WATER IN THE BALANCE

No. 4 October 1995

"Improving daily river management by integrating information exchange."

Colorado Water Resources Research Institute

Colorado State University

South Platte Water Rights Management System

A Tool for Informed Water Administration

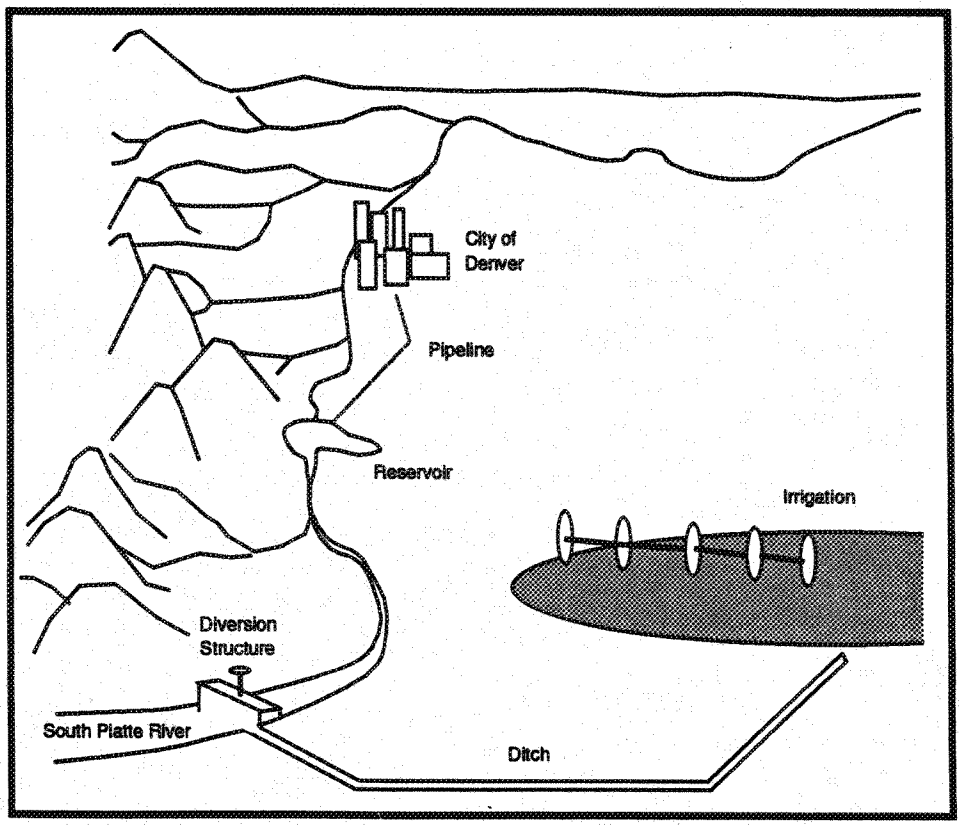
The South Platte Water Rights Management System (SPWRMS) is a set of computer programs created to assist water administrators in their daily duties and to make the results of their decisions known in a more timely manner.

The system provides a single repository for information concerning the South Platte River. Data indicating the physical state of the river resides in a central database with legal and administrative information. The database provides a single source for information of interest to administrators and water users. In addition, SPWRMS provides tools for viewing this data and testing hypothetical scenarios.

Having information about the entire South Platte in one central location gives administrators and water users access to a common set of information in an understandable format. Information concerning any specific section of the river, once available only by contacting the administrator of that section, now resides in an easily accessible database. The consolidation of information speeds the decision-making process and provides more timely information to those making the decisions. In addition to aiding the real time management of the South Platte River, water information records in the SPWRMS database will help administrators create the Official Diversion Record at the end of the water year.

The South Platte Water Rights Management System focuses on improving daily river management by enhancing information exchange. With streamlined information flow, administrators have more data on which to base decisions, and water users have immediate access to the same information.

CADSWES



Administration of the South Platte River must satisfy both municipal and agricultural needs.

An Open Letter on SPWRMS

Dear Reader:

The task of administering water in Colorado becomes more difficult over time as increasingly complex and often conflicting demands are made on the essentially fixed amount of water available. Nowhere is this more true than in the South Platte River Basin. Three of Colorado's four million inhabitants live in Front Range counties, most of them dependent on water from the South Platte River.

Efforts to increase the supply of water generally involve large-scale engineering projects which store spring runoff or bring water in from another basin. These types of projects are expensive and have a high impact on the areas where they are constructed. Even if the funding is available for such a project, it is still subject to objections from environmental groups and those affected by the rerouting of water. For example, the proposed Two Forks Dam was abandoned after many millions of dollars had been spent on its development.

Since the supply of water is limited, administrators look for means of making the current supply 'go farther' by increasing the efficiency of its use. The availability of accurate, timely information about the state of the river has proved to be a key element in administering the river efficiently -- it is necessary to know how much water is in the river before deciding who may use it, and such decisions must be made before the water has passed by a potential user.

The South Platte Water Rights Management System (SPWRMS) is a project conceived to enhance storage, transfer, and display of information about the South Platte River. The project was funded as a pilot through several cycles of grants from the Colorado Water Resources Research Institute and water users in the South Platte basin, with additional in-kind resources contributed by the University of Colorado at Boulder. Once the potential benefits of the system became clear, the Colorado Water Conservation Board approved the funds to develop the system into a fully-functional administrative tool. Many thanks are due to the Office of the State Engineer, the Colorado Water Resources Research Institute, City of Aurora, City of Boulder, City of Englewood, City of Thornton, Denver Water, Colorado State Parks, Northern Colorado Water Conservancy District, Riverside Irrigation District, St. Vrain and Left Hand Water Conservancy District, Centennial Water and Sanitation District, and Consolidated Ditches for their support of the South Platte Water Rights Management System in its pilot phases.

We who are involved directly or indirectly in the SPWRMS project hope that the system we have developed meets the goal of increasing the availability of water in the South Platte through enhancing the administrative process. We also hope that the system opens up the administrative process to some degree by making the river system data available to concerned water users.

Warm regards,

Jackie Sullivan

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Current Issues in Colorado Water Administration

Water differs from many natural resources by its renewable and reusable nature. Water evaporates from the world's oceans and lakes, falls as rain or snow over land, and then makes its way back to the oceans as surface and ground water. The combination of these processes is known as the hydrologic cycle. For consumptive purposes, humans make use of fresh water flowing in streams or stored beneath the ground. As water flows from land to sea, it may be reused many times by many different people for many purposes. On the South Platte River, for example, treated wastewater from Front Range municipalities is released into the river and used for irrigation downstream.

In Colorado and throughout the arid West, water remains an extremely valuable resource. As in many places, the value of water on the South Platte River grows with demand while supplies remain essentially fixed. Demands for irrigation water compete with mandated minimum stream flows and increasing domestic and industrial demands. Intensive water use engenders water quality problems, particularly for more downstream users.

Current Water Needs

By comparison, the South Platte River is small. The Colorado River, for example, has a native annual supply of 6.74 million acre-feet of water in the State of Colorado, while the South Platte has a native annual supply of only 1.44 million acre feet (U.S.B.R. 1974). Despite its relatively small size, the South Platte is vital to Colorado's economy. Although the South Platte River drains less than 20 percent of Colorado, more than 67 percent of the state's residents live within the South Platte drainage basin.

Agricultural uses accounted for 69 percent of South Platte surface water withdrawals in 1994, while municipal uses totaled about 17 percent.

Demand for water on the South Platte typically exceeds supply from the late spring until the end of the irrigation season in the fall. Water scarcity forces more junior appropriators to stop diverting water in order to satisfy the demands of senior appropriators. Each day of the irrigation season, water administrators decide who is allowed to divert water from the South Platte River.

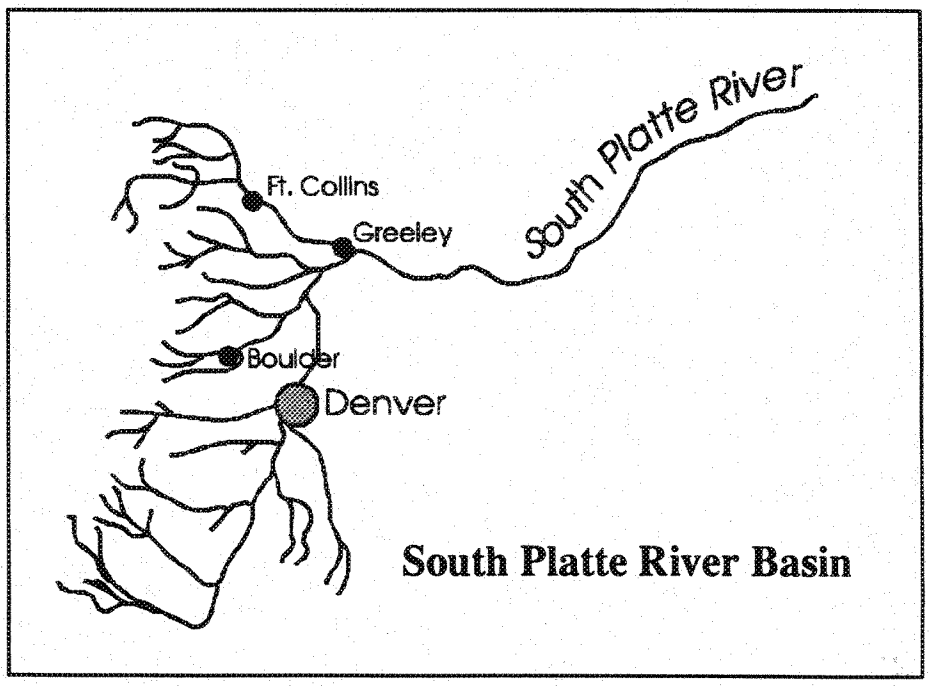
Administration and the Role of the Water Commissioner

In Colorado, the State Engineer heads the Division of Water Resources and holds responsibility for administration of the State's waters. There are seven administrative divisions in Colorado, each with a division engineer. The division engineers enforce the laws and protect the interests of the state with respect to the distribution of water. Each field division has a number of water commissioners who determine available river flows, gather information, and enforce the provisions of Colorado water law in their districts.

The South Platte River falls within Division 1. In Division 1, eleven water districts correspond to eleven major tributaries or sets of tributaries of the South Platte. A different water commissioner is responsible for each district, and many districts have deputy commissioners to assist the commissioners with their duties.

Duties of the water commissioner include: controlling and regulating the distribution of water; gathering, editing and compiling official diversion records; measuring flows in creeks, rivers, ditches, and pipes; and communicating between the division of water resources and water users. In addition, the water commissioner assists with inspection of dams and wells.

The water commissioner needs up-to-date information concerning his or her own district, as well as information about other districts. SPWRMS serves the Division of Water Resources, the water commissioner, and the South Platte water user by facilitating information exchange among water users and administrators.



The South Platte River drains the populous Colorado Front Range.

South Platte Water Rights Management System

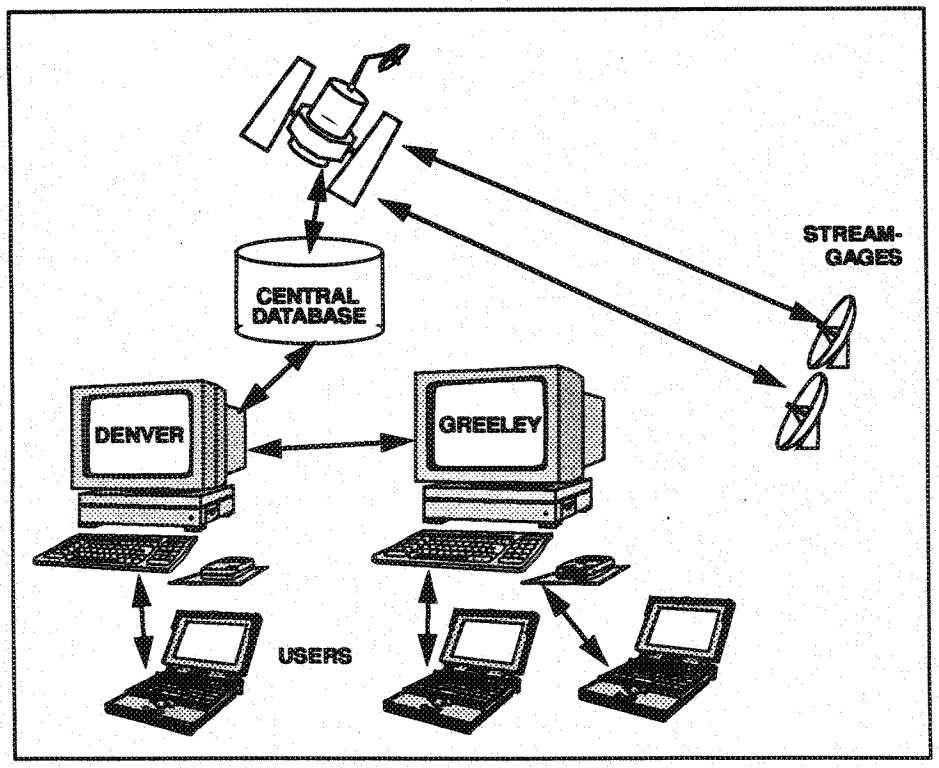
CADSWES (the Center for Advanced Decision Support for Water and Environmental Systems), the Colorado Division of Water Resources, and a coalition of South Platte Water users developed the South Platte Water Rights Management System (SPWRMS) as a decision support system to assist water commissioners and other water administrators by making information more readily available. SPWRMS is a computer software system that integrates information concerning a complex river system, the South Platte River and its tributaries, to facilitate the process of making administrative decisions about that system.

Central Database

The foundation of the SPWRMS software is a central database. Located at the Office of the State Engineer in Denver, the SPWRMS database holds information provided by users of the system, as well as important historical and legal information. The database contains administrative information, such as the State Water Rights Tabulation for Division 1, as well as real-time river flows for numerous gauges on the South Platte and its tributaries. Water administrators record real-time information about their respective portions of the river to the central database as they perform daily management tasks, making that information immediately available to other system users. SPWRMS users have access to current diversions, flows, and river calls, as well as historical information.

Network Communication

Users request information from and send information to the central SPWRMS database by several means. Water administrators in Denver and Greeley access the database using UNIX workstations and local computer networks. Water commissioners throughout the South Platte Basin connect to the database over conventional phone lines, using laptop PCs with modems to submit information concerning their own districts and retrieve data concerning other parts of the basin. Throughout the day, streamflow data enters the database automatically as it arrives via satellite transmission. Water users may view information using either UNIX workstations or personal computers.



The South Platte Water Rights Management System facilitates the exchange of information among system users throughout the river basin. Information enters the central database in Denver via satellite transmission and through user input.

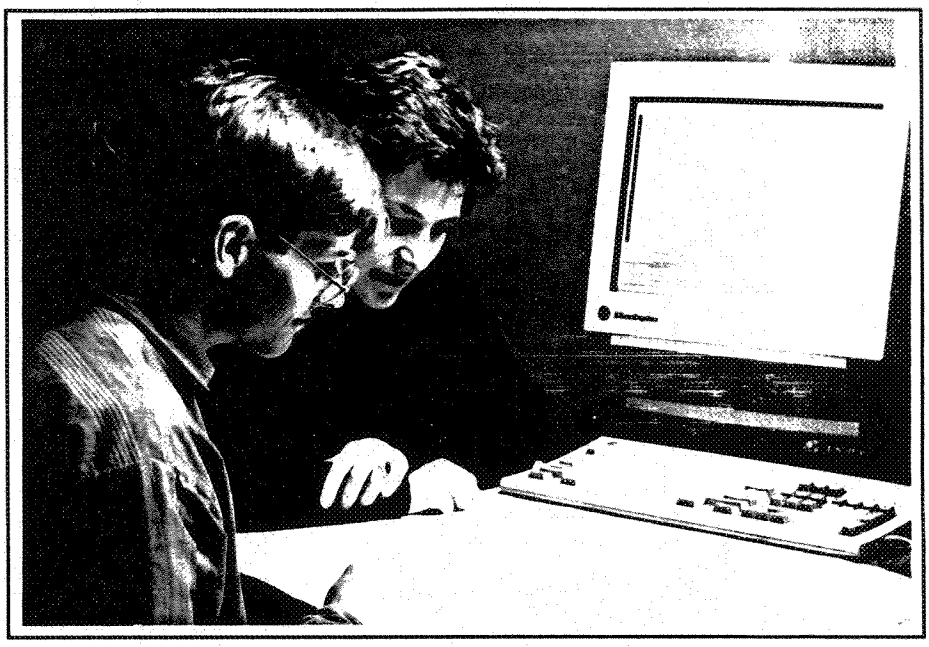
Water Information Sheet

At the heart of the SPWRMS user interface are daily water information sheets, which the Division 1 water commissioners use to record information specific to their district. Each district has its own water information sheet designed by the water commissioner(s) for that district. The information sheet consists of a list of diversion structures, inflows, and gauging points within the district that the commissioner considers important to track on a daily basis. Each district's information sheet is unique, reflecting specific water accounting solutions to unique water management situations. District 7 (Clear Creek), for example, handles a large amount of transmountain water, and the focus of the District 7 water information sheet is to track transmountain deliveries through Clear Creek.

By helping to determine the contents of their respective water information sheets, Division 1 water commissioners were instrumental in determining the exact information tracked by SPWRMS. Only diversion structures on the water information sheets are included in SPWRMS, as those are the key structures for the water commissioners to monitor on a daily basis.

Improving Water Administration

With the water information sheet, detailed information pertaining to each individual water district is available for users system-wide as soon as commissioners submit the information. One can see current river flows, diversions, and extenuating circumstances that affect the water commissioners' daily decisions. The water information sheet provides a snapshot of a district's water operations rather than an 'official' diversion record.



Terri Betancourt and Paddy McCarthy of CADSWES at work on SPWRMS.

The River Call

Users know who can divert water by a mechanism known as the river call. The calling right at any point on a stream is the most senior right downstream from that point at which a water shortage exists. A call is not enforced unless a user with a senior right experiences a shortage caused by the activities of junior users upstream. In such situations, the senior appropriator contacts Colorado Division of Water Resources administrative personnel who officially set the river call. Administrators inform junior appropriators upstream that they must stop diverting water or reduce the amount of their diversion, leaving additional water in the river to satisfy the senior appropriator. (For more on Colorado water law see page 7 at the end of this pamphlet.)

SPWRMS software keeps track of river calls. When a senior water user fails to receive adequate water to meet his/her demands, that user may exercise his/her water right by requesting that a call be placed on the river. SPWRMS includes functionality to change calls on the river, view the current call state, and test the effect of a new call. When a senior appropriator contacts the Colorado Division of Water Resources to request that a call be set, water administrators use SPWRMS to see who will be affected by the new call.

An important feature of the system is its knowledge of upstream-downstream relationships between points on the river. For example, the system can tell if one diversion structure is upstream or downstream from another. This allows the system to keep track of the call affecting every diversion structure on the river system.

River calls are stored in the central database. This provides all users of the system with an up-to-date representation of the call structure for the entire basin.

Scenario Testing

Curtailment refers to the forced cessation of diversion by junior appropriators when a senior water user requests that a call be set. The curtailment analysis tool in SPWRMS allows the system user to test hypothetical scenarios and see the effect of changing the call at a given diversion structure. Curtailment analysis helps administrators avoid placing a call that is too senior, thereby curtailing an excessive number of upstream diversions. If an unnecessarily senior call is placed, more water comes down the river than the calling right is able to use, and water is essentially wasted. Administrators would rather find a more junior call that curtails just the right amount of water to satisfy the immediate water need.

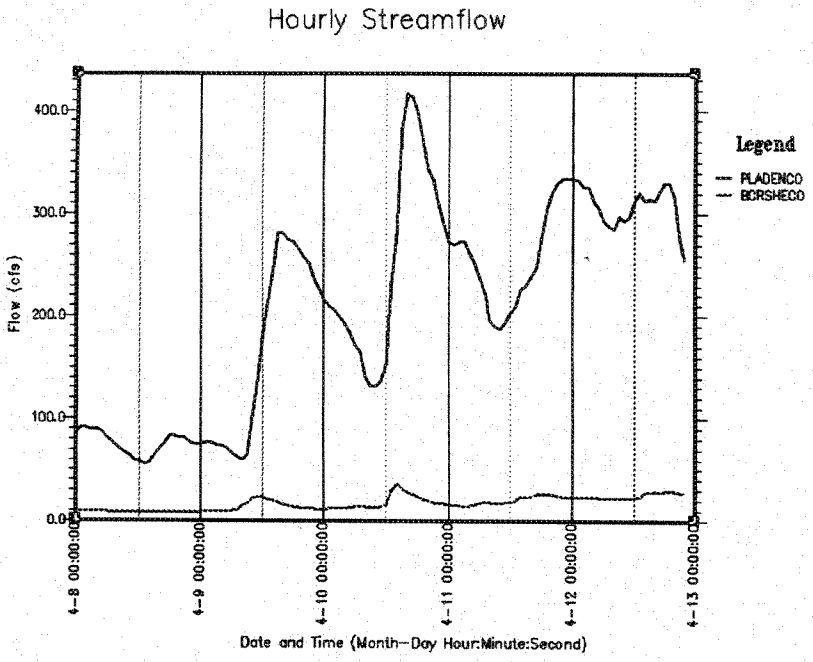
Using the curtailment analysis feature of SPWRMS, the administrator picks a diversion point on the river where the new call might come into effect and then selects a number of potential calls to test at that structure. SPWRMS traces the river to see which junior rights are currently diverting upstream from the new calls. If it finds any junior diversions, the software calculates how long it would take water from curtailed rights to reach the new calling structure. The software also lists the rights affected under various scenarios, telling water administrators who to contact to enforce a new call.

SPWRMS simulates turning off curtailed upstream diversions and allowing water to flow unimpeded in the river instead. The simulation is based on a table listing the empirically derived lag time (how long it takes for water to flow through a given stretch of river), and the loss (how much water is lost to seepage and evaporation along a stretch of river) for every river reach in the basin. As with

any modeling effort, SPWRMS model output is only as good as the input data pertaining to the physical characteristics of the river. SPWRMS is designed to help improve modeling accuracy with time by giving system users the opportunity to modify lag and loss values and save their changes.

Hydrographs

Hydrographs, depicting river and ditch flow over time, promise to be one of the most beneficial decision-making tools available to SPWRMS. Graphically depicted flow is far easier to interpret than the long, typed lists of flow information previously available. Graphs make it easy, for example, to follow a pulse of water released from a reservoir or initiated by rainfall as it moves down the river. This feature allows more precise decisions to maximize the use of water for irrigation and other purposes.



Using Hydrographs to Make More Water Available

This hydrograph depicts the flow of water in the South Platte River and the tributary of Bear Creek from April 8 - April 12, 1995. Each line represents flow at a different gauge on the river. The two curves show flow at the gauges named PLADENCO and BCRSHECO. PLADENCO measures flow in the South Platte at Downtown Denver, and BCRSHECO measures flow on Bear Creek near the town of Sheridan, about 8 miles upstream from the PLADENCO gauge.

The early spring of 1995 was very dry. On the 7th of April, a very senior call controlled the river -- a water right from 1866. Flows in the South Platte were below100 cfs (cubic feet per second), and in Bear Creek less than 20 cfs.

Snows on the weekend of the April 8th provided some relief, and this hydrograph shows that water started to arrive at these two gauges on the 9th. The flow in Bear Creek is small compared to that of the South Platte, but this creek is one of the many contributors to the total flow in the river.

Water administrators were able to use the information on these hydrographs to judge when more water became available to users. Administrators in Denver saw the flow at PLADENCO rise to 275 cfs on the 9th and relaxed the call on the river back to a 1911 water right. This allowed the Burlington Canal to begin diverting 225 cfs to storage on April 10th.

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More on Water Law in Colorado and the West

The system of water rights currently used in Colorado began with the gold rush that followed the discovery of gold at Sutter's Mill, California in 1848. Mining required large volumes of water, and early miners frequently were in conflict. The system of riparian rights used in eastern states was inappropriate for the arid west because it restricted water rights to those owning property adjacent to streams and other bodies of water. Due to more arid conditions, streamflow in the west was far lower than in the east. Mining activities and irrigation farming required the diversion of water away from riparian lands, however land belonged not to water users but to the federal government. Those who were effectively squatters on public lands had no riparian right to the waters that flowed past them.

Settlers developed rules and procedures governing the allocation of water that resembled the staking of mining claims. The first person to divert and utilize water from a stream had rights to the amount of water diverted, thus becoming the senior appropriator on that stream. All subsequent water users were junior appropriators whose right to divert water depended upon the satisfaction of more senior rights. The prior appropriation doctrine remained the basis of water rights law in the West when the United States dispensed lands through such laws as the Homestead Act of 1862, the 1866 Mining Act, and the 1877 Desert Land Act.

The doctrine of prior appropriation is also called the Colorado Doctrine because it first became law in Colorado in 1876. The eight most arid states (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming) adopted prior appropriation as the only method for acquiring water rights. These states still use prior appropriation today, although statutory systems for appropriation, distribution, and enforcement differ among them.

Water Rights Adjudication

To have protection by administrative statutes, a water right must be adjudicated--sanctioned by a water court. A decree establishing a water right specifies a priority date, a maximum amount, and a use to which the water may be put. Such uses include irrigation, domestic supply, recreation, power production, and municipal supply, among many others.

Much of the case load in a modern Colorado water court involves the transfer of water rights among different uses and users. If an agricultural right holder wished to divert his/her water at a different ditch to irrigate a given field more easily or efficiently, the decree would need to be modified accordingly. Increasingly, agricultural water rights are being sold to municipalities willing to pay more for water than it would yield in agricultural production. In such transfers the water court must determine that no injury will come to holders of more senior rights by modifications in the use of a given right.

Different uses vary greatly in the timing and amount of return flow. When a water right is transferred by court decree from one use to another, the appellate must convince the court that no harm will result to other water users from changes in timing or amount of return flows.

Protecting Instream Flows

The right to divert water under the prior appropriation system of water law has always been contingent upon the water being put to beneficial use. Traditionally, "beneficial" has been construed in terms of consumptive uses, or those involving diversion of water for mining, irrigation, and domestic and industrial supply. Increasingly, maintenance of free-flowing water to support recreation, fish and wildlife habitat, water quality, and aesthetics has come to be seen as beneficial.

Assuring instream flows on the South Platte and other Western rivers is a complex legal proposition. Typically, water rights for irrigation are more senior than others in the West. Acquiring rights with the seniority needed to protect instream flows in time of drought or shortage is quite often technically or financially problematic. Western states differ both in their level of recognition of instream flows as beneficial uses, and their institutional programs directed at safeguarding instream flows.

In Colorado, the Colorado Water Conservation Board comprises five elected officials and nine members appointed by the governor. The Water Conservation Board may appropriate water for instream flow and lake level maintenance, and is responsible for filing objections to water transfers which may impair instream flow rights.

SPWRMS can help water administrators on the South Platte River protect instream flows. By providing near real-time information concerning the state of the river and its tributaries, SPWRMS can help ensure that river flows do not drop below specified minimum levels. At the same time, the system can help avoid higher-than-necessary instream flows -- an unnecessary cost to colorado water users.

About CADSWES, CWRRI and Water in the Balance

CADSWES

The Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) is an interdisciplinary research and development center of the College of Engineering and Applied Science located at the University of Colorado at Boulder. The primary mission of CADSWES is to research, design, prototype, and develop decision support systems to assist in addressing real-world environmental and water resources issues.

Established in 1988, CADSWES performs research under the sponsorship of a number of organizations including the U.S. Geological Survey, the U.S. Bureau of Reclamation, the Environmental Protection Agency, the U.S. Army Corps of Engineers, the Electric Power Research Institute, and the National Science Foundation. In addition, CADSWES collaborates on numerous regional projects through the Tennessee Valley Authority, the Colorado Water Conservation Board, the Colorado Office of the State Engineer, and the Imperial Irrigation District in California.

At CADSWES, we believe that the best decisions are based upon a technically informed foundation. Our software systems can provide decision makers and analysts with the information to make efficient and effective decisions. Our software does not replace, but supports and extends, the individual's decision-making capabilities.

For additional information, please contact us at the address below:

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CWRRI

The Colorado Water Resources Research Institute (CWRRI) exists for the express purpose of focusing the water expertise of higher education on the evolving water concerns and problems being faced by Colorado citizens. CWRRI strives to bring the most current and scientifically sound knowledge to Colorado's water users and managers.

For more information about CWRRI and/or the water expertise available in the higher education institutions in Colorado, please contact CWRRI at the address below:

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Water in the Balance

"Water in the Balance" was created to inform the public about complex water management issues. This issue addresses the cooperative efforts of municipalities and higher education to apply state-of-the-art technology to more efficient decision making in water resource management. It is hoped that by presenting information about these efforts, an increased awareness will be achieved, and collaboration further increased

This issue of "Water in the Balance" was prepared for CWRRI by Paddy McCarthy and Adam Light of CADSWES as the final report for CWRRI projects #14-08-0001-G1551-04/10, #14-08-0001-G2008/12, and #14-08-0001-G2008-3/09.