Non-Binding Arbitration initiated August 21, 2009

pursuant to

Decree of May 19, 2003, 538 U.S. 720
Kansas v. Nebraska & Colorado
No. 126 Orig., U.S. Supreme Court

Report on the

Colorado Compliance Pipeline

Republican River Compact

Response to reports prepared on behalf of Colorado, dated May 24, 2010

Prepared by

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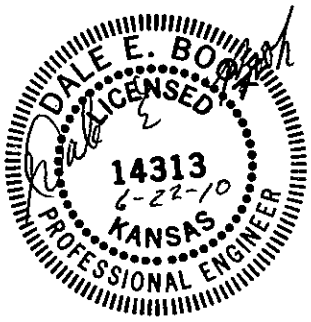

June 22, 2010

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1. Introduction

The State of Colorado has developed an augmentation plan and submitted it to the Republican River Compact Administration (RRCA) for approval. The plan is described in a formal submittal to the RRCA and two reports prepared for Colorado for this proceeding. The reports were prepared by Dick Wolfe, Colorado State Engineer and member of the RRCA, and James Slattery, consultant to the State of Colorado and Republican River Water Conservation District. A third report, prepared by Willem Schreuder, addresses the position of the State of Kansas to include the augmentation supply in the RRCA groundwater model. This report responds to issues raised in the three Colorado reports. Reports submitted by David Barfield and Steve Larson respond to other aspects of the Colorado augmentation plan not addressed in this report.

The Colorado proposal would provide credit for the State of Colorado for pumping and discharge of up to 15,000 ac-ft/yr, delivered to the North Fork of the Republican River by pipeline at the Colorado-Nebraska Stateline (pg. 4, Slattery report). The water will be derived from pumping wells located at some distance from the stream, where pumping effects on streamflow are a fraction of the amount pumped. The delivery of such water to the stream would add to the basin supply due to the delayed pumping effect on streamflow. The additional water would provide an offset to Colorado's use in excess of compact allocation (overuse).

The quantification of streamflow effects caused by pumping the augmentation wells is not at issue in this proceeding because; 1) Colorado will limit the pumping for augmentation to amounts historically pumped for irrigation, satisfying the requirement in the Final Settlement Stipulation (FSS) that depletions are not increased; and 2) the effects of pumping the wells will be determined with the RRCA groundwater model, adopted by the States for implementation of the FSS.

The primary technical issues raised by the State of Kansas concerning the Colorado proposal are summarized as:

1. The amount of augmentation supply to be delivered to the North Fork relative to the location and amount of overuse being augmented,

2. The need for limits on annual augmentation supply to correspond to the amounts needed for compact compliance, and

3. The need for inclusion of augmentation pipeline discharge in the calculation of pumping impacts downstream of the Stateline to Swanson Reservoir with the RRCA groundwater model.

2. Qualifications

I am a consulting civil engineer, specializing in water resources, water rights engineering, water supply and hydrology. I have both a Bachelors and a Masters degree in Civil Engineering, specializing in water resource engineering. I am a professional engineer registered in five states. I am president of the firm Spronk Water Engineers, located in Denver, Colorado. I have testified as an expert witness in matters related to water rights transfers and plans for augmentation, as well as in interstate water cases.

I have been involved with the Republican River Compact as an engineering consultant to the State of Kansas for approximately 15 years. During that time I have undertaken hydrologic investigations of the Republican River Basin related to matters of compact compliance. I participated in the settlement negotiations leading up to the adoption of the FSS. I was involved in the development of the Accounting Procedures and Reporting Requirements adopted by the RRCA to implement the provisions of the settlement. I was a member of the Technical Committee that developed the RRCA groundwater model. I am familiar with the calculations of Beneficial Consumptive Use that are developed annually for administration of the Compact. I have investigated and reviewed potential alternatives for Nebraska and Colorado to achieve compact compliance subsequent to the adoption of the FSS. I am familiar with the operation of the federal reservoir projects in the Republican River Basin and the relationship of ground and surface water use in the basin. I also assisted in establishing the process to compute the Imported Water Supply with the RRCA model and have evaluated proposals by the State of Nebraska to modify this process.

As a water resources and water rights consultant, I assist a variety of clients in evaluation and development of water supplies throughout the western United States, within the prior appropriation system. An important element of this process is the acquisition and transfer of water rights for new uses. I have more than 30 years of experience in consulting on water rights matters, including water transfers, plans for augmentation, use of water from federal projects, and interstate compacts. I have worked on behalf of applicants and other affected parties on various projects.

Technical specializations include river basin modeling, hydrologic investigations, evaluation of irrigation systems and the interaction of ground and surface water flow. I participated in the development of the Arkansas River model currently being used for assessing compliance with the Arkansas River Compact. This model includes reservoirs and canal systems covering a reach of 150 miles. The model simulates diversions, storage, irrigation and stream-aquifer interaction. I currently participate in the periodic updates of this model. Significant issues involved with this modeling have included irrigation practices, groundwater pumping measurement and estimation, reservoir

operations, crop evapotranspiration and model calibration. I have also worked on models in the Colorado River, Gunnison River, and Rio Grande in New Mexico.

I have developed and completed plans for augmentation in Colorado which involve development of groundwater supplies and changes of surface water rights. This process requires investigations to determine historical consumptive use and impacts to streamflow caused by well pumping and return flows. New water uses are conditioned on protecting streamflows from depletions by balancing historical consumptive use and return flows with pumping depletions.

3. Description of Colorado Augmentation Plan

The beneficial consumptive use in Colorado has exceeded its compact allocations each year since at least 2000. The State of Colorado has not been in compliance with its allocations under the Republican River Compact since 2007, the first year when the compliance test, which considers five years of allocation and consumptive use, could be tested under the provisions of the FSS. A large portion of the consumptive use in Colorado is due to groundwater use from the Ogallala aquifer. The ability to reduce consumptive use through pumping reductions alone is therefore limited. The State of Colorado and water users have concluded that a practical means to come into compliance would be to pump water from the aquifer directly to the stream. The proposal by Colorado is to deliver water pumped from the aquifer to the North Fork of the Republican River. This is one of the four sub-basins from which part of the water supply was allocated downstream to Kansas and Nebraska by the Compact.

Water would be pumped from eight wells located approximately 12 miles north of the river and discharged by pipeline to the stream near the Nebraska Stateline. All of the water made available under the plan would flow into Nebraska, and become part of the water supply of the mainstem of the Republican River. Colorado has indicated that the capacity of the pipeline would likely need to be increased to accommodate increasing overuse with time, as pumping depletions continue to increase into the future.

Compliance accounting is done on an annual basis for the Republican River Compact. Computed Water Supply (CWS) and Computed Beneficial Consumptive Use (CBCU) are determined and tabulated on an annual basis. Colorado's compliance is assessed on a five-year average basis, meaning five years of CWS, allocation and CBCU are compiled and used to evaluate Colorado's compact compliance. More detailed discussion of the specific components of the compliance tests from the FSS are provided below.

Colorado's proposed augmentation plan will produce an "Augmentation Water Supply" (AWS) each year, which will be deducted from the gaged flow of the North Fork at the Stateline to determine the CWS, and will be applied as a credit against Colorado's

CBCU. The credit will be applied both on a statewide basis and for the North Fork sub-basin.

The proposal is to pump up to 13,059 ac-ft/yr on average, corresponding to the historical consumptive use of the water rights purchased by the District for the plan. Pumping in individual years could exceed this value. Facilities are being planned to enlarge the capacity to 25,000 ac-ft/yr, in anticipation of increasing stream depletions and overuse in the future, as pumping effects on the stream continue to increase. The expectation of future enlargement of the North Fork pipeline is based on expected overuse of the statewide allocation, without consideration of how future depletions and resulting overuse may be distributed across Colorado sub-basins.

4. Status of Colorado Compliance

Compliance with the Compact and FSS is essentially measured by a comparison of the allocations and CBCU. The comparisons for each of the three states are made for various time durations (five year or two year) and for statewide totals or by sub-basin. The compliance tests for Colorado are only five-year tests.

4.1 Compliance Tests

The specific tests of compact compliance are established in the FSS. For Colorado, these include;

- State-wide normal year test – RRCA Accounting Procedures (AP) Table 3A
- Sub-basin test – RRCA AP Table 4A
- Water-short year basin-wide test – RRCA AP Table 5A

Each of these tests is for a five-year period.

Table 3A is used to compare the total state-wide allocation with CBCU. The figures are totaled and overuse is displayed by negative results for the total. An IWS placeholder in the table is not used, since there is not imported water supply in Colorado. Table 1 shows the compliance RRCA AP Table 3A for the years 2003 – 2008. Colorado's CBCU has exceeded the allocation by 52,599 ac-ft for the period 2003 - 2007, an average of approximately 10,500 ac-ft/yr, or 50% of the total allocation.

The sub-basin test is provided in the RRCA AP Table 4A, Colorado's Sub-Basin Non-impairment Compliance. This table includes several values, and reflects the flexibility from the FSS for sub-basin compliance by computing a value termed Total Available Supply. The Total Available Supply for this test is the sum of the State's allocation for the sub-basin and the unallocated supply on the tributary. The unallocated supply is defined as the amount of the total CWS for the sub-basin that is not allocated to any of the states in the sub-basin, but is allocated to the mainstem supply for Nebraska and Kansas. In summary, Colorado can use water allocated to the mainstem from the South Fork sub-basin, if compliance is maintained with its state-wide allocation by using less than its allocation in another sub-basin. Tables 2-A and 2-B show the RRCA AP Table 4A for Colorado for two periods; 2003 – 2007 and 2004 – 2008. The CBCU in Colorado exceeded the Total Available Supply on the South Fork sub-basin for 2003 - 2007 by 2,492 ac-ft/yr. Also shown in this table are the allocations to the individual sub-basins from the Compact. The CBCU in Colorado exceeded the sub-basin allocations in both the North Fork and South Fork sub-basins of the Republican River.

The water-short year test is provided in RRCA AP Table 5A, Colorado's Compliance during water-short year administration. This table is similar to RRCA AP Table 3A, except that the allocation to Beaver Creek is removed from both the state-wide allocation and the state-wide CBCU. Table 3 shows RRCA AP Table 5A. The CBCU for Colorado on Beaver Creek has been zero for many years. Colorado's overuse for 2003 - 2007 was 57,850 ac-ft for this test. 2007 was a water-short year.

4.2 Summary of Colorado Compliance

Basin-wide Test – The total CBCU exceeded the statewide allocation. For 2007, the more constraining test is RRCA AP Table 5A because it was a water-short year. The overuse averaged 11,570 ac-ft/yr during 2003 - 2007. For the years 2004 - 2008, the water-short requirements do not apply and RRCA AP Table 3A is applicable. CBCU exceeded the allocation by 9,120 ac-ft/yr for that period. The statewide overuse, using both the normal year and water short year tests are shown on Figure 1.

Sub-basin Test - The CBCU in the South Fork sub-basin exceeded the Available Supply by 2,492 ac-ft/yr for 2003 - 2007. Figures 2-A through 2-D plot the comparisons of CBCU by sub-basin with the sub-basin allocations and sub-basin Available Supply. Negative values on these graphs indicate CBCU less than allocation or Available Supply.

4.3 South Fork of the Republican River Sub-basin

The South Fork of the Republican River originates in Colorado in Kit Carson County, and flows into Cheyenne County, Kansas, near St. Francis. The stream continues across

the northwest corner of Kansas for a distance of approximately 40 miles, crossing into Nebraska near Benkleman, Nebraska. Allocations from the South Fork were made to each of the three states. The allocations to Colorado and Kansas on the South Fork are approximately equal; 44 % to Colorado and 40 % to Kansas. Some of the South Fork supply, 14 %, was unallocated in the sub-basin. The remaining was allocated to Nebraska in the sub-basin. The CBCU in recent years in Colorado has averaged 16,000 ac-ft/yr. The CBCU in Kansas has averaged just under 6,000 ac-ft/yr. The allocations, available supply, and CBCU for the two states are compared on Figure 3.

Bonny Reservoir is located in Colorado, just upstream of the Kansas-Colorado Stateline. The outlet of the dam is approximately eight miles west of the Stateline. Reservoir evaporation has averaged approximately 3,000 ac-ft/yr in recent years and is included in the CBCU for Colorado. The reservoir does not supply water for significant irrigation. A ditch immediately downstream of the dam in Colorado, the Hale Ditch, provides occasional supply for several hundred acres in Colorado. The potential for significant reductions of CBCU in Colorado for surface water use is limited to Bonny Reservoir. Colorado has included a reduction in CBCU for Bonny Reservoir as a potential component for moving towards compact compliance (See Figure 10, pg. 25 Slattery report). It is noted that this alternative would required Bonny Reservoir to be dry, essentially eliminating the reservoir for storage of inflows.

4.4 Comments on Colorado Report

In Figure 10, Mr. Slattery provides a projection of the expected amount of pumping for the augmentation plan, assuming existing irrigation pumping levels continue and other measures for reducing CBCU are placed in effect. This graph indicates projected AWS amounts of 3,500 ac-ft/yr presently and increasing to approximately 10,000 ac-ft/yr 25 years into the future. The assumptions included in the projection are that surface water CBCU for irrigation is reduced by 3,000 ac-ft/yr and Bonny Reservoir is no longer used to store water. The report does not describe the steps necessary to realize this significant change to eliminate the CBCU associated with the operation of Bonny Reservoir.

In Figure 5, Mr. Slattery compares the projected amount of augmentation pumping with projected groundwater depletions. The increase in pumping shown on this graph corresponds to the projected increase in depletions on the North Fork. Figure 5 was prepared to show the projected augmentation pumping to be less than the total stream depletion on the North Fork. The projected augmentation pumping assumes that other actions to reduce CBCU occur, and would understate the amounts sought to be pumped under this plan if they were not taken. The amounts shown here are significantly less than the amount requested in this plan. The pipeline capacity will be 15,000 ac-ft/yr, with the potential to increase to 25,000 ac-ft/yr. The comparison of North Fork

depletions is intended to demonstrate that this level of augmentation pumping to the North Fork is reasonable. However, a better comparison would be with overuse, which would reflect the need for augmentation.

Colorado proposed a maximum annual amount of augmentation pumping that would be allowed for credit in the RRCA proposal (See Colorado RRCA Resolution). As described in the report by Mr. Wolfe, this is referred to as the maximum augmentation water supply (AWS) Credit. The application of this term to establish operating levels for the augmentation pipeline is illustrated in Colorado Exhibit 4. This table shows how the augmentation pumping may occur with the RRCA proposal over hypothetical period with projected allocations and CBCU. A copy of this exhibit is attached as Appendix B to this report. The maximum AWS requested is based on the statewide overuse that has occurred. The derivation of the term is shown in Column F of the table. The methodology proposed to update this maximum is to use the prior ten-year period to determine the maximum statewide overuse value, multiplied by 1.40. The maximum AWS to be in effect through year 2012, is 20,300 ac-ft/yr, after which it would be reduced to 16,800 ac-ft/yr. Without other reductions in Colorado's CBCU, this maximum would gradually increase into the future as pumping depletions increase. Both of these figures exceed the average credit available from the water rights to be used for the pipeline, of 13,059 ac-ft/yr. However, Colorado notes that the banking provision of the Colorado Ground Water Commission will allow a maximum annual pumping of 23,391 ac-ft.

The actual amount of augmentation pumping each year, under the Colorado RRCA proposal would be somewhere between the minimum and maximum AWS, at the discretion of the State of Colorado and its water users. This value is shown in Column G of Appendix B.

In conclusion, the maximum AWS credit proposed by Colorado is based on comparing the statewide CBCU with Colorado's statewide allocation. This does not reflect the need to reduce CBCU in the South Fork sub-basin, as suggested by Figure 10. The actual AWS each year would be determined without necessarily being based on need for augmentation supply for compliance.

5. Operational Limit

The Colorado North Fork CCP will not aid in achieving compliance with the sub-basin test for the South Fork. The Slattery report notes that deliveries cannot be used to offset use of water by Colorado in a sub-basin that would impair the ability of another state to use its sub-basin allocation (pg 7, Slattery report). The proposal simply does not address Colorado's RRCA AP Table 4A compliance on the South Fork.

While the Colorado proposal does not allow for AWS to be assigned to the South Fork in RRCA AP Table 4A for the sub-basin test, it inconsistently includes a maximum AWS computed such that all of Colorado's past and projected overuse of its statewide allocation would be allowed, without adjustment for overuse on the South Fork.

The operational limit on the AWS credit should be established as the amount needed to offset overuse that can appropriately be replaced in one sub-basin.

5.1 Summary of Colorado Proposed Operation

Colorado's proposals for operational limits on the CCP are described in the reports of both Mr. Slattery (pg. 8) and Mr. Wolfe (pg. 9). Mr. Slattery describes a process that will implement an agreement between Colorado and Nebraska entered in this proceeding. Mr. Wolfe describes a process that was included in Colorado's transmittal of the Colorado CCP to the RRCA. The important elements in the procedure described in the Resolution are the minimum annual delivery and the maximum AWS, referenced previously.

The Colorado proposal will not reasonably limit the AWS credit to the amount of overuse that can be replaced with this augmentation plan. The proposed limits described in the Resolution would actually allow latitude to operate within the specified bounds without regard to the actual need to replace overuse. There are two reasons for the need to limit the AWS credit:

1. The AWS credit should correspond to the need for replacement to achieve Compact compliance. As water supply varies, the allocations and resulting overuse also vary. CBCU is relatively steady, without significant year to year variability, although increasing, because it is primarily caused by pumping the regional aquifer. Limiting the AWS credit to need for compliance would prevent the discretionary ability to deliver more water in years of high water supply and less overuse, while delivering less than the overuse in years of low supply.

2. The exclusion of the South Fork sub-basin overuse from this augmentation plan requires that the AWS credit be accordingly limited. Such a limitation would implement the stated purpose of this plan not to address the South Fork sub-basin overuse. The limitations proposed by Colorado do not accomplish this.

Both Mr. Wolfe and Mr. Slattery state the intention to match deliveries to the need in a number of places in their reports. For example, Mr. Slattery states that the operation described in his report "will provide a reasonable method to estimate the amount of augmentation water needed to offset stream depletions to keep Colorado in Compact compliance."

The arbitration proposal includes a procedure for estimating the amount of deliveries needed for Compact compliance for the current year. This description even references mid-year corrections.[1] However, none of this operational detail is included in the Colorado RRCA proposal, therefore leaving actual operation discretionary or subject to alternative operations.

Mr. Wolfe's report also references or alludes to the intention to operate the plan to provide replacement as needed:

- limit ability to "pre-load" (pg 8)
- refers to Exhibit 4 as limitation and notes the need to allow for slight "over-delivery" to make up for "under-delivery" in previous years. (Pg 9)
- will have to forecast to estimate amount of deliveries required; Colorado does not have desire to over-deliver. (Pg 10)
- need will be variable; will utilize banking to accommodate annual needs (pg 10)
- agreed to a schedule with Nebraska (pg 12)

It should be noted that all references by Mr. Wolfe or Mr. Slattery to over-delivery or augmentation supply corresponding to need are with respect to Colorado's statewide overuse, without adjustment for overuse of the South Fork sub-basin.

The conclusions about the Colorado proposal to determine the allowable AWS credit are:

1. Colorado's RRCA proposal includes a term "projected delivery" (see Col. E, Colorado Exhibit 4). This term is actually an intermediate calculation step in the derivation of the maximum augmentation water supply credit (col. F). The value is the maximum single year overuse for a period of 10 prior years, on a statewide basis. The proposed maximum is 140% of the value from Col. E or 4,000 + Col. E, whichever is larger. For example, the statewide CBCU in Colorado for 2002 exceeded the allocation by 14,487 ac-ft. The maximum augmentation credit to be allowed for the years through 2012 would be 20,282 ac-ft, or 140% of the maximum overuse.

[1] The plan states that the minimum of 4,000 ac-ft/yr would be delivered in the months of January - March each year, with a projection to be completed by September 1, incorporating current year hydrology, to estimate the need for the remaining months.

2. The actual pipeline deliveries in the Colorado RRCA proposal would occur within the range of the maximum, as calculated above, and the minimum of 4,000 ac-ft/yr. With the five-year accounting procedure, this would provide excessive flexibility for the amount pumped in any single year.

3. The process included in the arbitration proposal includes projecting the annual augmentation water supply needed for compliance, based on the status of compliance over the past four years and projected water supply. This process is materially different than the method included in the Colorado Resolution, as described by Mr. Wolfe.

4. The method described in the Slattery report is derived from an agreement developed between the states of Nebraska and Colorado. (Section 6.0, pg 8) (Nebraska Agreement). The procedure addresses some of the issues of concern from Colorado's original proposal, but does not adequately limit the AWS each year.

5. As Mr. Wolfe notes in his report, the deliveries on the North Fork would be made to Nebraska and therefore considerations are limited to Nebraska and its water users. However, it should be noted that, at least part of the water is destined for the State of Kansas in the Republican River. As a water user with an interest in the administration of surface water in Nebraska to maintain and protect water supply to Harlan County Reservoir, the State of Kansas and its water users do have an interest in the river operations in Nebraska. Nebraska officials had identified the need to convey some of the water to Hardy (letter from Brian Dunnigan to Dick Wolfe, April 10, 2009)

5.2 Recommendation for Changes to Colorado Proposed Limit on AWS Credit

The procedure proposed by Colorado does not adequately limit the AWS credit allowable under this augmentation plan. A procedure that would better provide augmentation deliveries to correspond with compliance needs is necessary for plan approval. The limit would also recognize the need for reduced CBCU, or alternatively, augmentation on the South Fork when the sub-basin test is not satisfied.

Several changes are necessary for the terms of the operating plan contained in the Colorado arbitration proposal.

- The term "projected delivery" is not currently defined. The term has a different meaning than that used in the Colorado Resolution (see 1 above). Mr. Slattery

described this as the amount needed to achieve compliance with the statewide test (five-year basis), comparing CBCU with allocation and augmentation water supply.

- The standard to be used to determine AWS is not adequately defined. It is stated as "sufficient for Compact compliance". Mr. Slattery clarified that this refers to the statewide test of compliance in the proposal. However, this term could be construed to include the sub-basin tests as well. The standard to be applied should specify how the AWS will be adjusted by overuse in a sub-basin. The calculations of AWS should be specifically described with formulas.

- The process used to develop projections on April 1 and September 1 should be specified in more detail to include specific data needs and calculations. The process will include a run of the RRCA groundwater model, but the specifics are not included. The process to use the model should be specified.

- The description provides for making up planned shortfalls in the following year, in the months of January through April. Although unclear how this provision will work exactly, the potential for shortfall appears to result from the prior year estimate of AWS credit. Since the September 1 projection will be used without consideration for over-estimation of supply and allocations, there is some probability that the AWS delivery computed by this method would not be sufficient to provide compliance. This could be resolved by including a factor of safety with the September 1 projection for AWS pumping, reducing the potential of shortfalls in years of low supply.

- The procedure to determine the AWS sufficient for Compact compliance should be adjusted to remove the amount of overuse required to be replaced in the South Fork sub-basin.

6. Computation of CBCU with RRCA Groundwater Model

The Colorado proposal for inclusion of augmentation supply in the RRCA accounting omits consideration of the impact on Colorado's CBCU of the augmentation discharge downstream of the accounting point at the Colorado-Nebraska Stateline. This is inconsistent with the current methods used to determine the CBCU with the RRCA Groundwater Model. Impacts would occur in the reach between the Stateline and Swanson Reservoir. Impacts in this reach are included in the calculation of Colorado's statewide CBCU from pumping under current accounting procedures. As described elsewhere (Larson, 2010 and Schreuder, RRCA, 2004), the physical process creating negative pumping impacts in this reach is the increase in stream channel loss that results from increased flow at the Stateline if upstream pumping did not occur.

It would be inconsistent to continue to make this calculation with the model into the future without consideration of the augmentation water added to the flow in the baseline model run for actual conditions of pumping in Colorado. The approach by Colorado would consider the base flow at the Nebraska Stateline to be depleted by the continued groundwater use in Colorado, as if the augmentation water had not been added to the streamflow.

The actual impact of depleted streamflow in this reach will be mitigated by the addition of the augmentation water at the Stateline. Since the change in stream channel loss depends on the change in stateline flow, the flow as augmented would be more appropriate for use in the modeling analysis. This would be accomplished by inputting the AWS into the model.

Although Mr. Schreuder stated the possibility that water users in Nebraska could theoretically take all of this water when it is delivered, this scenario is very unlikely. Any existing surface water facilities are not likely to significantly increase diversions in this reach when the augmentation flows serve to restore streamflows to rates more consistent with the condition of Colorado compliance. Much of the irrigation along this reach of the river is served by wells due to limited and variable streamflow. A moratorium on new surface water development in Nebraska prevents new diversions. Also, the agreement with Nebraska to limit discharges to the winter would minimize the potential for diversions of this water.

TABLES

Table 1

Table 3A of the Accounting Procedures

Table 3A: Colorado's Five-Year Average Allocation and CBCU

Year	Allocation	Computed Beneficial Consumptive Use	Imported Water Supply Credit	Allocation - (CBCU - IWS Credit)
2003	21,420	33,470	NA	(12,050)
2004	21,540	33,670	NA	(12,130)
2005	25,040	35,460	NA	(10,420)
2006	21,090	30,760	NA	(9,670)
2007	24,520	32,850	NA	(8,330)
2008	25,500	30,560	NA	(5,060)
2003 - 2007 avg.	22,722	33,242	NA	(10,520)
2004 - 2008 avg.	23,538	32,660	NA	(9,120)

Table 2-A

Table 4A of the Accounting Procedures
(avg 2003-2007)

Table 4A: Colorado's Sub-Basin Non-impairment Compliance

Basin	Allocation (Five-year Average)	Unallocated Supply (Five-year Average)	Imported Water Supply Credit (Five-year Average)	Total Available Supply	Computed Beneficial Consumptive Use (Five-year Average)	Available Supply - CBCU
North Fork	9,544	22,582	NA	32,126	17,358	14,768
Arikaree	1,576	(10)	NA	1,566	732	834
South Fork	10,548	3,326	NA	13,874	16,366	(2,492)
Beaver	1,054	32	NA	1,086	0	1,086

Table 2-B

Table 4A of the Accounting Procedures
(avg 2004-2008)

Table 4A: Colorado's Sub-Basin Non-impairment Compliance

Basin	Allocation (Five-year Average)	Unallocated Supply (Five-year Average)	Imported Water Supply Credit (Five-year Average)	Total Available Supply	Computed Beneficial Consumptive Use (Five-year Average)	Available Supply - CBCU
North Fork	9,680	22,900	NA	32,580	17,154	15,426
Arikaree	1,784	(10)	NA	1,774	968	806
South Fork	10,504	3,312	NA	13,816	16,132	(2,316)
Beaver	1,570	46	NA	1,616	0	1,616

Table 3

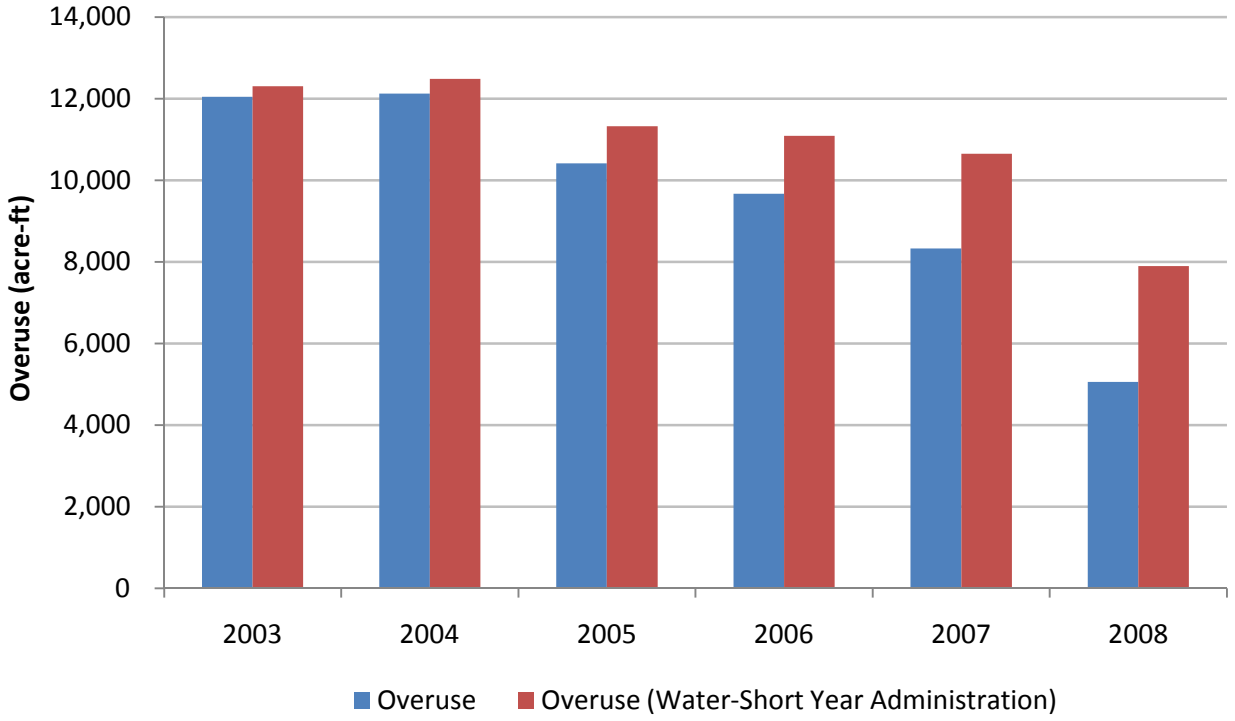
Table 5A of the Accounting Procedures

Table 5A: Colorado's Compliance During Water-Short Year Administration

Year	Allocation - Allocation Beaver	Computed Beneficial Consumptive Use - CBCU Beaver	Imported Water Supply Credit - IWS Beaver	Allocation - (CBCU - IWS Credit)
2003	21,160	33,470	NA	(12,310)
2004	21,180	33,670	NA	(12,490)
2005	24,130	35,460	NA	(11,330)
2006	19,670	30,760	NA	(11,090)
2007	22,200	32,850	NA	(10,650)
2008	22,660	30,560	NA	(7,900)
2003 - 2007 avg.	21,668	33,242	NA	(11,570)
2004 - 2008 avg.	21,968	32,660	NA	(10,690)

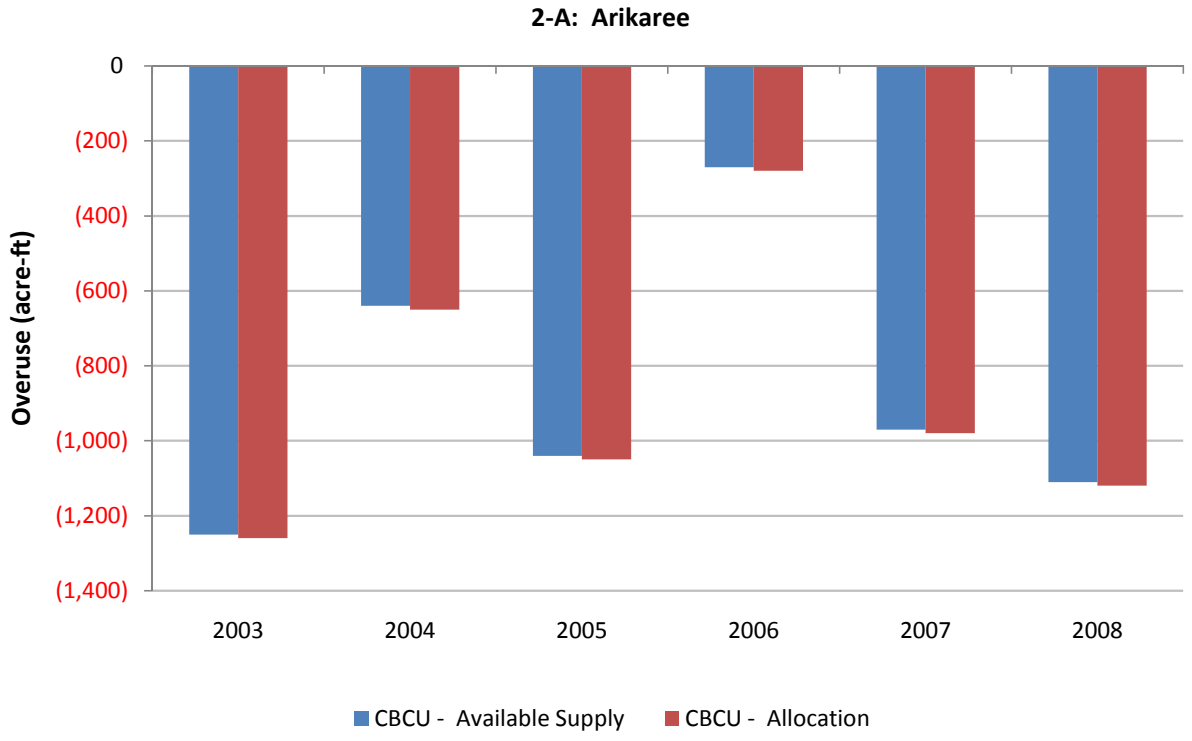
FIGURES

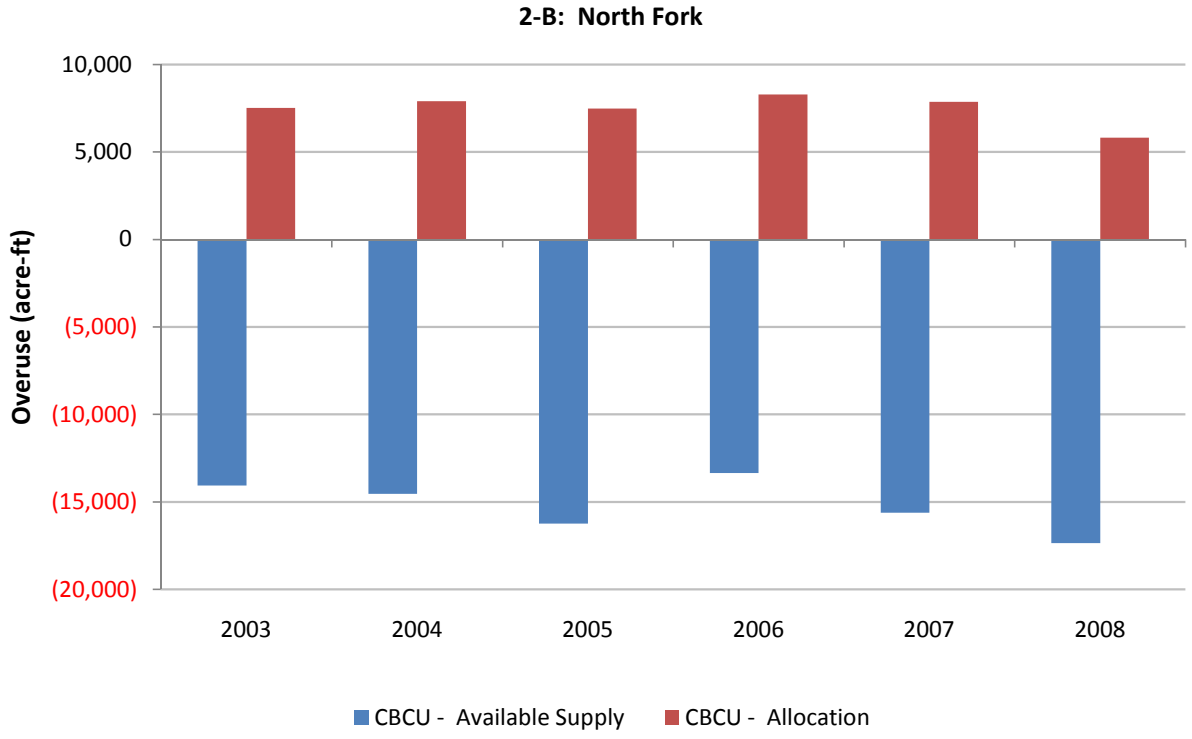
Figure 1
Amount Colorado Exceeded Compact Allocation
Statewide Overuse
2003 - 2008



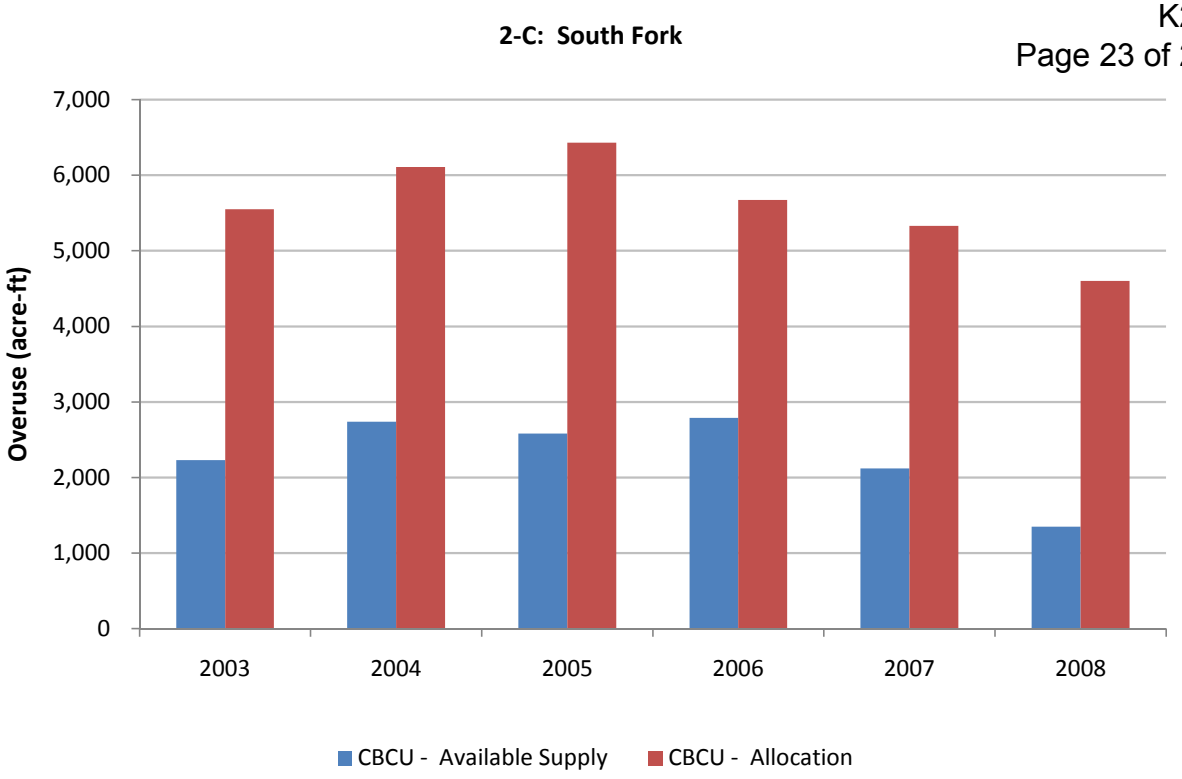
Note: Overuse equals the amount that Colorado's CBCU exceeded their Allocation. The graph shows the results from Tables 3A and 5A of the Accounting Procedures. 2007 was under Water-Short Year Administration.

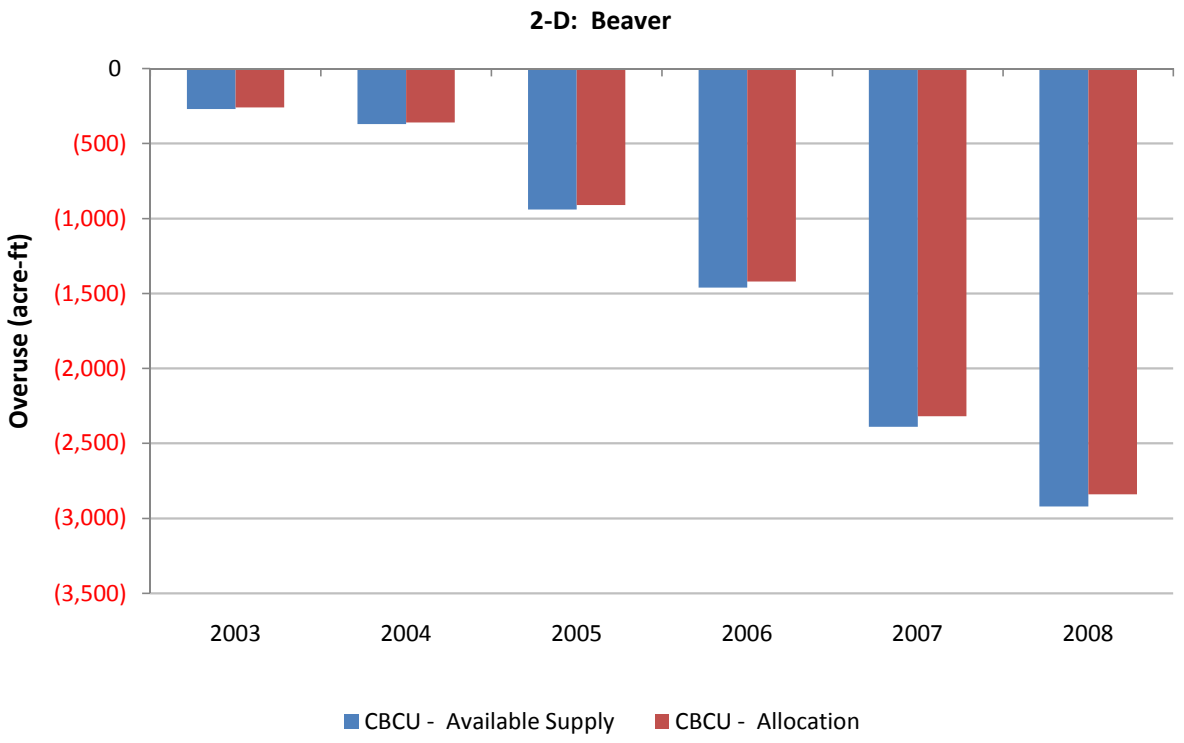
Figure 2(A-D)
Amount Colorado Exceeded Compact Allocation
Sub-Basin Non-impairment Overuse
2003 - 2008





Note: The graph shows the annual results from Table 4A of the Accounting Procedures (see Appendix A-1). Available Supply is the sum of Colorado's allocation and the unallocated supply. The allocation is Colorado's percent of the computed water supply in the specific sub-basin.





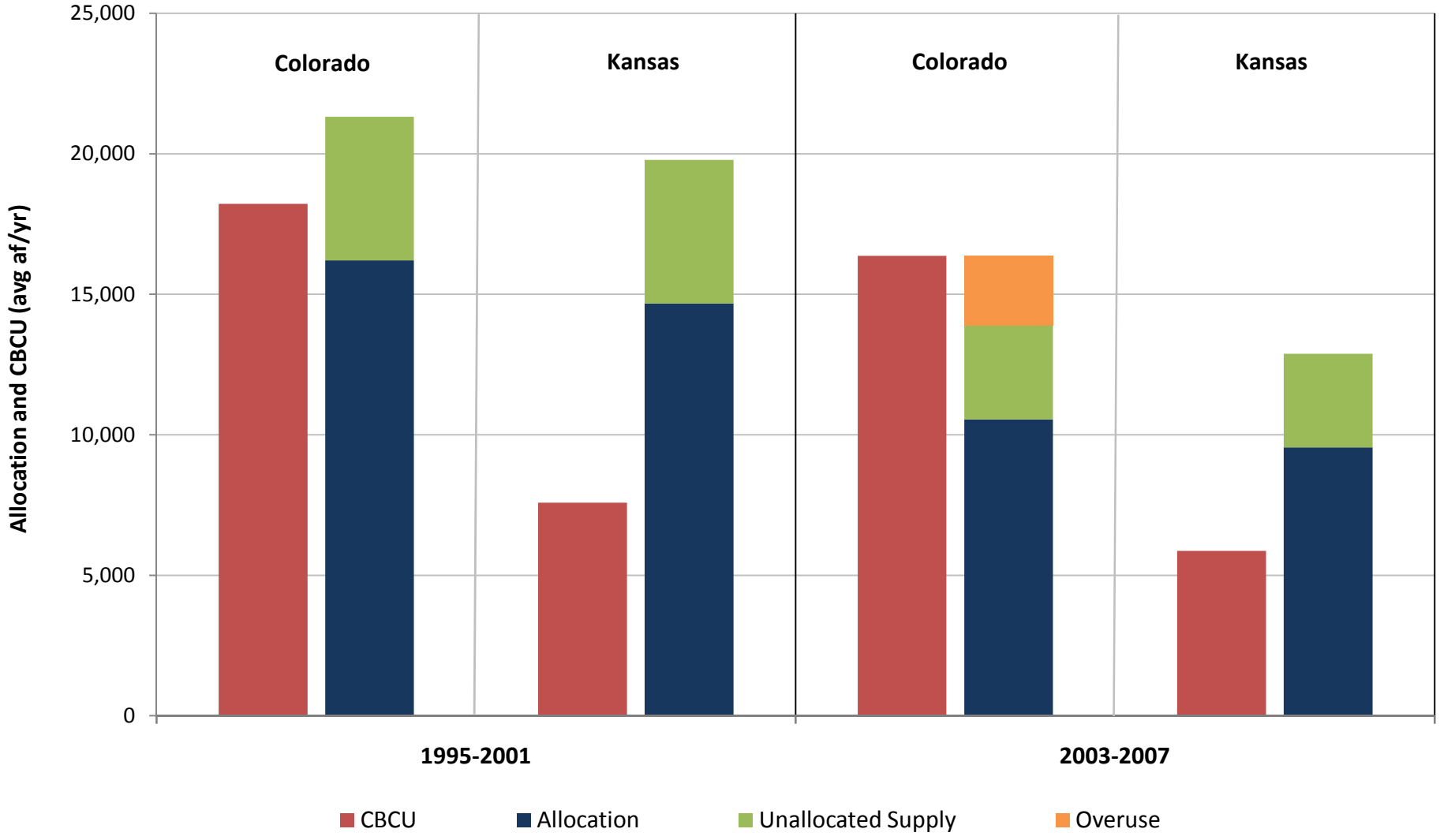
Note: The graph shows the annual results from Table 4A of the Accounting Procedures (see Appendix A-1). Available Supply is the sum of Colorado's allocation and the unallocated supply. The allocation is Colorado's percent of the computed water supply in the specific sub-basin.

Figure 3

South Fork of the Republican River

Comparison of CBCU and Available Supply for Colorado and Kansas

average acre-ft / yr



APPENDICES

Appendix A-1

Colorado Sub-basin Accounting Detail

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Basin / Year	Allocation	Unallocated Supply	Imported Water Supply Credit	Total Available Supply	Computed Beneficial Consumptive Use	Available Supply - CBCU	Allocation - CBCU
North Fork							
2003	9,120	21,590	NA	30,710	16,640	14,070	(7,520)
2004	9,490	22,450	NA	31,940	17,400	14,540	(7,910)
2005	10,040	23,740	NA	33,780	17,530	16,250	(7,490)
2006	9,150	21,650	NA	30,800	17,440	13,360	(8,290)
2007	9,920	23,480	NA	33,400	17,780	15,620	(7,860)
2008	9,800	23,180	NA	32,980	15,620	17,360	(5,820)
2003 - 2007 avg.	9,544	22,582		32,126	17,358	14,768	(7,814)
2004 - 2008 avg.	9,680	22,900		32,580	17,154	15,426	(7,474)
Arikaree							
2003	1,500	(10)	NA	1,490	240	1,250	1,260
2004	1,000	(10)	NA	990	350	640	650
2005	1,860	(10)	NA	1,850	810	1,040	1,050
2006	1,400	(10)	NA	1,390	1,120	270	280
2007	2,120	(10)	NA	2,110	1,140	970	980
2008	2,540	(10)	NA	2,530	1,420	1,110	1,120
2003 - 2007 avg.	1,576	(10)		1,566	732	834	844
2004 - 2008 avg.	1,784	(10)		1,774	968	806	816
South Fork							
2003	10,540	3,320	NA	13,860	16,090	(2,230)	(5,550)
2004	10,690	3,370	NA	14,060	16,800	(2,740)	(6,110)
2005	12,230	3,850	NA	16,080	18,660	(2,580)	(6,430)
2006	9,120	2,880	NA	12,000	14,790	(2,790)	(5,670)
2007	10,160	3,210	NA	13,370	15,490	(2,120)	(5,330)
2008	10,320	3,250	NA	13,570	14,920	(1,350)	(4,600)
2003 - 2007 avg.	10,548	3,326		13,874	16,366	(2,492)	(5,818)
2004 - 2008 avg.	10,504	3,312		13,816	16,132	(2,316)	(5,628)
Beaver							
2003	260	10	NA	270	0	270	260
2004	360	10	NA	370	0	370	360
2005	910	30	NA	940	0	940	910
2006	1,420	40	NA	1,460	0	1,460	1,420
2007	2,320	70	NA	2,390	0	2,390	2,320
2008	2,840	80	NA	2,920	0	2,920	2,840
2003 - 2007 avg.	1,054	32		1,086	0	1,086	1,054
2004 - 2008 avg.	1,570	46		1,616	0	1,616	1,570

Source: RRCA accounting spreadsheets

Notes: Total Available Supply (5) is the sum of Colorado's allocation (2) and the unallocated supply (3). Column (8) is not part of Table 4A and was added by Kansas. It is the difference between Colum (1) and Column (6).

Appendix A-2

Colorado's Republican River CBCU (2003 - 2008)
acre-ft

North Fork

Year	Surface Water CBCU						Ground Water CBCU	Total CBCU
	Haigler Canal	Non Federal Canals	Small Pumps	M&I	Non-Federal Reservoir Evap	Total SW CBCU		
2003	1,169	1,446	-	-	-	2,615	14,023	16,640
2004	1,243	1,733	-	-	46	3,023	14,373	17,400
2005	1,454	1,674	-	-	43	3,171	14,359	17,530
2006	1,592	1,498	-	-	50	3,140	14,301	17,440
2007	1,507	1,469	-	-	38	3,015	14,762	17,780
2008	279	354	-	-	38	671	14,946	15,620
Average	1,207	1,362	-	-	36	2,606	14,461	17,070

Arikaree

Year	Surface Water CBCU					Ground Water CBCU	Total CBCU
	Non Federal Canals	Small Pumps	M&I	Non-Federal Reservoir Evap	Total SW CBCU		
2003	0	0	0	0	0	242	240
2004	0	0	0	0	0	353	350
2005	0	0	0	0	0	811	810
2006	0	0	0	0	0	1,116	1,120
2007	0	0	0	0	0	1,143	1,140
2008	0	0	0	0	0	1,419	1,420
Average	-	-	-	-	-	847	850

South Fork

Year	Surface Water CBCU							Ground Water CBCU	Total CBCU
	Hale Ditch	Non Federal Canals	Small Pumps	M&I	Non-Federal Reservoir Evap	Bonny Reservoir Evap	Total SW CBCU		
2003	-	598	-	-	-	3,375	3,973	12,115	16,090
2004	-	770	-	-	-	3,158	3,928	12,874	16,800
2005	-	275	-	-	-	3,430	3,704	14,952	18,660
2006	-	-	-	-	-	3,031	3,031	11,756	14,790
2007	26	240	-	-	-	2,716	2,981	12,511	15,490
2008	-	52	-	-	-	1,980	2,032	12,892	14,920
Average	4	322	-	-	-	2,948	3,275	12,850	16,130

Mainstem

Year	Ground Water CBCU
2003	132
2004	-1,269
2005	-1,954
2006	-3,009
2007	-2,033
2008	-2,179
Average	(1,720)

Source: RRCA accounting spreadsheets

Appendix A-2

Kansas' South Fork CBCU (2003 - 2008)
acre-ft

Year	Surface Water CBCU					Ground Water CBCU	Total CBCU
	Non Federal Canals	Small Pumps	M&I	Non-Federal Reservoir Evap	Total SW CBCU		
2003	-	29	-	-	29	5,351	5,380
2004	-	19	-	285	303	5,781	6,080
2005	-	10	-	285	294	7,227	7,520
2006	-	-	-	325	325	4,398	4,720
2007	-	-	-	144	144	5,527	5,670
2008	-	-	-	121	121	5,748	5,870
Average	-	10	-	193	203	5,672	5,870

Source: RRCA accounting spreadsheets

Hypothetical Calculations of the Projected Delivery and the Limit on Augmentation Water Sup 8/5/2009

A	B	C	D	E	F	G	H	I	J		
Year	Colorado's Total Allocation	Computed Beneficial Consumptive Use	Deficit or Difference	Projected Delivery	Max Aug. Water Supply (AWS) Credit	Measured Pipeline Deliveries	Annual Calculation = Alloc - (CBCU - Deliveries)	Five-year running average	*Limited??*	Remarks	
1993	42,214	35,274	6940			0	6,940				
1994	35,831	32,967	2864			0	2,864				
1995	40,714	35,125	5589			0	5,589				
1996	39,659	36,469	3190			0	3,190				
1997	32,641	35,442	(2801)	0	4,000	0	-2,801	**3156**		No previous deficit; therefore, Max AWS Credit is 4000 af	
1998	33,294	36,148	(2854)	2,801	6,801	4,000	1,146	**1998**		Max AWS Credit is Projected Delivery plus 4000 af because it is larger	Minimum 4000 af delivery
1999	37,782	38,217	(435)	2,854	6,854	4,000	3,565	**2138**		Max AWS Credit is Projected Delivery plus 4000 af because it is larger	Minimum 4000 af delivery
2000	31,427	37,691	(6264)	2,854	6,854	4,000	-2,264	**567**		Max AWS Credit is Projected Delivery plus 4000 af because it is larger	Minimum 4000 af delivery
2001	27,572	36,132	(8560)	6,264	10,264	4,000	-4,560	**(983)**		Max AWS Credit is Projected Delivery plus 4000 af because it is larger	Minimum 4000 af delivery
2002	20,741	35,228	(14487)	8,560	12,560	4,000	-10,487	**(2520)**		Max AWS Credit is Projected Delivery plus 4000 af because it is larger	Minimum 4000 af delivery
2003	21,420	33,470	(12050)	14,487	20,282	4,000	-8,050	**(4359)**		Max AWS Credit is 140% of Projected Delivery because it is larger	Minimum 4000 af delivery
2004	22,540	33,670	(11130)	14,487	20,282	13,629	2,499	**(4572)**		Deliveries begin, but limited to Hist. CU b/c there has been no banking	
2005	25,040	35,460	(10420)	14,487	20,282	13,629	3,209	**(3478)**		Max AWS Credit is 140% of Projected Delivery because it is larger	
2006	21,090	30,760	(9670)	14,487	20,282	13,629	3,959	**(1774)**		Max AWS Credit is 140% of Projected Delivery because it is larger	
2007	24,520	32,850	(8330)	14,487	20,282	13,629	5,299	**1383**		Max AWS Credit is 140% of Projected Delivery because it is larger	
2008	27,000	32,000	(5000)	14,487	20,282	4,000	-1,000	**2793**		Max AWS Credit is 140% of Projected Delivery because it is larger	Minimum 4000 af delivery
2009	27,000	33,000	(6000)	14,487	20,282	4,000	-2,000	**1893**		Max AWS Credit is 140% of Projected Delivery because it is larger	Minimum 4000 af delivery
2010	27,000	33,000	(6000)	14,487	20,282	4,000	-2,000	**852**		Max AWS Credit is 140% of Projected Delivery because it is larger	Minimum 4000 af delivery
2011	21,000	33,000	(12000)	14,487	20,282	20,500	8,282	**1716**	*Limited to Max*	Deliveries > Hist. CU b/c of banking, but Max AWS Credit applies	
2012	27,000	32,000	(5000)	14,487	20,282	4,000	-1,000	**456**		Max AWS Credit is 140% of Projected Delivery because it is larger	Minimum 4000 af delivery
2013	27,000	33,000	(6000)	12,050	16,870	4,000	-2,000	**256**		Max AWS Credit is 140% of Projected Delivery because it is larger	Minimum 4000 af delivery
2014	32,641	35,442	(2801)	12,000	16,800	4,000	1,199	**896**		Max AWS Credit is 140% of Projected Delivery because it is larger	Minimum 4000 af delivery
2015	33,294	36,148	(2854)	12,000	16,800	4,000	1,146	**1525**		Max AWS Credit is 140% of Projected Delivery because it is larger	Minimum 4000 af delivery
2016	37,782	38,217	(435)	12,000	16,800	4,000	3,565	**582**		Max AWS Credit is 140% of Projected Delivery because it is larger	Minimum 4000 af delivery
2017	31,427	37,691	(6264)	12,000	16,800	6,500	236	**829**		Max AWS Credit is 140% of Projected Delivery because it is larger	
2018	27,572	36,132	(8560)	12,000	16,800	9,000	440	**1317**		Max AWS Credit is 140% of Projected Delivery because it is larger	
2019	20,741	35,228	(14487)	12,000	16,800	13,000	-1,487	**780**		Max AWS Credit is 140% of Projected Delivery because it is larger	
2020	21,420	33,470	(12050)	14,487	20,282	13,000	950	**741**		Max AWS Credit is 140% of Projected Delivery because it is larger	

= formula amended to account for lack of data for 10 yrs

A Accounting Year
B From RRCA Accounting
C From RRCA Accounting
D Allocation (B) minus CBCU ©
E Largest Deficit in previous 10 years
F E + 4000 or E * 140% whichever is larger
G Augmentation Water Pumped during the accounting year
H Annual Calculation = Alloc - (CBCU - Deliveries) (B-(C-G))
I Running Average = ave of this year plus previous 4 years (Column H)
J Flag that notes if pumping (G) exceeds AWS limit (F)