilization.

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# **Implementing an Integrated Watershed Approach in Urban Drainage Management**

**Kevin McBride**

City of Fort Collins

## **ABSTRACT**

The management of urban stormwater is undergoing a sea change as regulatory requirements and citizen desires move towards increasing demands for water and environmental quality. The City of Fort Collins Stormwater Utility has developed an approach looking at components of a watershed and outlining appropriate techniques for management in an urban setting. The framework stresses the use of local regulation and educational programs to prevent pollution on land surfaces; drainage system design which treats or mitigates polluted runoff; and protection and restoration of aquatic, wetland and riparian habitat along urban streams. This framework sets a vision for changes in the Utility 's approach to public involvement and education, revisions to its stormwater design criteria, and new considerations in drainage master planning. The outline and accompanying presentation serves a public participation and education function, starting with policy makers. This in turn addresses political implementation issues while providing an evolving framework to address economic issues as the program matures.

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# Resources



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138	Nov. 1985	7.00	The Potential of Modified Flow-Release Rules for Kingsley Dam in Meeting Crane Habitat Requirements--Platte River, Nebraska, by Hsieh Wen Shen, Kin Loi Hiew, and Eric Loubser.
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Charles W. Howe, James N. Corbridge, Jr., and W. Ashley Ahrens.

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## Notes

