The Arkansas River originates in the central mountains of Colorado near Leadville, then travels eastward through the southeastern part of Colorado toward the Kansas border. The Arkansas Basin is spatially the largest river basin in Colorado, covering slightly less than one-third of the state's land area. A large amount of land is devoted to agriculture, with one-third of agricultural lands requiring irrigation. Increasing urbanization is occurring throughout portions of the Arkansas Basin, and in the recent past, persistent drought has heavily affected the basin.

The Arkansas River Compact of 1948 apportions the waters of the Arkansas River between Colorado and Kansas, while providing for the operation of John Martin Reservoir. Since the early 20th century, Colorado and Kansas have litigated claims concerning Arkansas River water, which has led to the development of rules and regulations to administer the basin's water resources for compliance with the compact.

ARKANSAS


LIMON
KIT CARSON
Big Sandy Creek
Rush Creek
Adobe Creek Reservoir
District 17
Arkansas - Fowler to Las Animas
District 67
Arkansas - Las Animas to Stateline
ROCKY FORD
LA JUNTA
LAMAR
Apishapa River
Timpas Creek
Purgatoire River
District 19
Purgatoire River
District 66
Cimarron River

4.3 ARKANSAS BASIN RESULTS

4.3.1 BASIN CHALLENGES

The Arkansas Basin will face several key opportunities and challenges pertaining to water management issues and needs in the future. These were described in Colorado's Water Plan and are summarized below.

Table 4.3.1 Key Future Water Management Issues in the Arkansas Basin

<table>
<tr><th>Agriculture</th><th>Environment and Recreation</th><th>Municipal and Industrial</th><th>Compacts and Administration</th></tr>
<tr>
<td>• Concerns over permanent agricultural transfers and the effects on rural economies are substantial in the lower portion of the basin downstream of Pueblo Reservoir.</td>
<td>• As the most rafted river in the world, the Arkansas River Voluntary Flow Agreement provides a benchmark for cooperative integration of municipal, agricultural, and recreational solutions in support of recreational boating and a gold-medal fishery.</td>
<td>• Replacement of municipal water supplies that depend on the non-renewing Denver Basin aquifer and declining water levels in designated basins is becoming critical, exacerbated by continued growth in groundwater-dependent urban areas.
• Rural areas within the Arkansas Basin have identified water needs but face challenges in marshalling resources to identify and implement solutions.</td>
<td rowspan="2">• All new uses require augmentation. Increasing irrigation efficiency, i.e., conversion from flood to center-pivot irrigation for labor and cost savings, will require 30,000 to 50,000 AF of augmentation water in the coming years.
• Regional solutions are emerging, like the Southeastern Colorado Water Conservancy District (SECWCD) Regional Water Conservation Plan, which can serve as a model for future regional initiatives to address the needs of the Arkansas Basin.</td>
</tr>
<tr>
<td colspan="3">• Collaborative solutions, as demonstrated in the Super Ditch and alternative transfer methods pilot projects, are needed to forestall or minimize loss of irrigated acreage in agriculture.
• Concerns over water quality include drinking water in the Lower Valley and the impact of fires and floods in the Fountain Creek watershed.
• The great majority of surface storage reservoirs in the Arkansas Basin were constructed between 1890 and 1930. Many of these facilities are in need of repair or restoration.</td>
</tr>
</table>

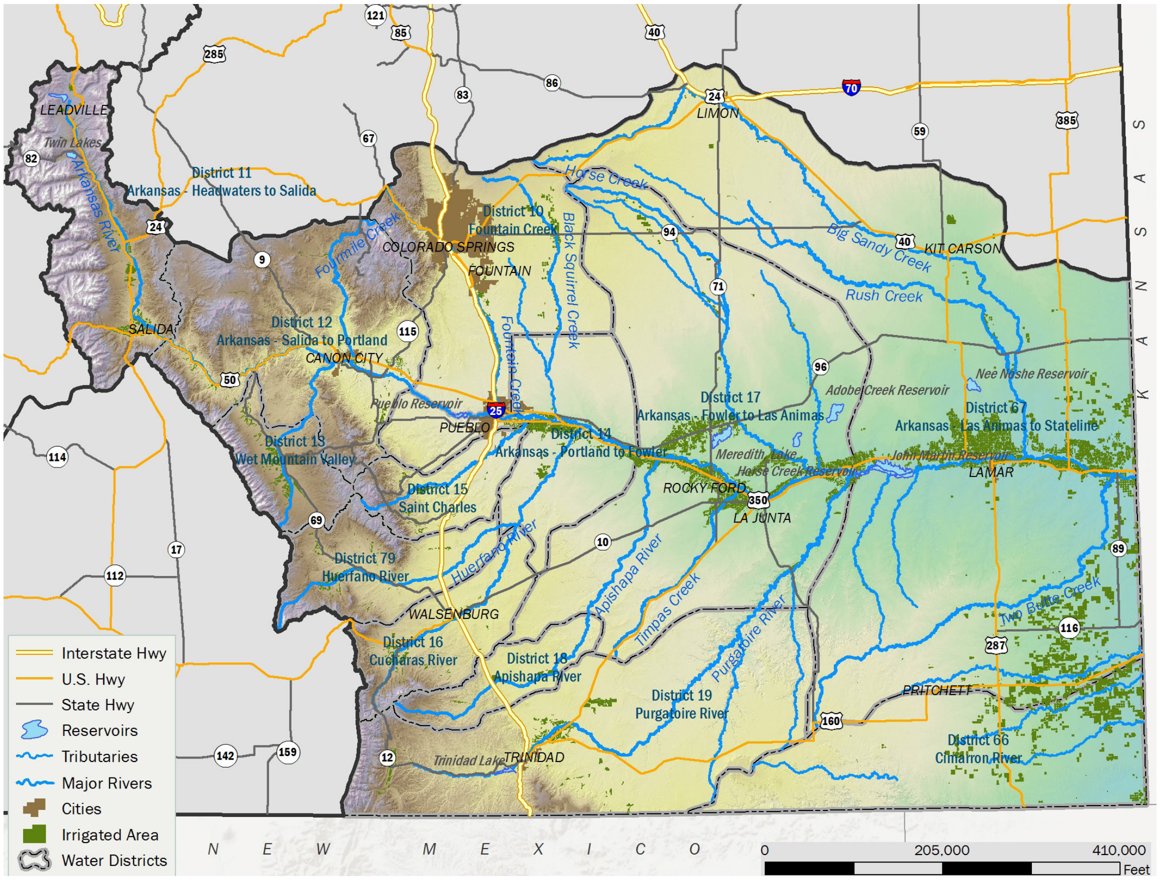


Figure 4.3.1 Map of Arkansas Basin

4.3.2 Summary of Technical Update Results

Key results and findings of the Technical Update pertaining to agricultural and M&I demands and gaps as well as findings related to environment and recreation attributes and future conditions are summarized in Table 4.3.2 below.

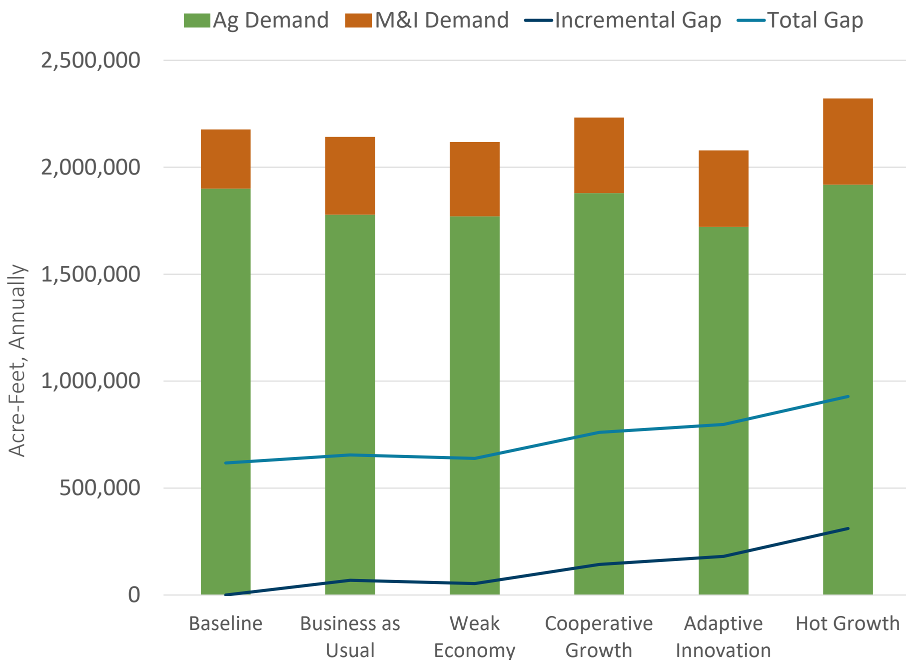
Table 4.3.2 Summary of Key Results in the Arkansas Basin

Agriculture	Environment and Recreation	Municipal and Industrial
• Agricultural demand will remain steady or be slightly reduced due to urbanization (20,000 acres), additional reduction of acres in the Southern High Plains Groundwater Basin, and increased sprinkler use (note that return flow reductions from increased sprinkler use would need to be mitigated). • Agricultural diversion demand gaps may increase due to a warmer climate as much as 10 percent.	• At high elevations, flow magnitude is not projected to significantly change under climate-impacted scenarios, but the annual hydrograph may shift with earlier snowmelt. Risks to riparian and fish habitat would remain low to moderate. • At montane elevations (between 5,500 and 8,500 feet), flow magnitude in climate-impacted scenarios is projected to drop significantly, creating high risk for riparian and fish habitat during the runoff season.	• M&I demand in this basin will grow to become a higher percentage of overall demand (from 13 to 17 percent). At the same time, municipal per capita use is projected to decline by various amounts depending on the scenario. • Municipal demand is driven by population growth in the Colorado Springs and Pueblo area, as well as modest increases in large industry and thermoelectric demand. • Gaps may be exacerbated by reductions in West Slope supplies.

Table 4.3.3 Summary of Diversion Demand and Gap Results in the Arkansas Basin

	Current (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Average Annual Demand						
Agricultural (AFY)	1,899,900	1,778,300	1,770,200	1,878,900	1,721,200	1,918,000
M&I (AFY)	276,700	363,300	347,900	353,200	357,600	403,500
Gaps						
Ag (avg %)	32%	33%	33%	37%	43%	43%
Ag (incremental- AFY)	-	-	-	84,400	117,500	202,200
Ag (incremental gap as % of current demand)	-	-	-	4%	6%	11%
M&I (max %)	0%	19%	15%	17%	18%	27%
M&I (max-AF)	0	68,500	53,100	58,500	62,900	108,700

Figure 4.3.2 Summary of Diversion Demand and Gap Results in the Arkansas Basin



Summary of Environmental and Recreational Findings

- A surface water allocation model was not available in the Arkansas Basin, so the available flow dataset only includes natural flows and natural flows as impacted by climate drivers; no management drivers are factored in. Management drivers impact river flows in the eastern plains. Because a water allocation model that incorporates management is not available, no data-based insights into flow change and risk to non-consumptive attributes in the eastern plains could be developed.
- At high elevation locations (e.g., near Leadville), peak flow magnitude is not projected to change substantially, but April and May streamflow may increase, and June flows may decrease under "In-Between" and "Hot and Dry" climate projections. Subsequent risk for riparian/wetland plants and fish habitat would remain low or moderate. Mid- to late-summer streamflow is projected to decrease by 30 to 40 percent, and risk for trout could change from low (current) to moderate (under all climate-driven scenarios).
- At montane locations (elevation approximately 5,500 ft to 8,500 ft), peak flow magnitude is projected to drop 40 to 60 percent under "In-Between" and "Hot and Dry" climate projections, putting riparian/wetland plants and fish habitat at high to very high risk. Mid- to late-summer flows are projected to drop 25 to 45 percent, keeping cold water fish risk low or moderate, although the risk may be higher in July and/or during dry years.

4.3.3 Notable Basin Considerations

Section 4.1 described several analysis assumptions and limitations that apply to all basins and should be considered when reviewing and interpreting analysis results. Additional considerations specific to the Arkansas Basin are listed below:

- Agricultural and M&I gaps in the Arkansas Basin could increase due to reductions in transbasin imports. The gap increase could be more than the reduction in transmountain imports because return flows from transmountain imports are used to extinction within the Arkansas Basin (by either the importing entity or by downstream agricultural and M&I water users).
- Water allocation models were not available in the Arkansas Basin; however, the StateCU portion of the ArkDSS was used to estimate agricultural diversion demands. The ArkDSS is being developed and will allow more robust modeling in the future.
- The analysis assumed that there is no unappropriated water available for new uses. As a result, increased demands in various scenarios contributed directly to the gap. Because of this, increases in demand in one sector will lead to decreases in supply in another sector.
- Agricultural diversion demands were calculated based on irrigated acreage and crop water needs. Because no unappropriated water is available in the basin, the gap evaluation focused on historical water shortages and additional future demands. In other words, given the lack of additional supply, the analysis focused on physical shortages and did not need to consider the presence of junior water rights and whether those rights were fulfilled. Additional future diversion demands contribute directly to the gap because no unappropriated supplies are available in the basin.
- Basin stakeholders have cautioned that large reductions in irrigated land could result in socio-economic impacts that cause a reduction of municipal population in rural areas.
- The analysis does not consider specific alternative crops that may be grown in the future under the different scenarios; however, it accounts for future changes in crop types in a general sense in *Adaptive Innovation* and assumed that future crops would have 10 percent lower IWR.

4.3.4 Agricultural Diversion Demands

Agricultural Setting

Producers irrigate more than 472,000 acres in the Arkansas Basin, with nearly half of these acres located along the river between Pueblo Reservoir and the state line. The fertile soils in the river valley support a wide variety of crops, including pasture grass, alfalfa, corn, grains, wheat, fruits, vegetables, and melons. Many of the large irrigation systems in this area rely on surface water diversions from the mainstem Arkansas River, supplemented with groundwater and Fryingpan-Arkansas Project deliveries. Pasture grass is the primary crop grown outside of the Arkansas River Valley, with concentrated areas of irrigated acreage under the Trinidad Project on the Purgatoire River, along Fountain Creek downstream of Colorado Springs, and in the southeastern corner in the Southern High Plains Ground Water Management District.

The basin also provides water to three of the fastest growing municipalities in the state—Colorado Springs, Aurora, and Pueblo—and competition for water is high. An over-appropriated basin, coupled with the constraints of developing new water supplies under the Arkansas River Compact, have historically led municipalities to purchase and transfer irrigation water rights to municipal uses to meet their growing needs. Beginning in the 1970s, large transfers of irrigation water rights in the Colorado Canal (including Twin Lake shares) resulted in the dry up of 45,000 acres in Crowley County alone, which contributed to socioeconomic and environmental impacts in the Lower Arkansas River Valley. More recently, however, the basin has been proactive at looking for solutions to share water supplies and has been one of the front runners in developing alternative transfer methods such as lease/fallow pilot projects and interruptible supply agreements in which irrigation rights can be temporarily leased to municipalities for a limited number of years (e.g., three years out of every 10 years).

Planning Scenario Adjustments

Section 2 described ways in which inputs to agricultural diversion demand estimates were adjusted to reflect the future conditions described in the planning scenarios. Discussions with stakeholders in the Arkansas Basin regarding what agriculture in the basin may look like by 2050 focused on three major areas: additional dry up of acreage for municipal purposes, declining groundwater aquifer levels in the Southern High Plains region, and irrigation practices. As discussed in more detail below, dry up of acreage and declining aquifer levels impact the amount of projected 2050 irrigated acreage. In addition, irrigation practices affect projected 2050 efficiencies.

Population projections by 2050 in the basin reflect significant increases for Colorado Springs and Pueblo. With limited acreage in close proximity, smaller amounts of irrigated acreage are expected to be urbanized by their growth compared to urbanization that may occur around smaller agricultural towns such as Salida, Canon City, and Lamar. Portions of two irrigation ditches, Fort Lyon Canal and Bessemer Ditch, have been purchased by municipalities, and their water rights are in the process of being transferred for municipal uses. It is anticipated that portions of these ditches, totaling 12,600 irrigated acres, will be dried up by 2050. Although additional purchase of irrigation water rights is expected, the stakeholders in the basin are hopeful that leasing agreements or other solutions may limit the permanent dry up of irrigated acreage in the future.

From a groundwater sustainability perspective in the basin, more than 85,000 acres in the southeast corner of the basin are irrigated by groundwater pumped from a series of deep aquifers, including the Ogallala, Dakota/Cheyenne, and Dockum aquifers. This area is largely disconnected from the mainstem of the Arkansas River and is managed as the Southern High Plains Designated Groundwater Basin (SHPDGWB). After review of groundwater reports documenting downward trends in groundwater levels, discussions with stakeholders, and conversations with landowners in the area, the acreage in this area was reduced between 10 and 33 percent across the planning scenarios. This range reflects the uncertainty associated with estimating the future water availability in the basin and the potential for increased pumping as projected climate change increases crop demands in the area.

Table 4.3.4 summarizes the planning scenario adjustments described above and other adjustments that impact agricultural diversion demands in the various scenarios, including constraints on improved irrigation efficiencies in the lower basin.

Table 4.3.4 Planning Scenario Adjustments to for Agricultural Demands in the Arkansas Basin

Adjustment Factor*	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Change in Irrigated Land due to Urbanization & Municipal Transfers	19,840 Acre Reduction	19,840 Acre Reduction	19,840 Acre Reduction	19,840 Acre Reduction	19,840 Acre Reduction
GW Acreage Sustainability	10% Acre Reduction (SHPDGWB)	15% Acre Reduction (SHPDGWB)	20% Acre Reduction (SHPDGWB)	33% Acre Reduction (SHPDGWB)	33% Acre Reduction (SHPDGWB)
IWR Climate Factor	-	-	18%	26%	26%
Emerging Technologies	20% Increased Sprinkler Use (H-I Area)	20% Increased Sprinkler Use (H-I Area)	20% Increased Sprinkler Use (H-I Area) 100% use of Sprinklers (SHPDGWB)	20% Increased Sprinkler Use (H-I Area) 100% use of Sprinklers (SHPDGWB) 10% IWR Reduction	20% Increased Sprinkler Use (H-I Area) 100% use of Sprinklers (SHPDGWB)

** See Section 2.2.3 for descriptions of adjustment methodologies and assumptions*

Agricultural Diversion Demand Results

Table 4.3.5 and Figure 4.3.3 summarize the acreage, IWR, and the agricultural diversion demand for surface water supplies in the Arkansas Basin for current conditions and the five planning scenarios. The largest variation in the basin occurred in *Adaptive Innovation* due to a 10 percent reduction in IWR and a 10 percent increase to system efficiency, both of which reduce diversion demands. In this basin, several planning scenarios projected less agricultural demand than the current demand, mainly due to reduced irrigated acres and resulting decreased IWR. Only *Hot Growth* had a slightly increased demand over baseline.

SYSTEM EFFICIENCY

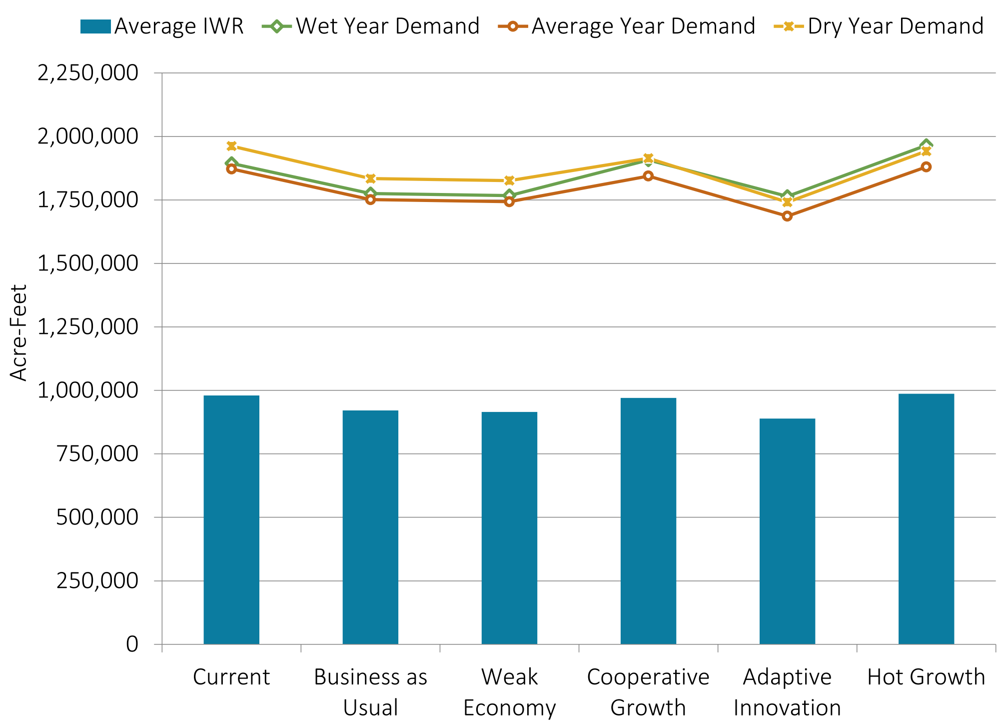
In some cases, diversion demands can be higher in wet years because system efficiency decreases due to the relative abundance of supply.

Table 4.3.5 Summary of Agricultural Diversion Demand Results in the Arkansas Basin

	Current (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Irrigated Acreage (acres)	445,000	417,700	413,600	409,500	398,900	398,900
Average IWR (AFY)	980,000	921,000	915,000	970,000	889,000	987,000
Diversion Demand						
Average Year (AFY)	1,872,000	1,751,000	1,743,000	1,844,000	1,686,000	1,880,000
Wet Yr. Change	1%	1%	1%	3%	5%	5%
Dry Yr Change	5%	5%	5%	4%	3%	3%

Average agricultural diversion demand was calculated using the average hydrologic years (i.e., years classified as neither wet or dry) from 1950-2013

Figure 4.3.3 Agricultural Diversion Demands and IWR Results in the Arkansas Basin



4.3.5 Municipal and Industrial Demands

Population Projections

The Arkansas Basin includes about 19 percent of the statewide population. Between the years 2015 and 2050, it is projected to grow from approximately 1.0 million to between 1.46 million and 1.63 million people in the low and high growth projections, respectively, which is an increase in population of 45 to 61 percent. Table 4.3.6 shows how population growth is projected to vary across the planning scenarios for the Arkansas Basin.

Table 4.3.6 Arkansas Basin 2015 and Projected Populations

2015 Population	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
1,008,400	1,509,500	1,462,800	1,544,400	1,626,000	1,568,000

Current Municipal Demands

In the Arkansas Basin, baseline water demands were largely based on 1051 data as shown on Figure 4.3.4.

Figure 4.3.4 Sources of Water Demand Data in the Arkansas Basin

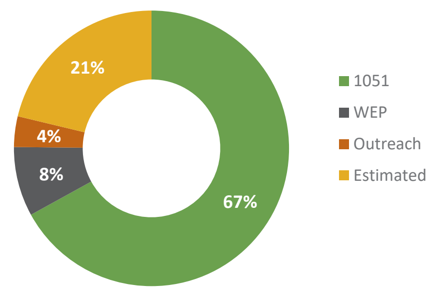
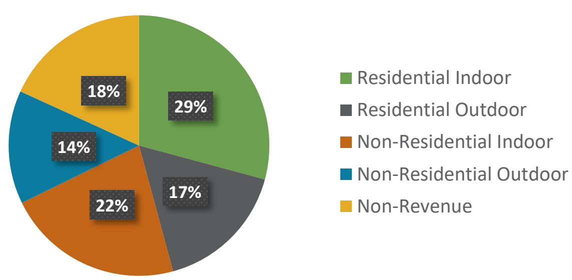


Figure 4.3.5 summarizes the categories of municipal, baseline water usage in the Arkansas Basin. On a basin scale, the residential outdoor demand as a percentage of the systemwide demands is one of the lowest reported throughout the state, at approximately 17 percent. Conversely, the baseline non-revenue water demand is one of the highest statewide, at approximately 18 percent of the systemwide demands.

Figure 4.3.5 Categories of Water Usage in the Arkansas Basin



DEMANDS

The Arkansas Basin average baseline per capita system wide demand has increased from 185 gpcd in SWSI 2010 to approximately 194 gpcd.

Projected Municipal Demands

Figure 4.3.6 provides a summary of per capita baseline and projected water demands for the Arkansas Basin. Systemwide, all of the projected per capita demands decrease relative to the baseline. Th *Hot Growth* is projected to be nearly as high as the baseline, with lower residential indoor but higher residential and non-residential outdoor demands that are significantly influenced by hotter and drier climate conditions.

The Arkansas Basin municipal baseline and projected diversion demands in Table 4.3.7 show the combined effect of population and per capita demands. Municipal demands are projected to grow from approximately 219,000 AFY in 2015 to between 294,000 and 337,000 AFY in 2050. El Paso County accounts for around half of the baseline demand, followed by Pueblo County at about one-third of basin demand.

Figure 4.3.6 Arkansas Basin Municipal Baseline and Projected Per Capita Demands by Water Demand Category

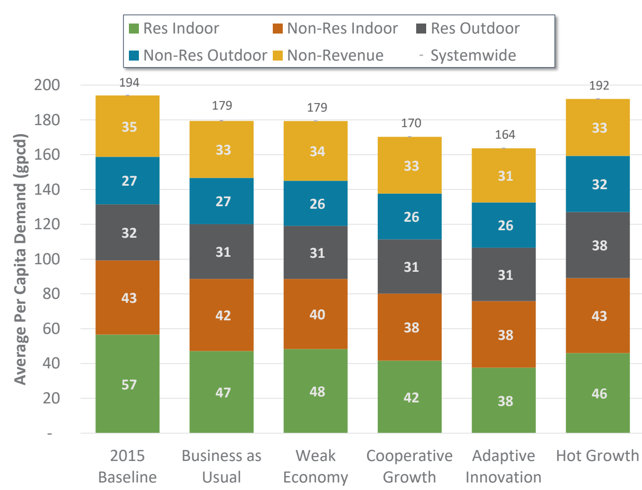
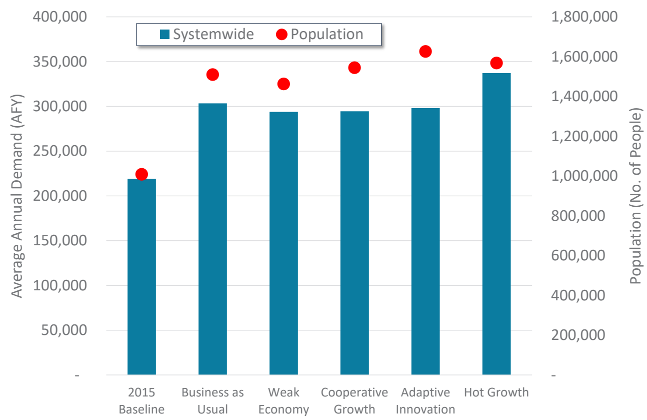


Table 4.3.7 Arkansas Basin Municipal Baseline and Projected Demands (AFY)

Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
219,200	303,400	293,800	294,500	298,100	337,200

The baseline and projected demand distributions are shown on Figure 4.3.7, which also shows how the population varies between the scenarios. All of the planning scenarios result in an increase relative to the baseline. Except *Hot Growth*, the systemwide demand projections are similar, which demonstrates how the pairing of drivers and population can offset each other and narrow the range of results. Higher levels of conservation associated with *Adaptive Innovation* help limit the impacts of the "Hot and Dry" climate projection and higher population.

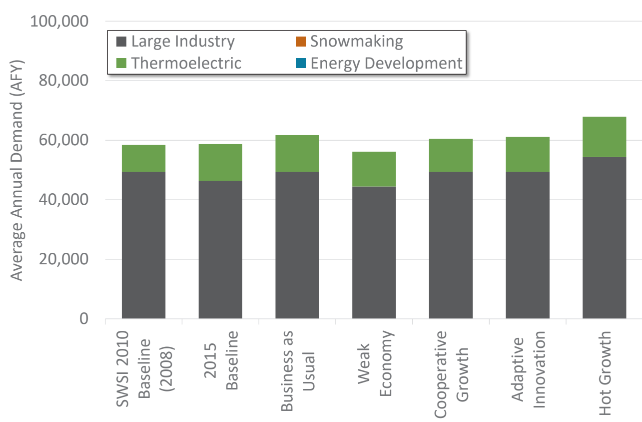
Figure 4.3.7 Arkansas Basin Baseline and Projected Population and Municipal Demands



Self-Supplied Industrial Demands

The Arkansas Basin includes about 33 percent of the statewide SSI demand. SSI demands in this basin are associated with the large industry and thermoelectric sub-sectors, with no demands projected for snowmaking or energy development sub-sectors. Basin-scale SSI demands are shown on Figure 4.3.8 and summarized in Table 4.3.8.

Figure 4.3.8 Arkansas Basin Self-Supplied Industrial Demands



Total M&I Diversion Demands

Arkansas Basin combined M&I demand projections for 2050 range from approximately 350,000 AFY in *Weak Economy* to 405,000 AFY in *Hot Growth*, as shown on Figure 4.3.9. SSI demands account for 16 to 17 percent of the projected M&I demands. On a basin scale, the demand projections do not follow the statewide sequence of the scenario rankings described in the CWP, with *Adaptive Innovation* falling out of sequence.

Figure 4.3.9 Arkansas Basin Municipal and Self-Supplied Industrial Demands

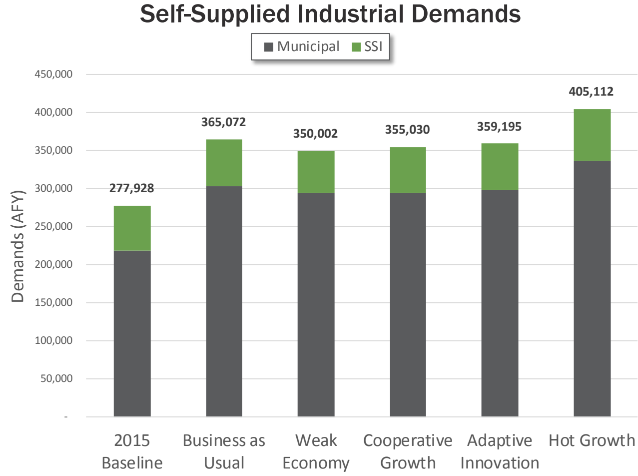


Table 4.3.8 Arkansas SSI Baseline and Projected Demands (AFY)

Sub-sector	Baseline (2015)	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Large Industry	46,400	49,400	44,460	49,400	49,400	54,340
Snowmaking	-	-	-	-	-	-
Thermoelectric	12,320	12,320	11,700	11,090	11,700	13,550
Energy Development	-	-	-	-	-	-
Sub-Basin Total	58,720	61,720	56,160	60,490	61,100	67,890

4.3.6 Water Supply Gaps

The agricultural and M&I diversion demands were compared against available water supply modeled for current conditions and the five planning scenarios. Gaps were calculated when water supply was insufficient to meet demands.

Agricultural

The Arkansas Basin agricultural diversion demands, demand gaps, and consumptive use gaps for the baseline and planning scenarios are presented in Table 4.3.9 and illustrated on Figure 4.3.10. An annual time series of gaps in terms of percent of demand that was unmet is shown on Figure 4.3.11.

> **INCREMENTAL GAP**
>
> The incremental agricultural gap quantifies the degree to which the gap could increase beyond what agriculture has historically experienced under water shortage conditions.

Table 4.3.9 Arkansas Basin Agricultural Gap Results (AFY)

		Scenario					
		Scenario	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Average	Average Annual Demand	1,899,900	1,778,300	1,770,200	1,878,900	1,721,200	1,918,000
	Average Annual Gap	617,300	586,400	585,200	701,700	734,800	819,500
	Average Annual Gap Increase from Baseline	-	-	-	84,400	117,500	202,200
	Average Annual Percent Gap	32%	33%	33%	37%	43%	43%
	Average Annual CU Gap	313,100	297,100	296,400	362,500	381,500	425,300
Maximum	Demand in Maximum Gap Year	2,303,900	2,152,100	2,141,500	2,149,300	1,932,700	2,157,900
	Gap in Maximum Gap Year	1,446,400	1,369,600	1,366,600	1,532,000	1,566,100	1,749,800
	Increase from Baseline Gap	-	-	-	85,600	119,700	303,400
	Percent Gap in Maximum Gap Year	63%	64%	64%	71%	81%	81%

Study period for Water Supply analysis is 1975-2013, reflecting different baseline demand than described in Agricultural Diversion Demands section.

Figure 4.3.10 Projected Averages Annual Agricultural Diversion Demand, Demand Met, and Gaps in the Arkansas Basin

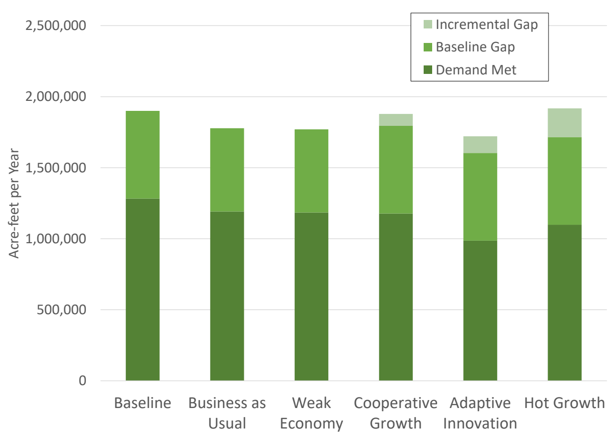
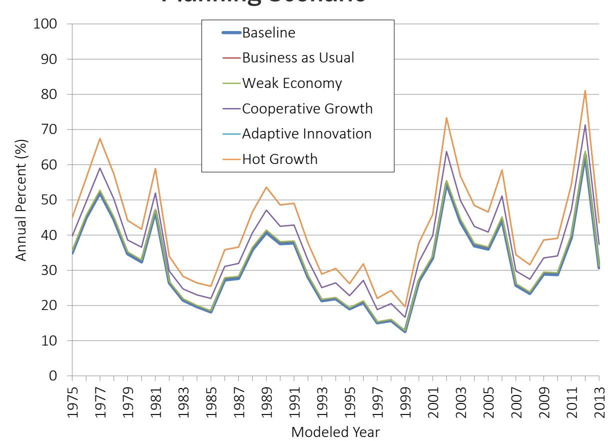


Figure 4.3.11 Annual Agricultural Gaps (expressed as a percentage of demand) for Each Planning Scenario



The following are observations on agricultural diversion demands and gaps:

- Agricultural diversion demands are projected to be similar or even reduced as compared to baseline in all five planning scenarios due to urbanization, transfers of agricultural water rights to municipal uses, and declining aquifer levels in the Southern High Plains, all resulting in reduced irrigated acres.
- The agricultural gap as a percent of demand is relatively large in this basin (32 to 43 percent). Current farming practices help to minimize this gap, which is projected to remain consistent in *Business as Usual* and *Weak Economy*; however, climate changes reflected in *Cooperative Growth*, *Adaptive Innovation* and *Hot Growth* are projected to increase water supply gaps up to 40 percent of demand.

M&I

The diversion demand and gap results for M&I uses in the Arkansas Basin are summarized in Table 4.3.10 and illustrated on Figure 4.3.12. Note that annual time series of M&I gaps are not available for the Arkansas Basin due to the lack of available CDSS tools.

The following are observations on M&I diversion demands and gaps:

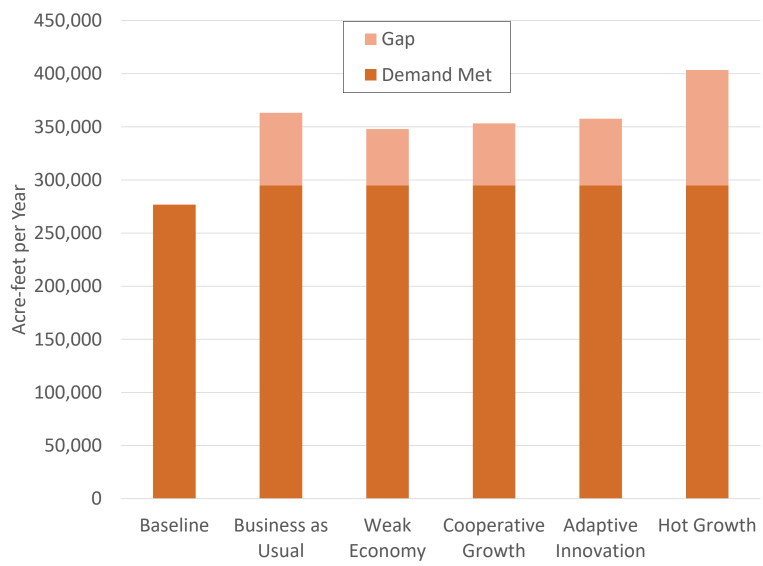
- M&I diversion demand in this basin is projected to grow to become a higher percentage of overall demand (from 13 to 17 percent).
- Municipal demand is driven by population growth in the Colorado Springs and Pueblo area, as well as modest increases in large industry and thermoelectric demand.
- The M&I gap in *Adaptive Innovation* is projected to be less than in *Business as Usual* even with high levels of projected population growth and increased outdoor water demands due to a hotter and drier climate.
- M&I gaps may be exacerbated by reductions in transbasin imports in planning scenarios that include considerations of climate change.

Table 4.3.10 Arkansas Basin M&I Gap Results

		Scenario					
		Scenario	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Average	Average Annual Demand	276,700	363,300	347,900	353,200	357,600	403,500
Average	Average Annual Gap	0	68,500	53,100	58,500	62,900	108,700
Average	Average Annual Percent Gap	0%	19%	15%	17%	18%	27%
Maximum	Demand in Maximum Gap Year	276,700	363,300	347,900	353,200	357,600	403,500
Maximum	Gap in Maximum Gap Year	0	68,500	53,100	58,500	62,900	108,700
Maximum	Percent Gap in Maximum Gap Year	0%	19%	15%	17%	18%	27%

Study period for Water Supply Analysis is 1975-2013, reflecting different baseline demand than described in M&I Demand section.
Baseline demand also may vary slightly from previous section due to differences in geographic distribution of demand for counties that lie in multiple basins.

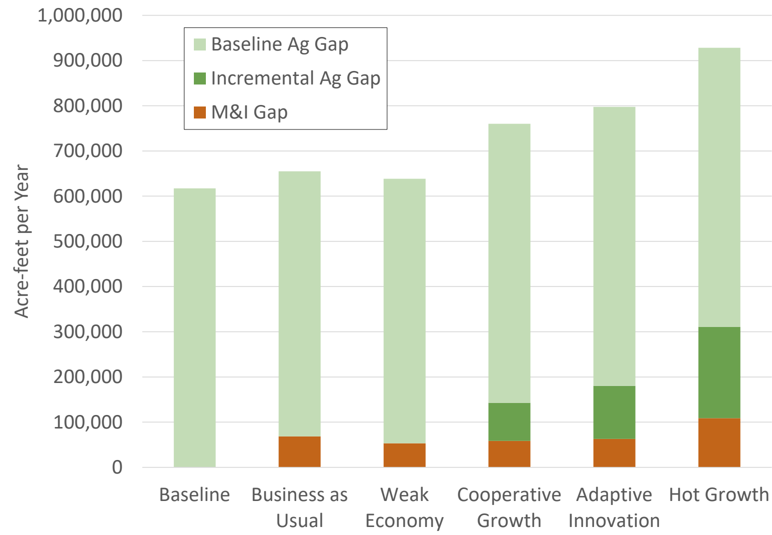
Figure 4.3.12 Projected Maximum Annual M&I Demand Met and Gaps in the Arkansas Basin



Total Gap

Figure 4.3.13 illustrates the total combined agricultural and M&I diversion demand gap in the Arkansas Basin. The figure combines the average annual baseline and incremental agricultural gap and the maximum M&I gap. In *Cooperative Growth*, *Adaptive Innovation*, and *Hot Growth*, gaps are driven by both agricultural and municipal demands, which increase in the "Hot and Dry" climate projection.

Figure 4.3.13 Projected Average Annual Agricultural Gaps and Maximum M&I Diversion Demand Gaps in the Arkansas Basin



Supplies from Urbanized Lands

By 2050, irrigated acreage in the Arkansas Basin is projected to decrease by more than 19,000 acres due to urbanization or lands that are no longer irrigated because of planned water right transfers from agricultural to municipal use in the Arkansas Basin. Irrigation supplies for these lands could potentially be used for M&I needs in the future (subject to a variety of unknowns such as seniority and type of water supply, willingness to change the use of water through water court, etc.). Acreage associated with planned transfers was derived based on stakeholder input.

The average annual historical consumptive use associated with potentially urbanized acreage and planned water right transfers for each scenario is reflected in Table 4.3.11. The data in the table represent planning-level estimates of this potential supply and has not been applied to the M&I gaps. The data in the table do not represent supplies from permanent water transfers that may be considered by a basin roundtable as a future strategy to meet gaps (note that SWSI 2010 included estimates of permanent transfers beyond those currently planned as a strategy for meeting potential future M&I gaps).

Table 4.3.11 Estimated Consumptive Use from Lands Projected to be Urbanized by 2050 and Planned Transfers in the Arkansas Basin

	Business as Usual	Weak Economy	Cooperative Growth	Adaptive Innovation	Hot Growth
Urbanized Acreage and Lands Subject to Planned Transfers (acres)	19,800	19,800	19,800	19,800	19,800
Estimated Consumptive Use (AFY)	29,600	29,700	29,400	25,200	27,900

4.3.7 Available Supply

For the purposes of the Technical Update, it was assumed that due to compact constraints, there are no available water supplies now or in the future that can meet new demands.

4.3.8 Environment and Recreation

A surface water allocation model is not currently available in the Arkansas Basin. As a result, hydrologic datasets in the Flow Tool include only naturalized flows and naturalized flows as impacted by climate change. A total of three water allocation model nodes were selected for the Flow Tool within the Arkansas Basin (Figure 4.3.14). The figure also shows subwatersheds (at the 12-digit HUC level) and the relative number of E&R attributes located in each subwatershed.

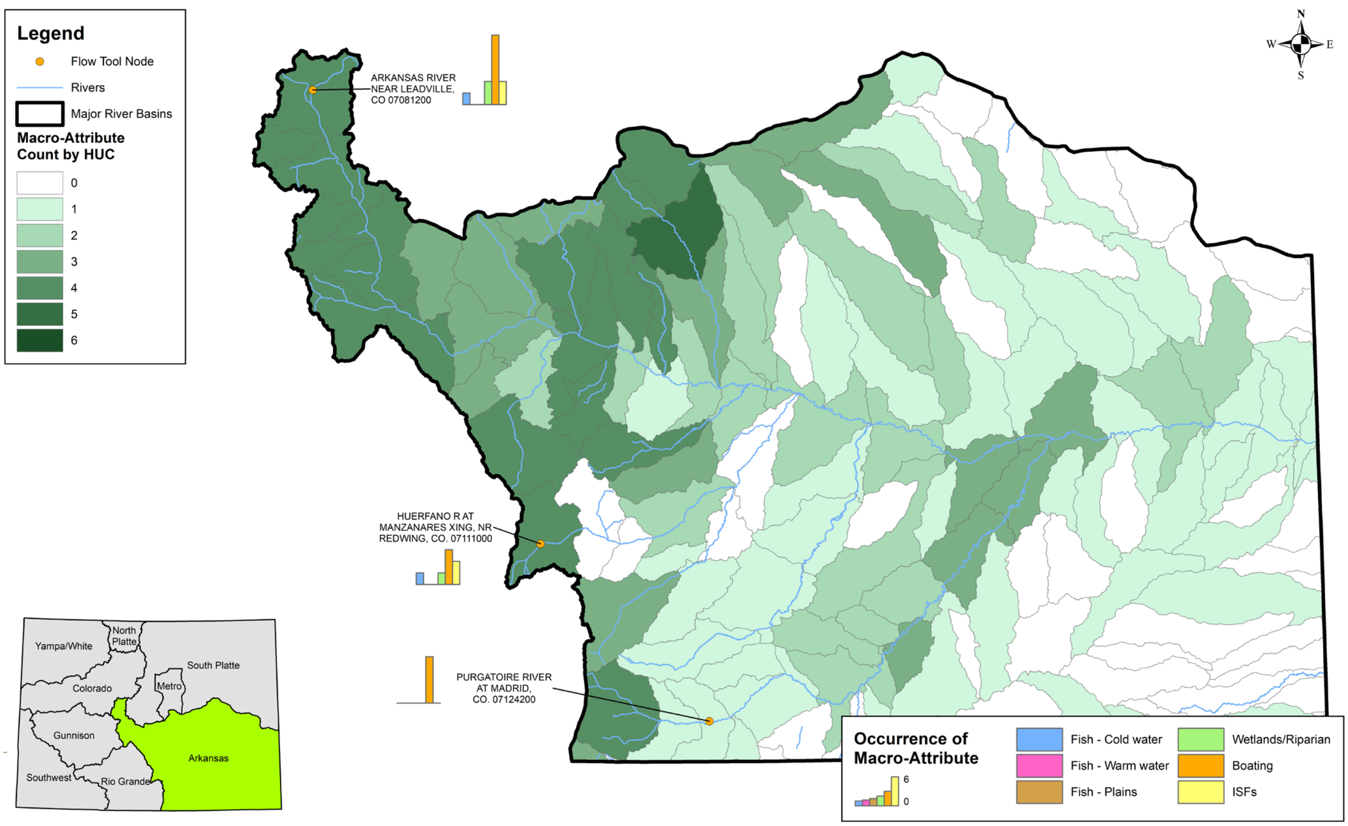
- Arkansas River near Leadville, Colorado (07081200)
- Huerfano River at Manzanares Crossing, near Redwing, Colorado (07111000)
- Purgatoire River at Madrid, Colorado (07124200)

The sites were selected because they are above major supply and demand drivers, and because future flow changes would likely be associated only with climate-change factors. Management drivers impact river flows on the eastern plains. Because a water allocation model that incorporates management is not available, no data-based insights into potential flow changes and risks to E&R attributes could be developed at this time. The Flow Tool results for the Arkansas Basin include only naturalized flows and naturalized flows as impacted by climate change factors ("In-Between" and "Hot and Dry" climate projections). These data do not represent changes in flow due to irrigation, transbasin imports, and/or storage.

NATURALIZED FLOW

Naturalized flows reflect conditions that would occur in the absence of human activities. Baseline flows reflect current conditions as influenced by existing infrastructure and river operations. While observations regarding naturalized flows may be informative, baseline flows reflect actual conditions and the diverse operations of the river's many users.

Figure 4.3.14 Flow Tool Nodes Selected for The Arkansas Basin



Results and observations from Flow Tool analyses using flow data developed in the water supply and gap analyses for baseline conditions and the planning scenarios are described in Table 4.3.12.

Table 4.3.12 Summary of Flow Tool Results in the Arkansas Basin

Category	Observation
Projected Flows	At high elevation locations (e.g., near Leadville), peak flow magnitude are not projected to change substantially. However, the timing of peak flow may shift to earlier in the year, with April and May flow magnitudes rising and June flows decreasing under the In-Between and Hot and Dry climate change projections.
	At montane and foothills locations (elevation range from approximately 5,500 feet to 8,500 feet), peak flow magnitude will likely drop under the In-Between and Hot and Dry climate change projections.
	Across all locations, mid- and late-summer streamflow is projected to decrease due to climate change.
Ecological Risk	At high elevations, peak-flow related risk for riparian/wetland plants and fish habitat remains low or moderate under future climate change projections.
	At lower elevations, the decline in peak flow magnitude is projected to increase the risk status for riparian/wetland plants and fish habitat. The reduction in peak flow may also adversely affect recreational boating.
	Metrics for coldwater fish (trout) indicate that even with climate-induced changes to mid- and late-summer flows, flows are projected to be sufficient to keep risk low or moderate, though risk may be higher in July and/or during dry years.
E&R Attributes	Because future flows under the five scenarios were not modeled in the Arkansas Basin, projected changes to flow at the selected nodes and the associated changes in risk to E&R attributes are entirely attributable to projected changes in climate. These climate-induced changes are similar to the general pattern seen in many parts of Colorado: earlier peak flow and reduced mid- and late-summer flows, with reduced peak flow magnitudes in some locations.