Rio Grande Decision Support System

An Overview

The Rio Grande Decision Support System (RGDSS) is a water management system being developed by the Colorado Water Conservation Board and Colorado Division of Water Resources to assist in making informed decisions regarding historic and future use of water in the Rio Grande basin.

1.0 INTRODUCTION

As Colorado enters a new era of water management, cooperation among state agencies, water providers, and water users is essential so that informed decisions can be made. The State of Colorado is constantly evaluating management of its water resources in response to increases in population and demand, droughts, and reductions in federal water program funding. Water management for more efficient use of existing supply is receiving greater attention by both water users and state agencies. Therefore, a comprehensive decision support system (DSS) is needed that will provide Colorado agencies, water users, and managers a better means for organizing, accessing, and evaluating a wide range of information and alternative strategies, and to establish informed and factual positions regarding the major issues.

In October, 1997 the Colorado Water Conservation Board (CWCB) and the Colorado Division of Water Resources (CDWR) identified a need for and funded a feasibility study to develop and implement a DSS for the Rio Grande Basin. In December, 1998, RGDSS construction began with the development of database and appropriate analytical tools for making informed decisions regarding Rio Grande basin water and water management (download RGDSS feasibility study). RGDSS, with an estimated completion data of December 2001, is expected to accomplish the following:

- Provide comprehensive, accurate, user-friendly databases compatible with the CDWR HydroBase database
- Provide data and models to evaluate alternative water development and administration strategies that can maximize the use of available resources in all types of hydrologic conditions and the development of sound water resources management strategies
- Provide a functional, integrated system that can be maintained and upgraded by the State
- Have the capability to accurately represent current and potential federal and state administrative and operational policies and laws
- Promote information sharing among government agencies and water users

2.0 Rio Grande Basin Conditions

2.1 Basin Setting

The Rio Grande basin (***Figure 1-1***) within Colorado is located in south-central Colorado and encompasses approximately 7,500 square miles (U.S. Department of Agriculture 1978). The primary feature of the basin is an open, almost treeless, relatively flat valley floor (known as the San Luis Valley) surrounded by mountains. The valley floor ranges in elevation from 7,440 feet on the south end to 8,000 feet on the north end, and is bounded on the west by the San Juan Mountains and on the east by the Sangre de Cristo Mountains.

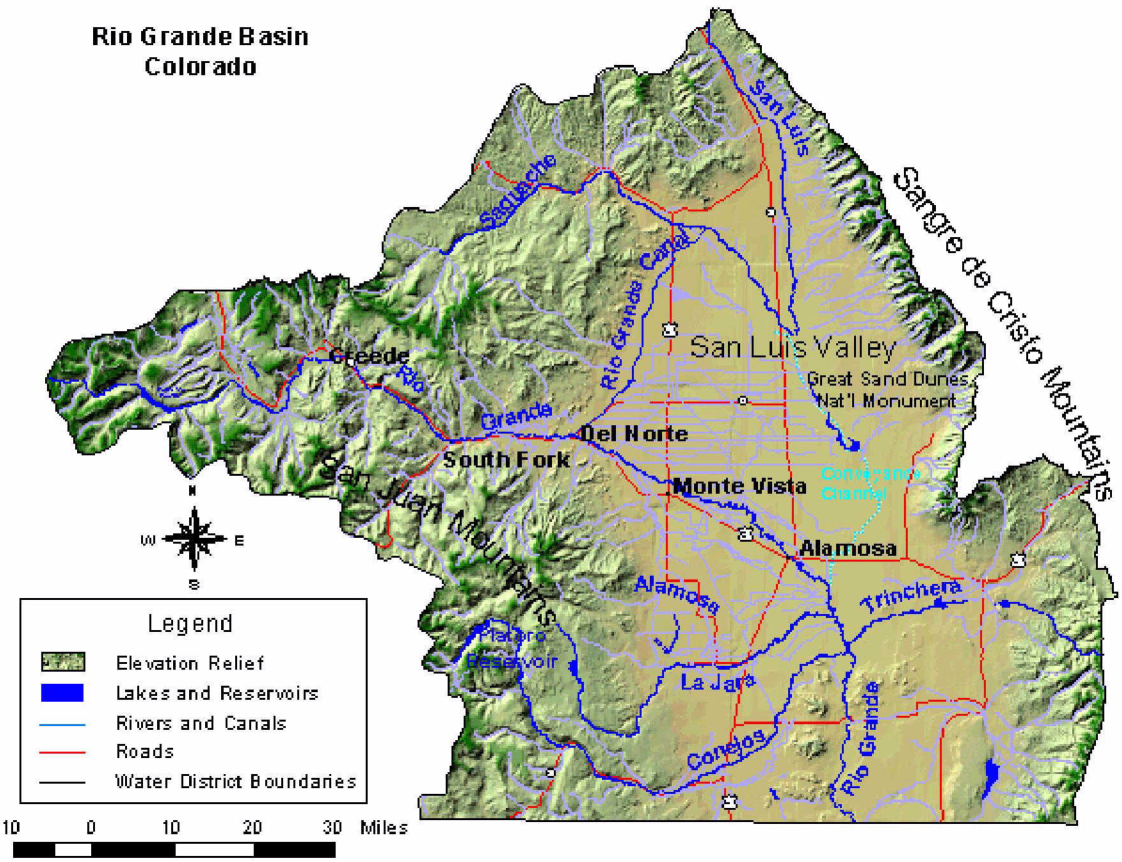

Figure 1-1 Rio Grande Basin (Full Size, from RGDSS Feasibility Study)

Of the 7,500 square miles, there is an area of approximately 3,000 square miles in the northern part of the valley that does not naturally drain into the Rio Grande because it is separated by a low divide in the shallow ground water table formed by the alluvial fan of the Rio Grande on the west and alluvial material from the Sangre de Cristo Mountains on the east. This non-tributary area is known as the Closed Basin.

The Rio Grande main stem rises in the San Juan Mountains in the vicinity of Creede, Colorado and flows easterly where it is joined by the South Fork of the Rio Grande at South Fork, Colorado. The main stem continues east to Del Norte where it flows out onto the San Luis Valley floor in a southeasterly direction. The main stem continues this path until it reaches Alamosa, where it abruptly turns south and flows to the state line.

2.2 Hydrogeologic Setting of the San Luis Valley

The San Luis Valley is considered to be a high mountain desert with cool summers and cold winters. Most of the precipitation on the valley floor comes in the form of scattered summer afternoon rain showers. Annual average precipitation ranges from approximately 7 inches at Alamosa to approximately 45 inches at Wolf Creek Pass. However, most streamflow originates from snowmelt in the San Juan and Sangre de Cristo mountains. Previous authors and investigations have offered water budgets for the valley. These estimates have historically been contested and were therefore not incorporated into this study.

The San Luis Valley is part of the Rio Grande depression, a north-trending series of intermontane basins extending from Texas to central Colorado. Despite its apparent simplicity and lack of topographic relief, the subsurface geology of the valley is complex and not yet fully understood. In general terms, the valley is called a graben, a geologic term meaning a down-dropped block of the earth's crust, bounded on the west side by the San Juan Mountains and on the east side by a major fault at the edge of the Sangre de

Cristo range. Over many millions of years the valley has continued to grow in depth, while at the same time filling with sediments and layers of volcanic rock shed from the surrounding mountains and carried to the valley by the Rio Grande, the Conejos River, and other streams.

Over time, the pore spaces between the grains of sediments, fractures, and other openings in the volcanic rocks beneath the valley floor have filled with water. These saturated sedimentary and volcanic rock layers comprise the aquifers of the valley, from which numerous wells draw water. Ground water continues to recharge the pore spaces in the aquifers by percolation from surface streams, leakage through canals, and recharge from the mountains surrounding the valley along some of the more permeable rock layers.

This complex, interconnected aquifer system is, in many areas, in hydrologic connection with the surface water system. The aquifer system is generally comprised of a shallow unconfined aquifer and a deeper, confined aquifer. The geometry and characteristics of both major aquifers are controlled by the geologic structure and stratigraphy (layering) that have developed over geologic time in the valley.

The uppermost water-saturated layer of sand and gravel, down to a depth of about 100 feet across most of the valley, is the unconfined aquifer. Below the unconfined in the central part of the valley are a number of clay layers that serve to separate, although not totally disconnect, the unconfined aquifer from deeper water-bearing layers of sand, gravel, and fractured volcanic rocks. The deeper layers, of which there are many, together make up the confined aquifer because of the overlying and confining clays. Water flows from many wells completed in the confined aquifer due to natural artesian pressure.

The volume of storage in the aquifer system of the valley is significant. However, not all of this water is recoverable, and in some locations and at selected depths the quality may limit its uses. The unconfined aquifer functions similar to a surface reservoir with a pattern of rising levels in the spring and early summer caused by recharge from streams, canals, and early irrigation season return flows. These increases are followed by a decline as the streamflow decreases and ground water is pumped largely for agricultural purposes.

Agricultural activities account for more than 85 percent of basin water consumption with an estimated 638,000 acres under irrigation (HRS 1987). The primary crops are potatoes, carrots, small grains, and alfalfa.

Along the edges of the valley there is little, if any, separation between the confined and the unconfined aquifers. This allows both aquifers to be recharged with water from runoff entering the San Luis Valley. However, the relationships between the two aquifers and between the aquifers and the surface water are not well defined. The RGDSS and additional data will improve the understanding of the physical system and improve estimates of potential water yield.

3.0 San Luis Valley Project

The San Luis Valley Project was authorized by Congress in 1940 and described in House Document 693. This project included a Rio Grande element (this was not built), a Closed Basin element (the Closed Basin Project), and a Conejos River element (Platoro Reservoir). The two primary purposes of the San Luis Valley Project were to assist Colorado in meeting its commitments to New Mexico and Texas under the Rio Grande Compact (see Section 4.1) and to assist the United States in meeting its commitments to Mexico under the Treaty of 1906.

3.1 Closed Basin Project

The Closed Basin Division of the San Luis Valley Project was authorized by Congress on October 20, 1972 (and modified in 1980 and 1984). Designed to pump water out of the Closed Basin, the Closed Basin Project consists of numerous wells and canals that deliver water to the Rio Grande. The total ultimate production capacity of the Closed Basin Project was estimated to be approximately 100,000 acre-feet per year (Leonard Rice Consulting Engineers, Inc. 1990). However, actual production to date has averaged 24,000 acre-feet per year. This low average is partly due to production curtailment in years when the water was not needed to help satisfy compact deliveries (S. Vandiver 1997). Basin water users agree that a more realistic goal would be a maximum of 65,000 acre-feet per year. According to Public

Law 92-514-October 20, 1972, the Closed Basin Project deliveries are categorized into four types of uses:

- Priority one deliveries are made to assist the State of Colorado in meeting its compact commitments to New Mexico and Texas. These deliveries are limited to an average of 60,000 acre-feet per year over any 10-year period.
- Priority two deliveries are made to enhance wildlife in the Alamosa National Wildlife Refuge and Blanca Wildlife Habitat Area. These deliveries are limited to 5,300 acre-feet per year.
- Priority three deliveries were applied to reduce and eliminate any accumulated deficit in compact deliveries that existed when the legislation was enabled. Priority three deliveries no longer apply since the pre-legislation debt was eliminated when Elephant Butte Reservoir spilled in 1985.
- Priority four deliveries are available at a charge from unused supply for general use by Rio Grande and Conejos water users after priority one and two users have been satisfied.

3.2 Conejos River

The U.S. Bureau of Reclamation (USBR) prepared a report in 1947 recommending the construction of Platoro Reservoir in the Conejos River basin. This reservoir was built from 1949 to 1951 with a capacity of approximately 60,000 acre-feet that includes a 6,000 acre-foot flood pool. Platoro Reservoir is decreed for 53,571 acre-feet. Because this reservoir was built after the compact was signed, it is referred to as a post-compact reservoir and is subject to special restrictions under the compact. The U.S. Army Corps of Engineers assumes operation of Platoro Reservoir during flood control situations.

4.0 Water Administration Issues

Colorado administers water according to the prior appropriation doctrine (first in time, first in right). The appropriation and adjudication dates decreed by the water court are the basis for determining which users are entitled to the river flow during periods when there is insufficient water for all appropriators. Ground water usage complicates water administration in the Rio Grande basin because the hydraulic connection between the surface water system and the confined and unconfined aquifers is not well understood. It is clear that this connection does affect streamflow, and for this reason irrigation well drilling is restricted by the State Engineer's Office. New well permits have been restricted for non-Closed Basin aquifers since 1970 and for the Closed Basin unconfined aquifer since 1981. The Colorado State Engineer and his agents, the Division 3 (Rio Grande basin) Engineer, staff, and water commissioners, administer the water rights to both surface and ground water in the Colorado portion of the Rio Grande basin as decreed by the water court. Water administration issues in the basin intensified in the 1970s and continue today with strict compliance with the compact.

4.1 Rio Grande Compact

Rio Grande water administration is greatly influenced by the Rio Grande Compact. The Rio Grande Compact was signed by the Compact Commissioners of Colorado, New Mexico, and Texas on March 18, 1938. The following two major purposes were identified by Colorado's original Compact Commissioner, M.C. Hinderlider (1938):

1. To "protect the present and future use of water in the various sections of the Rio Grande basin by setting up schedules of delivery of water at the Colorado New Mexico state line and at San Marcial, which is at the head of the Elephant Butte Reservoir, and by fixing the average annual releases from Elephant Butte Reservoir."
2. To "permit the construction and operation of additional reservoirs above Elephant Butte Reservoir to regulate the water which otherwise would spill from Elephant Butte Reservoir and be lost for beneficial use in the basin."

While the interpretation of the compact is complex and always under debate, these purposes are offered for general background. They do not represent any official position of the State of Colorado or any water user.

The Rio Grande Compact sets annual state line delivery obligations for Colorado based on the amount of flow at the index gaging stations within Colorado. Compact deliveries are not required to strictly adhere to the compact delivery tables on an annual basis; therefore, the compact accounts for over-deliveries (credits) and under-deliveries (debits) that may be carried forward. Provisions of the compact relate Colorado's compact obligations and its accumulation of credits and debits to storage levels at the Rio Grande Project, a major storage and irrigation project in New Mexico and Texas of which Elephant Butte Reservoir is the major feature.

A major provision of the compact permits Colorado to increase consumptive uses of water from the Rio Grande and the Conejos River to the extent that deliveries to the state line are satisfied or replaced with deliveries from the Closed Basin Project.

4.2 Ability to Meet Compact Obligations

Colorado had difficulty in meeting its compact obligations from 1952 through the onset of rigorous surface water administration in 1968. During this time, Colorado accrued a substantial debit under the compact. Several studies have been performed to better understand why Colorado's debits were so much greater than anticipated. Although a comprehensive review of this information was beyond the scope of this feasibility study, the major events are described here.

Because of the large debits accrued by Colorado from 1952 through the mid-1960s, a lawsuit was filed (Texas and New Mexico v. Colorado) in the U.S. Supreme Court in 1966 with Colorado's debt of almost 945,000 acre-feet as the central issue. This action led to a number of events over the next 20 years:

1968
The U.S. Supreme Court approved a stipulation between Colorado, Texas, and New Mexico that the pending litigation would be stayed as long as Colorado met its compact delivery obligation each and every year without incurring any further debt of water. Therefore, since 1967 Colorado water administrators have treated the compact delivery obligation as the paramount commitment on the rivers and have delivered water for compact purposes instead of allowing unrestricted diversions by Colorado water users. Colorado has succeeded in meeting this delivery obligation, but only at enormous cost in water to pre-compact surface water rights.

1970
The Colorado State Engineer's Office stopped issuing new well permits for the non-Closed Basin aquifers and the Closed Basin confined aquifer.

1972
The CWCB funded a program from the construction fund to cap and valve flowing small and large capacity stock, domestic, and irrigation wells to conserve the head in the confined aquifer.

1975
The Colorado State Engineer proposed rules for compact administration and for administering ground water in the valley.

1981
The Colorado State Engineer's Office stopped issuing new well permits for the Closed Basin unconfined aquifer.

1983
After a lengthy trial initiated in 1979 on the proposed rules, the Colorado Supreme Court largely approved the proposed rules for compact administration, but disapproved the rules for curtailing ground water use on the grounds that the State Engineer had improperly concluded that he was not permitted to consider a requirement that senior priority surface water users drill wells as a means of diversion prior to the curtailment of the junior priority ground water rights. The Colorado Supreme Court remanded the proposed rules back to the State Engineer for further consideration.

1985

Allocation of the yield of the Closed Basin Project by agreement of the San Luis Valley water users resolved the issue of regulating then-existing levels of ground water use that affected surface flows of the Rio Grande and the Conejos River.

1985

The U.S. Supreme Court dismissed with prejudice the Texas and New Mexico v. Colorado lawsuit following the spill of Rio Grande Project storage water from Elephant Butte pursuant to the terms of the Rio Grande Compact.

In light of the allocation of the yield of the Closed Basin Project by San Luis Valley Water Users, the State Engineer's Office did not find it necessary to adopt new rules and regulations to curtail existing levels of ground water use. Accordingly, the practice of curtailing surface water rights and supplementing the deliveries with Closed Basin Project water remains the cornerstone of Colorado's effort to satisfy the compact delivery obligations. This arrangement has been administered successfully since 1985.

The Rio Grande Compact continues to be viewed as the overriding commitment on the river. By comparing estimated compact delivery obligations with streamflow forecasts, water administrators derive an estimate of the flows that must be passed on for benefit of the compact. The remaining flows are available for distribution under the priority system to San Luis Valley water users. As the irrigation season progresses, estimated flows become known flows, and the compact obligations are re-evaluated. The division engineer compares the re-evaluated compact obligations with actual deliveries approximately every 10 days and adjusts the curtailment, if necessary.

4.3 Amended Costilla Creek Compact

Costilla Creek originates in the mountains of Colorado just north of the border with New Mexico and flows into New Mexico, where the first irrigation use occurs, and then back into Colorado. The creek then turns south and joins the Rio Grand just south of the Colorado - New Mexico border. In most years, however, no surface flow from Costilla Creek reaches the Rio Grande River. Most of the water supply for irrigation in the basin comes from surface water.

There have been historical conflicts between the Costilla Creek water users in Colorado and New Mexico. The Costilla Creek Compact was originally negotiated and signed in 1944. The compact was amended in 1963, and some differences of opinion persist to the present time. According to the compact, a water master is paid for by both Colorado and New Mexico to administer the compact. Each state also provides an engineer advisor to the water master. Important issues in the basin include maintenance of instream flows and timely data availability to help substantiate the water master's water administrative decisions.