Water Supply Management

Chapter 6 discusses the dynamic strategy Colorado envisions to meet its future water needs—including the types of projects and methods Colorado needs, and the actions it requires, to implement them. Scenario planning provides the framework for this strategy, and indicates what Colorado must accomplish in the short term in order to best balance tradeoffs among meeting future municipal needs, agricultural viability, and the health of Colorado's rivers and streams.

Section 6.1 and Section 6.2 provide information to help assess how close Colorado is to realizing this strategy. They also discuss the remaining municipal, industrial, agricultural, environmental, and recreational water gaps, and the methods by which basins propose to address those gaps.

Demand management strategies, such as conservation and reuse, will help address Colorado's growing demands while upholding our state's water values. Section 6.3 looks at various ways to use water efficiently and reduce water demands. Water sharing is worth special attention as an alternative method for effectively reducing the permanent dry-up of Colorado's irrigated lands. Section 6.4 discusses opportunities to share water between agricultural and municipal or environmental and recreational interests. These sections, as well as Sections 6.5 and 6.6, provide a summary of projects, methods, and policies the basin roundtables identified as necessary for meeting Colorado's future water needs. Section 6.5 focuses on the types of initiatives, projects, and methods that will support Colorado's cities and towns and ensure agriculture that remains viable into the future. Section 6.6 details the initiatives, projects, and methods needed to support the environment and river-based recreation.

Planning for Colorado's water future presents many challenges and opportunities, and this chapter demonstrates the variety of ways in which stakeholders at the state and local levels are collaborating to address these important issues.

Kayakers in Salida, including several children, enjoying the benefits of the Arkansas River's Voluntary Flow Management Program,which balances benefits across multiple needs.

6.1 SCENARIO PLANNING AND DEVELOPING AN ADAPTIVE WATER STRATEGY

GOAL

Colorado's Water Plan considers a range of possible future conditions. Through public engagement and sound science, the plan develops a practical, adaptive, and balanced path forward for meeting Colorado's future water needs.

The purpose of scenario planning is to develop strategies to meet Colorado's future water needs that are based on the best available science as well as input from stakeholders. Section 6.1 broadly describes what is required to meet our state's future needs over the next 10 to 15 years and prepare for a broad range of possible futures. Scenario planning also provides the opportunity to consider Colorado's water values and build portfolios of solutions. The state needs conservation, reuse, completion of planned projects, and development of alternative agricultural transfers in the near term. At the same time, Colorado must prepare for the possibility of further agricultural transfers, an additional TMD as Chapter 8 describes, and even higher levels of conservation to meet future M&I needs—while concurrently implementing environmental and recreational projects and continuing to support agriculture.[1]

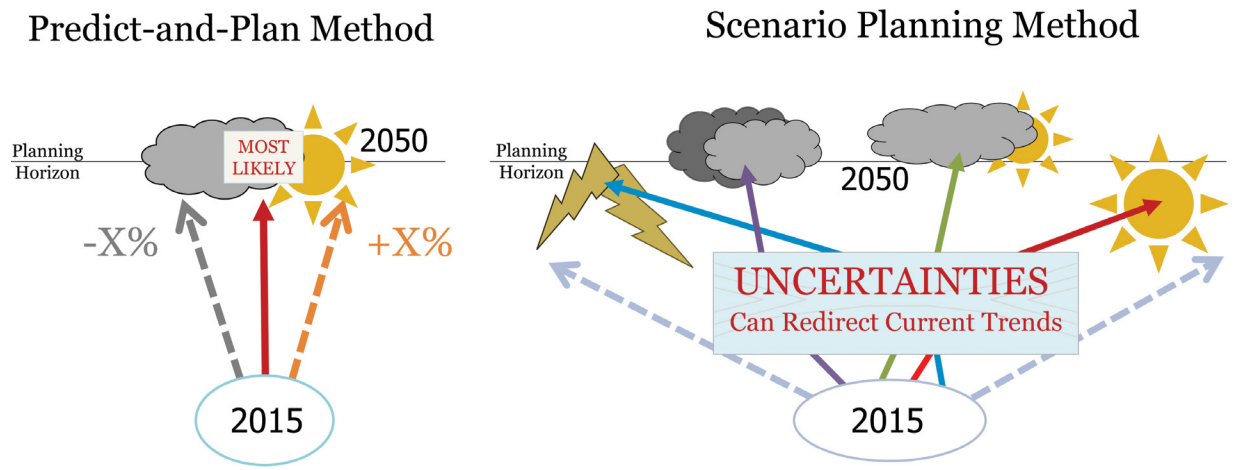
Rather than trying to predict the future by looking at the past, scenario planning allows us to identify and account for key uncertainties.

The elements of Colorado's adaptive strategy arose from significant technical work and the early and ongoing engagement of stakeholders. In developing Colorado's Water Plan, the CWCB, basin roundtables, and the IBCC adopted the scenario planning process to initiate a conversation among stakeholders about planning for uncertainties and emerging water resource challenges.[2] These groups worked together to explore how to meet the increasing water needs of Colorado's growing communities while balancing water interests.[3] Of particular concern, Colorado must contend with the significant and growing municipal water needs by 2050.[4] Scenario planning helps answer questions about how much water Colorado may need in the future, how much water may be available to meet our state's future needs, and what sources of water supply future generations will support. Subsequent sections in Chapter 6, as well as Chapter 8, provide details about ways in which Colorado can employ the scenario planning approach to more specifically respond to an uncertain future.

Scenario Planning: *Planning for Multiple Futures*

Given the uncertainties of future water supply and demand, the CWCB adopted a planning approach that many major water providers across the West use: scenario planning.[5] The use of scenario planning assumes that the future is unknown and provides flexibility in responding to various future conditions.[6] Rather than trying to predict the future by looking at the past, scenario planning allows the CWCB and stakeholders to identify and account for key uncertainties operating within the planning period (Figure 6.1-1).

FIGURE 6.1-1 THE TRADITIONAL "PREDICT-AND-PLAN" APPROACH COMPARED TO THE SCENARIO-PLANNING APPROACH

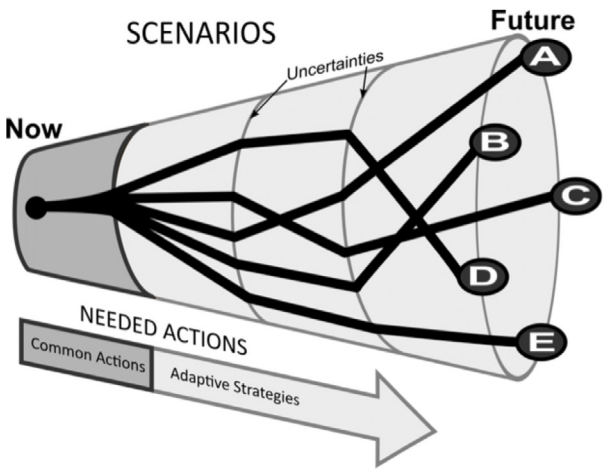


Adapted from Global Business Network, 2012 & Marra, 2013[7]

Scenario planning relies on several key driving forces in order to build multiple plausible futures (i.e., scenarios), whereas, by contrast, the more traditional "predict-and-plan" approach develops the most probable future. The IBCC and basin roundtables worked in partnership with the CWCB to explore the implications of multiple plausible futures. Given the unpredictability of factors driving Colorado's future, such as climate change, economic and population growth, and social values, the necessity of planning for multiple scenarios in Colorado's future requires a much more comprehensive planning and preparation tool. The IBCC and basin roundtables developed descriptions of several futures Colorado could face, and used those descriptions to identify and evaluate a prospective series of implementable projects and initiatives called "portfolios." One goal of this work was to identify projects and policies that are needed across multiple scenarios. Common actions would therefore apply to multiple futures, and Colorado can plan for and prioritize those first, while still monitoring uncertainties that may redirect recent trends.

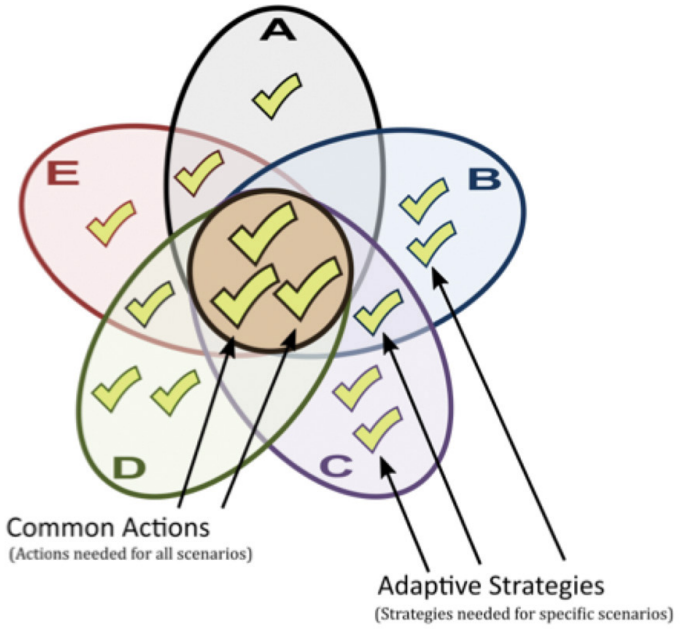
By implementing successive sets of common actions over time, decision makers can be more confident that the policies and investments Colorado makes in the near term will also be viable in the longer term. The near- and long-term actions combine with the scenarios to create a forward looking pathway of actions that both anticipate and prepare for the emerging needs of the future. Figure 6.1-2 conceptualizes ways in which Colorado can align various potential future conditions with near-term actions and long-term adaptive strategies.

FIGURE 6.1-2 SCENARIO PLANNING IDENTIFIES SUCCESSIVE SETS OF COMMON ACTIONS THAT APPLY TO MULTIPLE FUTURES



Adapted from Marra & Thomure, 2009.[8]

FIGURE 6.1-3 COMMON ACTIONS AND ADAPTIVE STRATEGIES IN SCENARIO PLANNING



In the near term, Colorado's way forward involves implementing actions that are common to all or most of the envisioned futures. These common actions have broad applicability, as Figure 6.1-3 shows. The common actions are necessary regardless of which scenario Colorado eventually encounters, and they can be implemented immediately. By contrast, the adaptive strategies are dependent on the specific scenario and will be evaluated based on future information. In the mid-to-long term, the direction forward may narrow and favor a smaller set of possible futures. In that case, the CWCB would work with stakeholders to reevaluate and update the planned actions as well as the strategies. The CWCB would base these updates on the status of predetermined "signposts" or decision points that reveal whether past uncertainties now have more clarity. For water in Colorado, these uncertainties include water needs, water supply, and Colorado's social values. The use of scenarios enables planners to respond and adapt to still-emerging issues and to explore the opportunities and challenges each possible future presents—without reducing options available going forward.[9]

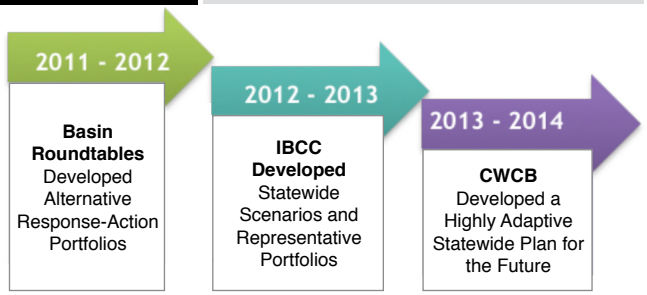
Developing Alternative Water Supply Portfolios

The SWSI 2010 report introduced the "status-quo portfolio"—a set of prospective water-supply actions that would likely be required if current trends continue their trajectories. The status quo is counter to Colorado's water values (as Chapter 1 presents), and leads to the transfer of large quantities of water out of the agricultural sector to satisfy M&I water-supply needs. Such a transfer would result in a substantial loss of agricultural lands and could potentially cause harm to the environment and to Colorado's economy. This plan discusses additional challenges with the status-quo portfolio below. The general statewide consensus is that the status-quo portfolio of actions, and the projected future it assumes, is not desirable for Colorado.[10]

Given these concerns, the CWCB initiated a multi-year, stakeholder plan development process in conjunction with the nine basin roundtables and the IBCC. Each basin roundtable represents the water interests of a specific region within Colorado, and the IBCC facilitates conversations among the basin roundtables and addresses broader, statewide water issues. Figure 6.1-4 on the following page summarizes the plan development process.

Each of the nine basin roundtables developed one or more statewide water supply portfolios to respond to the projected low, medium, or high future water needs of communities.[11] Each portfolio constitutes a unique combination of possible strategies communities could use to meet a range of projected M&I water needs. The strategies include conservation, reuse, agricultural transfers, development of water projects within each basin, and TMDs. The CWCB developed an interactive tool that quantifies tradeoffs—associated with Colorado's water values—that each portfolio would generate. These tradeoffs include effects on the environment, agriculture, reliability, and cost. This work brought basin roundtables together by showing how one water supply decision has multiple effects across the state. Most of the 34 portfolios the basin roundtables developed reduced these tradeoffs, thereby minimizing negative effects statewide and in each basin. They also presented combinations of solutions that both met a variety of possible future conditions and aligned with Colorado's water values.

FIGURE 6.1-4 SUMMARY OF THE STAKEHOLDER AND PLAN DEVELOPMENT PROCESS



The IBCC subsequently synthesized and reduced the 34 basin roundtable-generated portfolios into a smaller set of 10 "representative" portfolios to address projected low-, mid-, and high-range M&I water demands (as Chapter 5 describes). The basin roundtables determined that the representative portfolios successfully captured the intent and character of the original 34 portfolios.

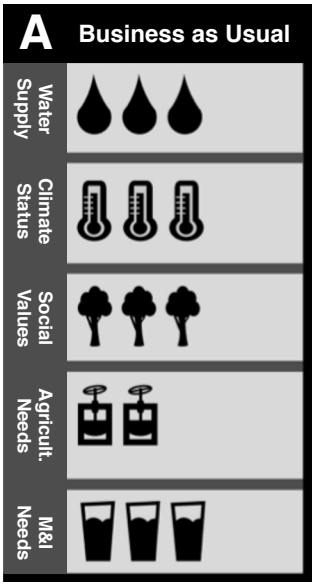
Formulating Plausible Scenarios

Potential changes in future M&I water demand and available water supply were among the most important drivers all of the basin roundtables considered when developing their portfolios. Some of the basin roundtables also considered changing societal values and other drivers outside of the water community's control. The IBCC took these perspectives into account when developing the list of nine high-impact drivers, which it factored-in to the scenario development process. These drivers will greatly influence the direction of Colorado's water future:

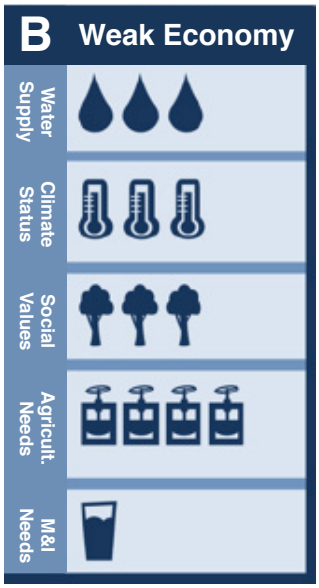
1. Population/Economic Growth
2. Social/Environmental Values
3. Climate Change/Water Supply Availability
4. Urban Land Use/Urban Growth Patterns
5. Energy Economics/Water Demand
6. Level of Regulatory Oversight/Constraint
7. Agricultural Economics/Water Demand
8. M&I Water Demands
9. Availability of Water-Efficient Technologies

Using these drivers, the IBCC developed five scenarios that represent plausible futures. It then matched the scenarios with five of the 10 representative portfolios of solutions that best met the needs each scenario described, and that aligned with Colorado's water values. The scenarios represent how Colorado's water future might look in 2050, even though the actual future at that time will likely contain a mixture of multiple scenarios. The scenario summary also includes a visualization of five of the main drivers. A chart for each scenario shows the relative increase and decrease in levels for each driver compared to current levels. The descriptive scenario names portray the overall essence that each scenario embodies in its respective views of the future.[12] The IBCC describes the scenarios as follows:

A. **Business as Usual:** Recent trends continue into the future. Few unanticipated events occur. The economy goes through regular economic cycles but grows over time. By 2050, Colorado's population is close to 9 million people. Single-family homes dominate, but there is a slow increase of denser developments in large urban areas. Social values and regulations remain the same, but streamflows and water supplies show increased stress. Regulations are not well coordinated and create increasing uncertainty for local planners and water managers. Willingness to pay for social and environmental mitigation of new water development slowly increases. Municipal water conservation efforts slowly increase. Oil-shale development continues to be researched as an option. Large portions of agricultural land around cities are developed by 2050. Transfer of water from agriculture to urban uses continues. Efforts to mitigate the effects of the transfers slowly increase. Agricultural economics continue to be viable, but agricultural water use continues to decline. The climate is similar to the observed conditions of the 20th century.

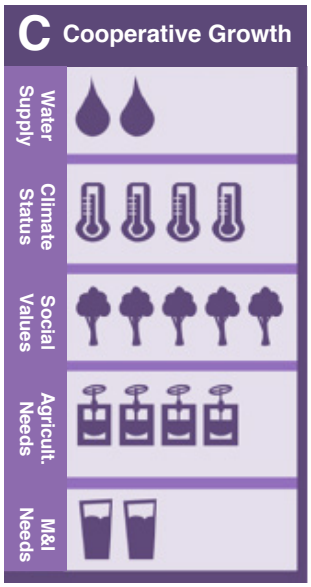


B. **Weak Economy:** The world's economy struggles, and the state's economy is slow to improve. Population growth is lower than currently

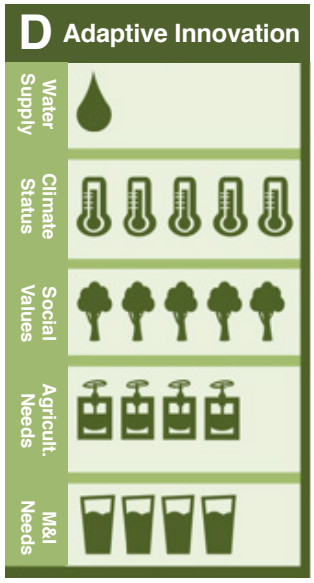


projected, slowing the conversion of agricultural land to housing. The maintenance of infrastructure, including water facilities, becomes difficult to fund. Many sectors of the state's economy, including most water users and water-dependent businesses, begin to struggle financially. There is little change in social values, levels of water conservation, urban land use patterns, and environmental regulations. Regulations are not well coordinated and create increasing uncertainty for local planners and water managers. Willingness to pay for social and environmental mitigation decreases due to economic concerns. Greenhouse gas emissions do not grow as much as currently projected and the climate is similar to the observed conditions of the 20th century.

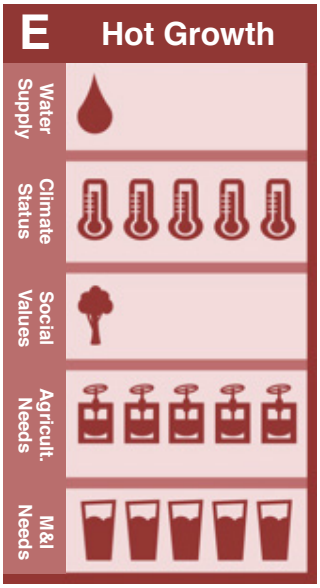
C. **Cooperative Growth:** Environmental stewardship becomes the norm. Broad alliances form to provide for more integrated and efficient planning and development. Population growth is consistent with current forecasts. Mass transportation planning concentrates more development in urban centers and in mountain resort communities, thereby slowing the loss of agricultural land and reducing the strain on natural resources compared to traditional development. Coloradans embrace water and energy conservation. New water-saving technologies emerge. Eco-tourism thrives. Water-development controls are more restrictive and require both high water-use efficiency and environmental and recreational benefits. Environmental regulations are more protective, and include efforts to re-operate water supply projects to reduce effects. Demand for more water-efficient foods reduces water use. There is a moderate warming of the climate, which results in increased water use in all sectors, in turn affecting streamflows and supplies. This dynamic reinforces the social value of widespread water efficiency and increased environmental protection.



D. **Adaptive Innovation:** A much warmer climate causes major environmental problems globally and locally. Social attitudes shift to a shared responsibility to address problems. Technological innovation becomes the dominant solution. Strong investments in research lead to breakthrough efficiencies in the use of natural resources, including water. Renewable and clean energy become dominant. Colorado is a research hub and has a strong economy. The relatively cooler weather in Colorado (due to its higher elevation) and the high-tech job market cause population to grow faster than currently projected. The warmer climate increases demand for irrigation water in agriculture and municipal uses, but innovative technology mitigates the increased demand. The warmer climate reduces global food production, increasing the market for local agriculture and food imports to Colorado. More food is bought locally, increasing local food prices and reducing the loss of agricultural land to urban development. Higher water efficiency helps maintain streamflows, even as water supplies decline. The regulations are well defined and permitting outcomes are predictable and expedited. The environment declines and shifts to becoming habitat for warmer-weather species. Droughts and floods become more extreme. More compact urban development occurs through innovations in mass transit.



E. **Hot Growth:** A vibrant economy fuels population growth and development throughout the state. Regulations are relaxed in favor of flexibility to promote and pursue business development. A much warmer global climate brings more people to Colorado with its relatively cooler climate. Families prefer low-density housing and many seek rural properties, ranchettes, and mountain living. Agricultural and other open lands are rapidly developed. A hotter climate decreases global food production. Worldwide demand for agricultural products rises, greatly increasing food prices. Hot and dry conditions lead to a decline in streamflows and water supplies. The environment degrades and shifts to becoming habitat for species adapted to warmer waters and climate. Droughts and floods become more extreme. Communities struggle unilaterally to provide services needed to accommodate the rapid business and population growth. Fossil fuel is the dominant energy source, and there is large production of oil shale, coal, natural gas, and oil in the state.



The five scenarios above collectively capture a broad range of future supply-and-demand possibilities and uncertainties. Of the five scenarios, "Business as Usual" is the most conventional, while "Adaptive Innovation" and "Hot Growth" are the most difficult to prepare for because of high water demands combined with the effects of climate change. The challenge is not to pick the most likely or attractive future; rather, it is to develop the capacity to prepare Colorado for all of them.

Developing an Adaptive Water Management Plan

In analyzing the portfolios, the IBCC identified common near-term strategies and actions that would provide baseline benefits for all five of the envisioned scenarios. Most of these actions would be necessary no matter what future Colorado faces, and would fully meet low demands, as the "Weak Economy" scenario describes. Some strategies prepare Colorado for future projects and methods that may be needed in one or more futures. These near-term commonalities are called "no-and-low-regret" strategies and actions, since they would most likely be viable no matter how the future might ultimately unfold.

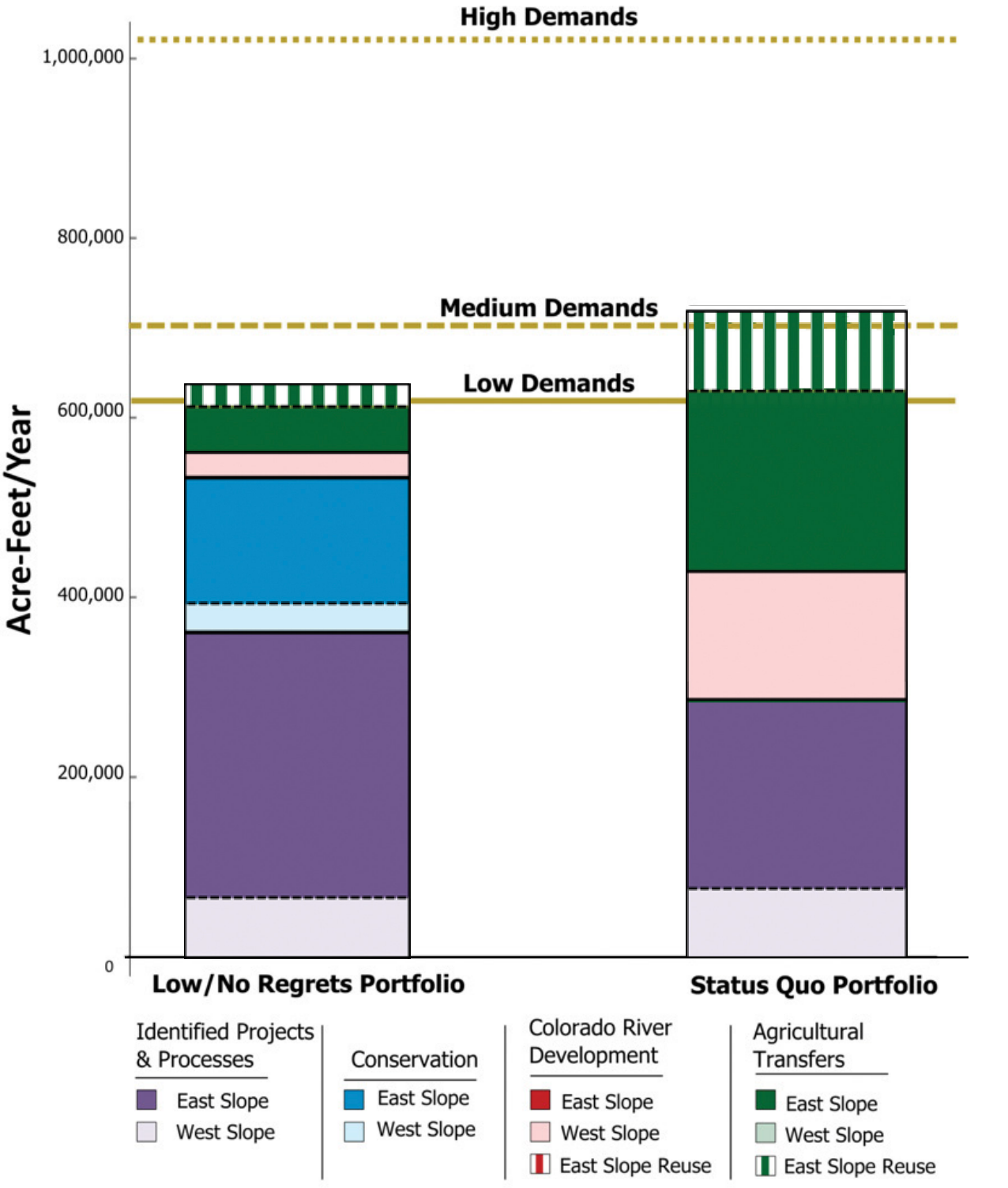
In this context, a "regret" is an action in which Colorado enters a future where there are:

1. Water shortages due to an insufficient number of implemented necessary projects and methods;
2. Significant consequences to Colorado's agriculture, environment, or economy because Colorado's water community did not implement projects and methods consistent with Colorado's water values; or
3. Too many unneeded and costly projects.

By implementing the No-and-Low-Regrets actions sooner rather than later, Colorado will be prepared for any future, without provoking serious tradeoffs. Figure 6.1-5 (page 6-9) illustrates how the No-and-Low Regrets party compares to the status-quo portfolio.

In contrast to the Status-Quo Portfolio, the No-and-Low-Regrets Portfolio reduces potential effects to the environment and agriculture by increasing the success of planned projects and levels of water conservation. The No-and-Low-Regrets Portfolio aligns with Colorado's water values; it avoids the unacceptable consequences resulting from the continued drying-up of Colorado's irrigated agriculture and the use of more Colorado River water. Nevertheless, the No-and-Low-Regrets Portfolio only meets the low-demand scenario (as Figure 6.1-5 shows), and additional water supplies or increased conservation will be required if Colorado faces medium or high water demands. In addition, several portfolios address higher demands while continuing to align with Colorado values; this chapter explores these below.

FIGURE 6.1-5 NO-AND-LOW-REGRETS PORTFOLIO VERSUS THE STATUS-QUO PORTFOLIO



Below are descriptions of the recommended No-and-Low-Regrets actions, along with the adaptive strategies that will prepare Colorado for other potential futures:

- **Minimize the transfer of statewide agricultural acres and implement agricultural sharing projects:** Limit traditional permanent dry-up of agricultural lands by supporting lower-impact alternatives for more than 300,000 people (requiring 50,000 acre-feet of water) in the near future. Simultaneously, track the reliability of these alternatives, and plan and preserve the option of additional agricultural transfers should a future scenario necessitate this action. Section 6.4 describes these opportunities.
- **Plan and preserve future options for developing unappropriated waters:** Develop additional water supplies from unappropriated water on the western slope for local use to serve a minimum of 200,000 people (requiring 35,000 acre-feet of water), and to support their associated jobs in the near future. At the same time, plan for and preserve the option of an additional TMD, should a future scenario necessitate such a project through the conceptual framework parameters Chapter 8 describes.
- **Establish low to medium conservation strategies:** Implement strategies to meet low to medium levels of conservation, and apply at least half of these savings to meet future M&I needs in order to support approximately 1 million people (requiring 170,000 acre-feet of water) and their jobs in the near future. At the same time, track the reliability of these conservation savings, and plan for ways to achieve additional conservation savings, should a future scenario necessitate this action. Section 6.3 describes several avenues for accomplishing this.
- **Implement projects and methods that support environmental and recreational uses:** Implement local projects, especially those that support imperiled species and recreational areas that are important to local economies. Section 6.6 describes these projects and methods.
- **Strive for high success rates for projects and methods that are already planned:** Work to support the projects that are already planned, as these already have a project proponent and are often smaller and less controversial than many of the other project options. Statewide, these projects may provide enough water for more than 2 million people (requiring 350,000 acre-feet of water) and their associated jobs in the near future. Continue to track the success rate of these projects and their ability to meet future community water needs. Section 6.5 further describes these projects and methods.
- **Assess and implement storage projects and other infrastructure:** Implement storage and other infrastructure to maximize flexibility and reliability. Focus on options that support multiple needs for communities, agriculture, and the environment. Section 6.5 further discusses storage.
- **Implement water reuse strategies:** Implement strategies that encourage increased use of recycled water, as Section 6.3 describes.

As indicated in SWSI, "Colorado faces a shortage of water for meeting the state's consumptive and nonconsumptive water needs. In order to meet Colorado's water management objectives, a mix of local water projects and processes, conservation, reuse, agricultural transfers, and the development of new water supplies should be pursued concurrently."[13] The No-and-Low-Regrets actions bring together the need to advance each of these which, together, are known as the "four legs of the stool."

The No-and-Low-Regrets Portfolio only satisfies the M&I water supply needs of the "Weak Economy" scenario, and would only be possible if the portfolio were successfully implemented in the near term. If medium or high water demands had to be met as the other scenarios envisioned, additional portfolio actions would be required in the mid and long term.

Colorado must be prepared for a range of possible futures, which may be dry or wet. Drought photo courtesy of USGS.

Building on the earlier work of the basin roundtables and the IBCC, the CWCB developed a scenario-based adaptive water strategy. While the No-and-Low-Regrets Portfolio is necessary no matter what future Colorado may face, the adaptive framework recognizes that the future hinges upon how much the primary drivers—M&I water demand, waters-supply availability, and social values—change over time. These drivers could tip the still-evolving future toward one scenario or another. The tipping points serve as water management decision points, or "signposts," that can lead toward the need to implement a certain portfolio of solutions. By developing an adaptive water management framework, managers and decision makers will be more aware of approaching signposts and can anticipate the need to make timely water management decisions.

An explanation of the primary drivers follows:

- Future changes in *M&I water demands* may trend "lower" or "higher" relative to the mid-level water demand forecasts previous SWSI efforts used. The State may anticipate such changes by tracking indicators of economic activity and demographic growth, as well as other secondary factors.
- Water *supply availability* may similarly trend "lower" or "higher" depending on climate change, watershed hydrology, and legal constraints associated with Colorado's interstate compacts, water law, and environmental regulations. The State will assess water supply availability as trending lower or higher over time as compared to earlier versions of the SWSI.

- The third primary driver, *social values,* is a measure of statewide public sentiment; it may trend toward a more "green" orientation or it may shift toward greater "resource utilization." "Green" values will likely favor more dense, low-impact urban development, greater reliance on water reuse and energy efficiency, greater protection of environmental and recreational resources, and preservation of local agriculture and open space. Values associated with more intensive resource utilization will gravitate toward full use of existing natural sources as well as the development of new sources to satisfy M&I water demands.

This scenario-based framework allows for incremental implementation of future portfolio response actions beyond the No-and-Low-Regrets actions recommended in the near term (Figure 6.1-6). Pre positioned portfolio actions—such as increased levels of conservation, agricultural transfers, or TMDs—can be implemented at specified key signposts. This will allow decision makers to adaptively respond in real time to changes in critical drivers that cannot be predicted with certainty. Critical drivers include water demands, water supply, and social values.[14]

Table 6.1-1, on page 6-13, illustrates the relationships between the three primary drivers, scenarios, and portfolios of solutions. The five portfolios that match the scenarios best meet both future conditions and Colorado's water values.

The No-and-Low-Regrets actions will not be easy to accomplish. Nevertheless, if Colorado does not implement these in the next 15 years, the effects will be severe. The water supply gap will be greater than any basin roundtable has envisioned, and the solutions will dry up more agriculture and cause further harm to the environment. If Colorado faces high demands and does not fully implement the No-and-Low-Regrets actions, the state will have to implement projects and methods beyond anything the basin roundtables have planned and prepared for in the portfolio development process.

FIGURE 6.1-6 COLORADO'S SCENARIOS AND THEIR MATCHING PORTFOLIOS

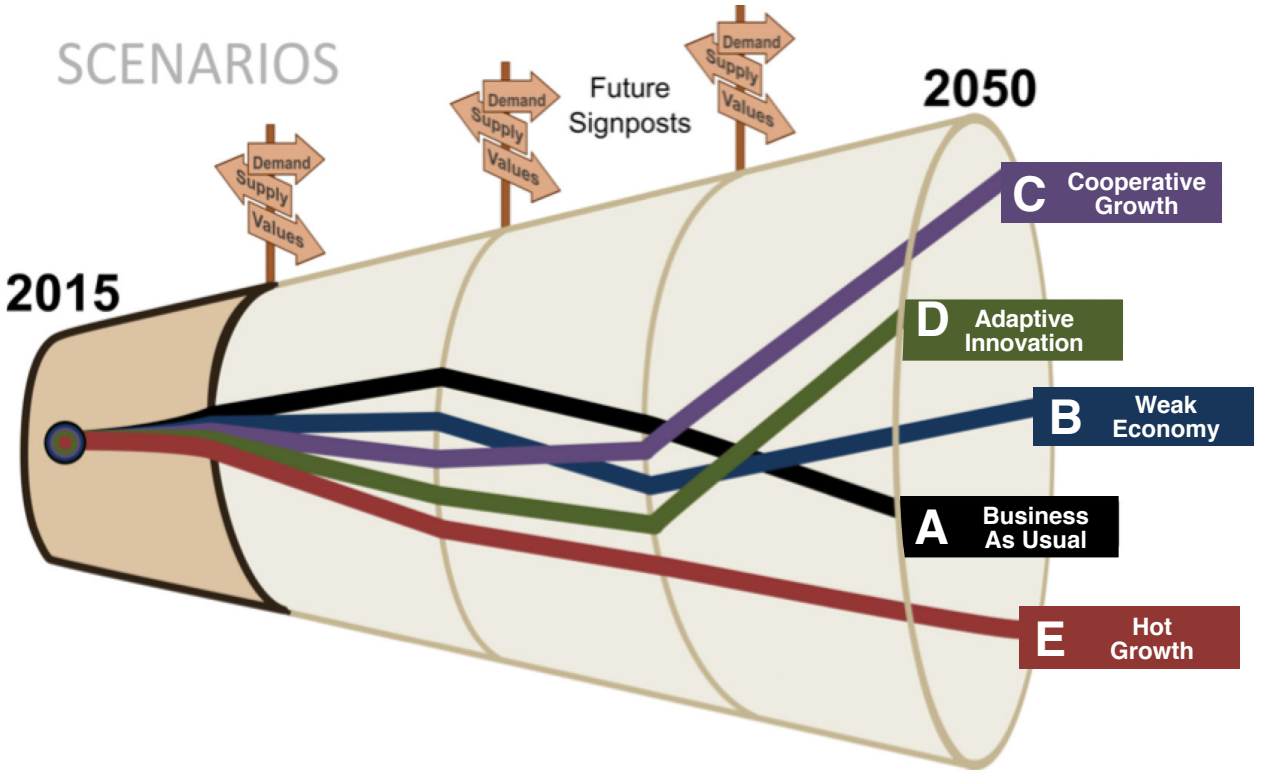
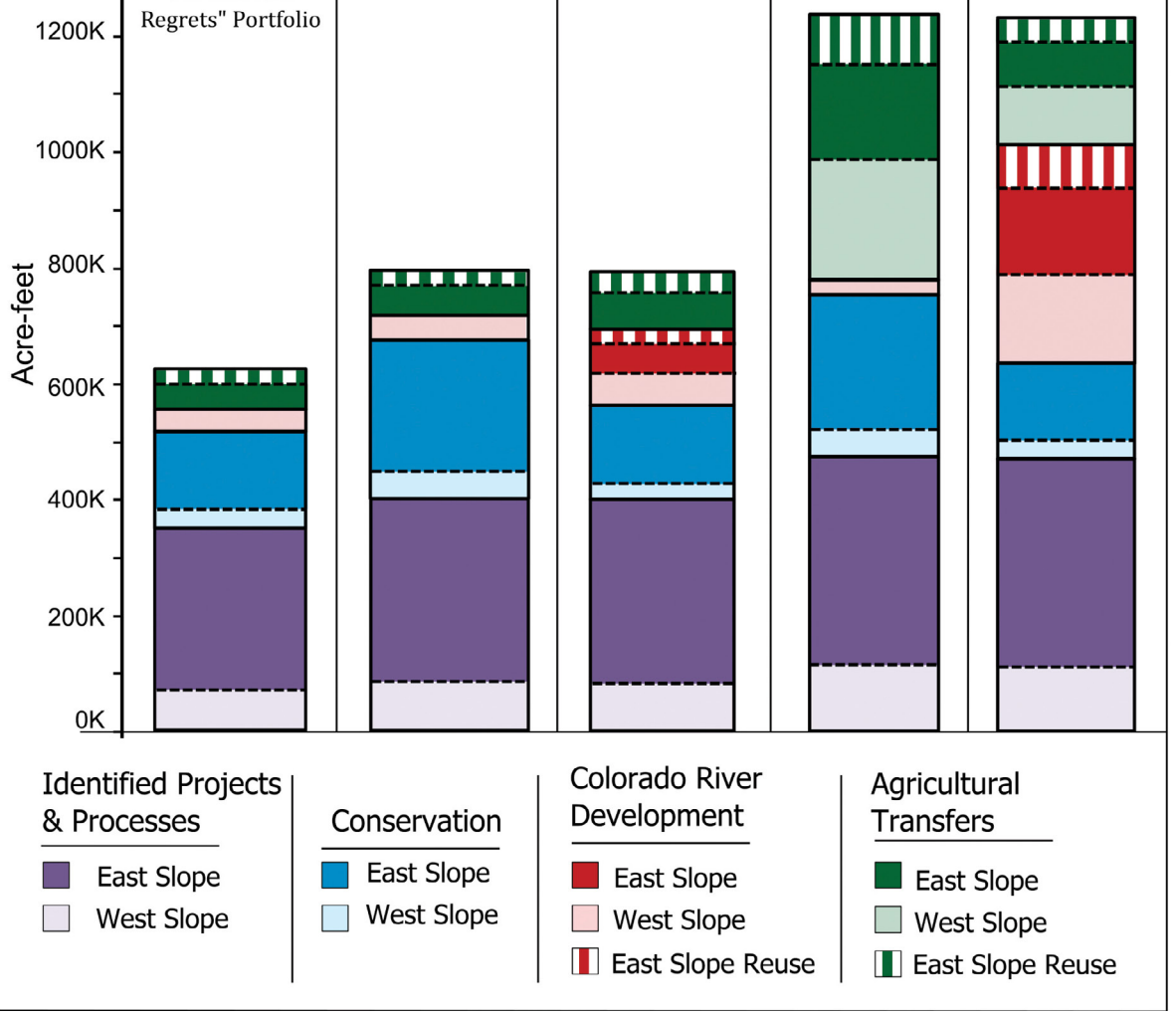


TABLE 6.1-1 SCENARIOS AND THEIR MATCHING PORTFOLIOS

		Scenarios				
		B Weak Economy	C Cooperative Growth	A Business as Usual	D Adaptive Innovation	E Hot Growth
Scenario Drivers	Water Demand	Lower	Lower	Higher	Higher	Higher
	Water Supply	Higher	Lower	Higher	Lower	Lower
	Social Values	No Change	"Green"	No Change	"Green"	"Resource Utilization"
Portfolio of Solutions		"Low Demand Conservation" / "No-and-Low Regrets" Portfolio	"Mid Demand Conservation" Portfolio	"Mid Demand Mixed" Portfolio	"High Demand Conservation" Portfolio	"High Demand Mixed" Portfolio



Depending on the scenario, this could be an even larger TMD, draconian conservation measures, or even greater amounts of agricultural dry-up—and these approaches would not be consistent with Colorado's water values. It is imperative that Colorado implement the No-and-Low-Regrets actions.

Section 6.2 assesses whether or not the BIPs would be able to meet the No-and-Low-Regrets actions. Sections 6.3 through 6.6 and Chapter 8 explore in detail how Colorado, at a minimum, can implement the No-and-Low-Regrets actions through the BIPs and other stakeholder projects and methods; the State would accomplish this by obtaining financial support, pursuing education efforts, forming partnerships, and pursuing legislative solutions.

If successfully implemented, this adaptive water strategy will provide a roadmap to a still-evolving future. Given the whims inherent in predicting future conditions, the plan must be a living document. As new critical drivers arise, or as decision points change over time, the CWCB in partnership with stakeholders, will need to assess and revise the scenarios and associated response-action portfolios in subsequent updates to the SWSI.

ACTIONS

The following actions will continue to support scenario planning and Colorado's adaptive strategies:

1. **Support the implementation of the No-and-Low-Regrets strategy:** The CWCB, in partnership with other state agencies, will commit state financial, technical, and regulatory resources to the near-term implementation of prioritized water management projects as specified in the No-and-Low-Regrets actions. As part of this work, and in partnership with the basin roundtables, the CWCB will evaluate progress toward achieving the No-and-Low-Regrets actions.
2. **Monitor drivers:** To determine which scenario Colorado will most likely face, the CWCB will work with partners, such as the Climate Change Technical Advisory Group, to monitor the critical drivers of water supply, demand, and the level of "green" versus "full-resource use" values through future SWSI updates and other technical work. As part of this work the CWCB will work with stakeholder groups to update the scenarios and adaptive strategies.
3. **Promote use of scenario planning and adaptive strategies:** The CWCB and the basin roundtables will continue to use and promote scenario planning and the use of adaptive strategies to respond to, mitigate, and prepare for climate change. In partnership with project proponents, the CWCB will also encourage and facilitate the adoption of adaptive strategies for municipal, industrial, agricultural, environmental, and recreational needs as Colorado moves into the future.
4. **Support Colorado's Decision Support Systems (CDSS):** The CWCB and the DWR will continue to develop and support the CDSS to encourage data-driven planning and decision making.
5. **Support innovative and collaborative science:** The CWCB will continue to work with local, state, and federal partners to build coalitions to purchase, deploy, maintain, and operate new equipment and new science necessary for 21st-century water management. Concepts and technologies such as watershed-based gap-filling radars for continuous weather coverage, radiometers for improved profiles of the atmosphere and modeling support, and improved high -resolution atmospheric and hydrological modeling specific to Colorado, lead to accurate quantification of the snowpack and runoff, regardless of the scenario.

6.2 MEETING COLORADO'S WATER GAPS

GOAL

Colorado's Water Plan uses a grassroots approach to formulate projects and methods that avoid some of the undesirable outcomes of the supply-demand gaps. The plan addresses the gaps from multiple perspectives—such as water storage, reuse, recycling, integrated water management, restoration, and conservation.

Overview

This section describes how the basin roundtables' BIPs meet Colorado's growing municipal, industrial, agricultural, environmental, and recreational water needs. It also describes the BIP goals and measurable outcomes, and identifies by basin the remaining needs Colorado must meet to accomplish those objectives. These remaining needs are referred to as "gaps." This section relies on previous technical work the SWSI 2010 conducted, the basin needs assessments, and the No-and-Low-Regrets work Section 6.1 describes.

In addition, this section assesses the projects and methods identified in the BIPs to determine whether they address the gaps. Finally, the section ends with a list of actions to support closing Colorado's water gaps. Sections 6.3 through 6.6 indicate the types of projects and methods the BIPs are considering, and actions to support them.

Colorado's Water Plan does not prescribe or endorse specific projects. However, the implementation of a combination of projects and methods, as the BIPs outline, will be necessary to meet Colorado's current and future municipal, industrial, agricultural, environmental, and recreational water needs. Failure to implement those projects and methods will result in an even greater water gap in Colorado's future.

In compiling its BIP, each basin roundtable developed goals and measurable outcomes that add up to each basin's vision for plans to support each major sector. While it is relatively easy to quantify a water supply gap for M&I needs, the future needs of agriculture, the environment, recreation, and other uses the BIPs identified are based on each basin roundtable's vision.

Goals and Measurable Outcomes by Basin

The degree to which the BIP goals and measurable outcomes demonstrate concurrence across Colorado is remarkable. The CWCB developed several long-term themes to meet the objectives the Governor's Executive Order outlined.[15] These include:

1. Meet Colorado's municipal water needs.
2. Meet Colorado's agricultural water needs.
3. Meet Colorado's environmental and recreational water needs.

In addition, Colorado has a long-term goal related to water quality, which Section 7.3 discusses:

4. Meet Colorado's water quality management needs.

The BIP goals and measurable outcomes reflect each of these major themes. Additionally, the basin roundtables identified several major themes that reach across all BIPs. These include:

- Protect and restore watershed health.
- Develop multipurpose storage/balance all needs and reduce conflict.

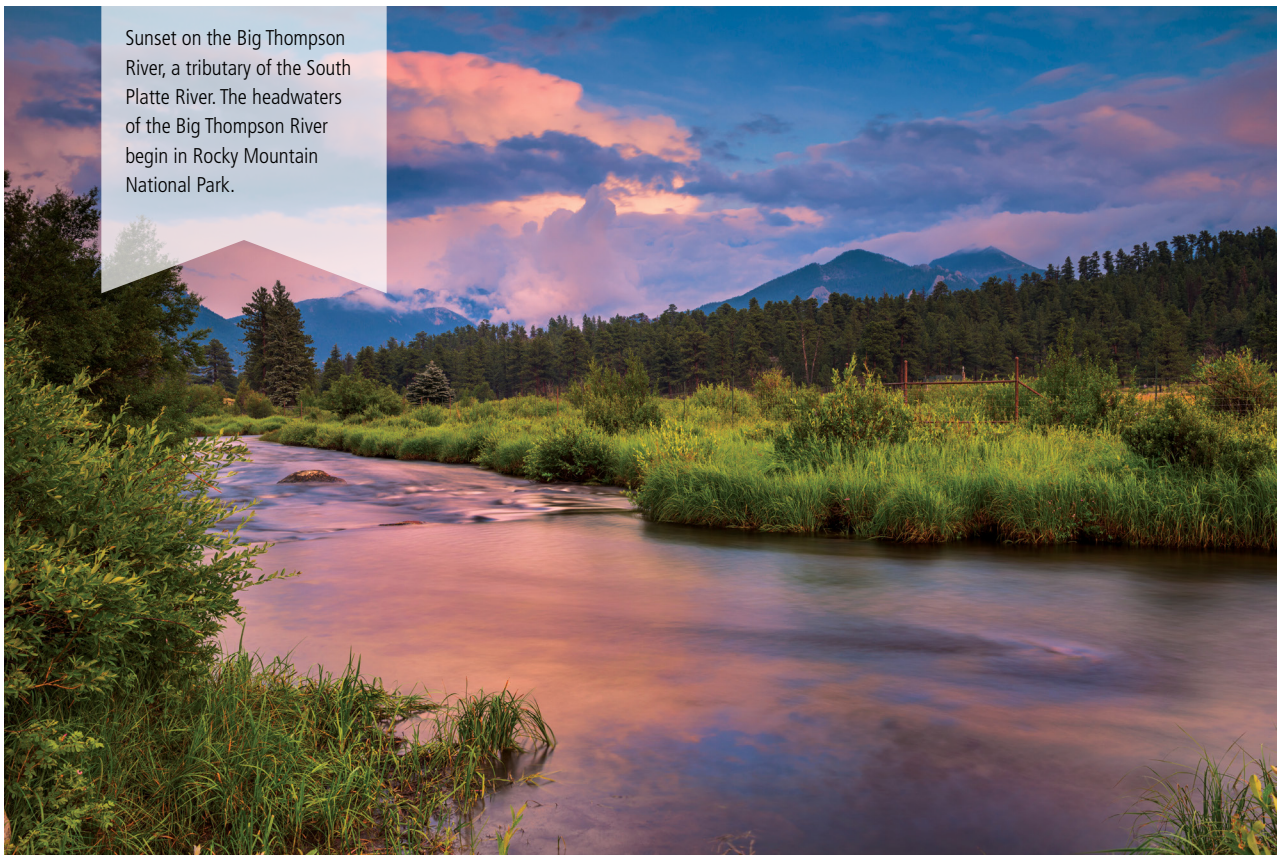
- Comply with and manage the risk associated with interstate compacts and agreements.
- Continue participation, education, outreach, and communication.

Table 6.2-1, on page 6-17, demonstrates the common themes across the eight BIPs, and outlines the steps by which the BIPs propose to specifically address these themes.

Below is a brief summary of how the basins addressed these themes through their BIPs.

Meet Colorado's Municipal Water Needs through Conservation and Identified Projects and Methods: Every basin roundtable discusses the importance of conservation. This is especially a focus for the Arkansas, Colorado, Metro, South Platte, and Southwest Basin Roundtables. In the Southwest and South Platte BIPs, the roundtables focus on implementing already-specified IPPs from SWSI 2010. The Southwest and the Colorado Roundtables also identify additional projects and methods. The Colorado, South Platte, Metro, and Arkansas Roundtables also feature reuse in their BIPs.

Meet Colorado's Agricultural Needs: In general, the Arkansas, Colorado, Rio Grande, and Southwest Basin Roundtables are approaching agricultural needs from an economic and productivity standpoint. The North Platte and Yampa/White Basin Roundtables seek to increase their irrigated acres, while several basins, such as the Gunnison and Colorado, seek to reduce agricultural shortages. Nearly every basin also focuses on improving agricultural efficiencies and modernizing water infrastructure. The South Platte and Metro Basin Roundtables are concerned about maintaining the viability of agriculture in the South Platte against the pressure of agricultural transfers and urbanization. They are therefore exploring alternative options, including the successful implementation of conservation, reuse, IPPs, alternative agricultural transfers, and the development of new supplies from the Colorado River system. Some western slope roundtables, such as the Southwest Roundtable, indicate that agriculture across the state is important, and have expressed support for strategies such as high-conservation to minimize the potential loss of irrigated acres. In the South Platte BIP, the South



Sunset on the Big Thompson River, a tributary of the South Platte River. The headwaters of the Big Thompson River begin in Rocky Mountain National Park.

TABLE 6.2-1 COMMON THEMES ACROSS BASIN IMPLEMENTATION PLANS

✓ = BIP goal or measurable outcome; ✓ = BIP activity	Ark	Co	Gu	NP	RG	SP/Mt	SW	Y/W/G
A. Meet Municipal Water Needs thoughout Colorado								
• *Focus on M&I gaps*	✓	✓	✓	✓	✓	✓	✓	✓
• *Focus on conservation / demand management*	✓	✓	✓	✓	✓	✓	✓	✓
B. Meet Colorado's Agriculture Needs								
• *Focus on agricultural economy*	✓	✓	✓		✓	✓		
• *Focus on reducing shortages*		✓	✓			✓	✓	✓
• *Improve agricultural efficiencies*	✓	✓	✓		✓		✓	✓
• *Increase irrigated acres*				✓				✓
• *Conduct the goals while protecting private property rights*	✓	✓	✓	✓	✓	✓	✓	✓
C. Meet Colorado's Environmental and Recreational Water Needs								
• *Focus on recovering imperiled and/or endangered species*	✓	✓	✓	✓	✓	✓	✓	✓
• *Protect wetlands and riparian areas*	✓	✓	✓	✓	✓	✓	✓	✓
• *Protect recreation*	✓	✓	✓	✓	✓	✓	✓	✓
• *Quantify nonconsumptive needs*	✓	✓	✓			✓	✓	✓
D. Protect and Restore Watershed Health								
• Include one or more goals / activities associated with watershed health	✓	✓	✓	✓	✓	✓	✓	✓
E. Balance All Needs and Reduce Conflict / Multi Purpose Storage								
• *Protect private property rights / water rights*	✓	✓	✓	✓	✓	✓	✓	✓
• *Multi-purpose focus*	✓	✓	✓	✓	✓	✓	✓	✓
• *Modernize water infrastructure*	✓		✓	✓	✓	✓	✓	✓
• *Determine how agriculture supports nonconsumptive needs*	✓	✓	✓	✓	✓	✓		✓
• *Increase storage*	✓	✓	✓	✓	✓	✓	✓	✓
F. Comply with Interstate Compacts, Agreements, and Manage the Risk Associated with These								
• Include one or more goals /activities associated with this	✓	✓	✓	✓	✓	✓	✓	✓
G. Continue Participation, Education, Outreach, and Communications								
• Include one or more goals / activities associated with this	✓	✓	✓	✓	✓	✓	✓	✓
H. Meet Colorado's Water Quality Management Needs								
• Include one or more goals / activities on water quality	✓	✓	✓	✓	✓	✓	✓	✓

Platte and Metro Roundtables indicate that they will need to consider all of these strategies to reduce the pressure on agricultural transfers. The Rio Grande Roundtable expresses concern about maintaining the viability of agriculture in light of current unsustainable groundwater depletions.

Meet Colorado's Environmental and Recreational Needs: Each of the state's basins has environmental water quality and water quantity needs and objectives it must meet. Every roundtable discusses the need to recover imperiled and/or threatened and endangered species, and to protect recreational opportunities, wetlands, and riparian areas. In addition, several roundtables state the need to further quantify environmental and recreational needs, and the Gunnison, South Platte, Metro, and Yampa/White/Green Roundtables discuss the need to better determine how agriculture supports environmental and recreational values.

Meet Colorado's Water Quality Management Needs: Although water quality is not an issue the basin roundtables traditionally study, every roundtable addresses water quality in its BIP. Section 7.3 summarizes this.

Protect and Restore Watershed Health: While the Arkansas, North Platte, Rio Grande, and Southwest Basin Roundtables are the most focused on watershed health, every roundtable recognizes the importance of watershed health in its BIP. Many roundtables link watershed health to environmental needs or the protection of important infrastructure for municipal and agricultural needs. Section 7.1 summarizes the watershed health efforts.

Continue Participation, Education, Outreach, and Communication: Every basin roundtable has active education and outreach activities, as Section 9.5 describes.

While each of the above topics demonstrates a gap associated with the goals and measurable outcomes, several other important themes do not directly address the gaps. Some of these include:

- **Protect private property and water rights:** Every roundtable makes it clear in its BIP that basins must pursue solutions to protect agriculture and the environment in the context of protecting private property and water rights. This general theme is consistent with Colorado's Water Plan.
- **Comply with and manage the risk associated with interstate compacts and agreements:** Every basin in Colorado must grapple with interstate compacts or agreements, and each basin has addressed this topic explicitly in its BIP. Chapter 8 discusses how the basins address the issue of TMDs.
- **Develop multipurpose storage and projects/ Balance all needs and reduce conflict:** In their BIPs, all roundtables stress an interest in multipurpose projects and approaches. Some, like the Arkansas, Colorado, Gunnison, North Platte, Rio Grande, and South Platte/Metro Basin Roundtables, are interested in ways in which agriculture supports nonconsumptive needs.

Meeting M&I Water Needs Throughout Colorado

In the BIP process, the CWCB identified three statewide long-term goals to meet community water needs throughout Colorado:[16]

- Use water efficiently to reduce overall future water needs.
- Identify additional projects and processes to meet the water supply gap for municipalities while balancing the needs of agriculture, the environment, and recreation across the state.
- Meet community water needs during periods of drought.

The SWSI 2010 indicated that under current conditions, the M&I gap could total between 310,000 and 560,000 acre-feet, depending on the rate of population growth in Colorado. As Section 6.1 discusses, this assumes that planned projects, or IPPs, are ultimately implemented at fairly high rates.[17]

As described in the updated SWSI glossary,[18] IPPs meet the following criteria and are listed in SWSI 2010:[19]

- The project or method has a project or method proponent.
- When the proponent is a retail water provider, the project or method is being used to meet the water supply needs of its customers by 2050.

- When the project proponent is a wholesale water provider, at least one retail water provider must express interest in writing and plan on using the project or method to meet the water supply needs of its customers by 2050.
- The project or method must have at least preliminary planning, design, conditional or absolute water rights, rights of way, and/or written negotiations with local governments the water project could affect.
- The water supply needs must be identified and included in the BIPs and/or SWSI documents.

The majority of Colorado's water providers responsibly plan to address their water needs according to their timelines and objectives. However, there is still a water supply gap. To address the minimum water gap, the basin roundtables and the IBCC developed several No-and-Low-Regrets goals and measurable outcomes, as Section 6.1 describes. In offering guidance to the basin roundtables, CWCB demonstrated how these measurable outcomes could inform the BIPs at a basin specific level. Table 6.2-2 compares BIP actions to these measurable outcomes, which include measures for conservation, IPPs, reuse, agricultural transfers, and Colorado River supplies:[20]

- *Establish low-to-medium conservation strategies*
  - Implement strategies at the basin-level to meet medium levels of conservation, and apply half of that to meet the M&I gap, equivalent to 67,000 acre-feet per year by 2030 and 167,000 acre-feet by 2050 statewide.
  - 2050 conservation savings by basin:
    - Arkansas: 36,000 acre-feet
    - Colorado: 15,000 acre-feet
    - Gunnison: 4,300 acre-feet
    - North Platte: 85 acre-feet
    - Rio Grande: 3,200 acre-feet
    - South Platte (including Metro Area): 97,000 acre-feet
    - Southwest: 7,500 acre-feet
    - Yampa/White/Green: 3,700 acre-feet
- *Have a high success rate for IPPs*
  - Implement IPPs to yield 80 percent of the statewide planned water deliveries, equivalent to 70,000 acre-feet per year for the western slope and 280,000 acre-feet per year for the eastern slope
  - 2050 No-and-Low-Regret IPP success by basin:
    - Arkansas: 76,000 acre-feet
    - Colorado: 45,000 acre-feet
    - Gunnison: 12,000 acre-feet
    - North Platte: 100 acre-feet
    - Rio Grande: 6,000 acre-feet
    - South Platte (including Metro Area): 200,000 acre-feet
    - Southwest: 13,000 acre-feet
    - Yampa/White/Green: 7,000 acre-feet
- *Implement reuse strategies*
  - Produce 25,000 acre-feet per year of yield resulting from new agricultural-transfer and TMD projects above and beyond the IPPs in the South Platte and Arkansas Basins.
- *Plan and preserve options for existing and new supply*
  - Develop 35,000 acre-feet per year of new supplies in the Colorado River system for the western slope.
  - Develop a conceptual framework among basin roundtables regarding ways to preserve the option for a potential future TMD from the western slope to the eastern slope. (Chapter 8 discusses the conceptual framework the IBCC developed.)

Many of the basins seek to meet these short- and long-term M&I goals in their BIPs; this subsection reviews BIPs by basin. Table 6.2-2 summarizes the success of each basin in meeting the overall water supply gap for municipalities and industry.

The current No-and-Low-Regrets actions and SWSI 2010 gap calculations do not take into account the potential effects of climate change. As this plan discusses, warming temperatures can affect water supply, water availability, and water demands. Should average annual temperature continue to increase at projected levels (2.5 to 5° F) by mid-century, it is reasonable to expect that the existing gap will increase.

TABLE 6.2-2 SUMMARY OF BASIN IMPLEMENTATION PLANS ADDRESSING THE MUNICIPAL AND INDUSTRIAL NO-AND-LOW-REGRETS AND GAPS

Basin	2050 New Needs (acre-feet)[21]	2050 Gap (acre-feet)[22]	BIP-Identified Potential New Projects and Methods (acre-feet)[a]	# of New Projects w/ acre-foot info	Are No/Low Regrets Likely Met?	Notes
Arkansas	110,000 - 170,000	59,500[23] (M&I Shortage) 45,000 - 94,000 (SWSI 2010)	125,000	10	Yes: IPP success, identify additional projects to meet the gap.	A database categorized which projects listed in the BIP count as IPPs
Colorado	65,000 - 110,000	26,000 - 48,000	40,000 (20,000 in projects and 20,000 from high active conservation)	3	Yes: High conservation; some IPP success; identify additional Colorado River Basin supply projects	The BIP identified priority projects by region, and the largest project has a large agricultural component, so it is unclear if the gaps will be fully met with only the priority projects[24]
Gunnison	16,000 - 23,000	3,700 - 6,100	17,500 (12,000 in projects and 5,500 from high active conservation)	5	Yes: High conservation; success of IPPs; identify additional Colorado River Basin supply projects	BIP indicates M&I needs "are generally expected to be managed with sufficient existing supplies and/or through planned projects"[25]
North Platte	100-300	10 - 30	N/A	Completed Project	Yes: Accept conservation standards; IPP success.	The North Platte has met its municipal gap[26]
Rio Grande	7,700 - 13,000	2,300 - 5,100	800	1	Partially: Little conservation discussion; some IPP success	Because the basin is focused on groundwater sustainability, the BIP did not identify additional acre-feet for municipal projects.[27]
South Platte (including Metro)	340,000 - 505,000	204,000 - 310,000	98,000 (45,000 in projects and 53,000 from active conservation)	8	Partially: Some conservation, IPP success, reuse success, some agricultural transfers.	The BIP developed portfolios, which conceptually fill the gap with additional agricultural transfers, ATMs, multipurpose projects, and potentially a new TMD[28]
Southwest	20,000 - 31,000	8,800 - 16,000	49,000 (40,000 in projects and 9,000 from high active conservation)	7	Yes: High conservation; high IPP success; develop additional Colorado River Basin supplies.	Projects and methods identified will meet M&I gap as well as the infrastructure needs of the basin[29]
Yampa / White / Green	34,000 - 95,000	24,000 - 83,000	203,000 (198,000 in projects and 5,000 from high active conservation)	8	Yes: Some conservation; high IPP success; develop additional Colorado River Basin supplies.	85 percent of the yield for M&I projects stems from one large project.[30]
TOTALS	590,000 - 950,000	310,000 - 560,000	530,000	**42**		

a. This column represents the total number of acre-feet gathered from the projects and methods (P&M) the roundtables identified in the BIPs, which could serve municipal or industrial uses. Conservation is included as a method. The values do not consider hydrological limitations. These values do not include the IPPs previously identified in SWSI 2010.

Arkansas

The Arkansas Basin faces an immediate municipal gap in some areas, especially if one takes into account the need to replace nontributary groundwater in El Paso and Elbert Counties.[31] Future needs in the Arkansas Basin are likely to increase by 110,000 to 170,000 acre-feet, and currently planned projects leave a municipal water supply gap of between 45,000 and 94,000 acre-feet within the basin. This assumes that the basin implements identified projects and processes at a relatively high success rate.[32]

Arkansas Goals and Measurable Outcomes

To address this municipal gap, the Arkansas Roundtable identifies four goals related to meeting M&I needs.[33] These goals and their associated measurable outcomes, as stated in the BIP, are:

- *Meet the municipal supply gap in each county within the basin.*
  - *Generate a study by December 2015 determining surpluses and deficits within sub-regions/counties.*
  - *Funds provided in support of collaborative efforts reported annually.*
- *Support regional infrastructure development for cost-effective solutions to local water supply gaps.*
  - *Agreements to regional use of identified IPPs such as Southern Delivery System.*
  - *New Water Supply Reserve Grant (WSRA) grant request for regional infrastructure studies.*
  - *Agreements for off take of conduit water; funding of conduit processes and construction.*
- *Reduce or eliminate Denver Basin groundwater dependence for municipal users.*
  - *Presentations by groundwater dependent entities on solutions that have been implemented.*
  - *Presentations on interim solutions and funding requests to support those solutions and funding requests to support those solutions.*
  - *Funds provided in support of collaborative efforts reported annually.*
- *Develop collaborative solutions between municipal and agricultural users of water, particularly in drought conditions.*
  - *Pilot project implemented as reported annually.*
  - *Engineering template implemented by the DWR to expedite temporary transfers at reduced cost.*
- *Increase surface storage available within the basin by 70,000 acre-feet by the year 2020.*
  - *Storage capacity and percentage of stored water annually from 2015 to 2020.*
- *Annual reporting of projects that have been permitted and/or constructed.*

Meeting the Arkansas' M&I Gaps

The BIP supports the three primary recommendations to address the Arkansas Basin's M&I supply gap:[34]

- *The Arkansas Basin Roundtable acknowledges that a limited number of IPPs may be able to meet most of the gap.*
- *Storage is essential to meeting all of the basin's consumptive, environmental, and recreational needs. In addition to traditional storage, aquifer storage and recovery must be considered and investigated as a future storage option.*
- *The roundtable identified a critical gap as the need to replace nonrenewable groundwater and augment the sustainability of designated basins.*

Within its 2015 IPPs list, the basin has identified six projects that address M&I needs, four projects that address both M&I and agricultural needs, and one conservation project for a total of 125,000 acre-feet. The M&I projects identify 77,000 new acre-feet; the combined M&I and agriculture projects identify 48,000 new acre-feet; and the conservation project may reduce 500 acre-feet by 2030. These projects meet basin M&I gaps. Additionally, the basin identified examples of rehabilitation of nonfederal Arkansas Basin reservoirs to modern standards. If all potential rehabilitations were implemented, they would affect 220,775 acre-feet, and the estimated costs of the repairs would total $37,500,000.[35]

Actions required in order to meet the basin goal of increasing surface storage available within the basin by 70,000 acre-feet by 2020 include:

- *Implement a critical IPP.*
- *Work with the Office of Dam Safety to identify storage projects for restoration, rehabilitation, and increased capacity.*
- *Support funding, including grant contributions where appropriate, for storage restoration and expansion projects.*

These actions will work to meet both M&I and agricultural gaps.

Colorado

The Colorado Basin faces a gap in Mesa County that could begin as early as 2030.[36] Future needs in the basin are likely to increase by 65,000 to 110,000 acre-feet, and currently planned projects leave a municipal water supply gap within the Colorado Basin of 26,000 to 48,000 acre-feet. This assumes that the basin implements identified projects and processes at a relatively high success rate.[37]

Colorado Goals and Measurable Outcomes

To address this municipal gap, the Colorado Basin Roundtable identifies seven goals in their BIP related to meeting M&I needs.[38] These goals and their associated measurable outcomes are:

- *Develop land use policies requiring and promoting conservation.*
  - *Develop recommendations for city, county, and state governing bodies promoting water awareness and efficiency in land use policy.*
  - *Develop educational materials or opportunities for municipal and county elected officials and planning officials on water supply issues and conservation options.*
  - *Preserve agriculture and reduce the transfer of agriculture water to municipal use.*
- *Raise awareness of current obstacles and efforts facing water providers.*
  - *Publish a summary of state and basin water providers' true cost of water by analyzing operation and maintenance costs including sustainable infrastructure replacement programs.*
  - *Development of national, state or local funding assistance programs to replace aging infrastructure.*
  - *All basin water providers have sustainable infrastructure replacement funding programs.*
- *Protect drinking water supplies from natural impacts such as extended droughts, forest fires, and climate change, among others.*
  - *Every basin water provider has a reliable redundant water supply to meet 2050 demands.*
  - *Colorado Basin Roundtable or the CWCB to establish a biannual basin conference on natural disaster planning for water providers and government officials.*
- *Improve water court process*
  - *Recommendations to improve the objector process.*
  - *Recommendations to limit vulnerability of water rights when changing existing water rights in water court.*
  - *Improvements to Colorado water law to encourage agricultural water efficiency practices without harming water right value.*
- *Secure growing water demand by developing in-basin supplies and expanding raw water storage supply.*
  - *All basin water providers to meet current supply needs with redundancy, drought plans, and viable project options to meet future water needs.*

- *Reduce average permitting time for a reservoir project to less than 10 years.*
- *Establish regional water provider and ditch company cooperatives focused on improving regional relationships, water supply redundancy and flexibility, water quality, coordinated efforts for multi-beneficial projects, and addressing environmental and recreational needs.*
- *Reduce demands by establishing water conservation goals and strategies.*

- *Improve Colorado Water Law to encourage efficiency, conservation, and reuse.*
  - *Revised Colorado water law through legislation to allow more flexibility among water providers and the agricultural community to promote stream health through conservation, bypass flows, and flexibility in diversion location.*
  - *Reduce time of average Division 5 water court process by adding staff including judges, referees, and supporting staff.*
- *Pursue continued M&I conservation.*
  - *Achieve and sustain a high level of conservation by all basin water providers and industrial users.*

Meeting the Colorado's M&I Gaps

The Colorado Basin Roundtable underwent a prioritization process to identify and include high-ranking projects in its BIP. From its initial list of high-priority projects, it quantified 20,272 acre-feet of additional supplies beyond the IPPs to meet both M&I and agricultural gaps. In addition, the roundtable plans to implement high conservation. Half of total savings, which is equivalent to 20,000 acre-feet, could be used to address new demands. Together, at just over 40,000 acre-feet, the Colorado mainstem could have sufficient water to meet the 26,000 acre-feet needed under the No-and-Low-Regrets scenario, but not enough for the high potential M&I gap of 48,000 acre-feet the SWSI 2010 identified.[39]

In addition, the basin roundtable developed an extensive list of potential M&I projects by interviewing more than 60 water providers throughout the basin.[40]

If all of the projects and methods identified were implemented, as a whole the Colorado Basin's M&I gap would be more than met. The BIP identified 54 potential M&I projects that quantified the acre-feet, which added up to nearly 510,000 to 540,000 acre-feet—far exceeding the amount needed under the high potential M&I gap.[41] However, given that many have not identified a project proponent, uncertainty exists about whether communities can count on many of these water projects becoming a reality.

In summary, even the high potential M&I gap could be fully met if the Colorado River Basin implements high conservation, the high-priority projects identified, and a small portion of the projects from the full list of potential projects. However, uncertainty about the viability of many of the projects, and about specific commitments from water providers, makes reliance on these projects and commitment to high conservation levels uncertain.

Gunnison

The Gunnison Basin faces a gap that could begin as early as 2035 in Delta County.[42] Future needs in the basin are likely to increase from 16,000 to 23,000 acre-feet, and currently planned projects leave a municipal water supply gap of 3,700 to 6,100 acre-feet within the Gunnison Basin. This assumes that the basin implements identified projects and processes at a relatively high success rate.[43] In addition, the Gunnison BIP states that demands in Ouray County may be higher than the SWSI 2010 indicated.[44]

Gunnison Goals and Measurable Outcomes

To address this municipal gap, in its BIP the Gunnison Basin Roundtable identifies one goal related to meeting M&I needs.[45] That goal and its associated measurable outcomes are:

- *Identify and address M&I water shortages.*
  - *Reliably meet 100 percent of essential municipal water provider system demands in the basin through the year 2050 and beyond.*
  - *Continue the current baseline of effective water conservation programs by covered entities in the basin, with the goal being high levels of conservation savings as defined in SWSI 2010.*

In addition, the Gunnison BIP outlines the following statewide principles related to municipal conservation, including implementation steps:[46]

- *Water conservation, demand management, and land use planning that incorporates water supply factors should be equitably employed statewide.*
  - *Work with other basin roundtables to support conservation, demand management, and the incorporation of water supply factors into land use planning and development.*
  - *Promote programs that encourage drought tolerant vegetation and discourage lawn irrigation.*

Meeting the Gunnison's M&I Gaps

The Gunnison Basin Roundtable identified two water conservation activities and five tier-1 projects that would help meet future M&I needs and that were not previously identified in the SWSI 2010. "Tier 1" signifies that implementation is likely feasible by 2025, and that the project does an excellent job of meeting basin goals. If the basin implements the five projects, they will provide nearly 12,000 acre-feet.[a] This volume fully meets the gap the SWSI 2010 identified. The Gunnison BIP states that, "M&I needs … are generally expected to be managed with sufficient existing supplies and/or through planned projects."[b] Given this analysis, the Gunnison Basin meets its M&I gap.

In addition to these projects, the Gunnison Basin Roundtable also advocates for high-conservation standards, as the SWSI 2010 identified. The implementation of these standards and active conservation would likely result in water savings of another 5,500 acre-feet, which the basin could apply to meet future demands.

North Platte

The North Platte Basin no longer has an M&I supply gap. As stated in the North Platte BIP, "The North Platte Basin has only one municipal water provider, the Town of Walden, serving a population of about 600. Limitations to the town's water supply were identified in the original SWSI report, and subsequently addressed through a CWCB funded study and multi-alternative project, eliminating the only municipal water supply gap in the basin."[47]

North Platte Goals and Measurable Outcomes

Nonetheless, the basin indicated support for municipal conservation, which could help meet any additional needs. As expressed in the BIP, this goal and its associated measurable outcome are:

- *Support the equitable statewide application of municipal water conservation.*
  - *Comply with future statewide municipal-conservation strategies and any related legislation by 2020, or as appropriate.*

Meeting the North Platte's M&I Gaps

The North Platte has met its future M&I needs.

Rio Grande

The Rio Grande Basin has a relatively small, though important, M&I gap. According to the CWCB's analyses, this gap could begin as early as 2025 in Costilla County.[48] The studies indicate that future needs in the Rio Grande are likely to increase by 7700 to 13,000 acre-feet, and currently planned projects leave a municipal water supply gap of between 2300 to 5100 acre-feet within the Rio Grande Basin.[49] This assumes that the basin implements the identified projects and processes at a relatively high success rate.[50] The Rio Grande Basin would like to better determine the amount, timing, and location of the gap once the Rio Grande Decision Support System groundwater model is ready. The basin expects that most water providers will have a gap and will need to join a groundwater management subdistrict or develop an independent augmentation plan.

Rio Grande Goals and Measurable Outcomes

To address this municipal gap, in its BIP the Rio Grande Basin Roundtable identifies three primary goals for meeting M&I needs. These goals and their associated measurable outcomes are:[51]

- *Operate, maintain, rehabilitate, and create necessary infrastructure to meet the basin's long-term water needs, including storage.*
  - *A database of existing water infrastructure including documentation of infrastructure condition and mapping of all storage reservoirs and major ditch diversions is created.*

[a] Wilson Water Group, Gunnison Basin Implementation Plan.
[b] Wilson Water Group, Gunnison Basin Implementation Plan.

- *Reservoirs operate at full design capacity without restrictions.*
- *Diversion structures and conveyance systems function optimally.*
- *Municipal potable water supplies are adequate to meet needs.*
- *Water supplies and wastewater treatment systems are fully functional and meet all necessary standards.*

- *Support the development of projects and methods that have multiple benefits for agricultural, M&I, and environmental and recreational water needs.*
  - *Opportunities for multiple use benefits have been explored and implemented where possible.*
  - *Multiple-purpose projects will have preference in the funding process.*
- *Meet new demands for water, to the extent practicable, without impacting existing water rights and compact obligations.*
  - *Reduce per capita per day water use to a reasonable level.*
  - *Inventory existing and expected future M&I and environmental and recreational water needs.*
  - *Add hydropower electrical generating capacity where possible.*
  - *Develop an M&I plan that addresses water needs, availability, and a strategy for meeting the needs for M&I while sustaining agricultural water use and minimizing effects on other uses.*

Meeting the Rio Grande's M&I Gaps

The Rio Grande Basin Roundtable identified very few municipal projects beyond the identified projects and processes in SWSI 2010, and only one of these projects provides additional acre-feet to meet growing municipal needs. In its BIP, it acknowledges this by stating:

- *While M&I and Self-Supplied Industrial (SSI) water use will remain a small percentage of overall basin water use, it is important to provide additional resources to M&I water providers to assist them in meeting future needs by identifying and assisting in the development of:*
  - *Measures to manage water demands and return flows and develop methods to receive augmentation credits for wastewater discharges and lawn irrigation return flows.*
  - *Water rights, storage and augmentation supplies, either directly or through the groundwater management subdistricts.*
  - *Finalization of the Rio Grande Decision Support System groundwater model so that M&I pumping depletions can be determined in amount, timing, and location.*[52]

The Rio Grande has not yet quantified its future M&I gap. Once the basin determines well-pumping depletions by amount, timing, and location, the M&I providers will either join a subdistrict or develop an independent augmentation plan.

South Platte (including the Metro Area and Republican Basin)

The Metro, South Platte, and Republican Basins face a municipal gap that could begin as early as 2020 in the Lower South Platte. When taking into account the need to replace nontributary groundwater, that gap already exists in the South Metro Area Basin.[53] The potential gap in the Lower South Platte is relatively small compared to that of the urbanized Front Range, which holds the largest gap in Colorado. Future needs in the basin as a whole are likely to increase by 340,000 to 505,000 acre-feet. However, water needs for hydraulic fracturing must be added to the water supply gap. With existing data, currently planned projects leave a municipal water supply gap within Colorado's northeast region of 204,000 to 310,000 acre-feet. This assumes that the basin implements identified projects and processes at a relatively high success rate.[54]

South Platte Goals and Measurable Outcomes

To address this M&I gap, the South Platte BIP developed a long-term goal:[55]

Meet community water needs throughout Colorado by: 1) Using water efficiently with high levels of participation in conservation programs; 2) Developing additional water throughout the state through balanced, multi-purpose projects and methods; and 3) Assuring strong drought protection programs through broad development of protection plans and dedicated reserves potentially including storage, interruptible service agreements (ISAs), water banks, water use restrictions and nontributary groundwater, among others.

In the short term, the South Platte developed four goals and associated measurable outcomes to meet the large M&I water supply gap in the South Platte Basin:[56]

- *Continue the South Platte River Basin's leadership in wise water use.*
  - *Further quantify the successes of programs implemented in the past several years throughout the South Platte River Basin and establish a general baseline against which the success of future programs will be assessed.*
  - *Distribute and encourage adoption of "best management practices" as "guidelines" (not standards) for M&I water suppliers to consider in their "provider-controlled" programs recognizing the substantial differences in climates, cultures, and economic conditions throughout the South Platte River Basin.*
  - *Enhance current levels of municipal water reuse and consider studies to quantify the effects of: 1) additional municipal water conservation on water available for reuse; 2) additional municipal water reuse in elation to water available for exchanges; 3) reuse and successive uses of water downstream including effects on agricultural water shortages.*
  - *Ensure conservation, reuse, and drought management plans take into consideration environmental and recreational focus areas and attributes.*
- *Bring a high percentage of entries in the updated IPP list online as a key strategy consistent with the "no/low regrets" scenario planning approach.*
  - *Maximize implementation of the updated IPP list.*
  - *Encourage multi-purpose projects that also provide environmental and recreational considerations. Foster opportunities to improve environment and recreation conditions of affected watersheds in association with IPPs.*
- *To the extent possible, develop multi-purpose storage, conveyance, system interconnections, and other infrastructure projects to take advantage of limited remaining South Platte supplies and enhance water use efficiencies and supply reliability.*

Baseball fields dot the landscape near the Denver Technological Center (DTC). The DTC is home to several major businesses and corporations.

- *Explore opportunities to maximize yield from additional South Platte Basin strategic and multi-purpose storage and other infrastructure including collaborative interconnections between water supply systems and above ground and groundwater (e.g. Aquifer storage and recharge (ASR) and alluvial recharge) storage.*
- *Encourage multi-purpose projects that provide environmental and recreational considerations.*
- *Take into consideration environmental and recreational attributes when considering Storage and Other Infrastructure projects and methods.*

- *Maintain, enhance and proactively manage water quality for all use classifications.*
  - *Maintain or improve the delivery of safe water supplies throughout the basin.*
  - *Monitor, protect and improve watershed water quality and identify and document progress and improvements.*
  - *Improve areas where water quality may be limiting the suitability of focus areas identified by BRTs through environmental and recreational mapping efforts.*
- *Develop agreements governing additional trans basin water imports that: 1) are in accordance with the South Platte Basin's overarching theme that economic, environmental and recreational benefits should equitably accrue to both the western slope and the eastern slope; 2) include project(s) or project elements that provide multiple types of uses; 3) supported with state investment; and 4) provide enough certainty in conditions to substantially lessen current trends of traditional buy-and-dry transfers from agricultural uses to M&I uses.*
  - *Through the IBCC, negotiate a conceptual agreement with the western slope basin roundtables on investigating, preserving, and developing potential options so that future multi-purpose projects benefiting both slopes can be addressed on a timely basis.*
  - *Encourage multi-purpose projects that provide environmental and recreational considerations.*

Meeting the South Platte's M&I Gaps

The South Platte BIP includes a list of potential M&I projects, a conservation strategy, and some initial portfolios to accomplish its goals and meet the identified M&I gaps.[57] It used similar categories to the No-and-Low-Regrets work Section 6.1 describes. A comparison is provided below:

- The BIP partially meets the No-and-Low-Regrets goals associated with conservation. The Metro and South Platte Basins estimate they will further reduce M&I demand to 129 gallons per day per capita (GPCD) and 146 GPCD, respectively. The BIP applies 50 percent of active conservation savings, plus all passive savings, to meet future needs in their portfolio work. Approximately 53,000 acre-feet of active conservation savings apply to future needs. The basins would need to apply a substantially higher percentage of active conservation in order to fully meet the No-and-Low-Regrets goal of applying 97,000 acre-feet to meet new demands.
- The BIP meets the No-and-Low-Regrets goal of 199,000 acre-foot yield from the IPPs. The total yield from the IPPs the basin describes in its BIP exceeds the No-and-Low-Regrets goals, yielding about 225,000 acre-feet. This is partly attributed to the fact that the BIP identifies 16 new projects (seven for reuse, four for agricultural transfers, and five for basin projects) that were not previously in the SWSI 2010.
- The No-and-Low-Regrets actions indicate that basins would need to generate 22,000 acre-feet of reuse water from new agricultural diversions and any new TMD projects. The BIP proposes 45,010 new acre-feet of water from reuse. Although the South Platte BIP discusses reuse, the BIP's portfolio work did not calculate reuse from these new projects.
- The No-and-Low-Regrets actions indicate that the basin needs a minimum of 44,000 acre-feet of additional agricultural transfers, and that these transfers should ideally be alternative agricultural transfers. The BIP identifies 4560 acre-feet of alternative transfer methods (ATMs). It also indicates that, by applying conservation to meet new demands, portfolios B and C would need between 25,000 and 90,000 acre-feet of

additional agricultural dry-up. Therefore, the BIP likely meets this No-and-Low-Regrets goal. Portfolios B and C identified about 30,000 acre-feet of alternative transfer-method water. The BIP also includes recommendations to streamline transaction costs for ATMs.

Southwest

The Southwest Basin faces a gap that could begin as early as 2015 in Montrose County.[58] Future needs in the Southwest Region are likely to increase by 20,000 to 31,000 acre-feet, and currently planned projects leave a municipal water supply gap within the Southwest region of 8,800 to 16,000 acre-feet. This assumes that the basin implements identified projects and processes at a relatively high success rate.[59]

Southwest Goals and Measurable Outcomes

To address this municipal gap, in its BIP the Southwest Basin Roundtable identified four goals related to meeting M&I needs. These goals and their associated measurable outcomes are below:[60]

- *Pursue a high success rate for identified specific and unique projects and processes to meet the municipal gap and to address all water needs and values.*
  - *Complete 40 IPPs aimed at meeting municipal water needs.*
- *Provide safe drinking water to Southwest Colorado's citizens and visitors.*
  - *Consistently meet 100 percent of residential, commercial, and industrial water system demands identified in SWSI 2010 in each sub-basin, while also encouraging education and conservation to reduce demand.*
  - *Implement at least one IPP that protects or enhances the ability of public water supply systems to access and deliver safe drinking water that meets all health-based standards.*
- *Promote wise and efficient water use through implementation of municipal conservation strategies to reduce overall future water needs.*
  - *Change the ratio of in-house to outside treated water use for municipal and domestic water systems (referred to as water providers herein) from the current ratio of 50 percent in-house use and 50 percent outside use, to 60 percent in-house use and 40 percent outside use (60/40 ratio) for Southwest Colorado and the entire defined as requiring a water court change case state by 2030.*
  - *Implement three informational events about water reuse efforts, tools, and strategies.*
  - *The water providers in the state that are using dry up of agricultural land[c] and/or pursuing a new TMD[d] shall have a higher standard of conservation. The goal for these water providers is a 70/30 ratio by 2030. This is a prerequisite for the roundtable to consider support of a new TMD.*
- *Support and implement water reuse strategies.*

Meeting the Southwest's M&I Gaps

The Southwest BIP includes a list of potential M&I projects compiled from interviews with providers in each sub-basin.[61] The roundtable identified seven new projects to include components that would meet future municipal supply needs, and several others that would address other infrastructure needs within the basin. Among these seven projects, a total of nearly 40,000 acre-feet was identified. However, it is not clear whether each geographic region in the basin will be able to meet its future needs if it implements the listed projects.[62]

The Southwest Basin Roundtable acknowledged that while it did not quantify every identified project in its BIP, the projects and methods would fully meet their M&I water supply gap as well as the basin's infrastructure needs.

[c] Defined as requiring a water court change case.
[d] As defined by the IBCC to be a new western slope to eastern slope diversion project.

Yampa/White/Green

The Yampa/White/Green Basin faces a gap that could begin as early as 2015 in Rio Blanco and Moffat Counties.[63] According to SWSI 2010, future needs in this northwest Colorado region are likely to increase by 34,000 to 95,000 acre-feet. However, these needs will likely be revised downward, since all indications show that oil shale will not become commercially viable by 2050.[64] Energy development from hydrologic fracturing is a new need that basins should also take into account when calculating the M&I water supply gap. With existing data, currently planned projects leave a municipal water supply gap of 24,000 to 83,000 acre-feet within Colorado's northwest region. This assumes that the basin implements identified projects and processes at a relatively high success rate.[65]

Yampa/White/Green Goals and Measurable Outcomes

To address this M&I gap, the Yampa/White/Green BIP identified four goals related to meeting M&I needs. These goals and their relevant measurable outcomes and processes are below:[66]

- *Protect and encourage agricultural uses of water in the Yampa/White/Green Basin within the context of private property rights.*
  - *Process*
    - *Identify agricultural water shortages and evaluate potential cooperative and/or incentive programs to reduce agricultural water shortages.*
    - *Identify projects that propose to use at-risk water rights, alternative transfer methods, water banking, and efficiency improvements that protect and encourage continued agricultural water use.*
    - *Encourage and support M&I projects that have components that preserve agricultural water uses.*
  - *Outcomes*
    - *Preserve the current baseline of about 119,000 irrigated acres and expand by 12 percent by 2030.*
    - *Encourage land use policies and community goals that enhance agriculture and agricultural water rights.*
- *Identify and address M&I water shortages.*
  - *Processes*
    - *Identify specific locations in the Yampa/White/Green Basin where M&I shortages may exist in drought scenarios and quantify shortages in time, frequency, and duration.*
    - *Identify effects throughout the Yampa/White/Green Basin in the context of water shortages (drought and climate change), wildfire and compact shortage on M&I demands.*
    - *Identify projects and processes that can be used to meet M&I needs.*
    - *Encourage collaborative multi-purpose storage projects.*
    - *Support efforts of water providers to secure redundant supplies in the face of potential watershed effects from wildfire.*
    - *Encourage municipal entities to meet some future municipal water needs through water conserv*ation and efficiency
  - *Outcomes*
    - *Reliably meet 100 percent of M&I demands in the basin through the year 2050 and beyond through the following processes:*
- *Maintain and consider the existing natural range of water quality that is necessary for current and anticipated water uses.*
  - *Processes*
    - *Encourage and support water quality protection and monitoring programs in the sub-basins of the Yampa/White/Green Basin through watershed groups, municipalities, land management agencies and other efforts.*
  - *Outcomes*
    - *Consider and maintain the existing water quality necessary for current and future water uses when reviewing IPPs.*
    - *Support the implementation of water-quality monitoring programs to create quality-controlled baseline data for all sub-basins of the Yampa/White/Green Basin.*

Meeting the Yampa/White/Green's M&I Gaps

The Yampa/White/Green Basin Roundtable conducted the most thorough analysis of how well the implementation of future projects and methods would meet M&I needs. In addition, the roundtable assessed these needs under a hot-and-dry future. Below is an excerpt from the BIP describing potential future shortages:

> *Municipal Shortages:*
>
> *M&I demands are small compared to agricultural demands in the Yampa/White/Green Basin. Under Baseline Conditions, no shortages exist to M&I demand nodes because of generally adequate water supply and augmentation from reservoirs.*
>
> *While M&I shortages exist under the high demand, low water supply scenarios of the Dry Future IPP Scenario and the Dry Future Scenario, the shortages remain below 10 percent. Under both scenarios, District 43 existing M&I in Rio Blanco County (Rangely Water, Meeker Demand) and District 58 existing M&I in Routt County (the City of Steamboat Springs) begin to exhibit shortages, whereas Moffat County municipal nodes do not show M&I shortages under either scenario. If IPPs are developed that include M&I use, shortages would likely decrease in locations with supply augmentation.*
>
> *Industrial Shortages:*
>
> *Under Baseline Conditions, no shortages exist for SSI, which consist of thermoelectric power generation needs. Slight shortages exist for the Hayden Station and units 1 and 2 of Craig Station under the Dry Future IPP Scenario and the Dry Future Scenario. These scenarios meet thermoelectric demands with redundant water supplies from Steamboat Lake for Hayden Station and Elkhead and Stagecoach Reservoirs for Craig Station. Using historical data, hypothetical shortages would have occurred for the Hayden Station in the dry months of August 1961, March 1962, September 1977, and September 2002) and for the Craig Station in the dry months of November 1963, September 1977, December 2002, and a few months in 1949.*

Nevertheless, SSI water users consider their water supply short when they must rely upon redundant water supplies. For example, some SSI water users considered the years 2002, 2003, 2012, and 2013 to be "water supply-short" or "borderline-short" due to their reliance on redundant supplies. Further discussions will take place regarding the most appropriate baseline conditions and shortage assessments in light of drought, climate change, and evolving power generation technologies[67]

Overall, the roundtable modeled nine M&I projects and methods, including conservation in Steamboat Springs, which the SWSI 2010 did not previously identify. The roundtable only modeled projects that identified a project proponent, a location, physical characteristics, and operations. It quantified acre-feet that are associated with eight of the projects, and that meet the potential needs of the energy industry. The total, newly quantified acre-feet to meet M&I needs adds up to 198,000.[68] In conclusion, the BIP identified projects that meet future M&I demands.

Meeting Colorado's Agricultural Needs

The agricultural gap is the difference between the status quo, which shows a reduction in irrigated acres in almost every basin (Figure 6.2-1, page 6-32), and what the State or a basin indicates it *wants to achieve* with regard to agriculture in accordance with its goals and measurable outcomes, minus the projects and methods that are *planned* to meet those needs.[69] While every basin indicated that maintaining viable agriculture is one of the most important aspects of its BIP, this definition allows for considerable variability between basins, which face different issues related to agriculture.

Colorado expects its irrigated acres to decline in almost every basin by 2050 (Figure 6.2-1, page 6-32)—but these projected declines have differing causes. Similarly, every basin has agricultural shortages. The BIPs work to address these challenges by identifying projects that could reduce shortages, maintain the agricultural economy and, in some cases, increase irrigated acres.

To address the challenges associated with shortages and declining irrigated acres, the CWCB has identified four statewide long-term goals:[70]

- *Ensure that agriculture remains a viable economic driver in Colorado by supporting food security, jobs, and rural communities while protecting private property rights.*
- *Meet Colorado's agricultural needs.*

- *Implement efficiency and conservation measures to maximize beneficial use and production.*
- *Protect and enhance Colorado's natural resources, and provide ecosystem services.*

Before exploring how the basins developed solutions within their BIPs to meet these and other local goals, it is important to understand some of the statewide issues related to shortages and the decline in irrigated acres. The CWCB expects irrigated acres to decline for three primary reasons:[71]

1. Urbanization of agricultural lands, which is primarily an issue in the South Platte and Colorado Basins;
2. Conversion of agricultural water rights to municipal rights in order to meet future municipal needs, which is mostly occurring in the South Platte, Colorado, and Arkansas Basins; and
3. Voluntary reductions in water use associated with sustainable groundwater supplies and compact obligations, which are ongoing in the Rio Grande and Republican Basins.

Underlying many of the reasons for agricultural decline are temporary and downward state, national, and international agricultural economic trends. However, by 2050, the CWCB expects the agricultural economy to be increasingly viable because of a global increase in the number of people who need food, and the number of people who can afford high-quality and high-protein agricultural products.[72] Colorado's agricultural production is also vital locally. As Chapter 3 describes, 50 percent of jobs are related to agriculture in some counties.

From a statewide perspective, it is important to provide options and incentives that help maintain, or even increase, Colorado's agricultural economy and production in light of the loss of irrigated acres. The "agricultural gap" described above will need to be addressed in order to meet the strategic position that

Headgates help water users control the flow of water throughout the state.

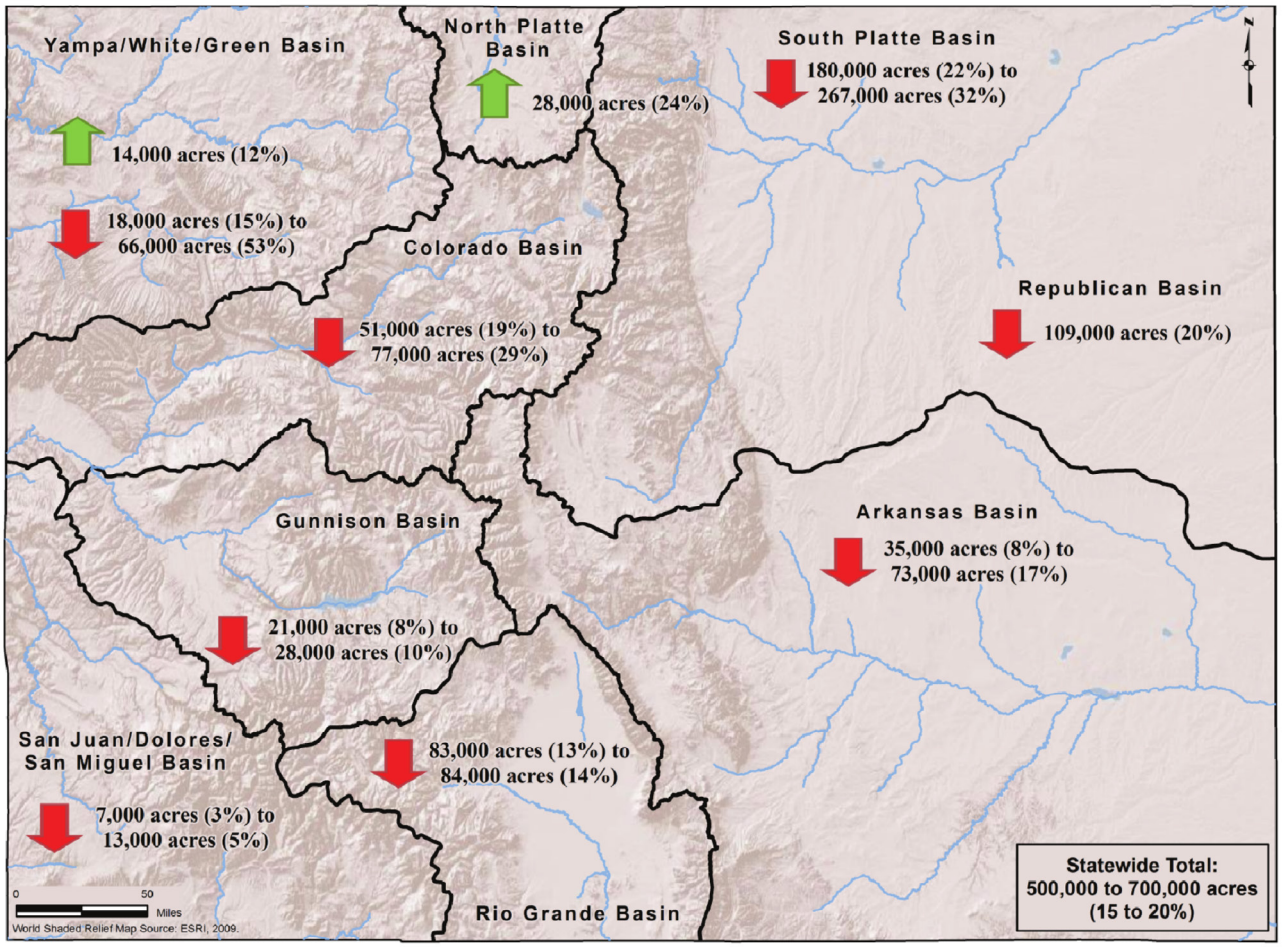
Colorado and the basins seek to achieve in 2050 from an agricultural perspective. Nevertheless, quantifying this prospective agricultural gap is difficult. As a result, many basins choose to reduce agricultural shortages or find alternative sources of water so that the transfer of agricultural water is not the default solution to meeting Colorado's growing needs.

Several basins discuss reduction of shortages, and it is therefore important to understand the definition of agricultural shortage. As the Gunnison BIP describes, three primary factors can cause agricultural shortages:[73]

> ***Physical shortages*** *are because of lack of physical supply. Such shortages are often seen later in the irrigation season principally by irrigators on smaller tributaries. Though irrigation water rights may be* in *priority, there is not enough supply. Although these shortages are exacerbated in dry years, on many of the tributaries physical flow is not sufficient to meet the crop irrigation requirement (CIR) for the entire growing season even in wet years.*
>
> ***Legal shortages*** *are those because of lack of legal supply; there may be physical supply at a headgate, but it must be bypassed to meet downstream senior water rights. This type of shortage is often seen later in the season by irrigators with junior water rights in average and wet years, and may be the situation for junior irrigators the entire growing season in dry years.*
>
> ***Irrigation practice "shortages"*** *result from specific irrigation practices; the irrigator may have physically and legally available supply but chooses not to irrigate. For example, some irrigators may need to reduce or cease irrigation to allow the land time to dry before haying or grazing. In addition, an irrigator may cease diverting because there is*

FIGURE 6.2-1 **POTENTIAL CHANGES IN IRRIGATED ACRES BY 2050**[74]

(↑ = increase in irrigated acres; ↓ = decrease in irrigated acres)



not enough time left in the growing season for an additional cutting. Note, though this [is] a very different type of shortage, it is equally important to document. Identification of shortages related to irrigation practices helps to quantify the difference between CIR and actual consumptive use in SWSI and other statewide planning efforts. In addition, since irrigation practice shortages cannot be addressed by increased water supply, their identification helps to focus on the implementation of projects that meet physical and legal shortages.

Due to variables such as economic viability, irrigation practice "shortages," and other factors, an agricultural shortage is not necessarily an agricultural gap. Colorado continues to have a healthy agricultural economy, despite shortages ranging between 17 and 45 percent statewide.

This subsection reviews information by basin, and Table 6.2-3 summarizes each basin's success in meeting its agricultural gaps as defined by its goals.

Arkansas

The Arkansas Basin has the third-highest acreage of irrigated land in Colorado and the highest percentage of shortages (45 percent) in comparison to other basins.[78] In addition, irrigated acres are likely to decline by 8 to 17 percent.[79] These estimated declines are primarily due to agricultural transfers from both within the basin and from municipal interests in the South Platte Basin. Still, as many as 3000 irrigated acres (1 percent) may urbanize.

Arkansas Goals and Measurable Outcomes

To address these pressures, in its BIP the Arkansas Basin Roundtable identified four goals related to sustaining agriculture.[80] These goals and their associated measurable outcomes are:

- *Sustain an annual $1.5 billion agricultural economy in the basin.*
  - *Increase in measured economic productivity by update of Colorado State University study in 2020.*
- *Provide augmentation water as needed to support increased farm efficiencies.*
  - *Document the baseline of current augmentation water available.*
  - *Track available storage facilities for augmentation sources.*
- *Develop a viable rotating fallow and/or leasing program between agriculture and municipal interests to address drought and provide risk management for agriculture.*
  - *Report on pilot projects underway as of December 2015.*
  - *Complete and present report by December 2015.*
  - *Survey of permanently retired acreage as of year 2020.*
- *Sustain recreational and environmental activities that depend on habitat and open space associated with farm and ranch land.*
  - *Measure the economic contribution of tourism to the basin economy within the CSU 2020 update.*
  - *Change of status for "protected" attributes as measured by nonconsumptive projects and methods in SWSI 2016 report.*
- *Increase surface storage available within the basin by 70,000 acre-feet by the year 2020.*
  - *Storage capacity and percentage of stored water annually from 2015 to 2020.*
- *Annual reporting of projects that have been permitted and/or constructed.*

Meeting the Arkansas' Agricultural Gap

The primary goal is to support the $1.5 billion agricultural economy in light of agricultural loss.[81] As the BIP indicates, a multipronged strategy is necessary:

> *To maintain that level of economic productivity, projects and methods described in [the BIP] focus on development of rotating fallowing, conservation easements, and increased storage capacity to allow agricultural water to sustain agricultural productivity. In particular, a three-pronged approach to understanding rotational fallowing within the Prior Appropriation Doctrine is underway — an administrative and accounting tool, pilot projects and public policy dialogue — and will continue.*[82]

The Arkansas Basin identified 89,000 new acre-feet associated with seven projects that focus primarily on agricultural needs, and four projects that focus on agricultural and M&I needs. One of the multipurpose projects, which meets both agricultural and M&I needs, will also irrigate 2000 new acres. Adaptive

TABLE 6.2-3 SUMMARY OF HOW EACH BASIN MET ITS AGRICULTURAL GAPS

Basin	Irrigated Acres[75]	Shortage (Acre-feet/Year)[76]	Potential New Acre-feet	# of New Projects	Summary of How BIPs Met Their Agricultural Goals/Gaps
Arkansas	428,000	30,000 – 50,000 (augmentation gap)[e]	89,000	22	Yes decrease shortages; potential to sustain agricultural $1.5 billion economy w/ actions; don't develop specific augmentation water projects; policies and projects support rotational fallowing, policies support agriculture- related recreational and environmental uses with conservation easements
Colorado	268,000	100,000	20,000	3	Partially decrease shortages; discuss some efforts to develop incentives and decrease urbanization and agricultural to urban transfers
Gunnison	272,000	116,000[77]	129,000	17	Yes decrease shortages, partially discourage agricultural transfers through policies
North Platte	117,000	110,000	12,000	12	Increase irrigated acreage to partially meet 17,000 acre goal; increase storage to partially meet 37,000 acre-feet goal
Rio Grande	622,000	428,000	800	1	Yes, improve infrastructure; partially improve agricultural economy
South Platte	1,381,000 (831,000 SP, 550,000 Republican)	434,000 (160,000 SP, 274,000 Republican)	0	0	Partially reduce permanent dry-up w/ conceptual ATMs and alternative sources, don't reduce urbanization or shortages
Southwest	259,000	198,000	20,000	6	Partially decrease shortages; Yes, increase efficiency w/ IPPs; discuss policy to minimize acres transferred, have no agricultural-sharing IPPs
Yampa / White / Green	119,000	54,000	25,000	3	Increase number of irrigated acres to partially meet 15,000 acre goal; partially decrease shortages by 46%
TOTALS	**3,466,000**	**1,470,000 – 1,490,000**	**296,000**	**64**	

[e] The Arkansas Basin Roundtable aspires to maintain the agricultural economy in the basin, and does not identify the agricultural gap in terms of irrigated acreage. Under the Arkansas River Compact, consumptive use is limited, so the roundtable believes that a gap expressed in terms of an "augmentation gap" is a more appropriate evaluation of needs.

Resources, Inc.[83] recently prepared a study for the Lower Arkansas Valley Water Conservancy District showing that the basin needs 25,000 to 30,000 acre-feet for augmentation today, and those needs will grow to more than 50,000 acre-feet by the year 2050. If the basin implements the identified projects it will meet its 2050 augmentation agricultural gap.

To meet its goal of increasing available surface storage by 70,000 acre-feet by 2020, the basin has identified the following actions in its BIP:

- *Implement a critical IPP.*
- *Work with the State Engineer's Office of Dam Safety to identify storage projects for restoration, rehabilitation, and increased capacity.*
- *Support funding, including grant contributions where appropriate, for storage restoration and expansion projects.*

These actions will work to meet both M&I and agricultural gaps.

Actions to meet the basin goal of providing augmentation-water to support increased farm efficiencies include:

- *Establish long-term sources of augmentation-water through leasing, water banks, or interruptible supply agreements.*
- *Construct recharge facilities to capture and re-time fully consumable water supplies.*

Colorado

The Colorado Basin has the fifth-highest acreage of irrigated land in Colorado and the lowest percentage of shortages as a basin (17 percent).[84] The CWCB expects irrigated acres to decline by 19 to 29 percent.[85] This likely decline is primarily due to urbanization, which accounts for 65 to 80 percent of the loss—and totals about 40,000 to 50,000 acres. The remaining agricultural loss is due to agricultural-to-municipal transfers.[86]

Colorado Goals and Measurable Outcomes

To address these pressures, in its BIP the Colorado Basin Roundtable identified four goals related to sustaining agriculture.[87] These goals and their associated measurable outcomes are:

- *Reduce agricultural water shortages.*
  - *Identify multi-purpose storage projects and methods that address the annual 100,000 acre-feet agricultural shortage.*
  - *Maintain existing irrigated agricultural acreage.*
  - *Research local agricultural shortage values in the Colorado River Basin.*
  - *Improve Colorado water law to encourage agricultural water efficiency practices without harming water right value.*
  - *Establish lease programs for excess water from existing supply projects in the M&I sector or multi-use projects.*
- *Minimize potential for transfer of agricultural water rights to municipal uses.*
  - *Identify farm improvements to develop strong sustainable farm economics.*
  - *Develop a set of quantifiable factors of agriculture pressures that can be measured and evaluated in the future to incentivize production and reduce trends towards transfers.*
  - *Adopt local land use codes to conserve water and reduce pressures for agricultural water transfers.*
  - *Promote conservation easements with the anticipated result that they will be more widely considered by the agricultural community.*
- *Develop incentives to support agricultural production.*
  - *Reimburse agriculture for value added to the environment including,water quality, wildlife, and views capes.*
  - *Track effectiveness of agricultural incentives in maintaining irrigated acres.*

- *Minimize regulatory disincentives such as overly stringent requirements for reservoir construction.*
- *Reduce taxes for true self-sustaining agriculture.*
- *Develop incentives that encourage continued agricultural production.*

- *Promote agricultural conservation that maintains agricultural production and viability.*
  - *Revise Colorado Water Law to allow agricultural conservation and improved efficiency measures without impacting water right value or risk of abandonment.*
  - *Strive towards a high level of conservation and efficiency within the agricultural industry.*

Meeting the Colorado's Agricultural Gaps

The Colorado Basin Roundtable identified 21 high-priority projects that meet basin theme 2: Sustain agriculture. The high-priority projects quantified a total of 20,272 acre-feet as meeting both agricultural and M&I gaps. While this amount is insufficient to fully address agricultural shortages in the basin, the Colorado BIP identified 41 projects with quantifications of acre-feet that could reduce agricultural shortages in the basin by a total of 453,000 to 483,000 acre-feet. These projects could eliminate the 100,000 acre-feet of shortages in the basin. However, neither a spatial nor a hydrological analysis has been done to confirm this. Furthermore, the number of projects the basin is likely to implement is unclear, as several of them lack active project proponents.

With regard to addressing agricultural losses due to urbanization, the BIP has several suggestions concerning land use. If these suggested actions are implemented, they could reduce urbanization, but the BIP has not quantified those effects. In addition, the BIP states a need to promote other activities to minimize agricultural loss from water rights transfers, improve agricultural efficiency, and support agricultural production. For policy implementation to occur, the BIP must provide more detail.

In summary, the basin will likely need to implement both high-priority projects and methods and some projects from the full projects list in order to fully address its agricultural shortages and partially address its other goals.

Gunnison

The Gunnison Basin has the fourth-highest acreage of irrigated land in Colorado and the second-lowest percentage of shortages as a basin (20 percent).[88] In addition, irrigated acres are likely to decline by 8 to 10 percent.[89] This anticipated decline is primarily due to urbanization, which could take 20,000 to 26,000 acres out of production.[90]

Gunnison Goals and Measurable Outcomes

To address these issues, the Gunnison BIP identified two goals related to sustaining agriculture.[91] These goals and their associated measurable outcomes are:

- *Improve agricultural water supplies to reduce shortages.*
  - *Reduce basin-wide agricultural shortages by developing 10 projects from the list of recommended solutions in the Gunnison BIP by the year 2030.*
  - *Implement the Inventory of Irrigation Infrastructure Improvement Needs projects from the list of recommended solutions in the Gunnison BIP by 2020.*
- *Discourage the conversion of productive agricultural land to all other uses within the context of private property rights.*
  - *Preserve the current baseline of 183,000 protected acres in the Gunnison Basin and expand the participation in conservation easements by five percent by 2030 through programs like the Gunnison Ranchland Conservation Legacy.*

The primary basin goal identified in the Gunnison BIP was to "Protect existing water uses in the Gunnison Basin." This goal framed much of the BIP discussion, especially with regard to meeting agricultural needs.

Meeting the Gunnison's Agricultural Gaps

The Gunnison Basin Roundtable identified 17 projects that it expects the basin to implement in the near term. If the basin implements these projects, it will reduce shortages by approximately 129,000 acre-feet. In addition, infrastructure improvement projects will improve agricultural efficiencies, even though they may not yield acre-feet. The Gunnison BIP also states a goal of protecting more irrigated acres. Currently,

based on data from the Gunnison Ranchland Conservation Legacy, 183,000 acres are protected through conservation easements. The Gunnison Basin Roundtable would like to see the protection of another 9,150 acres by 2030, but it is not clear if policies within the BIP will enable this to occur. Therefore, the BIP has partially met the second goal.

North Platte

The amount of irrigated land in the North Platte Basin has declined since the Supreme Court's Equitable Apportionment Decree, which states that the North Platte in Colorado can continue to irrigate at the historical levels the decree defines. The North Platte BIP has indicated an interest in irrigating more lands.[92]

North Platte Goals and Measurable Outcomes

To address this issue, the North Platte Basin Roundtable BIP contains two goals related to sustaining agriculture.[93] These goals and their associated measurable outcomes are:

- *Maintain and maximize the consumptive use of water permitted in the Equitable Apportionment Decree and the baseline depletion allowance of the Three State Agreement.*
  - *Develop three projects from the list of recommended solutions by 2020.*
  - *Incrementally bring up to 17,000 additional acres under irrigation by 2050.*
  - *Develop 37,000 acre-feet of additional storage (doubling of current storage) by 2050.*
- *Continue to restore, maintain, and modernize critical water infrastructure to preserve current uses and increase efficiencies.*
  - *Develop three projects from the list of recommended solutions by 2020.*

Meeting the North Platte's Agricultural Gaps

The North Platte identified 12 projects, and associated estimates of acre-feet, acreage, or cubic feet per second. The basin has access to water volume information for six of the projects, and half of those projects do not reveal the amount of associated increase in acreage they would provide. The basin estimates that these projects could generate approximately 12,000 acre-feet. Similarly, nine potential projects provide information on the acreage they could serve, but six of the descriptions do not identify the number of acre-feet associated with the projects. In sum, the BIP identified an increase of more than 12,000 acres. The CWCB assumes that the three projects without associated acreage would add to that number, but given the available data, the North Platte BIP meets about 70 percent of its goal to increase acreage. Additionally, several listed projects are working to restore, maintain, and modernize water infrastructure in the basin; however, the roundtable identified projects that only partially meet the basin's goal to increase storage by 37,000 acre-feet.

Rio Grande

The Rio Grande Basin has the second-highest acreage of irrigated land in Colorado and the basin as a whole uses 67 percent of its crop-irrigation water requirement.[94] Agriculture is the primary water use and is the base of the economy. At the same time, the basin must correct the water balance to achieve sustainability between senior surface-water rights and the more junior groundwater rights. To achieve sustainability and protect senior water rights, the CWCB estimates that approximately 15 percent, or 80,000, of currently irrigated acres may be dried up. These issues will be addressed by either the new rules and regulations the DWR is develoing or through the formation of groundwater management subdistricts.[95] The purpose of the rules and regulations is as follows:

The overall objective of this subdistrict plan is to provide a water management alternative to state-imposed regulations that limits the use of irrigation wells within the subdistrict, that is, a system of self-regulation using economic-based incentives that promote responsible irrigation water use and management and insure the protection of senior surface water rights.[96]

Rio Grande Goals and Measurable Outcomes

To address these issues, in its BIP the Rio Grande Basin Roundtable identified two goals related to sustaining agriculture.[97] These goals and the their associated measurable outcomes are:

- *Operate, maintain, rehabilitate, and create necessary infrastructure to meet the basin's long-term water needs, including storage.*
  - *A database of existing water infrastructure including documentation of infrastructure condition including M&I facilities, storage*

reservoirs and major ditch diversions is created.

- *Reservoirs operate at full design capacity without restrictions.*
- *Diversion structures and conveyance systems function optimally.*

- *Manage water use to sustain an optimal agricultural economy throughout the basin's communities.*
  - *The cultural heritage of agricultural water use in the San Luis Valley is recognized.*
  - *Agriculturally supported jobs are sustained.*
  - *Rangeland is maintained and improved.*
  - *Soil health is enhanced and soil loss is minimized on both farmland and rangeland.*
  - *Alternative agriculture practices that improve soil health and/or reduce consumptive use without impacting crop yields are supported and implemented to the extent practicable.*

Meeting the Rio Grande's Agricultural Gaps

As a result of the Rio Grande Compact's delivery requirements to downstream states, as well as current unsustainable groundwater pumping, the Rio Grande seeks to better manage its agricultural water resources and economy. It aims to achieve this with the formation of groundwater subdistricts that reduce pumping and sustain aquifer levels. Consequently, most of the 12 agriculture-related projects the Rio Grande Basin Roundtable analyzed are not associated with new acre-feet. Six of the projects the basin identified in its BIP focus on monitoring, assessment, and planning. The storage improvement and expansion projects largely focus on improved augmentation and administration opportunities that will help meet irrigation as well as environmental and recreational water needs. In summary, the Rio Grande's BIP meets its defined agricultural gap.

South Platte (Including the Metro Area and Republican Basin)

The South Platte and Republican River Basins have the highest acreage of irrigated land in Colorado, and on average, experience shortages of 25 percent.[98] The basin projects a gap of 160,000 acre-feet in the South Platte and 274,000 acre-feet in the Republican. In addition, according to SWSI 2010, irrigated land is likely to decline by 22 to 32 percent in the South Platte Basin and by 20 percent in the Republican Basin.[99] Using past trends as a baseline, the South Platte Roundtable reexamined potential loss of irrigated lands in the South Platte Basin, and estimated a range of 10 to 20 percent loss, and could be as much as 50 percent under one of the scenarios described in the BIP.[100] These anticipated declines are primarily due to agricultural-to-municipal transfers, but the CWCB expects urbanization to account for 6 to 7 percent of the loss—the equivalent of 47,000 to 61,000 acres.[101] In the Republican Basin, the loss of more than 100,000 irrigated acres is related to factors associated with sustainable groundwater and compact-related issues.

South Platte Goals and Measurable Outcomes

To address these issues, in their BIP the South Platte Basin and Metro Roundtable identified one goal related to sustaining agriculture.[102] This goal and its associated measurable outcomes are:

- *Fully recognize the importance of agriculture to Colorado's future well-being, support continued success, and develop new voluntary measures to sustain irrigated agriculture.*
  - *Support strategies that reduce traditional and permanent dry-up of irrigated land; achieve this through implementation of other solutions, including conservation, reuse, successful implementation of local IPPs, successful implementation of ATM, and development of new Colorado River supplies.*
  - *Support municipalities' and other local and state land-use authorities' strategies to reduce loss of irrigated land due to urbanization.*
  - *Support strategies involving IPPs, new multi-purpose projects, and innovative measures to address agricultural water shortages and maximize use of available water supplies.*

- *Develop local tools and elicit political and community support for tools to sustain irrigated farmland.*
- *Encourage the maintenance of existing wetlands in focus areas associated with agricultural lands.*
- *Ensure that agricultural dry-up and other alternatives take environmental and recreational focus areas and attributes into consideration.*

Meeting the South Platte's Agricultural Gaps

The roundtables discussed several strategies to reduce agricultural shortages and minimize permanent agricultural losses. Conceptually, the BIP indicates that ATMs could meet 30,000 acre-feet of future municipal demands. However, the BIP also lists several barriers to ATMs that the basin must overcome. The BIP also includes recommendations for streamlining transaction costs for ATMs and ATM grant programs in the South Platte Basin. In addition, the roundtables discussed the need to preserve the option for developing additional TMD water, which would lessen the need for significantly more agricultural transfers. The roundtables have not identified any IPPs that explicitly address agricultural shortages. The BIP indicates that the basin roundtable would like to further investigate land-use options, which could increase urban densities and therefore reduce the urbanization of a number of agricultural acres. The BIP does not go into depth about developing local political tools or ensuring that the basin take environmental and recreational values associated with agriculture into account. Therefore, the BIP has partially met its goals and measurable outcomes.

Southwest

The basins in the Southwest have the sixth-highest acreage of irrigated land in Colorado and the third-highest percentage of shortages (34 percent).[103] In addition, irrigated acres are likely to decline by 3 to 5 percent.[104] These anticipated declines are primarily due to urbanization, although, if Colorado River supplies are not available, some agricultural-to-urban transfers may be necessary.[105]

Southwest Goals and Measurable Outcomes

To address these issues, in its BIP the Southwest Basin Roundtable identified three goals related to sustaining agriculture.[106] These goals and their associated measurable outcomes are:

- *Minimize statewide and basin-wide acres transferred.*
  - *Implement projects (e.g. ATMs, efficiency, among others) to help preserve agriculture and open space values, and to help address municipal, environmental, recreational, and industrial needs; while respecting private property rights.*
  - *Implement strategies that encourage continued agricultural use and discourage permanent dry-up of agricultural lands.*
  - *The water providers in the state that are using dry-up of agricultural land and/or pursuing a new TMD shall have a higher standard of conservation. The goal for these water providers is a ratio of 70 percent use occurs in-house while 30 percent use occurs outside (70/30 ratio).*
- *Implement efficiency measures to maximize beneficial use and production.*
  - Implement at least 10 agricultural water efficiency projects identified as IPPs (by sub-basin).
- *Implement IPPs that work towards meeting agricultural water supply shortages.*

Meeting the Southwest's Agricultural Gaps

The Southwest Basin Roundtable identified six projects that have a combined 20,000 of new acre-feet associated with them. Of these projects, only one is not also considered for M&I uses. These projects work toward reducing agricultural water supply shortages. As the BIP states, none of the projects supports agricultural-sharing or implements strategies that discourage permanent dry-up of agricultural lands. This is because the basin does not expect the agricultural transfers to meet future municipal needs

beyond urbanization of agricultural lands. Therefore, the BIP meets its defined agricultural gaps.

Yampa/White/Green

Of the Colorado basins, the Yampa/White/Green River Basin contains among the least number of irrigated acres, and the third-lowest percentage of shortages (23 percent).[107] In addition, irrigated acres could either increase by 12 percent with adequate investment, or decrease by 15 to 53 percent.[108] The CWCB's estimated potential losses are determined by whether oil shale or other energy interests grow into a large commercial industry and need to rely on agricultural transfers to meet their needs. However, these needs will likely be revised downward since all indications are that oil shale will not be at full-scale production by 2050. Additional declines in irrigated acres are related to urbanization of agricultural lands.[109]

Yampa/White/Green Goals and Measurable Outcomes

To address these issues, in its BIP the Yampa/White/Green Roundtable identified two goals related to sustaining agriculture.[110] These goals and their associated measurable outcomes are:

- *Improve agricultural water supplies to increase irrigated land and reduce shortages.*
  - *Reduce agricultural shortages basin-wide by 10 percent by the year 2030.*
- *Preserve the current baseline of 119,000 irrigated acres and expand by and expand by 12 percent by 2030. Protect and encourage agricultural uses of water in the Yampa-White-Green Basin within the context of private property rights.*
  - *Preserve the current baseline of approximately 119,000 protected acres and expand by 12 percent by 2030.*
  - *Encourage land use policies and community goals that enhance agriculture and agricultural water rights.*

Meeting the Yampa/White/Green's Agricultural Gaps

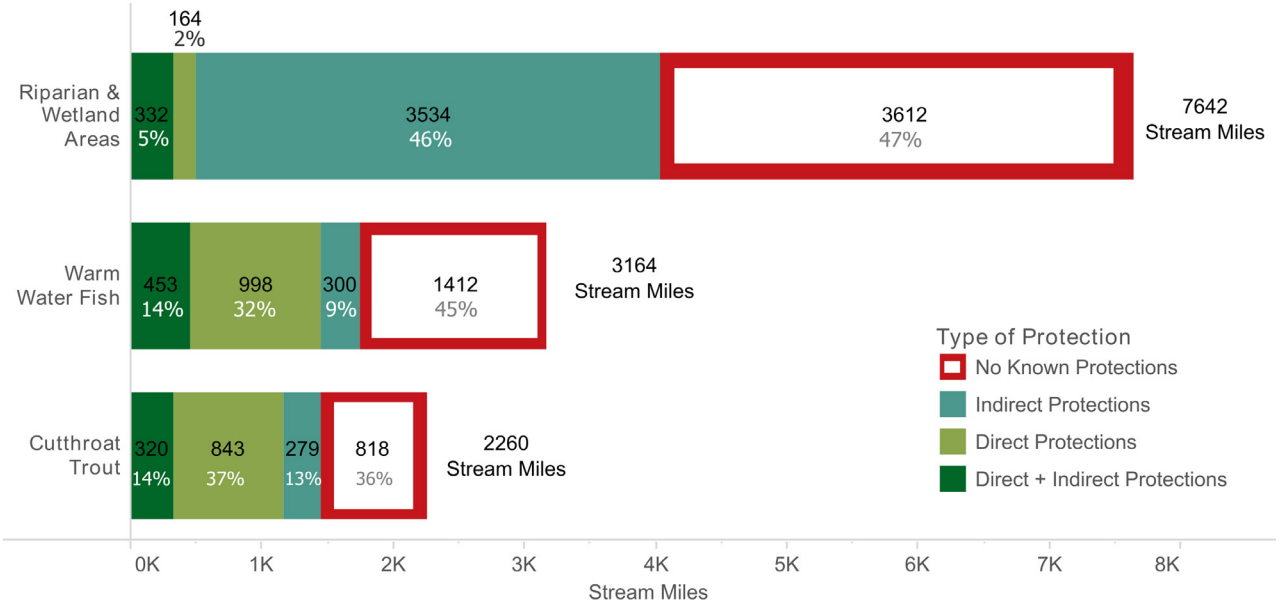
Three of the proposed agricultural projects include estimated acre-feet, totaling nearly 25,000 acre-feet. The projects address both agricultural needs as well as needs related to potential energy production and municipal growth. The planned energy project would meet many full-scale, oil-shale industry needs, and would therefore decrease the potential number of transferred irrigated acres for industrial purposes. On the other hand, some of these projects could cause additional shortages in the basin, although shortages are significantly reduced in the Yampa River between Craig and Maybell—an area with some of the most significant agricultural land in the basin. In addition, the identified projects would help develop some of the additional acreage the BIP included in its plans. While the document stresses the need for land-use policies that support agriculture, it identifies no specific policies. All in all, the BIP mostly meets its defined agricultural gaps, and the basin roundtable plans to continue to refine this work.

Meeting Colorado's Environmental and Recreational Needs

The water gap for environmental and recreational use is the difference between what a basin indicates it *wants to achieve* in accordance with its goals and measurable outcomes, and what projects and methods it *could implement* to meet those needs.[111] While every basin indicated that meeting its environmental and recreational needs is an important aspect of its BIP, this definition allows for considerable variability among basins, which face different issues related to the environment and recreation.

Colorado can meet its environmental and recreational needs through protection or restoration projects and methods. These projects and methods could include such components as flow, habitat, water quality, species connectivity, and non-native species management. In some cases, senior water rights holders help meet environmental and recreational needs upstream. Because of the diversity of the projects and methods that can help the environment and recreation, one often measures the water gap in stream-miles. With support from the CWCB, each basin roundtable developed focus-area maps as part of its 2011 needs assessment. These maps indicate the locations of significant species, recreational areas, and other environmental attributes. The CWCB then conducted a study to identify and determine the locations of existing and planned projects that meet the needs of some of the environmental and recreational focus areas each basin roundtable identified. From this data, stakeholders can identify areas with no known protections, compared to

FIGURE 6.2-2 PERCENT OF PERENNIAL STREAM-MILES STATEWIDE WITH PROTECTION FOR CUTTHROAT-TROUT SPECIES, WARM-WATER FISH, AND IMPORTANT RIPARIAN AND WETLAND FOCUS AREAS



areas with some type of protection (Figure 6.2-2, page 6-41). The Nonconsumptive Toolbox maps and features this information. Figure 6.2-3, page 6-41, shows an example.[112]

While a specific project or method may not sufficiently protect the stream in which it is implemented, and not every stream reach within the focus areas needs protection, these maps provide a good starting-point for assessing the locations of potential environmental and recreational gap areas. The CWCB is currently working to further refine this methodology and to include the additional projects and methods identified in the next update of SWSI.

To address the challenges of meeting Colorado's environmental and recreational needs, the CWCB identified five statewide long-term goals:[113]

- *Promote restoration, recovery, and sustainability of endangered, threatened, and imperiled aquatic and riparian-dependent species and plant communities.*
- *Protect and enhance economic values to local and statewide economies that rely on environmental and recreational water uses, such as fishing, boating, waterfowl hunting, wildlife watching, camping, and hiking.*
- *Support the development of multi- purpose projects and methods that benefit environmental and recreational water needs, as well as water needs for communities or agriculture.*
- *Protect, maintain, and improve conditions of streams, lakes, wetlands, and riparian areas to promote self-sustaining fisheries and functional riparian and wetland habitat, and to promote long-term sustainability.*

FIGURE 6.2-3 NONCONSUMPTIVE TOOLBOX

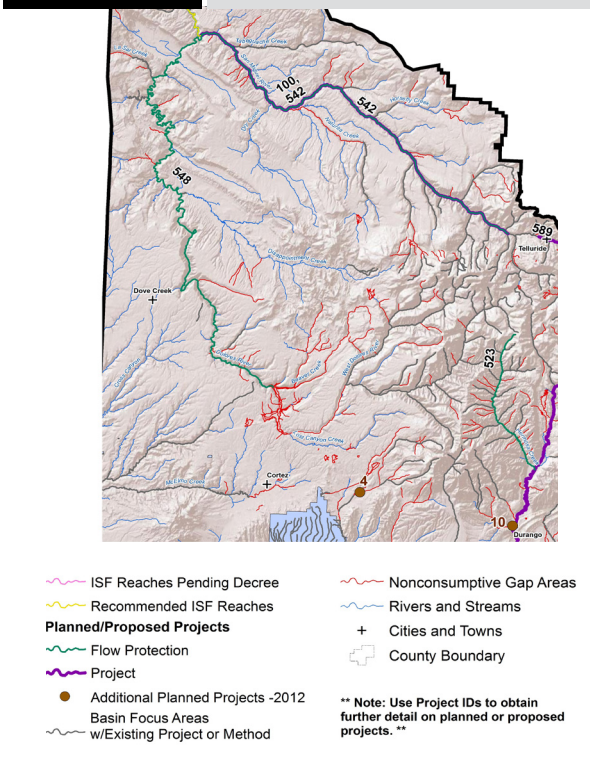


TABLE 6.2-4 SUMMARY OF HOW EACH BASIN MEETS ITS ENVIRONMENTAL AND RECREATIONAL GAPS*

Basin	Focus Area: Perennial Stream-miles	Number of Perennial Stream-Miles with No Known Protections	Quantified Stream-miles with New Projects or Methods	Number of New Projects with Stream-mile Info	Summary of How BIPs Met Their Environmental and Recreational Goals and Gaps
Arkansas	3,124	1,372 (44%)	380	15	Partially, through IPP support of greenback cutthroat trout, southern redbelly dace, Arkansas darter, and other target species
Colorado	1,762	844 (48%)	None identified	0	Partially, through support of projects and methods; did not identify new funding source or regional cooperatives that the basin deemed important
Gunnison	1,106	270 (24%)	None identified	0	Yes, through identification of 4 environmental projects, 30 multipurpose projects; support of federally listed endangered fish; explored some alternative funding sources
North Platte	954	231 (24%)	None identified	0	Mostly, through identification of more than 3 environmental and 2 multipurpose projects to be implemented; likely increases fishing, waterfowl hunting & viewing by 5 percent if implemented
Rio Grande	2,735	397 (15%)	410	11	Partially, through project implementation, but do not perform quantification of how to meet goals and measurable outcomes
South Platte	959	325	1 (plus 1,000 acre-feet)	3	Partially, through support of greenback cutthroat trout, boreal toad, common shiner, plains minnow, and other target aquatic species
Southwest	2433	1,009 (34%)	200	9	Partially, through project implementation, and will provide further quantification of how to meet goals and measurable outcomes
Yampa/ White/ Green	485	155 (32%)	370	16	Mostly, by quantifying and determining many projects that would support the current PBO on the Yampa, new PBO on the White, warm-water fish, riparian areas, and recreational boating; integrates consumptive and environmental and recreational interests
TOTAL	**13,558**	**4,601 (34%)**	**1,360**	**51**	

*NOTE: The percentage of streams with no known protections do not represent gaps for specific species or plant communities; those gaps may be larger

restoring watersheds that could affect critical infrastructure and/or environmental and recreational areas.

Arkansas

In the 2011 needs assessment, the Arkansas Basin Roundtable identified 342 perennial stream-miles containing Arkansas darter, 371 containing greenback cutthroat trout, and 1,811 featuring important riparian and wetland areas. There is protection for very few of the perennial stream-miles containing Arkansas darter. However, two-thirds of greenback cutthroat-trout stream-miles have some level of protection—whether

directly through flow protection or aquatic habitat restoration, or indirectly through land ownership geared toward wildlife protection, or riparian projects. Approximately one-third of riparian and wetland areas the basin roundtable identified have some level of protection, and most of those are indirect protections. In addition, 57 percent of the identified fishing areas and 22 percent of the identified waterfowl hunting and view areas have some level of protection.

Arkansas' Environmental and Recreational Goals

To address its environmental and recreational needs, the Arkansas Roundtable established nine goals:[114]

- *Maintain or improve native fish populations.*
- *Maintain, improve, or restore habitats for fish species.*
- *Maintain or improve recreational fishing opportunities.*
- *Maintain or improve boating opportunities, including kayaking, and other non-motorized and motorized boating.*
- *Maintain or improve areas of avian (including waterfowl) breeding, migration, and wintering.*
- *Maintain or improve riparian habitat and aquatic habitat, and restore riparian and aquatic habitat that would support environmental features and recreational opportunities.*
- *Maintain or improve wetlands, and restore wetlands that would support environmental features and recreational opportunities.*
- *Maintain, improve, or restore watersheds that could affect environmental and recreational resources.*
- *Improve water quality as it relates to the environment and/or recreation.*

Meeting the Arkansas' Environmental and Recreational Gaps

In its BIP, the Arkansas Roundtable lists 15 environmental and recreation projects with quantifiable stream improvements. Projects include, but are not limited to, water quality improvements, invasive species removal, and fish habitat restoration and passage across 380 stream-miles.

The Nonconsumptive Subcommittee has identified the following priority objectives. The subcommittee adapted these from previously mapped, 12-digit hydrologic unit codes, which outlined areas with high concentrations of environmental and recreational attributes in three primary locations: 1) the main-stem Arkansas River upstream of Pueblo; 2) Fountain Creek watershed; and 3) areas around major reservoirs on the Lower Arkansas River between Las Animas and Eads. Priority objectives include:[115]

- *Lake Isabel is an important fishing lake with multiple associated recreational activities that has insufficient water resources to cover evaporative loss. Because of limited water rights, the lake level has been lowered, thereby diminishing fishing and other recreational opportunities and risking deleterious impacts associated with this reduced water level. It is a priority to obtain additional water rights to allow the lake to be raised to its full, functioning level.*
- *Grape Creek is an important fishery that runs through the Grape Creek Wilderness Study Area, which adds to its importance as a nonconsumtive resource that has suffered from inadequate flow. Efforts are ongoing with DeWeese-Dye Ditch & Reservoir Company to re-operate the ditch to provide additional water flow through the stream during crucial periods.*
- *Important wetland resource evaluation needs to be accomplished. Although some information exists on the wetlands in this basin, it is not available basin-wide.*
- *Chilili Ditch, a canal that runs through the center of Trinidad in Las Animas County, is extremely outdated and in serious need of renovation to improve nonconsumptive resources. This priority would involve a project that addresses both consumptive and nonconsumptive*

needs, including an update to the ditch diversion to make it fish friendly through the use of fish ladders or other methods that allow fish to move up and down the stream more easily.

The Nonconsumptive Needs Subcommittee will continue to identify priority areas as it obtains additional data and information from current projects and studies, stakeholders, and the public.

The basin supports using the Gap Analysis Framework to evaluate the level of protection a project provides to environmental and recreation attributes.[116] The basin will first segment projects in the basin's IPPs list into the following categories: Information/Knowledge/ISF/RICD, Implementation, or Stewardship. Then, it will use the framework to analyze the projects and assign levels of protections to individual attributes.[117] Not all attributes require protection, and projects and methods may not be necessary at this time for select areas. The basin will support its analysis with input from stakeholders, subject-matter experts, and basin roundtable members.

Colorado

In the 2011 needs assessment, the Colorado Basin Roundtable identified 676 perennial stream-miles containing Colorado River cutthroat trout, and 435 stream-miles containing imperiled warm-water fish, including endangered fish species. The roundtable also identified an additional 1,098 perennial stream-miles of important riparian and wetland areas. A full two-thirds of the stream-miles containing warm-water fish species have some level of protection—much of it direct. Three-quarters of Colorado River cutthroat trout stream miles also have some level of protection. Similarly, approximately three-quarters of riparian and wetland areas the basin roundtable identified have some level of protection; however, most of these protections are indirect. In addition, more than 90 percent of the identified fishing areas have direct protection.

Colorado Basin's Environmental and Recreational Goals

To address its environmental and recreational needs, the Colorado BIP developed the theme, *"To protect and restore healthy streams, rivers, lakes, and riparian areas,"* and identified five goals. These goals and their associated measurable outcomes include:[118]

- *Protect and rehabilitate healthy rivers, streams, lakes, and riparian areas.*
  - *A map depicting high priority reaches that have insufficient or poorly timed flows (e.g., 15-Mile Reach, 303(d)) impaired streams, instream flows, monitoring and evaluation reaches, ecologically impacted, recreationally significant, reaches with existing dams.*
  - *Map or list of reaches where habitat has deteriorated as a result of non-flow related changes and could be restored.*
  - *Improve habitat conditions in all identified prioritized reaches to mitigate for harm caused by existing or additional water development.*
  - *Reduce the number of river miles where non-native invasive fish and invasive riparian species have degraded aquatic and riparian communities.*
- *Define water quality needs and at-risk water bodies (further described in Section 7.3).*
- *Preserve high quality recreational river and stream reaches with appropriate flows.*
  - *Maintain number of boater days on 28 reaches identified as recreation priorities by American Whitewater in cooperation with the Watershed Flow Evaluation Tool (WFET) work.*
  - *Protect access and flow levels for 28 popular recreational reaches.*
  - *Develop more recreational in-channel diversions (RICDs) structures and water rights on community and basin supported reaches to protect recreational flows.*
- *Develop a basin-wide funding system to meet basin environmental and recreational needs.*
  - *Establish a new funding agency or identify an existing agency for the basin or in every county in the basin to fund environmental and recreational management.*
  - *Leverage existing financial resources to*

further protect or restore all streams, rivers, and lakes that host prioritized recreational or natural attributes (determine source and scope of funding).

- *Fund the acquisition of conservation easements that retain agricultural purposes and current uses of water.*

- *Expand regional cooperation efforts to improve efficiencies, provide water supply flexibility, and enhance environmental and recreational amenities.*

  - *Establish regional water provider, ditch company and environmental and recreational advocate cooperatives focused on improving regional relationships, water supply redundancy and flexibility, water quality, coordinated efforts for multi-beneficial projects and addressing environmental and recreational needs.*

  - *Increase permanent interconnects between water providers where feasible.*

Meeting the Colorado Basin's Environmental and Recreational Gaps

The roundtable identified four top-priority projects that are explicitly environmental and recreational projects. The BIP listed 31 total projects, plus an additional 13 that address recreational needs, and 13 others that address water quality. Many of these are associated with the CRCA and the Windy Gap Firming Intergovernmental Agreement. Of these, approximately two-thirds are new projects and methods.

The roundtable recognizes that a basin-wide stream-management plan is a top priority, and the basin needs to better determine how to advance projects in ways that strategically meet the identified needs. The BIP states, "The most important project identified by the environmental and recreational PLT and the Colorado Basin Roundtable members is to continue assessing the systemic riverine environmental needs of the basin on-the-ground through the creation of a basin-wide stream management plan (SMP). The purpose of a SMP is to provide the framework for maintaining healthy stream systems while also protecting local water uses and planning for future consumptive and nonconsumptive water needs. SMPs identify environmental and recreational flow needs and assist in identifying areas where historical alterations of streamflows most likely affected the ecological resource conditions."[119]

The BIP further contends, "All basins statewide should make protecting and improving the health of our rivers and streams a top priority."[120]

At this point in time, it is not clear whether the dozens of identified projects would adequately address the environmental and recreational goals and measurable objectives, but these projects would at least partially meet the BIP's objectives. A streamflow management plan, if the basin implements it, would likely meet all of the objectives. One of the outstanding issues the BIP identified is the development of a new funding source within the basin.

Gunnison

In the 2011 needs assessment, the Gunnison Basin Roundtable identified 142 perennial stream-miles containing warm-water fish species, including federally listed species. Of these, more than 80 percent have some level of protection, and most of these stream-miles have one or more forms of direct protection. All of the identified 173 perennial stream-miles containing Colorado River cutthroat trout have some level of protection, with direct protection for approximately two-thirds of these miles. Nearly 90 percent of the

800 miles of identified perennial stream-miles with important riparian and wetland areas have some level of protection as well. However, nearly all of these protection methods are indirect.

Gunnison Basin's Environmental and Recreational Goals

To address its environmental and recreational needs, the Gunnison Roundtable identified two goals. As described in the BIP, these goals and their associated measurable outcomes are:[121]

- *Quantify and protect environmental and recreational water uses.*
  - *Meet identified environmental and recreational needs basin-wide by developing 10 projects from the list of recommended solutions in the Gunnison BIP by the year 2030.*
  - *Implement the Environmental and Recreational Project Identification and Inventory projects from the list of recommended solutions in the Gunnison BIP by 2020.*
  - *Improve the current baseline of native trout and endangered fish populations in the Gunnison Basin through the year 2050.*
- *Describe and encourage the beneficial relationship among agricultural, environmental, and recreational water uses.*
  - *Complete at least five new multi-purpose water projects, including two storage projects, in the Gunnison Basin by 2025 that demonstrate the beneficial relationship among agricultural, environmental, and recreational uses.*
  - *Explore and develop recommendations on alternative sources of funding from recreational users within the basin to support development of those multi-purpose water projects.*

Meeting the Gunnison Basin's Environmental and Recreational Gaps

The Gunnison Basin Roundtable reexamined its environmental and recreational needs, and added 27 focus segments. The roundtable added to the 21 segments identified in the Phase 2 NCNA process.[122] Many of these segments offer the opportunity for development of multipurpose projects that are beneficial to both nonconsumptive and agricultural and municipal interests. The roundtable designed four planned inventory projects in different sub-basins to assess the feasibility of specific potential projects in meeting the focus segments' needs. Within those segments, the BIP explored how well existing programs support the Colorado River Recovery Program for endangered fish species, cutthroat trout, and the three imperiled warm-water fish species: bluehead sucker, flannelmouth sucker, and roundtail chub.

The roundtable indicated that it supports the ongoing recovery program and the reoperation of the Aspinall Unit to meet environmental flow requirements in support of these species. In 2012, the Record of Decision for the Aspinall Unit Operations Final Environmental Impact Statement was implemented. Peak flow targets were first required in 2014, when hydrologic conditions were considered 'moderately wet.' The BOR will continue to monitor the reoperation and adapt to the needs of the endangered-fish species. The roundtable highlighted that non-native fish species are the most significant cause for concern in the Gunnison Basin, and recommended "that Colorado explore a must-kill policy for non-native fish control."

The roundtable indicated that ongoing work associated with the Colorado River Cutthroat Trout Conservation Strategy that Colorado, Utah, and Wyoming adopted was likely sufficient to meet cutthroat-trout habitat needs.

An interstate Three Species Agreement is in place to protect the three warm-water fish species: bluehead sucker, flannelmouth sucker, and roundtail chub, and CPW is in the process of developing a state strategy to manage the protection of these species. In support of this work, the BIP states, "It is imperative that fishery managers' work with water managers to continue to implement the actions articulated in the Three Species Agreement. In the Gunnison, flow protection provided by downstream senior water rights (e.g., the Redlands Water and Power Company water rights) becomes an important means of maintaining the native fishery."[123]

The roundtable identified several efforts in addition to these ongoing ones. Tier 1 features 49 projects and methods that are slated for completion by 2020. Of those, 30 feature nonconsumptive components that meet one or more of the BIP's identified environmental and recreational goals. The roundtable also identified 34 important and ongoing environmental and recreational protection and monitoring projects that meet one or more of the goals. Included in the tier 1 projects are many studies that would further develop additional nonconsumptive projects to meet each region's needs. The roundtable identified several types of projects the basin could implement while preserving existing agricultural uses. These include:[124]

- *Diversion infrastructure improvements that increase accuracy and reduce maintenance costs while preserving stream connectivity.*
- *Temporary and voluntary instream flow leasing arrangements that sustain flows during critical drought periods.*
- *Voluntary partial instream flow donations that maintain historical irrigation practices on a more limited basis.*
- *Multi-purpose storage projects that include operational flow agreements and/or dedicated environmental and recreational flow components.*

In summary, if the basin fully implements the BIP, it will fully satisfy its goals and measurable outcomes, and will meet its environmental and recreational gaps.

North Platte

In the 2011 needs assessment, the North Platte Basin Roundtable identified 222 perennial stream-miles, and named important fishing areas as the roundtable's top priority. Approximately one-third of these miles have some direct protection, and the remaining stream-miles have no known protections. Ninety-three miles of perennial streams feature waterfowl hunting and viewing, and 45 percent of these have some form of direct protection. More than one-quarter of the 220 miles of identified perennial stream-miles with important riparian and wetland areas have some level of protection as well.

North Platte Basin's Environmental and Recreational Goals

To address its environmental and recreational needs, the North Platte Roundtable identified two goals. As stated in the BIP, these goals and their associated measurable outcomes are below:[125]

- *Maintain healthy rivers and wetlands through the strategic implementation of projects that meet prioritized nonconsumptive needs.*
  - *Increase fishing user days by five percent by 2020.*
  - *Increase waterfowl hunting and viewing days by five percent by 2020.*
  - *Develop three projects from the list of recommended solutions by 2020.*
- *Describe and quantify the nonconsumptive benefits of agricultural use.*
  - *Complete at least two new multi-purpose water projects in the North Platte Basin by 2025 that meet multiple needs as identified in this report and other studies.*

Meeting the North Platte Basin's Environmental and Recreational Gaps

To better determine where the basin roundtable should focus its efforts, the roundtable developed a weighted attribute map. The map takes into account both the number of attributes and the priority rank the basin

roundtable gave during the needs assessment process. The BIP states, "This map will be used to help target projects to address identified environmental and recreational attributes in the basin, including both multipurpose projects and specific environmental and recreational projects."[126]

The roundtable identified 55 planned environmental and recreational projects, 33 of which are multipurpose. Of the potential projects on the list, the roundtable developed project summaries and methods for 14. Of these, five help maintain healthy rivers and wetlands, and four also demonstrate the connection among agricultural, environmental, and recreational values. The BIP describes these projects as follows:

- *Reservoir improvements to preserve a major water supply for the maintenance of habitat at the Arapahoe National Wildlife Refuge,*
- *The improvement of a major diversion structure to address fish connectivity while addressing other water user needs,*
- *Improvement of fisheries habitat at State Wildlife Areas (public access fishing), and*
- *Two inventory projects that could help identify other multipurpose project opportunities.*[127]

All in all, if the roundtable implements these projects, it will address the measurable outcomes calling for five projects that meet nonconsumptive needs. It is not clear whether these projects will reach the fishing and waterfowl hunting targets the BIP identified. However, the BIP mostly meets its identified environmental and recreational gaps.

Rio Grande

In the 2011 needs assessment, the Rio Grande Basin Roundtable identified 564 perennial stream-miles with Rio Grande chub, an imperiled fish species. Fifty-four percent of the stream-miles have some level of protection, most of which is direct. Another warm-water imperiled fish species is the Rio Grande sucker, which is listed as state-endangered. More than 60 percent of the 346 perennial stream-miles that support this species have some level of protection, though more than half of the protection is indirect. Nearly 40 percent of the identified 748 perennial stream-miles with Rio Grande cutthroat trout have some level of protection, although most of this protection is indirect. As of October 2014, the U.S. Fish and Wildlife Service (USFWS) determined that the Rio Grande cutthroat trout does not warrant an "endangered" listing, and that ongoing, extensive recovery efforts will continue for this species. Similarly, just over 40 percent of the 2,138 miles of identified perennial stream-miles with important riparian and wetland areas have some level of protection, most of it being direct.

Nevertheless, in the course of the BIP planning process, the Rio Grande's Environmental and Recreational Subcommittee chose to expand beyond the attributes previously identified in 2011 and undertake a more comprehensive approach. That approach uses updated geographic information systems (GIS) layers to determine where key environmental and recreation components exist in order to better determine their extent and conditions, identify where measures are in place to protect or restore those components, and identify where the basin needs to support action. Using these methods, the subcommittee has worked to identify the priority environmental and recreational attributes that need additional protection, restoration, and management.

For longer-term projects and methods, the Environmental and Recreational Subcommittee will continue to inventory, update, and quantify environmental attributes in relation to water needs. Through this process, the group will define and update maps of environmental and recreational focus areas in the Rio Grande Basin, and develop strategies to address needs and sustain their attributes.

The BIP also indicates that the San Luis Valley features approximately 200,000 acres of internationally important wetlands that provide critical habitat for endangered bird species as well as large numbers of migrating birds and waterfowl.

Rio Grande Basin's Environmental and Recreational Goals

To address its environmental and recreational needs, the Rio Grande Basin Roundtable identified four goals. As described in the BIP, these goals and their associated measurable outcomes are below:[128]

- *Protect, preserve, and enhance terrestrial and aquatic wildlife habitats throughout the basin.*
  - *Species that are listed by either the federal or state government as threatened, endangered, or candidate species are recovered or de-listed.*
  - *Additional species are prevented from being*

listed by the federal or state government.

- *Economic impact studies for environmental and recreational benefits are considered in the decision-making process for new water supply projects.*
- *Wildlife habitat needs are considered in the decision-making process.*
- *Natural resource agencies in the San Luis Valley (Rio Grande) coordinate and cooperate with each other to comply with the ground water rules and regulations and augmentation plans to benefit wildlife and recreation to the largest extent possible.*
- *Water needs for wildlife habitat are addressed in plans, databases and San Luis Valley-wide surveys of appropriate wildlife populations.*

- *Conserve, restore, and maintain wetlands and riparian areas for the benefit of a healthy watershed.*
  - *Identify the needs for properly functioning wetlands and riparian areas.*
  - *Restore the ecological function of wetlands and riparian areas.*
  - *Develop and implement projects to restore, conserve, and sustain functioning wetlands, riparian areas, and associated habitats with a focus on incorporating species connectivity.*
- *Work to establish active river flows throughout the year in cooperation with water users and administrators to restore and sustain ecological function of the rivers and floodplain habitats within the context of existing water rights and compact obligations.*
  - *Negotiate active plans and cooperative agreements that enhance stream flows through re-operations while ensuring full compliance with Colorado water law.*
- *Maintain and enhance water dependent recreational activities.*
  - *Floatable flow levels are identified by reach.*
  - *Cooperative water management provides flows to extend recreational opportunities.*
  - *Recreational facilities are improved and/or enhanced.*
  - *Quality and quantity of fishing opportunities are improved.*
  - *Fish and boat passages are installed where appropriate.*
  - *Conservation pools are rehabilitated, secured and/or conserved as possible.*
  - *Quality and quantity of hunting (e.g., water fowl, small game, and big game) opportunities are improved.*
  - *Fish hatcheries have sustainable, secure, and adequate physical and legal water supplies.*
  - *Recognize economic benefits of recreation in decision-making processes.*

Meeting the Rio Grande Basin's Environmental and Recreational Gaps

Of the 18 projects the Rio Grande Basin Roundtable analyzed in its BIP, 12 help meet the goals above. The roundtable will analyze an additional 15 projects that address environmental and recreational information gaps, further clarifying those gaps. These projects add a total of almost 410 new stream-miles and 60,650 acre-feet. At this point in time, the BIP partially meets its environmental and recreational water gaps.

South Platte (Including Metro and Republican)

In the 2011 needs assessment, the South Platte and Metro Basin Roundtables identified 628 perennial stream-miles with warm-water imperiled plains fish species. Approximately two-thirds of these stream-miles have some level of protection. Approximately 90 percent of the 79 perennial stream-miles identified with greenback cutthroat trout have some level of protection, although more than half of this protection is indirect. Approximately half of the 628 miles of identified perennial stream-miles with important riparian and wetland areas have some level of protection, most of it direct. In addition, approximately half of the important fishing areas, and one-third of the waterfowl hunting and viewing stream-miles, have some level of protection.

South Platte Basin's Environmental and Recreational Goals

To address its environmental and recreational needs,

the South Platte Basin Roundtable developed a goal. As described in the BIP, this goal and its associated measurable outcomes are listed below:[129]

- *Fully recognize the importance of, and support the development of, environmental and recreational projects and multipurpose projects that support water availability for ecologically and economically important habitats and focus areas.*
  - *Promote restoration, recovery, and sustainabiability of endangered, threatened, and imperiled aquatic, riparian and wetland dependent species and plant communities:*
    - *Maintain or increase the habitat for federally and state-listed threatened and endangered species or plant communities.*
    - *Maintain or increase habitats in the environmental and recreational focus areas with imperiled species or plant communities and secure the species in these reaches as much as they can be secured within the existing legal and water management context.*
    - *Maintain or increase the wetland, lake, or stream habitat used by migratory and breeding birds.*
    - *Develop tools and methodologies to adequately assess what is needed to maintain or increase aquatic, riparian, and wetland habitats throughout the basin.*
  - *Protect and enhance economic values to local and statewide economies derived from environmental and recreational water uses, such as fishing, boating, waterfowl hunting, wildlife watching, camping, and hiking.*
    - *Maintain or increase the surface area, stream miles, or public access for recreational opportunities.*
    - *Maintain or increase the miles and general appearance of trails and greenways to promote aesthetic values and enhance quality of life.*
    - *Maintain or increase public access to fishing opportunities in lakes and streams.*
    - *Maintain or increase the total area for birding, waterfowl hunting, and wildlife viewing.*
    - *Maintain or improve the amount of river miles or flatwater surface acres available to river and flatwater boaters.*
    - *Develop tools and methodologies to adequately assess what is needed to maintain or improve recreational opportunities derived from ecosystems throughout the basin.*
  - *Protect, Maintain, and Improve Conditions of Streams, Lakes, Wetlands, and Riparian Areas to Promote Self-Sustaining Fisheries and Functional Riparian and Wetland Habitat to Promote Long-Term Sustainability.*
    - *Maintain or increase the number of stream miles or surface area of streams, lakes, wetlands, and riparian areas for self-sustaining aquatic species populations, and wetland/riparian habitat.*
    - *Maintain or improve fish habitat by providing habitat enhancements, eliminating dry up points, and promoting connectivity.*
    - *Maintain or improve watershed health through source water protection, wildfire mitigation, sedimentation control, and erosion control.*
    - *Encourage existing and develop new innovative tools to protect instream flows where appropriate.*
    - *Develop tools and methodologies to adequately assess what is needed to protect, maintain or improve conditions of aquatic, riparian, and wetland habitat throughout the basin.*

Meeting the South Platte Basin's Environmental and Recreational Gaps

Through the BIP process, the roundtable identified seven additional focus-area reaches that it added to the basin needs assessment maps. This work expands the number of areas in which a focus on addressing environmental and recreational needs is important. The roundtable also assessed dry up points within the South Platte Basin, identifying 15 areas that experience no flows during some years at some points in time.

These dry-up points affect species connectivity and habitat.

To determine the types of projects the basin will need to implement in order to address these environmental and recreational concerns, the roundtable assessed the types of projects the following regions need:

1. Headwater areas (upper mountain area)
2. Metro corridor
3. Boulder/Fort Collins (northern area)
4. Plains (lower South Platte)

For each of these regions, the roundtable developed a suite of project types—including instream flows, stewardship projects, species reintroduction, fish passages, modification or improvements to dry-up points or diversion structures that inhibit fish passage, stewardship programs, and instream flow programs with water rights components that dedicate historic, consumptive use to a downstream user while improving streamflows within a reach of concern. In addition, the BIP assessed the number of miles with existing or planned protections. The BIP only included measurable objectives for three of these projects. Collectively, 1,000 new acre-feet and one stream-mile were identified, although more stream-miles are likely associated with these projects.

To move forward with addressing the South Platte Basin's environmental and recreational needs, the roundtable indicates in their BIP that:[130]

- *The South Platte vision includes working to meet the M&I gap, while minimizing the impacts to agricultural uses, and while also providing protections and enhancements to environmental and recreational attributes in candidate focus areas.*
- *The South Platte Basin will continue working to identify cooperative and attribute specific projects that protect or enhance environmental and recreational attributes.*
- *The South Platte Basin will encourage funding and cooperation to leverage new projects, improvements to, or replacements of structures which help provide protections.*
- *The South Platte Basin will continue working to quantify the environmental and recreational 'gap' and to assess projects that protect or enhance environmental and recreational attributes.*
- *Storage within the basin is vital to meeting the needs of the basin, and including storage for environmental and recreational needs is imperative.*

The current BIP partially meets the environmental and recreational gaps the goals and measurable outcomes process identified.

Southwest

In the 2011 needs assessment, the Southwest Basin Roundtable identified 834 perennial stream-miles with imperiled warm-water fish species, including the flannelmouth sucker, bluehead sucker, and roundtail chub. The CWCB's work in 2011 indicated that nearly two thirds of these stream-miles have or plan to have some level of protection, although most of these protections are indirect. Approximately 70 percent of the identified 178 perennial stream-miles with Colorado River cutthroat trout have some level of protection, and most of this protection is also indirect. Just under 60 percent of the 762 miles of identified perennial stream-miles with important riparian and wetland areas have some level of protection, all of which is direct. The needs assessment report also identified various forms of recreation, such as fishing, waterfowl hunting, and viewing. Very few stream-miles have identified protections for these values.

Southwest Basin's Environmental and Recreational Goals

To address its environmental and recreational needs, the Southwest Roundtable identified three goals. As described in the BIP, these goals and their associated measurable outcomes are below:[131]

- *Maintain, protect, and enhance recreational values and the value to local and statewide economies derived from recreational water uses such as fishing, boating, hunting, wildlife watching, camping, and hiking.*
  - *Implement 10 IPPs to benefit recreational values and the economic value they provide.*
  - *At least 80 percent of the areas with recreational opportunities have existing or planned IPPs that secure these opportunities and supporting flows/lake levels within the contemporary legal and water management context. Based on*

the map of recreational attributes generated for SWSI 2010, 80 percent of each specific value equates to approximately 428 miles of whitewater boating, 185 miles of flat- water boating, 4 miles of Gold medal Trout Streams, 545 miles of other fishing streams and lakes, 3 miles of Audubon Important Bird Area, 143 miles of waterfowl hunting/viewing parcels, and 6 miles of Ducks Unlimited projects.

- *Address recreational data needs.*

- *Encourage and support restoration, recovery, and sustainability of endangered, threatened, and imperiled aquatic and riparian-dependent species and plant communities.*
  - *Implement 15 IPPs to directly restore, recover, or sustain endangered, threatened, and sensitive aquatic and riparian-dependent species and plant communities.*
  - *At least 95 percent of the areas with federally-listed water dependent species have existing or planned IPPs that secure the species in these reaches to the extent possible within the existing legal and water management context.*
  - *At least 90 percent of areas with identified sensitive species (other than Endangered Species Act species) have existing or planned IPPs that provide direct protection to these values. Based on the map of environmental attributes generated for SWSI 2010, this 90 percent of areas with identified sensitive species equates to individual species as approximately 169 miles for Colorado River cutthroat trout, 483 miles for roundtail chub, 794 miles for bluehead sucker, 700 miles for flannelmouth sucker, 724 miles for river otter, 122 miles for northern leopard frog, 921 miles for active bald eagle nesting areas, and 229 miles for rare plants.*

- *Protect, maintain, monitor, and improve the condition and natural function of streams, lakes, wetlands, and riparian areas to promote self-sustaining fisheries, and to support native species and functional habitat in the long-term, and adapt to changing conditions.*
  - *Implement 26 IPPs to benefit the condition of fisheries and riparian/wetland habitat.*
  - *At least 80 percent of areas with environ mental values have existing or planned IPPs that provide direct protection to these values.*

Meeting the Southwest Basin's Environmental and Recreational Gaps

The Southwest Basin identified nine environmental and recreational projects and methods that included stream-mile information for more than 200 miles of stream. However, the Southwest Basin indicated that it can provide additional stream-mile information. If the basin implements them, these projects are sufficient to meet the number of IPPs the roundtable has identified in the above categories. The roundtable has not conducted an analysis of the extent to which these projects meet the stream-mile goals.[132] In addition, to better identify environmental and recreational needs, the roundtable identified two efforts that would extend across the sub-basin:

1. *Evaluation of environmental and/or recreational gaps is planned to be conducted for improvement of non-consumptive resources and/or in collaborative with development of consumptive IPPs. The evaluations may be conducted by a subgroup of the roundtable or by individuals, groups, or organizations with input from the roundtable. The evaluation may use methodologies such as the Southwest attributes map, Flow Evaluation Tool, R2Cross, and any other tools that may be available.*

2. *Where environmental and/or recreational gaps are identified, a collaborative effort will be initiated to develop innovative tools to protect water identified as necessary to address these gaps.*

Until additional stream-mile information associated with the identified projects and methods is available, it will remain unclear how well the BIP has met its measurable outcomes.

Yampa/White/Green

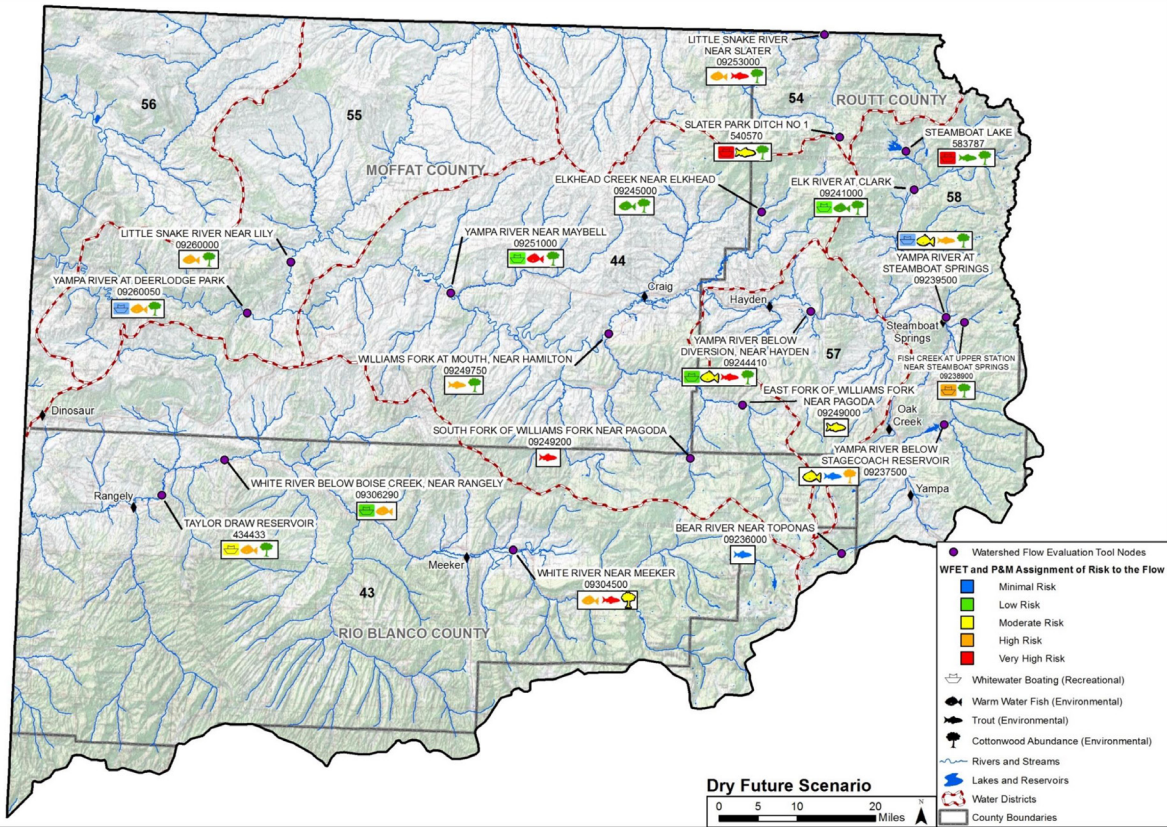
In the 2011 needs assessment, the Yampa/White/Green Basin Roundtable identified 218 perennial stream-miles with state-imperiled warm-water fish species, and 142 miles with federally listed warm-water fish species. Approximately 55 percent of these stream-miles have some level of protection, most of it being direct. Nearly two-thirds of the identified 35 perennial stream-miles containing Colorado River cutthroat trout have some level of protection, although most of this protection is indirect. More than three-quarters of the 275 miles of identified perennial stream-miles with important riparian and wetland areas have some level of protection as well, and nearly all of it is direct. The needs-assessment report also identified various forms of recreation. Very few stream-miles have identified protections for these values.

Yampa/White/Green Basin's Environmental and Recreational Goals

To address its environmental and recreational needs, the Yampa/White/Green Basin Roundtable identified two goals. As described in the BIP, these goals and their associated measurable outcomes and processes are below:[133]

- *Quantify and protect non-consumptive water uses.*
  - *To the extent that non-consumptive needs can be specified and projects can be analyzed, there will be projects for non-consumptive attributes within the existing legal and water management context.*
  - *Multi-purpose projects and methods will be researched and designed to meet the other goals enumerated here.*
  - *The Programmatic Biological Opinion (PBO) and its depletion coverage for the Yampa River Basin for existing and future expected and unexpected depletions will meet base flow targets in critical habitat areas and assist with endangered fish recovery.*
  - *A new PBO is planned for the White River Basin that provides certainty for existing and future anticipated and unanticipated depletions and that assists with endangered fish recovery.*
  - *The flow protection and any water leasing or re-operation of projects needed for native warm water fish, for cottonwoods, and for recreational boating on reaches with greater and overlapping flow alteration risks are integrated with the flow protection for endangered fish recovery and with projects to meet in- basin, consumptive needs. The flow needs of these non-consumptive attributes are otherwise met, including the avoidance of or offsetting the loss of minimum or optimal boating days that are related to multi-purpose projects and unrelated to drier or wetter hydrology.*
  - *The flow needs for all other non-consumptive attributes are quantified, integrated with projects to meet in-basin consumptive needs, and otherwise met through nonconsumptive IPPs. Multi-purpose projects will be researched and designed to improve riparian or aquatic ecology and bank stability without changing the existing flow regime while voluntarily modernizing irrigation diversion systems and reducing bedload. Similar projects will be researched and designed to improve recreational boating for existing flows while voluntarily modernizing irrigation systems.*
  - *The economic values of the relatively natural flow regimes of the Yampa and White River systems are recognized and protected, along with the economic values of consumptive water use.*
  - *Acres of restored riparian areas, degraded streams, and wetlands to restore natural water storage capacity, and improve water quantity and quality for non-consumptive needs.*
  - *Assess and quantify impact of IPP's on peak flows and ascertain whether further non-consumptive IPP's need to be identified.*
- *Develop an integrated system of water use,*

FIGURE 6.2-4 YAMPA/WHITE/GREEN BASIN IMPLEMENTATION PLAN - ASSOCIATED RISK IN DRY-FUTURE SCENARIO WITH IDENTIFIED PROJECTS AND PROCESSES IMPLEMENTATION



storage, administration, and delivery to reduce water shortages and meet environmental and recreational water needs.

- *Success in permitting and constructing in-basin storage projects.*
- *Reduction in consumptive shortages in drought scenarios.*
- *Reduction in identified non-consumptive shortages in drought scenarios.*
- *Administration and infrastructure improvements making decreed amounts of water available to diversion structures with reduced need for seasonal gravel dams in the river.*
- *Reduce the potential incidence of severe low flows in order for water users to exercise their water rights.*

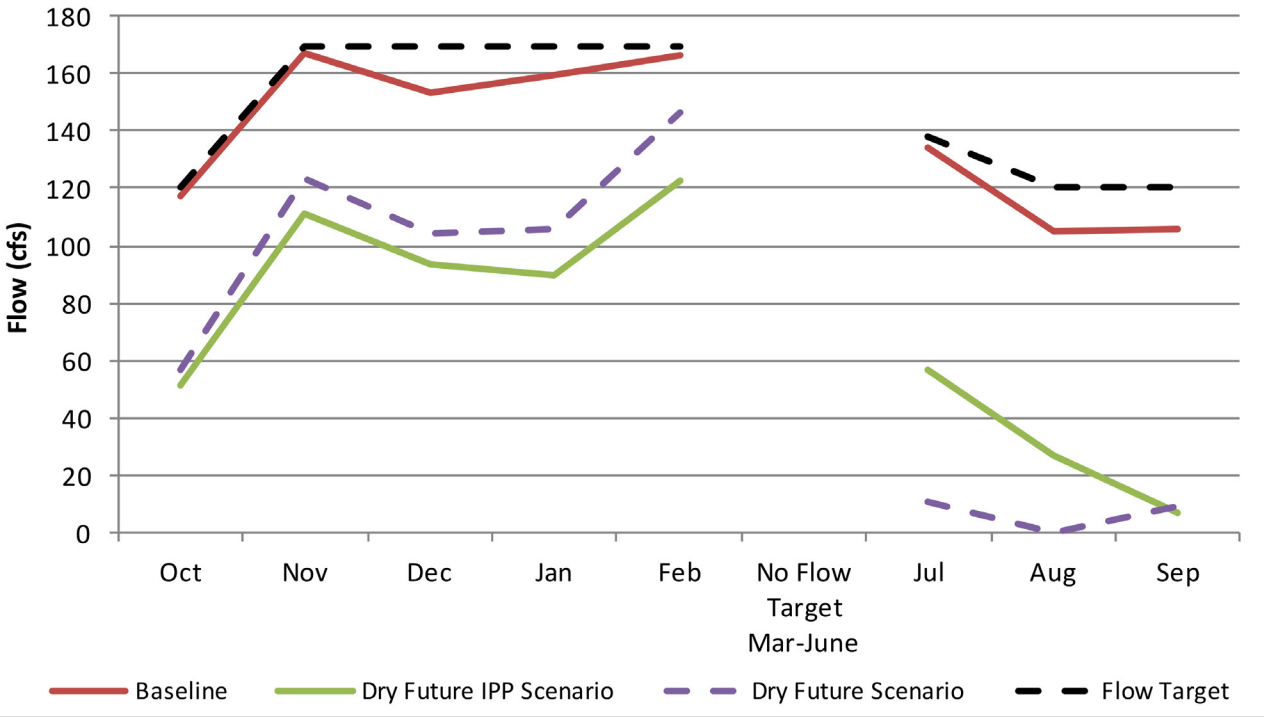
Meeting the Yampa/White/Green Basin's Environmental and Recreational Gaps

The previous Watershed Flow Evaluation Tool work examined whether cottonwood, warm-water fish, or cold-water fish were vulnerable to flow conditions within the basin roundtable's environmental and recreational focus areas. Additional analysis within the BIP assessed how often the basin was meeting instream flows and recreational in-channel diversions. These three efforts provide significant insight into how well the basin is currently addressing environmental and recreational needs. Furthermore, the roundtable overlaid potential future conditions within the basin to determine how future climate change and developing projects and processes would affect:

1. *The vulnerability of the species within the environmental and recreational focus areas,*
2. *The instream flow shortages, and*
3. *The recreational in channel diversion shortages*

For example, the BIP states that, "The modeling indicates that the implementation of the IPPs [in a

FIGURE 6.2-5 DEMONSTRATION OF HOW A DRY FUTURE COULD AFFECT THE YAMPA PROGRAMMATIC BIOLOGICAL OPINION, AND A DRY FUTURE WITH IMPLEMENTATION OF IDENTIFIED PROJECTS AND METHODS



dry future] would increase instream flow shortages by 27 percent on Trout Creek. The development of IPPs could reduce instream flow shortages on the following reaches: Oak Creek (by 1.4 percent, node 582290), Slater Creek (by 3.5 percent, node 542076), and Willow Spring and Pond (by 1.8 percent, node 582162)."[134] IPPs appear to have little effect on the environment for most locations (Figure 6.2-4), but could modestly influence endangered fish recovery flows in the Yampa River during the fall and winter (Figure 6.2-5).

The purpose of this analysis is to provide a course examination of potential environmental and recreational "shortages." This is the most thorough technical analysis any of the roundtables provided. In addition, the roundtable identified 16 environmental and recreational projects that include a measurable outcome, one of which is an agricultural project with some identified environmental and recreational benefits. The projects identify a total of 370 new stream-miles. As the BIP states, "The basin roundtable will continue to explore additional multipurpose opportunities where they may exist through future planning efforts."[135]

In summary, the BIP demonstrates progress towards meeting its future environmental and recreational needs and, if the basin supports the implementation of the projects, it will mostly meet the measurable outcomes listed above.

Other BIP-Identified Gaps

Other needs the basin roundtables identified in their BIPs include those associated with education, watershed health, and water quality. Section 9.5, 7.1, and 7.3 further explore these needs.

How Other States Have Worked to Meet Their Gaps

The challenges associated with meeting future water supply needs are not unique to Colorado's boundaries.

Other states across the West are facing the challenge of increased population and potentially limited water supplies. Other neighboring states have also undertaken water-planning efforts to increase certainty at both the intrastate and interstate levels.

State and federal water projects account for a substantial portion of the ongoing efforts around the West. For example, California's State Water Project, the Central Arizona Project, and the Lake Powell Pipeline all represent massive financial and political undertakings, with the goal of meeting future water supply needs. And efforts around water banking are underway in California. A key issue in the West is also the settlement of water rights concerns among tribes located throughout several states. Existing settlements in New Mexico and Arizona have provided a greater certainty to tribes and to water management agencies within those states. The State of Texas has invested large sums of capital into project implementation; Kansas has invested in corps-sponsored projects for storage; and the State of Utah has collaborated with the federal government on the Central Utah Project.

Appendix B contains more information on neighboring states' efforts to close water supply gaps.

ACTIONS

TABLE 6.2-5 STRATEGIES FOR IMPLEMENTATION OF THE BASIN IMPLEMENTATION PLANS

CATEGORY	CONSTRAINT	NEXT STEPS AND POTENTIAL ACTIONS
Project Evaluation	Conflict	• Partnerships • Cooperative Strategies
	Perception	• Public Education and Outreach • Incentive-Based Programs
	Regulations	• Cooperative Strategies • Effective and Efficient Permitting
Project Feasibility	Cost	• Creative Funding Mechanisms • Partnerships and Cooperative Strategies
	Water Availability	• Water Availability Analyses • Water Administrative Strategies
	Constructa-bility	• Feasibility Analyses • Engineering Design

The projects and methods in the BIPs met many of the identified gaps; however, gaps remain, even with the significant efforts described. Several next steps will help the basin round tables meet their needs. In its BIP, the Gunnison Roundtable summarized many of these next steps and potential actions; Table 6.2-5 illustrates this work.

A primary purpose of Colorado's Water Plan is to address Colorado's water gaps. To accomplish this, several of the next steps and potential actions include the following, as summarized in Table 6.2-5:

Partnerships and cooperative strategies are vital to overcoming conflict and building local con sensus so that a project can move forward. Section 9.4 further discusses this approach in the context of more effective and efficient permitting.

- Public education and outreach can also help inform people about Colorado's water needs and solutions. Section 9.5 explores avenues to better support water education throughout Colorado.
- Many sections of Colorado's Water Plan mention incentive-based programs. For instance, Section 6.3 explores opportunities to encourage conservation, reuse, and water-wise land-use practices. Section 6.4 explores opportunities to encourage ATMs.
- Funding is also a common theme throughout many of the BIPs. Section 9.2 further explores funding options.
- Many of the BIPs express concerns around permitting and other regulatory topics. Section 9.4 explores ways to make these processes more effective and efficient.

Colorado's Water Plan's success will ultimately be

measured by whether the municipal water supply and demand gap is closed. With increased efforts on conservation, storage, land use, alternative transfer methods, and reuse, Colorado can close its gap, balance Colorado's water values, and also address the water resource impacts of a changing climate. Colorado's Water Plan sets a measurable objective to identify proponents for new projects, processes, and initiatives by 2030 that would reduce the projected 2050 municipal and industrial gap from as much as 560,000 acre-feet to 0 acre-feet.

In SWSI 2010, the gap was calculated based on future water needs and the identification of projects and methods that water providers indicated they were planning to implement in order to serve future customers. The basin roundtables partially reduce this gap by identifying additional projects and methods within the BIPs, as Section 6.5 describes. However many of these additional projects and methods either do not have project proponents identified, or are insufficiently developed. Further development of these projects and methods, reductions in water use from conservation and changes in land-use practices, and refinement of additional options such as ATMs and regional reuse will address the remaining gap.

Colorado must identify and address its water gaps. The CWCB will take the following steps to accomplish this starting in 2016:

1. The CWCB will support the evaluation, feasibility, and completion of the BIPs through WSRA grants.

2. The CWCB will support increased consistency and technical support in the BIPs in the following ways:

   - Provide technical support for several of the BIPs through continued decision-support development and maintenance in order to explore municipal, agricultural, industrial, and environmental shortage analyses similar to those in the Yampa/White/Green BIP.
   - Provide technical support for several of the BIPs to explore the use of project information sheets and project tiering, similar to those delineated in the Rio Grande, North Platte, and Gunnison BIPs.
   - Support the further quantification of costs associated with projects and methods, development of new acre-feet, development of new irrigated acres, and protection of new stream-miles.

3. The CWCB will incorporate the BIP information into the next version of SWSI, and will reassess the municipal, industrial, environmental, recreational, and agricultural gaps at that time.

4. The CWCB will establish guidelines for basin-roundtable WSRA grants, enabling the basin roundtables to facilitate implementation of their BIPs in their basins. The purpose of the grants would be to foster the ability to meet municipal, industrial, agricultural, environmental, and recreational needs in a manner that is consistent with the BIPs.

Eastern Phoebe in
Chatfield State Park.

6.3 WATER CONSERVATION AND REUSE

GOAL

Colorado's Water Plan promotes technical and financial assistance throughout Colorado, enabling the State to plan and implement long-term water efficiency strategies that meet local and statewide water needs, and to achieve the following statewide long-term goals:

- Reduce overall future water needs through cost-effective water efficiency measures;
- Integrate water efficiency planning and projects into overall water resource management;
- Promote water efficiency ethic throughout Colorado;
- Explore additional water reuse options;
- Further integrate land use and water planning;
- Seek creative options for improving agricultural irrigation conservation and efficiency

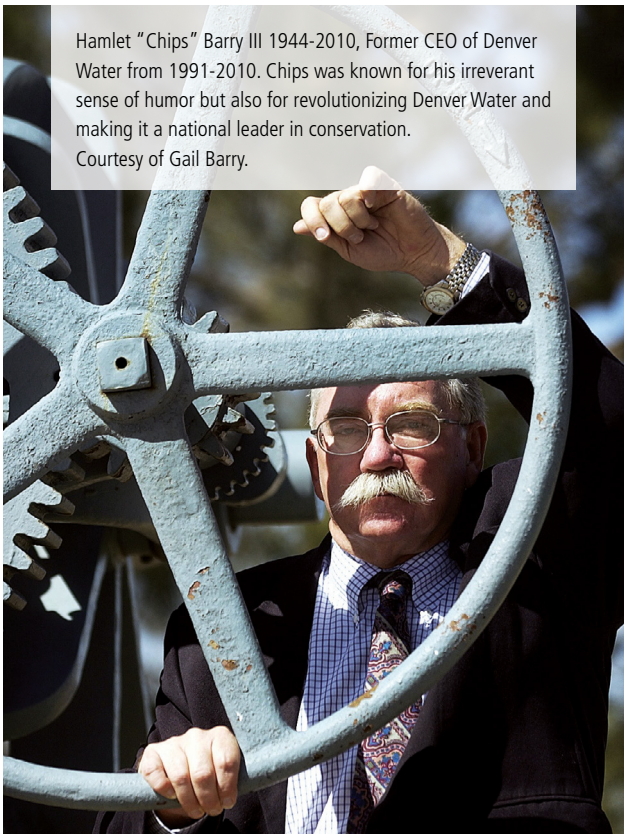
Introduction

Water conservation activities and water reuse will play an important role in balancing the need for additional water supply with strategies to lessen that need. By implementing a comprehensive, statewide approach for water conservation and water-reuse activities, CWCB and other state agencies will strengthen programs from the local to the state level. Much like TMDs, agricultural water transfers, and storage, conservation and reuse are not "silver-bullets;" however, they are critical components of strategies to address future needs. The creation of scalable technical resources, support of local initiatives through financial incentives, and best-practices sharing will bolster conservation and reuse.

This section examines water conservation, reuse, land use, agricultural water conservation, self-supplied industrial (SSI) conservation, and state agency conservation. These water management strategies will help Colorado close the water supply gap while minimizing trade-offs that other solutions might create. Increased conservation, reuse, and better integration of land use and water planning will help maintain a healthy environment, promote livable and sustainable cities, and preserve agricultural production into the future.

Faucet aerators help reduce water consumption. Because the aerator limits the water flow through the faucet, water use is reduced as compared to the same time of flow without an aerator.

6.3.1 MUNICIPAL WATER CONSERVATION



Hamlet "Chips" Barry III 1944-2010, Former CEO of Denver Water from 1991-2010. Chips was known for his irreverant sense of humor but also for revolutionizing Denver Water and making it a national leader in conservation. Courtesy of Gail Barry.

Governor John Hickenlooper stated that, "Every conversation about water should start with conservation."[136] Municipalities, special water districts, and other water providers have progressed in water conservation over the last decade, as Chapter 5 explains. Building on those efforts, future actions will define the direction Colorado takes to close the supply-and-demand gap.

Benefits of Water Conservation

Water savings resulting from water efficiency activities can reduce water demands and thereby assist providers in avoiding, downsizing, or postponing the construction and operation of water supply facilities and wastewater facilities—as well as eliminating, reducing, or postponing water purchases. In addition to these water supply benefits, Colorado can achieve other societal, political, and environmental benefits, including:[137]

- Reduced wastewater discharges through indoor water savings, which can improve water quality and aquatic habitat.
- Demonstration of a commitment to sustainability.
- The meeting of political and regulatory requirements necessary to obtain permitting for local and regional water supply projects.
- Delay of capital costs for new projects.

Conservation also acts as a management tool to buffer against drought using long-term conservation strategies, and to address shortages by implementing short-term conservation strategies. Water providers can store as a drought reserve the amount of water they realize through long-term water conservation efforts, and use that reserve during periods of shortages. In those cases, more storage may be required to maintain a drought reserve.[138] As with many water management decisions, there may be some disadvantages to water conservation. Some water providers, specifically in the South Platte Basin, are concerned that "indoor conservation measures can reduce the amount of available water for agriculture and environmental and recreational purposes by diminishing return flows the basin relies on."[139] Water conservation programming takes time to implement and water savings can take time to accrue. Long-term water conservation should be viewed as a long-term investment.

The State is wise to invest funds for implementing water conservation activities statewide. These are some of the most inexpensive implementation strategies today, and will allow local water providers to be more efficient with the water resources they already have.

Water Conservation in Colorado

In the past decade, water providers and their customers have done a remarkable job reducing per-capita water needs. Statewide, their efforts amount to just under 20 percent, but some municipalities have reduced their per-capita water use by as much as 30 percent.[140] Most of the largest water providers in Colorado have CWCB-approved water conservation plans, and these approved plans account for most of the M&I statewide demand. According to C.R.S. 37-60-126, covered entities, defined as those entities that deliver more than 2,000 acre-feet of water annually, are required to have a CWCB approved water conservation plan.

Many water providers adopted best practices, including landscape efficiencies, water loss management, and inclining block-rate structures. For example, in the CWCB-approved water conservation plans on file, approximately 85 percent of Front Range and eastern slope water providers, and 77 percent of western slope water providers, have tiered rate structures that increasingly cost customers more if they use more than a base amount of water. These tiered rate structures are called "inclining block-rate structures."[141]

A successful conservation strategy must build on past accomplishments and model in-place examples at the local level across the state. The examples below highlight some of the best efforts to date:

- **Aurora Water:** Aurora Water has implemented landscape and irrigation standards as well as tiered rate structures. Aurora Water also created a customer information system using GIS, an Excel-based water use calculator, and state-of-the-art communication tools to efficiently focus incentives for specific customers and to collaborate with customers more closely. Additionally, Aurora Water has been implementing a successful turf buy-back and landscape-design assistance program since 2007.
- **Douglas County:** All covered entities in Douglas County have CWCB-approved water conservation plans, and the majority of the smaller providers manage water conservation activities under a regional water conservation plan. Of the covered entities, all are implementing water conservation best practices. Specifically, the Town of Castle Rock is a leader in water conservation and is implementing best practices, such as landscape/irrigation ordinances; landscaper certification requirements; landscape incentives, including a turf buy-back program; water budgets based on irrigated landscape area; smart-metering with a customer feedback loop; new construction requirements in relation to water conservation; and customer education.
- **Denver Water:** Over the last eight years, Denver Water has made significant progress through its "Use Only What You Need" campaign. Now Denver Water is customizing water budgets based on irrigated area for its largest commercial customers. Water budgets allow both Denver Water and its customers to know exactly "what they need." As a result of this new program, schools, park districts, and multifamily community associations have already found significant leaks and irrigation-clock malfunctions, and have identified large areas for future conversion to landscaping other than turf.
- **Greeley, Boulder, Highlands Ranch, and Castle Rock:** All of these municipalities adopted water budget rate structures tied to actual water use on a site. Water budgets are rate structures derived from indoor use and from allocated amounts of water per square foot, based on plant requirements and local climate data. Because rates climb steeply if a customer uses more than his or her water budget, these communities use water budgets to manage their summer peak demands while maintaining healthy landscapes.
- **Ute Water/Grand Junction/Clifton:** Starting in 2002, the Grand Valley water providers came together to create a drought response plan called Drought Response Information Project or DRIP. The plan was a success, and is still active. Modeling this effort, the providers came together again to create a regional water conservation plan. Because their systems are interconnected and generally receive the same media, this effort was practical.

- **More Regional Plans:** Statute does not require many communities and water providers to have a CWCB-approved conservation plan due to their small size. These small water providers can, however, come together and create savings that equate to more than the sum of their parts.
  - In the lower Arkansas Valley, 38 small water came together under guidance from Southeastern Colorado Water Conservancy District to create a regional water conservation plan. This plan serves as a roadmap for conservation planning and implementation over the next 50 years. The main impetus of the plan is to ensure that all the water systems are more efficient before connecting to the Arkansas Valley Conduit, thus stretching the new supply further.
  - Steamboat Springs completed a community conservation plan that brought together three water providers under a single community plan in 2010.
  - Five communities in the Roaring Fork Watershed (Aspen, Snowmass Village, Basalt, Carbondale, and Glenwood Springs) have created a regional conservation plan that ties directly into the Roaring Fork Watershed Plan.
- **Other Projects:** Sterling Ranch Rainwater Harvesting Pilot Project
  - In July 2010, CWCB and DWR approved the Sterling Ranch Precipitation Harvesting Pilot Study. The study is currently in its fifth year and is the only pilot project of its kind in Colorado. The legislation that authorized the pilot project study allowed for up to three pilot projects in each river basin, and up to 10 pilot projects across the state.[142] Sterling Ranch is located in Douglas County within the South Platte Basin. Douglas County granted approval to the 3400-acre planned development on July 10, 2013. Sterling Ranch is incorporating precipitation harvesting systems into the first phase of development, which will occur within the next few years. The Sterling Ranch Water Conservation Plan is key to meeting the site's water conservation goals with a substantial, planned reduction in water demands. Preliminary estimates indicate that precipitation harvesting, on average, can supply as much as one-third of the irrigation demand for a typical Sterling Ranch water-wise home, further reducing Sterling Ranch's reliance on non-renewable water supplies.[143]

Social Norming/Behavioral Water Efficiency

Much of water conservation is based—and reliant—on human behavior. It requires constant communication and education to make water conservation a standard community practice (also known as social norming), and to directly influence behavior to achieve water conservation results. At the local water provider level, computer and smart-metering technology have improved greatly in recent years and allow for a direct link between provider and customer. Through this direct link, a water provider can communicate educational messaging about such topics as water consumption targets, water restrictions, and leak detection.

The field of social norming or behavioral water efficiency is becoming standard operating procedure for many water providers in Colorado. Fort Collins, Denver Water, Greeley Water, and City of Brighton are all using technology to provide water consumption goals, current usage statistics, and comparisons between neighbors to elicit more water-efficient behavior change.

The City of Fort Collins and the City of Brighton send water customers a personalized *Home Water Report* that illustrates the customer's consumption and how it compares to neighbors' consumption. The report also suggests customized actions to reduce water use. Equipped with this education, residential customers may change behaviors and can save 5 percent on their water consumption.[144] With Advanced Metering Infrastructure (AMI), feedback can be delivered daily, and even hourly if needed.

These communication links are not limited to water efficiency messaging, and illustrate the changing relationship between water provider and water customer. Continued financial support, technology research, and educational programming are needed for these types of customer relationship and education opportunities, and will be important to Colorado's path toward more efficient water usage and a more water-literate water customer base in the future.

Recent Legislation

Partly in response to the work of the basin roundtables and the IBCC, some recent legislative developments in water conservation have occurred.

In 2014, the Governor Hickenlooper signed legislation that sought to identify and quantify the types of best practices that could enhance municipal outdoor water conservation, and to determine whether further legislation would be needed to facilitate the implementation of those practices. The bill directly refers to the work of the basin roundtables and the IBCC, stating, "As part of the CWCB's statewide water supply initiative and the IBCC and basin roundtable process, a "No/Low Regrets Action Plan" has been developed, an important element of which is to establish and implement conservation strategies to extend the ability of existing water supplies to meet increasing needs and thereby minimize agricultural dry-up."[145]

In 2014, the "fixtures" bill became law.[146] The law phases out less-efficient water-using fixtures, and requires that only WaterSense-specified fixtures may be sold in Colorado. These fixtures carry the EPA WaterSense label, are third-party certified, and are 20 percent more efficient than existing fixtures. Future technology advances could make fixtures even more efficient. In addition, these fixtures do not cost more than their less-efficient counterparts. The bill's proponents estimate that long-term replacement of indoor fixtures will garner approximately 40,000 acre-feet of savings annually by 2050, and will increase the replacement rate of existing fixtures.[147] The bill is consistent with the IBCC's 2010 suggestion to require high-efficiency fixtures.

In 2015, Colorado enacted a law that provides incentives to encourage more participation in the precipitation harvesting pilot program.[148] Incentives include a less burdensome substitute water supply planning process. When calculating required stream replacements to account for captured precipitation, the project proponent would not have to replace the amount of precipitation that would have otherwise been consumed through natural vegetative cover's historical depletion. The proponent may rely on CWCB-established regional factors that specify the amount of precipitation consumed through evapotranspiration of preexisting, natural vegetative cover.

Past Legislation

In 2010, new legislation required most water providers to submit water use and conservation data to the CWCB.[149] This allows water providers to quantify and track water conservation activities and water demand. Implementation of this bill began in 2014 and will provide valuable data to the water plan.

In 2010, additional legislation required the builder of a new, single-family detached residence, for which a buyer is under contract, to offer the buyer a selection of water-saving options, including:

- Toilets, lavatory faucets, and showerheads that are water efficient.
- Dishwashers and clothes washers that meet federal EPA ENERGY STAR program standards if they are financed, installed, or sold as upgrades through the home builder.

The simple things in life, such as a refreshing drink of clean tap water on a warm summer day, cannot be taken for granted.

- Landscape design that follows the green industry's best management practices if landscaping is financed, installed, or sold as upgrades through the home builder and maintained by the homeowner.
- Pressure-reducing valve that limits water pressure to 60 pounds per square inch.[150]

In 2009, the Colorado General Assembly authorized a pilot program that allows for the collection of precipitation from rooftops for non-potable uses. The program can include up to 10 new residential or mixed-use developments. At present, the Sterling Ranch development in Douglas County is the first and only pilot to start, and is at the beginning of its first construction phase.[151]

In 2005, the governor signed legislation that protected water rights owners against abandonment of their water rights if they met certain conditions. Two conditions refer to "a water conservation program approved by a state agency and a water banking program as provided by law." While these conditions do not allow for water sharing, the bill does protect a water rights holder from losing his right if non-use results from water conservation activities.[152]

In 2005, the governor signed legislation that protected homeowners' property rights with regard to installation of xeriscape landscaping. This legislation amended the law that regulated homeowner associations by including a provision that invalidates any new or existing covenant or condition that prohibits or discourages a unit owner from employing xeriscape, or that requires landscaping to consist exclusively or primarily of turf grass.[153]

IBCC Conservation Actions and Goals

In 2010, the IBCC Water Conservation Subcommittee developed a list of water conservation strategies that the IBCC letter to governors included.[154] Among the recommendations were many short-term and longer-term conservation actions, ranging from statewide education campaigns to legislation that addressed indoor and outdoor water use.

In 2013, the IBCC developed the No-and-Low-Regrets Action Plan for water conservation. This strategy outlines the minimum level of water conservation implementation statewide. The IBCC reached consensus on the need to reach low-to-medium levels of water conservation, regardless of the future scenario, and the near-term potential future actions required to achieve that (Table 6.3.1-1).[155]

Three stakeholder processes identified as a goal the minimum amount of water saved through water providers' active conservation efforts. The basin roundtables underwent a process to develop portfolios of water solutions to meet future water needs. The IBCC examined these as part of its No-and-Low-Regrets Action Plan, and determined that it needed low-to-medium conservation levels to address the water supply gap, as the SWSI 2010 defined. The scenario planning process determined that water providers will need to achieve all of low-conservation or half of medium conservation SWSI active conservation levels, or nearly 170,000 acre-feet. Recently, the IBCC achieved consensus onan aspirational goal, known as the "stretch goal." This goal goes beyond the No-and-Low-Regrets actions, and is incorporated into the measurable objectives of Colorado's Water Plan. The goal aims to reduce Colorado's projected 2050 municipal water demands by 400,000 acre-feet through active conservation, while preserving the contribution of urban landscape to vibrancy and sustainability and local flexibility. The language approved by the IBCC is below:

Reduce Colorado's 2050 municipal water demands by 400,000 acre-feet statewide.

- ***Benefits:*** *A stretch goal is in the state's best interest as part of a responsible and sustainable water plan.*
- ***Achieving the Stretch Goal:*** *High levels of customer participation will result from new regulatory mandates, technology innovations, incentives, and changing customer behaviors to reduce Colorado's 2050 water demands by 400,000 acre-feet statewide. This level of conservation includes an additional 60,000 acre-feet of demand reduction beyond the no-and low regrets recommendations. Based on current conservation plans statewide, the committee believes this is achievable.*

- ***Implementation:***
  - ***Accountability:*** *For the goal to be successful, water providers will be encouraged to do comprehensive, integrated water resource planning, geared toward implementing the best practices at the high customer participation levels, as defined in SWSI. This planning will be one of the components that shall be considered to achieve state support for projects, and financial assistance. This planning allows for flexibility by the local water provider to do what is technically, economically, and legally practical for their system as not every conservation practice is appropriate for every community.*
  - ***Best Practice Based:*** *The goal can only be achieved by encouraging the implementation of best management practices at high customer participation levels as defined in SWSI. The best management practices will continue to adapt and evolve over time, incorporating innovative technologies, providing opportunities for contribution to these demand reductions.*
  - ***Maintain Local Control:*** *The goal recognizes the importance of local control and flexibility, while encouraging high levels of conservation and adoption of innovative practices across the state.*
  - ***Monitoring:*** *Tracking demand reductions as part of future SWSI updates will be necessary.*
  - ***Adaptive Management:*** *The goal may need to be adapted based on future demand and other factors and incorporated into the portfolios and scenarios over time.*

BIPs

For 2014, each basin roundtable formulated its own implementation plan. These plans included water conservation goals and activities, in addition to already-planned projects and methods, use of Colorado River water, and alternatives to agricultural water transfers.

TABLE 6.3.1-1 INTERBASIN COMPACT COMMITTEE POTENTIAL FUTURE ACTIONS SUMMARY

1. Improve Tracking and Quantification of Conservation
2. Establish a Statewide Conservation Goal with Intermittent Benchmarks a. Develop general political support for a statewide conservation goal. b. Develop statewide agreement tying conservation to new supply development and agricultural transfers. c. Support local entities in their efforts to outline and report their own approaches to help achieve the statewide goal. d. Explore best approach to implementation of standards to achieve goal. e. Develop and implement conservation standards.
3. Continue to Support Local Implementation of Best Practices a. Continue implementation of state conservation programs. b. Encourage use of levels framework and best practices guidebook.
4. Promote Enabling Conditions for Use of Conserved Water a. Maintain and develop storage and infrastructure for the use of conserved water. b. Promote incentives for the use of conserved water. c. Identify and, where possible, resolve legal and administrative barriers to the use of conserved water. d. Identify and explore barriers to sharing conserved water.
5. Develop New Incentives for Conservation a. Explore funding options in support of the Water Efficiency Grant Program. b. Develop professional education and certification programs. c. Develop new eligibility requirements for state grants and loans that include certain conservation levels or indications of commitment to conservation. d. Develop conservation standards for communities planning to use agricultural transfers or new supplies for future water needs. e. Develop incentives that incorporate the following concepts: Encourage a base level of conservation; assess issues, benefits, and drawbacks of the current definition of "covered entities;" conservation water markets; small community support; permitting incentives.
6. Explore Legislative Concepts and Develop Support a. Explore legislative options and support for indoor plumbing-code standards. b. Explore legislative options and support for outdoor water efficiency standards. c. Engage in outreach and education efforts to explain the need for legislation; develop political support.
7. Implement Education and Outreach Efforts a. Track public attitudes through baseline and ongoing surveys. b. Develop statewide messaging and use focus groups to refine and guide implementation. c. Develop decision-maker outreach strategies. d. Pursue a coordinated media campaign.

Arkansas Basin

The Arkansas Basin addressed conservation by stating, "Stakeholders should take all actions required to maintain current water supplies and prevent future water supply gaps from increasing." The Arkansas Basin stated four goals for meeting municipal water needs:

- Meet the municipal supply gap in each county within the basin.
- Support regional infrastructure development for cost-effective solutions to local water supply gaps.
- Reduce or eliminate Denver Basin groundwater dependence for municipal users.
- Develop collaborative solutions between municipal and agricultural users of water, particularly in drought conditions.

To illustrate progress to date, the Arkansas Basin highlighted many of the current water efficiency activities, such as the innovative, regional water efficiency planning efforts of the Southeastern Colorado Water Conservancy District (SECWCD), and the Best Management Practices Toolkit for providers. The regional efficiency planning efforts brought 47 mostly small water providers under one efficiency plan, while using the toolkit to create individual plans for each provider. The toolkit identifies five components as essential areas of water efficiency: Water production and treatment, water distribution, water delivery to customers, customer demand management, and overall water system management. As part of this regional effort, SECWCD will implement triennial system-wide water audits of all participants, and will report annual data to SECWCD.

As a solution for preventing the future increase of water supply gaps while attaining the basin's goals and aligning with the ongoing regional efficiency plan implementation, the basin listed several projects and recommendations related to water conservation. The projects focus on water loss metering and audits. The CWCB identified these as foundational water efficiency activities that every water utility should implement. Activities include master-meter improvements to aid in reliably measuring water flow, and properly accounting for water loss using the internationally accepted American Water Works Association M36 Water Loss Methodology. The BIP related all water efficiency activities that water providers are currently implementing in the Arkansas Basin, such as water loss management, re-evaluation of water rates, landscape water efficiency, adoption of advanced metering infrastructure, indoor fixture and appliance rebates, policies and regulations, and customer education.[156]

Colorado Basin

One of the Colorado Basin's themes is to "Encourage a high level of basin-wide conservation." Two goals specifically related M&I water conservation:

- Improve Colorado water law to encourage efficiency, conservation, and reuse.
- Pursue continued M&I conservation.

Measurable outcomes support these goals, and include revising Colorado water law to allow more flexibility in promoting stream health through conservation, and achieving and sustaining a high level of conservation by all basin water providers. The Colorado Basin identified projects and methods for the implementation of these goals. These include conducting a comparison of Colorado water law and procedures with those of other Western states in order to identify alternative practices and facilitate water transfers and various local water conservation efforts—both today and in the future. Additionally, the Colorado Basin created an extensive section that integrated water conservation with land-use policies. Section 6.3.3 describes this.[157]

Gunnison Basin

The Gunnison Basin BIP promotes high levels of water conservation. The BIP focused on identifying and addressing M&I shortages. As a way of fulfilling this goal the basin stated that it would "Promote the development of voluntary regional water conservation plans to help smaller entities (delivering less than an annual 2,000 acre-feet) achieve water savings and related reductions in expenses related to treatment, distribution, and infrastructure."[158]

To attain this goal, the plan listed two measurable outcomes for water conservation:

- Reliably meet 100 percent of essential municipa water provider system demands in the basin through the year 2050 and beyond.
- Continue the current baseline of covered entities' effective water conservation programs, with a goal to achieve high levels of conservation savings as the SWSI 2010 defined.

The Gunnison Basin also identified statewide principle connecting water efficiency, conservation, and demand management. The most salient of these is Principle 5:

> "Water conservation, demand management, and land-use planning that incorporates water supply should be equitably employed statewide."

The Gunnison Basin Roundtable believes that the best way to promote statewide water conservation—and thereby attain this principle—is by using incentives, not regulatory methods, and by focusing demand-management efforts on covered entities. Additionally, local land-use policies and regulations should discourage sprawl, link water supplies to development, and provide incentives for higher-density developments. Two implementation concepts focus on working with other roundtables to attain this principle, and to promote programs that encourage drought-tolerant vegetation and discourage lawn irrigation.[159]

The Gunnison Basin describes its water conservation planning process for the Upper Gunnison Basin as a means of reaching these measurable outcomes and the goal to address M&I shortages.[160]

MARK MARLOWE

SOUTH PLATTE RIVER BASIN

Mark is the Utilities Director for the Town of Castle Rock, where among other efforts, he spearheads some of the most innovative conservation efforts in the state. Mark is pictured in front of Chatfield Reservoir.

My vision for Colorado's Water Plan is that it brings the citizens of the State together to work towards a secure supply of water for every Coloradan to enjoy a hot shower, a clean bathroom, a cool glass of crystal clear tap water (or a hot cup of Joe), and clean/safe natural water bodies for the pursuit of happiness just as Castle Rock's plan has brought our community together to continually work towards this goal. Castle Rock will continue to be a leader in implementing common sense solutions identified in the state plan as we have already been doing.

I currently serve as the Utilities Director for the Town of Castle Rock. I am responsible for the water, wastewater and stormwater utility…

CONTINUED AT END OF CHAPTER

PROFILE

North Platte Basin

The North Platte Basin focuses mainly on agricultural and environmental water issues, since the municipal need is low due to lack of population. The North Platte Basin Roundtable states that it "supports the extensive water conservation efforts of major Colorado water providers, and encourages further conservation as permitted by technology, economics, and legislation. The North Platte Basin Roundtable supports a wide variety of water conservation methods including municipal conservation programs, strategic growth and development, and landscape limitations. The North Platte Basin Roundtable believes that the best way to promote statewide water conservation is through incentive-based measures as opposed to regulatory methods."[161]

To maximize water savings and avoid an unnecessary burden on smaller, rural water providers, the North Platte Basin Roundtable supports a focus on covered-entity conservation efforts by:

- *Supporting the use of state funding to provide incentives for reaching municipal conservation and efficiency standards.*
- *Working with appropriate entities to ensure that statewide conservation strategies and any related legislation allow flexibility to meet the needs of local governments.*

A measurable outcome for the North Platte Basin Roundtable for this process would be to:

- *Comply with future statewide municipal conservation strategies and any related legislation by 2020 or as appropriate.*

Currently, the North Platte Basin has not identified any proposed projects to address this goal; however, the North Platte Basin Roundtable will remain involved in the IBCC's and the Colorado Water Plan's ongoing processes to support the equitable statewide application of municipal water conservation measures.[162]

Rio Grande Basin

Much like the North Platte Basin, the Rio Grande Basin Roundtable focuses on agricultural water and environmental needs. With that said, the Rio Grande Basin Roundtable does have a goal "to meet new demands for water, to the extent practicable, without affecting existing water rights and compact obligations."[163]

The Rio Grande Basin Roundtable has several measurable outcomes for M&I water conservation:

- *Minimize per capita per day use to a reasonable level.*
- *Inventory existing and expected future M&I and environmental and recreational water needs.*
- *Develop an M&I plan that addresses water needs, availability, and a strategy for meeting the needs for M&I while sustaining agricultural water use and minimizing impacts to other uses.*[164]

South Platte/Metro Basin

The South Platte/Metro Basin has an overarching theme of continuing "its leadership role in efficient use and management of water."[165] It has also identified the following goals and measurable outcomes:

- *Goal: Continue the South Platte River Basin's leadership in wise water use.*
- *MO#1: Further quantify the successes of programs implemented in the past several years throughout the South Platte River Basin and establish a general baseline against which the success of future programs will be assessed.*
- *MO#2: Distribute and encourage adoption of "best management practices" as "guidelines" (not standards) for M&I water suppliers to consider in their "provider-controlled" programs recognizing the substantial differences in climates, cultures and economic conditions throughout the South Platte River Basin.*

It also identified as a nonconsumptive goal:

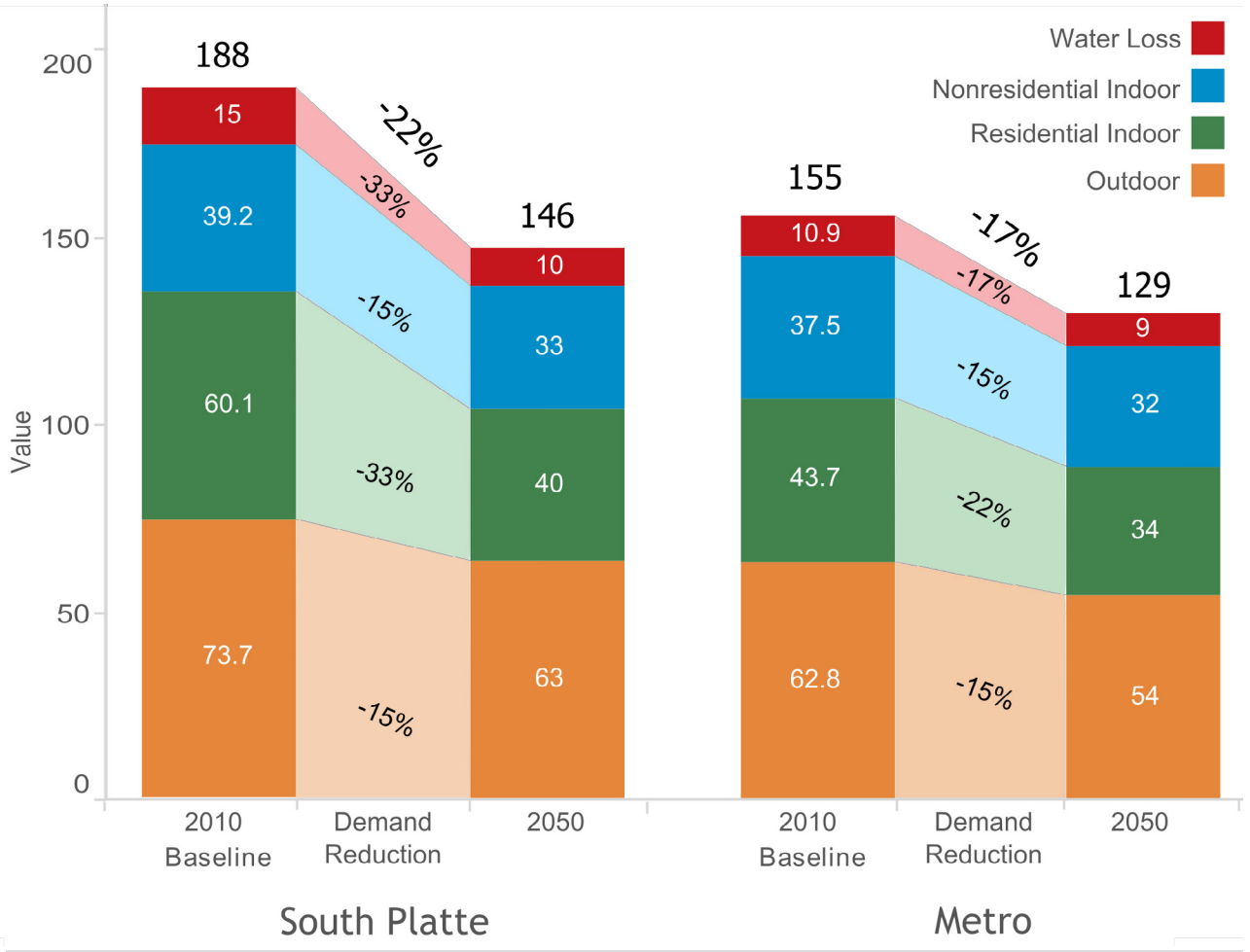
- *NC MO#1: Ensure conservation, reuse and drought management plans take into consider-ation environmental and recreational focus areas and attributes.*

The Metro and South Platte Basin focused on achievable demand reductions based on current trends in water conservation best practices—barring future regulation and major land-use changes. The Metro Basin Roundtable recommends pursuing conservation programs that would reduce per-capita water use from a baseline of 155 gallons per-capita per-day (gpcd) in 2010, to 129 gpcd by 2050. The South Platte Basin Roundtable recommends conservation programs that would reduce per-capita water use from a baseline of 188 in 2010, to 146 gpcd by 2050 (Figure 6.3.1-1). The South Platte Basin Roundtable believes that these goals are aggressive based on the present-day state of conservation best practices and the possible societal changes required to exceed these levels.[166]

The South Platte/Metro Basin shared examples of future work that will help achieve conservation savings. It suggested that "further standardization of the term "per-capita water use" and improvement in the understanding of the factors affecting water consumption rates can help the basin and State better understand the ways that conservation programs and reductions in per-capita water consumption can help meet supply gaps."[167]

Additionally, the South Platte/Metro Basin stated that certain regulatory, rate structure-driven, educational, and incentive-based approaches will assist in achieving conservation goals. "Providers encourage conservation through water rate designs, education, watering schedules, and rebate programs as well as water waste rules. Finding effective methods to strengthen code requirements and enact stronger land-use regulations will be an important factor in building efficiencies through conservation."[168]

FIGURE 6.3.1-1 SOUTH PLATTE AND METRO BASIN CONSERVATION GOALS



Landscaping features that use less water can help to reduce overall demand, and be pleasing to the eye at the same time.

The South Platte/Metro Basin finished with thoughts about ways more water efficiency could occur:

- *Greater savings in outdoor water use would require major changes in landscaping that moves beyond just efficiency measures; this would involve lifestyle considerations about our urban environments. These decisions must be made and implemented at the broader community level, as well as at the water-planner level.*
- *Higher levels of indoor conservation will require broad political and public support.*
- *Land-use planning has the potential to promote densification, growth management, and comprehensive plans to include considerations for impact fees and firm yield.*

The Metro and South Platte Basin Roundtables support ongoing statewide education to address these factors.[169]

Southwest Basin

The Southwest Basin has a "goal of promoting and incentivizing wise and efficient water use through implementation of municipal conservation strategies to reduce overall future water needs."[170] The Southwest Basin supports high conservation levels statewide.

The Southwest Basin stated the following measurable outcomes in its BIP. These outcomes work toward the goal of promoting wise and efficient water use through the implementation of municipal conservation strategies to reduce overall future water needs:

- *Consistently meet 100 percent of residential, commercial, and industrial water system demands identified in SWSI 2010 in each sub-basin, while also encouraging education and conservation to reduce demand.*
- *Change the ratio of in-house to outside treated water use for municipal and domestic water systems (referred to as water providers herein) from the current ratio of 50 percent in-house use and 50 percent outside use, to 60 percent in-house use and 40 percent outside use (60/40 ratio) for southwest Colorado and the entire State by 2030.*
- *The water providers in the state that are using dry up of agricultural land (defined as requiring a water court change case) and/or pursuing a new TMD (as defined by IBCC to be a new western slope to eastern slope diversion project) shall have a higher standard of conservation. The goal for these water providers is a 70/30 ratio by 2030. This is a prerequisite for the roundtable to consider support of a new TMD.*

The Southwest Basin did not develop specific IPPs for all possible management and conservation opportunities; however, overall strategies include:

- *Continue to reduce the amount of water needed for municipal, domestic, and industrial purposes through conservation efforts to meet the goal and measureable outcome herein.*

The Southwest Basin's process identified two project concepts, including: *"1) to work with public water suppliers, including municipalities, to assess their current indoor and outdoor water use ratio and to incentivize the attainment of the 60/40 ratio and; 2) the development of irrigation efficiency program."* No entity is actively pursuing these ideas for projects or processes in the basin yet.[171]

Another area in which the Southwest Basin proposes water conservation action is in the basin's public education and outreach plan. Short term goals "encourage education and conservation to reduce demand, implement information events on water conservation, land-use planning and reuse, and promote wise and efficient use through implementation of municipal conservation strategies to reduce overall future water needs".[172]

Yampa/White/Green Basin

The state demographer projects the Yampa/White/Green Basin population to nearly triple by the year 2050, and expects M&I water usage to nearly double, even with savings from passive conservation. The basin roundtable has identified such strategies as adequate storage, strong municipal conservation measures, and drought plans to address the situation. The Yampa/White/Green Basin identified M&I water conservation as one way to help meet future basin demands. Processes and measurable outcomes include:

- *Identifying specific locations in the basin where M&I shortages may exist in drought scenarios, quantifying the shortages in time, frequency, and duration.*
- *Identifying impacts throughout the basin in the context of water shortages (drought and climate change), wildfire, and compact shortage on M&I demands.*
- *Encourage municipal entities to meet some future municipal water needs through water conservation and efficiency.*[173]

Measurable Outcomes

- *Reliably meet 100 percent of M&I demands in the basin through the year 2050 and beyond.*

The Yampa/White/Green Basin Roundtable identified and quantified one water conservation project in the Yampa/White/Green Basin. The project goal is to reduce projected use by 720 acre-feet by 2035 in Steamboat Springs by reducing per-capita demand by 15 percent in the Steamboat Springs municipal water system. The aim is to achieve this through passive conservation and active conservation, including leak detection programs, fixture rebate programs, and a reduction in landscape irrigation needs.

ACTIONS

The actions below are based on the IBCC's No-and-Low-Regrets Action Plan, the work of the Water Conservation Technical Advisory Group, the basin roundtables, and utility water conservation plans.

1. **Adopt conservation incentives:** Over the next two years, the CWCB will adopt policies stating that water providers must conduct comprehensive, integrated water-resource planning geared toward implementing water conservation best practices at high customer participation levels, as defined in SWSI, as one of the components that shall be considered to achieve State support and financial assistance for water management projects.
2. **Support water management activities for all water providers:** The CWCB will continue to provide funding, technical support, and training workshops to assist water providers in improving the management of their water systems. This will include the use of techniques such as water budgets, smart-metering, comprehensive water loss management programs, savings tracking and estimating tools, and improved data collection on customer water uses. For example, in the next year, the CWCB will fund several regional training workshops about using the American Water Works Association M36 Methodology for Water Audits and Loss Control.
3. **Recommend WaterSense specifications for outdoor irrigation technology:** Through a stakeholder process, the DNR will work with the General Assembly to consider adopting WaterSense specifications for outdoor technology at the retail level. These specifications would create a minimum standard that water providers can easily adapt to accommodate higher-efficiency technologies as they are created and certified.

4. **Explore incentives for outdoor water conservation measures:** As part of a broader funding strategy the CWCB is developing over the next year, the CWCB will work with stakeholders to explore a tax-credit program. The program would incentivize water providers to retrofit higher water-use landscapes with lower water-use landscapes that preserve the environmental and economic benefits of urban landscape and encourage more efficient irrigation systems.

5. **Adopt a stretch goal:** The CWCB supports water providers in their plans to reduce projected 2050 demands by 400,000 acre-feet through active conservation savings. Based on stakeholder work, the CWCB will adopt a "stretch goal" to encourage demand-side innovation that places Colorado at the conservation forefront in a thoughtful way—while recognizing and addressing the effects of conservation. The CWCB will support a stakeholder process that examines various options, including options for local providers to establish targets that are consistent with the IBCC's identified stretch goal. At the same time, CWCB will give appropriate credit to water providers for recent strides they have made in demand reduction.

6. **Water conservation education and outreach:** The CWCB will develop an education and outreach strategy that includes water conservation topics. Section 9.5 offers more detail regarding specific education and outreach recommendations. Section 9.5 outlines education and outreach recommendations that will tie together other actions the section illustrates, and provide the reason for executing these actions. Each BIP will emphasize these efforts, which the roundtable will implement in order to address basin-specific issues. This work will include surveys of public attitudes, and partnerships with water providers and other water educators.

7. **Support local water smart ordinances:** Over the next two years, the CWCB will provide trainings that support local regulatory efforts that shape the ways in which new construction interacts with water use. For example, local jurisdictions could craft landscape and irrigation ordinances, tap fees that reflect actual water uses, education or certification for landscape professionals, green-infrastructure ordinances, and more stringent green-construction codes that include higher-efficiency fixtures and appliances and water-wise landscapes. It is imperative that this action explore the societal and environment benefits of urban landscapes. Section 6.3.3 further explores this action.

8. **Evaluation of barriers to green-building and infrastructure.** CWCB and CDPHE will work together to determine which state agencies govern green infrastructure and green-building, identify barriers, and work with the appropriate agencies to adapt regulations to allow for graywater, green infrastructure, on-site water recycling and other aspects of green developments.

9. **Strengthen partnerships:** The CWCB will create or renew partnerships between the CWCB and the following groups to reach water conservation goals:

    a. Local water providers and local governments to implement water conservation programs to benefit their water systems.

    b. Intra-state government (DOLA, DWR, Department of Regulatory Agencies (DORA), and state facilities) to coordinate and implement incentives.

    c. Green industry (GreenCO, Irrigation Association, Associated Landscape Contractors of Colorado, urban arborists, landscape-related businesses, property management companies) to implement efficient landscape installations and maintenance.

    d. Home building/construction (Home Builders Association, LEED, U.S. Green Building Council) to implement water-smart homes.

    e. Non-governmental organizations (Colorado WaterWise, Alliance for Water Efficiency, Western Resources Advocates, American Water Works Association, Water Research Foundation) to help educate Coloradans and advance conservation innovations and research.

    f. Academia (Colorado State University, CU-Boulder, CU-Denver, One World One Water Center-Metropolitan State) to bring a consortium of businesses, academia, and others together to examine behavioral science and research conservation innovations.

10. **Explore expanding conservation funding:** As Colorado water providers implement more sophisticated and integrated water conservation programs, the CWCB will require annual funding for the Water Efficiency Grant Program beyond the current $500,000 levels, and funding should consistently total $2,000,000 per year. In addition, the CWCB's loaning ability should expand to encompass conservation actions. The DNR will work with the General Assembly to institute these changes over the next two legislative cycles.

11. **Market for conserved, consumptive-use water:** To use conserved, consumptive-use water to the greatest extent possible, the CWCB will identify legal and administrative barriers to the use or sharing of conserved, consumptive-use water through a stakeholder process. If the CWCB can address barriers through acceptable legislative modification, the DNR will work with the Water Resources Review Committee to propose legislative action.

12. **Develop an alternative process for smaller entities to create water conservation plans and report water use data to the CWCB:** The CWCB will provide technical and financial support and will work to formalize the process into the CWCB Municipal Water Efficiency Guidance document.

13. **Continue implementation of state conservation programs:**

    a. The CWCB will continue to review and approve locally adopted water conservation plans to encourage long-term water conservation planning and water savings quantification, and to ensure that water providers document their water conservation goals.

    b. The CWCB will continue to use the Water Efficiency Grant Fund to ensure the implementation of water conservation best practices and to assist water providers in targeting their resources as efficiently as possible.

    c. The CWCB will focus on opportunities for water conservation planning where covered-entities or many small-water providers can create a regional water conservation plan. This will especially be the case when conservation in such communities could help reduce the M&I water supply gap, lessen the need for agricultural dry-up, or affect nonconsumptive values.

6.3.2 REUSE

As Chapter 5 mentioned, various sources of water can be reused to extinction. These sources include water from transbasin diversions, agricultural-municipal water transfers, and nontributary groundwater. Reuse water will affect future demands, and the following section describes future actions that will benefit Colorado. Many innovative reuse projects already exist, and Colorado can learn from several areas in the United States that are exploring future pathways in reuse technologies.

Nationally and internationally, research is focusing on potable reuse systems. In Colorado, most reuse systems have been non-potable in nature. Nonetheless, "de facto" potable reuse in Colorado occurs when one community discharges water to receiving-waters that downstream communities use for potable supply. Water quality standards in the receiving-waters, and Safe Drinking Water Act requirements for potable treatment, control this process (which also drives discharge permits from water reclamation facilities). Intentional, indirect potable reuse (IPR) projects are increasingly common: Aurora's Prairie Waters Project and the Town of Parker use water from their water reclamation facilities to supply Rueter-Hess Reservoir.

Denver Water pioneered direct potable reuse (DPR) through research and its potable-reuse demonstration project in the 1980s. While there continue to be public health and environmental concerns related to brine disposal, it is technically feasible to implement DPR today. However, the public does not fully accept DPR for reuse as drinking water and more research and education may help gain public acceptance.[174] In Colorado, no utilities have seriously pursued DPR.

Widespread development of potable reuse will be an important facet of closing the future water supply-demand gap. Over the last few years, the CWCB funded research into zero-liquid discharge (ZLD). The research focused on assessing the technology for addressing challenges associated with managing residuals from advanced treatment of alternative water supplies from lower-quality water sources. Most recently, the research team selected Brighton and La Junta as pilot sites for investigating the feasibility of technologies to minimize or eliminate brine disposal in a manner suitable for Colorado. The study found that the technology produced excellent water quality and had a very high recovery rate: 96 percent for the La Junta pilot site, and 90 percent for the Brighton site. Although the technology reduced concentrate and increased water recovery rates, the CWCB must conduct more research to understand ways to reduce costs, increase reliability of the technology, and create a more environmentally friendly technology before widespread adoption can occur in Colorado.[175]

The Water Quality Control Commission (WQCC) adopted Regulation 86 which establishes the allowed uses of graywater and prescribes minimum standards for the use of graywater. The bill defines graywater as wastewater collected within a building from sources other than toilets and urinals, kitchen sinks, dishwashers, and non-laundry utility sinks.[176] Once the Colorado Plumbing Board adopts suitable changes, counties and municipalities may adopt local legislation to allow graywater use, subject to water-rights restrictions. Graywater use is limited to subsurface irrigation and toilet-flushing. Once fully approved, graywater reuse should be an important component of

new construction.

In Colorado, reuse water that is used for non-potable uses, such as landscape irrigation, is subject to the requirements of Regulation 84. This regulation establishes standards to protect public health and the environment. Regulation 84 defines reuse water, also known as "reclaimed water," as "domestic wastewater that has received secondary treatment by a domestic wastewater treatment works and such additional treatment as to enable the wastewater to meet the standards for the approved uses."

As Chapter 5 briefly describes, Regulation 84 has adapted over the years to accommodate changes and advances in the science of reuse water. The WQCC promulgated Regulation 84 in 2000, and since then, has amended it four times in order to add new uses. As Colorado plans its reuse future, continued flexibility will be paramount to addressing water resource challenges. To many municipalities, reuse is critical in addressing identifies supply gaps in Colorado. Nonetheless, while reusing wastewater can help close the water supply gap, appropriate public health and environmental protections must remain in place. The CDPHE is committed to working with stakeholders to ensure that health and environment are protected while water reuse expands--but the CDPHE needs additional funding to support expanding safe and environmentally friendly water reuse. Without the ability to expand reuse, the gains that are forecasted to foster permanent growth in the reuse of limited water supplies may not be realistic.

While there is not a specific and defined regulatory pathway for DPR in Colorado, there are currently no regulations prohibiting or limiting a utility's pursuit of this option. At present, Colorado should work through and approve a proposed DPR project. Despite momentum toward more reuse planning and implementation in Colorado, barriers—such as public acceptance of DPR and costs of treatment for lower-quality water sources—are real issues the State must address. With that said, development of any new supplies will face implementation barriers as

The forebay at the Peter D. Binney Purification Facility, part of the Prairie Waters Project. The project is a key component of recycling water, serves Aurora, and will soon provide a renewable source of water to the South Metro Region. Courtesy of Havey Productions.

well. These include infrastructure capacities, losses, supply-and-demand timing, water quality, treatment costs and brine disposal, and regulatory requirements. In addition, the waste product resulting from reverse osmosis has very high salt levels and cannot be discharged into the stream; other disposal options for the waste product are limited. If a municipal provider has higher-quality source water to blend with lower-quality sources, this issue can be avoided. The State must address many, if not all, of these limitations in order to make many of the new water supplies available to meet future demands, whether through TMDs, agricultural transfers, or other methods. These limitations are not unique to reuse projects. In particular, brine disposal is a challenge in treating many lower-quality sources with reverse osmosis (RO), as evidenced by several facilities in Colorado that use RO to treat groundwater supplies for potable use.

Additionally, the issue of reduced return flows concerns many water providers and agricultural users with regard to the downstream effects of increased reuse of water supplies. Like the development of other local supplies through full use of absolute rights or development of conditional water rights, reuse may reduce return flows upon which downstream users have historically relied. Nevertheless, in combination with other water development, reuse can help mitigate the effects. Future research should focus on the possible effects of water reuse on return flows. Concurrently with DPR, Colorado also needs to explore other reuse methods such as, green infrastructure, on site water recycling for non-potable use, use of natural systems, and less energy-intensive treatment methods. The Net Zero Water Initiative is a current project in Colorado that explores many of these aspects of net-neutral water management (Chapter 6.3.3 contains a more detailed explanation of this project).

Recently, the CWCB funded a white paper titled, "Considering the Implementation of Direct Potable Reuse in Colorado," which the Water Environment Research Foundation sponsored and HDR Engineering authored. The draft paper explored the technical, operational, regulatory, and public acceptance challenges related to implementing DPR in Colorado. In alignment with Colorado's Water Plan's grassroots approach, the Water Environment Research Foundation, the Water Research Foundation, and Water Reuse Colorado sponsored a workshop to gather feedback about the white paper and to discuss direct potable reuse as a new water supply. Reuse experts from across the country attended, including first-hand practitioners from Texas, California, and other states. The draft white paper and the workshop elicited the following recommendations:

- *Convene a broad range of experts and interested parties to produce a roadmap to develop potable reuse in Colorado. This would include making policy, regulatory, technical, and operational recommendations.*
- *Sponsor a survey of Colorado utilities and water agencies to determine the extent to which DPR may be considered as a means to augment their water supply portfolios.*
- *Develop a program to educate the public, elected officials, and water utilities about the benefits and safety of DPR.*
- *Partner in research projects that advance the knowledge related to technical challenges associated with DPR including more cost-effective and environmentally acceptable RO concentrate management techniques and the evaluation of non-RO based treatment trains capable of producing water suitable for DPR.*
- *Investigate water quality of de facto reuse situations relative to potable reuse.*
- *Carry out a state funded potable reuse pilot project in Colorado to assess the impacts and benefits of potable reuse.*[177]

The actions below incorporate some of the results of this work.

Reuse Projects

In Colorado, there are 25 entities that treat reuse water and provide nonpotable recycled water. Regulation No. 84 refers to them as "treaters." Most of these water providers are located on the eastern slope along the Front Range. In addition, numerous examples demonstrate indirect reuse through exchange around the state.

As the IBCC's No-and-Low-Regrets Action Plan mentioned, examples of direct and indirect reuse projects in Colorado include:

Colorado Springs Utilities: For more than 50 years, Colorado Springs Utilities has produced reuse water in the form of direct reuse for irrigation and cooling. Irrigation consists of the provision of water to golf courses, parks, campuses, and other properties, while cooling-water is used at the Drake Power Plant's cooling towers. According to Colorado Springs Utilities, direct-reuse water has yielded a savings of 1 billion gallons of drinking water per year.

Aurora Water's Prairie Waters Project: This project employs IPR. Riverbank filtration (RBF) wells extract Aurora's fully reusable water from the South Platte River near Brighton, pump it into aquifer recharge and recovery (ARR) basins, and then pump it back through 34 miles of pipeline and three pumping stations. This provides nearly 1000 feet of lift to the Peter D. Binney Water Purification Facility near Aurora Reservoir. Natural filtration methods in the RBF wells and ARR basins partially treat the water, and then fully treat it at the Binney facility before mixing it with existing water resources and distributing it to Aurora's customers. The current system capacity is approximately10 million gallons per day (mgd), which is expandable to 50 mgd.

Denver Water: Denver Water has an extensive non-potable water reuse system that serves many large customers including Xcel Energy, parks, golf courses, and the Denver Zoo. This recycled water system is a direct reuse system and has a treatment capacity of 30 mgd, expandable to 45 million mgd. With a goal of attaining 17,500 acre-feet per year of recycled water use, Denver Water continues to add sites to its non-potable water distribution network.[178]

IBCC No-and-Low-Regrets Actions

In 2013, the IBCC developed the No-and-Low-Regrets Action Plan for water reuse. This strategy outlines the minimum level of water reuse water providers should implement statewide (Table 6.3.2-1).[179]

BIPs

Several BIPs have featured water reuse, and have stated the following draft goals.

TABLE 6.3.2-1 INTERBASIN COMPACT COMMITTEE NO-AND-LOW-REGRETS ACTIONS

COMPLETED AND ONGOING ACTIONS	POTENTIAL FUTURE ACTIONS
• Continue to support current reuse IPPs. • Continue to incorporate reuse in the state water planning process. • Continue the study of zero liquid discharge reverse osmosis plants through the Water Supply Reserve Account (WSRA) program.	1. Improve Tracking, Quantification, and Planning a. Use SWSI efforts to improve reporting of reuse IPPs b. Develop BIPs that incorporate reuse 2. Establish a Statewide Reuse Goal with Intermittent Benchmarks a. Develop general political support for a statewide reuse goal b. Develop statewide agreement tying reuse to new supply development and agricultural transfers c. Encourage relevant local entities to outline and report their own approaches to help achieve the statewide goal 3. Develop New Incentives for Reuse a. Explore funding options in support of the WSRA grant program b. Pursue breakthroughs in research c. Develop incentives 4. Implement Education and Outreach Efforts a. Track public attitudes through baseline and ongoing surveys

Arkansas Basin

The water conservation section of this plan iterated goals related to meeting municipal water needs; these same goals apply to water reuse. The Arkansas Basin Roundtable has identified the following four goals for meeting municipal water needs:

- *Meet the municipal supply gap in each county within the basin;*
- *Support regional infrastructure development for cost-effective solutions to local water supply gaps;*
- *Reduce or eliminate Denver Basin groundwater dependence for municipal users; and,*
- *Develop collaborative solutions between municipal and agricultural users of water, particularly in drought conditions.*[180]

While reuse projects—including Colorado Springs' Southern Delivery system, and ZLD research in La Junta—are occurring now in the Arkansas Basin, the Arkansas Basin has outlined opportunities and constraints for future reuse development. Opportunities include the creation of additional storage, including the Long-Term Excess Capacity Master Contract space in Pueblo Reservoir, and new reservoirs. New reservoirs may include a lined gravel-pit reservoir below the confluence with Fountain Creek, intended to capture transbasin return flows that are not immediately exchangeable to Pueblo Reservoir. Constraints consisted of the difficulties of reusing more water in the already over-appropriated Arkansas River system. Better management of existing supplies—including transbasin water supplies—will help meet the needs, but achieving better management will require extensive engineering studies and legal support.[181]

Colorado Basin

The Colorado Basin is focused on efforts that include developing water court process recommendations in order to encourage improvements in efficiency, conservation, and reuse.

Measurable outcomes support this goal. The outcomes include revising Colorado water law to allow more flexibility in promoting stream health through conservation, and achieving and sustaining a high level of conservation among all basin water providers. The Colorado Basin identified projects and methods it will need to implement these goals, such as conducting a comparison of Colorado water law and procedures with those of other Western states in order to identify alternative practices and facilitate water transfers and various local water conservation efforts—both today and in the future.[182]

Gunnison Basin

The Gunnison Basin framed its reuse discussion based on criteria for new supply projects using Colorado River Basin water. The criteria represent conservation, land use, and reuse. The Gunnison Basin describes reuse criteria as follows: "Entities must first reuse all legally available reusable water supplies to the maximum extent possible before further development of Colorado River System water."[183]

North Platte and Rio Grande Basin

Neither the North Platte Basin nor the Rio Grande Basin uses reuse as a future strategy to close supply gaps due to relatively minor municipal water use and low population numbers.

South Platte/Metro Basin

The South Platte/Metro Basin has an overarching theme of continuing "its leadership role in efficient use and management of water."[184]

The South Platte/Metro Basin regards reuse water in the context of the Colorado River. Its initial goals state, "A balanced program to plan and preserve options to responsibly develop Colorado River water to benefit both east slope and west slope consumptive and nonconsumptive, environmental and recreational

TABLE 6.3.2-2 SOUTH PLATTE AND METRO PROVIDERS' REUSE OF IDENTIFIED PROJECTS AND PROCESSES

BASIN	PROVIDERS	PROJECT	ESTIMATED YIELD (ACRE-FEET PER YEAR)	ESTIMATED COMPLETION DATE
Metro	Aurora	Prairie Waters Project Expansion and Storage[a]	TBD	2050
Metro	Northglenn	Northglenn Reuse Plan	700	
Metro	Thornton	Thornton Reuse	2,000	2030
Metro	Denver Water	Denver Water Reuse	17,500	2023
Metro	Westminster	Westminster Reclaimed Water		
Metro	Denver Water	Downstream Reservoir Exchanges	12,000	
Metro	Castle Rock	Alternative Northern Water Supply Project	2,500	
Metro	Castle Rock	Plum Creek Diversion and Water Purification Facility Upgrades	4,100	
Metro	Arapahoe County Water and Wastewater Authority	Reuse of ACWWA Flow Project Deliveries	3,250	
Metro	City of Brighton	South Platte and Beebe Draw Well		
Metro	South Metro Water Supply Authority, Denver Water, Aurora	WISE	7,225	2021
South Platte	Erie	Erie Reclaimed Water	5,390	
		TOTAL:	**58,135**	

[a] The yield of PWP expansion depends on the yield of other projects, such as the Eagle River Project, Box Creek and Growth into existing supply, in addition to the future demand scenario used to calculate Aurora's remaining gap.

water uses is needed to assure that the State's plan has equal focus on the other three previously identified strategies including: 1) developing IPPs, 2) municipal conservation and reuse, and 3) agricultural transfers."[185]

The basin also states the following goal and measurable outcomes in relation to reuse: The South Platte River Basin will "enhance current levels of municipal water reuse and consider studies to quantify the effects of: 1) additional municipal water conservation on water available for reuse, 2) additional municipal water reuse in relation to water available for exchanges, and 3) reuse and successive uses of water downstream including effects on agricultural water shortages."[186] In relation to nonconsumptive needs, the basin will ensure that conservation, reuse, and drought management plans consider environmental and recreational focus areas and attributes.[187]

Regional cooperation on reuse projects, such as the WISE project in the Metro area, can help stretch locally available supplies even further. The WISE partners have executed agreements and will begin deliveries in 2016, reaching a full delivery of 10,000 acre-feet per year (on average) by 2021. The project uses available, reusable supplies from Aurora Water and Denver Water, and diverts and delivers it through Aurora's Prairie Waters collection and treatment system. Nevertheless, some municipal supplies, including the Colorado Big Thompson Project, are single-use water supplies and cannot be reused by municipal water users.

The South Platte/Metro Basin raised some concerns about the limitations of reuse and the ways in which reuse affects downstream users. Some of the technical limits of reuse include infrastructure capacities, losses, supply-and-demand timing, water quality, treatment costs and brine disposal, and regulatory requirements.[188] The South Platte/Metro Basin Roundtable does, however, advocate that the State should "direct the Colorado Water Quality Control Commission to look for ways to assist and facilitate reuse."[189]

Southwest Basin

The Southwest Basin has a goal to "support and implement water reuse strategies" using an educational strategy. The basin proposes to implement at least three different informational events around reuse efforts, during which it will highlight tasks, tools, and strategies.[190]

Yampa/White/Green Basin

The Yampa/White/Green Basin considers reuse principally as a pre-condition for TMDs, and not necessarily as a strategy it will undertake firsthand.

The basin states, "Prior to undertaking development of a new trans-mountain diversion, the Front Range must first integrate all other water supply solutions including conservation, reuse, and maximize use of its own native water resources and existing trans-mountain supplies."[191]

ACTIONS

1. **Explore regional and expanded local reuse options:** Over the course of the next three years, the CWCB will conduct a technical review of on-site, local, and regional reuse options and provide grants to support on-site, local, and regional reuse plans and projects.
2. **Improve quantification, planning, and tracking for potential reuse projects:** Over the next two years, the CWCB will examine the quantity of water that is currently being reused, the quantity of water providers plan to reuse, and the potential to increase reuse with regional and local reuse options. As a future planning effort, CWCB should explore regional and local reuse plans and projects. To assess feasibility of potable reuse projects in Colorado, the CWCB will work with partners to map all wastewater and potable infrastructure, water rights, needs, cost, and benefits. In addition, it will examine potential effects on return flows.
3. **Clarify the regulatory environment:** Over the next two years, the CWCB and the CDPHE will work

with stakeholders to examine the application of water quality regulations to reuse water. The aim will be to identify potential change that fosters permanent growth in the reuse of limited water supplies, and that protects public health and the environment.

4. **Provide financial incentives for reuse innovation:** As a research team recommended in the DPR white paper, the CWCB will, over the next year, proactively seek applicants to use WSRA grant funds for expanded research and innovation related to the technical challenges and solutions of reuse. This includes exploring areas such as ZLD, IPR, and DPR; examining regional opportunities; increasing reliability of the technology; exploring on-site reuse of water; examining development of reuse water for food-crop irrigation; inland desalination; and exploring the possibility of sharing reuse water. This research also includes support for the continued development of more cost-effective and environmentally acceptable RO-concentrate management techniques, and the evaluation of non-RO based treatments that are capable of producing water suitable for DPR.[192]
5. **Encourage the Colorado Plumbing Board to adopt the International Plumbing Code to allow for graywater.** The CWCB will encourage the Colorado Plumbing Board to adopt and incorporate the appropriate graywater provisions from the International Plumbing Code to allow for graywater piping within structures.
6. **Expand loan programs:** The CWCB will explore expanding its loan program to include loans for reuse projects. The DNR will work with the General Assembly to institute this modification during the 2016 legislative session.
7. **Support reuse education:** As a research team

recommendations.

8. **Examine mechanisms to improve the ability to market, sell, and share reusable supplies:** Through a stakeholder process, the CWCB will investigate mechanisms to better allow for reuse water to be marketed to water providers outside of a service area, and to make it more desirable to build a reuse project.

6.3.3 LAND USE

As Colorado grows, land-use planning and water planning will become more closely connected through the integration of several principles. Integration does not mean dilution of local control. Connecting these planning disciplines will not diminish private property rights, 1041 powers, and local zoning and development control. Financial incentives, best practices, partnerships, and technical resources can potentially better coordinate and enhance land-use planning and water planning. While density will be a major factor in reducing urban water demand, it is but one facet of creating more water-sensitive land-use decisions.

The manner in which Colorado develops into the future will have a strong influence on Colorado's future water supply gap, and vice versa. This topic is relevant today, as illustrated by the fact that six boards of county commissioners representing both the eastern and western slopes, including Boulder, Denver, Eagle, Grand, Pitkin, and Summit Counties, as well as elected officials from the City and County of Broomfield, collaborated to craft comments about land-use-water integration for Colorado's Water Plan. The importance of water-sensitive land-use planning was stated as, "1. Decrease the water supply gap. As Colorado's population continues to grow, well thought out, effective, sustainable, and predictable land-use planning is essential. 2. Provide low cost alternatives for meeting the Gap. Water sensitive land-use often results in less stress on water systems, indoor and outdoor water savings, and reduction in expensive long-term capital outlay. 3. Protect the values of Colorado, including vibrant economies, agriculture, open space, and recreation. Local land-use planning should be among the first points of consideration to protect and support all of Colorado's values and economic drivers. 4. Create more predictability and reliability as well as reduce risk in water supply planning, in turn creating more sustainability for current and future

> "Every community can do better on water conservation and efficiency via locally determined measures, such as, but not limited to, reinvestment in aging infrastructure, community education, enhanced building codes, and water-sensitive land-use planning."– Guiding statement from county commissioners, as submitted in their input document regarding Colorado's Water Plan.[194]

recommended in the DPR white paper, the CWCB will support stronger education to describe the benefits of reuse water as an integral part of a water supply system. Specific recommendations include sponsorship of a survey of Colorado utilities and water agencies to determine the extent to which they may consider DPR as a means to augment their legally reusable water supply portfolios, and development of a program to educate the public, elected officials, and water utilities about the benefits and safety of DPR.[193] Section 9.5 contains more detail regarding specific education and outreach

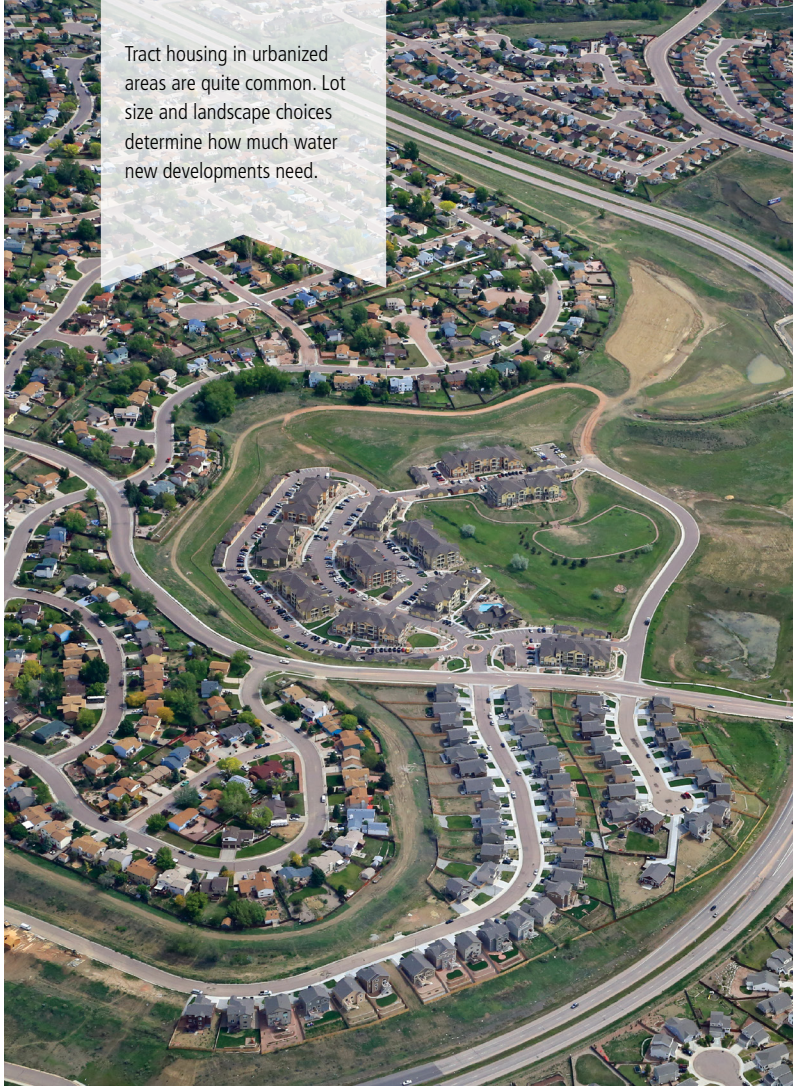
residents. 5. Encourage shared solutions including best management practices, collaborative physical projects and practical land-use models to address water quality and quantity challenges. 6. Result in benefits that reduce infrastructure and service costs, and enhance a community's quality of life."[195]

In 2009, the CWCB began preliminary work in this arena by hosting the *Water and Land Use Planning for a Sustainable Future* conference, and in 2010, it created an associated report and density memo describing several actions that bridge land and water issues.[196] Recently, urban land use has been a major discussion point at the IBCC, which incorporated several options into the Water Conservation No-and-Low-Regrets Action Plan. Additionally, at the July 24, 2013 Joint Front Range Roundtable meeting, 92 percent of participants strongly agreed or agreed with the recommendation that water supply planning and land-use planning should be coordinated. At that same meeting, 55 percent of participants agreed that "coordination of urban land planning and water supply planning" was the most important conservation recommendation to discuss that day.[197]

The following projects and initiatives illustrate these recommendations—and are being pursued in Colorado today.

Net-Zero Water Initiative

The Colorado Water Innovation Cluster is researching net-zero water through a CWCB water efficiency grant, and has assembled a large stakeholder group to create a net-zero water planning template, guidebook, and toolkit.[198] Net-zero water is a water management concept that mitigates effects on water quantity and quality through best practices, which are incorporated into the development or management of a site. While not truly a net-zero strategy, the best practices can result in a water-neutral site. Net-zero water strategies can be applied to a building site or on a more regional scale, and connect water management to land-use planning. The Net Zero Water Planning Template, as well as the guidebook and toolkit, will help users quantify their water footprint, evaluate reduction strategies, and recognize financial and environmental benefits by reducing their effects on water use and water quality.[199]



Tract housing in urbanized areas are quite common. Lot size and landscape choices determine how much water new developments need.

Land Use Leadership Alliance

A recent collaborative effort involving water planners and land-use planners from local jurisdictions is moving the dialogue forward. Pace University School of Law's Land Use Law Center brought its Land Use Leadership Alliance (LULA) training program to Colorado in fall 2013. This training convened land-use and water planners with city managers, city council members, developers, regional government planning groups, and CWCB staff for four all-day sessions focused on the land-use and water planning nexus. These sessions proved very productive in the development of strategies for better integration of land and water planning, and also assisted in the development of relationships between land and water planners within and among municipalities.[200]

This collaboration is a model for integrating local

planning efforts within a local government and with regional planning efforts. The latest LULA trainings took place in May 2015 and involved the participation of five more Front Range municipalities, including Westminster, Lakewood, Commerce City, Broomfield, and Aurora. Additionally, representatives from South Adams Water and Sanitation, Denver Water, Bancroft-Clover Water, and Green Mountain Water and Sanitation attended. The LULA trainings will serve as a template for trainings the CWCB and the DOLA will organize in 2016, as Senate Bill 15-008 outlines.

Denver Regional Council of Government's Metro Vision

The Denver Regional Council of Governments (DRCOG) has also been exploring the nexus between water use and land-use patterns in recent years. Adopted in 2011, the latest *Metro Vision 2035* document, which for the first time includes a section that ties water conservation to land-use planning.

DENVER REGIONAL COUNCIL OF GOVERNMENTS WATER CONSERVATION VISION, GOAL, AND POLICIES

Vision: The Denver metro region will maximize the wise use of limited water resources through efficient land development and other strategies, recognizing that no single strategy will meet the state's water needs and the region will need to pursue a range of strategies concurrently.

Goal: Reduce regional per-capita M&I water use by working with municipalities, counties, water providers, and other stakeholders within the next 6 to 12 months (February 2012) to identify a specific numeric target or measurable benchmark against which to measure progress.

Policies:

1. **Regional Collaboration.** DRCOG will bring together local governments, water providers, and other stakeholders to facilitate collaborative efforts that promote water conservation.
2. **Best Practices.** DRCOG will work to increase understanding of the link between land development and water demand, and to identify best practices for promoting the efficient use of water resources across the region.
3. **Efficient Land Development.** Compact development, infill and redevelopment consistent with DRCOG's urban growth boundary/area and urban centers policies will help reduce water demand and related infrastructure costs.

Source: DRCOG Metro Vision 2035:34

DRCOG has a sustainability goal of increasing housing density by 10 percent between 2000 and 2035.[201] According to DRCOG's most recent analysis, the region has increased in density by 5.3 percent since 2000. These data suggest that the region is well situated to achieve the 10 percent density level by 2035.[202] In the residential housing sector, that 10 percent increase will produce approximately a 5 percent decrease in water use—which equates to 31,000 to 46,000 acre-feet of annual savings for the Denver metro area, depending on population growth (both existing and new). At the medium population growth, this is nearly 42,000 acre-feet of savings annually.[203]

Colorado Water and Growth Dialogue

Through a WEGP grant that addresses the water and growth dilemma, the CWCB is funding a project to estimate demand reductions from various land-use patterns. The Keystone Center secured funding from several grantors (including the CWCB) to complete a two-year dialogue that will bring together water providers, land-use planners and developers, public officials, and other key stakeholders. The goal is to identify meaningful strategies, practices, and policies that will help Coloradans achieve a measurable reduction in the water footprint of new development and redevelopment, and move closer to a long-term balance between water use and growth. To date, the project has produced a draft research report that examines strategies for implementing land-use patterns that reduce water demand. The report identifies four strategies that have the most potential to reduce water demand: Developing smaller residential lots (cluster development), changing from single-family to multi-family development (infill), increasing multi-family development (moving-up), and imposing turf/irrigation restrictions.[204] Additionally, Denver Water and Aurora Water are modeling their service areas' water use patterns on top of existing land-use patterns.

The group will then use DRCOG's UrbanSim model to generate future land-use patterns with the overlay of water use patterns. As the project progresses, it will generate several different exploratory scenarios by 2040. These scenarios could reflect the effects of climate change, economics, market demand, and political will for regulation. In 2016, this water and growth project will create a report and roadmap that describes the most promising strategies for addressing the water and growth dilemma in Colorado, along with specific recommendations for implementing and disseminating the strategies.[205]

Recent Legislation

In 2008, Colorado passed legislation requiring that building permit applications for developments of more than 50 single-family equivalents include specific evidence of an adequate water supply. Adequate water supply is defined as one that is sufficient for the development in terms of quality, quantity, and dependability. Developers must submit proof of adequate supply to the local government through a report from a professional engineer, or from a water supply expert, that identifies the water source and the types of demand management appropriate for the site. Under this law, a local government was permitted to make the adequacy determination only once, at the beginning of the development permit approval process.[206] In 2013, the governor signed legislation that modified the definition of the term "development permit." The new definition clarifies that during the development permit approval process, the local government may grant permits for individual stages, rather than for the entire development.[207]

In 2015, Colorado passed Senate Bill 15-008, which tasks the CWCB and the DOLA with implementing trainings for local water use, water demand, and land-use planners. The topic areas will cover best management practices for water demand management, water efficiency, and water conservation. Additionally, the bill requires that all covered entities' water efficiency plans must evaluate best management practices for water demand management, water efficiency, and water conservation that they may implement through land-use planning efforts.

BIPs

Each basin roundtable is formulating its own implementation plan that will include land-use goals and activities, in addition to already-planned projects and methods. Chapter 6 explores all of these.

Arkansas Basin

The Arkansas Basin did not address land use in an extensive manner in its BIP. The Arkansas Basin did, however, create a policy calling for the integration of land-use and water resource planning.

The Arkansas Basin came to consensus on a policy statement regarding land-use and water resource planning.

- *Policy Statement: The Arkansas Basin Round table supports the integration of land-use and water-resource planning.*[208]

Creating a policy statement for this type of integration is an important first step in the future of demand management in the Arkansas Basin.

Colorado Basin

The Colorado BIP created a theme; set a goal, measurable outcomes, and short- and long-term needs; and identified projects and methods that connect land use with water conservation.

Theme 5 is to "develop local water conscious land use strategies," with a primary goal to "develop land-use policies requiring and promoting conservation." The measurable outcomes associated with this goal include:

- *Developing recommendations for city, county, and state governing bodies promoting water awareness and efficiency in land-use policy.*
- *Developing educational material or opportunities for elected and planning officials on water supply issues and conservation options.*
- *Preserving agriculture by reducing the transfer of agriculture water to municipal use.*[209]

The Colorado Basin established short-term needs, long-term needs, and projects and methods to accomplish this goal. In the short term, it will review existing land-use regulations for water-conscious development requirements and evaluate potential growth in unincorporated areas and water supplies

to those areas. In the long term, it will provide local jurisdictions with financial support to implement water-conscious development requirements, and draft recommended model-basin and statewide land-use planning guidelines that focus on water conservation and water-efficient land-use development. As for projects and methods to accomplish the goal, the Colorado Basin suggests the creation of statewide grant opportunities to enable local jurisdictions to review land-use regulations, conduct public outreach, and implement regulations. Additionally, current governmental council should develop model land-use regulations, and every county and city within the basin should have conservation plans with identified goals. The plan also asks that "the state land-use regulations be evaluated to meet long term exponential state population growth (and water demand) with a limited water supply."[210]

Additionally, the Grand County Region, Summit Region, Eagle River Region, Middle Colorado Region, and Roaring Fork Region all developed specific land-use themes and methods in their needs analysis.

The themes include:

- *Develop local water conscious land-use strategies that focus on growth that affects water supplies and nonconsumptive/environmental needs.*

The methods include:

- *Limit development to within urban boundaries*
- *Promote water conscious growth development through improved land-use policies.*
- *Water providers should work with neighboring entities to provide and plan for growth between boundaries*
- *Implement water provider conservation projects*
- *Review local governments' land-use policies for water-quality and environmental protection standards.*
- *Assess county master plans and codes for improvements in smart growth land-use policies*
- *Ensure new development appropriately incorporates water-related values.*[211]

Gunnison Basin

As with other BIPs, the Gunnison BIP ties land use to water conservation and demand management. The Gunnison Roundtable established goals related to land use and water conservation. Goal 9, which outlines public outreach and education regarding the role of citizens of the Gunnison Basin, identifies land use as a process to achieve this goal: "The GBRT Education Committee will prepare and present annual half-day State of the River seminars for local governments and planning staffs, with the objective of making sure that land-use decisions and new developments are made within the context of the Basin's probable water future." [212]

The Gunnison Basin also identified statewide principles that connect water efficiency, conservation, and demand management.

Principle 5: ***Water conservation, demand management, and land-use planning that incorporates water supply factors should be equitably employed statewide.*** *Demand management strategies supported by the Gunnison Basin include growth only in proximity to existing or planned infrastructure, high density versus urban sprawl, and landscape limitations. Development in proximity to existing infrastructure should be encouraged only in non productive, or the least productive, land to preserve productive agricultural land. The Gunnison Basin believes that land-use policies are essential to promoting both water and land conservation. Local land-use policies and regulations should discourage sprawl, link water supplies to development, and provide incentives for higher density developments."* [213]

Additionally, the Gunnison Basin discusses land use in terms of Colorado River supplies. Under Principle 3: ***Any new supply project from the Colorado River System must have specifically identified sponsor and beneficiaries and meet certain minimum criteria, and "entities must incorporate water supply factors into land-use planning and development.***[214]

North Platte Basin

Due to low population and little municipal use, the North Platte Basin did not address land use in its plan.

Rio Grande Basin

As this chapter stated previously, the Rio Grande Basin has a low population and relatively minor municipal water use. The Rio Grande Basin does not address land use as more urban water basins have, but instead describes the use of conservation easements to manage land development. The conservation easements preserve agricultural land as well as environmental attributes.[215]

South Platte/Metro Basin

According to the South Platte/Metro Basin, municipal water departments are tasked with meeting a large portion of the water supply needs in the South Platte Basin, and are already using programs such as water audits, rebates for efficient water fixtures and appliances, and education to reduce demand. These efforts could be more effective if water departments worked with their respective planning departments to plan and require water-efficient usage and land development within their cities. For instance, a water department may work with its planning department to implement water-efficient landscaping codes, subdivision regulations, zoning requirements, and master plans.[216]

Nevertheless, many water utilities' current roles are generally limited to providing for water needs within their service areas, with little cross-over to land-use authority. The South Platte/Metro Basin discusses current land-use authority and water provider authority, opportunities for collaboration, and examples of current work in this arena. The plan describes the issue that has made collaboration between water and land-use planning difficult in the past. The South Platte/Metro Basin states, "The primary responsibility held by water utilities is to provide for water needs within communities. Coordinating or integrating the land-use and water planning process is a relatively new area being explored for reducing municipal water use. Increasing awareness of limited future water supply opportunities and the potential effects of climate change helps to spur this integration of planning."[217]

The South Platte/Metro Basin indicates that there are opportunities for closer collaboration and reduction in water use through more integrated land-use planning. These include:

- *Updates to Comprehensive Plans,*
- *Changes to zoning requirements,*
- *Revising water/land-use subdivision regulations, and*
- *Using the direction provided by the State Water Engineer and recent legislation.*[218]

With regard to opportunities, the plan states that "increasing residential density has the potential to significantly improve water use efficiency and will continue to result in reduced effects on natural resources. The highly urbanized areas of the Front Range corridor have many opportunities to redevelop lands for higher population densities."[219]

Projects the South Platte/Metro Basin highlighted include the Keystone Center Land Use Study and LULA. The Keystone Center project will identify land-use patterns across the metro area and find ways to more closely integrate land and water planning. The LULA training program "focuses on finding land-use solutions to the challenges posed by growing Front Range populations and Colorado's limited water resources. The LULA program is designed to help local land-use and water leaders create new networks of support, identify successful land-use techniques, and develop implementable local strategies that will enable a more 'water-smart' future for the region."[220]

The South Platte/Metro BIP ends with a land-use recommendation in the section *Recommendation for Additional SP-BIP Analysis and Refinements.* This recommendation is:

Further Analysis of Planning Coordination— *The South Platte and Metro Roundtables recommend further investigation into options for increased coordination between water utilities and land-use planners to better plan for water-efficient growth.*[221]

Southwest Basin

The Southwest Basin identified a need to organize informational events about water conservation, land-use planning and water reuse efforts, tools and strategies. "One strategy to achieve the short-term goals of conservation, land-use planning (which will include coverage and discussion of the 60/40 and 70/30 ratios referenced above), and water reuse is to implement a pilot conservation and land-use planning session in 2015. Initially it is anticipated that this would be a two to four hour workshop for local decision makers and water utility personnel." If successful, the basin could host the session throughout the basin (for example, in Cortez, Telluride, Pagosa Springs, and other locations) as with the Water 101 Seminar.[222]

Yampa/White/Green Basin

The Yampa/White/Green Basin did not describe projects or plans for land use in its BIP.

ACTIONS

One objective of Colorado's Water Plan is that by 2025, 75 percent of Coloradans will live in communities that have incorporated water-saving actions into land-use planning. Ten communities have completed land-use and water trainings through the LULA process, and in order to reach the 75 percent population objective, a total of 80 communities and water providers will need to have participated in similar trainings by 2025. The trainings will support approximately 80 water providers and communities statewide to incorporate land-use practices into their water conservation plans. To facilitate the use of local land-use tools to reduce water demands for municipalities and urbanization of agricultural lands, the State will work with partners to pursue the following actions.

1. **Encourage the use of local development tools:** Through voluntary trainings in 2016, the CWCB and DOLA will encourage local governments to incorporate best management practices for water demand management, water efficiency, and water conservation into land-use decisions.

   Trainings may cover the following topics:

   - Expediting permitting for high-density buildings and developments that incorporate certain water efficiency measures, such as efficient irrigation systems (with plan-check and install-check).
   - Including water supply and demand management in comprehensive plans.
   - Installing climate-appropriate landscapes.
   - Understanding the societal and environmental benefits of urban landscapes
   - Using appropriate amounts of soil amendments.
   - Incentivizing maximum-irrigable-area or WaterSense-certified landscapes.
   - Instituting tax incentives for incorporating certain water efficiency measures for high-density developments, such as cluster developments.
   - Establishing structured impact (tap) fees designed to promote water-wise developments and in-fill.
   - Developing water-budget rate structures to help maintain initial projected water budgets for a site.
   - Introducing landscape and irrigation ordinances.
   - Exploring the environmental and farmland benefits of water sensitive urban land-use planning.
   - Creating more stringent green-construction codes that include higher-efficiency fixtures and appliances and more water-wise landscapes.
   - Exploring landscape-oriented professional education or certification programs.
   - Examining opportunities to reduce agricultural urbanization and fragmentation.[223]

2. **Examine barriers in state law for implementing the above local development tools:** Over the next 18 months, the CWCB will examine barriers local jurisdictions may face while implementing local development tools.

3. **Incorporation of land-use practices into water conservation plans:** Over the next 18 months, the CWCB, through partnerships, will develop new guidance for water conservation plans that requires

the incorporation of land-use practices. This is an addition to C.R.S. 37-60-126.

4. **Strengthen partnerships:** To be successful in integrating land-use and water planning, the CWCB will need to partner with many different agencies and groups. Within the next year, the CWCB will establish meetings with various agencies to map out ways in which the CWCB and other agencies can work together on these issues.

    - Local municipalities, local water providers, and county governments will implement water and land-use plans. Without their partnership and support of new ideas, comprehensive water and land planning will not succeed. In addition to partnering with local entities, the CWCB will partner with the Colorado Municipal League, Colorado Counties Incorporated and the Special District Association to ensure successful integrated water and land-use planning.
    - The DOLA is involved in the land-use in the local government arena. Like the CWCB, the DOLA can also leverage its grant funding for water and land-use planning initiatives, such as incentives for incorporating water supply into comprehensive land-use planning.
    - The DORA regulates professionals in various industries and works to create a fair market place. The CWCB will work with the DORA to focus on the landscape and irrigation industry or the property management industry, and to consider developing certifications for these industries to conserve water.
    - Home-building and construction organizations, such as the Home Builders Association, LEED, and the U.S. Green Building Council, will be building communities that have a direct influence on water demand. They must be involved in crafting the vision for future water-sensitive developments.
    - Non-governmental organizations, such as Keystone Center, Alliance for Water Efficiency, Western Resources Advocates, American Planning Association, and economic development councils, can advance land-use and water integration innovation and research.
    - Academic institutions, such as Colorado State University, University of Colorado Boulder, University of Colorado Denver, One World One Water Center-Metropolitan State, and Rocky Mountain Land Use Institute, can advance land-use and water-integration innovation and research.
    - LULA brings an innovative training model that could change the way Colorado looks at this subject by breaking down institutional silos. The CWCB will work with LULA, or another local group, to create a Colorado-specific training model for the integration of sustainable, long-term, land, and water planning.
    - Councils of governments make connections between the local and state government levels. Councils of governments can be strong allies in trainings and research about the land-water nexus.

5. **Funding:** The CWCB should use the WEGP funds and Water Supply Reserve Account grant funds to fund aspects of the land-use and water planning nexus. The CWCB will work with the basin roundtables to proactively seek applicants to use WSRA funds for larger regional efforts that tie more directly into the basin roundtables. It will use the WEGP funds for smaller, more localized efforts.

6.3.4 AGRICULTURAL CONSERVATION, EFFICIENCY, AND REUSE

Introduction

This section seeks to assist Colorado's agricultural industry in becoming more efficient and resilient, and to reduce non-beneficial water consumption and diversions without affecting statewide agricultural productivity and the environment. It also explores opportunities to stretch water supplies to help meet future needs. Discussions about agricultural water use often become confounded by imprecise use of terms and an incomplete understanding of agricultural water systems. This section presents a basis for an analysis using a common understanding of terms.

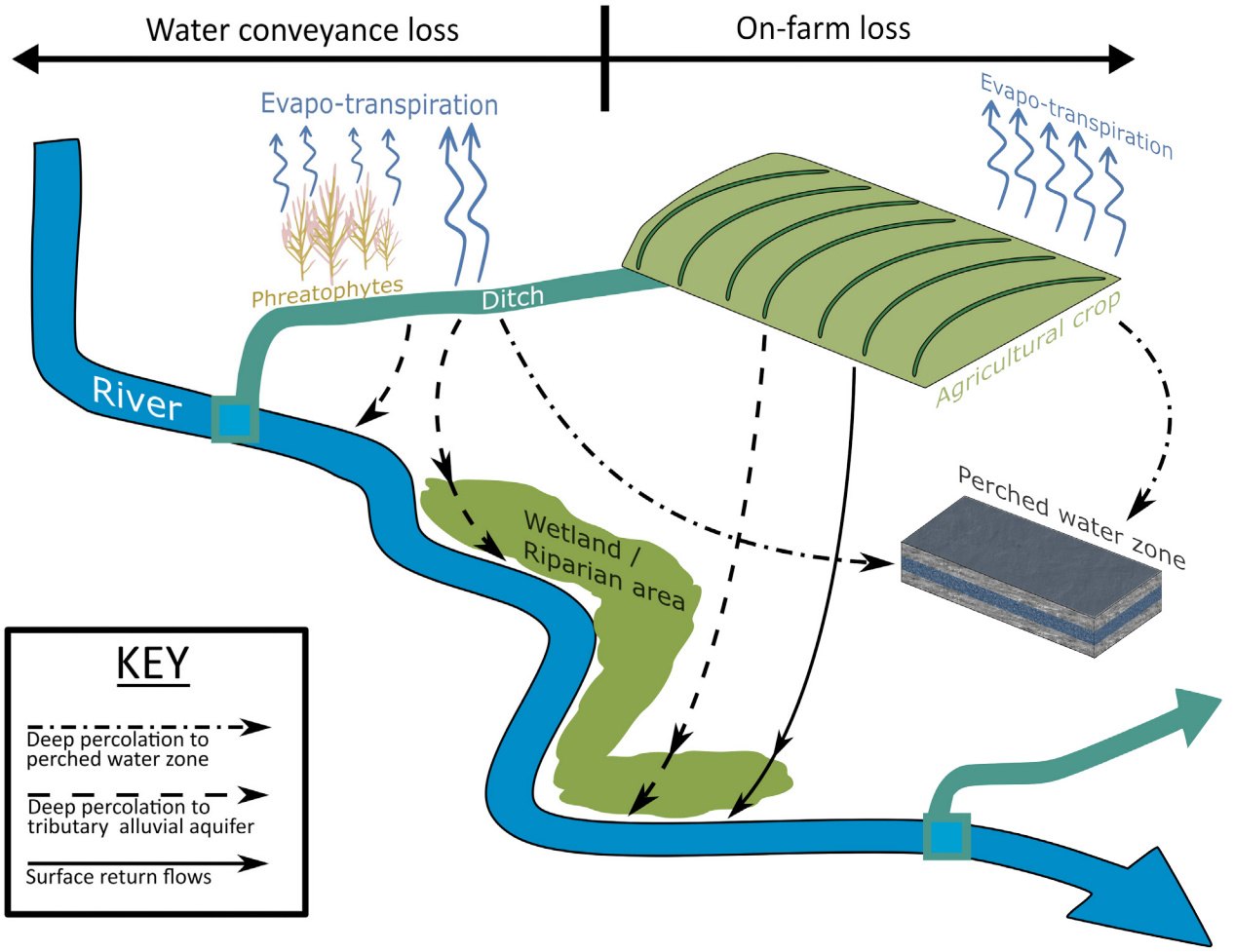
Background on Agricultural Water Use and Losses

Where rainfall is insufficient to meet crop needs, crop irrigation is a requirement. Figure 6.3.4-1 illustrates the irrigation process and its associated consumptive use (CU) and water losses. In some cases, a deep-rooted crop may withdraw water directly from shallow groundwater areas through a natural process known as sub-irrigation.

During the process of irrigation, water conveyance loss occurs when some of the water diverted via ditch or canal never reaches the crop. These losses can occur due to ditch or canal seepage, when the water either returns to the stream via seepage into the local groundwater system through deep percolation, or via non-beneficial consumptive use by phreatophytes.[223] Ditch or canal seepage is considered nonconsumptive because the water returns as surface flows in the river system, and is available for other users. Some conveyance loss is permanent, in which case it is frequently referred to as non-beneficial consumptive use.[224] For example, this loss can take the form of evaporation from exposed water or soil surfaces of ditches and canals and the unintentional growth of phreatophyte vegetation with no agricultural value. Colorado State University estimates that as much as 10 percent of the water lost during irrigation is a result of these types of non-beneficial consumptive use. Nevertheless, some of these unintended uses provide environmental benefits by creating wetlands and enhancing riparian corridors.

Once the water reaches the field, either the plant uses it as a CU, or the water becomes part of on-farm losses. Irrigation provides water to the crop's root zone to meet crop CU, which occurs through transpiration from the growing plants and evaporation from adjacent soil surfaces. The combined effect of transpiration and evaporation is call evapotranspiration (ET). Plants transpire water during photosynthesis while also incorporating a small portion of the water into the plant tissue. The water ET consumes is permanently removed from the local hydrologic system.[225] Since ET represents the water used by a plant, the beneficial consumptive use of an irrigation water right is measured by the amount of crop ET. Crop ET is not easily measured. Rather, theoretical or potential ET (the maximum amount of water a crop can consume) is calculated based on the factors that influence ET, such as crop type, growing season, and daily climatic conditions. Crop ET is measured at a specific location by adjusting for the amount of water applied to the crop.[226]

FIGURE 6.3.4-1 AGRICULTURAL WATER USE AND LOSSES



On-farm losses occur when water is applied to fields at a rate that exceeds the soil's capacity to retain the water. This results in deep percolation or surface runoff. Deep percolation into underlying groundwater systems raises the local groundwater table, thereby returning water to the surface system through stream accretions.[227] In locations where the amount of deep percolation exceeds the capacity of an aquifer to quickly transmit water back to the stream, groundwater storage occurs and produces lagged return flows. In some cases, deep percolation collects in perched zones that are not connected to the regional groundwater system, and is permanently lost to the river system as a type of non-beneficial CU. Surface runoff, on the other hand, occurs when the rate at which water is applied to a field exceeds the rate at which water infiltrates a given soil type. Surface runoff is returned to the surface water system via waste ditches and drainage works.

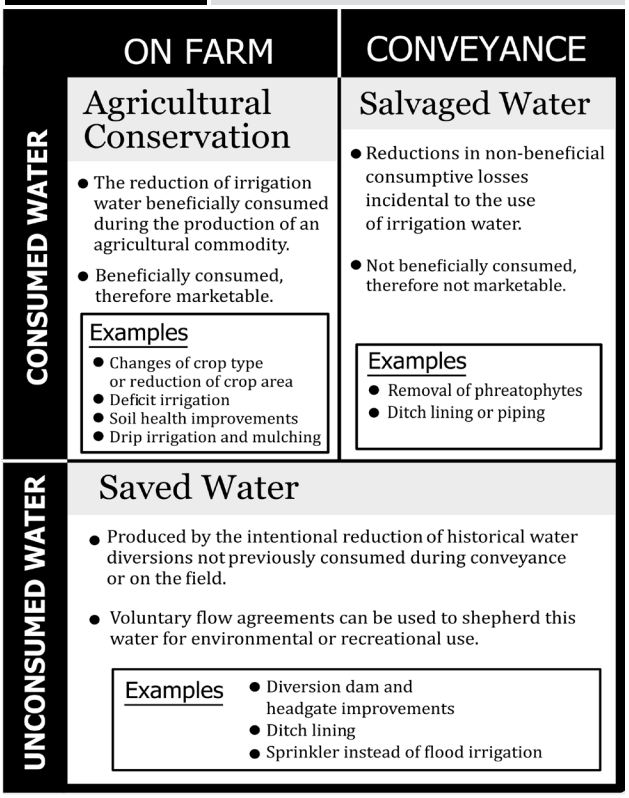
Collectively, the majority of water that is diverted, but not consumed, creates return flows to the stream.[228] Return flows are a critical component of the agricultural water balance, and Colorado water law rigorously protects them for the benefit of other users on the system.[229] Diversion of water in the stream as a result of return flows is a fundamental element of the water supply in Colorado. A portion of each subsequent diversion provides new return flows for users further downstream, allowing multiple diversions of the same water within a basin.[230] In over-appropriated basins, an individual molecule of water will be diverted several times before it leaves the state or is finally consumed.[231]

Terminology Related to Irrigation Efficiency

Several terms and phrases frequently arise in discussions related to irrigation efficiency. The following definitions, in conjunction with Figure 6.3.4-2, provide clarity to this complex topic.

- **Irrigation efficiency:** Irrigation efficiency is the ratio of the total amount of water diverted for an irrigation use to the volume of water the crop beneficially consumes through ET. Irrigation efficiency may be further refined by looking at the specific water losses that occur before and after the water is applied to the crop. There are often separate calculations of delivery efficiencies and on-farm efficiencies. Since irrigation efficiency is a ratio, it may be increased by practices that either reduce the amount of water consumed, or reduce the amount of water that is diverted but not consumed. As a result, "irrigation efficiency" is used as a general term to refer to agricultural conservation and efficiency practices on the farm, and it is associated with conveyance.
  - **Water-conveyance (delivery) efficiency:** Delivery efficiency reflects seepage, evaporation, and ET losses that occur in the canals, ditches, and laterals between the point of diversion and the turnout to the farm field.[232]
  - **On-farm efficiency:** On-farm or application efficiency reflects the losses that occur, after the farm turnout, as water is applied to a crop. These losses include deep percolation, evaporation, and field runoff.[233] Flood and furrow are application methods that have higher losses than more direct methods (such as sprinklers and drip).[234] However, sprinkler and drip irrigation may allow crops to better use the water applied and increase total beneficial consumptive use.[235]

FIGURE 6.3.4-2 IRRIGATION EFFICIENCY OUTCOMES



- **Agricultural water conservation:** "Agricultural water conservation" describes the water resulting from on-farm practices that reduce the amount of beneficially consumed irrigation water during the production of an agricultural commodity. The amount of such water can be measured as a reduction in historical consumptive use.[236] Examples of non-structural, agricultural water conservation practices include changes in crop type, reduction of crop area, deficit irrigation, and soil health improvements that reduce evaporative loss. Because agricultural water conservation is a reduction in historical consumptive use, it is the only irrigation efficiency practice that can be marketed to other beneficial uses. However, there may be challenges associated with administering these water-rights transfers.

- **Salvaged water:** Salvaged water is the recovery of water that is lost due to consumptive use or to permanent loss of water that does not provide a beneficial use. These losses are incidental to the use of irrigation water. For example, phreatophytes or deep percolation to a perched zone may result in ET. In all cases, water is lost or consumed, although not beneficially. Efficiency improvements that eliminate or prevent losses of water that would have otherwise been consumed can produce salvaged water.[237] For example, removing invasive phreatophytes, and ditch-lining or piping water, could yield salvaged water.
- **Saved Water:** Saved water is produced by intentionally reducing the unconsumed portion of water diversions that otherwise would have provided a portion of historical return flows. Such saved water can be the result of either on-farm or conveyance efficiency practices that reduce losses that were not previously consumed, such as historical return flows.[238] Such water can be left in the stream, but it may not provide a benefit to environmental or recreational values without a voluntary flow agreement. Headgate improvements, ditch-lining or piping, and other efficiency improvements can produce saved water.
- **Reuse:** Capturing and reusing irrigation water for crop use on the same ground—provided it complies with the underlying water right—is common. Because this water is also consumed, it does not result in agricultural water conservation, although it may reduce the total amount of water that is diverted. When reuse is not consistent with the terms of a water right (such as reuse on acres not described in a decree), it is considered an "expanded use," which is prohibited.[239]

On the other hand, the irrigator may potentially reduce irrigation diversions by reusing treated M&I water as an additional source of agricultural supply. Section 6.3.2 more fully explores reuse.

- **Waste:** Waste is a term that is often used pejoratively to refer to water that is diverted but not beneficially consumed.[240] People frequently use it in expressions such as, "By eliminating agricultural waste we can meet future needs," or "One man's waste is another man's water supply." Legally defined, "beneficial use" is the amount of water that is reasonable and appropriate, under reasonably efficient practices, to accomplish without waste the purpose for which the appropriation is lawfully made.[241] The DWR has the authority to curtail truly wasteful practices, and little waste is occurring in agricultural water use. Some elements of water use that might otherwise be considered waste are important to agricultural production. For instance, water is occasionally diverted into ditches and immediately returned to the stream in order to sluice sediments from diversion and conveyance works. Also, through intentional, deep percolation into the underlying water table, excess water is sometimes applied to fields to leach harmful salts from the crop root zone. In areas with limited availability of water storage and highly variable surface flows, some irrigators, in an effort to store the excess water in the soil profile, divert more water than a crop can use at that time. While this is a highly inefficient method of storage, for many irrigators, it is the only option for mitigating future supply shortages. The State does not consider this practice to be wasteful or unreasonable under the circumstances.
- **"Use it or lose it":** The common usage of this phrase is associated with the (incorrect) belief that by maximizing the amount of water diverted, one can enhance or preserve the magnitude of a water right. This notion is incorrect, since the true measure of the water right is actual historical, beneficial CU; in the case of an irrigation right, this is crop ET.[242] Thus, there is no real legal incentive to divert more irrigation water than the crop will eventually consume. In addition, a water right can be abandoned or lost due to non-use for a long period of time, but only if the non-use is indicative of an actual intent to permanently give up the water right.[243] One aspect of the "use it or lose it" perception does bear further consideration. Under current law, the determination about historical consumptive use is based on the amount of water the crop actually consumes—which is the lesser amount

Efficient irrigation methods do a better job of delivering water to crops than older methods. This often increases crop yield due to more even water delivery.

of the water actually applied to the crop or the maximum amount a given crop could potentially consume. Thus, engaging in deficit-irrigation for a period of time could reduce the transferable yield in a future change-of-water-right case, which is a disincentive to adopting these new practices. The legislature provided partial relief to this problem in Western Colorado via C.R.S. 37-92-305(c), of the Colorado Revised Statutes, which allows for CU reductions without affecting historical CU calculations, provided the water user is under a conservation plan.

Benefits of Irrigation Efficiency

Irrigation efficiency can increase crop production, enhance flows for environmental and recreational needs, and increase opportunities for water marketing through water-sharing practices. This section and Section 6.4 discuss water-sharing practices.

Increased crop production: A large segment of agriculture in Colorado operates at a water deficit.[244] This means that the available supply at some periods during the growing season is less than the amount needed to fully satisfy crop-irrigation water requirements (consumptive needs) at that time. Thus, for a producer that is making efficiency improvements, the primary incentive is to satisfy a crop's water consumption by eliminating conveyance and on-farm losses, ultimately increasing crop yields. The intention of this practice is to increase crop production through increased consumptive use. It does not create the availability of new water supplies for other users.

Reduced vulnerability to drought: Many existing irrigation systems were constructed 80 to 100 years ago and could be operated more efficiently - particularly in western Colorado where average irrigation efficiencies are low. These systems operate with a water deficit, in part because their inefficiencies prevent them from conveying available water from the river to the farm gate, or turnout. These issues may be exacerbated under climate change projections if water supply variabilities increase, drought becomes more common and extreme, and runoff patterns change. Efficiency improvements will help shield irrigators from some of these impacts by allowing them to reduce or eliminate conveyance losses and better manage demands in conjunction with upstream storage.

Enhanced flows for the environment & recreation: Refurbishing a headgate, building a diversion dam, or reducing diversions can increase flows below the water structure, potentially benefiting recreation and

the environment. Even though this water cannot be transferred, local instream flow benefits accrue from saved water left in the reach of the stream between the historic point of diversion and the downstream headgate. This is limited to the location where return flows previously entered the stream. Environmental benefits of refurbished agricultural infrastructure present an opportunity for state, federal, and foundation programs to contribute funding toward the costs of efficiency changes. A voluntary flow management program or agreement negotiated with downstream water users can enhance and protect environmental and recreational benefits.

Improved water quality: One benefit of improved irrigation efficiency is improved water quality. The process of deep percolation results from delivering more water into the root zone than the soil can retain for eventual crop consumption. This water migrates into the groundwater system, often dissolving natural salts, uranium, and selenium, and it also leaches manmade fertilizers and pesticides from the soil. These contaminant-loads eventually reach the stream system, and in some cases, seriously degrade surface water quality.[245] Recognition of water-quality benefits results in substantial amounts of federal funding for irrigation efficiency improvements. Over the past several decades, this funding has rapidly accelerated the historically slow trend toward improved irrigation efficiency.

Water sharing: While there are numerous reasons and methods for improving irrigation efficiency, there are limited opportunities for true agricultural water conservation that creates marketable supplies for other users. These methods rely on either crop-ET reduction, or soil moisture evaporation. The methods can be achieved by:

- Switching crop types to those with lower ET requirements.[246] The variation in ET needs among crops can be large. For instance, beans and small grains require 20 inches or less per year, while corn, beets, and alfalfa need 30 or more inches.
- Using deficit irrigation to intentionally supply less water to a given crop than its historical irrigation requirement. Deficit irrigation must result in lower crop yields in order to generate any salvaged water. [247]
- Reducing soil evaporative losses through improved cultivation methods, including mulching, drip irrigation, and "soil health" practices. [248]
- Temporarily and entirely removing a crop from the ground through fallowing.[249]
- Permanently and entirely removing a crop from the ground through land retirement.[250]

Addressing Barriers to Irrigation Efficiency

While irrigators have used these techniques in Colorado to address specific situations, legal, technical, and financial barriers often prevent long-term new water supplies. Section 6.4 discusses ways in which irrigators can use some of these techniques as alternatives to traditional, permanent dry-up of irrigated lands.

With the exception of phreatophyte removal, which the water court has expressly prohibited as a source of a transferable right, the transfer of salvaged water has not yet been tested in water court or addressed by the legislature. The volume of water resulting from any individual efficiency improvement is relatively small, and it is difficult to precisely quantify since it cannot be measured directly. This makes reliable management and administration of exchanges and transfers of salvaged water extremely complex and time-consuming for DWR personnel. Irrigators cannot use or market saved water to reliably provide water to the environment or recreation. There is little direct advantage for irrigators to shepherd this water downstream, and few legal mechanisms exist to support it. The generation of water using agricultural conservation practices, such as deficit irrigation, rotational fallowing, or a transition to cool-season crops, is the subject of ATMs. Section 6.4 of Colorado's Water Plan explores this further.

Examples of recent cases in which agricultural producers in Colorado have improved efficiencies and overcome barriers provide context to the descriptions of these agricultural efficiency concepts:

- The Uncompahgre Valley Water Users Association converted portions of its open-ditch delivery system to pipelines through the Colorado River Basin Salinity Control Program.[251] This reduced seepage and delayed storage releases to better meet late-season crop needs. It also created the added benefits

of reducing salt-loading to and salinity of the Colorado River, and improving downstream water quality. This is an example of a regional approach to irrigation efficiency using state and federal funding as incentives.

- Farmers in the Arkansas Basin converted thousands of acres from furrow and flood irrigation methods to sprinkler and drip application methods through the U.S. Department of Agriculture's Environmental Quality Incentives Program (EQIP). In doing so, they were able to stretch limited water supplies in a severely over-appropriated basin. They also achieved water-quality benefits through the reduction of deep percolation and associated salt-loading. A word of caution applies to efficiency programs in the Arkansas River basin due to the unique terms of Article IV.D of the Arkansas River Compact, which expressly prohibits any improvements to irrigation systems that cause increased depletions at the state line. Because crops in Colorado typically do not receive the full amount of water they are capable of consuming, most irrigation efficiency practices increase CU. Thus, producers who installed sprinklers and drip systems in the Arkansas Basin are required to fully replace the increased depletions with augmentation water.
- The Grand Valley near Grand Junction is an area with adequate senior water rights, and crops generally have a full supply throughout the growing season. Through federal programs, farmers were able to modernize their headgates and delivery systems, which produced saved water through reduced diversions. This action provided enhanced flows in the Colorado River for endangered fish species while simultaneously reducing saline return flows.
- The Rio Grande and Republican River Basins use alternate crops and fallowing to maintain a sustainable agricultural community in light of an imbalance between legally available groundwater supplies and current levels of water use.
- The City of Aurora and the Rocky Ford High-line Canal have made drought-driven, temporary-lease fallow arrangements.
- The CWCB's Alternative Agricultural Water Transfer Methods Program supports pilot projects such as the Colorado River Water Bank Working Group.[252] This group is notably exploring options for reducing irrigation demands through deficit irrigation, temporary forbearance, or other means in order to avoid, delay, or limit the likelihood or negative effects of a Colorado River compact curtailment. Section 6.4 further describes the work of the Water Bank Working Group.
- Implementation of soil health practices, such as low tillage, mulching, and cover crops (a crop planted to protect the soil), have improved the water-holding capacity of the soil and have reduced soil surface evaporation in many locations. These practices can reduce non-beneficial consumptive losses as well as make more available for crop CU. One example that demonstrates the potential of these techniques is in the Rio Grande Basin. The basin used soil health techniques to both reduce water consumption and increase specialty potato-crop quality and yield. Rockey Farm replaced a barley crop rotation with a permanent cover crop, which uses less water, reduces soil moisture loss through evaporation, and adds organic matter to the soil. This, in turn, leads to increased soil moisture for the potato crop planted the following year.[253] The Rio Grande Basin's education and tour program to promote soil health and other irrigation efficiency practices showcases this work.

Recent Legislative Actions Related to Irrigation Efficiency

There are some existing legislative exceptions to the aforementioned limitations to agricultural conservation and efficiency. These exceptions apply in narrow instances, such as:

SB 05-133 provides that the State will not deem a western slope water-rights holder to have abandoned his or her water rights if the water-rights holder has met certain conditions. Two conditions include "a

Spring peach orchard near Palisade. Many orchards in the Grand Valley are becoming more efficient through the use of diversion structures and drip irrigation.

water conservation program approved by a state agency and a water banking program as provided by law." These conditions don't allow water sharing, but they do stipulate that a water-rights owner won't lose the rights if non-use stems from water conservation activities.[254]

HB 13-1130 allows a water-rights owner with an interruptible water supply agreement (IWSA) to request up to two additional 10-year periods for the IWSA. IWSAs enable water users to transfer a portion of their water rights, called historical consumptive use, to another water user on a temporary basis, without permanently changing the water rights.[255]

SB 13-019 restricts a water judge from determining a water user's historical consumptive use based on water-use reductions that result from enrollment in a federal land-conservation program, participation in certain water conservation programs, participation in an approved land-fallowing program, provision of water for compact compliance, or participation in a water-banking program. Some water users may wish to reduce their water consumption in order to limit the effects of drought on streamflows. However, under current law, there is a disincentive that penalizes appropriators that decrease their consumptive use of water. This legislation seeks to mitigate that disincentive.[256]

SB15-183 allows court discretion in determining the appropriate period of record to use when calculating historical consumptive use in change-of-water-rights cases.[257]

HB 15-1006 establishes a two-year grant program for invasive phreatophyte control, and provides $2 million each year for administration and distribution through the CWCB.[266]

Basin Implementation Plans and Irrigation Efficiency

For 2015, each basin roundtable is formulating its own implementation plan. Several plans include agricultural water conservation and efficiency goals and activities.

Most of the roundtables' BIP goals indicate that the basins plan on increasing efficiencies and modernizing agricultural infrastructure. Several examples are below:

- Arkansas Basin Roundtable: Provide increased quantities of augmentation water to comply with Division 2 rules regulating increased farm efficiencies.[259]
- Colorado Basin Roundtable: Improve agricultural efficiency, preservation, and conservation.[260]

Irrigating potatoes in the San Luis Valley. Efficient irrigation methods do a better job of delivering water to crops than older methods. This often increases crop yield due to more even water delivery.

- Gunnison Basin Roundtable: Restore, maintain, and modernize critical water infrastructure, including hydropower.[261]
- North Platte Basin Roundtable: Continue to restore, maintain, and modernize critical water infrastructure to preserve current uses and increase efficiencies.[262]
- Rio Grande Basin Roundtable: Operate, maintain, rehabilitate, and create necessary infrastructure to the basin's long-term water needs, including storage.[263]
- South Platte/Metro Basin Roundtable: Meet agriculture goals with an intent to "support strategies that reduce traditional permanent dry-up of irrigated acreage through implementation of other solutions including conservation, reuse, successful implementation of local IPPs, successful implementation of ATMs, and development of new Colorado River supplies" and "support strategies to address agricultural water shortages through IPPs, new multipurpose projects and innovative measures to maximize use of available water supplies."[264]
- Southwest Basin Roundtable: Implement efficiency measures to maximize beneficial use and production.[265]
- Yampa/White/Green Basin Roundtable: Restore, maintain, and modernize water storage and distribution infrastructure.[266]

Interbasin Compact Committee No-and-Low-Regrets Actions

As part of the IBCC's ongoing work, the IBCC is recommending that "Colorado will continue its commitment to improve conservation and reuse." It has developed recommendations for agricultural conservation and efficiency improvements for current and future agriculture. The actions below incorporate those recommendations.

ACTIONS

The following actions will support Colorado's agricultural industry to make it more efficient, resilient, and capable of reducing water consumption without affecting agricultural productivity.

1. **Agricultural water incentive education program:** Over the next two years, the CWCB will work in partnership with the basin roundtables, Colorado Energy Office, the Colorado Department of Agriculture, Natural Resources Conservation Service, and Colorado State University's extension program to develop a strategic education plan. In addition to the topics Section 6.5 discussed with regard to the education and assistance program, the plan will cover the following topics:
   a. **Agricultural water conservation:** Outreach to the agricultural community about available agricultural water conservation techniques and incentives.
   b. **Soil health:** Begin a soil health education and tour program to help growers examine ways to increase net revenues while decreasing water inputs, and in some cases water consumption.
2. **Continue to support the rehabilitation of diversions and ditches:** The CWCB will continue to provide grants, loans, and technical support to refurbish diversions and ditches. This action will generate saved water and reduce losses where there are benefits to recreation, the environment, and other consumptive water uses.
3. **Voluntary flow agreements:** Over the next two years, the CWCB and the DWR will work with agricultural and environmental partners to develop model language for voluntary flow agreements paired with irrigation efficiency practices. CWCB will also provide funding, facilitation, and technical support to encourage these agreements.
4. **Removal of invasive phreatophytes:** The CWCB will support the management and removal of invasive phreatophytes through grant-funding House Bill 15-1006 provides.
5. **Explore additional incentives:** The CWCB will explore additional incentives to assist basins in implementing, where appropriate, irrigation efficiency practices, and in changing crop type to a lower water-use crop.228F The CWCB should first explore these incentives through conservation demonstration and pilot projects.
6. **New agricultural lands:** The CWCB will encourage newly developed agricultural lands (currently identified in the North Platte, Yampa, and Southwest Basins) to either be very efficient or provide direct and measurable benefits to the environment.
7. **Administrative tracking:** Over the next three years, the CWCB will work with the DWR to explore the development of administrative means to track and administer agricultural conserved water for the purposes of marketing these waters.
8. **Watershed scale planning and improved river basin predictive models and computational tools:** The CWCB and DWR will work with stakeholders to explore the development of tools and models that can serve as an approved common baseline, upon which water court litigants and parties to administrative change cases can rely, for conservative estimates of consumptive water use, return flows, and injury.
9. **Efficiency and conservation innovation:** The CWCB will continue to work with research institutions in Colorado to advance agricultural conservation and efficiency.

6.3.5 SELF-SUPPLIED INDUSTRIAL CONSERVATION AND REUSE

Introduction

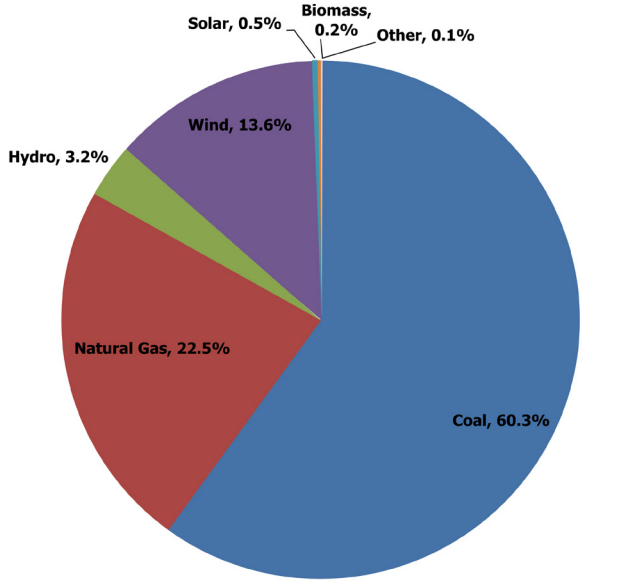
SSI water users describes industrial users that have developed their own, independent water supplies. Users include beer producers, power plants, mining-industry companies, and the ski industry, which uses water for snowmaking purposes. This section, however, will focus on the thermoelectric generation and energy extraction sectors within SSI. While SSI represents a small proportion of the water used statewide, it can represent a substantial amount of water in some local areas—including communities that are home to thermoelectric power generation plants or that have a significant energy-extraction presence, as these are the two major SSI water-user sectors. As a result, SSI water use is often included in the energy-water nexus. "The water-energy nexus is a term used to describe the interaction and interdependencies between water and energy resources. Understanding the dependencies, synergies, conflicts, and trade-offs between these two critical resources is necessary to identify and implement mutually beneficial strategies for their management and use."[267]

Water Use in Energy Production and Extraction

Electricity Generation

Electricity generation in Colorado totaled 53,524,000 megawatt-hours (MWh) in 2013. The demand for power requires an annual consumptive use of slightly more than 55,000 acre-feet, which represents 1 percent of Colorado's consumptive use (Colorado Energy Office calculations are based on utility resource plans). Overall, electricity demand has slowed over the past half-century; gains in energy efficiency have largely offset increased demand. Currently, the U.S. Energy Information Administration estimates a relatively flat electricity load-growth over time, at 0.9 percent per year nationally.[268]

FIGURE 6.3.5-1 COLORADO'S 2012 ELECTRICITY PORTFOLIO[269]



Thermoelectric Power

In 2012, thermoelectric facilities generated more than 85 percent of Colorado's electricity. Thermoelectric power generation heats water to produce steam, which in turn powers turbines to create electricity. While facilities can use a variety of fuel types to heat the water in thermoelectric power generation, the primary fuel sources in Colorado are coal and natural gas. Additionally, water is used to condense steam

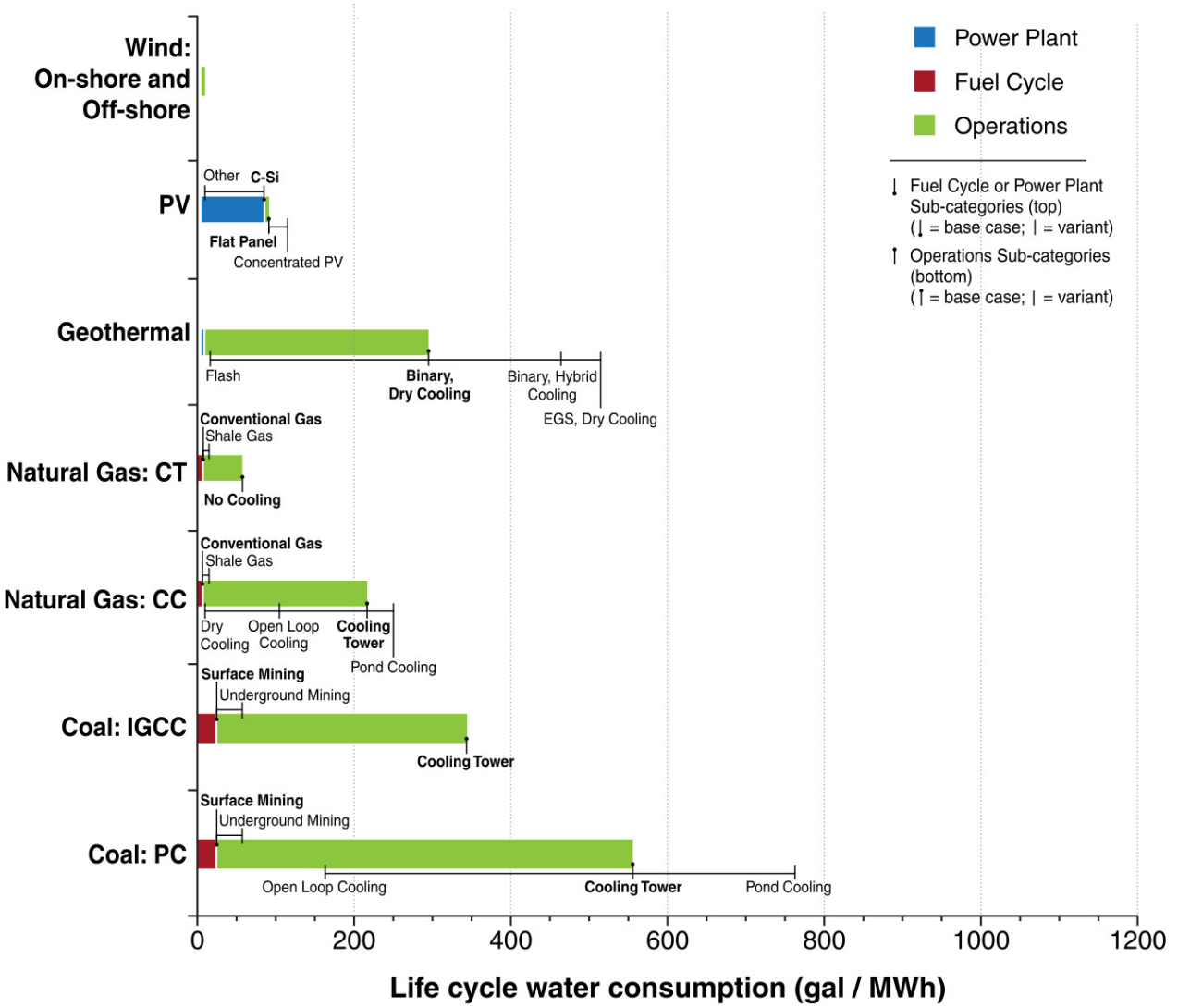
for reuse or discharge. The cooling process accounts for 95 percent of the consumptive use in electricity generation.[270]

Facilities can use a variety of cooling techniques in plant design, depending on process efficiency and an economic cost-benefit analysis. These techniques include once-through cooling, closed-loop, hybrid methods, and dry-cooling.

Once-through cooling systems typically require the greatest withdrawal, but have lower consumptive use because the water passes through a singular cooling process that absorbs heat and is then discharged. Historically, this has often been the least expensive and the most-used method nationwide, but it can have greater effects on the ecosystem because of warm-water discharge. Facilities in Colorado do not use once-through cooling systems.

Alternatively, closed-loop cooling systems use cooling towers to condense the steam. This requires comparatively lower withdrawal, but because of recirculation, it has a higher consumptive-use rate. Many of Colorado's electric generating units use this method, including Xcel's Arapahoe Station, Comanche Station Units 1 and 2, Cherokee Station, and Tri-State G&T's Craig Station.[271] Some facilities minimize freshwater consumption by using treated closed-

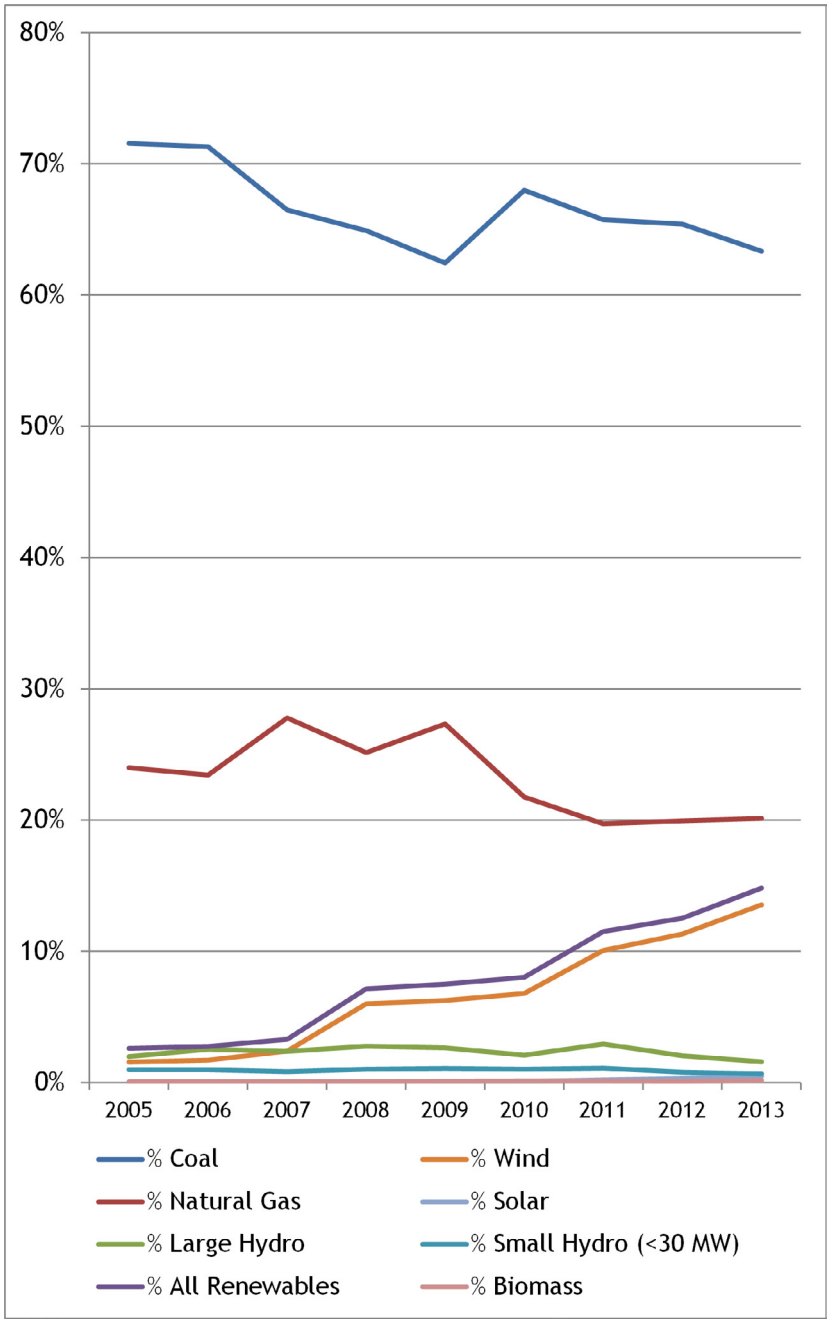
FIGURE 6.3.5-2 LIFECYCLE WATER CONSUMPTION FOR VARIOUS METHODS OF ENERGY PRODUCTION[272]



loop systems. For example, the Platte River Power Authority's Rawhide coal generator relies on 87 percent treated effluent water, and its natural gas turbines use closed-loop glycol cooling systems.

Facilities are researching and employing two other cooling systems in an effort to reduce water consumption. These systems use ambient air-cooling called dry-cooling. Dry-cooling uses only ambient air to condense steam, has lower plant efficiency, has a greater land footprint, and requires a higher electric load, which increases the expense of this method. Nevertheless, hybrid air and water systems that employ both techniques in concert—such as Xcel's Unit 3 at the Comanche Station—are becoming more prevalent.

FIGURE 6.3.5-3 COLORADO'S ELECTRICITY PORTFOLIO (NET-GENERATION)



Coal and natural gas are the primary fuel sources for electricity generation in Colorado, and accounted for 65 percent and 20 percent in 2012, respectively (Figure 6.3.5-1, page 6-102). Each source requires different amounts of water for its process (Figure 6.3.5-2, page 6-103). On average, coal plants consume roughly 40 percent more water per MWh produced when compared to combined-cycle natural gas plants (controlling for all cooling system types).[273] Nevertheless, the cooling techniques each facility employs are the primary source of consumption, regardless of the fuel source.

Beyond the electricity generation requirements, both fuel types also require minimal amounts of water to extract and deliver the resource to the plant.

Renewable energy generation can have consumptive water use depending on the technology, but overall, renewable energy requires substantially less water than fossil-fuel generation. In 2004, Colorado voters passed Amendment 37, which established a Renewable Electricity Standard. The standard required utilities to generate a portion of their electricity from renewable sources. Among other public policy goals, the legislative declaration for Amendment 37 specifically included language indicating that the measure would "minimize water use for electricity generation."[274] Currently, Colorado's renewable electricity standard requires 30 percent generation for investor-owned utilities, 20 percent for co-ops, and 10 percent for municipal utilities—all by 2020.

Additionally, in 2010, Colorado's legislature passed the Clean Air Clean Jobs Act, which sought to reduce emissions from power plants by retiring, retrofitting, or repowering some power plants that Xcel Energy and Black Hills Energy own. Because of these state-level policies, a variety of EPA regulations, and increasingly competitive wind and solar prices, Colorado is likely to reduce water use in electricity generation as Colorado's generation portfolio trends toward a larger mix of natural gas and renewable generation. In fact, generation from wind has grown the fastest of any fuel source as a percentage of the overall portfolio. That growth reached more than 12 percent between 2005 and 2012, and represents both the state's largest renewable energy generation source and the utility-scale source of electricity with the least consumptive use of water.

Public Disclosure and Resource Planning

Colorado's investor-owned utilities, Xcel Energy and Black Hills Energy, report their water consumption when filing resource plans with the Public Utilities Commission (PUC). The PUC is also allowed to consider water use in addition to fuel costs, construction costs, conventional operating costs, and transmission costs when evaluating resource selection. Investor-owned utilities in Colorado are also permitted to use water consumption as a factor when prioritizing and evaluating competitive solicitations for renewable energy.[275] Tri-State G&T provides water-consumption data to the PUC as part of its public resource-planning process.

Hydroelectric Power Generation

Currently, hydropower provides approximately 4 percent of Colorado's electricity, which is generated from more than 60 hydropower facilities throughout the state. With a combined installed capacity of 1162 megawatts (MW), hydroelectric facilities produce roughly 1 million MWh of electricity annually. Colorado's hydro plants range in size from 5 kilowatts to 300 MW, and include three pumped-storage facilities. While Colorado has an arid climate, the state has potential to further develop hydroelectric resources.

Colorado categorizes its hydroelectric resources into three areas: Large-hydro, small-hydro, and agricultural-hydro. Each project category has unique characteristics and affects water consumption in different ways. Typically, larger hydroelectric projects (with large

generating capacity) have larger evaporative losses due to the need for sizable dams and reservoirs. While Colorado has classified six projects as large-hydro (over 30 MW), these projects are still relatively small in size compared to others around the country. While there is no widely accepted definition of "small-hydro," small-hydro projects in Colorado are typically 2 MW or smaller in size.

Agricultural-hydro projects include a variety of system types, including pressurized irrigation systems. There are roughly 2.7 million acres of land under irrigation in Colorado. A Colorado Department of Agriculture (CDA) analysis found that 7 percent of these lands, representing approximately 175,000 acres, are candidates for pressurized irrigation systems. Of those candidate lands, 13 percent are already sprinkler-irrigated and would incur the lowest development cost. The remaining 87 percent are predominantly flood- or furrow-irrigated and would incur a higher cost for agricultural-hydro development due to necessary redesign and retrofits.[276]

Gravity-pressurized irrigation systems, or center-pivot sprinklers, have the potential to generate electricity if there is either excess flow or excess pressure available—or if the center-pivot system currently relies on diesel generators or the electrical grid. The hydroelectric generating potential (in excess of the power needed to pressurize the irrigation systems themselves) of Colorado's pressurized irrigation systems is estimated at 30 MW. Depending on the situation on a given parcel, excess hydroelectric power could help offset other electrical loads or mechanically drive the sprinkler system itself.[277]

A variety of organizations, including federal agencies, have explored the hydropower potential of existing agricultural dams. Colorado features more than 2000 dams, and a large number of those dams are very small or only hold water for a very short period of time. A CDA study of the use of small dams excluded dams that were not related to agriculture, were on federal lands, or were so small that they were very unlikely to hold potential. The CDA study found 102 small dams with the technical potential to generate hydroelectricity. The study determined that 23 sites would be economically feasible and could break-even within 20 years. Those 23 economically feasible sites total approximately 40 MW of capacity—25 MW of which are currently under development via six projects. That leaves about 15 MW of untapped, economically feasible potential statewide.[278]

Opportunities for additional large-hydro projects in Colorado are limited, as most of the ideal sites have already been developed. Nevertheless, small-hydro and agricultural-hydro systems have better outlooks for future growth. According to the BOR, Colorado currently has more than 30 potential hydropower sites at reclamation facilities, which could potentially produce more than 105,000 MWh annually.[279] A U.S. Department of Energy report estimates an additional 11 potential sites with the potential to produce more than 632,000 MWh annually.[280] Between these two studies, Colorado's estimated untapped, hydropower energy potential is more than 737,975 MWh annually.[281] If Colorado were to use this full potential, it could power more than 65,000 homes a year using new hydropower.

Oil and Gas Production

In Colorado, there are more than 52,000 active oil and gas wells. Oil and gas development accounts for less than one-tenth of 1 percent of the overall water usage in the state. The primary uses for water occur during the drilling and completion phases. Usage and processes include cooling the drill bit, bringing drill-cuttings to the surface, and hydraulic fracturing (fracking). During hydraulic fracturing, water mixed with sand and chemicals is pumped under high pressure down the wellbore to create tiny fractures in the rock, releasing oil and gas. Water usage for oil and gas operations varies, depending on the type and location of the well and whether or not the well is

hydraulically fractured. Vertical and directional wells use less water than horizontal wells, because they are not as long and they require lower pressure. Vertical and directional wells typically use between 100,000 and 1,000,000 gallons of water, depending on the depth of the well. Horizontal wells typically use between 2,000,000 and 5,000,000 gallons, depending on the depth and length of the well.

In June 2012, the Colorado Oil and Gas Conservation Commission (COGCC) began requiring oil and gas operators to report the volume of fluids used in hydraulic fracturing. That year, operators used approximately 7.3 billion gallons of water for 2294 well starts, including 664 horizontal wells. Of that total volume, operators reported about 3.8 billion gallons (53 percent) as recycled fluids. In 2014, approximately 4.2 billion gallons of water were used for 1609 well starts, including 1081 horizontal wells. Of this total volume, operators reported about 1.2 billion gallons (29 percent) as recycled fluids.[282]

COGCC does not formally track reuse of produced water. Anecdotally, the most significant reuse of produced water is for hydraulic fracturing. Since the produced water contains chemicals and naturally occurring hydrocarbons, COGCC and CDPHE regulations tightly control its use off of the well site. Operators are currently testing and implementing new treatment technologies to allow for the reuse and recycling of produced water for other purposes.

Coal Extraction

There are nine actively producing coal mines in Colorado. Most of the water in coal extraction is used for mining, washing, and transporting coal, as well as dust-suppression efforts. Consumptive water use at these coal mines ranges from 26 to 320 acre-feet per year, with an average of 165 acre-feet (1,000,000 gallons = 3 acre-feet).[282] A few mines are implementing water efficiency measures. For example, the West Elk Mine in Delta County uses a closed-loop system. It pumps all surface runoff into the mine for use in its wash plant and dust-suppression efforts. The mine only rarely pumps water from the North Fork of the Gunnison River, and discharges back to the river have been minimal and rare.

Energy Use in Water Conveyance

The other piece of the water-energy nexus is the energy that is required for water conveyance, water treatment, water distribution, and wastewater treatment. The 2009 study, titled, "Water Conservation = Energy Conservation: A Report for the CWCB," stated that, "Energy is embedded in water. Water utilities use energy to pump groundwater, move surface water supplies, treat raw water to potable standards, and distribute it to their customers. Customers use energy to heat, cool, and pressurize water; and wastewater treatment plants use energy to treat wastewater before discharging it (Figure 6.3.5-4, page 6-109)."[283]

Concerning domestic water, the water-energy nexus is centered on water conservation measures utilities can employ to lessen the energy intensity of water use. Water supplies carry vastly different energy intensities, depending on the point at which they originate and the manner in which they are conveyed. Some water supplies are almost purely conveyed using gravity, while other supplies are very energy-intensive and require a large amount of electricity to pump water from deep underground.

Water conservation and energy efficiency can play synergistic roles in lessening the effects of each other. Through more efficient changes in water treatment, distribution, and end-use, energy use can be made more efficient and vice versa. This extends back to saving energy in the SSI area of energy production, resulting in saving water that would normally go into the process of producing this energy.

Energy and Water Efficiency Tools

Many of Colorado's efficiency programs involve energy savings that also result in water savings. Although reducing water use alone can save energy, Colorado's efficiency programs generally focus on improving water efficiency and energy efficiency during a complete facility renovation.

Energy performance contracting is a tool that allows public facilities to finance capital improvements, including upgrades to efficient equipment. The tool allows facilities to contract an energy service out to company to conduct investment-grade audits to facilities, as well as obtain prioritized lists of facility improvement measures. By pursuing those measures through a performance contract, energy

Wind energy production in Limon. Water conveyance requires energy, and energy production requires water. Renewable energy generation typically consumes substantially less water than fossil fuel generation.

FIGURE 6.3.5-4 ENERGY IS USED TO PUMP, TREAT, DISTRIBUTE, AND USE POTABLE WATER, AND TO TREAT WASTEWATER[284]

service companies guarantee that their facilities will realize energy, water, and associated operations and maintenance savings as a result of the proposed improvements. In Colorado, facilities have used energy performance contracting to finance $447.4 million in facility investments. Those investments provide guaranteed annual savings of 141.8 million kWh of electricity, 9.95 million therms of heating fueling, 467,200 kgal of water, and $30.9 million.

The Colorado Energy Office also manages an Energy Savings for Schools Program, which helps K-12 school districts lower energy use, water use, and costs while improving building performance and comfort. This program's services and resources are designed to cover the variety of energy efficiency and energy management needs of schools. High energy costs particularly affect Colorado schools located in rural or lower-income districts, and these schools are therefore a high priority for the Colorado Energy Office's energy efficiency programs.

There is also significant potential for efficiency savings among Colorado's agricultural communities. The CDA is working with agricultural producers to reduce energy and water costs. Some of these efforts also reduce thermoelectric energy use with concomitant water savings. Projects include locally sited micro-hydro, solar, and wind-power generation.[285] In addition, the Colorado Energy Office developed an agricultural efficiency pilot with dairy farmers. This pilot focused on energy efficiency improvements, but the State could further develop the program to include water efficiency measures.

Through Senate Bill 14-171, the Colorado Legislature expanded another energy efficiency program to include water use savings last year. Commercial Property-Assessed Clean Energy Bonds previously allowed commercial building owners to arrange financing, secured by a lien, for the installation of energy efficiency improvements. Senate Bill 14-171 allows water conservation fixtures to be included in the improvements, so that buildings can benefit from both energy and water efficiency.

ACTIONS

1. Examine the feasibility of water-energy nexus programs that conserve both water and energy. Some concepts to further explore include:
    a. Joint water and energy home or commercial audits.
    b. Joint rebate programs, which combine water and energy utility rebates to most effectively incentivize customers to purchase a specific energy- or water-efficient appliance.
    c. Treat water utilities as a large customer of the energy utility and explore system-wide water- and energy-reducing measures, such as reduction of distribution system leaks.
2. When exploring new water supply projects, consider opportunities for renewable energy to meet the increased demands.
3. Conduct outreach to energy companies to encourage and promote the most water-efficient technologies for energy extraction.

4. Ensure that the Colorado Energy Office continues to support energy saving associated with on-farm agricultural practices that also reduce water use.
5. Ensure that the CWCB works with the Colorado Energy Office and local agricultural producers to financially and technically support a pilot that combines renewable energy development with an alternative agricultural transfer. Such a pilot would aim to lessen the potential economic effects on the local community.
6. Ensure that the CWCB encourages energy companies to continue collaborating with agricultural and environmental interests when managing their water portfolio.
7. Ensure that the State helps to protect critical infrastructure by working with power providers to identify areas of their systems that are prone to failure or impact during water shortages and natural disasters.
8. Ensure that the State works with power providers to mitigate the possibility of curtailment in severe droughts, and to diversify their water rights portfolio.
9. Encourage demand-side management:
    a. Continue support of research into innovative ways to reuse produced water.
    b. Decrease vulnerability during times of water shortages.
10. Encourage technologies that reduce water use in energy extraction processes.

6.3.6 STATE AGENCY CONSERVATION

The State of Colorado plans to increase conservation efforts within state facilities to help demonstrate the ability to save water. The Colorado Energy Office has been facilitating the Greening Government initiative since Governor Bill Ritter issued Executive Orders D 0011 07 and D 0012 07. The Greening Government Leadership Council recently generated a new draft goal for water demand reduction at state facilities. The state will achieve this goal by 2020 with a baseline of 2015, and will normalize the goal for weather and other external factors.

Water goal: *Collectively, all executive state agencies and departments shall reduce potable water consumption by a minimum of 1 percent annually (normalized for weather) and at least 7 percent by FY 2020, relative to an FY 2015 baseline.*

State agencies reduce their water consumption by various methods, including installation of efficient plumbing fixtures, use of advanced lawn irrigation controls, and use of reuse water.

The 2012 Greening Government Annual Report Card provided the following information.[286] The state saw an increase of 8.4 percent (112.5 million gallons of water) in water use. Each agency provided the following data, and the data reflects that agency's best attempt to record all water purchases between FY'06-FY'12 in EnergyCAP. Water usage has not been normalized for the increase in state employees, increasingly hot weather, or new water-intensive industries. Of the 14 agencies and departments that own square footage, six reduced their water use by more than 10 percent, four reduced their water use by less than 10 percent, and four increased their water use.[287]

Exemplary State Agency Projects

1. The CDPHE has decreased its water use by 11 percent since 2005. It replaced two acres of bluegrass lawn with xeric grass species, an action that is saving more than 2.5 million gallons per year. It also replaced high-flushing urinals with 0.5 gallons-per-flush urinals, and installed waterless urinals.
2. Capitol Complex facilities personnel conducted some notable efforts over the last few years. They worked with Denver Water to audit all cooling towers for the Capitol Complex, and have the capacity to reduce consumption by almost 500,000 gallons per year. Additionally, facilities personnel can now take advantage of Denver Water incentives. In an example that this annual report did not capture, a landscape transformation initiative is taking place on the Capitol grounds. A collaborative group from the Governor's Office, CWCB, Denver Water, the Denver Botanic Gardens, Colorado Nursery and Greenhouse Association, and Capitol Complex Facilities is working on plans to reduce water consumption and demonstrate the benefits of water-wise landscaping on the Capitol building grounds. This high-profile project will highlight to the public what can be done with Colorado-appropriate landscapes.

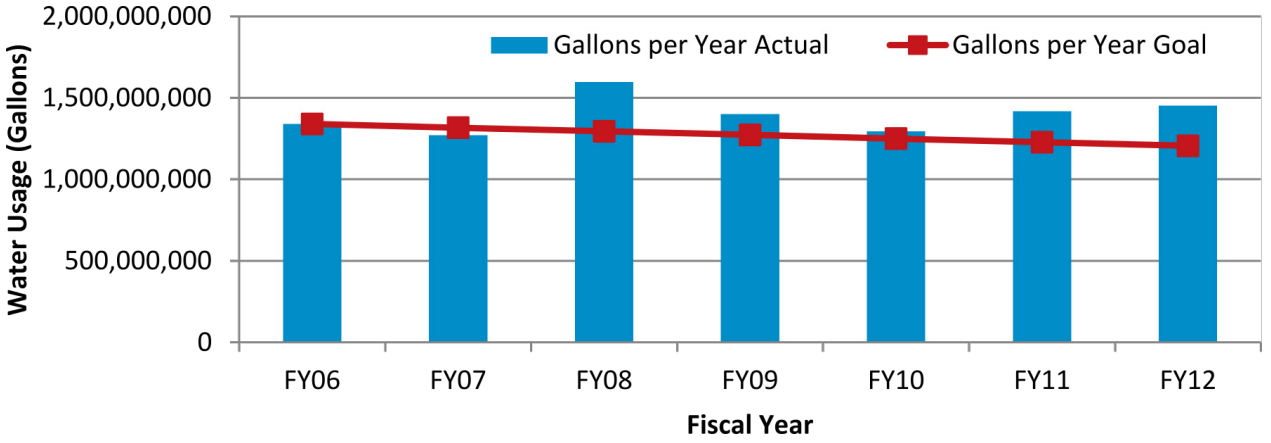
State agencies have been working for years, under greening government policies, to help reduce water and energy use in State facilities and are committed to doing so in the future.

Recommendations from Annual Report Card

- *Continue requiring water reductions by all state agencies.*
- *Require agencies to take advantage of free or reduced cost water audits by their water utility, if applicable.*
- *Look into bulk purchasing of water efficient appliances for state agencies.*
- *Continue educating Council about the water-energy nexus.*
- *Research and identify alternative ways to provide sufficient funding for water efficiency.*
- *Continue encouraging agencies to use their water rights.*[288]

This type of water use is an important standard to pursue in that the State of Colorado should lead by example in its own facility water use. This idea ties back to the SWSI Levels Framework philosophy that water providers should prioritize their foundational activities first, and then focus on what they have direct control over within their own facilities. While state facilities have accomplished much, better tracking and quantification could help normalize the data for weather, number of employees, and any new intensive uses that have been introduced.

FIGURE 6.3.6-1 WATER USE (ACTUAL AND GOAL) THROUGH TIME



ACTION

The CWCB will provide grants and technical support to state agencies for the installation of high-efficiency toilets and urinals, replacement of turf grass with plants that use less water, and improvement of cooling towers.

State agencies are working collaboratively with the Denver Botanic Gardens, shown here, and other organizations on plans to reduce water consumption and demonstrate the benefits of water-wise landscaping. One goal of this partnership is to educate the public on Colorado-appropriate landscapes.

6.4 ALTERNATIVE AGRICULTURAL TRANSFERS

GOAL

Colorado's Water Plan will respect property rights and the contributions of the agricultural industry by maximizing options for alternatives to permanent agricultural dry-up.

Background

Agriculture uses the largest amount of water in Colorado and is the economic backbone for many rural communities. It supports important environmental attributes, strengthens Colorado's food security, and upholds our state's cultural identity. There are approximately 66.3 million acres of land in Colorado, of which 10.6 million acres are cropland.[289] Global, national, and state population growth will place additional pressure on our food sources, which means that the long-term economic viability of agriculture is strong.[290] Local economies in rural areas depend on wholesale, retail, banking, and support services related to agricultural production. When farmers stay in agriculture, cash-flow related to their operations can increase the vitality of their communities. Agriculture is an important contributor to Colorado's economy as a whole, which Chapter 5 further discusses.

Respect the contributions of the agricultural industry by maximizing options to permanent buy-and-dry. Achievement of a sharing goal of 50,000 acre-feet could serve up to 350,000 people annually.

Pressures at state, national, and international levels threaten to reduce agricultural lands in the short term. Future municipal water demands contribute to an increasing pressure to transfer agricultural water rights to help satisfy urban demands and other non-agricultural water needs across the state.[291]

Agricultural interests are concerned about the possibility of drying up more agricultural lands in the future.[292] If Colorado continues down its current path, the South Platte River Basin could lose up to one-third of today's irrigated land by 2050.[293] The Arkansas River Basin could lose another 17 percent of its total.[294] The main-stem watershed area of the Colorado River Basin could also lose another 29 percent of its irrigated lands.[295] Reduction of irrigated lands can be measured as actual acres lost, but can also be measured in economic terms based on a reduction of crops that are irrigated before the water transfer.

The SWSI estimates that by 2050, Colorado may lose 500,000 to 700,000 acres of currently irrigated farmland in order to meet municipal growth demands. The IBCC and basin roundtables conclude that the current status-quo path of buy-and-dry is not the best path for Colorado. Across the state, water stakeholders want to minimize buy-and-dry in a way that respects property rights, recognizes the importance of agriculture in Colorado, and supports a sustainable agricultural industry—while identifying solutions to provide water for municipal needs. As numerous groups, including the Colorado Agricultural Water Alliance and the IBCC, have indicated, a variety of alternative options have the potential to appreciably decrease the projected permanent losses of irrigated acres in Colorado.

These options, referred to as ATMs, do not limit the choice of private water-rights owners to permanently sell their water rights. ATMs offer voluntary, not mandatory, tools that enable both farmers and water users to depart from the status quo. In addition, ATMs can support the environment, recreation, industry, and groundwater sustainability and, through the creation of

water-banks, reduce demands on a water system. ATMs are agile enough to focus on reducing net-profit loss or, on the other hand, to help protect higher-value crops for economic benefits.

The Low-and-No-Regrets scenario planning, which Section 6.1 discusses, indicates that the minimum goal of water needed from ATMs to meet the planning outlook is approximately 50,000 acre-feet. This amount would reduce permanent transfer of agricultural water rights, but would still result in agricultural dry-up. Currently, ATMs are more expensive and legally burdensome than traditional buy-and-dry approaches that permanently transfer water rights, making it difficult to obtain the estimated amount of water from existing alternatives. There are many creative and cutting-edge alternatives (as Table 6.4-1 shows) that can help decrease permanent reductions in irrigated acreage.

Goals of ATM Programs

Short-term or long-term temporary water-transfer alternatives provide options that address concerns about permanent agricultural buy-and-dry. Program goals related to ATMs are aimed at specific objectives for various regions across Colorado. It is highly unlikely that any one concept will be universally accepted in every basin. Rather than a one-size-fits-all approach, we understand that a variety of alternatives will be needed to meet specific needs. The goal of alternative water transfers is to benefit the agricultural community, as well as cities and towns that are seeking viable sources of water supply to keep up with demands. The State has learned important information about developing, evaluating, and monitoring ATMs from pilot and demonstration projects, but has more to learn to fully understand the potential of ATMs.

TABLE 6.4-1 TYPES OF ALTERNATIVE TRANSFER METHODS PROMOTED IN COLORADO

Rotational fallowing – Rotational fallowing keeps land in irrigated production mode while systematically fallowing specific plots. A rotation occurs to systematically fallow each plot in successive crop seasons. It allows leased water to become a base supply for a municipality, while keeping most the farming operation in production. It also works very well for drought supply, drought recovery, and conjunctive use. Revegetation protection, erosion control, and weed control of the fallowed plots are important considerations for this type of ATM.
Interruptible supply agreements – This type of ATM is between non-agricultural water users and farmers, shareholders, or a ditch company. Water is temporarily transferred from agricultural use to another use, such as municipal. Farms are fallowed during specific periods of time, and water is leased to the end-user based on the historical consumptive use portion of the water right. These arrangements are made through contractual agreements that satisfy the authorizing statutes. This could also include water conservation easements. See examples below. Revegetation protection, erosion control, and weed control are important considerations for this type of ATM.
Municipal-agricultural water-use sharing – This concept embodies a complex array of options based on continued farming operations for all lands associated with the sharing arrangement. Methods are used to reduce the consumptive use of crops, which makes water available for municipalities by sharing the historic consumptive use amount. Two main sub-categories are continued farming and deficit irrigation. In deficit irrigation, crop-watering is strategically limited to save water for other uses. Plants are typically stressed, but production and crop yield still occur. Revegetation protection, erosion control, and weed control are important considerations for this type of ATM.
Water cooperatives – Although there are a number of ways a water cooperative could work, only one concept has been tested in Colorado. This concept identifies periodic excess water supplies that can be used for optimization in the system. It includes use of surplus augmentation water and other supplies. The framework for moving water from one use to another involves mutually beneficial transactions that work within the existing system of water rights so that no injury occurs.[296] The Lower South Platte Cooperative is a current working example of this type of ATM.
Water banks – A water bank acts as an intermediary or broker based on water supply arrangements with owners of certain water rights. The bank could help avoid or endure a compact curtailment, for example.[297] Irrigators would be paid to reduce their consumptive uses, which could trigger fallowing of agricultural lands or deficit irrigation practices on a temporary basis. The saved water could be banked in a reservoir for later release into the system. This approach is being regularly discussed and studied in the Colorado River Basin. Revegetation protection, erosion control, and weed control are important considerations for this type of ATM.
Flex markets – These ATMs are defined as voluntary agreements between municipal and industrial water users, agricultural water users, and environmental/conservation water users.[298] The idea is to change the use of a senior irrigation right to include multiple end uses in addition to irrigation. These markets establish trading platforms to help provide water used by all participants. The goal of this approach is to allow part of the senior right to be used by cities and towns and for environmental purposes based on contractual arrangements. The economic benefit of the senior water right is kept in place by maintaining enough agricultural water to sustain robust farming operations. Revegetation protection, erosion control, and weed control are important considerations for this type of ATM.

Hay field along Highway 131 near Steamboat Springs. Photo M. Nager.

To achieve widespread implementation of ATMs across the state, researchers need to build a deeper understanding of their challenges and opportunities. To do so, Colorado needs more data and measurements on the outcomes from actual case studies. Researchers need to collect more information to be able to quantify results and inform decisions. In addition, there are significant legal, technical, and financial barriers to implementing ATMs. An in-depth look at existing ATMs and future project models will help identify program constraints and how to address them. There is potential for tremendous local, statewide, and regional benefits, but stakeholders need further information to expand their knowledge and ability to implement projects.

Potential Impediments to ATM Success

The execution of ATMs at this time can be difficult, or sometimes impractical, due to institutional, legal, financial, and court-related barriers, as well as the type of operation. For example, rotational fallowing would not work on an established orchard, since the trees would not survive without water during a growing season. Some legal impediments include long-standing water court procedures that change water rights, and legal requirements for ATM applications to prevent injury to other water rights. New and creative ATM ideas face many challenges because they do not fit into the historic way of handling water rights.

Other obstacles to success include irrigators' concern regarding the outcome of historic consumptive-use analyses and the potential for expanded uses of changed water rights. Cities and towns wonder if temporary supplies will actually be available when needed over the long haul.[299] Another impediment is the lack of necessary infrastructure for water transfers and the inability to form agreements, depending on the seniority of water rights or productivity of the lands involved.[300] Transaction costs tend to be relatively high, which can discourage potential water transfers. In addition, Colorado needs to assess fair and effective pricing for farmers and water suppliers, and the ability of farmers to invest ATM revenues back into their operations. To avoid the problem of where and how to store ATM water, Colorado needs to better understand and define the infrastructure that may be needed. Infrastructure improvements, expanded reservoir operations, or reservoir re-operations may bring needed utility and agility for storing ATM water. The CWCB believes that it would also be helpful to provide a means to support prioritization of research, as well as investments into technology systems such as automated delivery techniques.

Colorado's Water Plan encourages all interested parties to openly and constructively find ways to adapt to changing times. Colorado's Water Plan recognizes that water-sharing agreements between municipalities and agricultural interests for water transactions, such as the sale or lease of surplus water and use of excess return flows, can be important tools for moving forward to meet supply gaps. To alleviate water supply pressures, stakeholders need to find solutions to reduce barriers to implementing ATMs for enhanced success. The strength of Colorado's agriculture is its diversity. A full mandate of ATMs across all sectors is not the answer, whereas creative options and solutions can apply to feasible situations. Municipalities and agricultural interests can achieve successes and overcome barriers using creativity at the grass-roots level—which then could generate momentum at the ditch and basin levels.

Examples of ATMs

A variety of existing examples demonstrate ways in which ATMs work in Colorado, including:

- *Morgan Ditch Company & Xcel Energy* formed a voluntary lease arrangement in the South Platte River Basin. For more than 20 years, a separate water company that the Morgan Ditch Company developed has provided firm-yield supply to Xcel Energy's Pawnee power station. The power station is conveniently located near the ditch system on the eastern plains south of Brush, which enables several options for physically delivering the water to the power station. While a traditional water court process helped codify the legal ability to transfer water from agricultural use to industrial use, the arrangement has built-in agility to handle wet, average, and dry years. The dry-year deliveries typically involve temporary dry-up (fallowing) of sufficient farmland under the ditch to meet delivery requirements to Xcel. This also means that remaining farmland is fully irrigated with senior direct flows or senior reservoir rights. In those cases, the system does not operate in a deficit-irrigation mode to apply water to all lands during the really dry years. The mutually beneficial agreement is desirable in the eyes of those in the system, and has a proven track record of success. This is an example of ways in which industrial interests and farmers can continue to operate.
- *City of Thornton* formed a short-term lease and temporary substitute supply plan to provide emergency water to the Platte River Power Authority.
- *Lower Arkansas Valley Water Conservancy District* provided an economic and engineering analysis of the Lower Arkansas Valley Super Ditch Company (Super Ditch). The Super Ditch allows irrigators under a group of ditch companies to collectively lease agricultural water for other uses, including municipal use. The Super Ditch acts as a negotiating entity for irrigators that are interested in leasing water for temporary use by cities, towns, water districts, and other users.[301] The farmers still retain ownership of their water, keeping farms in operation for agricultural sustainability.

HAROLD GRIFFITH

SOUTH PLATTE RIVER BASIN

Harold was a dairy farmer for 50 years in Morgan County. He served on numerous boards supporting agriculture and pioneering temporary agricultural leases to support municipal and industrial interests. These lease agreements, now known as a form of alternative transfer methods, were ahead of their time and speak volumes about Harold's leadership and lasting legacy. Harold is pictured in his corn field near the Xcel Energy Pawnee Generating Station in Fort Morgan, which has a lease agreement with the Morgan Ditch Company.

When it comes to challenges, I believe that we are sometimes our own worst enemy by creating our own roadblocks. Being involved in the water court system and negotiating agreements, I knows it is a slow process, but perseverance and belief in the task at hand sees you through and makes a huge difference for the future of a community...

CONTINUED AT END OF CHAPTER

PROFILE

- *The Water Bank Working Group* consists of the Colorado River Water Conservation District, the Southwest Water Conservation District, the Front Range Water Council, the Nature Conservancy, the CWCB, and other interested parties. The working group is investigating the feasibility of a water-banking program within the Colorado River Basin. In the short term, the water bank could operate as part of the demand-management component of the State's contingency plan to prevent Lake Powell from dropping below critical levels. In the long term, a water bank could help prevent shortages under the Colorado River Compact and help Colorado water users during regional shortages. The Water Bank Working Group engages with agricultural users to gauge interest in participating in the program, and to identify potential costs or compensation for involvement. The "Colorado River Water Bank Feasibility Study," which the Water Bank Working Group crafted and released, with consulting firm assistance, in March 2012, details potential uses for such a program, as well as potential sources of supply. The preliminary study modeled the potential frequency of situations in which a water bank would be useful. The study examined several scenarios that showed water-bank annual-use estimates and an estimate of the number of irrigators willing to participate. The CWCB is examining additional studies about the water bank.
- *City of Aurora & Rocky Ford Ditch* partnered for a creative water-transfer arrangement to allow continued farming. Aurora invested to help purchase highly efficient irrigation equipment (e.g. drip or sprinkler technology) for farming operations. Farmers also received augmentation water from Aurora to supply new wells for irrigation rather than using water directly from the Rocky Ford Ditch. Several farmers have maintained strong agricultural production by using augmentation supplies for depletions from the well use on their farm. The farmers have reduced their consumptive use by switching to crops that need less water. This arrangement still maintains a healthy agricultural operation. For successful outcomes, municipalities offer strong financial commitments, and the farmers offer willingness and agility to modify their traditional practices.
- *City of Aurora & Rocky Ford Highline Canal* partnered for a water-leasing agreement in 2004 and 2005. Farmers under the Rocky Ford Highline Canal directly leased water to the City

The Catlin Canal pilot project is an excellent example of an alternative agricultural transfer. Courtesy of the Lower Arkansas Valley Water Conservancy District.

Once farmed, certain plots of land are systematically fallowed to provide temporary water that is leased to municipalities. The fallowed plot can be planted with non-irrigated vegetation to prevent blowing soils.

of Aurora. Reaching an agreement required a substantial amount of time and included complex contracts between the city, individual farmers, and the canal company. It also required approval of a substitute water supply plan from the Division of Water Resources at that time. Nevertheless, newer statutory authorizations for interruptible water supply agreements assist in the implementation of these types of ATMs. Intermittent leases of this nature fill a specific need, including drought relief and the recovery of reservoir levels following drought. They could also supplement base water supplies during dry periods.

- *Ducks Unlimited* partnered with Aurora Water and Colorado Corn Growers Association to develop augmentation ponds that support waterfowl.
- *Metropolitan Water District of Southern California & Palo Verde Irrigation District* agreed to a land-fallowing, crop-rotation, and water supply program.[302] They began the 35-year agreement for voluntary water transfers in 2004 to help to meet California's urban water demands through a mutually beneficial partnership. The program is designed to supply 25,000 to 118,000 acre-feet annually by temporarily drying up 7 to 28 percent of the irrigated farmland in the Palo Verde Valley.[303]
- *The Lower Arkansas Valley Water Conservancy District and Super Ditch, LLC* submitted a pilot project proposal, followed by a full application to the CWCB in 2014, which the CWCB ultimately approved. The pilot began during the 2015 irrigation season and involves temporary transfers of water from certain agricultural lands on the Catlin Canal system to the communities of Fowler, Fountain, and Security. This project will assist in helping the CWCB learn from an actual ATM implementation in the basin.

ATM Grant Program Overview

Colorado's Water Plan encourages alternatives to permanent dry-up. One way that Colorado continues to address ATMs is through the CWCB's long-standing grant program. The ATM grant program assists in developing and implementing creative alternatives to the traditional purchase and permanent transfer of agricultural water.

Colorado Senate Bill 07-122 (a CWCB Projects Bill) authorized the ATM grant program, which applies to a wide array of issues related to lease fallowing, pilot projects, flex market studies, demonstration efforts, and other alternatives for a variety of beneficial uses of agricultural water supplies. The CWCB has awarded nearly two dozen grants, ranging from about $8,000 to almost $500,000 each. Colorado Senate Bill 07-122 initially funded the program with a total of $4 million, and, through Colorado House Bill 14-1333 (also a CWCB Projects Bill), approved an additional $750,000 in funding. CWCB is making available detailed summaries of the program and awarded grants.[304]

ATM Related Existing Legislation

Colorado's Water Plan recognizes the need to increase agility within Colorado's system of water law, while respecting individual property rights. ATMs could provide a viable option for municipal water providers now and in the future, and the key to their success is the development of methods that meet the needs and respect the property rights of the agricultural water-rights owners. ATMs can also provide long-term security and financial practicality to urban water providers.

Irrigating the cornfields near Xcel Energy's Pawnee power station. This site is a great example of an ATM project at work in Colorado. The project is further explained within the text of this chapter.

State legislation influences the availability of tools necessary to further facilitate ATMs. This section of the water plan discusses one important legislative bill related to a fallowing-leasing pilot program. Colorado House Bill 13-1130 (HB13-1130 or C.R.S. 37-92-309) enacted legislation for Interruptible Water Supply Agreements, and the associated statute supplemented or amended previous authorizations. The legislation allows for a temporary change of an absolute water right for a new use once the DWR approves it.[305] The statute does not require the arrangements to go through a typical water court process. Table 6.4-1, page 6-116, includes a general description of this type of ATM.

Colorado House Bill 13-1248 (HB13-1248 or C.R.S. 37-60-115), which Governor Hickenlooper signed into law on May 13, 2013, authorized the Fallowing-Leasing Pilot Program. It allows for a pilot program to test the usefulness of fallowing-leasing as an alternative to permanent agricultural buy-and-dry.[306] The pilot program may include up to 10 separate pilot projects statewide; however, no more than three are allowed in any single river basin. Each pilot can operate for up to 10 years in duration.

In HB13-1248, the Colorado General Assembly declared its commitment to develop and implement programs to advance various agricultural-transfer methods as alternatives to permanent agricultural dry-up. It further stated that Colorado needs to evaluate whether fallowing-leasing is a practical alternative to traditional buy-and-dry methods.[307] The General Assembly designated the CWCB as the appropriate state agency to test the efficacy of implementing fallowing-leasing.

HB13- 1248 charged the CWCB, working in consultation with the DWR, to establish "criteria and guidelines" for the application, selection, and approval process for pilot projects. In accordance with the legislative directive, the cooperation and collaboration of the CWCB, DWR, and the public resulted in the development of a set of criteria and guidelines. These criteria and guidelines assist the CWCB and interested parties in fulfilling the spirit and intent of HB13-1248.[308]

HB13-1248 allows fallowing-leasing pilot projects to be tested in an effort to overcome challenges, and to develop and demonstrate opportunities for temporary agriculture-to-municipal water transfers.

The Lower Arkansas Valley Water Conservancy District and the Lower Arkansas Valley Super Ditch Company, Inc. formally submitted a proposal to the CWCB's staff on July 14, 2014 for a fallowing-leasing pilot project under the auspices of HB13-1248 and the CWCB's Criteria and Guidelines for the Fallowing-Leasing Pilot Projects. At its September 2014 board meeting, the CWCB approved the proposal to move forward on the full application. The sponors then submitted an application, which calls for transfers of certain shares of agricultural water from farmland irrigated by the Catlin Canal (in Otero County) for temporary municipal uses by the Town of Fowler, the City of Fountain, and the Security Water District. The project proponents aim to implement the pilot operation beginning in the 2015 irrigation season (the "Examples of ATMs" section above also explains this).

More recently, the governor signed Senate Bill 15-198 into law, expanding upon the authorities in HB13-1248. The pilot program may now include temporary transfers from agriculture to agriculture, agriculture to the environment, agriculture to industry, and agriculture to recreation.

BIPs

The basins submitted their final BIPs to the CWCB in April 2015, and provided valuable information regarding their plans for agricultural needs. These needs are summarized below.

The Arkansas Basin Roundtable has three goals associated with ATMs. First is to "Develop collaborative solutions between municipal and agricultural users of water, particularly in drought conditions" by continuing the ATM process of engineering, public policy, and pilot projects.[309] Second is to "Provide increasing quantities of augmentation water for increased farm efficiencies" by establishing long-term sources of augmentation water through leasing, water banks, or interruptible supply agreements.[310] Third is to "Develop a viable rotational fallow and/or leasing program between agriculture and municipal interests to address drought and provide risk management for agriculture" by: 1) Completing the ongoing technical studies and engineering to facilitate temporary transfers; 2) defining and quantifying potential third-party effects on shareholders within a ditch system that are engaged in a fallow program, by providing funding in support of an economic study; and 3) minimizing permanent dry-up.[311]

The Arkansas Basin is working on ATM projects, and others are under development. The use of stakeholder input and current pilot project data will identify future ATM projects.[312]

The Colorado Basin Roundtable notes the difficulties associated with ATMs. The main obstacles to alternative-transfer methods are loss of income, lost market share, and the lack of expertise in farming new crops. The plan also states that stakeholders need to address problems on a broad scale as they occur in each basin across Colorado.[313]

The Gunnison Basin Roundtable does not specifically identify ATMs as a method to meet its future needs. Nevertheless, the Gunnison Basin Roundtable does state that it is committed to the voluntary preservation of agriculture. The measurable outcome for this goal is to preserve the current baseline of approximately 183,000 acres of protected agricultural land, and to expand participation in conservation easements by 5 percent by 2030.[314]

The North Platte Basin Roundtable, like the Colorado and Gunnison Basin Roundtables, does not include ATMs as a means to achieve the goals and measurable outcomes of its basin. The plan does include agricultural use for the basin: "Describe and quantify the environmental and recreational benefits of agricultural use." The measurable outcome for this goal is to complete at least two new multipurpose water projects that meet multiple needs the plan identifies, by 2025.[315]

The Rio Grande Basin Roundtable explores innovative soil health and CU reduction techniques as part of the goal to achieve groundwater sustainability. While specific water-rights transfers may not be needed as part of these practices, the techniques are similar. As stated in the BIP:

> *The amount of water available to irrigators is projected to decrease, as discussed extensively in this Plan. As such, some producers may want to explore opportunities to reduce pumping through alternative cropping rather than drying up productive farm ground. Incorporating alternative crops and farming methods that reduce consumptive water use are opportunities to maintain an economically stable future for agricultural producers but have challenges, as equipment needs and market conditions make switching to new crops complex.*

Valley producers may consider growing fewer acres of higher-value crops, such as organics. Demand for locally grown, organic food continues to rise. Assistance for growers wanted to diversify their operations, switch to organic farming altogether, or enter into grower cooperatives would be a great benefit to expanding this option. Local farmers' markets have become a major source of local foods and are now a regular summer-into-fall feature in towns throughout the Valley.

Growers can also reduce water use by incorporating green manure into their crop rotation. Green manure is a mix of crops, such as mustards, radishes, and sorghum-sudan grass, which is specifically grown to be turned into the soil. Green manures improve soil health, as discussed in Section 5.2.6: Improving Soil Health, and require less water to go than other rotational crops. While the grower would not be selling a product in these years, the improvement to their operations has been shown to pay back the investment in green manure….

There are water savings through such methods as drip irrigation that will be realized through reduced evaporation losses. In addition to more efficient water use, the subsurface irrigation system may produce a higher quality of crop with less herbicides and pesticides required. , the widespread viability of subsurface irrigation has not yet been demonstrated in the Valley.

Improved water management techniques, such as irrigation scheduling, can also boost efficiency without reducing crop yields. Finally, such practices as deficit irrigation — giving crops just enough water to produce a minimal profit — may be a noteworthy technique for water rights holders on the cusp of receiving deliveries.[316]

The South Platte/Metro Basin Roundtable identifies successful implementation of ATMs as a measurable outcome for its plan's agricultural goal.[317] The joint plan also lists minimizing traditional agricultural buy-and-dry and maximizing the use of ATMs to the extent practical as one of 11 key elements to its plan. ATMs play a key role in the South Platte/Metro's B and C portfolios for meeting approximately 30,000 acre-feet of the basin's future water demands.[318] Through the CWCB's Alternative Agricultural Water Transfer Methods Grant Program, the South Platte/Metro Basin has completed and is currently working on several ATM grants, and lists one of these projects as a new IPP. The plan lists several recommendations for overcoming ATM barriers associated with water court and transaction costs:

- Development of special review procedures to facilitate ATM agreements.
- Adoption of presumptive CU procedures.
- Determination of historical CU for a canal or ditch system.
- Development of specific methodologies for measuring, calculating, and monitoring CU water transferred through ATM projects. (The Arkansas Basin is developing an "Administrative Tool" to calculate a farm's historic CU and return flow obligations.)
- State funding of infrastructure cost.
- Pursuit of transfer of a portion of a water right.[319]

The Southwest Basin Roundtable lists as a measurable outcome the implementation of ATMs as a means to preserve agriculture while addressing other water-use needs.[320]

The Yampa/White/Green Basin Roundtable mentions ATMs as a process to achieve its goal to "Protect and encourage agricultural uses of water in the Yampa/White/Green Basin within context of private property rights." Part of this goal's purpose is not only to preserve current protected agricultural acreage, but to expand it as well. The plan specifically states that a process for this goal is to "Identify projects that propose to use at-risk water rights, alternative transfer methods, water banking, and efficiency improvements that protect and encourage continued agricultural water use."[321] The plan has not identified any specific ATMs to meet this goal.[322]

IBCC No-and-Low-Regrets Action Plan

The IBCC developed several ATM recommendations as part of the No-and-Low-Regrets Action Plan, as Table 6.4-2 (page 6-125) summarizes.[323]

Additional details regarding IBCC low-and-no-regrets information pertaining to alternative agricultural-transfer methods are available in the latest version of the IBCC No-and-Low-Regrets Action Plan.

TABLE 6.4-2 NO-AND-LOW-REGRETS ALTERNATIVE TRANSFER METHOD ACTIONS

COMPLETED AND ONGOING ACTIONS	POTENTIAL FUTURE ACTIONS
• Implement ATM Grant Program • Support CWCB and IBCC	1. Develop an Incentives Program a. Financial incentives b. Streamlined approval processes c. Selective and systematic considerations (encourage maintaining or increasing highly productive lands) 2. Establish ATM Demonstration Projects a. Overlay-district or authority b. Storage and other infrastructure c. Multipurpose objectives d. Adequate measurement and monitoring 3. Establish Basin Goals and Track Ongoing Progress 4. Implement ATM Program 5. Analyze Infrastructure Needs for Storage of ATM Water

ACTIONS

The CWCB should consider the following options or action steps to help ensure attainment of alternatives to permanent farmland dry-up:

1. Monitor current and future legislation necessary for the implementation of ATMs, including enhanced sharing opportunities and system agilit
2. Encourage funding grants that focus on implementing on-the-ground ATM projects, data collection, agile administration practices, ATM affordability, basin-specific ATM projects, and infrastructure modernization.
3. Support appropriate fallowing-leasing pilot projects, such as the Catlin Canal pilot project, by responding to and processing applications in a timely manner under House Bill 13-1248 (C.R.S 37-60-115). The ATM grant program could further support these projects. To proactively cultivate these projects, the CWCB will work with partners or co-sponsors to organize and conduct regional workshops. These events will enable stakeholders to share lessons learned on actual ATM projects, and to garner additional interest by discussing program benefits.
4. Encourage adaptive strategies that capture a "learning by doing" concept for pilot programs and other on-the-ground ATM applications.
5. Continue to provide ATM leadership as well as technical and financial support to basin roundtables during the development of their BIPs.
6. Assess quantitative information related to agricultural dry-up in SWSI 2016, including evaluating lessons learned and monitoring the effects of ATMs in reducing permanent agricultural dry-up.
7. Explore financial incentives through a stakeholder process as part of the funding Section 9.2 describes. These incentives or grants could include new and ongoing revenue streams and tax incentives at the local and state level.
8. Work with the South Platte, Metro, and Arkansas Basin Roundtables to explore a WSRA or an ATM grant, with municipal and agricultural stakeholders that could lead to the formation of one or more pilot regional water sharing cooperatives. The mission of a cooperative would be to facilitate water-sharing arrangements. The cooperative could include ways to determine initial start-up costs necessary to reach stated goals. For instance, methods may include acquiring funding needed to reduce barriers associated with the high transaction costs of water-rights transfers, and working through water court to make a water right more agile.
9. Continue collaborating with water users to develop tools and models that can be used as an approved common baseline for water court litigants and parties. Administrative change cases could rely upon these for conservative yet streamlined estimates of consumptive use, return flows, and injury.

10. Seek to help stakeholders understand the benefits and social barriers of ATMs and how they can function under existing and future law

11. Interact with the Colorado water community and decision makers to consider the following options in support of ATM goals:

    - Continue to monitor basin-level work and explore options to develop agility in the use of certain agricultural water rights for multiple purposes.
    - Implement tools Senate Bill 15-198 (C.R.S. 37-60-115) provides that broaden pilot-project end uses House Bill 13-1248 (C.R.S. 37-60-115) sets forth. Such pilot projects could demonstrate agricultural transfers that meet environmental, recreational, industrial, or compact needs in addition to urban needs. The CWCB will encourage pilot projects to test the latest concepts or meet multiple benefits.
    - Reduce barriers, such as high transaction costs associated with water-rights transfers and water-rights accounting uncertainties, through continued exploration of pilot projects and other voluntary transactions that demonstrate a streamlined approach or provide financial support.
    - After a thorough outreach and stakeholder process, consider legislation to protect existing municipal, transferred water-rights owners that choose to undergo the court process to demand that their permanent agricultural transfers operate as ATMs. Such legislation could help ensure that a water-rights owner could revert to its previously adopted stipulations, if the water court process for an ATM option yields an unfavorable outcome.
    - Strengthen recognition for new types of legal beneficial uses, such as leased or agile-use water.
    - Identify and develop a request for a multi-basin WSRA grant through the basin roundtables. The goals of a potential grant would be to compile ATM data, identify actions to encourage irrigators to enter agreements, analyze barriers, and increase program awareness.
    - Research benefits and challenges of "buy and supply," which could preserve local irrigated agriculture and associated benefits. The concept of "buy and supply" is that M&I water users purchase irrigated lands with associated water rights, establish a conservation easement for future farming, and then supply a full amount of water for a certain number of years within a 10-year period. The M&I user could then receive water supply in the remaining non-farming years.
    - Explore the possibility of third parties providing assistance in funding ATMs to ensure that farmers are appropriately compensated and that water suppliers pay a reasonable incremental cost for firm yield. In this case, the third party would essentially assist in the effort to uphold the value of continued viable agriculture.
    - Support research into the benefits and challenges of temporary rotational "idling" of crops, deficit irrigation, and split-season irrigation.
    - Incorporate improved water-use data into decision-making processes in a way that reduces uncertainty for water managers, and develop basin-specific models for use in water court cases to help reduce transaction costs.

6.5 MUNICIPAL, INDUSTRIAL, AND AGRICULTURAL INFRASTRUCTURE PROJECTS AND METHODS

GOAL

Colorado's Water Plan encourages the use of grassroots efforts to identify and implement projects and methods to meet community and agricultural water needs throughout Colorado, and to achieve the following statewide long-term goals:

- **Use water efficiently to reduce overall future water needs.**
- **Establish a process to identify the projects and processes to meet the water supply gap for communities while balancing the needs of agriculture, the environment, and recreation across the state.**
- **Obtain the State's encouragement and assistance in the development of balanced and appropriate storage that can meet multiple benefits, including instream flow and augmentation needs.**
- **Meet community water needs during periods of drought.**
- **Develop and implement policies and strategies that support meaningful agricultural viability statewide.**

Colorado will require the implementation of many identified projects, storage, other infrastructure, and methods to meet future municipal, industrial, and agricultural needs. This section discusses the different types of projects that communities must implement to meet Colorado's growing needs, how the basin roundtables identified these projects and methods, and what is required to support those communities. This section also includes a discussion of the IBCC's adopted No-and-Low-Regrets Action Plan as it relates to the implementation of projects and methods, and a summary of ongoing initiatives relating to the viability of agriculture statewide. Colorado's water values name agricultural viability as a priority, and Colorado's Water Plan includes specific policies and strategies to advance this concept. It also addresses the role of storage in meeting Colorado's future supply needs.

Overview

The draft BIP process produced a compendium of projects and methods to meet Colorado's future water needs. These projects and methods are the foundation of this section. In developing their respective lists of projects and methods, the basin roundtables relied upon previously developed IPPs, conducted interviews with water providers, and solicited public input to update existing IPPs and identify additional projects and methods. For the purposes of Colorado's Water Plan, the term projects and methods refers to IPPs and additional efforts the BIPs featured to close the M&I gaps and reduce agricultural shortages.

The basin roundtables vetted these proposed projects and methods in order to develop a draft list for their respective BIPs. Some roundtables vetted the preliminary list through the entire roundtable, while others reviewed projects and methods using subcommittees. In the end, each roundtable reviewed or adopted the draft BIPs. In addition, many roundtables tiered or prioritized their projects and methods to assist with future implementation.

The goal of developing lists of projects and methods is to meet Colorado's future water needs. In addition, this work will help calculate the remaining M&I water supply and demand gaps, determine residual agricultural shortages, estimate the costs of implementing the proposed projects and methods, identify the potential for intrabasin and interbasin

collaboration on proposed projects and methods, and identify the interrelationships and the potential for collaboration between consumptive and nonconsumptive projects and methods.

The basin roundtables proposed a great number of projects and methods beyond those identified in SWSI 2010. Although they primarily designated some of the proposed projects and methods as single-purpose, many are multipurpose. The multipurpose projects could benefit agricultural M&I interests. Alternatively, these projects could benefit the environment or expand recreational opportunities while meeting municipal or agricultural needs. Those projects and methods that intentionally target consumptive and nonconsumptive benefits are categorized as *multipurpose*.

The basin roundtables' projects and methods aim to close the M&I gaps or reduce agricultural shortages—or both. They may require financial expenditures, and while many roundtables included implementation cost estimates, some did not. Proposing a project or method and developing cost estimates and financing mechanisms are two components of implementation. Roundtables have many well-developed proposed projects and methods that are currently in the permitting stages; however, some projects and methods are conceptual in nature, with uncertain or no stated cost estimates. The validity of cost estimates varies greatly across proposed projects and methods and across BIPs. With that caveat, individual project and method implementation costs range from $50,000 to $211 million.

It should also be noted that some proposed projects or methods are multi-year efforts and consist of a wide array of implementation strategies and approaches. Cost estimates to implement the proposed projects and methods range from $500,000 to $486 million per BIP, with a statewide preliminary total of approximately $2 billion. Many roundtables have not yet determined costs for their projects, and most have not done so on a consistent basis. Therefore, this number represents a minimum financial need.

Roundtables must also take into consideration their estimated yield for the identified projects and methods. Estimated yield affects the calculated M&I gaps and agricultural shortages, and is subject to some variability and further refinement by basin roundtables, as well as variability in project permitting and financing. That said, the estimated yield of the proposed projects and methods by BIP ranges from 6,030 acre-feet per year of new supply to 321,316 acre-feet per year. Similarly, the range of yield reflects the level of participation of project sponsors and project beneficiaries. Some projects and methods have multiple sponsors, ranging in size from small, localized water providers, to regional water providers such as conservancy and conservation districts or cities. Furthermore, while a single entity may sponsor some projects, there may be many associated beneficiaries; in other cases, a single entity may sponsor a proposed project or method, with only one beneficiary. The roundtables propose many combinations of project sponsors and project beneficiaries, reflecting the collaborative nature of the BIP process and the anticipated results. This section conducts a more in-depth examination of each BIP, and discusses the IBCC's No-and-Low-Regrets Action Plan and actions.

New and Emerging Water Supply Projects and Methods

As the State of Colorado and the basin roundtables move toward implementing BIPs and Colorado's Water Plan, they will need innovative and creative solutions to meet future demands, given the availability of funding and the nature of limited water resources. There is no perfect solution, but a range of emerging trends add to the suite of options that the State and the basins can implement.

Aquifer Recharge

Aquifer recharge, also referred to as artificial recharge, is the process of infiltrating water to an aquifer through ponds, basins, canals, or wells.[324] Artificial recharge to the alluvial aquifer is most commonly used in Colorado for augmentation of stream depletions because of well pumping. Most of these alluvial recharge projects for augmentation occur in the South Platte Basin, outside of the designated groundwater basins.[325] Permanent artificial recharge projects outside of the designated basins must ultimately receive a decree through water court, and must operate within the confines of Colorado's prior appropriation system. Additionally, a protocol for alluvial recharge within the South Platte Basin is available.[326]

ASR

Aquifer storage and recharge (ASR) uses aquifer recharge or injection to achieve water storage in the aquifer during times of low demand and high water supply, and it later recovers the water by pumping when demand exceeds surface supply.[327] In an alluvial aquifer, recharge for ASR occurs when water is allowed to seep into underlying aquifer. For confined aquifers, ASR uses wells to inject the water at pressures greater than what exists in the aquifer. Several water providers have used Colorado's Denver Basin Bedrock aquifers for the storage of water over the past several decades. The Denver Basin aquifers are confined bedrock aquifers, and they are not considered tributary to the stream system. The water in these aquifers is appropriated under a separate legal framework based on overlying land ownership. Additionally, specific rules govern ASR projects utilizing these Denver Basin aquifers. Although the majority of ASR projects use the Denver Basin aquifers, two ongoing ASR projects in Colorado involve the use of alluvial aquifers. These are Aurora's Prairie Waters project in the South Platte basin, and Cherokee Metropolitan District's aquifer replacement plan in the Upper Black Squirrel Basin.

Collaborative Management Solutions

These sort of projects and methods frequently cross basin boundaries, and comprise multiple parties working together to achieve often-disparate goals. Section 9.2 highlights several solutions in which entities representing many uses come together for creative water management. Examples include the CRCA, the Arkansas River Voluntary Flow Agreement, and the WISE Partnership. In these solutions, creative collaboration and the involvement of many stakeholders throughout the entire agreement process meet a host of different needs.

ATMs

For much of Colorado's water history, the agricultural water user has been faced with two options: continue operations as normal, or sell water rights to an interested party—often a municipality seeking to firm-up supply. Seeking potential alternatives to agricultural transfer, interested parties seek to provide a third option that falls within the boundaries of Colorado's prior appropriation system.

Though the CWCB and other stakeholders are still reviewing the viability of certain types of alternative transfers, ATMs should offer an avenue by which Colorado seeks to meet future needs, in contrast to the permanent "buy-and-dry" of agricultural lands. Section 6.4 discusses ATMs in more detail.

6.5.1 BIP Identified Municipal, Industrial, and Agricultural Infrastructure Projects and Methods

The types of projects and methods basins could potentially implement are as varied as the needs in each basin, as well as statewide needs. While projects and methods generally fall into two generic categories (structural and non-structural), this overview of the BIPs warrants a more specific categorization. These summaries will present tallies of projects by type and use, even though many projects may have multiple benefits.

SWSI 2010 identified several categories of IPPs, which have been consolidated into the following:

- Agricultural water transfers (including ATMs)
- Reuse of existing fully consumable supplies
- Growth into existing supplies
- In-basin projects
- New transbasin projects.[328]

The majority of projects the roundtables identified fall into the category of "In-Basin Projects." For the purposes of this summary, in-basin projects could align with the following descriptions:

- Collaborative Management
- Storage Improvements & Expansion
- New Storage
- Ditch & Diversion Improvements
- Monitoring, Assessment, and Planning Efforts
- Municipal Infrastructure
- Energy
- ASR
- Water Rights and Supply
- Multipurpose

This section examines each BIP's "primary message," which summarizes the prioritized projects and describes how the projects or methods align with basin goals and measurable outcomes. This section also describes the process each basin used to garner public input, which demonstrates how basins generated project lists. Finally, this section describes highlights of the projects and methods, and identifies the acre-feet of development and costs, when available.

In the basin summaries, material in the BIPs identifies project costs and associated, identified acre-feet. Each basin conducted outreach and assimilated and evaluated projects in a manner that is unique to the respective basin. As the basin roundtables further refine the BIPs and projects and methods move to implementation, they will better define project information, costs, and associated acre-feet.

Arkansas Basin

Primary message: The basin roundtable identified additional storage as a primary goal of the implementation plan. Roundtable members believe preservation of existing storage is critical to continuing to meet the basin's supply needs for all uses, along with development of new storage. New storage can include reoperation of existing structures in need of repair, along with underground storage (ASR). Additional methods the basin roundtable identified include ASR projects and alternatives to ATMs. Moving forward, the roundtable plans to focus efforts on a disaggregation of the basin gaps to identify more localized needs at the county level. The roundtable will also take a closer look at identified projects and methods to prioritize available funding and resources. In project implementation, the roundtable identified compact compliance issues as a key challenge. The replacement of nonrenewable groundwater and sustainability of designated basins also represents a critical gap.[329]

ARKANSAS BASIN AT A GLANCE

120 projects identified on the IPP List that meet municipal, industrial, or agricultural needs

$344,700,000 in costs identified for **4** projects

166,500 acre-feet of development identified for **17** projects

Process: The roundtable reviewed the SWSI 2010 IPP list, and held 17 public outreach meetings at which stakeholders submitted more than 100 input forms.[330] These forms proposed projects, methods, and potential policy implementation. The roundtable will review and rank these input forms, and will invite some proponents to attend roundtable meetings and present the identified project, method, or suggestion. As part of the roundtable's organization of basin needs, projects, and methods, the group created a comprehensive database. The roundtable categorized projects that met a basin need as follows within the database:

- All Input List: all identified needs from all sources.
- Preliminary Needs List: filtered to remove complete or obsolete needs.
- Master Needs List: The provider of each need on the Preliminary Needs List was asked to identify a Solution and a Plan of Action to implement a solution for the identified need. All needs with a defined Solution and Plan of Action carried forward onto the Master Needs List. Projects on the Master Needs List were located by latitude and longitude for later mapping.
- IPP List: Needs on the Master Needs List were compared to the criteria for an IPP per the SWSI 2016 draft glossary. Needs on the Master Needs List that met the SWSI 2016 IPP criteria are included in the IPP List.

While projects and methods included in the "All Input List" may include obsolete or completed projects, the IPP list is designed to meet SWSI criteria for an IPP.

Projects and methods summary: The roundtable identified a total of 120 projects and methods on the IPP List that meet municipal, industrial, or agricultural needs.[331] Of these projects, 17 identify acre-feet, totaling 166,500 acre-feet of development.

Colorado Basin

Primary message: The Colorado Basin Roundtable is focused on completing a basin-wide stream management plan. The plan will contain more in-depth analysis and understanding of the amounts of water necessary to maintain environmental and recreational attributes. The roundtable expressed concern about uncertainty regarding current water supplies' capacity to meet in-basin consumptive use, as well as environmental and recreational needs, for future projects and methods. The basin emphasized the need for more in-depth studies and work about the effects of climate change on water supplies, and the variability of wet and dry years. The roundtable stated: "The most prudent planning approach… is to assume that there is no more water to develop for export from the Colorado Basin."[332] The extensive public outreach the basin undertook resulted in a comprehensive list of potential identified projects and methods. This list comprises a suite of options the basin can pursue to meet its future needs.

COLORADO BASIN AT A GLANCE

31 projects identified as Top Projects that meet municipal, industrial, or agricultural needs

$500,000 - $152,500,000 in costs identified for **13** projects

24,082 acre-feet of development identified for **3 top** projects

Process: The roundtable members divided into Project Leadership Teams (PLTs), which focused on particular subject matter areas within the BIP. The consumptive PLT worked to identify projects within the basin that would meet future water supply needs. The PLT interviewed water providers, either in-person or through a standardized questionnaire, throughout the basin. These information-gathering efforts focused on existing and forecasted supply, as well as on projects and methods to meet demands. The PLT also analyzed existing studies and reports for planned projects. The basin held town hall meetings, and roundtable members and consultants traveled to many meetings, including county commission and city council meetings, to gather information. Roundtable members took a closer look at the list of projects and methods,

and then identified representative projects in each basin sub-region that met basin themes and sub-region goals. These projects were designated as "Top Projects" and represent important needs at both the basin-wide and sub-region levels.

Projects and methods summary: The roundtable identified a total of five basin-wide Top Projects and methods,[333] and 26 Top Projects by sub-region. It identified all 26 sub-region projects as multipurpose. Beyond the identified Top Projects, the BIP Exhibits lists additional projects and methods the public-input and targeted technical-outreach process generated.

Basin Top Projects were evaluated by basin goals:

- 21 Top Projects were identified that meet the basin goal of "Sustain Agriculture."
- 23 Top Projects were identified that meet the basin goal of "Secure Safe Drinking Water."[334]

Future basin efforts will focus on implementation of identified projects and methods. Modeling efforts are underway to further understand potential constraints and opportunities within the river system.

Gunnison Basin

Primary message: The primary goal of the Gunnison Basin is to "Protect existing uses in the Gunnison Basin."[335] With that overarching goal in mind, the basin is pursuing other goals that promote the continued importance of agriculture, the protection of environmental and recreational uses, and the maintenance of infrastructure within the basin. A primary focus is on agricultural shortages, and methods to address this need. The basin identifies and prioritizes projects and methods accordingly.

GUNNISON BASIN AT A GLANCE

49 projects identified on the Tier 1 list that meet municipal, industrial, or agricultural needs

$478,107,269 in costs identified for **33** projects

139,406 acre-feet of development identified for **21** projects

The roundtable quantified M&I needs, which it currently expects the basin to meet using currently existing supplies and implementing currently planned projects and methods. The roundtable modeled projects and potential constraints to evaluate the potential effects of project or method implementation on supply and water rights. This modeling effort provided a cursory feasibility analysis for projects at a basin-wide scale, taking into account water availability, irrigation decrees, agricultural effects on streamflows, and instream flows. The roundtable evaluated and divided into tiers the projects and methods the basin identified.

Process: Working with water management agencies and stakeholders to identify projects and methods intended to meet future basin needs, the roundtable members and consultants conducted a series of targeted technical outreach meetings throughout the basin. They created a list of current projects intended to represent the state of water planning at the time of BIP publication. The outreach process identified projects that the roundtable compared to the basin goals, and evaluated according to their timeline for completion. With these comparisons and evaluations in mind, the BIP committee approved three "tiers" of identified projects and methods:

- **Tier 1:** implementation likely feasible by 2025; project does excellent job of meeting Basin Goals.
- **Tier 2:** implementation likely not feasible by 2025; project would excel at meeting Basin Goals. Project may also have important conditional water rights and/or completed planning efforts.
- **Tier 3:** implementation likely not feasible by 2025; project in preliminary stages of planning and/or may meet Basin Goals to lesser degree.[336]

Modeling analyses also informed the tiering process, leading to the identification of projects and methods with multipurpose uses, and the selection of agricultural projects that most effectively address shortages. As stated, the project list is intended to be a "snapshot" of current planning efforts. Future updates and additions to the BIP may affect current prioritization or offer updated information about projects and methods.[337] Future studies may also affect prioritization as the roundtable updates and refines supplies, demands, or processes.

The roundtable created "Project Summary Sheets" in which it analyzed the Tier 1 projects and methods. These sheets provide a more in-depth look at the projects and methods, featuring information such as project yield, sponsor, and details about ways in which the project meets basin goals. A table briefly outlines projects the roundtable classified as Tiers 2 or 3. The table also features inventory projects, which will further examine regional projects and methods.

Projects and methods summary: The roundtable identified a total of 49 Tier 1 projects and methods meeting municipal, industrial, or agricultural needs.[338] Tier 1 projects were rated by their ability to meet basin goals:

- All 49 Tier 1 projects meet the overarching basin goal of "Protect existing water uses in the Gunnison Basin."
- 40 projects and methods seek to specifically "Improve agricultural water supplies to reduce shortages."
- 9 projects meet the basin goal of "Identify and address municipal and industrial water shortages."[339]

A great number of the Gunnison roundtable's identified projects have an agricultural benefit, as one would expect in this largely agricultural area.

North Platte Basin

Primary message: The basin goals the North Platte Basin Roundtable established are intended to maintain historical water uses within the basin, as well as provide a look forward at the future of development. Chief concerns in this particular basin are the equitable apportionment decree and the depletion allowance of the Three State Agreement.[340] Agricultural needs related to shortages, as well as infrastructural storage and water delivery concerns, are paramount. The roundtable created a list of "potential basin solutions," to include both structural projects and methods for water management.

NORTH PLATTE BASIN AT A GLANCE

52 total projects identified that meet municipal, industrial, or agricultural needs.

14 projects analyzed in summary sheets

12,197 acres of new irrigation for **9** projects

11,993 acre-feet of development identified for **5 projects**

Process: Similar to the Gunnison Basin roundtable, identification of projects, and a comparison of those projects to the basin goals, drove the North Platte process. The roundtable conducted targeted technical outreach to water managers and other stakeholders. The basin performed modeling analyses to identify challenges to implementation and to examine the effects of specific projects. As the roundtable reviewed projects, it highlighted potential multiple use projects, and called out potential water availability constraints. With the focus on agricultural needs, the roundtable conducted a shortage analysis to identify projects and methods that most effectively addressed shortages.

The roundtable prioritized the list of solutions by conformity with the basin goals, as well as in accordance with the timeline for potential implementation. It selected some projects that will receive additional analysis in the form of a project summary sheet, for these reasons:

- The project, and associated analysis herein, is representative of other projects on the list, such as the case with the Proposed Willow Creek Reservoir and the Hanson and Wattenberg Ditch Acreage;
- Implementation of the project is currently being pursued, such as the case with the Protocols and MacFarlane Reservoir; or
- Implementation of the project is potentially more feasible than projects on the following list because of limited constraints or challenges or more support from the Basin Roundtable, as with the Canal Maintenance and Improvements project.[341]

The project summary sheets provide a more extensive analysis of project or method information, including such details as "project constraints, implementation strategies and how well the project meets the Basin Goals."[342]

Projects and methods summary: The roundtable identified a total of 52 projects and methods that meet municipal, industrial, or agricultural needs.[343] The 14 projects that received additional analysis were compared with the basin goals:

- 13 projects met the basin goal to "Maintain and maximize the consumptive use of water permitted in the Equitable Apportionment Decree and the baseline depletion allowance of the Three State Agreement."
- 7 projects specifically addressed the basin goal to "Continue to restore, maintain, and modernize critical water infrastructure to preserve current uses and increase efficiencies."
- 3 projects met the basin goal to "Increase economic development and diversification through strategic water use and development."[344]

The majority of the projects and methods identified serve an agricultural benefit. The most numerous of projects are agricultural improvements, and many of the new storage projects will require further study to enable the roundtable to refine acre-feet projections.

Rio Grande Basin

Primary message: The Rio Grande Basin Roundtable identified 14 different goals, with central tenets being "a resilient agricultural economy, watershed and ecosystem health, sustainable groundwater resources, the encouragement of projects with multiple benefits, and the preservation of recreational activities."[345] Additionally, the roundtable identified preservation of the agricultural economy, which represents 99 percent of the basin's water use, as an overarching goal. Through public outreach and the work of roundtable subcommittees, the roundtable identified projects that met basin goals. It identified as desirable those projects and methods that meet multiple benefits and uses, and that stand a greater chance of receiving funding. In future planning efforts, the roundtable plans to develop project-ranking criteria, and to continue identifying projects and methods that meet basin goals.

RIO GRANDE BASIN AT A GLANCE

61 projects identified that meet municipal, industrial, or agricultural needs

$129,754,895 in costs identified for **29** projects

6,030 acre-feet of development identified for **2** projects

Process: Through the subcommittee and stakeholder outreach process, the roundtable selected 29 projects that would receive a more in-depth analysis through project fact sheets.[346] These fact sheets provided more information about each project, and featured the sponsor, location, estimated project costs, and a comparison of the project outcomes with basin goals. The roundtable also generated a matrix that displayed each project, the needs it met, and the basin goals its implementation would meet. Twenty-five of these projects were site-specific, and had associated cost estimates through the year 2020.[347]

The roundtable identified 21 additional projects and methods for future consideration and discussion. The roundtable did not analyze these projects at the fact-sheet level due to time constraints and available information, but the roundtable believes these projects could be beneficial to meeting basin needs and goals. The basin intends that this plan will remain dynamic, and will add projects and methods as it identifies additional needs, methodologies, and focus areas.

Projects and methods summary: The roundtable identified a total of 61 projects and methods meeting municipal, industrial, or agricultural needs.[348] It evaluated the projects and methods by their ability to meet basin goals. Within the 29 projects the fact sheets evaluated:

- 14 projects meet the goal of "Operate, maintain, rehabilitate, and create necessary infrastructure to meet the Basin's long-term water needs, including storage."
- 14 projects and methods seek to "Manage water use to sustain optimal agricultural economy throughout the Basin's communities."

- 24 projects and methods are identified as multi purpose, meeting the basin goal to "Support the development of projects and methods that have multiple benefits for agricultural, municipal and industrial, and environmental and recreational water needs."

South Platte Basin (Including Metro)

Primary message: The South Platte and Metro Basin Roundtables worked together on a joint BIP and sought water supply solutions that were "pragmatic, balanced, and consistent with Colorado water law and property rights."[349] The BIP emphasized multipurpose projects and specifically identified the following three objectives. "Projects and methods should be configured to meet multipurpose objectives that balance:

a. Consumptive with environmental and recreational needs;

b. Surface and groundwater utilization and storage; and

c. Current versus potential future needs and values."[350]

This BIP specifically referenced the "Four Legs of the Stool," a result of the IBCC's work that identifies four key tactics for meeting future water supply.

SOUTH PLATTE / METRO BASINS AT A GLANCE

63 projects identified that meet municipal, industrial, or agricultural needs

191,980 acre-feet of development identified for **23** projects

The South Platte/Metro Roundtable identified three categories of water development to meet future uses within the basin: 1) Water use efficiency improvements and water sharing strategies, including conservation, reuse, ATMs, and system integration; 2) Supply development involving new storage and conveyance systems and investigating, preserving, and developing Colorado River options; and 3) Watershed health and water quality management.[351] The roundtable examined both larger-scale concepts, such as TMDs, and smaller-scale projects and methods, such as storage and reuse projects. Project concepts the joint BIP identified are primarily geared toward meeting municipal, industrial, and agricultural needs. The BIP further divided these concepts into project categories such as reuse, agricultural transfers, ASR, and TMDs.

Process: Like some other basins, the South Platte/Metro joint effort began with the IPP list the SWSI 2010 process identified. The basin roundtable interviewed potential project sponsors (water conservancy districts, municipalities, and counties) via project summary sheets to gather basin project information, such as sponsor and estimated cost. The Metro Roundtable's executive committee and the South Platte's Rio Chato committee reviewed the project summary sheets gathered through the outreach process. Both roundtables then reviewed the projects and methods in full to consider them for inclusion in the BIP. Additionally, the roundtables considered three conceptual projects that were intended to demonstrate a collaborative approach to meeting basin needs moving forward.

Projects and methods summary: The basin roundtables identified a total of 63 projects and methods meeting municipal, industrial, or agricultural needs:[352]

- 13 projects identified as Reuse IPPs
- 8 Agricultural Transfer IPPs
- 17 In-Basin IPPs
- 5 Transbasin IPPs

Southwest Basin

Primary message: The Southwest Basin takes the approach that all needs should be viewed equally, be they agricultural, municipal, industrial, environmental, or recreational. The roundtable adopted 21 goals and 31 measurable outcomes in its BIP, with a focus on water supply needs.[353] Since SWSI 2010, the roundtable has identified the completion of 55 projects within the basin. Through the basin's outreach process, which it conducted in support of the BIP, the basin added more than 80 new projects to the list, totaling 164 IPPs. Of these identified projects and methods, "agricultural IPPs make up about 19 percent of the total IPPs on the list to date. Municipal and industrial IPPs make up about 29 percent of the

total IPPs on the list to date."[354] The BIP serves as a living document that provides guidance for basin water supply planning, while continuing to refine projects, methods, and goals as needs evolve.

SOUTHWEST BASIN AT A GLANCE

117 projects identified that meet municipal, industrial, or agricultural needs

$60,000,000 in costs identified for **1** project

30,354 acre-feet of development identified for **8** projects

Process: The basin identified themes, goals, and measurable outcomes that are geared toward identifying and meeting water supply gaps. Themes B and C directly address the matter: "B) Maintain Agriculture Water Needs, C) Meet M&I Water Needs."[355] With these overarching themes in mind, the roundtable conducted outreach across the basin. In that outreach, it contacted water managers and other stakeholders to identify potential new projects and methods that had developed since SWSI 2010. Roundtable members and consultants also conducted public workshops members to inform the public about the BIP and Colorado's Water Plan process, and to elicit information about potential projects or methods. The listing of projects in the BIP began with the SWSI 2010 identified projects, and then roundtable members and consultants contacted potential project proponents to gather information in the form of a questionnaire. The roundtable vetted the project questionnaires, and adopted projects or methods by including them in the BIP.

Projects and methods summary: The roundtable identified a total of 117 projects and methods meeting municipal, industrial, or agricultural needs.[356] The BIP highlights some specific IPPs that meet basin goals and measurable outcomes, and that demonstrate the types of projects and methods the basin has planned:

- 8 multi-purpose, cooperative, and regional projects and processes such as renewable energy partnerships, water conservation and management plans, and optimization studies
- 5 potential IPPs related to hydropower
- 7 agricultural infrastructure improvements

The Southwest Basin Roundtable will continue to evaluate projects and methods. Additional refinement of project information will provide more detail about cost estimates and new acre-feet.

Yampa/White/Green Basin

Primary message: In the Yampa/White/Green BIP, the roundtable focused on two main concepts with regard to implementation of projects and methods for municipal, industrial, and agricultural uses. First, the roundtable sought to provide sufficient supply of "local water resources for existing uses and future development."[357] It also identified the need for implementation of projects and methods that are "appropriately located, sized, and operated…to protect important water uses and the environment."[358] The roundtable discussed the importance of the Colorado River Compact, and the need to keep compact concerns in mind when planning for the implementation of projects and methods. With these overarching themes in mind, the roundtable adopted eight primary basin goals, with chief concerns around meeting existing and anticipated future uses within the basin.

YAMPA/WHITE/GREEN BASIN AT A GLANCE

27 projects identified that meet municipal, industrial, or agricultural needs

$4,950,000 in costs identified for **3** projects

317,316 acre-feet of development identified for **12** projects

In consultation with basin water managers and other stakeholders, the roundtable developed a list of projects and processes. The roundtable intends the list to remain dynamic; it will update it as basin needs, the understanding of river operations, and potential project proponents are updated and refined. The projects and processes the roundtable identified stem from information basin studies provided. These include SWSI 2020 and the 2014 Project and Method Study, which the roundtable funded. The roundtable identified 21 projects as having met basin goals, and as being appropriate for implementation. The majority of the projects identified are new storage projects; implementation has met municipal, industrial, and agricultural needs.

TABLE 6.5.1-1 NO-AND-LOW-REGRETS ACTION PLAN SUMMARY TO HAVE A HIGH SUCCESS RATE FOR IDENTIFIED PROJECTS AND PROCESSES

COMPLETED, EXISTING, AND ONGOING ACTIONS	POTENTIAL FUTURE ACTIONS
• Make policy recommendations in support of IPP implementation through the 2010 "Letter to the Governors" • Establish the "Collaborative Approach to Water Supply Permit Evaluation" group to improve communication among state and federal agencies about permitting issues • Support key IPPs (e.g., the Chatfield Reallocation Project, WISE, CRCA. • Coordinate the DNR's responses to IPPs through the DNR Executive Director's Office • Provide technical and financial support to project proponents through WSRA grants	1. Support Local Implementation of IPPs a. Provide technical and financial support, including facilitation, to BIPs b. Support the conversion of single-purpose IPPs into multipurpose IPPs when a project proponent requests it c. Streamline state-permitting processes for IPPs that meet values of the CWP d. Continue state coordination with the federal permitting entities e. Encourage cooperative projects through BIPs f. Support local permitting authorities to identify, as requested, multipurpose components up front in project planning to incorporate county and local concerns 2. Update Tracking and Data Collection via the Basin Needs Decision Support System a. Support basin roundtables in providing updated IPP data as part of their BIPs b. Track and analyze effects of IPPs on the projected water supply gap 3. Optimize Funding Sources for IPPs a. Assess funding needs b. Target existing funding sources towards IPPs c. Identify new funding sources for IPPs 4. Generate Political Support for IPPs a. Facilitate and encourage regular, active communication about IPPs between the CWCB, the IBCC, and the basin roundtables b. Upon a project proponent's request, convene a facilitated dialogue among stakeholders, project proponents, and state agency representatives if there is disagreement about a proposed project or process c. Conduct outreach and education about IPPs and the state water-planning process d. Develop an approach for determining whether a project meets the values of the CWP and has broad stakeholder support e. Upon a project proponent's request, encourage legislative resolutions in support of IPPs that meet the values of the CWP f. Publicly advocate for IPPs that meet the values of the CWP and have stakeholder support

Process: Throughout the basin, the roundtable undertook a public outreach process to engage stakeholders and gather input about the BIP and Colorado's Water Plan. The roundtable updated projects and processes identified through SWSI 2010, and the 2014 P&M Study identified the most up-to-date project information.[359] With the basin goals in mind, the roundtable gathered information from project proponents and stakeholders. It distributed surveys throughout the basin at public information meetings or via individual BIP committee member contact. These surveys were intended to identify projects the SWSI and the P&M Study did not include.

Projects and methods summary: The BIP identified a total of 27 projects and methods meeting municipal, industrial, or agricultural needs.[360] Some representative projects and methods presented in the BIP are as follows:

- 9 projects identifying potential new storage sites
- 2 irrigation improvement projects
- 2 reservoir improvements or expansion

Ongoing studies in the basin will inform additional acre-feet yield, and project proponents can develop project costs during the permitting and financing stages.

IBCC No-and-Low-Regrets Identified Projects and Processes Actions

In 2014, the IBCC developed the No-and-Low-Regrets Action Plan to have a high success rate for identified projects and processes, and to implement and assess storage and other infrastructure. These strategies outline the minimum level of effort required regarding these topics on a statewide basis.

Table 6.5.1-1 explores potential future actions the IBCC agreed could generate a high success rate for identified projects and processes. Statewide, the No-and-Low-Regrets Action Plan indicates that on average, basins stakeholders need to implement 80 percent of the yield—equivalent to 350,000 acre-feet— identified in these projects. The BIP and Colorado's Water Plan processes are already addressing many of the IBCC's requests.

6.5.2 AGRICULTURAL VIABILITY

Governor Hickenlooper's executive order directed the CWCB to incorporate "a productive economy that supports vibrant and sustainable cities, viable and productive agriculture, and a robust skiing, recreation, and tourism industry" as key values Colorado's Water Plan is intended to reflect.[361] In every BIP, the roundtables identified the importance of agriculture as an economic driver and an overall community benefit to the basin landscapes. In discussing agricultural viability, the path forward is complicated; to some extent, hydrology, commodity prices, and federal programming dictate the landscape to farmers and ranchers.

Colorado's Water Plan sets an objective that agricultural economic productivity will keep pace with growing state, national, and global needs, even if some acres go out of production. Though irrigated acreage has declined by 338,000 acres statewide, agricultural productivity has increased.

The following table shows an estimate of irrigated lands that have been taken out of production in Colorado over the past several decades. Although the CWCB made an attempt to present agricultural statistics from the USDA, the unreliable nature of the data and the mix of available data through the years made estimates loose at best. Instead, the CWCB used CDSS GIS data gathered during the various DSS projects statewide. Estimates were derived by determining which parcels from past datasets were no longer catalogued in the CWCB's "master" parcel files of irrigable lands for each division. The exception to this was Division 3, where the 1998 dataset (which had greatest total lands) was compared to 2012 (which had the lowest total lands). It should be noted that the CWCB has not determined permanent loss of agricultural lands due to urbanization or permanent dry-up; such a determination would require a more laborious process.

Also included is a chart (Figure 6.5.2-1, page 6-139) of total irrigated lands for the state, as reported by the USDA Census of Agriculture.

In order to meet the objective to maintain agricultural economic productivity, innovation and technological improvements will be integral to future agricultural water management. As the CWCB advances future funding initiatives and technical support, support for viable agriculture will remain a key consideration. Section 9.2 more thoroughly explores the role of future funding for agriculture. Potential long-term funding sources for agricultural viability could support the following endeavors:

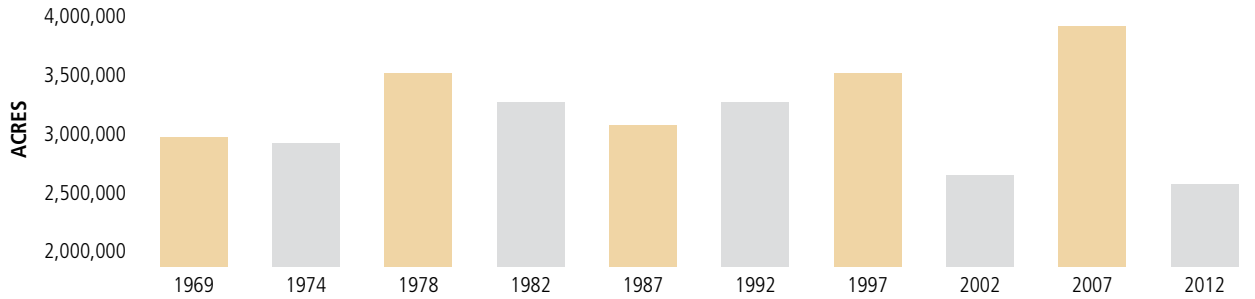
- Exploring conservation easements for irrigation water.
- Developing incentives to keep water in irrigated agriculture, in addition to developing alternative methods for urban transfer.
- Upgrading irrigation and diversion systems.
- Purchasing water rights specifically to create an "agricultural water bank" for water sharing.
- Providing adequate staff resources to manage and coordinate an Agricultural Water Program.

TABLE 6.5.2-1 IRRIGATED LANDS TAKEN OUT OF PRODUCTION

	Div 1	Div 2**	Div 3*	Div 4	Div 5	Div 6	Div 7
No longer Irrigated	136,760	115,630	13,882	13,573	38,476	7,359	13,140
Total irrigated lands in Div	998,214	~	585,457	311,659	235,240	116,380	205,645
% of total	13.7%		2.4%	4.4%	16.4%	6.3%	6.4%

**Permanent dry-up acres from Div 2 staff
*See note above

FIGURE 6.5.2-1 STATEWIDE IRRIGATED ACRES



The basin roundtables proposed solutions, stakeholders submitted comments to the CWCB, and the IBCC convened a subcommittee with the express purpose of exploring policies and concepts—with a goal to maintain viable agriculture in light of future water supply-and-demand challenges. The roundtables summarized these initiatives with the acknowledgement that agricultural viability is an ongoing matter that will require greater study, collaboration, and action items moving forward.

Basin Implementation Plans and Agricultural Viability

Arkansas Basin

In its BIP, the Arkansas Basin Roundtable proposes an economic measure of agricultural benefit. Members of the roundtable worked with a team from Colorado State University to establish a baseline for agricultural production at $1.5 billion annually.[362] Given the constraints of water management within the Arkansas Basin, including the Arkansas River Compact, the roundtable seeks to maintain or increase this baseline by identifying and implementing sources of augmentation water, supporting the development of leasing/fallowing programming within the basin, and further exploring the nexus between agricultural and environmental and recreational uses.[363]

> "The preservation of irrigated agriculture in the Arkansas Basin shall be given a high priority in the state water plan. It is too important to tourism, the preservation of food production, recreation, the environment and the health and well-being of our citizens as well as the economy of the State of Colorado to be ignored."
>
> — *Arkansas BIP*

Colorado Basin

In assessing the future of agriculture in the Colorado Basin, the roundtable first articulated concerns regarding development of a new TMD from the Colorado main-stem, citing existing diversions and the effect that further development could have on the agricultural economy.[364] The roundtable prioritized agriculture in one of six basin themes, and established the following guiding principles for the Colorado BIP: "Sustain, Protect, and Promote Agriculture." The BIP cites the importance of return flows to other economic drivers in the basin, such as recreation and tourism, and points to the 100,000 acre-feet in shortages the SWSI 2010 estimated.[365] The roundtable identified four goals to support this basin theme:

- Reduce agricultural water shortages
- Minimize potential for transfer of agricultural water rights to municipal uses (within private property rights)
- Develop incentives to support agricultural production
- Increase education among the agricultural community about Colorado River Basin water issues

The BIP articulates in greater detail measureable outcomes, short-term needs, long-term needs, and projects and methods in support of each goal.[366]

Gunnison Basin

Under the umbrella goal of "Protect existing water uses in the Gunnison Basin," the Gunnison roundtable also identified three basin goals centered on agricultural viability:

- Discourage the conversion of productive agricultural land to all other uses within the context of private property rights.
- Improve agricultural water rights to reduce shortages.
- Describe and encourage the beneficial relationship between agricultural and environmental recreational water uses.

> "Traditional agricultural water uses not only provide direct economic benefits but also help to drive the recreational economy by preserving the beautiful landscape enjoyed by the Basin's inhabitants and visitors."
>
> — *Gunnison BIP*

In the inventory of projects and methods, the Gunnison Roundtable identified projects that specifically seek to advance these three basin goals.[367] The roundtable discussed each goal in detail, proposed a process to achieve each goal, and defined a measurable outcome that often included a quantifiable target. For example, in discussions about the first bulleted basin goal, the roundtable hopes to achieve the following measurable outcome: "Preserve the current baseline of about 183,000 protected acres in the Gunnison Basin and expand the participation in conservation easements by 5 percent by 2030 through programs like the Gunnison Ranchland Conservation Legacy."[368] The roundtable also includes implementation goals, which may include a number of projects it will develop in accordance with a certain benchmark, or the completion of a study to assess infrastructural needs. The BIP further explores specific processes and measurable outcomes.

North Platte Basin

The North Platte Basin Roundtable identified in its BIP agricultural shortages and issues related to infrastructure as priority needs, along with concerns regarding long-term implications of the equitable apportionment decree.[369] Similar to the Gunnison BIP, one basin goal in the North Platte seeks to "describe and quantify the nonconsumptive benefits of agricultural use."[370] Moving forward, the roundtable hopes to complete further study of this relationship by quantifying the benefits and their overall effect on water management within the basin. Measurably, the roundtable seeks to complete at least two multipurpose projects in the basin meeting multiple needs.[371] The BIP identifies four specific projects by directly addressing this multipurpose-projects goal.

The roundtable also described shortages in the basin and the causes of these shortages, which fall into three categories: physical, legal, and irrigation-practice related.[372] Other basin goals seek to resolve identified issues with water availability under the decree, and address issues related to aging or non-functional infrastructure. Detailed project information is available for projects that address agricultural needs for multipurpose benefits.

Rio Grande Basin

The Rio Grande BIP begins by recognizing the importance of agriculture to the basin economy. Agriculture accounts for approximately 99 percent of the basin's water use.[373] The challenges inherent in compliance with the Rio Grande Compact and the basin's Well Rules and Regulations make viability of agricultural production a major concern for basin stakeholders. Twelve of the 14 basin goals include an agricultural consideration, ranging from compliance with legal mechanisms to optimal management of agricultural and environmental water uses.[374]

The BIP discusses the role of innovations in agriculture, and examines the future roles of strategic crop development and irrigation improvements as potential water management strategies.[375] Additionally, the BIP includes a summary of current approaches within the basin to improve soil health as a component of improved water management as it relates to agricultural production.[376] The roundtable took a closer look at 29 projects and methods identified to meet future

needs within the basin. Of those 29 projects, 24 meet identified agricultural needs.[377] Beyond the projects and methods the project sheets explored in further detail, the BIP identifies 18 additional projects and methods with an agricultural nexus. These range from specific improvements, to agricultural infrastructure, to an "Alternative Cropping Education and Promotion Program."[378]

South Platte Basin (Including Metro)

> "The importance of agricultural production in the South Platte and Republican River Basins should not be overlooked. It is a major factor in the State's economy and includes processing of food and livestock from the entire state."
>
> — *South Platte BIP*

In proposing strategies to meet the projected water supply gap in the South Platte and Metro Basins, the roundtables set guidelines recognizing the importance of agriculture to the basin economy, and encouraging multipurpose projects with a minimal effect on agricultural uses.[379] In planning for the future of water within the basin, the roundtable set a basin goal to "Minimize traditional agricultural "buy and dry" and maximize use of ATMs to extent practical and reliable."[380] Specific recommendations for achieving this goal include further support of water-sharing methods and improvements to the water court process, with an acknowledgement of the importance of vested rights to water-rights holders.

The BIP discusses the benefits and challenges associated with the implementation of ATM projects, and identifies some lessons learned from previous and ongoing ATM projects within the basin. The roundtables also provided some strategies at the local level to minimize agricultural dry-up, such as switching to cool-weather crops, deficit irrigation, and dry-year leasing. The BIP emphasizes continuation of state pilot programs for water sharing, as well as collaborative solutions such as the coupling of agricultural easements with municipal lease options.[381]

Southwest Basin

Similar to other western slope basins, the Southwest Basin expresses concerns about the Colorado River Compact, and the influence future development of Colorado River supplies may have on basin agriculture, given downstream obligations. To that end, the roundtable proposed that proponents of a new TMD, or water providers that are utilizing agricultural dry-up to meet demands, should meet a 70:30 ratio of inside-to-outside use of municipal water by 2030.[382] In assembling the BIP, the roundtable identified 21 goals, three of which specifically address the theme of "Meet Agricultural Needs."[383] In addition to the proposed municipal-use ratio, the roundtable recommended implementation of ATM and efficiency projects, strategies to discourage permanent dry-up, and the implementation of at least 10 agricultural water efficiency projects identified as IPPs by 2050.[384]

The Southwest BIP also presents the challenges inherent in achieving these measurable outcomes, such as potential opposition to a statewide conservation ratio, and the difficulties in ATM implementation under water-rights administration within the basin.[385] In compiling the Southwest BIP, the roundtable conducted extensive outreach to update the IPP list. Of the total IPPs listed, agricultural projects and methods total about 19 percent, while 17 percent are multipurpose and may have an agricultural component.[386]

Yampa/White/Green Basin

The Yampa/White/Green Basin Roundtable identified eight goals, two of which specifically mention agricultural uses of water:

- Protect and encourage agricultural uses of water in the Yampa/White/Green Basin within the context of private property rights.
- Improve agricultural water supplies to increase irrigated land and reduce shortages.[387]

In looking to the future of the basin, the roundtable undertook a modeling exercise that demonstrated agricultural shortages under a baseline scenario, and substantial shortages under a dry-future scenario.[388] The roundtable projected the addition of up to 14,805 irrigated acres within the basin. As a result of the exercise, roundtable members determined their priority to be the identification of timing and location

of shortages. In the context of private property rights, the BIP proposes potential cooperative programs to reduce shortages, while encouraging multipurpose projects with a benefit to agricultural uses.[389] With this closer study of shortages, and the encouragement of policies and programming to benefit agriculture, the roundtable has identified some quantifiable outcomes:

- Preserve the current baseline of approximately 119,000 irrigated acres and expand by 12 percent by 2030.
- Reduce agricultural shortages basin-wide by 10 percent by the year 2030.[390]

Additionally, the roundtable identified several processes related to improving agricultural infrastructure. These processes involve collaboration and more in-depth analysis of potential for improvements, taking into account the effects on other water uses.

BIPs and Agriculture Summary

The roundtables are exemplary in their detailed accounting of projects and methods, with the goal of achieving agricultural viability. In their BIPs, they establish and inventory these projects and methods at the grassroots level, incorporating policy suggestions from the stakeholders who are actively involved at the local basin level. Local stakeholders, water managers, and water users know what sorts of practices are actionable, and what will work in their area. Moving beyond an acknowledgement of the importance of agriculture to the economy and communities, the roundtables make a series of bold steps toward actionable and measurable strategies that seek to maintain the viability of agriculture across the basins. The IBCC Agricultural Viability Actions and Strategies section summarizes work occurring at the IBCC level, and highlights policies and strategies that have statewide applicability. The roundtables strive to measurably and meaningfully encourage the viability of agriculture around the state through a series of action items, and they also take a broader approach by seeking actions that may provide a benefit.

Effects of Agricultural Dry-Up

As basin roundtables and stakeholders statewide seek to identify projects and methods that promote agricultural viability, a greater understanding of the relationship between irrigated agriculture and the surrounding communities and ecosystems should be encouraged. Governor Hickenlooper's executive order and the work of the IBCC and CWCB support creative alternatives to traditional "buy-and-dry," while respecting the private property rights involved.

Return flows must be maintained in the case of an agricultural water rights transfer. However, reduction in use of an agricultural irrigation water right may still result in impacts on wetlands associated with agricultural dry-up, the loss of open space and wildlife habitat, and to local businesses and economies that depend on agricultural industry within a community.

These sorts of impacts merit further exploration, but not in a way that affects private property rights, increases uncertainty, or unduly burdens water users seeking to enter into a transaction. As with other action items in Colorado's Water Plan, the purpose of this effort should not be to increase red tape or create regulatory hoops, but foster a greater understanding of the role of viable agriculture in local communities, given the water supply challenges identified in other chapters and sections of this plan.

Moving forward, the CWCB should provide technical work and financial support of grassroots efforts to clarify the effects of transfers and to understand the relationship between irrigated agriculture and the surrounding communities and ecosystems. Entities in the Arkansas and Yampa/White/Green have applied for WSRA funds in this vein, and the IBCC Agricultural Viability subcommittee has suggested a potential "Framework for evaluations of agricultural transfers," described below. Such efforts should strive to include potential proponents of a water use change, as well as community members who would potentially be affected. These efforts would ideally lead to a greater understanding between members of the community regarding the effects of transfers.

IBCC Agricultural Viability Actions and Strategies

To inform the ongoing statewide discussion about agricultural viability, the IBCC assembled a subcommittee in 2015. The intent of the subcommittee was to propose specific concepts and strategies to attain the IBCC's support and achieve potential short-term implementation. The committee presented to the IBCC draft concepts for discussion, and the IBCC approved

the pursuit of further work and implementation of those action items. Moving forward, the CWCB's members and staff will work with stakeholders and other interested parties to implement these action items, while recognizing the challenges and opportunities each presents. The following summary briefly describes each of the IBCC concepts.

Agricultural viability long-term goal: The IBCC asked the subcommittee to craft a long-term goal that would be closely tied to continued, long-term viability for agricultural uses, and to reflect the broad need to educate Coloradans about the importance of agriculture. Ideally, the goal should be measurable.

Program to facilitate agricultural opportunities: The state needs to provide additional education and assistance to farmers and ranchers to help realize more transactions that allow for ATMs, and to enable new Colorado farmers to successfully enter the agricultural industry. This assistance may include financial and other support for land links, land trusts, and conservation easements that protect working farmland and make irrigated land affordable for the next generation of farmers and ranchers. The program should include education on and assistance with the following:

- Deals, contracts, and other options for sharing agricultural water.
- Strategies to remain market competitive.
- Ways to achieve long-term certainty for both water lessors and lessees.
- ATMs that allow the farmer to continue owning the land.
- Opportunities to overcome entry barriers for young growers (in collaboration with such entities as Land Link, Farm Bureau's Young Farmer Group, and Colorado State University Extension).
- Perpetual agricultural agreements, such as conservation easements (such as those demonstrated by entities like the Lower Arkansas Valley Water Conservancy District).
- Other similar contractual agreements that allow for more long-term flexibility (an example is the purchase of water rights in the Arkansas Basin by Aurora Water).
- Funding opportunities for agricultural producers.

Proponents need to create the program's scope of work, goals, geographic range, and responsibilities, as well as measurements for success. Because many aspects of the program relate to agreements between municipalities and agricultural producers, program sponsors should involve both sectors in the development of the program and solicit their continued input.

Enforcement of minimum standard for water-rights applications: The court should be diligent in enforcing the minimum water-rights application requirements, which are already in existence, and should standardize these requirements statewide. Better guidance should be provided and advertised for applicants who do not have legal counsel or engineering consultants.

Incentives to reduce urbanization and fragmentation of agricultural lands: Colorado's Water Plan should indicate that current land-use incentives it describes would also help to keep agricultural lands in production. The CWCB should review these incentives to determine whether more incentives will be needed to further encourage local governments and land owners to reduce fragmentation and urbanization of agricultural lands. The CWCB's intent is that the incentives will provide additional options, but not infringe upon private property rights.

Addressing barriers to keeping agricultural land and water ownership when water sharing: Members of the IBCC will work with BRTs to apply for a multi-basin WSRA grant in order to compile ATM data, identify areas that will encourage irrigators to enter agreements, analyze barriers (beyond law review), and bring in municipalities' perspectives to understand both buyers' and sellers' viewpoints. CWCB will develop next steps once it has compiled and reviewed this data.

Framework for evaluations of agricultural transfers: More transparency with regard to agricultural transfer transactions is needed to help agriculture producers and the general public understand the effects of agricultural transfers to agriculture, the local community, and the environment. An evaluation of agricultural transfers could help, but several concerns and details that would need to be determined. An evaluation of agricultural transfers could encroach on private property rights, stall operations, and create a permitting hurdle, thereby functioning like an environmental impact statement (EIS). The end goal of such an evaluation would not be to create another hurdle in the permitting or water court process, but

to provide transparency for the cumulative effects of such a transfer. Other remaining details to determine include the party responsible for conducting the evaluation, the evaluation's end goal, the evaluation's effect on agricultural viability, and timing of such an evaluation in the water-rights transaction process. The CWCB will host a stakeholder group comprising landowner and water provider participants to develop a framework for an evaluation of agricultural transfers to determine whether such a framework is appropriate from a technical, legal, and policy perspective.

Agricultural-to-agriculture, -environment, or -industry sharing pilot: In 2015 Governor Hickenlooper signed Senate Bill 198 into law, allowing pilot projects to share water among agricultural entities and industrial or nonconsumptive uses. To implement this program, the CWCB should encourage a pilot project to test the concept, and should educate ditch companies about this opportunity. Some ditch companies may need to change their bylaws to allow for water sharing.

Updates and improvements to Colorado's aging infrastructure: For many agriculture producers, building new storage and other infrastructure, and updating aging infrastructure, is too expensive and difficult due to the myriad regulations, permits, and costs. Storage both benefits and supports all uses and all sectors. Therefore, the CWCB encourages additional work to improve the permitting, system, water administration review, court system, and law, as well as work to increase funding for aging infrastructure and identified agricultural projects.

Regulations that increase costs for growers, and how to modify them: The agricultural community needs relief from increased government regulations across sectors. Stakeholders must address these mounting regulations as one of agriculture's top priority issues for the future, especially when encouraging young agriculturalists to continue farming.

Additional recommendations: The IBCC discussed the need for two additional points that focus on funding agricultural infrastructure and agricultural IPPs. The latter recommendation will support agricultural and municipal IPPs that reduce reliance on agricultural dry-up.

ROBERT T. SAKATA

SOUTH PLATTE RIVER BASIN

Robert is a vegetable farmer in Brighton and served on the Water Quality Control Commission, Metro Roundtable, and several other boards where he's demonstrated leadership statewide in the agriculture and water community. Robert is pictured on his farm.

One of my favorite quotes is from Albert Einstein who said, "We cannot solve our problems with the same thinking we used when we created them." And yet change is never easy. But I will need to change the way that I farm if I'm going to stay in business. Everybody is going to have to change the way we think about water in the world we live in. The Colorado Water Plan can be a first step. It outlines the parameters of how water administration works, it states the need, and it develops a basic action plan…but to carry out the outlined actions will require the state to provide the leadership to facilitate and minimize...

CONTINUED AT END OF CHAPTER

PROFILE

6.5.3 STORAGE

The implementation of projects and methods with a storage component will play a crucial role in meeting Colorado's water supply needs. Basin roundtables have identified storage as an important element of the BIPs, and have highlighted the necessity for storage through basin goals and measurable outcomes, or identified specific projects and methods with a storage component, as discussed in the BIP summaries above. Additionally, the IBCC has called attention to the future role of storage through the No-and-Low Regrets Action Plan, as summarized in Table 6.5.3-1 (page 6-152).

These types of projects and methods are identified in every BIP, which point out the many benefits that can be realized from new or reoperated storage projects. In establishing goals and measurable outcomes for the BIPs, basin roundtables universally expressed a preference for multipurpose storage projects moving forward. These projects can potentially meet multiple needs and serve multiple beneficiaries. This more inclusive model of collaboration in project planning may lead to more diverse funding models for project financing, and reduce hurdles to project implementation by working with a diverse set of users.

While new storage projects will certainly play a role in meeting the state's water needs, the enlargement and rehabilitation of existing dams and reservoirs will provide more options for the path forward, as Chapter 4 discussed. Additionally, options for storage in alluvial and bedrock aquifers provide another solution to supply challenges.

Colorado's Water Plan sets a measurable objective of attaining 400,000 acre-feet of water storage in order to manage and share conserved water and the yield of IPPs by 2050. This objective equates to an 80 percent success rate for these planned projects.

Extreme weather events and conditions such as those in 2013 and 2015 have precipitated discussion statewide and at the basin roundtable level regarding the benefits of storage for an array of purposes. Storage vessels can meet a variety of needs beyond water conservation, including but not limited to:

- **Flood Control:** In spring 2015, a "Miracle May" of late season snow and rain fell statewide, bringing Colorado's various regions out of drought classifications. Chatfield Reservoir south of Denver was one of many storage projects used statewide to control flows, which avoided property damage and unsafe river conditions.
- **Compact Compliance:** In recent years, discussions among Upper Basin states have focused on drought contingency planning, as discussed in Chapter 2. Upper Basin reservoirs have been key to the discussion of reoperation, with the intent of keeping levels in Lake Powell above minimum power pool. Reservoirs that could conceptually be used in a drought contingency planning reoperation strategy include Flaming Gorge, Navajo, and the Aspinall Unit. Reservoirs are also critical to meeting compliance with compact obligations; and example is the role of John Martin Reservoir with respect to the Arkansas River Compact.

- **Drought Mitigation:** The Soil Conservation Service (now the NRCS) and the Colorado DWR originally developed the Surface Water Supply Index. The purpose of the index is to describe drought severity in regions where water availability is driven by winter snow accumulation and subsequent melt. The index is comprised of four elements: snowpack, streamflow, precipitation, and reservoir storage. As a part of state and local planning and mitigation for drought, the inclusion of reservoir storage in this tool demonstrates the importance of this resource for water managers and resource officials around the state.[391] As climate change affects supplies, storage vessels also afford more flexibility to water managers planning for associated effects.
- **Crop Protection**: The Division 2 office of the DWR administers the Winter Water Storage Program, and the Southeastern Colorado Water Conservancy District coordinates it. This program allows agricultural users on the Arkansas River to store flows, which had historically been diverted onto their lands during the winter, in Pueblo Reservoir. With this reservoir in place, the stored water can be released during the irrigation season, allowing for better water usage by the farming and ranching communities in the Lower Arkansas Valley.[392]
- **Minimizing Buy and Dry:** The Southern Water Supply Project operated by Northern Colorado Water Conservancy District (NCWCD) provides water from Carter Lake to several northeastern Colorado communities. Rapidly growing communities such as Broomfield, Louisville, and Superior are project beneficiaries. These communities needed a year-round water supply, and the ability to contract with NCWCD for this water provided a solution, without needing to purchase agricultural water rights and converting these to municipal use.[393]
- **Ecosystem Health:** In August 2015, the CWCB entered into an agreement with the Ute Water Conservancy District to supplement flows in the Colorado River with water stored in Ruedi Reservoir. This agreement allows the CWCB to lease between 6,000 and 12,000 acre-feet of water for instream flow use on the "15-Mile Reach" of the river, which provides critical spawning habitat for endangered fish species.[394]
- **Environmental and Recreational Enhancements:** In 2012, 2013, and 2015, the Colorado Water Trust entered into an agreement with multiple partners to boost summer flows in the Yampa River upstream of Steamboat Springs by releasing water from Stagecoach Reservoir. This purchase of water from the Upper Yampa Water Conservancy District augments stream health and provides recreational opportunities in this area.[395]

BIPs and the Role of Storage

Every BIP addresses the role of storage within the roundtable's planning horizon. Addressing storage is accomplished in two different ways statewide: through the establishment of goals or measurable outcomes that relate to the future of storage within the basin, or through the identification of proposed projects and methods with a storage component. Some basin roundtables established a policy-based goal by stating the importance of storage to future needs within the basin and listing roundtable action items as a means to further such a goal. Other roundtables set a numerical measurable outcome by establishing a benchmark of new storage (in acre-feet) to be achieved by a certain time. Roundtables that chose to list proposed projects and methods within the basin boundaries included specific information, such as project proponents, estimated project yield, or timeline for project completion. Below is a summary of each BIP, specifically outlining how each roundtable addressed the matter of storage.

Arkansas Basin

The Arkansas Basin Roundtable identified three broad themes to guide the Arkansas BIP. The first theme directly addresses storage:

- *Increased water storage and preservation of existing water storage capacity is critical to all solutions.*[396]

This theme is echoed in a series of "Storage Goals," which the basin roundtable developed based on input basin stakeholders provided during the BIP public outreach process. These storage goals include a numerical acre-feet goal to be accomplished by 2020, and three goals that are action items the basin roundtable and basin stakeholders to implement. These three action items reflect the general sentiment statewide, emphasizing the importance of multipurpose projects and the exploration of a variety of storage options:

1. *Increase surface storage available within the basin by 70,000 acre-feet (AF) by the year 2020;*
2. *Develop alluvial and designated storage in gap areas within the basin;*
3. *Support multiple uses at existing and new storage facilities; and*
4. *Identify storage facilities that can be renovated, restored, or enhanced for additional storage.*[397]

The roundtable also identified a set of specific actions needed to accomplish these goals. It explored potential rehabilitation of nonfederal reservoirs, and listed action items such as implementation of IPPs and funding plans.

Colorado Basin

The Colorado Basin Roundtable discussed storage chiefly in two different sections of the BIP: storage as identified through the public input process, and the role of storage in meeting identified basinwide themes. The roundtable undertook an ambitious public outreach and input process for the BIP, and that led to the development of six major basin themes. While conservation was the most frequently advocated solution for meeting future water supply gaps, respondents also discussed increased water storage.

The roundtable also identified basin goals that correspond to the six basinwide themes. It mentioned storage as part of several action items in support of basin themes. For example:

- ***Basin Goal:*** *Develop a basinwide funding system to meet basin environmental and recreational needs.*
  - ***Long Term Needs:*** *Evaluate future storage projects in-basin and the potential impacts to nonconsumptive values.*[398]
- ***Basin Goal:*** *Reduce agricultural water shortages.*
  - ***Measurable Outcomes:*** *Identify multipurpose storage projects and methods that address the annual 100,000 acre-feet agricultural shortage.*
  - ***Short Term Needs:*** *Expand the storage capacity in existing reservoirs.*[399]
- ***Basin Goal:*** *Secure growing water demand by developing in-basin supplies and expanding raw water storage supply.*[400]
- ***Basin Goal:*** *Expand regional cooperation efforts to improve efficiency, provide water supply flexibility, and enhance environmental and recreational amenities.*
  - ***Long Term Needs:*** *Expand scope of smaller water providers to proceed on needed water storage projects as multi-beneficial projects.*[401]

Lake San Cristobal near Lake City is the second largest natural lake in Colorado.

The goals and actions the basin roundtable identified are consistent with statewide themes: addressing multiple beneficiaries through implementation of multipurpose projects and exploring multiple types of storage projects including new storage and rehabilitation of existing projects. The roundtable also discussed the role of storage across the different regions of the basin; it identified storage as a solution to regional concerns, and identified specific proposed projects as a solution to water supply concerns by region.

Gunnison Basin

The Gunnison Basin Roundtable identified a set of basin goals and a set of statewide principles. In discussion of these goals and principles, the roundtable identified storage in established processes as a way to achieve basin goals, and as a measurable outcome for implementation. As a result of conversations with water providers and proponents within the basin, the roundtable also compiled an extensive list of proposed projects, methods, and basin needs. Many of these specifically identified projects and methods include a storage component.

The primary goal the roundtable identified is to "Protect existing water uses in the Gunnison Basin."[402] Complementary basin goals seek to improve water supplies to reduce municipal, industrial, and agricultural shortages. In proposed processes to achieve these goals, the roundtable identified a common action item:

- *Recommend potential solutions in collaboration with local water users. Recommendations could include an initial analysis of hydrology (water variability), cost, financing, and permitting. Such projects could include new storage, water right exchanges, efficiency measures, operational optimization, etc.*[403]

The roundtable also identifies the benefits of projects and methods that meet multiple objectives. Basin measurable outcomes also directly address implementation of multi-purpose storage projects, geared to exploration of the beneficial relationship between agricultural and environmental and recreational water uses:

- *Complete at least five new multi-purpose water projects, including two storage projects, in the Gunnison Basin by 2025 that demonstrate the beneficial relationship between agricultural, environmental, and recreational uses.*
- *Explore and develop recommendations on alternative sources of funding from recreational users within the Basin to support development of those multi-purpose water projects.*[404]

Similar to the Colorado Basin Roundtable, the Gunnison Roundtable identified situations in which storage is a part of the solution to regional water supply challenges, and highlighted the role of storage in addressing environmental and recreational needs.

North Platte Basin

The North Platte Basin Roundtable also focused on the role of storage in meeting identified basin goals, most noticeably through measurable outcomes. The BIP focuses on maximizing the beneficial water use in the North Platte Basin within the limitations of the Equitable Apportionment Decree and the Three State Agreement.[405] The roundtable proposed an action item to meet this goal, with a storage component:

- *Recommend potential solutions in collaboration with local water users. Recommendations should include an initial analysis of hydrology (water availability), cost, financing, and permitting. Solutions will include storage and supplemental supplies (e.g. augmentation plans) to mitigate late season shortages.*[406]

The roundtable identified three measureable outcomes associated with this basin goal, which include development of projects and methods, as well as a numerical acre-feet goal for storage:

- *Develop three projects from the list of recommended solutions by 2020.*
- *Incrementally bring up to 17,000 additional acres under irrigation by 2050.*
- *Develop 37,000 AF of additional storage (doubling of current storage) by 2050.*[407]

Projects the basin roundtable identified include an array of solutions including "both structural solutions such as reservoirs and irrigation ditches, and nonstructural solutions such as protocols for the Colorado Division of Water Resources (storage, irrigated acreage, irrigation season)."[408] The list of proposed projects, methods, and actions the roundtable provided include a compilation of project summaries, some of which include a storage component.

Rio Grande Basin

The Rio Grande Compact affects the implementation of storage within the basin, limiting storage potential in post-Compact reservoirs. The Rio Grande Basin Roundtable identified a series of basin goals, some of which directly involve the development of storage, and also highlight the importance to the roundtable of multipurpose projects and methods:

- *Operate, maintain, rehabilitate, and create necessary infrastructure to meet the Basin's long-term water needs, including storage.*
- *Support the development of projects and methods that have multiple benefits for agricultural, municipal and industrial, and environmental and recreational water needs.*[409]

The Rio Grande BIP discussed a multi-pronged approach to storage concerns, including the rehabilitation of existing reservoirs, augmentation of water sources, and acquisition of storage or recharge necessary to replace well pumping depletions.[410] Aquifer sustainability is a primary concern within this basin, and the roundtable described declining levels of aquifer storage as a major need to be addressed with projects and methods within the BIP. The basin roundtable identified 29 primary projects and methods which are examined in further detail in Project Fact Sheets. Of those 29 projects, 14 address the first basin goal relating to storage, and 24 address the basin goal relating to the implementation of multipurpose projects.[411]

South Platte Basin (Including Metro)

The South Platte and Metro Roundtables collaborated on this BIP, which emphasizes the importance and benefits of multipurpose projects, and advocates for balanced approaches to the implementation of storage projects. In the list of elements needed to address South Platte water supply challenges, the roundtables emphasize the role storage must play in meeting current and future needs through this specific action:

- *Promote multi-purpose storage projects that enhance other South Platte basin solutions.*

The roundtables established a list of "South Platte Solutions" which seek to provide the water needed for current and future uses. The solutions are categorized into three groups, one of which addresses storage:

- *Supply development involving new storage and conveyance systems and investigating, preserving, and developing Colorado River options.*

With regard to this solution, the roundtables developed two goals that directly address the implementation and development of storage. These goals are supported by associated measurable outcomes, noted below.

- ***IPP Implementation***
  - ***Goal:*** *Bring a high percentage of entries in the updated IPP list on-line as a key strategy consistent with the "no/low regrets" scenario planning approach.*
  - ***Measurable Outcome:*** *Maximize implementation of the updated IPP list.*
  - ***Environmental and Recreational Measurable Outcome:*** *Encourage multi-purpose projects that also provide environmental and recreational considerations.*
  - ***Environmental and Recreational Measurable Outcome:*** Foster opportunities to improve environment and recreation conditions of affected watersheds in association with IPPs.
- ***South Platte Storage and Other Infrastructure***
  - ***Goal:*** *To the extent possible, develop multipurpose storage, conveyance, system interconnections and other infrastructure projects to take advantage of limited remaining South Platte supplies and enhance water use efficiencies and supply reliability.*
  - ***Measurable Outcome:*** *Explore opportunities to maximize yield from additional South Platte Basin strategic and multipurpose storage and other infrastructure including collaborative interconnections between water supply systems and including both above ground and groundwater (e.g. ASR and alluvial recharge) storage.*
  - ***Environmental and Recreational Measurable Outcome:*** *Encourage multipurpose projects that provide environmental and recreational considerations.*
  - ***Environmental and Recreational Measurable Outcome:*** *Take into consideration environmental and recreational attributes when considering Storage and Other Infrastructure projects and methods.*

These themes, goals, and measurable outcomes reflect the ongoing statewide discussion regarding storage. The roundtable emphasized multipurpose projects and the implementation of varied storage options, including implementation of new projects, maximization of yield from existing projects, and the incorporation of ASR and alluvial storage strategies.

Southwest Basin

In its BIP, the Southwest Basin Roundtable established seven primary themes, and 21 total goals to address those themes. The roundtable also identified 31 measurable outcomes, many of which relate to the implementation of IPPs that may have a storage component. The Southwest Roundtable also expressed support for multipurpose projects "when possible and when they can be accomplished in a manner that is protective of the values present."[412]

The first theme identified by the roundtable is "Balance all Needs and Reduce Conflict" is, with the following goals and measurable outcomes related to the implementation of IPPs:

- ***Goal:*** *Pursue a high success rate for identified specific and unique IPPs to meet identified gaps and to address all water needs and values.*
- ***Goal:*** *Support specific and unique new IPPs important to maintaining the quality of life in this region, and to address multiple purposes including municipal, industrial, environmental, recreational, agricultural, risk management, and compact compliance needs.*
- ***Goal:*** *Implement multi-purpose IPPs (including the creative management of existing facilities and the development of new storage as needed).*

These goals address identified gaps by seeking IPP implementation, with a focus on projects that serve multiple purposes and multiple uses. Measurable outcomes for the basin also focus on a quantified goal for implementation:

- ***Measurable Outcome:*** *Complete 27 multipurpose IPPs to meet identified gaps.*
- ***Measurable Outcome:*** *Complete 40 IPPs aimed at meeting municipal water needs.*

Through public and stakeholder outreach, the Southwest Basin Roundtable also compiled a list of projects and methods, many of which feature a storage component. The BIP details some of these projects, and provides project information and the water supply needs they will address.

Yampa/White/Green Basin

The Yampa/White/Green Basin Roundtable begins by addressing the relative underdevelopment of the basin drainages in as comparison to other basins within the state. Storage in the Yampa/White/Green area is limited, and the majority of existing storage serves current municipal and industrial needs.[413]

The roundtable adopted eight goals and associated measurable outcomes to meet current and future YWG Basin needs. Two of those goals directly address the role of storage within the basin:

- *Restore, maintain, and modernize water storage and distribution infrastructure.*
- *Develop an integrated system of water use, storage, administration and delivery to reduce water shortages and meet environmental and recreational needs.*[414]

The roundtable established a series of processes to accomplish these two goals, and outlined measurable outcomes as benchmarks for each goal moving forward. Processes include identification of basin infrastructure that requires improvement or replacement, identification of potential locations for small scale water storage projects, and opportunities for collaborative partnerships for improvements with multiple benefits.[415] Given the existing and proposed storage options within the basin, the roundtable also plans to complete modeling to evaluate storage operations and explore contracting possibilities. Basin measurable outcomes with a potential storage component include:

- *Implement at least one project every year in the YWG Basin focusing on the restoration, maintenance, and modernization of existing water infrastructure.*
- *Administration and infrastructure improvements making decreed amounts of water available to diversion structures with less need for seasonal gravel dams in the river.*[416]

The Yampa/White/Green Roundtable also compiled a summary of current IPPs, several of which have a storage component. IPPs are identified by location, proponent, and primary purpose of project, though consideration is given to potential multiple benefits and to uses of each project or method.[417]

TABLE 6.5.3-1 NO-AND-LOW-REGRETS ACTION PLAN SUMMARY TO IMPLEMENT AND ASSESS STORAGE AND OTHER INFRASTRUCTURE

COMPLETED AND ONGOING ACTIONS	POTENTIAL FUTURE ACTIONS
• Identify needed storage	1. Manage and Develop Strategic Storage and Infrastructure a. Identify storage and other infrastructure opportunities through BIPs b. Manage and improve storage and infrastructure to effectively use conserved water c. Prepare for uncertainty in hydrology and climate change d. Explore and implement ASR e. Explore and implement storage and other infrastructure to support meeting Colorado's compact obligations 2. Identify and Prioritize Multipurpose Storage and Infrastructure Opportunities a. Manage and improve storage, infrastructure, and reservoir operations to benefit environmental and recreational values b. Support basin roundtables in identifying feasible multipurpose projects c. Prioritize implementation of multipurpose projects that meet values of the Colorado Water Plan d. Identify partners for permitting, funding, and constructing multipurpose projects e. Manage and improve storage, infrastructure, and reservoir operations to benefit agriculture f. Manage and improve storage, infrastructure, and reservoir operations to benefit M&I uses g. Manage and improve storage, infrastructure, and reservoir operations to support hydropower production 3. Analyze Infrastructure Needs for Storage of ATM water a. Analyze existing storage and infrastructure for opportunities to increase exchange capacity b. Develop water-quality treatment infrastructure c. Manage and improve agricultural storage and infrastructure, including support of single-purpose projects as needed

IBCC No-and-Low-Regrets Storage Actions and Strategies

The IBCC has defined storage and other infrastructure as a critical cross-cutting topic. Storage can help water users maximize supplies by re-timing water availability. This allows users to capitalize on average and wet years, and may increase the possibility of sharing water resources when possible. Storage and infrastructure are also important for minimizing agricultural losses, maximizing the use of conservation and reuse savings, and allowing for additional new supplies. In addition, storage can play a critical role in supporting the environment, particularly in support of endangered- and threatened-species recovery programs. Moreover, storage is an important element in protecting Colorado's interstate water rights, pursuant to the State's compacts and equitable apportionment decrees.

As Colorado plans for its water future and looks ahead to a projected 2050 supply gap, it will need new storage and infrastructure to share, transfer, store, and convey water for the benefit of all. Additionally, the State should explore new opportunities for existing storage and infrastructure to provide maximum utilization for all purposes and to ensure compact compliance.

STORAGE GOALS AT A GLANCE

The **IBCC No-and-Low-Regrets Action Plan** identifies a goal of **80 percent yield** of IPP implementation.

This equates to **70,000 acre feet** of additional yield per year for the western slope and **280,000 acre-feet** of additional yield per year for the eastern slope.

This goal is based on implementation of IPPs as enumerated in SWSI 2010 and **does not include** additional projects and methods identified by roundtables during the BIP process.

While this section discusses new storage, it is not meant to include storage that would increase transbasin diversions. Therefore, this section does not include concerns related to new-supply development.

6.5.4 MAINTENANCE OF EXISTING PROJECTS AND METHODS

New projects and methods will be critical to Colorado's ability to meet its water supply needs. However, existing infrastructure and currently operational projects and methods require maintenance and upkeep, which are equally important to bringing new methods online. In evaluating funding mechanisms for future projects, many proponents will include operations and maintenance costs within the proposed budget. Many federal projects include maintenance costs in repayment contracts, or associate costs with power revenues. Many municipal projects pass maintenance costs on to the ratepayer. Funding mechanisms through entities such as the CWCB, as Section 9.2 discusses, are available for costs associated with maintenance, repair, and improvements.

Every BIP includes goals to modernize water infrastructure or improve agricultural efficiencies. Through the BIP process, many basins also identified operations, maintenance, and improvements as part of their plan for future needs. For example, 10 of the North Platte Basin's projects identified ditch and diversion improvements as their primary benefit. In these agriculturally focused basins, improvements to conveyance systems will be of high importance when planning for future needs.[418] The Gunnison Basin Roundtable classified 22 projects as storage improvements and expansion—which either maintain existing reservoirs or plan for more storage.[419] Similarly, the Colorado Basin listed many projects associated with storage expansion, as well as plans for improving or updating existing municipal infrastructure.[420] In this manner, the basins are preparing for new projects and methods while maintaining the existing supply systems.

Working on ultraviolet oxidation reactors at the Peter D. Binney Purification Facility. The reactors help remove substances such as pharmaceuticals and personal care products, part of the multibarrier treatment process used before water reaches Aurora residents. Courtesy of Havey Productions.

ACTIONS

Colorado's Water Plan sets a 2050 measurable objective to attain 400,000 acre-feet of innovative storage in order to manage and share conserved water and the yield of IPPs. This objective equates to an 80 percent success rate for these planned projects, as stated in the IBCC's No-and-Low Regrets Portfolio.

While the right to buy or sell private property water rights must not be infringed upon, the State will encourage innovation and creativity by agricultural producers and research institutions to maximize the productivity of every drop of water. Colorado's Water Plan sets an objective that agricultural economic productivity will keep pace with growing state, national, and global needs, even if some acres go out of production.

To support projects and methods that meet future municipal, industrial, and agricultural needs, several next-steps are necessary.

1. **BIP project support:** The CWCB will continue to support and assist the basin roundtables in moving forward the municipal, industrial, and agricultural projects and methods they identified in their BIPs. It will accomplish this through technical, financial, and facilitation support when a project proponent requests it.
2. **Climate change incorporation:** The CWCB will work with the basin roundtables and, upon request, work with project proponents, to incorporate the potential effects of climate change on municipal, industrial, and agricultural projects and methods.
3. **Expansion of projects to be multipurpose:** The CWCB will prioritize funding to the basin roundtables to support an integrated approach to understanding the ways in which environmental and recreational projects and methods may interact with municipal, agricultural, and industrial projects and methods. As part of this task, basin roundtables will work with local stakeholders and project proponents to explore multipurpose projects and convert existing and planned single-purpose projects and methods into those that are multipurpose.
4. **Project tracking:** In partnership with the basin roundtables, the CWCB will continue to track municipal, industrial, and agricultural projects and methods.
5. **Project support:** The CWCB will continue to support and implement State programs that contribute to implementing municipal, industrial, and agricultural projects and methods. These include loan and grant programs, as well as ongoing studies, such as
the SWSI.
6. **Project funding:** As Section 9.2 discusses, the CWCB will work with partners to strengthen funding opportunities for municipal, industrial, and agricultural projects and methods by:
    a. Coordinating current funding
    b. Assessing funding needs
    c. Exploring additional funding opportunities
7. **Storage opportunity assessment:** As part of the next version of SWSI, the CWCB will work with the DWR and local partners to assess storage opportunities to determine where existing storage can and should be expanded, where it is needed to prepare for climate change, where it can help to better improve sharing and use of conserved water, and where it can help meet Colorado's compact obligations. Furthermore, the CWCB will provide financial support to technical and practical innovations in the use of aquifer storage and recharge where it is practicable.
8. **Multipurpose project funding:** The CWCB will prioritize support for multipurpose projects and those that modernize, make more efficient, or lead to the building of new critical infrastructure for agriculture purposes, M&I uses, and hydropower production. Section 9.2 explores these programs.
9. **Permitting:** As Section 9.4 discusses, the CWCB will refine the permitting process to make it more effective and efficient.

10. **Technical and financial support of efforts to understand impacts to agricultural viability:** The CWCB and IBCC will work with stakeholders to provide grassroots-level support for efforts that foster a greater understanding of the effects of reductions in agricultural use on communities.

11. **Facilitation of agricultural opportunities:** The CWCB and the CDA will establish an education and assistance program for farmers and ranchers to help realize more transactions that allow for ATMs, and to enable new Colorado farmers to successfully enter the agricultural industry. This assistance may include financial and other support for land links, land trusts, and conservation easements that protect working farmland and make irrigated land affordable for the next generation of farmers and ranchers. The CWCB will need to create the program's scope of work, goals, geographic range, and responsibilities, in addition to measurements for success. Because many aspects of the program relate to agreements between municipalities and agricultural producers, the CWCB should involve both sectors in the development of the program, and should provide continued input.

12. **Enforcement of minimum standard for water-rights applications:** The court should be diligent in enforcing the minimum water-rights application requirements, which are already in existence, and should standardize these requirements statewide. Better guidance for applicants who do not have legal counsel or engineering consultants should be provided and advertised.

13. **Framework for evaluations of agricultural transfers:** The CWCB will develop a technical and legal framework for an evaluation of agricultural transfers before considering the requirement of such an evaluation. To help produce such a framework, the CWCB will host a stakeholder group, which will include local government, agricultural producers, municipalities, water providers, landowners, and environmental interests.

14. **Update and improve Colorado's aging agricultural infrastructure:** Over the next five years, the CWCB will work with the basin roundtables and agricultural partners to further identify and prioritize aging infrastructure projects, especially where there can be a large effect on or multiple benefits to other sectors. The CWCB will coordinate funding opportunities to address these needs.

15. **Encourage ditch-wide and regional planning:** Over the next two years, the CWCB will work with agricultural partners to explore opportunities to conduct ditch-wide and regional planning, such as the planning that is occurring in the Uncompahgre. These plans will explore system-wide conservation and efficiency opportunities, explore the potential for water sharing, and develop a long-term infrastructure-maintenance and upgrade plan.

6.6 ENVIRONMENTAL AND RECREATIONAL PROJECTS AND METHODS

GOAL

The policy of the State of Colorado is to identify and implement environmental and recreational projects and methods to achieve the following statewide long-term goals:

- Promote restoration, recovery, sustainability, and resiliency of endangered, threatened, and imperiled aquatic- and riparian-dependent species and plant communities.
- Protect and enhance economic values to local and statewide economies that rely on environmental and recreational water uses, such as fishing, boating, waterfowl hunting, wildlife watching, camping, and hiking.
- Support the development of multipurpose projects and methods that benefit environmental and recreational water needs as well as water needs for communities or agriculture.
- Understand, protect, maintain, and improve conditions of streams, lakes, wetlands, and riparian areas to promote self-sustaining fisheries and functional riparian and wetland habitat to promote long-term sustainability and resiliency.
- Maintain watershed health by protecting or restoring watersheds that could affect critical infrastructure and/or environmental and recreational areas.

One cannot overstate the importance of Colorado's natural environment and recreational opportunities to its quality of life and to its economy. Outdoor recreation—including hunting, fishing, biking, hiking, skiing, golfing, wildlife watching, and many other types of outdoor activities—significantly contributes to Colorado's economy, and nonconsumptive water-based recreation is an important part of that economy. Healthy watersheds, rivers and streams, and wildlife are vital to maintaining Colorado's quality of life and a robust economy. Section 5 of Colorado's Water Plan contains more information about the economic benefits recreational activities provide to the state.

This section details the projects and methods by which Colorado has protected nonconsumptive, river-based environmental and recreational water needs in the past, as well as how the State may maintain these values in the future. To that end, this section will describe the benefits of such projects and methods, and will illustrate existing examples. The section contains several subparts: 1) An overview of existing tools for assessing environmental and recreational needs; 2) an account of knowledge gaps; 3) an overview of environmental and recreational statutes and recent legislation; and 4) a description of projects and methods the eight BIPs contain.

While water is vital to many types of recreational activities, including skiing and sports that require grassy areas, such as soccer, golf, and baseball, this section focuses on recreational uses of water in Colorado's streams and rivers, which roundtables define as primarily nonconsumptive. Section 5 of Colorado's Water Plan addresses the importance of recreational water needs that involve consumptive uses of water that are primarily associated with municipal or SSI uses (for example, irrigation of parks and golf courses and snowmaking).

Overview

Water is a crucial element in the maintenance of environmental and recreational values that are important to Coloradans. Adequate streamflows support the outstanding fisheries in the upper Arkansas River, rafting activities in Glenwood Canyon, snowmaking at world-class ski areas, and habitat maintenance for the water-dependent natural environment. A healthy environment depends upon good water quality, connectivity of streams, and

robust instream and riparian habitats. Careful water management and dedication of significant resources have also led to progress toward recovering threatened and endangered species.[421]

Comprehensive water planning must include meeting environmental and recreational needs, in addition to meeting agricultural, municipal, and industrial needs. The IBCC's conceptual agreement supports this concept and states:

> "Colorado's Water Plan, BIPs, and stakeholder groups across the state should identify, secure funding for, and implement projects that help recover imperiled species and enhance ecological resiliency whether or not a new [TMD] is built. This could create conditions under which future projects may be possible…. These existing environmental and recreational gaps should be meaningfully addressed in the near term."[422]

Projects and methods that maintain or improve Colorado's environmental and recreational values, and that achieve long-term sustainability and environmental resiliency, are an important part of Colorado's water future. An ecosystem's resilience is a measure of its ability to absorb changes and return to similar levels after disturbance.[423] According to Principle 7 of the IBCC Draft Conceptual Agreement, resilience of a stream or watershed can be measured as an ecosystem's ability to recover functionality after an acute or chronic disturbance. Resilient river systems require seasonal flow fluctuations and provide complex and connected aquatic and riparian habitats in order to sustain stable, diverse, abundant, and reproducing populations of aquatic and riparian species.[424]

To determine resiliency levels, it is necessary to identify the baseline status of these characteristics and to monitor stream ecological functions and watershed processes on an ongoing basis.[425] o promote environmental resiliency, planned projects and methods should incorporate the potential stressors of drought and climate change, including decreased supply, changes in water temperature, and changes in runoff magnitude, duration, frequency, rate of change, and timing.[426]

The challenges environmental and recreational project proponents face in the future include learning how to make the most of limited funding opportunities.

JACKIE BROWN

YAMPA RIVER BASIN

Jackie is the Natural Resource Policy Advisor to Tri-State Generation and Transmission and has been a leader in environmental stewardship in the Yampa Valley and on the Yampa-White-Green Basin Roundtable. Jackie is pictured next to the Yampa River.

I am most proud of working on collaborations. Whether it is an improvement project, our Yampa White Green Basin Implementation Plan goals and measurable outcomes, or a slow compromise, collaboration is the key to our water future. My hope for the future is that we begin to realize how adaptable we actually are as humans and continue carefully researching our trade-offs. Long term, big picture planning is difficult in natural resources, but we cannot exhaust our supplies and resources prematurely nor can we pick every battle. Careful and thoughtful implementation is of the utmost importance. I commit to staying at the table, listening, learning and collaborating. When the Colorado Compact was negotiated, it was...

CONTINUED AT END OF CHAPTER

PROFILE

There is a host of nongovernmental proponents of environmental and recreational needs; however, funding opportunities are scarce when one compares them with existing programs for municipal, industrial, or agricultural uses.[427] In addition to strengthening existing and exploring additional funding opportunities for environmental and recreational projects and methods, strategic partnerships will play an important role. Those seeking to fund additional storage or a new diversion may find that working with a diverse group of stakeholders from the beginning will make the process more successful.

In their BIPs, the roundtables have identified new multipurpose projects or methods as desirable, and by working to associate a project with an environmental or recreational use, project proponents will garner support from a wider range of stakeholders. For example, if the proponent can associate a new storage project with a potential recreational opportunity, such as boating or fishing, the proponent can count on a greater range of advocates to support the project through permitting and financing. As another example, a proponent can include a project component that focuses on habitat or flow restoration to address environmental and recreational needs. Proponents can leverage restoration projects and methods, and coordination of water uses among water users, to address the effects of traditional consumptive water uses on water quality and habitat degradation. Such balanced approaches to meeting future water needs could accomplish multiple objectives.

Strategic cooperation on environmental and recreational projects and methods has proven to be a successful mechanism in the past, as Section 9.3 will examine and discuss. In planning for multipurpose projects or methods, proponents should take into account the watershed nature of projects and methods, and the manner by which they influence more than one particular stream reach.[428] With an eye toward serving multiple purposes, proponents may also consider a project or method that meets multiple environmental and recreational purposes in a reach where the project or method leads to the most beneficial outcome.

With multipurpose projects and methods in mind, it is important to note that many environmental and recreational attributes benefit from more traditional existing consumptive uses. Although municipal or agricultural projects can affect environmental and recreational interests, these uses can also provide benefits. A reservoir provides wildlife and fish habitat as well as recreational opportunities for visitors, and provides a mechanism for beneficial management of streamflows. Agricultural water uses also provide these types of benefits. Crop cultivation around the state provides habitat and open space for many species, and the agricultural tourism sector has boomed in Colorado: wineries and orchards are bringing visitors and development to agriculturally centered communities. While these direct benefits are obvious, agricultural diversions also offer some indirect benefits. Diversions that occur in the irrigation season come back to the stream in the form of return flows. These late-season return flows that occur in early fall provide a boost to streamflows that would otherwise not be present. These re-timed flows benefit riparian health and provide instream habitat.

Existing Environmental and Recreational Projects & Methods

Recognizing the value of a robust recreational economy and the obvious benefits of healthy ecosystems, Colorado has implemented programs and invested in projects to protect and improve these attributes. Below are some examples.

Colorado's Instream Flow and Natural Lake Level Program

In 1973, the Colorado Legislature recognized the need to "correlate the activities of mankind with some reasonable preservation of the natural environment" and passed Senate Bill 73-097, leading to the creation of the CWCB's Instream Flow and Natural Lake Level Program.[429] This program, one of the nation's first, vested the CWCB with exclusive authority to protect streamflow through a reach of a stream, rather than just at a point, and to protect levels in natural lakes. Before Colorado passed this law, all appropriations of water in the state were required to divert water from its natural course in the stream.[430] Senate Bill 73-097 removed the diversion requirement for the CWCB and allowed it to appropriate water instream between specific points on a stream, and for levels on natural lakes.[431]

Any person or entity may recommend streams and lakes for appropriation in order to preserve the natural environment. The law also requires CWCB to request recommendations from CPW, the U.S. Department of Agriculture, and the U.S. Department of the Interior.[432]

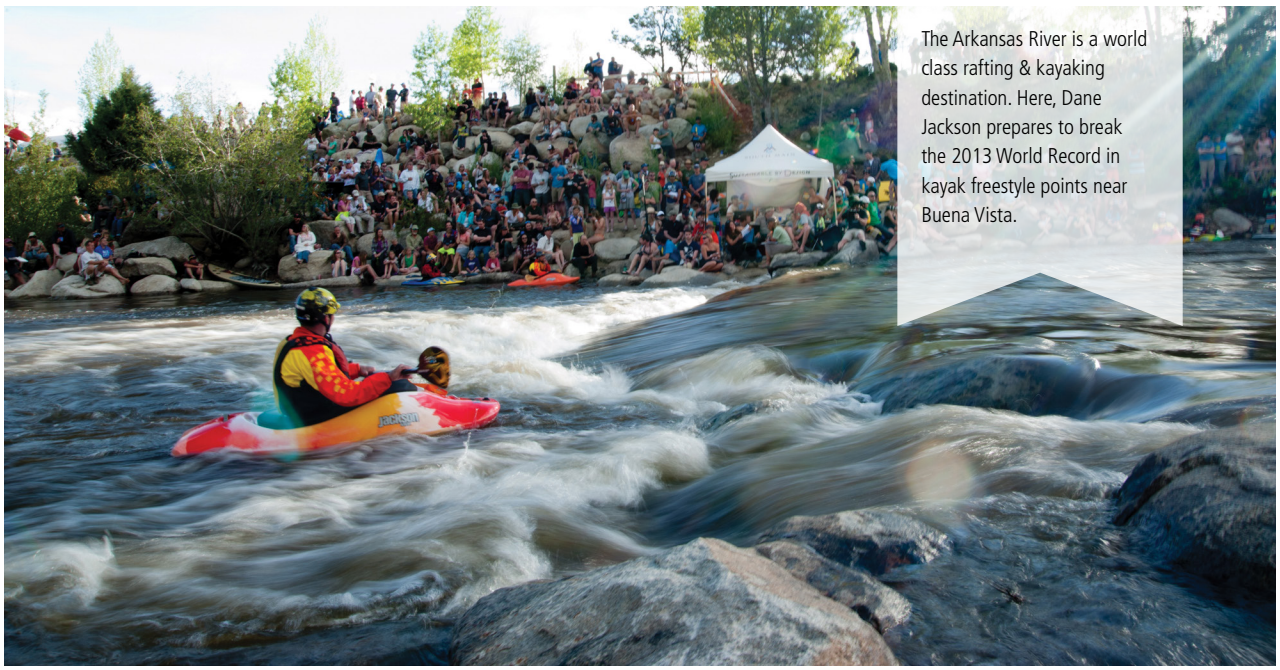
The CWCB uses a public notice and comment procedure to determine whether to appropriate instream flow water rights.[433] Before applying to water court for an instream flow water right, the CWCB must determine that: (1) There is a natural environment that can be preserved to a reasonable degree with the instream flow water right; (2) the natural environment will be preserved to a reasonable degree by the water available for the appropriation; and (3) such environment can exist without material injury to water rights.[434] Once the water court decrees instream flow water rights, the DWR administers those rights through the State's water rights priority system, like it does with any other water right in the state. The CWCB has legal standing in water court to protect instream flow water rights from injury at any point within an instream flow reach.

The CWCB can also acquire water, water rights, and interests in water to preserve and improve the natural environment, on a permanent or temporary basis, from willing water rights owners. The acquisition process involves a biological analysis by CPW, the CWCB's consideration of several factors related to the transaction, and opportunity for public input.[435]

Since 1973, Colorado has appropriated instream flow water rights covering more than 9,200 miles of stream, and natural lake-level water rights on 480 natural lakes.[436] This protection represents approximately 23 percent of the perennial stream miles in the state.

Instream flow water rights appropriations: (1) Protect healthy native- and sport-fish populations, aquatic insects, and rare and distinctive riparian-vegetation communities; (2) achieve federal agencies' resource protection goals through a state-held water right; (3) are a key element of a management plan a diverse stakeholder group developed as an alternative to suitability for Wild and Scenic designation for three reaches of the Colorado River; and (4) provide numerous other benefits to Colorado citizens. Appendix C contains specific examples of instream flow water right appropriations. The CWCB has encouraged entities that recommend instream flow appropriations to focus on streams that provide habitat for threatened, endangered, and imperiled native species.

In 2002, the General Assembly passed Senate Bill 156, authorizing the CWCB to use acquired water to improve the natural environment to a reasonable degree.[437] The CWCB has completed 26 water acquisition transactions. These include acquisitions to protect critical habitat for endangered species on the Yampa River; improve the natural environment of the Blue River downstream from Dillon Reservoir; restore native flows to a degraded stream system near Silverton, Colorado; and re-water a historically dried-up stream near Crested Butte, Colorado.[438] Appendix C contains specific examples of water acquisitions for instream flow use.



The Arkansas River is a world class rafting & kayaking destination. Here, Dane Jackson prepares to break the 2013 World Record in kayak freestyle points near Buena Vista.

RICDs

Colorado is one of several states that authorize the appropriation of water rights for recreational boating purposes within a natural stream. However, Colorado is the only state that allows for the appropriation of water rights for recreational boating uses associated with man-made whitewater parks—specifically requiring structures in the stream that create recreational experiences. These water rights are known in Colorado as RICDs, and the holders of such rights can call water for recreational boating purposes when in priority. Depending on their location, the size and the magnitude of river flows called by some RICD water rights potentially restrict future upstream development potential, and may reduce the flexibility Colorado has in managing its water resources. Colorado law limits RICDs to the minimum streamflow necessary for a reasonable recreational experience, and RICD water rights holders must divert this water through a control structure, often a whitewater park itself.[439] Section 37-92-103(10.1), C.R.S. (2015) defines "reasonable recreation experience" as "the use of a recreational in-channel diversion for, and limited to, nonmotorized boating." Only a local governmental entity may apply for an RICD.[440] The statutes require that the CWCB must consider any water court application for an RICD after deliberation takes place in a public meeting to determine whether the proposed RICD will:

1. Promote the maximum beneficial use of waters of the state;
2. Not impair Colorado's ability to fully develop and use its compact entitlements; and
3. Not cause material injury to the CWCB's instream flow water rights.[441]

To ensure that a proposed RICD adequately meets these requirements, the CWCB has encouraged applicants to include specific provisions within their proposed water court decrees. These specific provisions have included concepts such as "carve-outs" and "no-call provisions." Examples of specific provisions of the CWCB's past findings of facts are available here.[442]

The CWCB then provides its findings to the water court for consideration. The water courts must also consider whether:

1. The water right sought is the minimum necessary for a reasonable recreational experience;
2. The RICD is accessible to the public; and
3. The RICD includes only that stream reach that is appropriate for the intended use.[443]

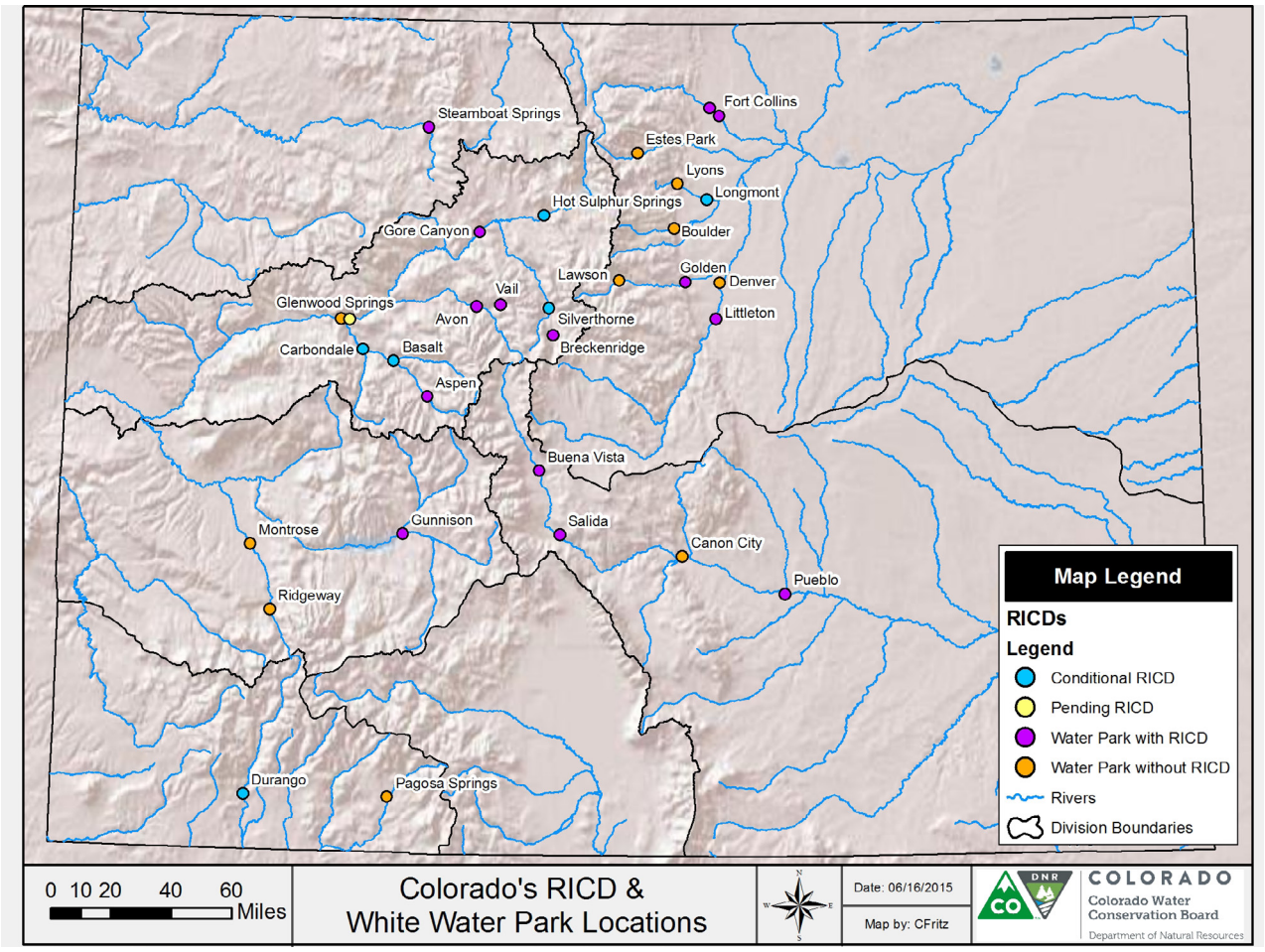
In Colorado, 15 existing whitewater parks have RICD water rights, and eight existing whitewater parks operate without an RICD water right. The map on the opposite page (Figure 6.6-1) illustrates Colorado's existing and planned whitewater parks.

Endangered Species Recovery Programs

Many of Colorado's water projects are likely to have what is known as a "federal nexus." A water project is considered to have a federal nexus if it involves federal funding, federal permitting or licensing, use of federal lands, or a federal program. The existence of a federal nexus often triggers the need for consultation under Section 7 of the ESA.[444] The result of a Section 7 consultation is a biological opinion that states whether a project is likely to jeopardize the continued existence of listed threatened or endangered species, or result in the destruction or adverse modification of critical habitat.

To mitigate these effects, Colorado participates in three cooperative programs designed to protect and recover stream-dependent species in various river basins. The Upper Colorado, San Juan, and Platte River Recovery Programs provide organized collaboration among states, federal agencies, local agencies, water users, water providers, power providers, and environmental organizations. These programs differ from the Three Species Agreement, as described below. These programs' goal is to recover the endangered species while allowing water use and development to continue in compliance with all applicable state and federal laws and interstate compacts.

FIGURE 6.6-1 COLORADO'S RECREATIONAL IN-CHANNEL DIVERSIONS & WHITEWATER PARK LOCATIONS



Funding and resources from participants are dedicated to activities that benefit the species.

Collaboration and a focus on recovery activities are intended to:

- Maximize benefit to the species and the environment by leveraging funding and resources expended.
- Minimize resources spent on adversarial activities, including litigation.
- Provide ESA compliance for water users.
- Streamline Section 7 consultations for water users and federal agencies.
- Reduce uncertainty and delays in planning and permitting processes.
- Reduce likelihood of jeopardy opinions.

Upper Colorado River Endangered-Fish Recovery Program

In 1988, various interests in Colorado, Wyoming, and Utah established the Upper Colorado River Endangered Fish Recovery Program. These interests formed the program as a unique partnership of groups working toward recovery of four endangered fish species: Humpback chub, bonytail, razorback sucker, and Colorado pikeminnow. These species are long-lived, warm-water fish and are endemic to the Colorado River Basin. Recovery efforts focus on creating self-sustaining populations of native fish through restoration and management of habitat, propagation and stocking of hatchery-raised fish, and management of certain deleterious non-native fish species throughout the mainstem Colorado, Gunnison, Yampa/White/Green River Basins.

Outdoor recreation, such as fishing and other water-related activities, highlight some of the quality experiences that tourists and Coloradans enjoy statewide.

The Upper Colorado Endangered Fish River Recovery Program provides ESA compliance for more than 2,050 water projects, encompassing more than 2.5 million acre-feet of existing water use and more than 300,000 acre-feet of new development. No entities have filed lawsuits regarding these projects' compliance with the ESA. The program has established procedures, projects, and agreements to provide streamflow protection, voluntary flow augmentation during critical spring peak and late summer time periods, habitat management and improved habitat access, genetic propagation, hatchery and stocking operations, non-native fish-control efforts, and research and monitoring. The cooperative nature of the program has led to multiple successes and cost efficiency, and the program has become a model for other endangered-species recovery programs.[445]

San Juan River Basin Recovery Implementation Program

A group of federal, state, and tribal agencies established the San Juan River Recovery Implementation Program in 1992 for the San Juan River Basin, a major tributary to the Colorado River. The Navajo Nation, Jicarilla Apache Nation, Southern Ute Indian Tribe, and Ute Mountain Ute Indian Tribe and other stakeholders are active partners in this collaborative effort to recover the razorback sucker and Colorado pikeminnow within the San Juan River Basin in Colorado and New Mexico.

The San Juan River Basin Recovery Implementation Program provides ESA compliance for more than 340 water projects using more than 880,000 acre-feet of water in the San Juan River Basin. Major accomplishments include extensive research in biology and geomorphology, and the establishment of procedures and agreements to provide streamflow augmentation and protection, habitat management and improvement, genetic propagation, hatchery and stocking operations, non-native fish control, and continued research and monitoring.[446]

Platte River Recovery Implementation Program

During the early 1990s, all ESA Section 7 consultations that were conducted on Platte River projects received jeopardy biological opinions, which meant that these water projects could not proceed. In response, Colorado, Nebraska, Wyoming, and the Department of the Interior entered into a collaborative conservation partnership with many other stakeholders. That partnership is now known as the Platte River Recovery Implementation Program.[447]

The Platte River Recovery Implementation Program is now working to recover four threatened and endangered species—the whooping crane, interior least tern, piping plover, and pallid sturgeon—in Nebraska. This allows water use and development to continue on the Platte River. With the current involvement of Wyoming, Nebraska, and Colorado; federal agencies; and many water, power, and environmental interests, the program provides ESA compliance for water projects and fully complies with the participating states' water law as well as existing interstate river compacts and decrees. The partnership is implementing the program in an incremental manner; the first incremental, programmatic biological opinion covers the 13-year period from 2007 through 2019.

Officially in place since 2007, the Platte River Recovery Implementation Program has provided 237 successful, streamlined Section 7 consultations using the programmatic biological opinion for every Colorado entity that has joined the South Platte Water-Related Activities Program. The preceding Cooperative Agreement, signed in 1997, resulted in bridge measures to allow for ESA compliance for approximately 120 Platte River Basin consultations while negotiations were underway.

Through 2019, South Platte water users will pay more than $13 million, and the State of Colorado will pay $24 million (based on 2005 inflation rates), for the Platte River Recovery Implementation Program. Water users and the public view the program to be well worth the cost in comparison to the untold costs water users would likely face without the program, including:

- Needing to undergo uncertain, individual Section 7 consultations, including bearing the risk of receiving jeopardy biological opinions.
- Potentially being required to replace past and future depletions on a one-to-one basis, which would likely add additional pressure to dry-up agriculture.
- Facing delays in the planning and permitting process.
- Risking court challenges to existing programmatic biological opinions.

Three Species Agreement

The CPW, five other Colorado River Basin state wildlife agencies, the USFS, the BLM, the BOR, and sovereign tribes are parties to a multi-state, multi-agency, range-wide conservation and strategy agreement that provides the framework for conservation actions designed to preserve three declining native fish species across their historic range. These species are the roundtail chub, bluehead sucker, and flannelmouth sucker.[448] Noting range-wide declines of these species, the Three Species Agreement addresses the species' potential for a USFWS listing as threatened or endangered under the ESA of 1973, as amended. The USFWS relies on implementation of the multi-state Three Species Agreement to protect and conserve these three native warm-water species.

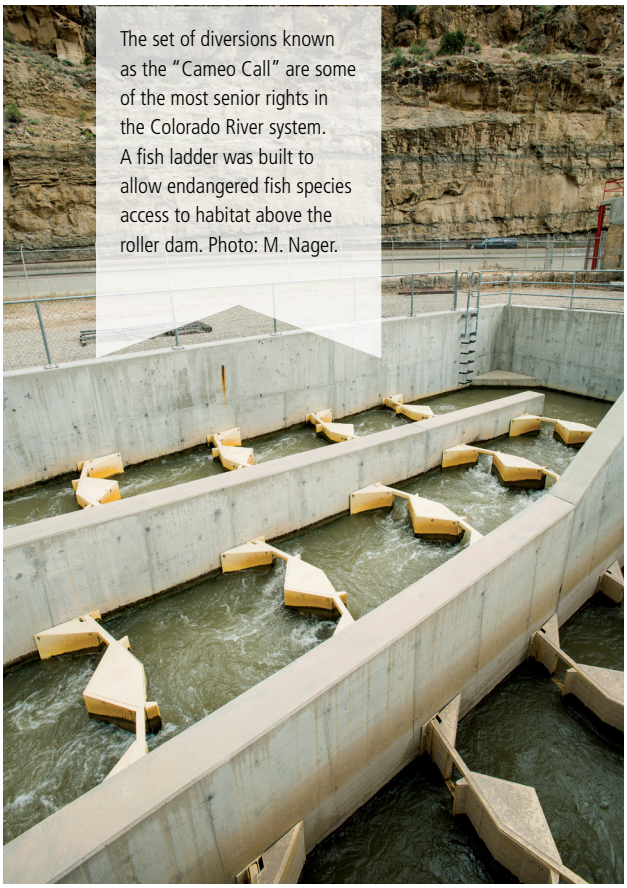
The Three Species Agreement provides that within their jurisdictional authorities, signatories are responsible for taking action to conserve native fish, coordinating status assessments, developing and maintaining data sets on occupancy and genetics, and documenting conservation measures taken on behalf of the three species. The agreement is predicated on the concept that collectively, local, state, and federal agencies, and other willing partners, can work together with communities that are most affected by a potential listing. It encourages all signatories to cooperate on science, research, education, and outreach to send a clear and consistent message about the conservation of these species. One of the agreement's goals is to develop and implement voluntary actions that pre-empt the need for federal listing of any of these species under the ESA. The agreement also prioritizes the establishment of instream flow protection for streams known to provide habitat for the three species. CPW and the BLM have recommended that the CWCB appropriate instream flow water rights to preserve the habitat of the three species. A recent example of such an appropriation is an instream flow water right on the San Miguel River from Calamity Draw to the confluence with the Dolores River. The water court decreed this water right in May 2013.

Colorado River Cutthroat Trout Conservation Strategy

Colorado River cutthroat trout (CRCT) is a state-listed species of special concern in Colorado, Wyoming, and Utah. Federal land management agencies—particularly the BLM and the USFS—that manage habitats where CRCT is present also characterize it as a sensitive species. CPW works closely with Utah, Wyoming, and federal land managers to manage the recovery and persistence of CRCT throughout their historic range. The Conservation Strategy for Colorado River cutthroat trout guides this work. It is a multi-pronged strategy that articulates steps that, if implemented, would be most likely to preserve CRCT in perpetuity.[449] Implementation of the CRCT Conservation Strategy, and an ability to show progress on measurable benchmarks, has allowed the USFWS to maintain its opinion that CRCT is "not warranted" for listing under the ESA of 1973, as amended.[450] This finding has been beneficial to state wildlife-management agencies to maintain state-management authority for this species. Based on this finding, Section 7 of the ESA does not require consultation with the USFWS for projects in CRCT-occupied waters, which is also critically important to water managers.

In general, the CRCT Conservation Strategy focuses on the following objectives:

- Identify populations of CRCT and characterize the level of genetic introgression;
- Secure "conservation" and "core conservation" populations from further genetic dilution (from non-CRCT salmonids) or inter-specific competition (e.g., barrier construction, reclamation, stocking restrictions);
- Maintain and enhance watershed conditions, including streamflow protection, riparian buffers, and habitat projects;
- Public outreach and education;
- Monitoring and data exchange among state fish managers and federal land management agencies; and
- Coordination of all CRCT activities among the same agencies and non-governmental organization partners.[451]



The set of diversions known as the "Cameo Call" are some of the most senior rights in the Colorado River system. A fish ladder was built to allow endangered fish species access to habitat above the roller dam. Photo: M. Nager.

As the CRCT Conservation Strategy outlines, the partnership is continually updating maps, regulations, and the list of CRCT conservation waters as new monitoring data and research unfold. Of current interest is the further delineation of historic, native cutthroat trout into two distinct lineages. These lineages reflect pre-settlement occupation endemic to the Yampa/White/Green River Basins ("blue" lineage) and the Colorado-Gunnison-Dolores River Basins ("green" lineage).[452] Regardless of the nomenclature for particular genotypes of native cutthroat trout, the CRCT Conservation Strategy partners will continue to evolve their management strategies to address new challenges, such as climate change, and research findings.

Wild and Scenic Rivers

The National Wild and Scenic Rivers Act requires federal land agencies—including the BLM, the National Park Service, the USFS, and the USFWS—to use their land and resource management planning processes to identify and evaluate rivers that may be "eligible" and "suitable" for designation as Wild and Scenic rivers.[453]

To be eligible, a river, stream, or segment must be free-flowing and must possess at least one Outstandingly Remarkable Value (ORV). ORVs include scenic, recreational, geologic, fish and wildlife, historic, cultural, or similar values. Once a federal agency establishes eligibility, it evaluates that river or river segment for its suitability for designation as a Wild and Scenic river.[454] Agencies consider many factors in the suitability evaluation, including whether nonfederal entities that may implement protective management demonstrate a commitment to protect the river and its ORVs.

Agencies that find a specific river segment suitable may recommend that segment for designation as a Wild and Scenic river. Only an act of the Secretary of the Interior (upon the governor's request) or an act of Congress may make the designation. The USFS, NPS, and the BLM have determined many river segments in Colorado to be suitable for designation since passage of the original Wild and Scenic Rivers Act in 1968.

If the Secretary of the Interior or an act of Congress designates a river as a Wild and Scenic river, that designation may include a federal reserved water right for a quantity of water necessary to achieve the Act's purposes—including protecting the ORVs for which a river is designated. However, the managing agency has discretion about whether to quantify, adjudicate, or request enforcement of the federal water right. In this context, Colorado can work with local managing agencies to protect flows that can support ORVs using Colorado's Instream Flow Program. Additionally, federal land management agencies may impose conditions on permits or other federal land management decisions to protect the free-flowing nature, water quality, and classification associated with ORVs for candidate (eligible and suitable) Wild and Scenic rivers. Federal land management agencies review proposed projects in, above, or below a designated reach to determine if "they would invade the area or unreasonably diminish the Outstandingly Remarkable Values."[455] If so, the agency may request that project proponents modify the project to avoid adverse effects. If proponents cannot modify the proposed project, the permitting agency may deny the request for a federal permit or assistance. While federal agencies have determined that several rivers in Colorado (for example, the Dolores and Arkansas Rivers) are suitable for designation, and manage them as suitable in the absence of congressional designation, water development and management have proceeded.

In 2009, Colorado's General Assembly established the CWCB Wild and Scenic Rivers Act Alternatives Fund to support cooperative and collaborative processes that are committed to exploring alternative avenues for resource protection.[456] These processes typically consist of stakeholder groups aimed at protecting the ORVs associated with rivers within Colorado, while protecting Colorado's ability to fully use its compact and decree entitlements. The goal of such processes is to find alternatives to Wild and Scenic designation that satisfy the federal agencies' requirements to protect the ORVs. Representatives of diverse interests—including state agencies, local governments, conservation groups, recreation groups, and individuals—participate in these stakeholder groups, and each brings a different perspective to the group's work.

The Cache la Poudre River is the only river in Colorado that is currently designated as a Wild and Scenic river.[457] However, the BLM and the USFS are currently evaluating several river segments in Colorado for Wild and Scenic eligibility and suitability as part of their current land and resource management planning processes. Some NPS units have evaluated their resources for Wild and Scenic eligibility; however, most of those units have not evaluated their resources for suitability. Currently, three active stakeholder groups are using the Wild and Scenic Fund to discuss the merits of suitability findings and, in most cases, to develop alternative ways of protecting the ORVs several federal agencies identified. Stakeholder groups include the Upper Colorado River Wild and Scenic Stakeholder Group, the River Protection Workgroup (working in southwest Colorado), and the Dolores River Dialogue's Lower Dolores Plan Working Group. Additionally, since 1997, the South Platte Enhancement Board has been actively implementing its alternative plan to a possible designation under the Wild and Scenic Rivers Act.[458]

A pied billed grebe feeds in Colorado wetlands.

State of Knowledge

As part of the process the Colorado Water for the 21st Century Act established in 2005, the nine basin roundtables and the CWCB have worked to identify Colorado's environmental and recreational water needs, also referred to as nonconsumptive needs. Below is a brief description of some resources the roundtables and the CWCB have developed so far. Still, it is apparent that these groups can do additional work to develop common metrics for environmental and recreational attributes and to develop focused, basin-specific knowledge of environmental and recreational needs.

SWSI Phase 1—Nonconsumptive Mapping (2010)

As part of the nonconsumptive needs assessments, each basin roundtable mapped out the locations of important nonconsumptive attributes. These reaches or watersheds are known as "focus areas." Each focus area is associated with one or more attributes, such as imperiled fish species, important boating and fishing areas, and important waterfowl hunting areas, among others.[459] Environmental attributes the roundtables identified include federal and state threatened, endangered, and imperiled species (e.g. piping plover, greenback cutthroat trout, boreal toad, bluehead sucker); significant riparian-wetland plant communities; and special-value waters (e.g. the CWCB's instream flow water rights, eligible Wild and Scenic rivers).[460] Recreational attributes the roundtables identified include whitewater and flatwater boating; cold- and warm-water fish species; Audubon important bird areas; waterfowl hunting; and wildlife viewing.

SWSI Phase 2—Nonconsumptive Projects and Methods (2010)

In Phase 2, basin roundtables determined the locations of planned and existing nonconsumptive projects and methods, also known as identified projects and processes, in relation to the focus areas they developed in Phase 1. This information can help determine where known, nonconsumptive identified projects and processes offer direct or indirect protection for a specific attribute. Equally important, it can help determine where there are no known protections for a given focus area. For example, important riparian and wetland areas cover 18,767 stream-miles statewide.[461] Of those miles, existing and planned projects and processes provide or will provide direct protection to 2 percent, a combination of direct and indirect protection to 2 percent, and indirect protection to 23 percent. Of those stream-miles, 73 percent currently have no known protection. The CWCB organized the survey information in a database with Phase 1 information, and summarized it in maps created using GIS.[462] The maps include a list of planned nonconsumptive projects and methods, and show: 1) Where planned and existing projects and methods overlap with the nonconsumptive focus areas, and 2) Where there are no known projects that support those reaches.

Watershed Flow Evaluation Tool

The CWCB partnered with The Nature Conservancy and CDM Smith to pilot a tool known as the Watershed Flow Evaluation Tool (WFET). The WFET provides a framework for examining the risk of ecological change as it relates to streamflow alteration at a watershed or regional level. By contrast, site-specific quantification applies standard techniques to develop reach-based flow quantification based on historic data collection efforts. The WFET can help identify reaches where the historical alteration of streamflow has either increased or decreased risk to a given attribute, such as a cold-water fishery, a warm-water fishery, and riparian vegetation. The WFET can also help project ecological responses to future streamflow scenarios that result

from new water development projects, a compact call, or climate change. To date, the Colorado and Yampa/White/Green Basin Roundtables have applied the WFET to their basins.

It is important to note that the WFET and site-specific flow-quantification techniques possess different capabilities and limitations, and therefore complement each other. For example, the WFET can help target areas that may need further site-specific studies to quantify flow needs, and site-specific quantification can help refine risk-level categories the WFET identifies.[463]

Stream Management Plans

Stream management plans can play an important role in identifying both the needs of environmental attributes, and the projects and methods that will benefit those attributes. For example, the Grand County Stream Management Plan examined approximately 30 stream reaches in the Upper Colorado River Basin to "provide a framework for maintaining a healthy stream system in Grand County, Colorado, through the protection and enhancement of aquatic habitat while at the same time protecting local water uses, and retaining flexibility for future water operations."[464] or each stream reach, the plan includes a reach description, study methodology and results, recommendations for environmental target flows, review of existing temperature and water quality data, monitoring guidelines, unique features and issues, and supporting data.[465] Action items the plan identified include restoration opportunities and monitoring recommendations by stream reach, and the "Learning by Doing" process (similar to adaptive management). Learning by Doing includes monitoring, evaluation, and adjustment of restoration opportunities—including flow enhancements—for the purpose of meeting pre-established goals.[466]

Well-developed stream management plans should be grounded in the complex interplay of biology, hydrology, channel morphology, and alternative water use and management strategies. They should also consider the flow and other structural or management conditions needed to support both recreational uses and ecosystem function. A stream management plan should: (1) Involve stakeholders to ensure their acceptance of the plan; (2) assess existing biological, hydrological, and geomorphological conditions at a reach scale; (3) identify flows and other physical conditions needed to support environmental and recreational water uses; (4) incorporate environmental and recreational values and goals identified both locally and in a basin roundtable's BIP; and (5) identify and prioritize alternative management actions to achieve measurable progress toward maintaining or improving flow regimes and other physical conditions. For basin roundtables, local stakeholder groups, and decision makers, such plans can provide a framework for decision making and project implementation related to environmental and recreational water needs.[a]

The necessary steps for the development of a stream management plan include: (1) Gathering stakeholders to participate in plan development; (2) identifying the plan's objectives; (3) identifying and prioritizing ecological and recreational values; (4) establishing goals for flows and other physical conditions in order to protect or enhance environmental and recreational attributes on streams and rivers within a given watershed; (5) collecting and synthesizing existing data describing flows for river ecosystems, boating, or other needs in the watershed; (6) assessing existing physical conditions of stream reaches, including geomorphological and riparian conditions; (7) selecting quantitative measures that can be used to assess progress made toward articulated goals; (8) determining what new information is needed and the best methods for obtaining that information; (9) quantifying specific numeric flow recommendations (or ranges of flow) and physical conditions and assessing the potential for channel reconfiguration to support environmental and recreational values; (10) identifying temporal, geographical, legal, or administrative constraints and opportunities that may limit or assist in the basin's ability to meet environmental and recreational goals; and (11) implementing a stakeholder-driven process to identify and prioritize environmental and recreational projects and methods. Stream management plans should provide data-driven recommendations that have a high probability of protecting or enhancing environmental and recreational values on streams and rivers.[b]

[a] This summary of the elements of a stream management plan is based upon public comments that incorporated information the Colorado River basin roundtable compiled, and upon comments that the Northwest Colorado Council of Governments Water Quality/Quantity Committee submitted.

[b] This description of the steps to develop a stream management plan is based upon public comments that incorporated information from the Grand County Stream Management Plan and upon comments that the Northwest Colorado Council of Governments Water Quality/Quantity Committee submitted.

Section 7.1's recommendation for a collaborative approach to watershed planning is one that includes stakeholder involvement and management actions supported by sound science—and it applies equally to stream management plans. An inclusive stakeholder approach expedites cooperative and integrated project planning, which leads to successful implementation of measures that will meet the needs the stream management plan identified.

Additionally, while stakeholders can develop stream management plans independently of watershed master plans, a stronger stream management plan will result if the basin conducts it as part of, or in conjunction with, watershed master plans. Numerous watershed master plans incorporate important components of stream management plans. Future stream management plans should build off of existing watershed plans and other available studies.

Conclusion

While this body of work represents an increase in the understanding of Colorado's nonconsumptive needs, more work is required to understand and quantify recreational and environmental needs. Additionally, the roundtables need information about whether existing nonconsumptive identified projects and processes are sufficient to protect the environmental and recreational attributes the projects and processes target. Based upon the above-described information and information the basin roundtables, stakeholder groups, and others are developing, Colorado can develop a strategic approach to meeting its nonconsumptive needs and provide meaningful protection to environmental and recreational attributes.

Existing Environmental and Recreational Legislation

Instream Flow Legislation

Colorado's General Assembly established the Instream Flow and Natural Lake Level Program in 1973, recognizing "the need to correlate the activities of mankind with some reasonable preservation of the natural environment."[467] This legislation vested the CWCB with exclusive authority "on behalf of the people of the state of Colorado, to appropriate or acquire...such waters of natural streams and lakes as may be required to preserve the natural environment to a reasonable degree."[468] Over the years, the General Assembly has amended and clarified aspects of this legislation. Highlights of recent legislation are presented below.

In 2002, Senate Bill 02-156 authorized the CWCB to use acquired water rights to improve the natural environment to a reasonable degree.[469] In 2003 and 2005, the General Assembly responded to the 2002 drought conditions by allowing temporary changes of water rights to instream flow purposes, with DWR approval.[470] In 2007 and 2008, the General Assembly established protections for water rights owners that lease water to the CWCB for instream flow use. These protections provide that a lease to the CWCB will not reduce the historical consumptive use of a water right. It also eliminates the legal presumption of abandonment for water rights that the CWCB has used nonconsumptively.[471]

In 2008, the General Assembly authorized an annual appropriation of $1 million from the CWCB Construction Fund for costs of acquiring water for instream flow use.[472] That same year, the General Assembly authorized an annual appropriation of $500,000 from the Species Conservation Trust Fund for the costs of acquiring water for instream flow use to preserve or improve the natural environment of species that have been listed as threatened or endangered under state or federal law, or are candidate species, or are likely to become candidate species.[473] In 2009, the General Assembly established a tax credit that created a market-based incentive for voluntary donation of water rights to the CWCB for instream flow use.[474]

Recreational In-Channel Diversion Legislation

In 2001, the General Assembly established authority and procedures for local government entities to apply for and hold in-channel water rights for recreational uses, referred to as RICDs.[475] The legislation charged the CWCB with making findings of fact and submitting recommendations to the water court regarding RICD water court applications. It also authorized the CWCB to hold hearings on such applications if any party requested it. In 2006, the General Assembly updated the procedures for RICD water rights applications. It also clarified the role of the CWCB's administrative process as well as its determination of findings of fact to submit to the water court.[476]

BIP-Identified Environmental & Recreational Projects & Methods

As part of the BIP process, the basin roundtables identified projects and methods that could assist in meeting environmental and recreational needs within their basins. The process for identifying these projects and methods was unique to each basin; roundtables collected and organized information through public outreach, input solicitation, and review by committees or the full roundtable. As a result, because these processes were different in each basin, the manner in which the BIPs presented these projects and methods varied. Some basins identified reaches of concern, and others consolidated existing compilations of project information.

A lake near Boulder with views of the Flatirons.

This section examines and summarizes the work of the basin roundtables. It focuses on a brief description of the process each basin used, a general overview of projects and methods identified, and the path forward as basins move to meet their goals and measurable outcomes. More information on the BIP process and how each basin collected and organized its environmental and recreational projects is available in the individual BIPs, which are available on the Colorado's Water Plan website.[477]

Arkansas River Basin

The Arkansas Basin Roundtable undertook an ambitious public outreach process by hosting meetings around the basin to gather input and suggestions from residents. One of the hallmarks of this process was the input form the roundtable designed. The input form encouraged basin residents to submit ideas and projects for the roundtable's consideration. The roundtable also considered the list of IPPs from SWSI 2010, as well as focus areas or areas of concern the Nonconsumptive Needs Committee identified.[478]

ARKANSAS BASIN AT A GLANCE

135 projects identified on the IPP List that meet environmental or recreational needs

$345,230,000 in costs identified for **2** projects

382 stream-miles identified for protection by **15** projects

The roundtable has gathered project lists from several sources, including SWSI 2010, The Nature Conservancy, CPW, and others. The BIP also identifies projects the roundtable funded through the WSRA program, and projects or methods the public input process helped identify and the roundtable undertook. Through this inventory of potential projects, the roundtable seeks to prioritize available WSRA funding, and to demonstrate the types of projects it believes conform to the basin's goals and measurable outcomes.[479]

The BIP Project Database includes environmental and recreational projects, classifying them by definitions of Master Needs, Preliminary Needs, and IPPs. These projects line up with the basin's environmental and recreational goals of maintaining and improving key attributes. Many of the identified projects concentrate on the protection and restoration of key habitat through diversion replacement, wetland improvement, and reoperation of currently existing storage rights. Three of the identified projects are associated with some aspect of instream habitat restoration. Two projects identified by the Committee focus on recreational needs through activities such as boat chute improvement, campsite restoration, and reservoir renovation with recreational needs in mind.

Moving forward, the Arkansas Basin Roundtable plans to delve deeper into the public input it received through its outreach program. For projects that meet basin goals, proponents may be invited to a roundtable meeting to present on their projects, and to potentially work with the roundtable to meet funding needs. As it moves forward to maintain an updated inventory of activities within the basin, the roundtable plans to take a holistic view of projects and methods, exploring concepts such as watershed health. GIS mapping of needs and identifying areas of concern is a roundtable priority, and supports the BIP's efforts. The roundtable plans to complement this path forward with the pending revised edition of the SWSI, with specific identification of projects and methods that meet the definition of an IPP.

Colorado River Basin

The Colorado Basin Roundtable also began with an extensive public outreach campaign in which consultants interviewed water providers throughout the basin and hosted many town hall meetings and opportunities for gathering BIP input. This outreach process yielded a comprehensive list of projects, organized by basin themes and geographical location. Similar to the Arkansas Basin approach, the roundtable believed that a comprehensive inventory of projects and methods would serve the basin well as a suite of options for moving forward and for meeting its future water supply needs. The basin also compiled projects and methods from existing sources, such as SWSI 2010, into this inventory. Roundtable members took a closer look at the list of projects and methods. Then, in each basin sub-region, they identified representative

COLORADO BASIN AT A GLANCE

27 projects identified on the Top Projects list that meet environmental or recreational needs

$117,500,000 - $152,500,000 in costs identified for **13** projects

24,082 acre-feet of development for environmental or recreational needs identified by **3 top** projects

projects that met basin themes and sub-region goals. These projects were designated "Top Projects" and represent important needs at both the basin-wide and sub-region levels.

The Colorado Basin Roundtable established several themes to sum up and organize the input it received from basin stakeholders. Theme #1 is: "Protect and Restore Healthy Streams, Rivers, Lakes, and Riparian Areas."[480] In its identification of Top Projects, the roundtable identified several projects that complement this basin-wide theme. Central to this theme is the roundtable's goal of establishing a basin-wide stream management plan. Data gaps for environmental and recreational needs are a key issue of concern for this basin. The roundtable would like to see more progress statewide in scientifically quantifying the amounts of water necessary to maintain or improve these attributes.

Many of the roundtable's identified Top Projects and methods have an environmental or recreational focus. Many include the acquisition of water rights to restore or protect streamflow, or flow-related recreational protection. The needs of endangered species in the Colorado Basin are highlighted in the BIP's goals and measurable outcomes; species recovery is a measurable outcome to be achieved through habitat improvement and addressing invasive species.

Moving forward, the roundtable plans to begin organizing the inventory of projects for potential implementation. To prioritize the projects and methods, the roundtable will examine each through the lens of the basin-wide themes, and will identify projects that may serve multiple purposes or meet basin goals. Many of the water management-related projects and methods may already be in the planning stages. Some of these may be associated with the CRCA, and some may be roundtable-funded projects that anticipate multiple phases.[481]

Gunnison River Basin

The Gunnison Basin Roundtable identified two basin goals that address environmental and recreational water needs, and then identified projects and methods within the basin that could assist in meeting those needs.[482] The roundtable compiled this inventory of projects and methods through outreach within the basin and through stakeholder participation in the BIP process. The roundtable also convened a group of environmental and recreational advocates, including staff from state and federal agencies, to provide input and assist in identifying focus reaches. As part of the BIP process, the roundtable approved the use of "project summary sheets," which help break down elements of projects and methods such as project proponent, project cost, and effectiveness in meeting basin goals.[483]

GUNNISON BASIN AT A GLANCE

30 projects identified that meet environmental or recreational needs

$427,848,100 in costs identified for **23** projects

21,472 acre-feet of development for environmental or recreational needs identified by **10** projects

In organizing its projects and methods inventory, the roundtable established three tiers of projects. The tiering criteria were the timeline and the effectiveness in meeting basin goals. The basin roundtable also identified 29 target stream reaches within the basin as areas where environmental and recreational projects and methods could be beneficial. While identifying potential projects and methods, the roundtable highlighted a series of ongoing efforts involving environmental protections and monitoring that help to maintain these attributes within the basin.

The Gunnison Basin Roundtable defined Tier 1 projects and methods as those whose implementation is likely feasible by 2025 and that do an excellent job of meeting basin goals.[484] Of the 49 projects classified as Tier 1, 18 are associated with Basin Goal #5: "quantify and protect environmental and recreational water uses."[485] These projects mostly focus on improving or restoring stream channels within the aforementioned target stream reaches, or on improving native trout

populations. Many projects identified as Tier 1 are multipurpose projects that include an environmental or recreational benefit. The roundtable also identified 22 projects as meeting Basin Goal #7: "Describe and encourage the beneficial relationship between agricultural and environmental and recreational water uses."[486] These projects are chiefly multipurpose projects for agricultural uses with environmental and recreational benefits identified, making them in-line with the basin goal.

For its environmental and recreational goals, the Gunnison Roundtable also established some measurable outcomes that are based in project implementation. Moving forward, the roundtable aspires to develop 10 projects from the list of recommended solutions by 2030. Additionally, the roundtable included a more comprehensive inventory of environmental and recreational projects as a method in the list of recommended solutions, and hopes to see completion of this "Identification and Inventory" by 2020.[487]

North Platte River Basin

The North Platte Basin also had two primary goals related to environmental and recreational uses and needs.[488] The public outreach and education process the roundtable had been doing up to that point informed the BIP process. The public outreach and education process engaged stakeholders within the basin and also included more technically oriented outreach to identify specific projects and methods. Similar to the Gunnison BIP, the North Platte Basin Roundtable identified one goal associated with the maintenance of healthy rivers and wetlands, and one goal geared toward the nexus with agricultural water use. For both of these goals, the BIP's measurable outcomes are based on project implementation, with an inventory of potential projects and methods that serve as "recommended solutions."[489]

NORTH PLATTE BASIN AT A GLANCE

55 projects identified that meet environmental or recreational needs

6,226 acre-feet of development for environmental or recreational needs identified by **3** projects

The projects and methods the BIP identified complement the roundtable's previous work, which prioritized environmental and recreational attributes within the basin. The roundtable applied the previous prioritization of attributes to the inventory of recommended solutions, and established a process for identifying locations where these needs are not being met, and for finding solutions. Measurably, the roundtable plans to develop three projects from the inventory of solutions by 2020.[490] Regarding the goal of supporting environmental and recreational benefits through agricultural projects, the roundtable plans to complete at least two multipurpose projects by 2025.[491]

In its inventory of recommended solutions, the roundtable identified 50 environmental and recreational projects.[492] Of these projects, 37 are classified as restoration of wetlands, riparian, or stream projects. These projects identify specific species for protection and habitat restoration, and many are also associated with water quality or watershed health. The North Platte Basin Roundtable particularly emphasizes wetlands protection and restoration, so it identified amphibians and waterfowl as direct beneficiaries of implementation projects. Ten of the basin projects are focused on habitat restoration through projects that will improve livestock-grazing management through fencing. The focus in this basin, as is evident by its goals and implementation-based outcomes, is on multipurpose projects and methods.

Through implementation of these projects and methods, the roundtable hopes to accomplish incremental increases in recreational activities within the basin. Specifically, the basin aspires to a 5 percent increase in waterfowl hunting and viewing days by 2020, as well as a 5 percent increase in fishing user-days in the same time period.[493] Moving forward, the basin will use its existing prioritization system to evaluate funding for projects and methods in this inventory of recommended solutions.

The Rio Grande River flows from high mountain peaks in southern Colorado.

Rio Grande River Basin

The Rio Grande Basin Roundtable, like others around the state, established a set of basin goals, and then examined potential projects and methods with these goals in mind. The roundtable compared its basin goals with basin needs, and developed a multipurpose focus, since all basin goals had a nexus with environmental and recreational needs.[494] The roundtable gathered and consolidated projects and methods through its public outreach process, and through the work of subcommittees the BIP Steering Committee led. To date, the roundtable has identified 29 projects and methods, which were preliminarily evaluated in accordance with basin goals. The "Project Fact Sheets" describe these in detail.[495]

The roundtable assessed the projects and methods the BIP identified as multipurpose projects. Of those, 28 identify some nexus with environmental and recreational needs.[496] Additionally, the basin compiled a list of additional projects and methods that may merit future consideration, but that the BIP did not consider in this iteration due to time constraints. This additional section identified 19 projects and methods that would meet an environmental or recreational need, often as part of a multipurpose project.[497]

RIO GRANDE BASIN AT A GLANCE

58 projects identified that meet environmental or recreational needs

$129,674,531 in costs identified for **24** projects

4 stream-miles of protection for environmental or recreational needs identified by **3** projects

In keeping with this roundtable's goals and measurable outcomes, many of the identified projects and methods focus on riparian restoration and watershed health. Projects that fall into these categories include those intended to improve fish habitat, restore headwaters, and result in comprehensive watershed planning. Identified storage projects are potential sites for wildlife habitat and recreational opportunities, such

as angling and boating. Other projects and methods fall into the category of water management, with plans to study hydrology within the basin, examine post-fire conditions, and potentially optimize streamflow.

Moving forward, the roundtable has estimated costs for 25 of the 29 projects the Project Fact Sheets examined. These 25 projects total an estimated financial need of more than $218 million through the year 2020.[498] As the roundtable moves forward with the basin planning effort, it will explore funding avenues, and may refine the list of identified projects and methods. The roundtable will do additional analysis of the supplementary list of projects and methods, and as it measures these potential recommendations against basin goals, may prioritize some of them. Similar to the Colorado Basin Roundtable, the Rio Grande Roundtable has identified the need to fill information gaps regarding environmental and recreational needs, and to find ways to better understand how water may be managed to maintain and protect these attributes. The BIP provides a list of projects and methods that would address these information gaps, and provides guidance to the roundtable as it moves forward on project funding and implementation.[499]

South Platte River Basin (Including Metro)

The joint BIP the South Platte Basin and Metro Roundtables prepared required a large amount of outreach throughout the basin, as these comprise the most populous areas in Colorado. The roundtables chose "Protect and enhance environmental and recreation attributes" as an area of focus when looking to future water needs in the basin. In addition, the roundtable identified a series of measurable outcomes to meet the basin's environmental and recreational goal: "Fully recognize the importance of, and support the development of environmental and recreational projects and multipurpose projects that support water availability for ecologically and economically important habitats and focus areas."[500]

SOUTH PLATTE/METRO BASIN AT A GLANCE

75 projects identified that meet environmental or recreational needs

The South Platte/Metro BIP highlights examples of projects throughout the basin that are consistent with the above environmental and recreational goal. It lists these examples by basin sub-region, and provides mapping and analysis that demonstrates key attributes in those areas. The South Platte/Metro team, similar to other basins, chose to create an inventory of projects and methods to serve as a suite of options for fulfilling these nonconsumptive measurable outcomes. A great deal of the projects listed for environmental and recreational projects came from the SWSI 2010 nonconsumptive needs assessment, and many of those projects have been completed. Beyond these identified projects, the roundtables also created an inventory of "Additional Identified Environmental and Recreational Projects."[501] The roundtables identified these projects through the public outreach process or through proponent submission, or identified them as active, in-progress projects the roundtables chose to identify as steps toward meeting the nonconsumptive measurable outcomes.

Beyond the inventory of SWSI and additional environmental and recreational projects, the roundtables identified specific examples of projects they believe meet their measurable outcomes, and would be good models to follow in the future. The roundtables specifically highlighted existing multipurpose projects throughout the basin that were in line with goals and measurable outcomes. These goals focus on endangered and threatened species, the economic value of environmental and recreational uses, and the sustainability of water-dependent areas. Following these goals, the roundtables categorized many projects that were identified beyond the SWSI needs assessment as wetlands restoration, riparian restoration, and stream habitat projects. Measurably, the roundtables identified the recovery of key species of trout and native plains fish as important. Serving as a snapshot of the current state of affairs in the basin, this list identified projects that are proposed, planned, completed, and ongoing.

The BIP also included an analysis of the benefits to environmental and recreational needs that multipurpose projects can provide. Examples include the potential for installation of environmentally friendly passages after flood events, coordinated reservoir operations, and recharge projects.[502] Moving forward, the roundtables will continue to identify projects and methods that match up with their identified measurable outcomes, and seek to identify projects that may meet multiple needs.

Southwest Basin

The Southwest Basin Roundtable completed an extensive public outreach process to provide a comprehensive update to the SWSI 2010 IPP list. Through a series of public meetings, newspaper articles, and conversations with water management entities within the basin, the roundtable created a complete inventory of new IPPs within the basin. Additionally, the roundtable identified "Conceptual IPPs," which have no active sponsor, but are ideas for projects and methods within the basin that may conform to basin goals and measurable outcomes.[503] The Southwest Basin Roundtable, similar to the Rio Grande, evaluates any project or method for potential multiple uses and benefits. Approximately 50 percent of the IPPs are primarily meeting potential environmental and recreational needs.[504]

SOUTHWEST BASIN AT A GLANCE

72 projects identified that meet environmental or recreational needs

$30,000 in costs identified for **1** project

202 stream-miles of protection for environmental or recreational needs identified by **9** projects

The goals the roundtable identified specifically recognized the benefit environmental and recreational values provide to statewide and local economies. The roundtable's measurable outcomes include the maintenance, protection, and enhancement of these uses, as well as species recovery and watershed health. The inventory of projects and methods listed 67 environmental and recreational projects.[505] The inventory identified projects that pertain to invasive species removal, native revegetation, hydroelectric projects, natural disaster mitigation, habitat protection and restoration for trout and warm-water fish, appropriation of instream flows, habitat assessments, and fish passage projects.

Within the text of the BIP, the roundtable identified representative environmental and recreational IPPs. These example projects provided a look at the type of implementation of environmental project and method implementation that is planned or ongoing within the multiple sub-basins of the southwest. In line with the basin's measurable outcomes relating to the "condition and natural function of streams, lakes, wetlands, and riparian areas," the basin plans riparian restoration projects for key reaches of the La Plata, Dolores, Navajo, and San Juan Rivers.[506] On the Florida River, the basin identified livestock fencing as a means to protect a riparian buffer zone.

Moving forward, the basin will continue to consider all proposed IPPs equally, and will evaluate each one for potential multiple uses and benefits. In the BIP text, the roundtable considered opportunities for funding availability. It also explored the concept of "bundling" a package of proposals, and ways in which such an approach may help make the most of limited funding.[507] The Southwest Basin Roundtable, similar to the Rio Grande and Colorado, identified the data gaps in environmental and recreational water needs as a priority moving forward. The roundtable discussed identification and evaluation of gaps in this body of knowledge, and believes that by addressing these gaps, it can accomplish more reliable planning for the water supply future of the basin, and can make project implementation more efficient.

Yampa/White/Green River Basin

The Yampa/White/Green Basin Roundtable drew from two different sources to compile an inventory of projects and methods within the basin. First, the roundtable conducted an extensive outreach process, including holding several public meetings, publishing information in local publications, and issuing surveys. Also, the roundtable had previously begun the Projects and Methods Study, which identified projects and methods within the basin, as well as compared certain IPPs against potential future hydrological scenarios.[508]

YAMPA/WHITE/GREEN BASIN AT A GLANCE

22 projects identified that meet environmental or recreational needs

$5,050,000 in costs identified for **4** projects

371 stream-miles of protection for environmental or recreational needs identified by **16** projects

The roundtable identified two main inventories of projects with an environmental and recreational nexus. Many of the projects and methods listed in the inventory of "Current M&I, SSI, Agriculture, and Multipurpose IPPs" have an identified or potential benefit for environmental and recreational needs, some of which were modeled.[509] Additionally, some of the identified projects are the subject of ongoing feasibility studies that could potentially identify environmental and recreational benefits that project implementation can help realize. Drawing from interviews and information basin stakeholders provided, the roundtable identified a collection of projects with primarily environmental and recreational benefits. Most of these projects and methods are located within focus areas the roundtable identified. This collection identifies 18 projects and methods. Several of these projects have a completion date before 2020, while others are classified as ongoing through 2020.[510]

The list of Environmental and Recreational Identified Projects and Processes focuses heavily on the improvement of existing river conditions to restore and improve environmental and recreational attributes. Several projects identified the modification of specific reaches for the benefit of endangered fish or for recreational access. Other projects seek to restore and preserve the natural state of the river for watershed health and erosion control. Other proposed methods would study potential solutions to identified challenges, such as flow regimes for endangered fish, or potential augmentation of instream flow shortages. However, the roundtable emphasized that the current inventory is not exhaustive, and that other projects and methods will be necessary to fully address the environmental and recreational needs located within focus segments or otherwise. As planning efforts continue within the basin, the roundtable will identify additional projects and methods to meet these needs.

Like other basin roundtables, the Yampa/White/Green BIP stressed the need for accurate information and analysis of data gaps for environmental and recreational needs. To that end, and to fully assess the

TABLE 6.6-1 COMPLETED, ONGOING, AND POTENTIAL FUTURE ACTIONS

COMPLETED AND ONGOING ACTIONS	POTENTIAL FUTURE ACTION
• Implement ESA recovery programs • Implement basin nonconsumptive projects • Develop draft Nonconsumptive Toolbox • Put Wild and Scenic alternatives in place • Implement the CWCB Instream Flow Program • Implement Colorado Watershed Restoration Program • Implement Species Conservation Trust Fund • Implement CPW Management Plans	1. Develop statewide goals and measurable outcomes to be considered for incorporation into BIPs a. Develop goals and measurable outcomes for federally listed endangered and threatened species b. Develop goals and measurable outcomes for imperiled species c. Develop goals and measurable outcomes for economically important nonconsumptive uses d. Develop goals and measurable outcomes for multipurpose projects and methods 2. Pursue projects and methods to meet nonconsumptive needs as part of the BIPs a. Develop basin-wide goals b. Develop measurable outcomes c. Identify needs and opportunities d. Use the decision process to determine projects and methods 3. Track nonconsumptive projects and methods a. Conduct nonconsumptive surveys and analysis b. Create web portal c. Use existing database d. Use the Basin Needs Decision Support System 4. Develop incentives, including funding for projects and methods in the nonconsumptive focus areas a. Assess funding needs b. Target existing funding sources and programs to provide enhanced levels of support for implementation of nonconsumptive needs c. Explore additional incentives, including funding options 5. Develop environmental metrics that can help evaluate future projects (to be considered in the new supply discussions) Manage and improve storage, infrastructure, and reservoir operations to benefit environmental and recreational values [Section 6.5]

effects of projects and methods, the roundtable plans to use studies and modeling efforts that are already completed or underway. The roundtable will use these analyses to determine which type of project or location would be the most beneficial regarding stream conditions and hydrologic impact.

IBCC Actions

In 2013, the IBCC developed the No-and-Low-Regrets Action Plan to implement environmental and recreational projects and methods. This strategy outlines what should be carried out in the near term statewide. The IBCC reached consensus on the need to implement the actions, regardless of the future scenario. Table 6.6-1 summarizes these actions.

ACTIONS

A strong Colorado environment is critical to the state's economy and way of life. Colorado's Water Plan sets a measurable objective to cover 80 percent of the locally prioritized lists of rivers with stream management plans, and 80 percent of critical watersheds with watershed protection plans, all by 2030.

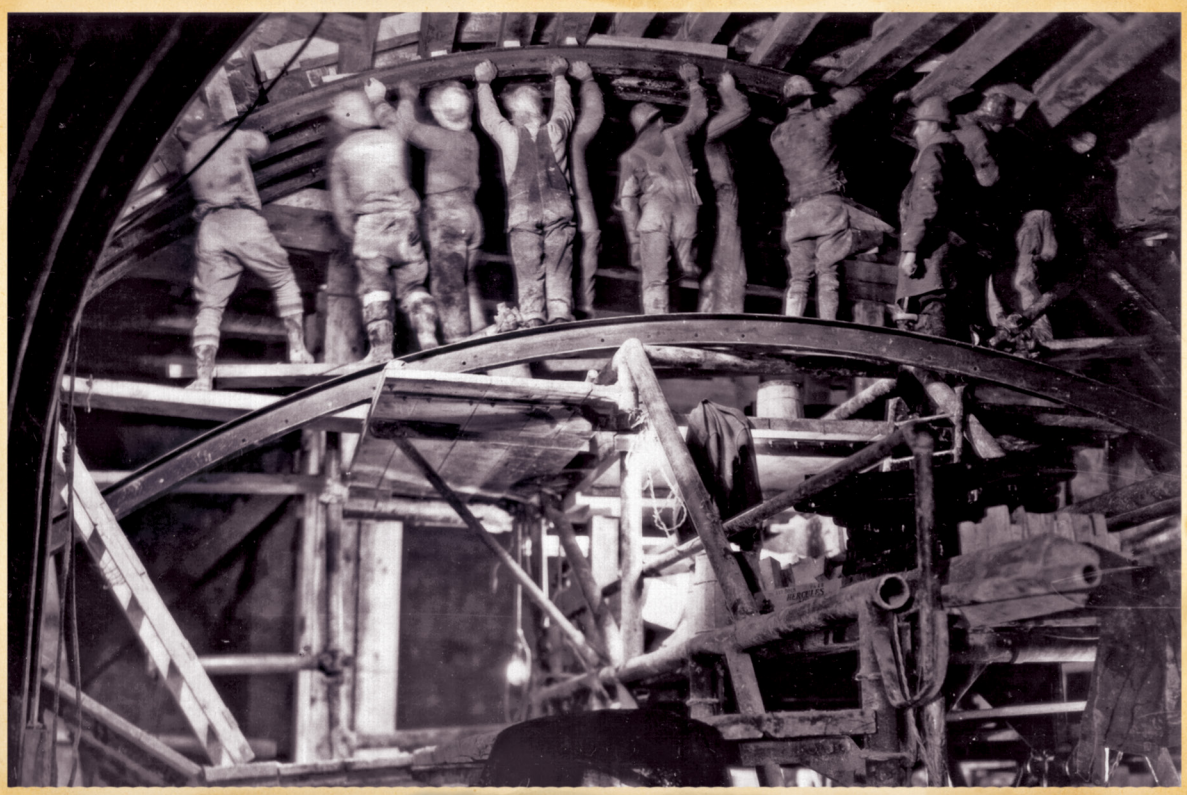
To support a strong environment that includes healthy watersheds, rivers and streams, and wildlife, as well as a robust recreation and tourism industry, several actions are necessary:

1. **Technical work:** As part of the next version of SWSI, the CWCB, in consultation with the basin roundtables, will conduct additional technical work associated with the environmental and recreational focus areas to better determine the levels of existing protections, and where additional projects and methods should focus.
2. **Near-term projects and methods to address high-priority needs:** The CWCB will work with CPW, the basin roundtables, and other relevant agencies to establish and achieve measurable outcomes for (a) federally and state-listed endangered and threatened species, and imperiled species; and (b) economically important water-based recreational uses. It will accomplish this by developing a plan within the next three years that compiles and develops near-term projects and methods that address these high-priority needs, including projects the BIPs identified. This work will build on the work of the basin roundtables and the SWSI, including the work done in Action 1 above. At the same time, the CWCB will continue to provide technical and financial assistance to support the strategic implementation of currently identified projects.
3. **Common metrics:** In coordination with other state agencies, basin roundtables, and other stakeholders, the CWCB will develop common metrics for assessing the health and resiliency of watersheds, rivers, and streams.
4. **Watershed master plans:** As Section 7.1 indicates, the CWCB will work with watershed and other stakeholder groups toward a long-term goal of developing watershed master plans for every large watershed area to maintain watershed health. The CWCB will encourage and support capacity in areas that currently do not have watershed groups or other broad, local stakeholder groups.
5. **Stream management plans:** To promote healthy watersheds, rivers, streams, and wildlife, the CWCB encourages and will work with basin roundtables and other stakeholder groups to develop stream management plans for priority streams identified in a BIP, or otherwise identified as having environmental or recreational value. As part of this work, the CWCB will provide guidelines and templates for developing stream management plans, and will conduct ongoing analyses through the SWSI. To ensure continued planning and implementation in this context, the CWCB will explore additional funding sources, in addition to funding sources the 2015 CWCB Projects Bill provides.
6. **Incorporation of drought and climate change:** The basin roundtables and the CWCB will incorporate into the BIPs and the next update of the SWSI the potential effects of drought and climate change on environmental and recreational attributes.
7. **Multipurpose projects:** To support the development of multipurpose projects and methods, the CWCB will work with the basin roundtables and other stakeholders on an integrated approach to understanding how environmental and recreational projects and methods can interact with municipal,

agricultural, and industrial projects and methods to achieve multiple benefits. The CWCB will strategically support the implementation of BIP-identified multipurpose, projects, and methods that help meet environmental, recreational, agricultural and community water needs. It will accomplish this with state financial and technical resources, taking into consideration locally identified geographic and/or seasonal gaps. This will include establishing priorities in Colorado's grant and loan programs for multipurpose projects and methods. Working with the basin roundtables and BIPs, the CWCB will also coordinate with project sponsors to explore and support opportunities to increase benefits to environmental and recreational values associated with existing and planned storage and infrastructure.

8. **Proactive implementation of existing programs:** The CWCB, other state agencies, basin roundtables, and other interested stakeholders will continue to support and implement state programs that benefit environmental and recreational attributes, such as the Colorado Watershed Restoration Program, Instream Flow and Natural Lake Level Program, Wild and Scenic Rivers Act Alternatives Fund, and CPW's Wetlands for Wildlife Program. The DNR and its agencies will institute policies, criteria, and programmatic approaches to proactively developing projects and methods that strategically address important aquatic, riparian, and wetland habitats.
9. **Continued support of ESA activities:** The CWCB, CPW, and water users will continue to support and participate in collaborative approaches to ESA issues, including recovery programs, cooperative agreements, and other efforts to prevent listings and promote the sustainability of endangered, threatened, and imperiled aquatic- and riparian-dependent species and plant communities.
10. **Broadened support of recreational uses:** The CWCB will support local governments with water recreation opportunities through continued technical consultation and funding, where appropriate. To assist with water project planning, the CWCB will support the development of tools that can be used to better understand the relationship between stream flows and recreational water uses. Additionally, the DNR will explore opportunities to protect instream flows for recreational uses without the requirement of a control structure.
11. **Funding:** As Section 9.2 discusses, the CWCB will work with appropriate entities to strengthen funding opportunities for environmental and recreational projects, including funding for long-term monitoring and maintenance of such projects, by:
    a. Coordinating current funding
    b. Assessing funding needs
    c. Exploring additional funding opportunities

Sunrise reflection of Hallet Peak on Dream Lake, Rocky Mountain National Park.



A LOOK AT HISTORY

Construction of the Alva B. Adams Tunnel, a feature of the C-BT Project, began in 1940. The tunnel drops 109 feet in elevation over its 13.1 mile length and is 3,800 feet below the Continental Divide at its deepest point. The tunnel transfers water from the Colorado River drainage to Colorado's Front Range. Construction was suspended in 1943 for nearly a year due to WWII, but was completed on March 31, 1944. When the tunnel was holed through, NBC Radio broadcast the event live throughout the United States.

SOURCE: Bureau of Reclamation.

CAPTION: Thomas V. Cech, J William McDonald, Defened and Develop:
A Brief History of the Colorado Water Conservation Board's First 75 Years,
[Denver: Wellstone Press and the Colorado Water Conservation Board, 2012.]

A LOOK AT HISTORY

Increasing demand for municipal water supplies along the Front Range, symbolized here by the growth of subdivisions on former farmlands, was one of the issues which prompted the creation of the IBCC process.

Courtesy of the Northern Colorado Water Conservancy District.

CAPTION: Thomas V. Cech, J William McDonald, Defened and Develop: *A Brief History of the Colorado Water Conservation Board's First 75 Years,* [Denver: Wellstone Press and the Colorado Water Conservation Board, 2012.]

A LOOK AT HISTORY

Boy irrigating alfalfa, date unknown.

Courtesy of City of Greeley Museums, Permanent Collection. source: Bureau of Reclamation.

MARK MARLOWE, CONTINUED FROM PAGE 6-68

operations and lead a team of 79 employees in their mission of providing excellent service to over 55,000 residents. I also serve on a number of regional water boards including the South Metro Water Supply Authority and the WISE Authority. Prior to becoming the Utilities Director for the Town in March of 2013, I spent 10 years with Dalton (GA) Utilities most recently as the Senior Vice President of Watershed Services. In this position, I was responsible for running the water, wastewater, and stormwater business unit, an award winning full service utility that provided water service to approximately 100,000 people in Northwest Georgia. My career also includes experience working for General Electric as a project manager as well as several regional consulting/engineering firms in the Southeast over approximately a 10 year period before joining Dalton Utilities.

I earned a Bachelor of Arts (Russian Studies and Mathematics) from the University of North Carolina at Chapel Hill and a Bachelor of Science in Civil Engineering from the Georgia Institute of Technology. I also hold a Master of Environmental Engineering from the Georgia Institute of Technology and am a licensed professional Engineer in Colorado and Georgia. I have been a Rotarian since 2005 and served as the President of the Rotary Club of Dalton during the 2011 to 2012 Rotary year.
I am currently a member of the Rotary Club of Castle Rock. I live in Castle Rock with my wife and two children, Brett and Cecilia. I am an avid soccer fan, and coach my daughters in my spare time. My family supported my desire to come to Castle Rock to join Castle Rock Water because water is recognized by the community as the most important thing for the long term success of the community. I loved the idea of being a part of a community where the importance of water was recognized.

I spent the early part of my career searching for meaning in my life. First, I started searching in the environmental industry, but when I took a position with a water utility and became part of the mission of providing clean water and sanitation, I found my calling. In addition to loving water for all kinds of reasons (you need water for coffee and even more importantly hot showers a.k.a. heaven on earth), I quickly realized that it is the people in this "water" industry that make it so fulfilling. The people are servants of society in the truest sense of the word. Generally, they do what they do out of the sheer caring and loving of the communities they serve, not for money or recognition or any other reason.
I cherish working with these people.

I am most proud of being selected and given the opportunity to work with the Castle Rock water team to secure the communities long term renewable water future. Castle Rock has a top notch team and has been a statewide leader in water conservation and long term water planning for many years. To get the opportunity to come from a utility in Georgia, and help lead this amazing team's efforts in Colorado, where water is king, is nothing short of a great honor.

My hope for water supply for the future is that we reach a point on earth where all human beings get to enjoy a hot shower, a clean bathroom, a cool glass of crystal clear tap water, and clean/safe natural water bodies for their beauty and recreational value. Of course, my other hope and quite honestly mission in life is to teach the world about the value of tap water, the best deal on the planet, a value thousands of times better than bottled water or anything else you can buy anywhere with money. I love spending my time working towards that future for my local community and when I get the opportunity, for others across the globe. I will work towards this future till I drop dead or am otherwise required by circumstances to retire from this mission.

HAROLD GRIFFITH, CONTINUED FROM PAGE 6-118

Born and raised in Fort Morgan, graduating from Fort Morgan High School in 1958, me and my late wife, Karenjo, owned Griffith Dairy in Morgan County where I milked Grade A cows for more than 50 years. We have nine children, 3 boys and 6 girls, as well as 22 grandchildren.

Passionate about water concerns in eastern Colorado, I spent much of my time as a farmer negotiating water agreements for Morgan County and beyond. I became a member of the Board of Directors for Fort Morgan Irrigation and Reservoir Company in 1977, became president in 1979 and helped with the establishment of the water court filing standards. also helped create a cadillac water plan for Morgan County residents. During my tenure with the commonly known Morgan Ditch Company, I was able to negotiate agreements with the City of Fort Morgan for parks and golf course water use and city of Brush for their municipal wells. One of my biggest accomplishments was the agreement with Public Service Company of Colorado, which created a 40 year lease for the water and sprinkler market.

Why did I do this? I am passionate about negotiating solutions so that farmers can continue to farm and do not run out of water. I am proud of the work I've done for the ditch system. These agreements have boosted the local economy for the Fort Morgan and Brush communities.

I am perhaps most proud of being part of and helping to create the Morgan County Dairy Calf Catch-it program. When participation dwindled to just a few students, I joined with other dairy farmers, and together created the Dairy Calf Catch-it program. A two-year program, students are given a dairy heifer to raise and care for before showing at the County Fair. The average price for the champion Dairy Heifer in the last two years has been $5,000. And in 2015, the Catch-It program had 12 participants. Although it is sponsored by local dairy farmers, veterinarians, and citizens, I believe it is about the students, not the sponsors.

In my youth, I was president of a Future Farmers of America chapter and head of the parliamentary procedure team (a skill I still use today). And I still use my Ag Work Manual on a regular basis – refer to it all the time.

ROBERT T. SAKATA, CONTINUED FROM PAGE 6-144

the risk associated with new inventive approaches and change.

I am a Colorado native, born and raised in Brighton Colorado on a family farm started by my fathe Bob Sakata. Currently, my parents, Joanna and Bob, and I are one of the largest fresh market sweet corn growers in Colorado. We also grow broccoli, cabbage, dry bulb onions, pinto beans, field corn, wheat, and barley. My father taught me the importance of investing in good land with good water and to care for those resources like family. With that upbringing, my interest has always been in science, and I worked for AmGen before going back to the farm. I served on the Colorado Water Quality Control Commission for 15 years, was a member of the Metro Basin Roundtable since its inception, and serve on the board of directors for several of the mutual ditch companies that my family farm receives irrigation water from.

Brighton, CO is where I was born and raised and now find myself growing old! Being just north of the Denver metropolitan area I have seen lots of changes but I couldn't ask for a better place to live. Once strictly a farming community, we still have a Cabbage Avenue na, which has grown to include many different industries. We maintain that small community feel…but it's great that we are only minutes away from all of the big city activities that the Denver metropolitan area has to offer.

It was such an honor to serve the citizens of Colorado on the Colorado Water Quality Control Commission for 15 years. In the semi-arid climate that we live in I think most people are keenly aware of water quantity issues but often as a headwaters state we take for granted water quality. In the past there has been a distinct division between water quantity and quality but as the resource becomes more limited the linkage between the two will mandate cooperative management discussions in order to meet both needs.

The Colorado Water Plan along with the Statewide Water Supply Initiative have highlighted the demands that will be placed on our water resources and my hope is simply that we don't end having water wars… like the song says, can't we just all get along? There will have to be a lot of creative minds that develop some unique partnerships to share this limited resource. To grow hig quality, nutritious fresh vegetables we need good soil, a good climate and a reliable supply of high quality irrigation water - it's as simple as that - no water-no food.

To be a farmer requires a person to have a lot of faith and belief that what you are doing is going to all work out. When you prepare the soil in the spring, plant the seed, irrigate and nurture it through the summer you are hoping that after months of dedication, you will finally be able to harvest your crop. No different than that, Coloradoans need to step up and know that planning for tomorrow is more important than what we may desire for today. I truly believe that locally grown fresh nutritious vegetables are an important piece of the overall well being of our society. When I went off to college the last thing I wanted to be was a farmer because watching how hard my parents worked when I grew up I knew that there had to be an easier way to earn a living. My goal was to get into molecular cellular research and to find the cure for cancer…little did I realize then that as a vegetable farmer I was already providing the cure…and now as a farmer I feel I am doing more than I ever could in oncology research. I am committed to ensure that I can continue to play an important role in being a part of creating my hope for the future… as a farmer.

JACKIE BROWN, CONTINUED FROM PAGE 6-158

done wisely in a manner that allowed slower growing basins to develop in their own time. I hope to see SB1177 continue, which supports collaboration.

I grew up in Steamboat Springs, Colorado. I am a self-proclaimed lifelong learner who has studied at Boston University, the University of Colorado and Colorado State University. I have a diverse career background spanning project and business management, natural resources, and of course, water in the west. I am currently the Natural Resource Policy Advisor to Tri-State Generation and Transmission. I live in the mountains with a fantastic husband, a four-year old son, and a stubborn black lab puppy who all remind me constantly of the important things in life – not cleanliness.

I became addicted to water at a young age – constantly drenched in fluid or frozen water. My interest in policy came about in 1999 on a trip through the Grand Canyon. As a water rat once said, "there is nothing – absolutely nothing – half so much worth doing as simply messing about in boats" (*Wind in the Willows* by Kenneth Grahame). Living in Steamboat Springs in 2008, I began attending Basin Roundtable Meetings and the rest is history.
It gives me great pleasure to work with people and the resource that sustains us.

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