Overview of Each Basin

Chapter 3 examines the river basins in the context of the larger river systems they comprise. While Colorado is one state, each river basin is unique. An understanding and recognition of each basin's particular landscape, historical context, and current challenges provide the necessary basis to explore Colorado's complete water picture.

Basin residents provided the following descriptions. Members of the basin roundtables and of the CWCB reviewed and updated these descriptions, working from the SWSI report the CWCB released in 2011. The CWCB updated the basin descriptions, concerns, and challenges with recent feedback from the basin roundtables.

Green Mountain Reservoir near Kremmling is important for water management in the mainstem of the Colorado River. Photo: M. Nager.

Basin Descriptions and Challenges

Arkansas Basin

Basin Description: The Arkansas River originates in the central mountains of Colorado near Leadville, at an elevation of more than 14,000 feet. The river travels eastward through the southeastern part of Colorado toward the Kansas border, dropping more than 10,000 feet to an elevation of 3,340 feet at the Colorado-Kansas line. Several tributaries flow from the high southern mountains toward the mainstem of the Arkansas, and drainage from the higher plains to the north also contributes to the flows. The Arkansas River Basin is spatially the largest river basin in Colorado, covering slightly less than one-third of the state's land area (28,268 square miles, or 27 percent of the state's total surface area).

Rafting on the Upper Arkansas, Colorado's most popular river for rafting. Photo: M. Nager.

Grassland and forest cover approximately 67 percent and 13 percent of the basin, respectively. More than 20 percent of the land is publicly owned. A large amount of the grassland is devoted to agriculture, with one-third of agricultural lands requiring irrigation. Increasing urbanization is occurring throughout portions of the Arkansas River Basin, and over the last few years, persistent drought has heavily affected the basin.

The Arkansas River Compact of 1948 apportions the waters of the Arkansas River between Colorado and Kansas, while providing for the operation of John Martin Reservoir. The compact is "not intended to impede or prevent future beneficial development… as well as the improved or prolonged functioning of existing works: Provided, that the waters of the Arkansas river… shall not be materially depleted in usable quantity or availability.…"[1] The primary tool for administering the Arkansas River Compact is the 1980 Operating Principles, which provide for storage accounts in John Martin Reservoir, and the release of water from those accounts for Colorado and Kansas water users.

Since the early 20th century, Colorado and Kansas have litigated claims concerning Arkansas River water; these claims ultimately led to the negotiation of the compact. In 1995, the United States Supreme Court found that Colorado had depleted stateline flows through the use of tributary groundwater, which violated the compact. As a result, the Colorado DWR developed well administration rules to bring Colorado into compliance with the compact, and Colorado compensated Kansas for damage claims, which totaled about $34 million. Recently, the DWR developed irrigation efficiency rules, which require augmentation for any upgrades to water delivery systems, such as drip irrigation or sprinkler systems.

Garden of the Gods, near Colorado Springs, is open to the public free of charge and a popular spot for visitors.

Basin Challenges: The Arkansas Basin will face several key opportunities and challenges pertaining to water management issues and needs over the next 40 years. These are as follows:

- All new uses require augmentation. Increasing irrigation efficiency, i.e. conversion from flood to center-pivot irrigation for labor and cost savings, will require 30,000-50,000 acre-feet of augmentation water in the coming years.
- Replacement of municipal water supplies that depend on the non-renewing Denver Basin aquifer and declining water levels in designated basins is becoming critical, exacerbated by continued growth in groundwater-dependent urban areas.
- Concerns over agricultural transfers and the effects on rural economies are substantial in the lower portion of the basin downstream of Pueblo Reservoir.
- Collaborative solutions, as demonstrated in Alternative Transfer Methods pilot projects, are needed to forestall or avoid loss of irrigated acreage in agriculture.
- As the most rafted river in the world, the Arkansas River Voluntary Flow Agreement provides a benchmark for cooperative integration of municipal, agricultural and recreational solutions in support of recreational boating and a gold medal fishery.
- Concerns over water quality include drinking water in the Lower Valley and the impact of fires and floods in the Fountain Creek watershed.
- Rural areas within the Arkansas Basin have identified water needs, but face challenges in marshalling resources to identify and implement solutions. Support from the Roundtable and CWCB is needed.
- The great majority of surface storage reservoirs in the Arkansas Basin were constructed between 1890 and 1930. Many of these facilities are in need of repair or restoration.
- Regional solutions are emerging, like the SECWCD Regional Water Conservation Plan, which can serve as a model for future regional initiatives to address the needs of the Arkansas Basin.

The Arkansas Basin Implementation Plan (BIP) identifies specific projects and methods for meeting the future water needs of the Arkansas Basin.

Snowshoeing near the Continental Divide.

Basins of the Colorado River System

The basins in the Colorado River system (including tributary basins) are more than one-third the size of the state's geographic area. Originating in the north central mountains, the main stem of the Colorado River flows southwesterly and is met at Grand Junction by the Gunnison River before flowing west into Utah. The Yampa River and the White River move westward across the northwest quadrant of the state to the Utah border where they join the Green River, another tributary of the Colorado. The San Miguel River and the Dolores River begin near the southwestern corner of Colorado and travel north along the western border into Utah. The San Juan River and its tributaries collect the water in the southernmost regions west of the Continental Divide and flow into New Mexico.

Less than 20 percent of the entire Colorado River Basin lies inside Colorado; however, approximately 75 percent of the water in the entire river basin originates in the state. In Colorado, transmountain diversions account for approximately 5 percent of the total water supply, or approximately 500,000 acre-feet per year. Most of these transbasin diversions move water from west to east, supplying water to the Front Range.

Mainstem Colorado River Basin

Basin Description: The Colorado River Basin in Colorado encompasses approximately 9,830 square miles. Elevations in the basin range from greater than 14,000 feet in the headwaters areas, to about 4,300 feet at the Colorado-Utah state line. The basin's mountainous upper reaches gradually give way to a series of canyons and gentler terrain as the river flows along the Interstate 70 corridor toward Grand Junction and the Utah border.

Snowpack in the elevations above 9,000 feet is an important water source for human use on both sides of the Continental Divide in Colorado. This water is also important for compliance with legal obligations, since as much as 70 percent of the river flows out of state.

A substantial portion of the basin is composed of federally owned land. Rangeland and forest are the predominant landscapes in the Upper Colorado River Basin, comprising about 85 percent of the area. Livestock grazing, recreation, timber harvesting, and gas drilling are the leading uses of the federal lands, and the basin also features active and inactive mines.

Basin Challenges: The Colorado River Basin will face several key challenges pertaining to water management issues and supply needs over the next 40 years, some of which are as follows:

- Recreational use and environmental conservation are major drivers in the basin and are important for economic health and quality of life. There is some concern that many of these areas are vulnerable for various reasons, and competition with other water needs is one of those concerns.
- Agriculture is important in the basin, especially in the lower basin (Grand Valley). However, despite the importance of agriculture, the continued expansion of communities causes agricultural lands to become urbanized, which could affect 20 percent of irrigated lands in the basin.
- The success of the Upper Colorado River Endangered Fish Recovery Program is vital to the future of the river. The program is designed to address the recovery needs of the endangered

Lamphier Lake rests in a high alpine basin about 20 miles from Gunnison. The lake offers hiking and fishing near the Fossil Ridge Wilderness Area.

fish in the Colorado River while protecting existing water uses and allowing for the future use of Colorado River water in compliance with interstate compacts, treaties, and applicable federal and state law.

- There is concern over a potential compact shortage during severe and sustained drought and the potential effects to in-basin supplies.
- The development of water rights associated with transbasin projects is a concern, and Colorado must consider the effect on in-basin supplies.
- Water quality is a concern, particularly related to selenium and salinity issues.

Gunnison River Basin

Basin Description: The Gunnison River Basin stretches across more than 8000 square miles of western Colorado, extending from the Continental Divide to the confluence of the Gunnison and Colorado Rivers near Grand Junction. The Gunnison River Basin is defined by the Elk Range to the north, the Sawatch Range to the east, the San Juan Mountains to the south, and the Uncompahgre Plateau to the southwest. Water traveling from the headwaters to Grand Junction experiences an elevation change of more than 9,500 feet.

The Gunnison River Basin is largely forested, with forest area covering approximately 52 percent of the total basin area. About 5.5 percent of the land in the basin is classified as planted or cultivated land and is primarily concentrated in the Uncompahgre River Valley between Montrose and Delta, with additional pockets near Gunnison and Hotchkiss.

Basin Challenges: Basin residents have identified several water management issues that will present challenges to Gunnison River Basin water users over the next 40 years. These issues include:

- Growth in the headwaters region will require additional water management strategies.
- Addressing agricultural water shortages in the upper portion of the basin is an important goal of the community. Lack of financial resources is an impediment.
- There is concern over possible future transbasin diversions and the potential effect this might have on existing uses within the basin.

Ice climbing at the annual Ouray Ice Festival happens in a natural gorge within walking distance of the City of Ouray. The park remains free and open for public use.

Young patron at the Demolition Derby and the 4H competition at the Routt County Fair in Hayden. Photo: M. Nager.

- The area between Ouray and Montrose is rapidly growing. Tourism is important in the headwaters areas, but agriculture is dominant in the Uncompahgre Valley. A rapid influx of retirees and growth in the Uncompahgre Valley may dramatically change the agricultural uses and other land uses in the area.

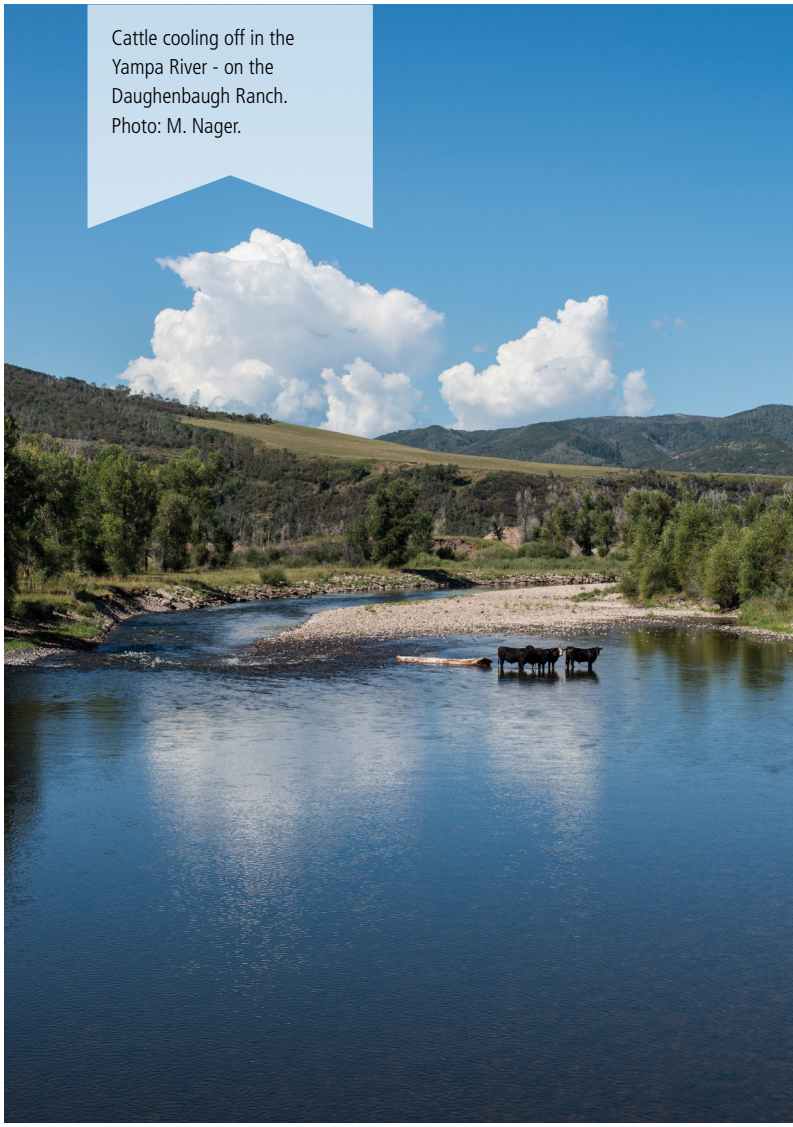
Yampa River, White River, and Green River Basins

Basin Description: The Yampa River, White River, and Green River Basins cover roughly 10,500 square miles in northwest Colorado and south-central Wyoming. The Continental Divide on the east defines, in part, the basin's boundaries. The elevation in the basin ranges from 12,200 feet at Mount Zirkel in the Park Range, to about 5,100 feet at the confluence of the Yampa and Green Rivers at Echo Park within Dinosaur National Monument. The basin contains diverse landforms, including steep mountain slopes, high plateaus, rolling hills, incised sandstone canyons, and broad alluvial valleys and floodplains.

Large portions of land in the basin are federally owned. Livestock, grazing, and recreation are the predominant land uses. Near the towns of Craig, Hayden, Steamboat Springs, Yampa, and Meeker, much of the land is dedicated to agricultural use, and the mountains are densely covered by forest. The valleys and plateaus are mostly covered by shrubland with some forested areas. The Steamboat Springs area, featuring a destination ski resort, is likely to experience continued and rapid population growth.

Basin Challenges: Within the Yampa River, White River, and Green River Basins, key water management issues for the next 40 years include:

- The emerging development of gas and oil shale resources is affecting water demand, for both direct production and the associated increase in municipal use.
- Agriculture, tourism, and recreation are vital components of this basin's economy. As the needs of communities and industry grow, competition among sectors could increase.
- Industrial uses, especially power production, are a major water use. Future energy development is less certain.
- While rapidly growing in some areas, particularly in the Yampa River/Steamboat Springs area, the basin as a whole is not developing as rapidly as other portions of the state. This has led to concern that the basin will not get a "fair share" of water use the Colorado River Compact affords to Colorado in the event of a compact call.
- Implementation of a successful Upper Colorado River Endangered Fish Recovery Program is vital to ensuring protection of existing and future water uses.
- Agricultural producers in the basin would like to increase the amount of irrigated land by 14,000 to 18,000 acres, but the lack of financial resources is an impediment.



Cattle cooling off in the Yampa River - on the Daughenbaugh Ranch. Photo: M. Nager.

Dolores River, San Juan River, and San Miguel River Basins

Basin Description: The San Juan River, Dolores River, and San Miguel River Basins are located in the southwest corner of Colorado and cover an area of approximately 10,169 square miles. The Upper San Juan River and its tributaries flow through two Native American reservations in the southern portion of the basin—the Ute Mountain Ute Reservation and the Southern Ute Indian Reservation. The Southwest Basin is a series of nine sub-basins, eight of which flow out of state before they join the San Juan River in New Mexico or the Colorado River in Utah. The Colorado River Compact, the Colorado Ute Indian Water Rights Settlement, and several BOR storage projects have shaped the water history of the Southwest Basin.

Basin Challenges: In addition to the three compacts governing water use across the broader Colorado River Basin, other compacts, settlements, and species-related issues are specific to the San Juan/Dolores/San Miguel region:

- The Colorado Ute Indian Water Rights Settlement Act of 1988 settled the reserved water-rights claims of the Southern Ute and Ute Mountain Ute Tribes concerning quantity, priority, and administration on all streams that cross the two tribes' reservations.
- The Dolores Project was integral to the Ute Mountain Ute portion of the Indian Water Rights Settlement. Construction of the Dolores Project proceeded in 1977 by order of the Secretary of Interior, because it provided potable water for the first time to the Ute Mountain Ute community of Towaoc and irrigation water for a highly productive, 7,600-acre tribal farm in exchange for subordinating senior tribal water rights claims that could have dried up the Mancos River Valley.
- Tribal water allocations out of the Animas-La Plata Project component of the settlement provided the tribes with a municipal and industrial (M&I) water source to supply and augment future depletions of the San Juan River system that are constrained by the San Juan Recovery Program for Endangered Native Fish. The Animas-La Plata Project also provided the City of Durango and surrounding areas with a long term M&I supply.
- The Southwest Basin includes numerous instream flow segments. Instream flows have served as a tool to balance valued agricultural uses with instream water to support recreational and environmental values, all of which combine to support the economic and aesthetic values that drive settlement and commerce in the Southwest Basin.
- The USFS and the BLM have extensive owner ship of land in the Southwest Basin. Most Southwest Basin headwaters originate on federal land. These federal agencies have worked with the CWCB Instream Flow Program to secure substantial flow protection at high elevations throughout the basin. As stream-flow protections have increasingly focused on lower elevation streams that are below stored water and communities, instream flow appropriations have become more complex and challenging.

Agriculture and ranching have, for many generations, prevailed in the lower elevations of La Plata, Montezuma, Dolores, San Miguel, and Montrose Counties. Tourism and recreation have become more established in the region as the Animas, Piedra, Dolores, and San Miguel Rivers offer both fishing and rafting opportunities along with flat-water recreation on the region's many reservoirs.

This multiple-basin area of the state is extremely diverse and is experiencing changing demographics:

- The Pagosa Springs-Bayfield-Durango corridor is rapidly growing while experiencing areas of localized water shortages. This area is transitioning from oil and gas, mining, and agricultural use to tourism and recreation use, and to a retirement or second-home area.
- The Cortez and Dove Creek area remains strongly agricultural, supplemented by energy production, but it is also seeing growth with an increase in retirees who are moving to the area.
- The San Miguel area shows a mix of recreation and tourism activities, along with a strong desire to maintain agriculture in the western part of the county.

As a result of numerous storage projects built primarily to supply irrigation water, water supply

The Bridal Veil Falls, near Telluride, is the tallest free falling waterfall in Colorado at 365 feet. The falls entice many people to hike, bike or four-wheel drive up the road.

Students studying the aquatic ecosystem along the San Miguel River near Placerville. Photo: M. Nager.

is available in the Southwest Basin. Several of these storage projects have been able to allocate or carve out small amounts of M&I water to supply domestic growth. Resulting revenues from M&I sales are being re-invested in delivery system efficiencies that will yield the water necessary to meet future M&I needs without diminishing agricultural deliveries. The remaining challenge is the development of sufficient infrastructure to deliver M&I water where it is needed. There is also a need for new storage to meet long-term supply requirements in the Pagosa Springs area, as well as in Montrose County.

The Southwest Basin Roundtable takes very seriously the need to make a strong commitment to balancing a vibrant agricultural sector with healthy streams to support environmental and recreational values. In keeping with this philosophy, the Southwest Basin is organizing a list of Identified Projects and Processes (IPPs) by sub-basin. By addressing agricultural, municipal, industrial, environmental, and recreational values and needs, the IPP approach is intended to reveal opportunities for multi-benefit projects that address water supply gaps.

South Platte River Basin

Basin Description: The South Platte River Basin is the most populous basin in the state. Per SWSI 2010, the South Platte Basin population may nearly double from about 3.5 million people to 6 million people by 2050. Approximately 85 percent of Colorado's population resides in the South Platte Basin, and the Front Range area of the basin is Colorado's economic and social engine. The South Platte River Basin also has the greatest concentration of irrigated agricultural lands in Colorado.

The topographic characteristics of the South Platte River Basin are diverse. Its waters originate in the mountain streams along the Continental Divide in the northern portion of the Front Range. The river emerges from the mountains southwest of Denver and travels north through the Denver area, where numerous tributaries, such as Cherry Creek, Clear Creek, Coal Creek, Boulder Creek, St. Vrain Creek, the Big Thompson River, and the Cache La Poudre River join the South Platte before crossing northeast across the High Plains. The western portions of the basin and its mountainous and subalpine areas are mostly forested, while the High Plains region is mainly grassland and planted or cultivated land. Approximately one-third of the South Platte Basin land area is publicly owned, and most of these lands are situated in the forested mountains. The South Platte River crosses the Colorado Nebraska state line near Julesburg and merges with the North Platte River in southwestern Nebraska to form the Platte River.

The hydrology of the South Platte Basin is highly variable, with an approximate average-annual native-flow volume of 1.4 million acre-feet. About 400,000 acre-feet of TMDs from the Colorado River Basin and approximately 100,000 acre-feet from the Arkansas, North Platte and Laramie River Basins supplement the water supply in the South Platte Basin. In addition, these basins pump more than 30,000 acre-feet from nontributary groundwater aquifers to supplement supplies. Yet, surface-water diversions in the South Platte Basin average about 4 million acre-feet annually, with groundwater withdrawals totaling an additional annual 500,000 acre-feet on average. The amount of diversion in excess of native-flow highlights the return flow-dependent nature of the basin's hydrology, and the basin-wide efficient use and reuse of water supplies. On average, only 400,000 acre-feet of water leaves the basin.

The Platte River Recovery Implementation Program (PRRIP) and the Upper Colorado River Endangered Fish Recovery Program provide limited ESA coverage for program participants. Participation in these programs protects existing uses and allows continued water development.

Coors Field, home of the Colorado Rockies, in Denver. Photo: G. Malowany.

Center pivot irrigation waters the fields at Sakata Family Farms in Brighton. Photo: M. Nager.

Basin Challenges: The South Platte Basin is Colorado's most economically diverse basin. Urban sector businesses and industries within the South Platte Basin provide for most of the state's overall economy, and agricultural production is the highest among basins across Colorado. This basin also supports a wide range of ecological systems and important water-dependent ecological and recreational attributes. Thanks to the basin's many environmental features, Coloradans and tourists regularly take advantage of the South Platte's recreational opportunities, including skiing, boating, fishing, and wildlife viewing and hunting. Willing water transfers from the agricultural sector to the M&I sector have proven reliable, although the State views these as unsustainable if the South Platte and the State of Colorado continue to diversify their economy as the population continues to grow. The challenge of preserving the M&I, agricultural, and recreational economies as well as the basin's environmental features makes water management in the South Platte Basin especially complex. Several of the complexities include:

- Accounting for 85 percent of total water diversions, agriculture is the dominant water use in the basin. Agricultural transfers, or conversion of agricultural water to M&I uses, will continue to be an important option for meeting future M&I needs, especially in those areas where agricultural land will be urbanized. However, agricultural transfers are likely to have negative effects on rural communities, open spaces, wetlands, and recreation areas that are tied to irrigated lands. Loss of irrigated agricultural lands will negatively affect the local economy and the state's economy, as well as the state's food security.
- Competition for additional M&I water supplies is substantial, and in some cases, multiple M&I suppliers have identified the same water supplies as future water sources. Competition increases the costs to M&I customers, and competition for the same water supplies could result in the chance that some M&I suppliers will lack sufficient water in the future.
- A substantial amount of the basin's water supply originates in the Colorado River Basin. As such, compliance with the Colorado River Compact, and efforts to avoid a compact curtailment, are critical to the South Platte Basin.

- Notwithstanding the recent construction of Reuter-Hess Reservoir, the lack of new major water storage in recent decades has led to reliance on non-renewable groundwater in Douglas and Arapahoe Counties. Strong economic and population growth in these counties, coupled with the lack of surface-water supplies, has led to the need to develop renewable surface-water supplies and additional water storage for the south metro area.
- Conjunctive use of surface water and alluvial groundwater, as well as use of alluvial aquifers for storage, offer opportunities to expand sustainable water use. Aquifer storage is generally considered to have fewer environmental effects, and water stored in alluvial aquifers is not subject to evaporation losses. Aquifer storage poses control and administrative issues that state agencies and water managers will need to address to ensure that other water rights are not injured.
- Water quality will continue to be a challenge as entities divert more water for use and as point and non-point sources discharge to the basin's waters. The salt content of soil and water in the South Platte River Valley, and sedimentation and erosion in parts of the basin, are likely to continue to increase over time, which will negatively affect the ability to use this water for agricultural and M&I purposes. Technological solutions are expensive and non-sustainable because of high energy demands and environmental issues associated with disposal of concentrated treatment residuals.
- The South Platte Basin is leading the state in M&I water-use efficiency. Efficient use of the basin's resources through water reuse and conservation is a critical step toward meeting future water needs. Nevertheless, increased M&I water-use efficiency will reduce the quantity of water available for agricultural and ecological practices and other uses, because M&I return-flows will diminish.
- The urban environment is an important component of the quality of life for many South Platte Basin residents. Judgments about the value of the urban environment, including both the need to provide water for irrigated landscape and the vital benefits that landscape provides to citizens and the environment, make the discussions about water supply development needs all the more difficult.
- The environmental and recreational features within the basin, including amenities such as mountain streams and rivers for fishing and rafting, city green ways, flatwater reservoirs, wetlands, and open space, are all extremely important to Colorado's tourism economy and quality of life for the state's residents.

The joint BIP, completed in partnership with the Metro Basin Roundtable, identifies specific projects and methods needed for meeting the future water needs of the South Platte Basin.

Republican River Basin

Basin Description: The Republican River Basin in Colorado is located on the Northeastern High Plains. The headwaters of the North Fork and South Fork of the Republican River, as well as the Arikaree River, originate in the Northeastern High Plains of Colorado near Wray, Cope, and Seibert, respectively. The Republican River is formed by the confluence of the North Fork of the Republican River and the Arikaree River just north of Haigler, Nebraska, while the South Fork of the Republican joins just southeast of Benkelman, Nebraska. Other major drainages within the Republican River Basin include Frenchman Creek, Beaver Creek, and Red Willow Creek. The Republican River Basin in Colorado encompasses approximately 7,760 square miles, which represents 31 percent of the total Republican River Basin located in Colorado, Nebraska, and Kansas.

The topographic characteristics of the Republican River Basin, which are similar to the High Plains region of the South Platte River Basin, consist mainly of grassland and planted or cultivated land. The Republican River Basin in Colorado is underlain by the High Plains or Ogallala aquifer, which is one of the largest water bodies in the United States, extending from South Dakota to Texas.

Arikaree River wetland habitat. The Arikaree is a tributary to the Republican River.

In 2004, the General Assembly established the Republican River Water Conservation District to cooperate with and assist Colorado regarding compact compliance. The Republican River Water Conservation District recently completed the construction of the Republican River Compliance Pipeline to assist in compact compliance.

Administration of surface water in the Republican River Basin is separate from groundwater administration. The water courts have judicial authority regarding surface-water rights, whereas the Colorado Ground Water Commission has regulatory and adjudicatory authority regarding the management and control of designated groundwater. Much of the Republican River Basin lies within the Northern High Plains Groundwater Management District.

Basin Challenges: The Republican River Basin will face several key issues and challenges pertaining to water management over the next 40 years. These challenges and issues are as follows:

- Republican River Compact compliance.
- Depletions to the Ogallala Aquifer. These depletions continue to reduce the amount of readily available water supplies for the agricultural economy in the basin. In some cases, this presents feasibility issues related to providing adequate water supplies for crop irrigation or, in some cases, providing no water supply.
- The continuation of detailed coordination and communication among multiple water-rights and administrative authorities, including the Colorado Ground Water Commission, Department of Water Resources, Ground Water Management Division, and Colorado Water Court, among others.

North Platte River Basin

Basin Description: The North Platte River Basin, also known as North Park, is a high-altitude valley covering about 2,000 square miles in north-central Colorado, adjacent to Wyoming. The basin includes all of Jackson County and the small portion of Larimer County that contains the Laramie River watershed.

Both the North Platte and Laramie Rivers flow north into Wyoming, and are subject to use-limitations stemming from Supreme Court decrees. Water use in the basin is dominated by irrigated pastures associated with ranching operations. More than 400 irrigation ditches divert water from the mainstem and the numerous tributary streams throughout the basin. Total irrigated acreage in the basin, based on 2001 estimates, is approximately 116,000 acres. The basin exports a portion of North Platte water to the Front Range via Michigan Ditch and Cameron Pass Ditch which, together, divert about 4,500 acre-feet per year out of the basin. The basin also contains a major wildlife refuge in addition to numerous public lands and the recreational opportunities they offer.

North Platte River near Cowdry. Photo: M. Nager.

The Three State Agreement of the PRRIP governs water use in the basin, and water use is tied to endangered species-recovery efforts on the Platte River in Central Nebraska. The agreement employs a "one-bucket concept" for the North Platte Basin of Colorado, which currently limits water use in the basin to depletions associated with the irrigation of up to 134,467 acres, while allowing for flexibility in the type of water use.

Basin Challenges: The North Platte River Basin will face several key issues and challenges pertaining to water management over the next 40 years. These include:

- Maintaining compliance with the equitable apportionment decrees on the North Platte and Laramie Rivers. The decrees quantify the amount of available water and lands that can be irrigated.
- Increasing economic development and diversification through strategic water use and development.
- Continuing to restore, maintain, and modernize critical water infrastructure to preserve current uses and increase efficiencies.
- Gaining knowledge of the basin's consumptive uses and high-altitude crop coefficients.
- Quantifying and strategically developing available unappropriated waters within the basin.
- Successfully resolving endangered species issues on the Platte River in Central Nebraska through the PRRIP in a manner that does not put pressure on water users to reduce existing uses.
- Maintaining healthy rivers through the strategic implementation of projects that meet prioritized nonconsumptive needs.
- Promoting water-rights protection and management through improved streamflowgauging data.
- Enhancing forest health and management efforts for wildfire protection and beetle-kill effects.

Rio Grande Basin

Basin Description: The Colorado portion of the Rio Grande drainage basin is located in south-central Colorado and encompasses less than 10 percent of the state's land area, or approximately 7,700 square miles. The San Juan Mountains to the west, the Sangre de Cristo Range to the north and east, the Culebra Range to the southeast, and the Colorado-New Mexico state line to the south define the boundaries of the Rio Grande Basin within Colorado. Between the San Juan Mountains and the Sangre de Cristo Mountains lies the San Luis Valley, a principal feature of the Rio Grande Basin, with an average elevation of 7,500 feet and precipitation of less than eight inches per year.

Basinwide, land is evenly divided between public and private ownership. Nevertheless, most of the land in the San Luis Valley is privately owned. The primary use of more than 600,000 acres of irrigated land is for agricultural purposes in the central portion of the basin, and producers in the valley are the second-largest provider of fresh potatoes in the United States. Non-irrigated areas in the valley are mostly classified as shrubland (24 percent) and grassland (31 percent). The

Sandhill cranes "dancing" in the Rio Grande basin. Monte Vista hosts a crane festival every spring.

A potato farm in the San Luis Valley, where agriculture has long been the basis of the economy. Other principal crops grown in the Rio Grande Basin are alfalfa, native hay, barley, wheat, and vegetables like lettuce, spinach and carrots.

San Juan and the Sangre de Cristo Mountain ranges are largely forested. The northern one-third of the basin is considered a "closed basin" and does not contribute any surface-flows to the Rio Grande.

Interstate compacts and international treaties affecting water use in the Rio Grande Basin include the Rio Grande, Colorado, and Tijuana Treaty of 1945 between the U.S. and Mexico; the Rio Grande Compact of 1938; and the Amended Costilla Creek Compact of 1963. In particular, the Rio Grande Compact establishes Colorado's obligations to ensure delivery of water at the New Mexico state line and New Mexico's obligation to ensure delivery of water at Elephant Butte Reservoir, with some allowance for credit and debit accounts. The compact dictates that obligations be calculated based on the amount of flow at indexed stations, which then determine the amount of flow that must be delivered to the downstream states during that year. The Rio Grande Compact established the Rio Grande Compact Commission to administer the terms of the agreement. The commission consists of one representative from each state and a non-voting federal representative.

Basin Challenges: The Rio Grande Basin will face several key issues and challenges related to water management and needs over the next 40 years. These include:

- The Rio Grande Compact and the effects of sustained drought make the objective of sustainability difficult.
- Groundwater use for agriculture is currently at unsustainable levels.
- Economic effects of reduced irrigation use based on groundwater supplies will be difficult, but working on community-based solutions offers the best hope of minimizing the effects.
- Residential growth, primarily in the form of second homes and vacation homes (especially in the South Fork area) is creating a need for additional water supplies.
- Groundwater is a key component of water use in the basin for both M&I and agriculture. Groundwater management presents an ongoing challenge.

Basin Implementation Plan Themes

Throughout the BIP process, roundtables engaged in public outreach activities, technical outreach with basin entities, and a series of discussions regarding the priorities and values within the respective basins. While the BIPs outline projects and methods by which water supply needs may be met, they also serve as an up-to-date summary of issues of concern and greater water policy management themes within each basin. The following section presents some of the major themes each draft BIP identified. Chapter 6 discusses in more detail the goals and measurable outcomes each roundtable generated, along with projects and methods they identified. The discussion in this chapter is limited to major themes and points of consideration that guide the work of the roundtables.

Arkansas Basin

A major emphasis of the Arkansas Basin Roundtable was a public outreach program that aspired to reach all corners of the basin. The roundtable held a series of public meetings and provided information about Colorado's Water Plan and the BIP process. In addition to these public meetings, the annual Arkansas River Basin Water Forum served as a point for receiving major input into the BIP. [2]

> "The roundtable first identified 'the interdependence of all water usage types,' recognizing the connections among agricultural use, environmental and recreational uses, and the effects of M&I supplies."

The roundtable identified several important points of consideration that underpin the BIP document. These points represent the major challenges and opportunities the roundtable faces in planning for the water supply future of the Arkansas basin. The roundtable first identified "the interdependence of all water usage types," recognizing the connections among agricultural use, environmental and recreational uses, and the effects of M&I supplies.[3] As an importing and exporting basin, the roundtable faces complex hydrology, and faces the complicated administration of water the *Kansas v. Colorado* lawsuit mandated. Moving forward, declining levels of groundwater, in addition to the demand for augmentation water, will represent a major challenge to basin users.[4]

Recognizing the variety of needs and capacities of water providers and municipalities, the BIP process has also continued robust discussions regarding conservation within the basin. On the heels of a year in which Colorado saw record wildfires, drought, and floods, the roundtable also formed the Watershed Health Working Group, which brought together stakeholders to discuss the ways in which agencies and affected parties can collaborate before, during, and after such natural disasters.[5]

During the public outreach process, the roundtable solicited input forms to gather basin residents' ideas and concepts related to projects or methods.[6] As part of the roundtable's organization of basin needs, projects, and methods, the roundtable created a comprehensive database. Projects that met a basin need were categorized within the database as follows:

- All Input List
- Preliminary Needs List
- Master Needs List
- IPP List

The All Input List is the most comprehensive, and includes the Preliminary Needs, Master Needs, and IPP Lists. The IPP List is the most narrow, with a more rigorous definition of IPP as the CWCB defines it in the SWSI.[7] The roundtable also commissioned the creation of a Simplified Water Allocation Model, which demonstrates at a large scale water availability and potential future shortages, with an eye toward future demands.[8] The creation of the project database, and this high-level model, are useful tools for future planning efforts in the basin, as well as for the roundtable's evaluation of projects and methods.

The Arkansas BIP is available here.[9]

Colorado Basin

In the creation of the BIP, the Colorado Basin Roundtable looked within the basin's boundaries to enumerate the projects and processes by which stakeholders plan to meet future water needs. The roundtable conducted interviews with water providers and provided information about identified projects or methods.[10] This process resulted in a comprehensive list of ongoing and planned efforts within the basin—the first aggregation of its kind. The roundtable organized projects and methods, as well as overarching concerns and challenges, by subregion within the BIP.

The roundtable also articulated a set of prevailing basin themes that reflect the concerns of basin stakeholders and roundtable members. Within the Colorado Basin, a major concern is the development of a new transmountain diversion (TMD), beyond the diversions the Colorado River Cooperative Agreement addresses.[11] Concerns regarding the Colorado River Compact, as well as issues regarding environmental health within the mainstem and tributaries, drive this theme. The BIP identifies the relationship among various water uses, and the potential negative effects to uses resulting from overdevelopment of the river.

"Within the Colorado Basin, a major concern is the development of a new transmountain diversion, beyond the diversions the Colorado River Cooperative Agreement addresses. Concerns regarding the Colorado River Compact, as well as issues regarding environmental health within the mainstem and tributaries, drive this theme."

As a result of the public input process and roundtable discussion, the roundtable identified six themes representing the overarching messages of basin stakeholders. The themes are as follows:

1. Protect and restore healthy streams, rivers, lakes, and riparian areas.
2. Sustain agriculture.
3. Secure safe drinking water.
4. Develop local water-conscious land-use strategies.
5. Assure dependable basin administration.
6. Encourage a high level of basinwide conservation.[12]

Within each theme, the roundtable identified potential actions and strategies to address these areas. For example, the roundtable suggested a Stream Management Plan as a path toward achieving the first theme, and identified major water rights, such as the Shoshone Hydroelectric Plant, as crucial to meeting the fifth theme.[13]

The BIP was divided into several sections that each focused on a different subregion within the greater basin. Within each subregion, the roundtable identified concerns and challenges within the greater context of the basinwide themes. Roundtable members took a closer look at identified projects and methods within the subregions, including identifying a few representative "Regional Top Projects" that meet basin themes and the criteria the subregion stakeholders proposed.[14] The roundtable examined in more detail these top projects, and developed project information sheets about project proponents and the basin needs these projects and methods seek to meet.[15] Looking forward, roundtable members have identified several future actions. These include supporting the implementation of stream management plans basinwide, and a modeling effort to gain greater understanding of potential larger-scale hydrologic effects on the basin.

The Colorado BIP is available here.[16]

Gunnison Basin

The Gunnison Basin Roundtable began with one primary goal: "Protect existing water uses in the Gunnison Basin."[17] From this foundation, the roundtable established eight additional complementary goals and six statewide principles.[18] The roundtable completed targeted, technical-outreach activities throughout the basin, with the goal of identifying ongoing and planned projects and methods. Additionally, the roundtable built upon previous public outreach and education efforts, ensuring that the established goals and principles reflected the concerns of basin citizens and stakeholders.

The roundtable selected projects and methods by highlighting those that met or reflected the concerns and priorities of basin goals, and further sorted them according to their implementation schedule. The roundtable then identified those that were "likely feasible by 2025" and represented an "excellent job of meeting basin goals," and classified them as Tier 1 projects.[19] These projects and methods are intended to provide solutions to basin water needs as enumerated within the BIP, and include agricultural shortages, M&I needs, and environmental and recreational needs.

"...the roundtable built upon previous public outreach and education efforts, ensuring that the established goals and principles reflected the concerns of basin citizens and stakeholders."

For the benefit of other roundtables and Colorado's Water Plan, the BIP identifies statewide principles that communicate the roundtable's position on interbasin issues in Colorado. As part of the Colorado River system, the statewide principles include a few points regarding the development of water supply from that system. The Gunnison Basin Roundtable primarily emphasizes the variability of Colorado River supply, as well as the importance of the prior appropriation system to protecting existing uses from adverse effects.[20] Additionally, the statewide principles advocate for local solutions to water needs and the equitable application of conservation strategies.[21]

The Gunnison BIP also includes several basin evaluations of hydrologic modeling and mapping of potential projects and methods, as well case studies in water management.[22] The modeling exercise aided an assessment of water availability under current hydrology and legal administration. The major emphasis of this BIP is the identification of projects and methods, and the relationships among these proposed projects and basin goals. To that end, the roundtable recommends a path to implementation that takes into consideration "securing project acceptance and demonstrating project feasibility."[23]

The Gunnison BIP is available here.[24]

North Platte Basin

The North Platte Basin Roundtable identified eight basin goals, which reflected the basin's unique water management challenges and values. The projects and methods this roundtable identified must operate within two major legal frameworks as expressed in the basin goals: "Maintain and maximize the consumptive use of water permitted in the Equitable Apportionment Decree and the baseline depletion allowance of the Three State Agreement."[25] Within these boundaries, the roundtable identified further goals, and ongoing public outreach and education efforts helped to further inform those goals.

> "...the roundtable recognizes the benefits that agricultural uses provide to environmental and recreational attributes, such as healthy rivers and wetlands."

Of primary importance in the North Platte BIP is the maintenance of agricultural uses within the basin. Basin goals reflect this concern, as they identify the need to strategically develop water while maintaining and upgrading existing critical infrastructure. Additionally, the roundtable recognizes the benefits that agricultural uses provide to environmental and recreational attributes, such as healthy rivers and wetlands.[26] The BIP also articulates statewide issues, advocating for the management of forest health through wildfire and beetle-kill efforts, as well as the "equitable statewide application of municipal water conservation."[27]

The North Platte Basin Roundtable also used hydrologic modeling and mapping to provide a technical assessment of the effect of projects and methods within the greater basin. Through these basin evaluations, roundtable members were able to gauge the feasibility of particular identified projects and methods, and identify situations in which the implementation of multiple projects or methods would present a challenge.[28]

The North Platte Basin Roundtable chose to address its basin goals through the identification of projects and methods that meet identified needs and concerns. In its analysis of projects, the roundtable determines which specific basin goals each project may address, and generally outlines potential challenges to implementation. The roundtable also provides a list of planned environmental and recreational projects, which address specific attributes the roundtable has identified as important to basin citizens and stakeholders.

The North Platte BIP is available here.[29]

Rio Grande Basin

The Rio Grande Basin Implementation Plan provides an in-depth look at the basin's issues and proposed solutions, beginning with a comprehensive overview of the basin itself. The plan discusses processes for Colorado's Water Plan and the Basin Water Plan, with an explanation of the Rio Grande Basin's unique challenges and subcommittee approach to BIP development. The overview includes an analysis of factors that affect water management, including geography, the history of development, and legal frameworks, such as the Rio Grande Compact and the administration of water rights.[30] This overview provides a backdrop for the parts of the plan to follow, and describes the landscape in which the plan intends to establish solutions for water management challenges.

> "Modeling-efforts and scenario-planning support the goals and their accompanying measurable outcomes, with the vision of preventing 'harm to existing water rights while maximizing Colorado's entitlement under the Rio Grande and Costilla Creek compacts.'"

The plan defines goals and measurable outcomes, which the roundtable's public outreach process and discussions at the roundtable level helped inform. The goals seek to address the basin's key attributes, which are defined as "a resilient agricultural economy, watershed and ecosystem health, sustainable groundwater resources, the encouragement of projects with multiple benefits, and the preservation of recreational activities."[31] Modeling efforts and scenario planning support the goals and their accompanying measurable outcomes, with the vision of preventing "harm to existing water rights while maximizing Colorado's entitlement under the Rio Grande and Costilla Creek compacts."[32] The plan further explores the goals by identifying the particular water needs each goal meets, whether goals are related to agricultural, M&I, environmental and recreational, or water administration needs.[33] The plan discusses the needs, analyzes how these needs interrelate, and looks to the future of each sector.

After setting the stage with the basin overview and the goals, the plan explores solutions. It examines the projects and methods and compares them to the list of basin goals. It then selects for review certain projects that meet multiple basin goals, and summarizes them in a project fact sheet.[34] The fact sheet provides a closer look at the project, supplying information such as project proponent, estimated budget, and an indication of which basin goals the project meets. The plan also provides an estimate of funding needs for these identified projects and includes a list of projects that meet environmental and recreational information gaps, paving the way for more-informed project identification in the future.[35]

After project and method identification, the plan examines the means by which implementation may be possible. First, the plan summarizes the roundtable's outreach and educational efforts, and includes a plan for future efforts. Then, it discusses strategies for implementation.[36] These strategies include stakeholder involvement, future modeling improvements, and cooperative in-basin water management efforts.[37] The roundtable intends for the Rio Grande Plan to remain a living document, and will provide updates and additions that offer meaningful input into the basin's water management future.

The Rio Grande BIP is available here.[38]

South Platte Basin and Metro Basin

Recognizing the common geography and pertinent issues shared by the South Platte and Metro Basin areas, these two roundtables chose to work together on a BIP. In preparing the BIP, both roundtables sought to provide a reference for other basin roundtables, as well as stakeholders statewide, regarding the challenges and opportunities present in the South Platte Basin. Facing future challenges related to population growth, a wide variety of water needs, and numerous constraints, the roundtables plan to find solutions balancing these hurdles. The roundtables identified the following challenges for the water supply future: Limited native supply, groundwater and aquifer administration and management, interstate water commitments, project-permitting concerns, environmental and recreational values, and water quality issues.[39]

With this host of challenges, the roundtables recognized that they must carefully craft and select solutions that maximize benefits and use. To that end, the roundtables have identified three major assessment guidelines:

1. Minimize adverse impacts to agricultural economies.
2. Develop new, multipurpose projects that either offset transfers from agricultural uses or provide additional water to reduce current agricultural shortages.
3. Proactively identify and implement methods to protect and enhance environmental and recreational water uses.[40]

Additionally, in preparing for future needs, the roundtables have incorporated the "four legs of the stool" approach the IBCC posed. This approach consists of conservation and reuse, IPPs, agricultural transfers, and new Colorado River supplies.[41] Specifically, the BIP lists 11 implementation strategies. These strategies mostly follow the "four legs of the stool" discussion, with a focus on maximum implementation of IPPs, as well as the advancement of conservation and reuse efforts.[42] Other strategies address the maximization of

native-basin supplies while using alternative-transfer methods to minimize traditional buy-and-dry of agricultural lands for municipal supply.[43] Regarding transmountain diversions, the roundtable advocates the following action: "Simultaneously advance the consideration and preservation of new Colorado River supply options."[44]

> "...in preparing for future needs, the roundtables have incorporated the 'four legs of the stool' approach the IBCC posed. This approach consists of conservation and reuse, IPPs, agricultural transfers, and new Colorado River supplies."

The roundtables believe that this suite of strategies is the best approach to meet the basin's varied needs while addressing the identified challenges. Looking to the future, the roundtables evaluated three representative portfolios, each portraying a different vision of future South Platte/Metro supply and demand, in order to demonstrate the challenges inherent in meeting future needs while maintaining basin values.[45] The roundtable also identified conceptual projects for which there are no current project proponents; the roundtable members believe these conceptual projects offer a good demonstration of the intent of the basin implementation strategies.

The South Platte BIP is available here.[46]

Southwest Basin

Through the BIP process, the Southwest Basin Roundtable sought to address the basin's many complexities, including the existence of nine sub-basins, various compacts and treaties, and the disparate interests of stakeholders within that corner of Colorado.[47] Agricultural, M&I, environmental, and recreational needs all play a role in the Southwest Colorado landscape, and the roundtable seeks to address them with equal attention throughout the BIP process.

The Southwest Basin Roundtable has expressed concern regarding new development of the Colorado River system as part of a new transmountain diversion.[48] Compact concerns, as well as potential future needs within the Southwest Basin itself, underpin the development issue. To that end, the roundtable has set forth eight factors to consider before development occurs, as well as communicates a commitment to remain involved in statewide discussions on the matter. Interwoven with these transmountain diversion policies is a commitment to higher levels of conservation for water providers receiving any new diversion.[49]

> "The BIP specifies that 'the roundtable encourage and support creative solutions sought through collaborative efforts' regarding federal policies and actions, as well as tribal water rights.."

The roundtable also identifies interaction between state and federal entities as a key concern and opportunity. The BIP specifies that "the roundtable encourage and support creative solutions sought through collaborative efforts" regarding federal policies and actions, as well as tribal water rights.[50] Recognizing the importance of environmental and recreational attributes within the basin, the roundtable has emphasized a greater understanding of the water needs toward maintaining these values, and identified two methods for addressing the need for data and assessment.[51]

The Southwest Basin Roundtable undertook an ambitious public outreach process to solicit input from basin stakeholders. Resulting from this public outreach and roundtable discussions, the Southwest Basin Roundtable adopted 21 goals and 30 measurable outcomes[52] and took an aggressive approach to listing newly identified projects and processes. It identified 80 new projects and methods, bringing the total list of IPPs for all sub-basins to about 160 proposals geared toward meeting future water needs.[53]

The Southwest BIP is available here.[54]

Yampa/White/Green Basin

The Yampa/White/Green Basin Roundtable views the BIP process as an opportunity to articulate stakeholder viewpoints from northwest Colorado, and to inform ongoing statewide discussions and Colorado's Water Plan process.[55] To that end, the roundtable encourages dialogue at the roundtable level and, in the public outreach process, set a vision for the basin moving forward. This basin vision includes an assessment of meeting in-basin future needs at the M&I, agricultural, and environmental and recreational levels. The roundtable also examines the Yampa/White/Green Basin's role within Colorado and establishes statements of policy on interbasin and interstate concerns.

Of key concern to the roundtable is the basin's role in

the Colorado River system. The roundtable emphasizes the role of the Colorado River Compact and the competing needs of "downstream states, the needs of the urbanized eastern slope of Colorado, and its own in-basin needs."[56] As such, the roundtable advocates for an "equitable allocation of native flow in the Yampa, White, and Green Rivers to meet existing and future in-basin water demands, including PBO depletion allowances."[57] Chapter 8 of this plan discusses this concept in more detail.

> "The primary goal of the roundtable is to ensure the 'maintenance and protection of historical use in the Yampa/White/Green Basin as well as the protection of water supplies for future in-basin demands.'"

The primary goal of the roundtable is to ensure the "maintenance and protection of historical use in the Yampa/White/Green Basin as well as the protection of water supplies for future in-basin demands."[58] To that end, the roundtable members identified eight primary basin goals.[59] Within those goals, the roundtable seeks to address potential shortages and improve the current infrastructure, with an emphasis on water quality and nonconsumptive uses.[60]

The roundtable integrated ongoing studies into the BIP process, and used its 2014 Projects and Methods Study to analyze potential water supply solutions under various hydrologic scenarios. The study and the BIP outreach process resulted in the creation of a list of potential projects and methods within the basin, as well as an analysis of water availability, including implementation of identified projects and processes and their effects on nonconsumptive values.[61] Moving forward, the roundtable will continue to refine ongoing studies, seek additional projects and methods, and continue outreach and education efforts it initiated within the basin.[62]

The Yampa/White/Green BIP is available here.[63]

Conclusion

As this brief overview demonstrates, each basin features its own remarkable opportunities as well as its own distinct challenges that make planning for Colorado's water future difficult. Solutions will affect not only one basin, but basins throughout Colorado. Although unique issues and concerns characterize each area, Colorado's water future connects every region statewide. Every basin grapples with drought, interstate compacts and agreements, growing populations, important environmental and recreational values, and sustainable agriculture. Due to the fact that there are so many shared interests across the state, all stakeholders must continue working together to collectively solve Colorado's water supply gaps, so that the Colorado we all value can continue to flourish.

The Colorado River, flowing just south of Byers Canyon. Photo: M. Nager.

A LOOK AT HISTORY

1877 historic drainage [basin] map of Colorado.

source: Justice Gregory Hobbs' personal collection.

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