

## **Engineering Committee Report**

### **Republican River Compact Administration**

August 27, 2015

#### **EXECUTIVE SUMMARY**

The Engineering Committee (EC) met four times since last August's Republican River Compact Administration (RRCA) Annual Meeting. Over the past year, the EC completed these assignments: 1) holding quarterly meetings and 2) exchanging information listed in Section V of the RRCA Accounting Procedures and Reporting Requirements, including all required data and documentation.

Ongoing assignments include 1) continuing efforts to resolve concerns related to varying methods of estimating ground and surface water recharge and return flows and related issues, 2) continuing to finalize accounting for 2006-2014, 3) working to resolve issues preventing agreement on final accounting for 2006-2014, and 4) discussing any accounting changes that may be needed for surface water diversions for the purpose of recharging groundwater.

The EC recommends discussion by the RRCA on the exchange of data and documentation and the modeling runs completed by Principia Mathematica for 2014, discussion of Nebraska's proposal to revise the RRCA Accounting Procedures and Reporting Requirements and RRCA Rules and Regulations documents, and the recommended EC assignments for the following year.

Details of the various EC tasks are described further in the remainder of this report, including as attachments, the EC meeting notes.

#### **COMMITTEE ASSIGNMENTS AND WORK ACTIVITIES RELATED TO THESE ASSIGNMENTS**

1. Meet quarterly to review the tasks assigned to the committee.
  - a. Assignment completed.
  - b. The EC held four meetings since the August 2014 RRCA Annual Meeting. Notes from the four EC meetings are attached: November 4, 2014 (Attachment 1), January 28, 2015 (Attachment 2), May 14, 2015 (Attachment 3), and August 19, 2015 (Attachment 4).
2. Exchange by April 15, 2015, the information listed in Section V of the RRCA Accounting Procedures and Reporting Requirements, and other data required by that document, including all necessary documentation. By July 15, 2015, the states will exchange any updates to these data.
  - a. Assignment completed.

- b. Kansas, Nebraska, and Colorado posted preliminary data by April 15, 2015. The status and details of the preliminary data exchange was discussed at the May 14 and August 19, 2015, EC meetings (Attachments 3 and 4). All three states had final data posted by August 25, 2015.
    - c. In advance of the January 2015 meeting, Willem Schreüder of Principia Mathematica executed model runs as prescribed by the committee for 2014 using full-year temperature and precipitation data, river data, and pipeline information. He also executed preliminary model runs for 2015 using temperature data, long-term average precipitation data, 2014 evaporation data, river data, and pipeline information. This information has been posted to the RRCA website.
    - d. The Committee discussed the process of updating documentation of the modeling processes. Principia Mathematica will continue to update the modeling process documentation. The write-up for the update will have two versions of the processing programs: 2001 to 2006 and 2007 to present.
3. When possible, continue efforts to resolve concerns related to varying methods of estimating ground and surface water irrigation recharge and return flows within the Republican River Basin and related issues.
  - a. Assignment ongoing.
  - b. Kansas is working on a scope and needs document for this task regarding changes in irrigation efficiency through time.
4. When possible, continue efforts to finalize accounting for 2006-2013.
  - a. Assignment ongoing.
  - b. The EC discussed Schreüder's concerns about which values to use for accounting, due to issues with items like the USGS streamflow gages date, which are subject to change. Schreüder prepared an accounting spreadsheet for discussion at the July 2015 EC meeting.
5. Work to resolve issues preventing agreement on final accounting for 2006-2013, as identified in the 2014 EC Report. These issues include:
  - a. Evaluation of whether to include direct return data from canals in accounting calculations and modeling (Column C of Attachment 7 to the RRCA Accounting Procedures).
    - i. Assignment complete.
    - ii. Nebraska submitted a proposal for changes to the RRCA Accounting Procedures and Reporting Requirements document, which included changes proposed in the Report of the Special Master, as well as changes to Attachment 7 of the document for Spill to Waste-way data, and Percent Field and Canal Loss that Returns to Stream for the Non-Irrigation Season. This proposal is available as Attachment A to the May 2015 EC Minutes (Attachment 3). The EC discussed this proposal at the August 2015

- meeting and has agreed that the proposal should be recommended for approval by the RRCA.
- b. Kansas's request for beginning and ending meter data from other states.
    - i. Assignment ongoing.
    - ii. Kansas reviewed and approved Nebraska's beginning and ending meter data, does not see a need for further review of these data, and
    - iii. Kansas is reviewing Colorado's meter data. Colorado's 2012, 2013, and 2014 meter data are now available on the RRCA website. As Colorado has no meter data older than 2012, Kansas is examining how the 2012-2014 data correspond with the 75 percent Gross Irrigation Requirement assumption.
  - c. Reaching consensus about how to model Bonny Reservoir.
    - i. Assignment ongoing.
    - ii. Kansas and Colorado discussed this issue in ongoing confidential conversations.
6. Discuss any accounting changes that may be needed for surface water diversions for the purpose of recharging groundwater, as data become available from Nebraska projects.
- a. Assignment ongoing.
  - b. Nebraska submitted a proposal for changes to the RRCA Accounting Procedures and Reporting Requirements document, which included changes proposed in the Report of the Special Master, as well as changes to Attachment 7 of the document for Spill to Waste-way data, and Percent Field and Canal Loss that Returns to Stream for the Non-Irrigation Season. This proposal is available as Attachment A to the May 2015 EC Minutes (Attachment 3). The EC discussed this proposal at the August 2015 meeting and recommends that discussions continue within the EC on this topic.
7. When possible, discuss developing an application and approval process for future augmentation plans.
- a. Assignment not completed.
  - b. Due to ongoing consideration of this topic at Three-States meetings throughout the year, the EC deferred discussion of this assignment.
8. Continue to explore options for sharing evaporation charges for Harlan County Lake when accounts exist separate from the project water supplies of Bostwick Irrigation District and explore potential means to adjust the compact accounting of Harlan County Lake for the mutual benefit of the States.
- a. Assignment not completed
  - b. Kansas and Nebraska have discussed the issues related to calculating the incremental increase in reservoir areas, and they are close to being resolved. Discussion of these issues will continue at Three-States meetings.

9. Continue to explore the development of an RFP to determine contractor options for the annual model update and model repository.
  - a. Assignment not completed

## OTHER COMMITTEE ACTIVITIES

1. A Conservation Committee Terraces Study Report was provided to the RRCA for their consideration at the August 2014 Annual Meeting. Since the August meeting, the EC has been working on two follow-up tasks related to this report. First, preliminary data from the report have been posted on the RRCA website, with final data forthcoming when Schreüder receives it from the Bureau of Reclamation. Second, the EC has developed an author and participants' page for the report and it is posted to the RRCA website ([http://www.republicanrivercompact.org/misc/Reference%20Page\\_Conservation%20Committee\\_Jun2014FinalReport.pdf](http://www.republicanrivercompact.org/misc/Reference%20Page_Conservation%20Committee_Jun2014FinalReport.pdf)). A copy is included in this report as Attachment 5.
2. The EC discussed changes in status for three stream gages: Beaver Creek, Republican River at Guide Rock, and Republican River at Benkelman. The Beaver Creek and Guide Rock gages were formerly maintained by Nebraska, now, due to an increased allocation of funds, the USGS has been able to assume responsibility for them. Benkelman had been discontinued by the USGS, but was started again due to the increase in funds. In addition, Nebraska kept the EC informed about WISKI, its new website for real-time data for Nebraska stream gages.
3. Updates on the status of the development and review of RRCA annual reports for 2013, 2014, and 2015 were given by the states at each quarterly EC meeting.
4. The EC discussed Nebraska's 2015 water administration during the January 2015 meeting. This is a Compact Call Year, but the Rock Creek and N-CORPE augmentation projects will provide for the forecasted water shortage. Nebraska and Kansas expressed mutual interest in being relieved of the burden of Warren Act contracts.
5. Kansas suggested that the RRCA develop an administrative website that would be an informational page for the general public. Kansas is developing a draft to share with the EC for discussion.
6. Nebraska has developed a new method for tracking non-federal reservoirs. The new method was discussed at the August EC meeting.
7. Willem Schreüder of Principia Mathematica executed model runs for the years 2007 – 2013 incorporating the new values for the accounting change required by the February 2015 Court order.

## **ITEMS FOR RRCA DISCUSSION & ACTION**

Based upon the EC discussions and information presented in this report, the EC recommends RRCA discussion and potential action on the following items:

1. Agreement that the Data Exchange & Modeling Results for 2014 are complete. The EC has examined the data exchanged and the results from Principia Mathematica and agrees that the 2014 modeling runs are complete.
2. Discussion and direction on the specific modeling and data tasks to be assigned to Principia Mathematica for new data in year 2015.
3. Discussion of Nebraska's proposal to revise the RRCA Accounting Procedures and Reporting Requirements document and RRCA Rules and Regulations to include changes proposed in the Report of the Special Master as well as Attachment 7 of the Accounting Procedures to include direct return data from canals in accounting calculations and modeling.
4. Discussion of the recommended EC assignments and other potential assignments for the next year and agreement on a final set of assignments. The EC presents the list of 7 items in this report as recommended assignments for 2015.

## **RECOMMENDED ASSIGNMENTS FOR THE COMING YEAR**

The Engineering Committee recommends the Republican River Compact Administration assign the following tasks:

1. Meet quarterly to review the tasks assigned to the committee.
2. Exchange by April 15, 2016, the information listed in Section V of the RRCA Accounting Procedures and Reporting Requirements, and other data required by that document, including all necessary documentation. By July 15, 2016, the states will exchange any updates to these data.
3. When possible, continue efforts to resolve concerns related to varying methods of estimating ground and surface water irrigation recharge and return flows within the Republican River Basin and related issues.
4. When possible, continue efforts to finalize accounting for 2005-2014.
5. Work to resolve issues preventing agreement on final accounting for 2006-2014, as identified in the 2015 EC Report. These issues include:
  - a. Kansas's review of Colorado meter data.
  - b. Reaching consensus about how to model Bonny Reservoir.
6. Discuss any accounting changes that may be needed for surface water diversions for the purpose of recharging groundwater, as data become available from Nebraska projects.

7. Assign responsibility for collecting specific fields of data collected for the annual data exchange by determining who has the best available data and assigning them the responsibility of populating those fields in order to avoid confusion between multiple datasets.
8. Draft a letter to the USGS to discuss how the RRCA can get finalized gage data by April 15 of each year.
9. Create a document memorializing when RRCA Accounting Procedures have changed over the years and incorporate it into the Accounting Procedures

The Engineering Committee Report and the exchanged data will be posted on the web at [www.republicanrivercompact.org](http://www.republicanrivercompact.org).

**SIGNED BY**



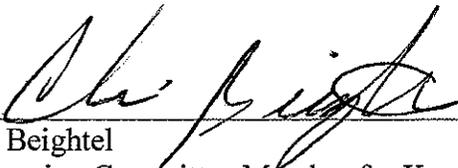
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James Schneider  
Chair, Engineering Committee Member for Nebraska



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Ivan Franco  
Engineering Committee Member for Colorado



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Chris Beightel  
Engineering Committee Member for Kansas

Drafted 12/10/2014

Meeting Notes for the  
**QUARTERLY MEETING of the  
ENGINEERING COMMITTEE of the  
REPUBLICAN RIVER COMPACT ADMINISTRATION**  
November 20, 2014, 1:00 PM Central, 12:00 Noon Mountain

## Attendees:

Jim Schneider	Nebraska	Chris Beightel	Kansas
Jennifer Schellpeper	Nebraska	Chelsea Erickson	Kansas
Kathy Benson	Nebraska	Willem Schreuder	Principia Mathematica
Ivan Franco	Colorado		

1. Introductions
2. Review/Modify Agenda – no modifications were made at the meeting.
3. Publication of RRCA Annual Reports
  - a. Erickson stated that work continues on the 2013 (4 & 5) annual reports. Franco continues work also on the meetings he is processing (2 & 3) and **they are both to have them ready for the August annual meeting.** Nebraska sent their comments on the December 2012 meeting to Erikson.
  - b. Nebraska has the transcripts for the 2014 reports and the summaries are currently being worked on. **Processing on the annual meeting will be next and drafts for will review will be forthcoming.**
4. Modeling and Data Tasks for Principia Mathematica
  - a. **Schreuder continues to work on documentation.** He has had little time to make much progress.
5. Conservation Committee Terraces Study
  - a. Data is posted on the website **with final data forthcoming when Schreuder receives it from the BOR.**
  - b. Need to add author and participants page to the report. The 2004/05 Conservation committee formed. Martin/Koelleker are the authors. **Kansas will draft an author page and route it for review. Schreuder can post it to the website.**
6. Data Exchange
  - a. Colorado still needs NASS data for crop distribution. NASS may no longer have irrigated/non-irrigated data differentiated so process is taking longer. Not a measurable difference in pumping from 2013 data. The original canal leakage calculations for the CNPPID system were incorrect. Nebraska supplied corrected canal leakage values and Schreuder re-ran the analysis. Model results stayed nearly the same.
  - b. 2014 Accounting-Schreuder ran models repeating the 2013 values in 2014, CCP used historical data. 2014-2015 ran website model as committee wanted. Data is on the website.
  - c. 2015 runs-repeat 2014/2013 data. First cut is done for 2015.
7. Estimating Ground and Surface Water Irrigation Recharge and Return Flows
  - a. Beightel hasn't had time to work on this

Drafted 12/10/2014

Meeting Notes for the  
**QUARTERLY MEETING of the  
 ENGINEERING COMMITTEE of the  
 REPUBLICAN RIVER COMPACT ADMINISTRATION**  
 November 20, 2014, 1:00 PM Central, 12:00 Noon Mountain

8. Accounting changes for Nebraska Groundwater Recharge Project
  - a. Nebraska has pulled together some data and **will have ready for the next meeting.**
9. Future Augmentation Plans – no discussion at this time.
10. Harland County Lake-Evaporation Charges and Compact Accounting Adjustments – no discussion at this time
11. Evaluation of Whether to Include Direct Return Data from Canals in Accounting Calculations and Modeling
  - a. Schneider asked Kansas for feedback. Response by Beightel was to use the Meeker Driftwood example. He also suggested Nebraska offer a resolution and propose a solution and it be done in that manner. Schneider stated he was not sure that Meeker Driftwood was the best example but maybe the Cambridge Canal spills would be better. **Schneider offered to put something together and have it tested next year.**
12. Beginning and Ending Meter Data
  - a. Nebraska has given some data to Kansas, and **Kansas would like to continue their audit until the end of the year then will return it to Nebraska. Beightel needs to review the Colorado data** as there is a question on over pumping. Colorado data is online for 2013 but it is not complete, 2012 data is complete but not out yet. 95% of the data is complete. Beightel requested data as far back as possible. **Franco will get the numbers to Beightel.** There is data on Schreuder's website.
13. Modeling Bonny Reservoir
  - a. **Kansas and Colorado discussions are ongoing**
14. Streamgages-Status Updates
  - a. Schneider stated that USGS took over the responsibility for Beaver Creek and the Republican River at Guide Rock and Benkelman.
  - b. DNR will be responsible for the gage at Medicine Creek below Harry Strunk Reservoir. A website has been developed and data migration software is going through an upgrade (WISKI 6 to 7). Hopefully real-time data will be posted by the end of the year. Beightel asked how many real-time gages there were. Schneider shared there are approximately 10 real-time gages in the Republican River Basin and statewide approximately 100 streamgages. Should be good data availability soon with Phase I becoming available.
15. Summary of Meeting Actions/Assignments
  - a. Assignments and agenda stay the same
16. Future Meeting schedule
 

The next meeting is a Three-States Meeting on January 13<sup>th</sup>, 2015, in Lincoln. The meeting was adjourned at 1:40 p.m.

Drafted 02/12/15

Meeting Notes for the  
**QUARTERLY MEETING of the  
ENGINEERING COMMITTEE of the  
REPUBLICAN RIVER COMPACT ADMINISTRATION**  
January 28, 2015, 1:00 PM Central Time, 12:00 PM Mountain Time

## Attendees:

Jim Schneider	Nebraska	Chris Beightel	Kansas
Jennifer Schellpeper	Nebraska	Ginger Pugh	Kansas
Ryan Werner	Nebraska	Willem Schreuder	Principia Mathematica
Kathy Benson	Nebraska	Ivan Franco	Colorado
Bill Peck	BOR, McCook	Tom Riley	Flatwater Group
Craig Scott	BOR, McCook		

1. Introductions
2. Review/Modify Agenda
  - a. Schneider requested to add to the agenda discussion about Three-States meeting dates and discussion on water administration activities year-to-date. A proposal letter was sent to the Department from the Bureau that suggested being more in sync with tracking water administration or we may have the same situation as before with Kansas water in Nebraska.
3. Publication of RRCA Annual Reports
  - a. 2013 Reports (Kansas)
    - i. Erickson was to give an update but was not able to attend the meeting. **This item will stay on the agenda.**
  - b. 2014 Reports (Nebraska)
    - i. Benson gave the report on the status of the meeting minutes. The November EC minutes were emailed to everyone on 12/12 and 1/16 and are ready for a final copy. For the special meeting minutes, the December 2013 minutes were emailed on January 8<sup>th</sup> with attachments and sent to Kansas for review. **Kansas still has possession of them and is to send them on to Colorado.** For the October 2014 special meeting, Nebraska is currently drafting the summary, and Nebraska is still waiting on the transcript for the November 2014 special meeting. The August 2014 annual meeting summary has been drafted **and will be ready to send to everyone in the near future.**
4. Modeling and Data Tasks for Principia Mathematica

- a. Documentation
    - i. Schreuder reports no progress on this.
5. Conservation Committee Terraces Study
- a. Posting of final data from BOR to website
    - i. Schrueder continues to wait on the GIS data.
  - b. Draft Author Page
    - i. Beightel reported Erickson has been able to collect data from her contacts with Drs. Martin and Koelliker as well as some of the farmers and plans on giving them space on the author page. **Erickson is working on the draft and hopes to have it ready by the next EC meeting.**
6. Data Exchange
- a. 2014 Accounting
    - i. Schrueder ran 2014 using full-year temperature/precipitation data, river data, and pipeline information.
    - ii. Franco referred to the information Schrueder sent out on January 7<sup>th</sup>. There have not been any new data from Schrueder with the 2014 correct data crop statistics. Schrueder reported that he heard from Jim Slattery who is working on county totals on the Colorado crop data but the problem exists wherein irrigated acres are no longer specified. Total values are being used for both dry and irrigated values. Beightel suggested to Schrueder to use pumping data to differentiate dry and irrigated land. Schrueder was not sure if that would work the way he would want it to.
  - b. 2015 Accounting
    - i. Schrueder ran the same data as in 2014 verbatim except he used the long-term average data for precipitation. For evapotranspiration he used 2014 data. This information is posted to the website. He also cleaned up the output as there was starting to be too many large columns.
7. Estimating Ground and Surface Water Irrigation Recharge and Return Flows
- a. Draft scope and needs document regarding changes in irrigation efficiency.
    - i. Beightel reported there has not been any progress made on this. **He reassured the attendees that it will get done.**
8. Accounting changes for Nebraska Groundwater Recharge Project
- a. Discuss how accounting procedures address evaporation and diversion at different times of the year
    - i. Werner put together the data that were sent out on Friday showing how evaporation varies throughout the year. Schneider stated these data are foundational information for a proposal that Nebraska is working on for a different way of accounting for diversions outside of the irrigation season (October to April). Nebraska will be specifically looking at the value of Table 7, which states an 82% loss of water not returning to the stream. **The goal is to**

**present an accounting change proposal to the RRCA by August and so hopefully to the engineering committee at the April meeting. Jim encouraged the group to contact Werner if they had any questions on the data.**

9. Future Augmentation Plans – Application and Approval Process

- a. Schneider stated **this item will be discussed at the Three-States Meeting.**

10. Harlan County Lake - Evaporation Charges and Compact Accounting Adjustments

- a. Examples for calculating the incremental increase in reservoir areas  
i. Beightel reported no progress.

11. Evaluation of Whether to Include Direct Return Data from Canals in Accounting Calculations and Modeling

- a. Proposed resolution and example (Nebraska)  
i. Schneider reported this has to do with Table 7 and direct returns to the stream. A minor change was added to compute canal loss. **Nebraska will have a proposal ready by the April meeting using Meeker Driftwood/Cambridge**, which will be running and do have monitored drains on them. It will be a fairly small change, as the BOR will be running the canals “tight” to minimize spills. Scott has reported in the past that data do exist for the Franklin canal and other canals on the Bostwick system. Peck confirmed this. Schneider asked if Beightel was willing to entertain this option on a trial basis if the proposal looks good. Beightel stated he was open to this. Schneider stated that **a formal proposal and example would be sent out before the next meeting, and a recommendation made to the RRCA before August.**

12. Beginning and Ending Meter Data

- a. Audit of Nebraska data (Kansas)  
i. Beightel approved the data. He does not feel there is need for any further review, and sees no roadblock for the accounting.  
b. Review of Colorado Data (Kansas)  
i. Beightel and Franco seemed unsure as to what data were given and what needed to be given and said they would check on this. Schrueder thought Kansas was given 2012 and 2013 back in August. Franco stated 2011 data were not used because that was a year of trying to get meter data figured out. Schneider stated **this will be kept on the agenda.**

13. Modeling Bonny Reservoir

- a. Kansas and Colorado discussions  
i. Schneider stated that, as ongoing conversations between Kansas and Colorado are confidential, this agenda item will be skipped today and **kept on the agenda for the next meeting.**

## 14. Stream gages - Status updates

- a. Real-time data availability for Nebraska's gages
  - i. Schneider reported there is a real-time data website up and running. The Nebraska gage data will be operated similarly to USGS stream gage data. The site also provides links to USGS gage data. The goal is to include historical data at some point and make the map interactive. **Schneider encouraged the committee to contact Jeremy Gehle at the Department if there were any questions or comments.**

## 15. New Agenda Item:

- a. 2015 Water Administration
  - i. Schneider stated this is a Compact Call Year with a forecasted shortage of 17,600 acre-feet. The augmentation projects will provide for this shortage. Schneider's understanding is that Rock Creek is running into this year in order to meet the target from last year, which was not met due to equipment issues. When Rock Creek hits its target they will shut it down, as it has been pumping 36,000 acre-feet over the last two years. The N-CORPE project is operating. They also had issues with wells, but are now pumping water for 2015 compliance. Harlan County Lake is accruing water, and the BOR has been reporting their monthly tracking data. Nebraska received the data at the end of 2014 with 30,000 acre-feet of water. 14,100 acre-feet will be retained under the Warren Act contract and the rest back under project water, and then the BOR will start tracking the accruals to the various accounts. Schneider said **this will be revisited in April.** Nebraska is not planning any changes in the Water Administration until the 17,600 acre-feet is into Harlan County Lake. It appears Nebraska is 5,000 acre-feet on the way towards that goal, as inflows have picked up since the beginning of the month. The BOR proposes releasing water out of Harry Strunk to help meet that goal faster and allow for water rights to be opened to store water for project use this year. Schneider is not sure the release is necessary, but it might help Harlan County Lake operations. Data were received from Craig Scott showing how they would expect to operate, based on historic conditions, if there was no water administration before the irrigation season and possibly during the irrigation season. **Jesse Bradley is looking at that data and the goal is to provide more certainty to the irrigation districts. More discussion is needed throughout the year** or we may end up in the same situation, wherein Kansas water is still in Nebraska with Kansas having no place to store it. Schneider asked if this was okay to add to the agenda items.

Beightel was in favor of this being on the agenda. No response from Franco. Beightel had questions for the BOR. He suggested the arrangement seems to be a *quid pro quo* to release water from Harry Strunk in lieu of Nebraska opening up the basin. Beightel asked whether closing notices being off would mean that the water released would automatically become project water and under the BOR's full control. He also asked if all the enclosed water in Harlan County Lake is

accrued to the Kansas Bostwick District's account, what is that account? He wanted more clarification on what the BOR was referring to in their correspondence and how Kansas will be impacted. **Bill Peck said he would pass this question on.** Peck did confirm on the first question that his understanding was that once the 17,600 acre-feet is met, the rest would be project water. Beightel also asked Peck for more clarification on the N-CORPE pumping and **Peck stated he would get more clarification.**

Beightel asked Schneider about the Rock Creek and N-CORPE pumping to meet targets for last year and asked if those were Nebraska targets. Schneider stated that Nebraska has already administered the water through to Kansas, but still needs to keep its commitment so the administration has minimal impact to the water users. Riley also commented on Beightel's question, stating that Nebraska still needs to fulfill its commitment even though Kansas has its water.

Schneider feels the issues that have come up over time for the BOR and water users that have been causing an impact, such as a need to enter into new contracts or the increased uncertainty in terms of water supplies, are all related to Nebraska's water administration. He stated that water administration is the only tool Nebraska has to ensure its compact obligations, but that Nebraska would be happy with not having to use that tool if it knew that compact compliance would be ensured. He stated that under the IMPs, augmentation projects are used to pump water in the river, administration to shepherd it through, and administration to address any uncertainty in the forecast. If Nebraska knew it would happen some other way, Schneider would be thrilled not to send opening and closing letters throughout the year. He feels that if there were not the burden of Warren Act contracts, Kansas might then provide more flexibility on how Nebraska sends the water, such as making up shortfalls in the fall or winter. Everyone can get what they want by giving something. **This will be a topic of discussion for upcoming meetings.**

Beightel supports Schneider's statements, and stated that Kansas would be interested in looking at what kinds of flexibilities they could afford if they did not have to deal with the Warren Act contracts, which are quite a burden to the Kansas district. Beightel states that Kansas also needs to look long-term to protect its allocations.

**Schneider asked Peck to relay these comments to the BOR.** (Craig Scott had stepped out of the meeting).

## 16. Summary of Meeting Actions/Assignments

- a. Schneider reported that meeting notes will be sent out again to cover assignments.

17. Future Meeting Schedule

- a. The Engineering Committee has meetings scheduled for April and July of this year, which will fulfill the four meetings for the year. Schneider asked if anyone needed more meetings scheduled. Beightel felt the EC meetings and Three-States meetings were enough for now. The proposed Three-States meetings for the next three months will be in Denver next month, Manhattan the following month and then back in Lincoln. Schreuder will not be able to make all these meetings due to his schedule. Schneider stated phone access will be made available if needed.

Beightel asked that the next Three-States meeting be done in a day for cost effectiveness. Beightel did speak with Mandi Maser of Jim Schneider's office about arranging this for February 26<sup>th</sup>. Kansas would rather do meetings in one day, and if others want to, they can get together the evening before. Schneider said the extra time on the second day was being allocated for the BOR and saw no reason it could not all be done in one day. Schneider asked for feedback on whether the EC is ready for the BOR to come in and have more discussion. Beightel stated they (BOR) should be there as often as they can so issues can be resolved.

18. Adjournment

- a. The meeting adjourned at 2:02 p.m.

Drafted 6/17/2015

KS Edits 6/26/15

CO Edits 6/29/15

Final Meeting Notes for the  
**QUARTERLY MEETING of the**  
**ENGINEERING COMMITTEE of the**  
**REPUBLICAN RIVER COMPACT ADMINISTRATION**  
 May 14, 2015, 1:00 PM Central Time, 12:00 PM Mountain Time

## Attendees:

Jim Schneider	Nebraska	Chris Beightel	Kansas
Jennifer Schellpeper	Nebraska	Chelsea Erickson	Kansas
Kathy Benson	Nebraska	Willem Schreuder	Principia Mathematica
Craig Scott	BOR, McCook	Ivan Franco	Colorado

1. Introductions
2. Review/Modify Agenda
  - a. Erickson requested to add discussion of creating a new RRCA-oriented website. The Agenda modification was approved.
3. Publication of RRCA Annual Reports
  - a. 2013 Reports (Kansas)
    - i. Erickson reported that Kansas is still finalizing the report from the Colby, KS meeting and will pass it to Colorado. Colorado is currently reviewing the March, May, and July 2013 reports and will pass them to Nebraska. All States have reviewed the December 2012 report, and Erickson is finalizing it with edits.
  - b. 2014 Reports (Nebraska); Benson reported that:
    - i. The December 2013 Special Meeting minutes were emailed to Kansas for review, and they are to send these minutes on to Colorado.
    - ii. The August 2014 Annual Meeting minutes were emailed to Kansas for review, with no return edits as of this writing.;
  - c. 2015 Reports (Nebraska); Benson reported that:
    - i. The October 2014 Special Meeting summary has been drafted and the exhibits are ready for inclusion.
    - ii. The November 2014 Special Meeting summary has been drafted,
    - iii. The March 2015 Special Meeting summary has not yet been drafted.
4. Modeling and Data Tasks for Principia Mathematica
  - a. Documentation
    - i. Schreuder explained that the write-up for the update would have two versions of the processing programs, like what is currently on the website for 2001 to 2006 and 2007 to present. He asked if everyone was okay that the methodology used today be used for 2007 to present, and gave an example of precipitation recharge,

Drafted 6/17/2015

KS Edits 6/26/15

CO Edits 6/29/15

Final Meeting Notes for the  
**QUARTERLY MEETING of the  
ENGINEERING COMMITTEE of the  
REPUBLICAN RIVER COMPACT ADMINISTRATION**  
May 14, 2015, 1:00 PM Central Time, 12:00 PM Mountain Time

etc. Beightel asked for more clarification in email form. **Schreuder stated he would send clarification via email to everyone.**

5. Conservation Committee Terraces Study
  - a. Posting of final data from BOR to website
    - i. Schreuder continues to wait on the GIS data to be posted to the website. **Erickson will ask Scott about this.** Erickson stated she does have a copy of the model documentation from the BOR and **will send it to Schreuder.**
  - b. Draft Author Page
    - i. Erickson reported there is a draft of the author page. She is waiting on final approval **and then will send it to the EC for review.** It will then be posted with the final report.
6. Data Exchange
  - a. 2014 Accounting
    - i. Schreuder ran a preliminary model run on 2014 data using full-year temperature and precipitation data, river data, and pipeline information. He had nothing new to add. Nebraska is not working on any updates at this point, so the Nebraska data are considered final. Beightel stated that Kansas continues to work on updates until at least mid-July. Beightel requested that **the Nebraska data be posted as a zip file**, as has been done in past years. Schneider explained that the process has been more streamlined and that Marc Groff (Flatwater Group) could walk through the process with the EC if needed. It was suggested to **contact Schellpeper about any further data exchange issues.**
    - ii. Franco reported that Colorado now has 2012, 2013, and 2014 meter data available on the website.
  - b. 2015 Accounting
    - i. Per an RRCA resolution, Nebraska has been sending out preliminary estimates for 2015 accounting by the 10<sup>th</sup> of each month. There are not a lot of data to update at this point, as it is early in the year, but that will change in the summer months of June, July, August, and September.
  - c. Finalization of 2014 and previous years accounting (2007-2014)
    - i. Schneider stated that a list of issues preventing finalization was made in the past and that **the EC needs to revisit this list.** Schreuder expressed some of his concerns about having the correct numbers for the accounting sheet due to issues with items like the USGS streamflow gage data, which can change when the USGS works their records. **Schreuder will develop and share with the EC an accounting spreadsheet from 1995 to 2014 for discussion.** Schneider

Drafted 6/17/2015

KS Edits 6/26/15

CO Edits 6/29/15

Final Meeting Notes for the  
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**suggested that everyone review Schreuder's data before the next meeting. If the EC is to finalize accounting before the upcoming RRCA Annual Meeting, more time would need to be scheduled for the EC to meet – Nebraska will extend the meeting.**

7. Estimating Ground and Surface Water Irrigation Recharge and Return Flows
  - a. Draft scope and needs document regarding changes in irrigation efficiency.
    - i. **Beightel reported there has not been any progress made on this.**
  
8. Accounting changes for Nebraska Groundwater Recharge Project
  - a. Discussion on how accounting procedures address evaporation and diversion at different times of the year
    - i. Accounting change proposal (Nebraska) – Attachment A
      1. Schellpeper gave explanation of the procedure in Werner's absence. Three proposed accounting procedures were presented: the first incorporated changes from the Special Master's Report, the second included revisions for the additional spill-to-wasteway values, and the third included non-irrigation season diversions. Schneider stated that **in July, the EC should come prepared to discuss the proposed procedures and what may be carried forward to the Annual RRCA meeting in August for consideration.**
  
9. Future Augmentation Plans – Application and Approval Process
  - a. Ongoing discussions at the Three-States Meeting
    - i. Schneider stated **this item will be discussed at the Three-States Meeting.**
  
10. Harlan County Lake – Evaporation Charges and Compact Accounting Adjustments
  - a. Examples for calculating the incremental increase in reservoir areas
    - i. Schneider reported that he spoke with Barfield and Beightel on the 13<sup>th</sup> and these issues are being wrapped up. **Discussions will continue at the Three-States Meetings.**
  
11. Evaluation of Whether to Include Direct Return Data from Canals in Accounting Calculations and Modeling
  - a. Proposed resolution and example (Nebraska)
    - i. Schneider reported on this item under agenda item 8.

Drafted 6/17/2015

KS Edits 6/26/15

CO Edits 6/29/15

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## 12. Beginning and Ending Meter Data

- a. Review of Colorado Data (Kansas)
  - i. Beightel shared that the **older accounting from 2007 to 2010 needs approval**. The FSS requirement is that some metering is required so that samples can be reviewed. Since Colorado has no meter data older than 2012, Kansas needed to look at the data from 2012 to 2014 that Colorado recently provided and examine how those data corresponds with the 75 percent GIR assumption. If a discrepancy is found, Kanas will then look into it further.

## 13. Modeling Bonny Reservoir

- a. Kansas and Colorado discussions
  - i. Schneider asked about the seepage run that was done by Kansas for the South Fork. Erickson said that she had circulated the measurements to Kansas, and there appear to be gaining reaches on the south end and losing reaches on the upper end. The gauges at the Kansas-Colorado line and Benkelman were similar (11 and 12 cfs). Erickson stated that the Arikaree is still 7 or 8 miles from the gauge but was hopeful due to the rain. Beightel had no other updates.

## 14. 2015 Water Administration (Harlan County Lake)

- a. Schneider, Beightel, and Franco decided to remove this item from the agenda.

## 15. Creating a New RRCA-oriented Website

- a. Beightel suggested that the Compact develop an administrative website that would be an information page for the general public. **Erikson will develop a draft to share with the EC**. Schneider stated that Jen Rae Wang would be the Nebraska staff person to work on this item. Schreuder will share with the EC information based upon his previous experience with similar projects.

## 16. Summary of Meeting Actions/Assignments

- a. **Schreuder will email out his data input page, and everyone else will review it and discuss it in July**
- b. **Accounting change proposal that was drafted by Nebraska will be reviewed by everyone and discussed in July.**
- c. **Erickson will finalize the Conservation Committee Terraces Report author page and then include it as an attachment to that report.**
- d. **The 2015 EC Report to the RRCA will be drafted by Nebraska and discussed at the July meeting**

Drafted 6/17/2015

KS Edits 6/26/15

CO Edits 6/29/15

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- e. **Erickson will follow up with Scott about the BOR data**

17. Future Meeting Schedule

- a. The next meeting of the RRCA Engineering Committee is scheduled for Wednesday, July 29<sup>th</sup>, 2015, at 1:00 p.m. Central Time.

18. Adjournment

- a. The meeting adjourned at 2:20 p.m.



# DNR MEMO

DATE: May 14, 2015

TO: Jennifer Schellpeper, Integrated Water Management Coordinator and Acting IWM Division Head, Nebraska Department of Natural Resources

FROM: Ryan Werner, Integrated Water Management Planner

SUBJECT: Changes to the RRCA Accounting Procedures Documentation Including those Ordered by the U.S. Supreme Court and those Regarding Attachment 7 of the August 12, 2010 RRCA Accounting Procedures and Reporting Requirements Document

## ➤ Executive Summary

The purpose of this Memorandum is to provide documentation of the August 2012 RRCA Accounting Procedures and Reporting Requirements edited to comply with the Special Master Report findings on RRCA accounting procedures and to suggest changes to Attachment 7 in the document.

Proposed changes to Attachment 7 include editing the spreadsheet in order to utilize Spill to Waste-way (SWW) data provided for USBR Canals while also adjusting the Estimated Percent Loss for Column 9 of the original attachment to 92.2875% for diversions which take place during the Non-Irrigation period (October – April).

The following sections provide justification for both the required and proposed changes to the RRCA Accounting Procedures documentation. For the proposed changes, editing the table to incorporate SWW data will not result in any necessary changes to §IV.B of the document, while adjusting the Percent Field and Canal Loss that Returns to the Stream will result in additions to the specific formulas for each sub-basin and the main stem.

Attachments A, B, and C provide examples from the year 2009 using the proposed changes to Attachment 7. Attachment D contains the edited Republican River Compact Administration Accounting Procedures and Reporting Requirements document in its entirety, including all required changes proposed in the Report of the Special Master. Attachments E, F, and G contain the aforementioned document including all required changes proposed in the Report of the Special Master in addition to proposed changes for

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editing Attachment 7 for Spill to Waste-way data, Percent Field and Canal Loss that Returns to Stream for the Non-Irrigation Season, and all changes, required and proposed, in this document, respectively.

➤ **Special Master Report Findings on RRCA Accounting Procedures**

**Special Master Report Findings on RRCA Accounting Procedures**

The following language included in this section has been required by the Supreme Court of the United States in *Kansas v. Nebraska ET AL. On Exceptions to Report of Special Master Decided February 24, 2015.*

APPENDICES TO REPORT OF THE SPECIAL MASTER November 15, 2013

APPENDIX F, Exhibit A: Changes to the Accounting Procedures

**III A 3. Imported Water Supply Credit Calculation:** The amount of Imported Water Supply Credit shall be determined by the RRCA Groundwater Model. The Imported Water Supply Credit of a State shall not be included in the Virgin Water Supply and shall be counted as a credit/offset against the Computed Beneficial Consumptive Use of water allocated to that State. Currently, the Imported Water Supply Credits shall be determined using two runs of the RRCA Groundwater Model:

a. The “base” run shall be the run with all groundwater pumping, groundwater pumping recharge, and surface water recharge within the model study boundary for the current accounting year turned “on.” ~~This will be the same “base” run used to determine groundwater Computed Beneficial Consumptive Uses.~~

b. The “no NE import” run shall be the run with the same model inputs as the base run with the exception that surface water recharge associated with Nebraska’s Imported Water Supply shall be turned “off.” This will be the same “no NE import” run used to determine groundwater Computed Beneficial Consumptive Uses.

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The Imported Water Supply Credit shall be the difference in stream flows between these two model F2 runs. Differences in stream flows shall be determined at the same locations as identified in Subsection III.D.1. for the “no pumping” runs. Should another State import water into the Basin in the future, the RRCA will develop a similar procedure to determine Imported Water Supply Credits.

### III D Calculation of Annual Computed Beneficial Consumptive Use

#### 1. Groundwater

Computed Beneficial Consumptive Use of groundwater shall be determined by use of the RRCA Groundwater Model. The Computed Beneficial Consumptive Use of groundwater for each State shall be determined as the difference in streamflows using two runs of the model:

The “baseno NE import” run shall be the run with all groundwater pumping, groundwater pumping recharge, and surface water recharge within the model study boundary for the current accounting year “on”, with the exception that surface water recharge associated with Nebraska’s Imported Water Supply shall be turned “off.”

The “no State pumping” run shall be the run with the same model inputs as the base “no NE import” run with the exception that all groundwater pumping and pumping recharge of that State shall be turned “off.”

An output of the model is baseflows at selected stream cells. Changes in the baseflows predicted by the model between the “baseno NE import” run and the “no-State-pumping” model run is assumed to be the depletions to streamflows. i.e., groundwater computed beneficial consumptive use, due to State groundwater pumping at that location. The values for each Sub-basin will include all depletions and accretions upstream of the confluence with the Main Stem. The values for the Main Stem will include all depletions and accretions in stream reaches not otherwise accounted for in a Sub-basin. The values for the Main Stem will be computed separately for the reach above Guide Rock, and the reach below Guide Rock.

\*Taken from the August 12, 2010 Accounting Procedures

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A copy of the RRCA Accounting Procedures and Reporting Requirements document containing only the required changes proposed in the Report of the Special Master can be viewed in Attachment D of this document.

➤ Edits to Attachment 7 Regarding Column 3, “Spill to Waste-Way”

The RRCA Compact Accounting Document Attachment 7, Column 3 labeled Spill to Waste-Way (SWW) in its current state in the table, does not directly contribute to %BRF, “Return as Percent of Canal Diversion.” Therefore, as it does not directly affect %BRF, the column is seldom used to incorporate the spill data reported by USBR.

Several changes to the table format in Attachment 7 must be made in order for the total volume returned to stream to reflect the original spill data entered in Column 3. The following list of formulas display the necessary changes to the columns in Attachment 7. The addition of a new column (now Column 4), along with all columns and formulas can be viewed in Attachment A of this document.

- A. Column 4, ~~Field Deliveries~~ “Canal Initial Volume”
  - i. (Col 2 – Col 3) or Canal Diversion – Spill to Waste-way
- B. Column ~~5 6~~, “Canal Loss”
  - i. (Col 2 – Col 4 5 + Col 3) or Canal Diversion – Field Deliveries + Spill to Waste-Way
- C. Column ~~7 8~~, “Field Loss”
  - i. (Col 4 5 \* Col 6 7) or Field Deliveries \* Average Field Loss Factor
- D. Column ~~8 9~~, “Total Loss from District”
  - i. (Col 5 6 + Col 7 8) or Canal Loss + Field Loss
- E. Column ~~10 11~~, “Total Return to Stream from Canal and Field Loss”
  - i. (Col 8 9 \* Col 9 10) + (Col 3 \* 0.18) or Total Loss from District \* Percent Field and Canal Loss that Returns to the Stream + (Spill to Waste-Way \* 0.18)
- F. Column ~~11 12~~, “Return as Percent of Canal Diversion” (BRF)
  - i. (Col 10 11 / Col 2) or Total Return to Stream from Canal and Field Loss / Canal Diversion

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Using these formulas, the volume listed in Column 3 will be represented in equal value in Column 11, as shown in the following example in Attachment A. For this example we will assume a Canal Diversion value of 100 Ac-ft., SWW of 5 Ac-ft., Field Deliveries of 60 Ac-ft., and an Average Field Loss factor of 30%.

### **Almena Canal data 2009**

Data from the year 2009 is also entered in Attachment A for Almena Canal. A value of 36 Ac-ft. is inserted in Col 3. The result of this addition is then reflected in Col 11 where the difference between the adjusted value (1,136 Ac-ft.) and the original value (1,100 Ac-ft.) is equal to the SWW amount of 36 Ac-ft.

%BRF, or Percent of Diversion from Bureau Canals that Returns to the Stream (Col 12), is the only value from Attachment 7 which is represented in the special formulas in §IV.B of the RRCA Accounting Procedures Document. Therefore, the changes to Attachment 7 are sufficient when calculating the specific formulas for each sub-basin and the main stem. No further edits to the formulas must be made to implement this data into the accounting process.

A copy of the RRCA Accounting Procedures and Reporting Requirements document containing the required changes proposed in the Report of the Special Master, in addition to the changes necessary to implement Spill to Waste-way data can be viewed in Attachment E of this document.

### ➤ **Edits to Attachment 7 Regarding Column 9, “Percent Field and Canal Loss that Returns to the Stream”**

In a previous Memorandum entitled “Documentation of Procedures Producing Charts Depicting Net Evaporation, with Executive Summary of Comparisons between Irrigation and Non-Irrigation Seasons or Months for Reservoirs along the Republican River,” it was determined that during the Irrigation Season (May-September), much larger amounts of water are annually lost to evaporative effects than during the Non-Irrigation Season (October-April). On an annual basis, an average ratio of Irrigation Season Evaporation to Non-Irrigation Season Evaporation was determined to be 70/30 after analyzing data for the 10-year period from 2004-2013.

Given that the current evaporation rate of 18% (Percent Field and Canal Loss that Returns to the Stream = 82%) applied in Column 9 of Attachment 7 of the RRCA Accounting Procedures document is a seasonal value normally used for diversions during the Irrigation season, and that the ratio of Irrigation Season to Non-Irrigation Season is equal to 70/30, the following proof can be implied to determine an appropriate value for

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the evaporation rate (1-Percent Field and Canal Loss that Returns to the Stream) during the Non-Irrigation Season.

**Proof:**

X = Irrigation Season Evaporation Rate (18%)

**Y = Non-Irrigation Season Evaporation Rate (\_\_\_%)**

70/30 = Ratio of Irr. Season to Non-Irr. Season Evaporation Rates

Where,

$$X / Y = 70 / 30$$

And

$$Y = X / (70/30)$$

Therefore,

$$Y = 0.18 / (70/30)$$

Or

$$Y = \mathbf{0.077143}$$

From this proof, it can be implied then that if Col 9 of Attachment 7 = 82% (1-0.18) for the Irrigation Season, Col 9 of Attachment 7 would then equal 92.2857% (1-0.077143) for the Non-Irrigation Season. Calculations for each canal must then be broken down according to Irrigation Season diversions and Non-Irrigation Season diversions as shown in the following example in Attachment B for the year 2009.

For this example we will assume a Canal Diversion value of 100 Ac-ft., SWW of 0 Ac-ft., Field Deliveries of 0 Ac-ft., and an Average Field Loss factor of 30%.

*\*Note: For Non-Irrigation Season calculations, Column 2 "Spill to Waste-way" is null and Column 4 "Field Deliveries" will always be zero, as water is not diverted for field use.*

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Because Column 4 is equal to zero, Column 5 “Canal Loss” will always be equal to the original diversion amount, and Column 7 “Field Loss” will also be zero. Therefore, Column 8 “Total Loss from District” will be equal to the original diversion amount.

Then, because of these implications, Column 10 “Total Return to Stream from Canal and Field Loss” is equal to the original diversion amount multiplied by the value present in column 9 (92.2857%).

Finally, it is then implied that Column 11 “Return as Percent of Canal Diversion” (%BRF) will always be equal to 92.2857% as it is equal to the Column 10 value divided by the original diversion amount. %BRF, or Percent of Diversion from Bureau Canals that returns to the Stream (Col 11), is the only value from Attachment 7 which is represented in §IV.B of the RRCA Accounting Procedures Document. Therefore, the changes to Attachment 7 must be reflected when calculating the specific formulas for each sub-basin and the main stem. Edits to the formulas must be made to implement this data into the accounting process.

The following example formula from §IV.B #8 of the RRCA Accounting Procedures document for Frenchman Creek in Nebraska depicts the necessary formula additions needed to calculate CBCU Nebraska.

CBCU Nebraska = Culbertson Canal Diversions (IRR Season) x (1-%BRF) + Culbertson Canal Diversions (Non-IRR Season) x (1-92.2857%) + Culbertson Extension (IRR Season) x (1-%BRF) + Culbertson Extension (Non-IRR Season) x (1-92.2857%) + 0.6 x Champion Canal Diversion + 0.6 x Riverside Canal Diversion + 0.6 x Dn + % x Pn + 0.5 x M&In + EvNFRn + Enders Reservoir Ev + GWn

This correction should be applied to all CBCU Nebraska and CBCU Kansas calculations for Sub-Basins and Main-Stem in §IV.B of the RRCA Accounting Procedures documentation.

A copy of the RRCA Accounting Procedures and Reporting Requirements document containing the required changes proposed in the Report of the Special Master, in addition to the changes necessary to edit the Percent Field and Canal Loss that Returns to the Stream for the Non-Irrigation Season can be viewed in Attachment F of this document.

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- Edits to Attachment 7 Regarding both Column 3, “Spill to Waste-Way” and Column 9, “Percent Field and Canal Loss that Returns to the Stream”

Sections II and III of this Memorandum can be combined to implement both changes to Attachment 7 of the RRCA Accounting Procedures document as seen in Attachment C.

The spreadsheet format will be equivalent to that expressed in Section II of this Memorandum with the addition of a second row for each canal in the attachment to include the Non-Irrigation Season diversion data expressed in Section III. In this case, changing one of these conditions has no effect on the other. Because SWW data is null for all Non-Irrigation Season entries, the newly introduced Column 4 “Canal Initial Volume” (Col 2 – Col 3) will be equivalent to the original canal diversion amount, and the final %BRF is still equal to 92.2857%.

When implementing both Sections I and II into the new Attachment 7, the same procedures apply for editing §IV.B “Specific Formulas for Each Sub-basin and the Main Stem” of the RRCA Accounting Procedures documentation as described in their respective sections.

A copy of the RRCA Accounting Procedures and Reporting Requirements document containing the required changes proposed in the Report of the Special Master, in addition to the proposed changes for editing Attachment 7 for Spill to Waste-way data and Percent Field and Canal Loss that Returns to the Stream for the Non-Irrigation Season can be viewed in Attachment G of this document.

- **Conclusions and Final Documentation**

Attachments A, B, and C provide examples from the year 2009 using the proposed changes to Attachment 7. Attachment D contains the edited Republican River Compact Administration Accounting Procedures and Reporting Requirements document in its entirety, including all required changes proposed in the Report of the Special Master.

Attachments E, F, and G contain the aforementioned document including all required changes proposed in the Report of the Special Master in addition to proposed changes for editing Attachment 7 for Spill to Waste-way data, Percent Field and Canal Loss that Returns to Stream for the Non-Irrigation Season, and all changes, required and proposed, in this document, respectively.

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All changes made are red-lined in the attachments, including specific formula changes to CBCU Nebraska and CBCU Kansas calculations regarding the addition of Non-Irrigation Season diversion data to Attachment 7.

The objective of this document is to justify certain changes which are either required or proposed to what is considered to be the most recent document concerning Republican River Compact Administration Accounting Procedures. The aforementioned additions to the accounting procedures provide a more accurate representation of water use in the Republican River Basin.

Attachment A

**Attachment 7: Calculations of Return Flows from Bureau of Reclamation Canals**

Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12
Canal	Canal Diversion	Spill to Waste-Way		Field Deliveries	Canal Loss	Average Field Loss Factor	Field Loss	Total Loss from District	Percent Field and Canal Loss That Returns to the Stream	Total return to Stream from Canal and Field Loss	Return as Percent of Canal Diversion
Name Canal	Headgate Diversion	Sum of measured spills to river	Col 2 - Col 3	Sum of Deliveries to the field	Col 2 - Col 5 + Col 3	1 -Weighted Average Efficiency of Application System for the District*	Col 5 x Col 7	Col 6 + Col 8	Estimated Percent Loss*	Col 9 x Col 10 + (Col 3 * 0.18)	Col 11/Col 2
Example	100	5	95	60	45	30%	18	63	82%	53	53%
	100		100	60	40	30%	18	58	82%	48	48%
Culbertson											
Culbertson Extension											
Meeker - Driftwood											
Red Willow											
Bartley											
Cambridge											
Naponee											
Franklin											
Franklin Pump											
Almena	1,551	36	1,515	300	1,287	30%	90	1,377	82%	1,136	73%
	1,551		1,551	300	1,251	30%	90	1,341	82%	1,100	71%
Superior											
Nebraska Courtland											
Courtland Canal Above Lovewell (KS)											
Courtland Canal Below Lovewell											

Attachment B

**Attachment 7: Calculations of Return Flows from Bureau of Reclamation Canals**

Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11
Canal	Canal Diversion	Spill to Waste-Way	Field Deliveries	Canal Loss	Average Field Loss Factor	Field Loss	Total Loss from District	Percent Field and Canal Loss That Returns to the Stream	Total return to Stream from Canal and Field Loss	Return as Percent of Canal Diversion
Name Canal	Headgate Diversion	Sum of measured spills to river	Sum of Deliveries to the field	Col 2 - Col 4	1 -Weighted Average Efficiency of Application System for the District*	Col 4 x Col 6	Col 5 + Col 7	Estimated Percent Loss*	Col 8 x Col 9	Col 10/Col 2
∑ Irrigation Season										
∑ Non-Irrigation Season										
Example	100 100	5 0	60 0	40 100	30% 30%	18 0	58 100	82% 92%	48 92	48% 92%
Culbertson	9,624 1,444		537	9,087 1,444	30% 30%	161 0	9,248 1,444	82% 92%	7,583 1,332	79% 92%
Culbertson Extension	0 0		0	0 0	30% 30%	0 0	0 0	82% 92%	0 0	
Meeker - Driftwood	23,274 3,491		5,603	17,671 3,491	30% 30%	1,681 0	19,352 3,491	82% 92%	15,869 3,222	68% 92%
Red Willow	5,166 775		1,256	3,910 775	30% 30%	377 0	4,287 775	82% 92%	3,515 715	68% 92%
Bartley	10,711 1,607		2,088	8,623 1,607	30% 30%	626 0	9,249 1,607	82% 92%	7,585 1,483	71% 92%
Cambridge	23,961 3,594		8,846	15,115 3,594	30% 30%	2,654 0	17,769 3,594	82% 92%	14,570 3,317	61% 92%
Naponee	1,095 164		246	849 164	35% 35%	86 0	935 164	82% 92%	767 152	70% 92%
Franklin	23,246 3,487		7,227	16,019 3,487	35% 35%	2,529 0	18,548 3,487	82% 92%	15,210 3,218	65% 92%
Franklin Pump	909 136		250	659 136	35% 35%	88 0	747 136	82% 92%	612 126	67% 92%

Attachment C

**Attachment 7: Calculations of Return Flows from Bureau of Reclamation Canals**

Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12
Canal	Canal Diversion	Spill to Waste-Way		Field Deliveries	Canal Loss	Average Field Loss Factor	Field Loss	Total Loss from District	Percent Field and Canal Loss That Returns to the Stream	Total return to Stream from Canal and Field Loss	Return as Percent of Canal Diversion
Name Canal	Headgate Diversion	Sum of measured spills to river	Col 2 - Col 3	Sum of Deliveries to the field	Col 2 - Col 5 + Col 3	1 -Weighted Average Efficiency of Application System for the District*	Col 5 x Col 7	Col 6 + Col 8	Estimated Percent Loss*	Col 9 x Col 10 + (Col 3 * 0.18)	Col 11/Col 2
Irrigation Season											
Non-Irrigation Season											
Example	100 15	5 0	95 15	60 0	45 15	30% 30%	18 0	63 15	82% 92%	53 14	53% 92%
Culbertson											
Culbertson Extension											
Meeker - Driftwood	23,274 3,491	 0	23,274 3,491	5,603 0	17,671 3,491	30% 30%	1,681 0	19,352 3,491	82% 92%	15,869 3,222	68% 92%
Red Willow											
Bartley											
Almena	1,551 233	36 0	1,515 233	300 0	1,287 233	30% 30%	90 0	1,377 233	82% 92%	1,136 215	61% 92%
Superior											
Nebraska Courtland											

# Attachment D

# Republican River Compact Administration

ACCOUNTING PROCEDURES

AND

REPORTING REQUIREMENTS

Revised August 12, 2010

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## **I. Introduction**

This document describes the definitions, procedures, basic formulas, specific formulas, and data requirements and reporting formats to be used by the RRCA to compute the Virgin Water Supply, Computed Water Supply, Allocations, Imported Water Supply Credit and Computed Beneficial Consumptive Use. These computations shall be used to determine supply, allocations, use and compliance with the Compact according to the Stipulation. These definitions, procedures, basic and specific formulas, data requirements and attachments may be changed by consent of the RRCA consistent with Subsection I.F of the Stipulation. This document will be referred to as the RRCA Accounting Procedures. Attached to these RRCA Accounting Procedures as Figure 1 is the map attached to the Compact that shows the Basin, its streams and the Basin boundaries.

## **II. Definitions**

The following words and phrases as used in these RRCA Accounting Procedures are defined as follows:

**Additional Water Administration Year** - a year when the projected or actual irrigation water supply is less than 130,000 Acre-feet of storage available for use from Harlan County Lake as determined by the Bureau of Reclamation using the methodology described in the Harlan County Lake Operation Consensus Plan attached as Appendix K to the Stipulation.

**Allocation(s)**: the water supply allocated to each State from the Computed Water Supply;

**Annual**: yearly from January 1 through December 31;

**Basin**: the Republican River Basin as defined in Article II of the Compact;

**Beneficial Consumptive Use**: that use by which the Water Supply of the Basin is consumed through the activities of man, and shall include water consumed by evaporation from any reservoir, canal, ditch, or irrigated area;

**Change in Federal Reservoir Storage**: the difference between the amount of water in storage in the reservoir on December 31 of each year and the amount of water in storage on December 31 of the previous year. The current area capacity table supplied by the appropriate federal operating agency shall be used to determine the contents of the reservoir on each date;

**Compact**: the Republican River Compact, Act of February 22, 1943, 1943 Kan. Sess. Laws 612, codified at Kan. Stat. Ann. § 82a-518 (1997); Act of February 24, 1943, 1943 Neb. Laws 377, codified at 2A Neb. Rev. Stat. App. § 1-106 (1995), Act of March 15, 1943, 1943 Colo. Sess. Laws 362, codified at Colo. Rev. Stat. §§ 37-67-101 and 37-67-102 (2001); Republican River Compact, Act of May 26, 1943, ch. 104, 57 Stat. 86;

**Computed Beneficial Consumptive Use:** for purposes of Compact accounting, the stream flow depletion resulting from the following activities of man:

- Irrigation of lands in excess of two acres;
- Any non-irrigation diversion of more than 50 Acre-feet per year;
- Multiple diversions of 50 Acre-feet or less that are connected or otherwise combined to serve a single project will be considered as a single diversion for accounting purposes if they total more than 50 Acre-feet;
- Net evaporation from Federal Reservoirs;
- Net evaporation from Non-federal Reservoirs within the surface boundaries of the Basin;
- Any other activities that may be included by amendment of these formulas by the RRCA;

**Computed Water Supply:** the Virgin Water Supply less the Change in Federal Reservoir Storage in any Designated Drainage Basin, and less the Flood Flows;

**Designated Drainage Basins:** the drainage basins of the specific tributaries and the Main Stem of the Republican River as described in Article III of the Compact. Attached hereto as Figure 3 is a map of the Sub-basins and Main Stem;

**Dewatering Well:** a Well constructed solely for the purpose of lowering the groundwater elevation;

**Federal Reservoirs:**

- Bonny Reservoir
- Swanson Lake
- Enders Reservoir
- Hugh Butler Lake
- Harry Strunk Lake
- Keith Sebelius Lake
- Harlan County Lake
- Lovewell Reservoir

**Flood Flows:** the amount of water deducted from the Virgin Water Supply as part of the computation of the Computed Water Supply due to a flood event as determined by the methodology described in Subsection III.B.1.;

**Gaged Flow:** the measured flow at the designated stream gage;

**Guide Rock:** a point at the Superior-Courtland Diversion Dam on the Republican River near Guide Rock, Nebraska; the Superior-Courtland Diversion Dam gage plus any flows through the sluice gates of the dam, specifically excluding any diversions to the Superior and Courtland Canals, shall be the measure of flows at Guide Rock;

**Historic Consumptive Use:** that amount of water that has been consumed under appropriate and reasonably efficient practices to accomplish without waste the purposes for which the appropriation or other legally permitted use was lawfully made;

**Imported Water Supply:** the water supply imported by a State from outside the Basin resulting from the activities of man;

**Imported Water Supply Credit:** the accretions to stream flow due to water imports from outside of the Basin as computed by the RRCA Groundwater Model. The Imported Water Supply Credit of a State shall not be included in the Virgin Water Supply and shall be counted as a credit/offset against the Computed Beneficial Consumptive Use of water allocated to that State, except as provided in Subsection V.B.2. of the Stipulation and Subsections III.I. – J. of these RRCA Accounting Procedures;

**Main Stem:** the Designated Drainage Basin identified in Article III of the Compact as the North Fork of the Republican River in Nebraska and the main stem of the Republican River between the junction of the North Fork and the Arikaree River and the lowest crossing of the river at the Nebraska-Kansas state line and the small tributaries thereof, and also including the drainage basin Blackwood Creek;

**Main Stem Allocation:** the portion of the Computed Water Supply derived from the Main Stem and the Unallocated Supply derived from the Sub-basins as shared by Kansas and Nebraska;

**Meeting(s):** a meeting of the RRCA, including any regularly scheduled annual meeting or any special meeting;

**Modeling Committee:** the modeling committee established in Subsection IV.C. of the Stipulation;

**Moratorium:** the prohibition and limitations on construction of new Wells in the geographic area described in Section III. of the Stipulation;

**Non-federal Reservoirs:** reservoirs other than Federal Reservoirs that have a storage capacity of 15 Acre-feet or greater at the principal spillway elevation;

**Northwest Kansas:** those portions of the Sub-basins within Kansas;

**Replacement Well:** a Well that replaces an existing Well that a) will not be used after construction of the new Well and b) will be abandoned within one year after such construction or is used in a manner that is excepted from the Moratorium pursuant to Subsections III.B.1.c.-f. of the Stipulation;

**RRCA:** Republican River Compact Administration, the administrative body composed of the State officials identified in Article IX of the Compact;

**RRCA Accounting Procedures:** this document and all attachments hereto;

**RRCA Groundwater Model:** the groundwater model developed under the provisions of Subsection IV.C. of the Stipulation and as subsequently adopted and revised through action of the RRCA;

**State:** any of the States of Colorado, Kansas, and Nebraska;

**States:** the States of Colorado, Kansas and Nebraska;

**Stipulation:** the Final Settlement Stipulation to be filed in *Kansas v. Nebraska and Colorado*, No. 126, Original, including all Appendices attached thereto;

**Sub-basin:** the Designated Drainage Basins, except for the Main Stem, identified in Article III of the Compact. For purposes of Compact accounting the following Sub-basins will be defined as described below:

North Fork of the Republican River in Colorado drainage basin is that drainage area above USGS gaging station number 06823000, North Fork Republican River at the Colorado-Nebraska State Line,

Arikaree River drainage basin is that drainage area above USGS gaging station number 06821500, Arikaree River at Haigler, Nebraska,

Buffalo Creek drainage basin is that drainage area above USGS gaging station number 06823500, Buffalo Creek near Haigler, Nebraska,

Rock Creek drainage basin is that drainage area above USGS gaging station number 06824000, Rock Creek at Parks, Nebraska,

South Fork of the Republican River drainage basin is that drainage area above USGS gaging station number 06827500, South Fork Republican River near Benkelman, Nebraska,

Frenchman Creek (River) drainage basin in Nebraska is that drainage area above USGS gaging station number 06835500, Frenchman Creek in Culbertson, Nebraska,

Driftwood Creek drainage basin is that drainage area above USGS gaging station number 06836500, Driftwood Creek near McCook, Nebraska,

Red Willow Creek drainage basin is that drainage area above USGS gaging station number 06838000, Red Willow Creek near Red Willow, Nebraska,

Medicine Creek drainage basin is that drainage area above the Medicine Creek below Harry Strunk Lake, State of Nebraska gaging station number 06842500; and the drainage area between the gage and the confluence with the Main Stem,

Sappa Creek drainage basin is that drainage area above USGS gaging station number 06847500, Sappa Creek near Stamford, Nebraska and the drainage area between the gage and the confluence with the Main Stem; and excluding the Beaver Creek drainage basin area downstream from the State of Nebraska gaging station number 06847000 Beaver Creek near Beaver City, Nebraska to the confluence with Sappa Creek,

Beaver Creek drainage basin is that drainage area above State of Nebraska gaging station number 06847000, Beaver Creek near Beaver City, Nebraska, and the drainage area between the gage and the confluence with Sappa Creek,

Prairie Dog Creek drainage basin is that drainage area above USGS gaging station number 06848500, Prairie Dog Creek near Woodruff, Kansas, and the drainage area between the gage and the confluence with the Main Stem;

Attached hereto as Figure 2 is a line diagram depicting the streams, Federal Reservoirs and gaging stations;

**Test hole:** a hole designed solely for the purpose of obtaining information on hydrologic and/or geologic conditions;

**Trenton Dam:** a dam located at 40 degrees, 10 minutes, 10 seconds latitude and 101 degrees, 3 minutes, 35 seconds longitude, approximately two and one-half miles west of the town of Trenton, Nebraska;

**Unallocated Supply:** the “water supplies of upstream basins otherwise unallocated” as set forth in Article IV of the Compact;

**Upstream of Guide Rock, Nebraska:** those areas within the Basin lying west of a line proceeding north from the Nebraska-Kansas state line and following the western edge of Webster County, Township 1, Range 9, Sections 34, 27, 22, 15, 10 and 3 through Webster County, Township 2, Range 9, Sections 34, 27 and 22; then proceeding west along the southern edge of Webster County, Township 2, Range 9, Sections 16, 17 and 18; then proceeding north following the western edge of Webster County, Township 2, Range 9, Sections 18, 7 and 6, through Webster County, Township 3, Range 9, Sections 31, 30, 19, 18, 7 and 6 to its intersection with the northern boundary of Webster County. Upstream of Guide Rock, Nebraska shall not include that area in Kansas east of the 99° meridian and south of the Kansas-Nebraska state line;

**Virgin Water Supply:** the Water Supply within the Basin undepleted by the activities of man;

**Water Short Year Administration:** administration in a year when the projected or actual irrigation water supply is less than 119,000 acre feet of storage available for use from Harlan County Lake as determined by the Bureau of Reclamation using the methodology described in the Harlan County Lake Operation Consensus Plan attached as Appendix K to the Stipulation.

**Water Supply of the Basin or Water Supply within the Basin:** the stream flows within the Basin, excluding Imported Water Supply;

**Well:** any structure, device or excavation for the purpose or with the effect of obtaining groundwater for beneficial use from an aquifer, including wells, water wells, or groundwater wells as further defined and used in each State’s laws, rules, and regulations.

**III. Basic Formulas**

The basic formulas for calculating Virgin Water Supply, Computed Water Supply, Imported Water Supply, Allocations and Computed Beneficial Consumptive Use are set forth below. The results of these calculations shall be shown in a table format as shown in Table 1.

Basic Formulas for Calculating Virgin Water Supply, Computed Water Supply, Allocations and Computed Beneficial Consumptive Use	
Sub-basin VWS	= Gage + All CBCU + ΔS – IWS
Main Stem VWS	= Hardy Gage – Σ Sub-basin gages + All CBCU in the Main Stem + ΔS – IWS
CWS	= VWS - Δ S – FF
Allocation for each State in each Sub-basin And Main Stem	= CWS x %
State's Allocation	= Σ Allocations for Each State
State's CBCU	= Σ State's CBCUs in each Sub-basin and Main Stem

Abbreviations:

- CBCU = Computed Beneficial Consumptive Use
- FF = Flood Flows
- Gage = Gaged Flow
- IWS = Imported Water Supply Credit
- CWS = Computed Water Supply
- VWS = Virgin Water Supply

% = the ratio used to allocate the Computed Water Supply between the States. This ratio is based on the allocations in the Compact

$\Delta S$  = Change in Federal Reservoir Storage

## **A. Calculation of Annual Virgin Water Supply**

### **1. Sub-basin calculation:**

The annual Virgin Water Supply for each Sub-basin will be calculated by adding: a) the annual stream flow in that Sub-basin at the Sub-basin stream gage designated in Section II., b) the annual Computed Beneficial Consumptive Use above that gaging station, and c) the Change in Federal Reservoir Storage in that Sub-basin; and from that total subtract any Imported Water Supply Credit. The Computed Beneficial Consumptive Use will be calculated as described in Subsection III. D. Adjustments for flows diverted around stream gages and for Computed Beneficial Consumptive Uses in the Sub-basin between the Sub-basin stream gage and the confluence of the Sub-basin tributary and the Main Stem shall be made as described in Subsections III. D. 1 and 2 and IV. B.

### **2. Main Stem Calculation:**

The annual Virgin Water Supply for the Main Stem will be calculated by adding: a) the flow at the Hardy gage minus the flows from the Sub-basin gages listed in Section II, b) the annual Computed Beneficial Consumptive Use in the Main Stem, and c) the Change in Federal Reservoir Storage from Swanson Lake and Harlan County Lake; and from that total subtract any Imported Water Supply Credit for the Main Stem. Adjustments for flows diverted around Sub-basin stream gages and for Computed Beneficial Consumptive Uses in a Sub-basin between the Sub-basin stream gage and the confluence of the Sub-basin tributary and the Mains Stem shall be made as described in Subsections III. D. 1 and 2 and IV.B.,

### **3. Imported Water Supply Credit Calculation:**

The amount of Imported Water Supply Credit shall be determined by the RRCA Groundwater Model. The Imported Water Supply Credit of a State shall not be included in the Virgin Water Supply and shall be counted as a credit/offset against the Computed Beneficial Consumptive Use of water allocated to that State. Currently, the Imported Water Supply Credits shall be determined using two runs of the RRCA Groundwater Model:

- a. The “base” run shall be the run with all groundwater pumping, groundwater pumping recharge, and surface water recharge within the model study

boundary for the current accounting year turned “on.” ~~This will be the same “base” run used to determine groundwater Computed Beneficial-Consumptive Uses.~~

- b. The “no NE import” run shall be the run with the same model inputs as the base run with the exception that surface water recharge associated with Nebraska’s Imported Water Supply shall be turned “off.” This will be the same “no NE import” run used to determine groundwater Computed Beneficial Consumptive Uses.

The Imported Water Supply Credit shall be the difference in stream flows between these two model runs. Differences in stream flows shall be determined at the same locations as identified in Subsection III.D.1. for the “no pumping” runs. Should another State import water into the Basin in the future, the RRCA will develop a similar procedure to determine Imported Water Supply Credits.

## **B. Calculation of Computed Water Supply**

On any Designated Drainage Basin without a Federal Reservoir, the Computed Water Supply will be equal to the Virgin Water Supply of that Designated Drainage Basin minus Flood Flows.

On any Designated Drainage Basin with a Federal Reservoir, the Computed Water Supply will be equal to the Virgin Water Supply minus the Change in Federal Reservoir Storage in that Designated Drainage Basin and minus Flood Flows.

### **1. Flood Flows**

If in any calendar year there are five consecutive months in which the total actual stream flow<sup>1</sup> at the Hardy gage is greater than 325,000 Acre-feet, or any two consecutive months in which the total actual stream flow is greater than 200,000 Acre-feet, the annual flow in excess of 400,000 Acre-feet at the Hardy gage will be considered to be Flood Flows that will be subtracted from the Virgin Water Supply to calculate the Computed Water Supply, and Allocations. The Flood Flow in excess of 400,000 Acre-feet at the Hardy gage will be subtracted from the Virgin Water Supply of the Main Stem to compute the Computed Water Supply unless the Annual Gaged Flows from a Sub-basin were in excess of the flows shown for that Sub-basin in Attachment 1. These excess Sub-basin flows shall be considered to be Sub-basin Flood Flows.

If there are Sub-basin Flood Flows, the total of all Sub-basin Flood Flows shall be compared to the amount of Flood Flows at the Hardy gage. If the sum of the Sub-basin Flood Flows are in excess of the Flood Flow at the Hardy gage, the flows to

<sup>1</sup> These actual stream flows reflect Gaged Flows after depletions by Beneficial Consumptive Use and change in reservoir storage above the gage.

be deducted from each Sub-basin shall be the product of the Flood Flows for each Sub-basin times the ratio of the Flood Flows at the Hardy gage divided by the sum of the Flood Flows of the Sub-basin gages. If the sum of the Sub-basin Flood Flows is less than the Flood Flow at the Hardy gage, the entire amount of each Sub-basin Flood Flow shall be deducted from the Virgin Water Supply to compute the Computed Water Supply of that Sub-basin for that year. The remainder of the Flood Flows will be subtracted from the flows of the Main Stem.

### C. Calculation of Annual Allocations

Article IV of the Compact allocates 54,100 Acre-feet for Beneficial Consumptive Use in Colorado, 190,300 Acre-feet for Beneficial Consumptive Use in Kansas and 234,500 Acre-feet for Beneficial Consumptive Use in Nebraska. The Compact provides that the Compact totals are to be derived from the sources and in the amounts specified in Table 2.

The Allocations derived from each Sub-basin to each State shall be the Computed Water Supply multiplied by the percentages set forth in Table 2. In addition, Kansas shall receive 51.1% of the Main Stem Allocation and the Unallocated Supply and Nebraska shall receive 48.9% of the Main Stem Allocation and the Unallocated Supply.

### D. Calculation of Annual Computed Beneficial Consumptive Use

#### 1. Groundwater

Computed Beneficial Consumptive Use of groundwater shall be determined by use of the RRCA Groundwater Model. The Computed Beneficial Consumptive Use of groundwater for each State shall be determined as the difference in streamflows using two runs of the model:

The “baseno NE import” run shall be the run with all groundwater pumping, groundwater pumping recharge, and surface water recharge within the model study boundary for the current accounting year “on”, with the exception that surface water recharge associated with Nebraska’s Imported Water Supply shall be turned “off.”

The “no State pumping” run shall be the run with the same model inputs as the base “no NE import” run with the exception that all groundwater pumping and pumping recharge of that State shall be turned “off.”

An output of the model is baseflows at selected stream cells. Changes in the baseflows predicted by the model between the “baseno NE import” run and the “no-State- pumping” model run is assumed to be the depletions to streamflows.

i.e., groundwater computed beneficial consumptive use, due to State groundwater pumping at that location. The values for each Sub-basin will include all depletions and accretions upstream of the confluence with the Main Stem. The values for the Main Stem will include all depletions and accretions in stream reaches not otherwise accounted for in a Sub-basin. The values for the Main Stem will be computed separately for the reach above Guide Rock, and the reach below Guide Rock.

## **2. Surface Water**

The Computed Beneficial Consumptive Use of surface water for irrigation and non-irrigation uses shall be computed by taking the diversions from the river and subtracting the return flows to the river resulting from those diversions, as described in Subsections IV.A.2.a.-d. The Computed Beneficial Consumptive Use of surface water from Federal Reservoir and Non-Federal Reservoir evaporation shall be the net reservoir evaporation from the reservoirs, as described in Subsections IV.A.2.e.-f.

For Sub-basins where the gage designated in Section II. is near the confluence with the Main Stem, each State's Sub-basin Computed Beneficial Consumptive Use of surface water shall be the State's Computed Beneficial Consumptive Use of surface water above the Sub-basin gage. For Medicine Creek, Sappa Creek, Beaver Creek and Prairie Dog Creek, where the gage is not near the confluence with the Main Stem, each State's Computed Beneficial Consumptive Use of surface water shall be the sum of the State's Computed Beneficial Consumptive Use of surface water above the gage, and its Computed Beneficial Consumptive Use of surface water between the gage and the confluence with the Main Stem.

## **E. Calculation to Determine Compact Compliance Using Five-Year Running Averages**

Each year, using the procedures described herein, the RRCA will calculate the Annual Allocations by Designated Drainage Basin and total for each State, the Computed Beneficial Consumptive Use by Designated Drainage Basin and total for each State and the Imported Water Supply Credit that a State may use for the preceding year. These results for the current Compact accounting year as well as the results of the previous four accounting years and the five-year average of these results will be displayed in the format shown in Table 3.

## **F. Calculations To Determine Colorado's and Kansas's Compliance with the Sub-basin Non-Impairment Requirement**

The data needed to determine Colorado's and Kansas's compliance with the Sub-basin non-impairment requirement in Subsection IV.B.2. of the Stipulation are shown in Tables 4.A. and B.

## **G. Calculations To Determine Projected Water Supply**

### **1. Procedures to Determine Water Short Years**

The Bureau of Reclamation will provide each of the States with a monthly or, if requested by any one of the States, a more frequent update of the projected or actual irrigation supply from Harlan County Lake for that irrigation season using the methodology described in the Harlan County Lake Operation Consensus Plan, attached as Appendix K to the Stipulation. The steps for the calculation are as follows:

Step 1. At the beginning of the calculation month (1) the total projected inflow for the calculation month and each succeeding month through the end of May shall be added to the previous end of month Harlan County Lake content and (2) the total projected 1993 level evaporation loss for the calculation month and each succeeding month through the end of May shall then be subtracted. The total projected inflow shall be the 1993 level average monthly inflow or the running average monthly inflow for the previous five years, whichever is less.

Step 2. Determine the maximum irrigation water available by subtracting the sediment pool storage (currently 164,111 Acre-feet) and adding the summer sediment pool evaporation (20,000 Acre-feet) to the result from Step 1.

Step 3. For October through January calculations, take the result from Step 2 and using the Shared Shortage Adjustment Table in Attachment 2 hereto, determine the preliminary irrigation water available for release. The calculation using the end of December content (January calculation month) indicates the minimum amount of irrigation water available for release at the end of May. For February through June calculations, subtract the maximum irrigation water available for the January calculation month from the maximum irrigation water available for the calculation month. If the result is negative, the irrigation water available for release (January calculation month) stays the same. If the result is positive the preliminary irrigation

water available for release (January calculation month) is increased by the positive amount.

Step 4. Compare the result from Step 3 to 119,000 Acre-feet. If the result from Step 3 is less than 119,000 Acre-feet Water Short Year Administration is in effect.

Step 5. The final annual Water-Short Year Administration calculation determines the total estimated irrigation supply at the end of June (calculated in July). Use the result from Step 3 for the end of May irrigation release estimate, add the June computed inflow to Harlan County Lake and subtract the June computed gross evaporation loss from Harlan County Lake.

## **2. Procedures to Determine 130,000 Acre Feet Projected Water Supply**

To determine the preliminary irrigation supply for the October through June calculation months, follow the procedure described in steps 1 through 4 of the “Procedures to determine Water Short Years” Subsection III. G. 1. The result from step 4 provides the forecasted water supply, which is compared to 130,000 Acre-feet. For the July through September calculation months, use the previous end of calculation month preliminary irrigation supply, add the previous month’s Harlan County Lake computed inflow and subtract the previous month’s computed gross evaporation loss from Harlan County Lake to determine the current preliminary irrigation supply. The result is compared to 130,000 Acre-feet.

### **H. Calculation of Computed Water Supply, Allocations and Computed Beneficial Consumptive Use Above and Below Guide Rock During Water-Short Administration Years.**

For Water-Short-Administration Years, in addition to the normal calculations, the Computed Water Supply, Allocations, Computed Beneficial Consumptive Use and Imported Water Supply Credits shall also be calculated above Guide Rock as shown in Table 5C. These calculations shall be done in the same manner as in non-Water-Short Administration years except that water supplies originating below Guide Rock shall not be included in the calculations of water supplies originating above Guide Rock. The calculations of Computed Beneficial Consumptive Uses shall be also done in the same manner as in non-Water-Short Administration years except that Computed Beneficial Consumptive Uses from diversions below Guide Rock shall not be included. The depletions from the water diverted by the Superior and Courtland Canals at the Superior-Courtland Diversion Dam shall be included in the calculations of Computed Beneficial Consumptive Use above Guide Rock. Imported Water Supply Credits above Guide Rock, as described in Sub-section III.I., may be used as offsets against the Computed Beneficial Consumptive Use above Guide Rock by the State providing the Imported Water Supply Credits.

The Computed Water Supply of the Main Stem reach between Guide Rock and the Hardy gage shall be determined by taking the difference in stream flow at Hardy and Guide Rock, adding Computed Beneficial Consumptive Uses in the reach (this does not include the Computed Beneficial Consumptive Use from the Superior and Courtland Canal diversions), and subtracting return flows from the Superior and Courtland Canals in the reach. The Computed Water Supply above Guide Rock shall be determined by subtracting the Computed Water Supply of the Main Stem reach between Guide Rock and the Hardy gage from the total Computed Water Supply. Nebraska's Allocation above Guide Rock shall be determined by subtracting 48.9% of the Computed Water Supply of the Main Stem reach between Guide Rock and the Hardy gage from Nebraska's total Allocation. Nebraska's Computed Beneficial Consumptive Uses above Guide Rock shall be determined by subtracting Nebraska's Computed Beneficial Consumptive Uses below Guide Rock from Nebraska's total Computed Beneficial Consumptive Use.

### **I. Calculation of Imported Water Supply Credits During Water-Short Year Administration Years.**

Imported Water Supply Credit during Water-Short Year Administration years shall be calculated consistent with Subsection V.B.2.b. of the Stipulation.

The following methodology shall be used to determine the extent to which Imported Water Supply Credit, as calculated by the RRCA Groundwater Model, can be credited to the State importing the water during Water-Short Year Administration years.

#### **1. Monthly Imported Water Supply Credits**

The RRCA Groundwater Model will be used to determine monthly Imported Water Supply Credits by State in each Sub-basin and for the Main Stem. The values for each Sub-basin will include all depletions and accretions upstream of the confluence with the Main Stem. The values for the Main Stem will include all depletions and accretions in stream reaches not otherwise accounted for in a Sub-basin. The values for the Main Stem will be computed separately for the reach 1) above Harlan County Dam, 2) between Harlan County Dam and Guide Rock, and 3) between Guide Rock and the Hardy gage. The Imported Water Supply Credit shall be the difference in stream flow for two runs of the model: a) the "base" run and b) the "no State import" run.

During Water-Short Year Administration years, Nebraska's credits in the Sub-basins shall be determined as described in Section III. A. 3.

## **2. Imported Water Supply Credits Above Harlan County Dam**

Nebraska's Imported Water Supply Credits above Harlan County Dam shall be the sum of all the credits in the Sub-basins and the Main Stem above Harlan County Dam.

## **3. Imported Water Supply Credits Between Harlan County Dam and Guide Rock During the Irrigation Season**

a. During Water-Short Year Administration years, monthly credits in the reach between Harlan County Dam and Guide Rock shall be determined as the differences in the stream flows between the two runs at Guide Rock.

b. The irrigation season shall be defined as starting on the first day of release of water from Harlan County Lake for irrigation use and ending on the last day of release of water from Harlan County Lake for irrigation use.

c. Credit as an offset for a State's Computed Beneficial Consumptive Use above Guide Rock will be given to all the Imported Water Supply accruing in the reach between Harlan County Dam and Guide Rock during the irrigation season. If the period of the irrigation season does not coincide with the period of modeled flows, the amount of the Imported Water Supply credited during the irrigation season for that month shall be the total monthly modeled Imported Water Supply Credit times the number of days in the month occurring during the irrigation season divided by the total number of days in the month.

## **4. Imported Water Supply Credits Between Harlan County Dam and Guide Rock During the Non-Irrigation Season**

a. Imported Water Supply Credit shall be given between Harlan County Dam and Guide Rock during the period that flows are diverted to fill Lovewell Reservoir to the extent that imported water was needed to meet Lovewell Reservoir target elevations.

b. Fall and spring fill periods shall be established during which credit shall be given for the Imported Water Supply Credit accruing in the reach. The fall period shall extend from the end of the irrigation season to December 1. The spring period shall extend from March 1 to May 31. The Lovewell target elevations for these fill periods are the projected end of November reservoir level and the projected end of May reservoir level for most

probable inflow conditions as indicated in Table 4 in the current Annual Operating Plan prepared by the Bureau of Reclamation.

c. The amount of water needed to fill Lovewell Reservoir for each period shall be calculated as the storage content of the reservoir at its target elevation at the end of the fill period minus the reservoir content at the start of the fill period plus the amount of net evaporation during this period minus White Rock Creek inflows for the same period.

d. If the fill period as defined above does not coincide with the period of modeled flows, the amount of the Imported Water Supply Credit during the fill period for that month shall be the total monthly modeled Imported Water Supply Credit times the number of days in the month occurring during the fill season divided by the total number of days in the month.

e. The amount of non-imported water available to fill Lovewell Reservoir to the target elevation shall be the amount of water available at Guide Rock during the fill period minus the amount of the Imported Water Supply Credit accruing in the reach during the same period.

f. The amount of the Imported Water Supply Credit that shall be credited against a State's Consumptive Use shall be the amount of water imported by that State that is available in the reach during the fill period or the amount of water needed to reach Lovewell Reservoir target elevations minus the amount of non-imported water available during the fill period, whichever is less.

## 5. Other Credits

Kansas and Nebraska will explore crediting Imported Water Supply that is otherwise useable by Kansas.

## J. Calculations of Compact Compliance in Water-Short Year Administration Years

During Water-Short Year Administration, using the procedures described in Subsections III.A-D, the RRCA will calculate the Annual Allocations for each State, the Computed Beneficial Consumptive Use by each State, and Imported Water Supply Credit that a State may use to offset Computed Beneficial Consumptive Use in that year. The resulting annual and average values will be calculated as displayed in Tables 5 A-C and E.

If Nebraska is implementing an Alternative Water-Short-Year Administration Plan, data to determine Compact compliance will be shown in Table 5D. Nebraska's compliance with the Compact will be determined in the same manner as Nebraska's Above Guide Rock

compliance except that compliance will be based on a three-year running average of the current year and previous two year calculations. In addition, Table 5 D. will display the sum of the previous two-year difference in Allocations above Guide Rock and Computed Beneficial Consumptive Uses above Guide Rock minus any Imported Water Credits and compare the result with the Alternative Water-Short-Year Administration Plan’s expected decrease in Computed Beneficial Consumptive Use above Guide Rock. Nebraska will be within compliance with the Compact as long as the three-year running average difference in Column 8 is positive and the sum of the previous year and current year deficits above Guide Rock are not greater than the expected decrease in Computed Beneficial Consumptive Use under the plan.

**IV. Specific Formulas**

**A. Computed Beneficial Consumptive Use**

**1. Computed Beneficial Consumptive Use of Groundwater:**

The Computed Beneficial Consumptive Use caused by groundwater diversion shall be determined by the RRCA Groundwater Model as described in Subsection III.D.1.

**2. Computed Beneficial Consumptive Use of Surface Water:**

The Computed Beneficial Consumptive Use of surface water shall be calculated as follows:

a) Non-Federal Canals

Computed Beneficial Consumptive Use from diversions by non- federal canals shall be 60 percent of the diversion; the return flow shall be 40 percent of the diversion

b) Individual Surface Water Pumps

Computed Beneficial Consumptive Use from small individual surface water pumps shall be 75 percent of the diversion; return flows will be 25 percent of the diversion unless a state provides data on the amount of different system types in a Sub-basin, in which case the following percentages will be used for each system type:

Gravity Flow.                      30%

Center Pivot	17%
LEPA	10%

c) Federal Canals

Computed Beneficial Consumptive Use of diversions by Federal canals will be calculated as shown in Attachment 7. For each Bureau of Reclamation Canal the field deliveries shall be subtracted from the diversion from the river to determine the canal losses. The field delivery shall be multiplied by one minus an average system efficiency for the district to determine the loss of water from the field. Eighty-two percent of the sum of the field loss plus the canal loss shall be considered to be the return flow from the canal diversion. The assumed field efficiencies and the amount of the field and canal loss that reaches the stream may be reviewed by the RRCA and adjusted as appropriate to insure their accuracy.

d) Non-irrigation Uses

Any non-irrigation uses diverting or pumping more than 50 acre-feet per year will be required to measure diversions. Non-irrigation uses diverting more than 50 Acre-feet per year will be assessed a Computed Beneficial Consumptive Use of 50% of what is pumped or diverted, unless the entity presents evidence to the RRCA demonstrating a different percentage should be used.

e) Evaporation from Federal Reservoirs

Net Evaporation from Federal Reservoirs will be calculated as follows:

(1) Harlan County Lake, Evaporation Calculation

April 1 through October 31:

Evaporation from Harlan County Lake is calculated by the Corps of Engineers on a daily basis from April 1 through October 31. Daily readings are taken from a Class A evaporation pan maintained near the project office. Any precipitation recorded at the project office is added to the pan reading to obtain the actual evaporation amount. The pan value is multiplied by a pan coefficient that varies by month. These values are:

March	.56
April	.52
May	.53
June	.60
July	.68
August	.78
September	.91
October	1.01

The pan coefficients were determined by studies the Corps of Engineers conducted a number of years ago. The result is the evaporation in inches. It is divided by 12 and multiplied by the daily lake surface area in acres to obtain the evaporation in Acre-feet. The lake surface area is determined by the 8:00 a.m. elevation reading applied to the lake's area-capacity data. The area-capacity data is updated periodically through a sediment survey. The last survey was completed in December 2000.

November 1 through March 31

During the winter season, a monthly total evaporation in inches has been determined. The amount varies with the percent of ice cover. The values used are:

HARLAN COUNTY LAKE

Estimated Evaporation in Inches  
Winter Season -- Monthly Total

PERCENTAGE OF ICE COVER

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
JAN	0.88	0.87	0.85	0.84	0.83	0.82	0.81	0.80	0.78	0.77	0.76
FEB	0.90	0.88	0.87	0.86	0.85	0.84	0.83	0.82	0.81	0.80	0.79
MAR	1.29	1.28	1.27	1.26	1.25	1.24	1.23	1.22	1.21	1.20	1.19
OCT	4.87			NO ICE							
NOV	2.81			NO ICE							
DEC	1.31	1.29	1.27	1.25	1.24	1.22	1.20	1.18	1.17	1.16	1.14

The monthly total is divided by the number of days in the month to obtain a daily evaporation value in inches. It is divided by 12 and

multiplied by the daily lake surface area in acres to obtain the evaporation in Acre-feet. The lake surface area is determined by the 8:00 a.m. elevation reading applied to the lake's area-capacity data. The area-capacity data is updated periodically through a sediment survey. The last survey was completed in December 2000.

To obtain the net evaporation, the monthly precipitation on the lake is subtracted from the monthly gross evaporation. The monthly precipitation is calculated by multiplying the sum of the month's daily precipitation in inches by the average of the end of the month lake surface area for the previous month and the end of the month lake surface area for the current month in acres and dividing the result by 12 to obtain the precipitation for the month in acre feet.

The total annual net evaporation (Acre-feet) will be charged to Kansas and Nebraska in proportion to the annual diversions made by the Kansas Bostwick Irrigation District and the Nebraska Bostwick Irrigation District during the time period each year when irrigation releases are being made from Harlan County Lake. For any year in which no irrigation releases were made from Harlan County Lake, the annual net evaporation charged to Kansas and Nebraska will be based on the average of the above calculation for the most recent three years in which irrigation releases from Harlan County Lake were made. In the event Nebraska chooses to substitute supply for the Superior Canal from Nebraska's allocation below Guide Rock in Water-Short Year Administration years, the amount of the substitute supply will be included in the calculation of the split as if it had been diverted to the Superior Canal at Guide Rock.

## (2) Evaporation Computations for Bureau of Reclamation Reservoirs

The Bureau of Reclamation computes the amount of evaporation loss on a monthly basis at Reclamation reservoirs. The following procedure is utilized in calculating the loss in Acre-feet.

An evaporation pan reading is taken each day at the dam site. This measurement is the amount of water lost from the pan over a 24-hour period in inches. The evaporation pan reading is adjusted for any precipitation recorded during the 24-hour period. Instructions for determining the daily pan evaporation are found in the "National Weather Service Observing Handbook No. 2 – Substation Observations." All dams located in the Kansas River Basin with the exception of Bonny Dam are National Weather Service Cooperative Observers. The daily evaporation pan readings are totaled at the end

of each month and converted to a “free water surface” (FWS) evaporation, also referred to as “lake” evaporation. The FWS evaporation is determined by multiplying the observed pan evaporation by a coefficient of .70 at each of the reservoirs. This coefficient can be affected by several factors including water and air temperatures. The National Oceanic and Atmospheric Administration (NOAA) has published technical reports describing the determination of pan coefficients. The coefficient used is taken from the “NOAA Technical Report NWS 33, Map of coefficients to convert class A pan evaporation to free water surface evaporation”. This coefficient is used for the months of April through October when evaporation pan readings are recorded at the dams. The monthly FWS evaporation is then multiplied by the average surface area of the reservoir during the month in acres. Dividing this value by twelve will result in the amount of water lost to evaporation in Acre-feet during the month.

During the winter months when the evaporation pan readings are not taken, monthly evaporation tables based on the percent of ice cover are used. The tables used were developed by the Corps of Engineers and were based on historical average evaporation rates. A separate table was developed for each of the reservoirs. The monthly evaporation rates are multiplied by the .70 coefficient for pan to free water surface adjustment, divided by twelve to convert inches to feet and multiplied by the average reservoir surface area during the month in acres to obtain the total monthly evaporation loss in Acre-feet.

To obtain the net evaporation, the monthly precipitation on the lake is subtracted from the monthly gross evaporation. The monthly precipitation is calculated by multiplying the sum of the month's daily precipitation in inches by the average of the end of the month lake surface area for the previous month and the end of the month lake surface area for the current month in acres and dividing the result by 12 to obtain the precipitation for the month in acre feet.

f) Non-Federal Reservoir Evaporation:

For Non-Federal Reservoirs with a storage capacity less than 200 Acre-feet, the presumptive average annual surface area is 25% of the area at the principal spillway elevation. Net evaporation for each such Non-Federal Reservoir will be calculated by multiplying the presumptive average annual surface area by the net evaporation from the nearest climate and evaporation

station to the Non-Federal Reservoir. A State may provide actual data in lieu of the presumptive criteria.

Net evaporation from Non-Federal Reservoirs with 200 Acre-feet of storage or greater will be calculated by multiplying the average annual surface area (obtained from the area-capacity survey) and the net evaporation from the nearest evaporation and climate station to the reservoir. If the average annual surface area is not available, the Non-Federal Reservoirs with 200 Acre-feet of storage or greater will be presumed to be full at the principal spillway elevation.

## **B. Specific Formulas for Each Sub-basin and the Main Stem**

All calculations shall be based on the calendar year and shall be rounded to the nearest 10 Acre-feet using the conventional rounding formula of rounding up for all numbers equal to five or higher and otherwise rounding down.

### Abbreviations:

CBCU	= Computed Beneficial Consumptive Use
CWS	= Computed Water Supply
D	= Non-Federal Canal Diversions for Irrigation
Ev	= Evaporation from Federal Reservoirs
EvNFR	= Evaporation from Non-Federal Reservoirs
FF	= Flood Flow
GW	= Groundwater Computed Beneficial Consumptive Use (includes irrigation and non-irrigation uses)
IWS	= Imported Water Supply Credit from Nebraska
M&I	= Non-Irrigation Surface Water Diversions (Municipal and Industrial)
P	= Small Individual Surface Water Pump Diversions for Irrigation
RF	= Return Flow
VWS	= Virgin Water Supply
c	= Colorado
k	= Kansas
n	= Nebraska
$\Delta S$	= Change in Federal Reservoir Storage
%	= Average system efficiency for individual pumps in the Sub-basin
% BRF	= Percent of Diversion from Bureau Canals that returns to the stream
###	= Value expected to be zero

### 3. North Fork of Republican River in Colorado <sup>2</sup>

$$\text{CBCU Colorado} = 0.6 \times \text{Haigler Canal Diversion Colorado} + 0.6 \times D_c + \% \times P_c + 0.5 \times M\&I_c + E_vNFR_c + GWC$$

$$\text{CBCU Kansas} = GW_k$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Haigler Canal Diversion Nebraska} + GW_n$$

Note: The diversion for Haigler Canal is split between Colorado and Nebraska based on the percentage of land irrigated in each state

$$\text{VWS} = \text{North Fork of the Republican River at the State Line, Stn. No. 06823000} + \text{CBCU}_c + \text{CBCU}_k + \text{CBCU}_n + \text{Nebraska Haigler Canal RF} - \text{IWS}$$

Note: The Nebraska Haigler Canal RF returns to the Main Stem

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Colorado} = 0.224 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.246 \times \text{CWS}$$

$$\text{Unallocated} = 0.53 \times \text{CWS}$$

### 4. Arikaree River <sup>2</sup>

$$\text{CBCU Colorado} = 0.6 \times D_c + \% \times P_c + 0.5 \times M\&I_c + E_vNFR_c + GWC$$

$$\text{CBCU Kansas} = 0.6 \times D_k + \% \times P_k + 0.5 \times M\&I_k + E_vNFR_k + GW_k$$

$$\text{CBCU Nebraska} = 0.6 \times D_n + \% \times P_n + 0.5 \times M\&I_n + E_vNFR_n + GW_n$$

$$\text{VWS} = \text{Arikaree Gage at Haigler Stn. No. 06821500} + \text{CBCU}_c + \text{CBCU}_k + \text{CBCU}_n - \text{IWS}$$

<sup>2</sup> The RRCA will investigate whether return flows from the Haigler Canal diversion in Colorado may return to the Arikaree River, not the North Fork of the Republican River, as indicated in the formulas. If there are return flows from the Haigler Canal to the Arikaree River, these formulas will be changed to recognize those returns.

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Colorado} = 0.785 \times \text{CWS}$$

$$\text{Allocation Kansas} = 0.051 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.168 \times \text{CWS}$$

$$\text{Unallocated} = -0.004 \times \text{CWS}$$

### 5. Buffalo Creek

$$\text{CBCU Colorado} = 0.6 \times \text{Dc} + \% \times \text{Pc} + 0.5 \times \text{M\&In} + \text{EvNFRc} + \text{GWc}$$

$$\text{CBCU Kansas} = \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + \text{GWn}$$

$$\text{VWS} = \text{Buffalo Creek near Haigler Gage Stn. No. 06823500} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} - \text{IWS}$$

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Nebraska} = 0.330 \times \text{CWS}$$

$$\text{Unallocated} = 0.670 \times \text{CWS}$$

### 6. Rock Creek

$$\text{CBCU Colorado} = \text{GWc}$$

$$\text{CBCU Kansas} = \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + \text{GWn}$$

$$\text{VWS} = \text{Rock Creek at Parks Gage Stn. No. 06824000} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} - \text{IWS}$$

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Nebraska} = 0.400 \times \text{CWS}$$

$$\text{Unallocated} = 0.600 \times \text{CWS}$$

## 7. South Fork Republican River

$$\text{CBCU Colorado} = 0.6 \times \text{Hale Ditch Diversion} + 0.6 \times \text{Dc} + \% \times \text{Pc} + 0.5 \times \text{M\&Ic} + \text{EvNFRc} + \text{Bonny Reservoir Ev} + \text{GWc}$$

$$\text{CBCU Kansas} = 0.6 \times \text{Dk} + \% \times \text{Pk} + 0.5 \times \text{M\&Ik} + \text{EvNFRk} + \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + \text{GWn}$$

$$\text{VWS} = \text{South Fork Republican River near Benkelman Gage Stn. No. 06827500} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} + \Delta \text{S Bonny Reservoir} - \text{IWS}$$

$$\text{CWS} = \text{VWS} - \Delta \text{S Bonny Reservoir} - \text{FF}$$

$$\text{Allocation Colorado} = 0.444 \times \text{CWS}$$

$$\text{Allocation Kansas} = 0.402 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.014 \times \text{CWS}$$

$$\text{Unallocated} = 0.140 \times \text{CWS}$$

## 8. Frenchman Creek in Nebraska

$$\text{CBCU Colorado} = \text{GWc}$$

$$\text{CBCU Kansas} = \text{GWk}$$

$$\text{CBCU Nebraska} = \text{Culbertson Canal Diversions} \times (1 - \% \text{BRF}) + \text{Culbertson Extension} \times (1 - \% \text{BRF}) + 0.6 \times \text{Champion Canal Diversion} + 0.6 \times \text{Riverside Canal Diversion} + 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + \text{Enders Reservoir Ev} + \text{GWn}$$

$$\text{VWS} = \text{Frenchman Creek in Culbertson, Nebraska Gage Stn. No. 06835500} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} + 0.17 \times \text{Culbertson Diversion RF} + \text{Culbertson Extension RF} + 0.78 \times \text{Riverside Diversion RF} + \Delta \text{S Enders Reservoir} - \text{IWS}$$

Note: 17% of the Culbertson Diversion RF and 100% of the Culbertson Extension RF return to the Main Stem

$$\text{CWS} = \text{VWS} - \Delta S \text{ Enders Reservoir} - \text{FF}$$

$$\text{Allocation Nebraska} = 0.536 \times \text{CWS}$$

$$\text{Unallocated} = 0.464 \times \text{CWS}$$

### 9. Driftwood Creek

$$\text{CBCU Colorado} = \text{GWc}$$

$$\text{CBCU Kansas} = 0.6 \times \text{Dk} + \% \times \text{Pk} + 0.5 \times \text{M\&Ik} + \text{EvNFRk} + \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + \text{GWn}$$

$$\text{VWS} = \text{Driftwood Creek near McCook Gage Stn. No. 06836500} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} - 0.24 \times \text{Meeker Driftwood Canal RF} - \text{IWS}$$

Note: 24 % of the Meeker Driftwood Canal RF returns to Driftwood Creek

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Kansas} = 0.069 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.164 \times \text{CWS}$$

$$\text{Unallocated} = 0.767 \times \text{CWS}$$

### 10. Red Willow Creek in Nebraska

$$\text{CBCU Colorado} = \text{GWc}$$

$$\text{CBCU Kansas} = \text{GWk}$$

$$\text{CBCU Nebraska} = 0.1 \times \text{Red Willow Canal CBCU} + 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + 0.1 \times \text{Hugh Butler Lake Ev} + \text{GWn}$$

Note:

Red Willow Canal CBCU = Red Willow Canal Diversion x (1- % BRF)

90% of the Red Willow Canal CBCU and 90% of Hugh Butler Lake Ev charged to Nebraska's CBCU in the Main Stem

VWS = Red Willow Creek near Red Willow Gage Stn. No. 06838000 + CBCUc + CBCUk + CBCUn + 0.9 x Red Willow Canal CBCU + 0.9 x Hugh Butler Lake Ev + 0.9 x Red Willow Canal RF + ΔS Hugh Butler Lake – IWS

Note: 90% of the Red Willow Canal RF returns to the Main Stem

CWS = VWS - ΔS Hugh Butler Lake - FF

Allocation Nebraska = 0.192 x CWS

Unallocated = 0.808 x CWS

### 11. Medicine Creek

CBCU Colorado = GWc

CBCU Kansas = GWk

CBCU Nebraska = 0.6 x Dn above and below gage + % x Pn above and below gage + 0.5 x M&In above and below gage + EvNFRn above and below gage + GWn

Note: Harry Strunk Lake Ev charged to Nebraska's CBCU in the Main Stem.

CU from Harry Strunk releases in the Cambridge Canal is charged to the Main stem (no adjustment to the VWS formula is needed as this water shows up in the Medicine Creek gage).

VWS = Medicine Creek below Harry Strunk Lake Gage Stn. No.

06842500 + CBCUc + CBCUk + CBCUn – 0.6 x Dn below gage - % x Pn below gage – 0.5 \* M&In below gage - EvNFRn below gage + Harry Strunk Lake Ev + ΔS Harry Strunk Lake– IWS

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

CWS = VWS - ΔS Harry Strunk Lake - FF

Allocation Nebraska = 0.091 x CWS

Unallocated = 0.909 x CWS

## 12. Beaver Creek

CBCU Colorado = 0.6 x Dc + % x Pc + 0.5 x M&Ic + EvNFRc + GWc

CBCU Kansas = 0.6 x Dk + % x Pk + 0.5 x M&Ik + EvNFRk + GWk

CBCU Nebraska = 0.6 x Dn above and below gage + % x Pn above and below gage + 0.5 x M&In above and below gage + EvNFRn above and below gage + GWn

VWS = Beaver Creek near Beaver City gage Stn. No. 06847000 + BCUC + CBCUk + CBCUn – 0.6 x Dn below gage - % x Pn below gage – 0.5 \* M&In below gage - EvNFRn below gage – IWS

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

CWS = VWS – FF

Allocation Colorado = 0.200 x CWS

Allocation Kansas = 0.388 x CWS

Allocation Nebraska = 0.406 x CWS

Unallocated = 0.006 x CWS

**13. Sappa Creek**

CBCU Colorado = GWc

CBCU Kansas = 0.6 x Dk + % x Pk + 0.5 x M&Ik + EvNFRk + GWk

CBCU Nebraska = 0.6 x Dn above and below gage + % x Pn above and below gage + 0.5 x M&In above and below gage + EvNFRn above and below gage + GWn

VWS = Sappa Creek near Stamford gage Stn. No. 06847500 – Beaver Creek near Beaver City gage Stn. No. 06847000 + CBCUc + CBCUk + CBCUn – 0.6 x Dn below gage - % x Pn below gage – 0.5 \* M&In below gage - EvNFRn below gage – IWS

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

CWS = VWS - FF

Allocation Kansas = 0.411 x CWS

Allocation Nebraska = 0.411 x CWS

Unallocated = 0.178 x CWS

**14. Prairie Dog Creek**

CBCU Colorado = GWc

CBCU Kansas = Almena Canal Diversion x (1-%BRF) + 0.6 x Dk + % x Pk + 0.5 x M&Ik + EvNFRk + Keith Sebelius Lake Ev + GWk

CBCU Nebraska = 0.6 x Dn below gage + % x Pn below gage + 0.5 x M&In below gage + EvNFRn + GWn below gage

VWS = Prairie Dog Creek near Woodruff, Kansas USGS Stn. No.

$$06848500 + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} - 0.6 \times \text{Dn below gage} - \% \times \text{Pn below gage} - 0.5 \times \text{M\&In below gage} - \text{EvNFRn below gage} + \Delta S \text{ Keith Sebelius Lake} - \text{IWS}$$

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

$$\text{CWS} = \text{VWS} - \Delta S \text{ Keith Sebelius Lake} - \text{FF}$$

$$\text{Allocation Kansas} = 0.457 \times \text{CSW}$$

$$\text{Allocation Nebraska} = 0.076 \times \text{CWS}$$

$$\text{Unallocated} = 0.467 \times \text{CWS}$$

**15. The North Fork of the Republican River in Nebraska and the Main Stem of the Republican River between the junction of the North Fork and the Arikaree River and the Republican River near Hardy**

$$\text{CBCU Colorado} = \text{GWc}$$

$$\begin{aligned} \text{CBCU Kansas} = & \\ & (\text{Deliveries from the Courtland Canal to Kansas above Lovewell}) \times (1 - \% \text{BRF}) \\ & + \text{Amount of transportation loss of Courtland Canal deliveries to Lovewell that does not return to the river, charged to Kansas} \\ & + (\text{Diversions of Republican River water from Lovewell Reservoir by the Courtland Canal below Lovewell}) \times (1 - \% \text{BRF}) \\ & + 0.6 \times \text{Dk} \\ & + \% \times \text{Pk} \\ & + 0.5 \times \text{M\&Ik} \\ & + \text{EvNFRk} \\ & + \text{Harlan County Lake Ev charged to Kansas} \\ & + \text{Lovewell Reservoir Ev charged to the Republican River} \\ & + \text{GWk} \end{aligned}$$

$$\begin{aligned} \text{CBCU Nebraska} = & \\ & \text{Deliveries from Courtland Canal to Nebraska lands} \times (1 - \% \text{BRF}) \end{aligned}$$

- + Superior Canal x (1- %BRF)
- + Franklin Pump Canal x (1- %BRF)
- + Franklin Canal x (1- %BRF)
- + Naponee Canal x (1- %BRF)
- + Cambridge Canal x (1- %BRF)
- + Bartley Canal x (1- %BRF)
- + Meeker-Driftwood Canal x (1- %BRF)
- + 0.9 x Red Willow Canal CBCU
- + 0.6 x Dn
- + % x Pn
- + 0.5 x M&In
- + EvNFRn
- + 0.9 x Hugh Butler Lake Ev
- + Harry Strunk Lake Ev
- + Swanson Lake Ev
- + Harlan County Lake Ev charged to Nebraska
- + GWn

Notes:

The allocation of transportation losses in the Courtland Canal above Lovewell between Kansas and Nebraska shall be done by the Bureau of Reclamation and reported in their "Courtland Canal Above Lovewell" spreadsheet. Deliveries and losses associated with deliveries to both Nebraska and Kansas above Lovewell shall be reflected in the Bureau's Monthly Water District reports. Losses associated with delivering water to Lovewell shall be separately computed.

Amount of transportation loss of the Courtland Canal deliveries to Lovewell that does not return to the river, charged to Kansas shall be 18% of the Bureau's estimate of losses associated with these deliveries.

Red Willow Canal CBCU = Red Willow Canal Diversion x (1- % BRF)

10% of the Red Willow Canal CBCU is charged to Nebraska's CBCU in Red Willow Creek sub-basin

10% of Hugh Butler Lake Ev is charged to Nebraska's CBCU in the Red Willow Creek sub-basin

None of the Harry Strunk Lake EV is charged to Nebraska's CBCU in the Medicine Creek sub-basin

VWS

=

- Republican River near Hardy Gage Stn. No. 06853500
- North Fork of the Republican River at the State Line, Stn. No. 06823000
- Arikaree Gage at Haigler Stn. No. 06821500
- Buffalo Creek near Haigler Gage Stn. No. 06823500
- Rock Creek at Parks Gage Stn. No. 06824000
- South Fork Republican River near Benkelman Gage Stn. No. 06827500
- Frenchman Creek in Culbertson Stn. No. 06835500
- Driftwood Creek near McCook Gage Stn. No. 06836500
- Red Willow Creek near Red Willow Gage Stn. No. 06838000
- Medicine Creek below Harry Strunk Lake Gage Stn. No. 06842500
- Sappa Creek near Stamford Gage Stn. No. 06847500
- Prairie Dog Creek near Woodruff, Kansas Stn. No. 68-485000

- + CBCUc
- + CBCUn

- + 0.6 x Dk
- + % x Pk
- + 0.5 x M&Ik
- + EvNFRk
- + Harlan County Lake Ev charged to Kansas
- +Amount of transportation loss of the Courtland Canal above the Stateline that does not return to the river, charged to Kansas
- +GWk

- 0.9 x Red Willow Canal CBCU
  - 0.9 x Hugh Butler Ev
  - Harry Strunk Ev

- + 0.6 x Dn below Medicine Creek gage
- + % x Pn below Medicine Creek gage
- + 0.5 \* M&In below Medicine Creek gage
- + EvNFRn below Medicine Creek gage

+ 0.6 x Dn below Beaver Creek gage  
 + % x Pn below Beaver Creek gage  
 + 0.5 \* M&In below Beaver Creek gage  
 + EvNFRn below Beaver Creek gage

+ 0.6 x Dn below Sappa Creek gage  
 + % x Pn below Sappa Creek gage  
 + 0.5 \* M&In below Sappa Creek gage  
 + EvNFRn below Sappa Creek gage

+ 0.6 x Dn below Prairie Dog Creek gage  
 + % x Pn below Prairie Dog Creek gage  
 + 0.5 \* M&In below Prairie Dog Creek gage  
 + EvNFRn below Prairie Dog Creek gage

+ Change in Storage Harlan County Lake  
 + Change in Storage Swanson Lake

- Nebraska Haigler Canal RF  
 - 0.78 x Riverside Canal RF  
 - 0.17 x Culbertson Canal RF  
 - Culbertson Canal Extension RF to Main Stem  
 + 0.24 x Meeker Driftwood Canal RF which returns to Driftwood Creek  
 - 0.9 x Red Willow Canal RF

+ Courtland Canal at Kansas-Nebraska State Line Gage Stn No. 06852500

- Courtland Canal RF in Kansas above Lovewell Reservoir

-IWS

Notes:

None of the Nebraska Haigler Canal RF returns to the North Fork of the Republican River

83% of the Culbertson Diversion RF and none of the Culbertson Extension RF return to Frenchman Creek

24 % of the Meeker Driftwood Canal RF returns to Driftwood Creek.

10% of the Red Willow Canal RF returns to Red Willow Creek

Courtland Canal RF in Kansas above Lovewell Reservoir =  
 $0.015 \times$  (Courtland Canal at Kansas-Nebraska State Line  
 Gage Stn No. 06852500)

CWS = VWS - Change in Storage Harlan County Lake - Change in  
 Storage Swanson Lake - FF

Allocation Kansas =  $0.511 \times$  CWS

Allocation Nebraska =  $0.489 \times$  CWS

## **V. Annual Data/ Information Requirements, Reporting, and Verification**

The following information for the previous calendar year shall be provided to the members of the RRCA Engineering Committee by April 15<sup>th</sup> of each year, unless otherwise specified.

All information shall be provided in electronic format, if available.

Each State agrees to provide all information from their respective State that is needed for the RRCA Groundwater Model and RRCA Accounting Procedures and Reporting Requirements, including but not limited to the following:

### **A. Annual Reporting**

#### **1. Surface water diversions and irrigated acreage:**

Each State will tabulate the canal, ditch, and other surface water diversions that are required by RRCA annual compact accounting and the RRCA Groundwater Model on a monthly format (or a procedure to distribute annual data to a monthly basis) and will forward the surface water diversions to the other States. This will include available diversion, wasteway, and farm delivery data for canals diverting from the Platte River that contribute to Imported Water Supply into the Basin. Each State will provide the water right number, type of use, system type, location, diversion amount, and acres irrigated.

**2. Groundwater pumping and irrigated acreage:**

Each State will tabulate and provide all groundwater well pumping estimates that are required for the RRCA Groundwater Model to the other States.

**Colorado** – will provide an estimate of pumping based on a county format that is based upon system type, Crop Irrigation Requirement (CIR), irrigated acreage, crop distribution, and irrigation efficiencies. Colorado will require installation of a totalizing flow meter, installation of an hours meter with a measurement of the pumping rate, or determination of a power conversion coefficient for 10% of the active wells in the Basin by December 31, 2005. Colorado will also provide an annual tabulation for each groundwater well that measures groundwater pumping by a totalizing flow meter, hours meter or power conversion coefficient that includes: the groundwater well permit number, location, reported hours, use, and irrigated acreage.

**Kansas** - will provide an annual tabulation by each groundwater well that includes: water right number, groundwater pumping determined by a meter on each well (or group of wells in a manifold system) or by reported hours of use and rate; location; system type (gravity, sprinkler, LEPA, drip, etc.); and irrigated acreage. Crop distribution will be provided on a county basis.

**Nebraska** – will provide an annual tabulation through the representative Natural Resource District (NRD) in Nebraska that includes: the well registration number or other ID number; groundwater pumping determined by a meter on each well (or group of wells in a manifold system) or by reported hours of use and rate; wells will be identified by; location; system type (gravity, sprinkler, LEPA, drip, etc.); and irrigated acreage. Crop distribution will be provided on a county basis.

**3. Climate information:**

Each State will tabulate and provide precipitation, temperature, relative humidity or dew point, and solar radiation for the following climate stations:

State	Identification	Name
Colorado		
Colorado	C050109	Akron 4 E
Colorado	C051121	Burlington
Colorado	C054413	Julesburg
Colorado	C059243	Wray
Kansas	C140439	Atwood 2 SW
Kansas	C141699	Colby 1SW
Kansas	C143153	Goodland
Kansas	C143837	Hoxie

Kansas	C145856	Norton 9 SSE
Kansas	C145906	Oberlin1 E
Kansas	C147093	Saint Francis
Kansas	C148495	Wakeeny
Nebraska	C250640	Beaver City
Nebraska	C250810	Bertrand
Nebraska	C252065	Culbertson
Nebraska	C252690	Elwood 8 S
Nebraska	C253365	Gothenburg
Nebraska	C253735	Hebron
Nebraska	C253910	Holdredge
Nebraska	C254110	Imperial
Nebraska	C255090	Madrid
Nebraska	C255310	McCook
Nebraska	C255565	Minden
Nebraska	C256480	Palisade
Nebraska	C256585	Paxton
Nebraska	C257070	Red Cloud
Nebraska	C258255	Stratton
Nebraska	C258320	Superior
Nebraska	C258735	Upland
Nebraska	C259020	Wauneta 3 NW

**4. Crop Irrigation Requirements:**

Each State will tabulate and provide estimates of crop irrigation requirement information on a county format. Each State will provide the percentage of the crop irrigation requirement met by pumping; the percentage of groundwater irrigated lands served by sprinkler or flood irrigation systems, the crop irrigation requirement; crop distribution; crop coefficients; gain in soil moisture from winter and spring precipitation, net crop irrigation requirement; and/or other information necessary to compute a soil/water balance.

**5. Streamflow Records from State-Maintained Gaging Records:**

Streamflow gaging records from the following State maintained gages will be provided:

Station No	Name
00126700	Republican River near Trenton
06831500	Frenchman Creek near Imperial
06832500	Frenchman Creek near Enders

06835000	Stinking Water Creek near Palisade
06837300	Red Willow Creek above Hugh Butler Lake
06837500	Red Willow Creek near McCook
06841000	Medicine Creek above Harry Strunk Lake
06842500	Medicine Creek below Harry Strunk Lake
06844000	Muddy Creek at Arapahoe
06844210	Turkey Creek at Edison
06847000	Beaver Creek near Beaver City
	Republican River at Riverton
06851500	Thompson Creek at Riverton
06852000	Elm Creek at Amboy
	Republican River at the Superior-Courtland Diversion Dam

**6. Platte River Reservoirs:**

The State of Nebraska will provide the end-of-month contents, inflow data, outflow data, area-capacity data, and monthly net evaporation, if available, from Johnson Lake; Elwood Reservoir; Sutherland Reservoir; Maloney Reservoir; and Jeffrey Lake.

**7. Water Administration Notification:**

The State of Nebraska will provide the following information that describes the protection of reservoir releases from Harlan County Lake and for the administration of water rights junior in priority to February 26, 1948:

- Date of notification to Nebraska water right owners to curtail their diversions, the amount of curtailment, and length of time for curtailment.
- The number of notices sent.
- The number of diversions curtailed and amount of curtailment in the Harlan County Lake to Guide Rock reach of the Republican River.

**8. Moratorium:**

Each State will provide a description of all new Wells constructed in the Basin Upstream of Guide Rock including the owner, location (legal description), depth and diameter or dimension of the constructed water well, casing and screen information, static water level, yield of the water well in gallons per minute or gallons per hour, and intended use of the water well.

Designation whether the Well is a:

- a. Test hole;
- b. Dewatering Well with an intended use of one year or less;
- c. Well designed and constructed to pump fifty gallons per minute or less;
- d. Replacement Water Well, including a description of the Well that is replaced providing the information described above for new Wells and a description of the historic use of the Well that is replaced;
- e. Well necessary to alleviate an emergency situation involving provision of water for human consumption, including a brief description of the nature of the emergency situation and the amount of water intended to be pumped by and the length of time of operation of the new Well;
- f. Transfer Well, including a description of the Well that is transferred providing the information described above for new Wells and a description of the Historic Consumptive Use of the Well that is transferred;
- g. Well for municipal and/or industrial expansion of use;

Wells in the Basin in Northwest Kansas or Colorado. Kansas and Colorado will provide the information described above for new Wells along with copies of any other information that is required to be filed with either State of local agencies under the laws, statutes, rules and regulations in existence as of April 30, 2002, and;

Any changes in State law in the previous year relating to existing Moratorium.

#### **9. Non-Federal Reservoirs:**

Each State will conduct an inventory of Non Federal Reservoirs by December 31, 2004, for inclusion in the annual Compact Accounting. The inventory shall include the following information: the location, capacity (in Acre-feet) and area (in acres) at the principal spillway elevation of each Non-Federal Reservoir. The States will annually provide any updates to the initial inventory of Non-Federal Reservoirs, including enlargements that are constructed in the previous year.

Owners/operators of Non-Federal Reservoirs with 200 Acre-feet of storage capacity or greater at the principal spillway elevation will be required to provide an area-capacity survey from State-approved plans or prepared by a licensed professional engineer or land surveyor.

## B. RRCA Groundwater Model Data Input Files

1. Monthly groundwater pumping, surface water recharge, groundwater recharge, and precipitation recharge provided by county and indexed to the one square mile cell size.
2. Potential Evapotranspiration rate is set as a uniform rate for all phreatophyte vegetative classes – the amount is X at Y climate stations and is interpolated spatially using kriging.

## C. Inputs to RRCA Accounting

### 1. Surface Water Information

- a. Streamflow gaging station records: obtained as preliminary USGS or Nebraska streamflow records, with adjustments to reflect a calendar year, at the following locations:

Arikaree River at Haigler, Nebraska  
 North Fork Republican River at Colorado-Nebraska state line  
 Buffalo Creek near Haigler, Nebraska  
 Rock Creek at Parks, Nebraska  
 South Fork Republican River near Benkelman, Nebraska  
 Frenchman Creek at Culbertson, Nebraska  
 Red Willow Creek near Red Willow, Nebraska  
 Medicine Creek below Harry Strunk Lake, Nebraska\*  
 Beaver Creek near Beaver City, Nebraska\*  
 Sappa Creek near Stamford, Nebraska  
 Prairie Dog Creek near Woodruff, Kansas  
 Courtland Canal at Nebraska-Kansas state line  
 Republican River near Hardy, Nebraska  
 Republican River at Superior-Courtland Diversion Dam near  
 Guide Rock,  
 Nebraska (new)\*

- b. Federal reservoir information: obtained from the United States Bureau of Reclamation:

Daily free water surface evaporation, storage, precipitation,  
 reservoir release information, and updated area-capacity  
 tables.  
 Federal Reservoirs:  
 Bonny Reservoir

Swanson Lake  
Harry Strunk Lake  
Hugh Butler Lake  
Enders Reservoir  
Keith Sebelius Lake  
Harlan County Lake  
Lovewell Reservoir

c. Non-federal reservoirs obtained by each state: an updated inventory of reservoirs that includes the location, surface area (acres), and capacity (in Acre-feet), of each non-federal reservoir with storage capacity of fifteen (15) Acre-feet or greater at the principal spillway elevation. Supporting data to substantiate the average surface water areas that are different than the presumptive average annual surface area may be tendered by the offering State.

d. Diversions and related data from USBR

Irrigation diversions by canal, ditch, and pumping station that irrigate more than two (2) acres  
Diversions for non-irrigation uses greater than 50 Acre-feet  
Farm Deliveries  
Wasteway measurements  
Irrigated acres

e. Diversions and related data – from each respective State

Irrigation diversions by canal, ditch, and pumping station that irrigate more than two (2) acres  
Diversions for non-irrigation uses greater than 50 Acre-feet  
Wasteway measurements, if available

## 2. Groundwater Information

(From the RRCA Groundwater model as output files as needed for the accounting procedures)

a. Imported water - mound credits in amount and time that occur in defined streamflow points/reaches of measurement or compliance – ex: gaging stations near confluence or state lines

- b. Groundwater depletions to streamflow (above points of measurement or compliance – ex: gaging stations near confluence or state lines)

### **3. Summary**

The aforementioned data will be aggregated by Sub-basin as needed for RRCA accounting.

## **D. Verification**

### **1. Documentation to be Available for Inspection Upon Request**

- a. Well permits/ registrations database
- b. Copies of well permits/ registrations issued in calendar year
- c. Copies of surface water right permits or decrees
- d. Change in water right/ transfer historic use analyses
- e. Canal, ditch, or other surface water diversion records
- f. Canal, ditch, or other surface water measurements
- g. Reservoir storage and release records
- h. Irrigated acreage

### **2. Site Inspection**

- a. Accompanied – reasonable and mutually acceptable schedule among representative state and/or federal officials.
- b. Unaccompanied – inspection parties shall comply with all laws and regulations of the State in which the site inspection occurs.

Table 1: Annual Virgin and Computed Water Supply, Allocations and Computed Beneficial Consumptive Uses by State, Main Stem and Sub-basin

Designated Drainage Basin	Col. 1: Virgin Water Supply	Col. 2: Computed Water Supply	Col. 3: Allocations				Col. 4: Computed Beneficial Consumptive Use		
			Colorado	Nebraska	Kansas	Unallocated	Colorado	Nebraska	Kansas
North Fork in Colorado									
Arikaree									
Buffalo									
Rock									
South Fork of Republican River									
Frenchman									
Driftwood									
Red Willow									
Medicine									
Beaver									
Sappa									
Prairie Dog									
North Fork of Republican River in Nebraska and Main Stem									
Total All Basins									
North Fork Of Republican River in Nebraska and Mainstem Including Unallocated Water									
Total									

Table 2: Original Compact Virgin Water Supply and Allocations

Designated Drainage Basin	Virgin Water Supply	Colorado Allocation	% of Total Drainage Basin Supply	Kansas Allocation	% of Total Drainage Basin Supply	Nebraska Allocation	% of Total Drainage Basin Supply	Unallocated	% of Total Drainage Basin Supply
North Fork - CO	44,700	10,000	22.4			11,000	24.6	23,700	53.0
Arikaree River	19,610	15,400	78.5	1,000	5.1	3,300	16.8	-90	-0.4
Buffalo Creek	7,890					2,600	33.0	5,290	67.0
Rock Creek	11,000					4,400	40.0	6,600	60.0
South Fork	57,200	25,400	44.4	23,000	40.2	800	1.4	8,000	14.0
Frenchman Creek	98,500					52,800	53.6	45,700	46.4
Driftwood Creek	7,300			500	6.9	1,200	16.4	5,600	76.7
Red Willow Creek	21,900					4,200	19.2	17,700	80.8
Medicine Creek	50,800					4,600	9.1	46,200	90.9
Beaver Creek	16,500	3,300	20.0	6,400	38.8	6,700	40.6	100	0.6
Sappa Creek	21,400			8,800	41.1	8,800	41.1	3,800	17.8
Prairie Dog Creek	27,600			12,600	45.7	2,100	7.6	12,900	46.7
Sub-total Tributaries	384,400							175,500	
Main Stem + Blackwood Creek	94,500								
Main Stem + Unallocated	270,000			138,000	51.1	132,000	48.9		
Total	478,900	54,100		190,300		234,500			

Table 3A: Table to Be Used to Calculate Colorado's Five-Year Running Average Allocation and Computed Beneficial Consumptive Use for Determining Compact Compliance

Colorado				
	Col. 1	Col. 2	Col. 3	Col. 4
Year	Allocation	Computed Beneficial Consumptive	Imported Water Supply Credit	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Col 1 – (Col 2- Col 3)
Year t= -4				
Year t= -3				
Year t= -2				
Year t= -1				
Current Year t= 0				
Average				

Table 3B. Table to Be Used to Calculate Kansas's Five-Year Running Average Allocation and Computed Beneficial Consumptive Use for Determining Compact Compliance

Kansas				
	Col. 1	Col. 2	Col. 3	Col. 4
Year	Allocation	Computed Beneficial Consumptive	Imported Water Supply Credit	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Col 1 – (Col 2- Col 3)
Year t= -4				
Year t= -3				
Year t= -2				
Year t= -1				
Current Year t= 0				
Average				

Table 3C. Table to Be Used to Calculate Nebraska's Five-Year Running Average Allocation and Computed Beneficial Consumptive Use for Determining Compact Compliance

Nebraska				
	Col. 1	Col. 2	Col. 3	Col. 4
Year	Allocation	Computed Beneficial Consumptive	Imported Water Supply Credit	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Col 1 – (Col 2- Col 3)
Year T= -4				
Year T= -3				
Year T= -2				
Year T= -1				
Current Year T= 0				
Average				

Republican River Compact Administration

Accounting Procedures and Reporting Requirements  
Revised August 2010

Table 4A: Colorado Compliance with the Sub-basin Non-impairment Requirement

	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
Sub-basin	Colorado Sub-basin Allocation (5-year running average)	Unallocated Supply (5-year running average)	Credits from Imported Water Supply (5-year running average)	Total Supply Available = Col 1+ Col 2 + Col 3 (5-year running average)	Colorado Computed Beneficial Consumptive Use (5-year running average)	Difference Between Available Supply and Computed Beneficial Consumptive Use = Col 4 – Col 5 (5-year running average)
North Fork Republican River Colorado						
Arikaree River						
South Fork Republican River						
Beaver Creek						

Table 4B: Kansas Compliance with the Sub-basin Non-impairment Requirement

	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7
Sub-basin	Kansas Sub-basin Allocation (5-year running average)	Unallocated Supply (5-year running average)	Unused Allocation from Colorado (5-year running average)	Credits from Imported Water Supply (5-year running average)	Total Supply Available = Col 1+ Col 2+ Col 3 + Col 4 (5-year running average)	Kansas Computed Beneficial Consumptive Use (5-year running average)	Difference Between Available Supply and Computed Beneficial Consumptive Use = Col 5 – Col 6 (5-year running average)
Arikaree River							
South Fork Republican River							
Driftwood Creek							
Beaver Creek							
Sappa Creek							
Prairie Dog Creek							

Revised August 2010

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

Colorado				
	Col. 1	Col. 2	Col. 3	Col 4
Year	Allocation minus Allocation for Beaver Creek	Computed Beneficial Consumptive minus Computed Beneficial Consumptive Use for Beaver Creek	Imported Water Supply Credit excluding Beaver Creek	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit for All Basins Except Beaver Creek Col 1 – (Col 2 – Col 3)
Year T= -4				
Year T= -3				
Year T= -2				
Year T= -1				
Current Year T= 0				
Average				

Table 5B: Kansas Compliance During Water-Short Year Administration

Kansas						
Year	Allocation			Computed Beneficial Consumptive Use`	Imported Water Supply Credit	Difference Between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit
Column	1	2	3	4	5	6
	Sum Sub-basins	Kansas's Share of the Unallocated Supply	Total Col 1 + Col 2			Col 3 – (Col 4 – Col 5)
Previous Year						
Current Year						
Average						

Revised August 2010

Table 5C: Nebraska Compliance During Water-Short Year Administration

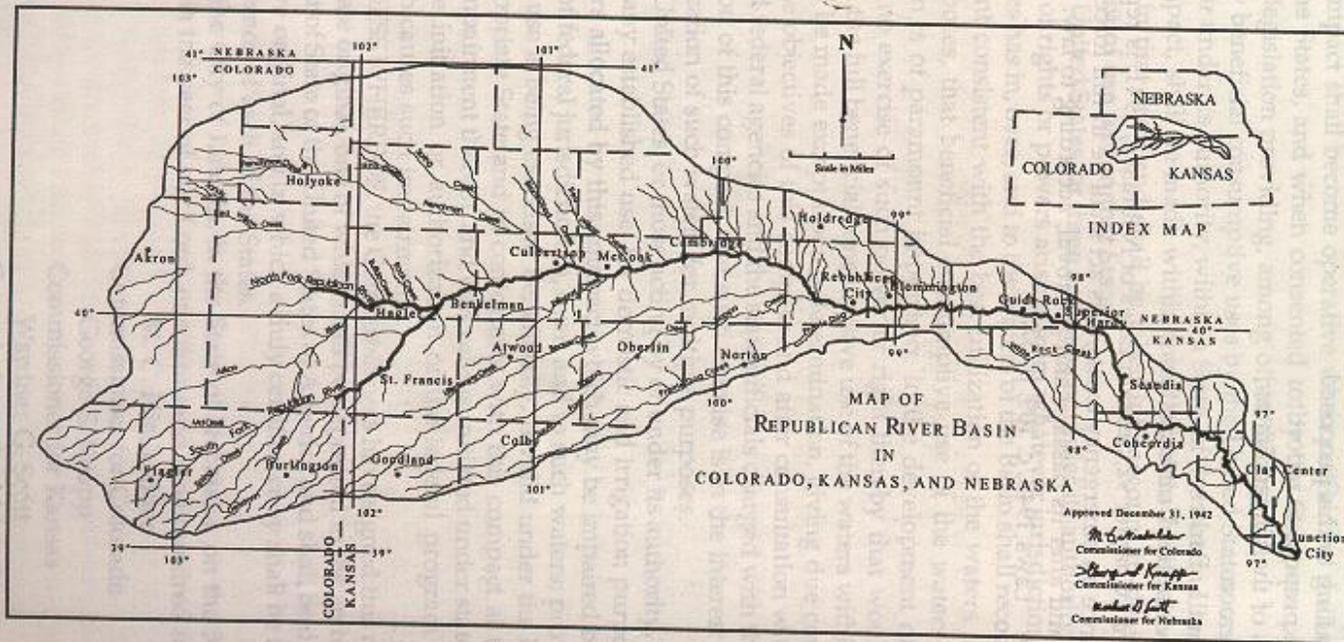
Nebraska								
Year	Allocation			Computed Beneficial Consumptive Use			Imported Water Supply Credit	Difference Between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Above Guide Rock
Column	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
	State Wide Allocation	Allocation below Guide Rock	State Wide Allocation above Guide Rock	State Wide CBCU	CBCU below Guide Rock	State Wide CBCU above Guide Rock	Credits above Guide Rock	Col 3 – (Col 6 – Col 7)
Previous Year								
Current Year								
Average								

Year	Allocation			Computed Beneficial Consumptive Use			Imported Water Supply Credit	Difference Between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Above Guide Rock
Column	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
	State Wide Allocation	Allocation below Guide Rock	State Wide Allocation above Guide Rock	State Wide CBCU	CBCU below Guide Rock	State Wide CBCU above Guide Rock	Credits above Guide Rock	Col 3 – (Col 6- Col 7)
Year = -2								
Year = -1								
Current Year								
Three-Year Average								
Sum of Previous Two-year Difference								
Expected Decrease in CBCU Under Plan								

Table 5E: Nebraska Tributary Compliance During Water-Short Year Administration

Year	Sum of Nebraska Sub-basin Allocations	Sum of Nebraska's Share of Sub-basin Unallocated Supplies	Total Available Water Supply for Nebraska	Computed Beneficial Consumptive Use	Imported Water Supply Credit	Difference between Allocation And the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
Previous Year						Col 3 -(Col 4-Col 5)
Current Year						
Average						

Figure 1

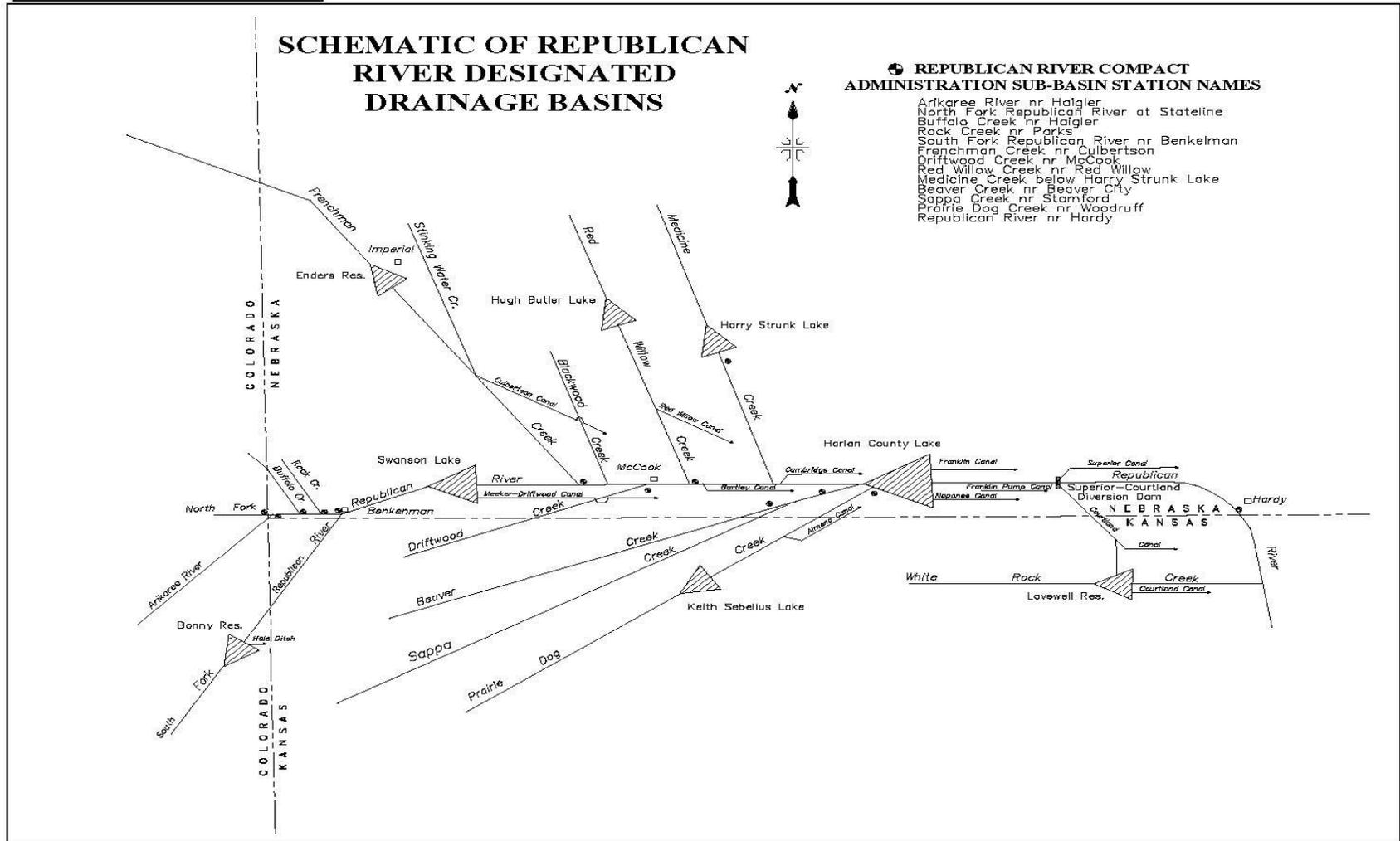


Basin Map Attached to Compact that Shows the Streams and the Basin Boundaries

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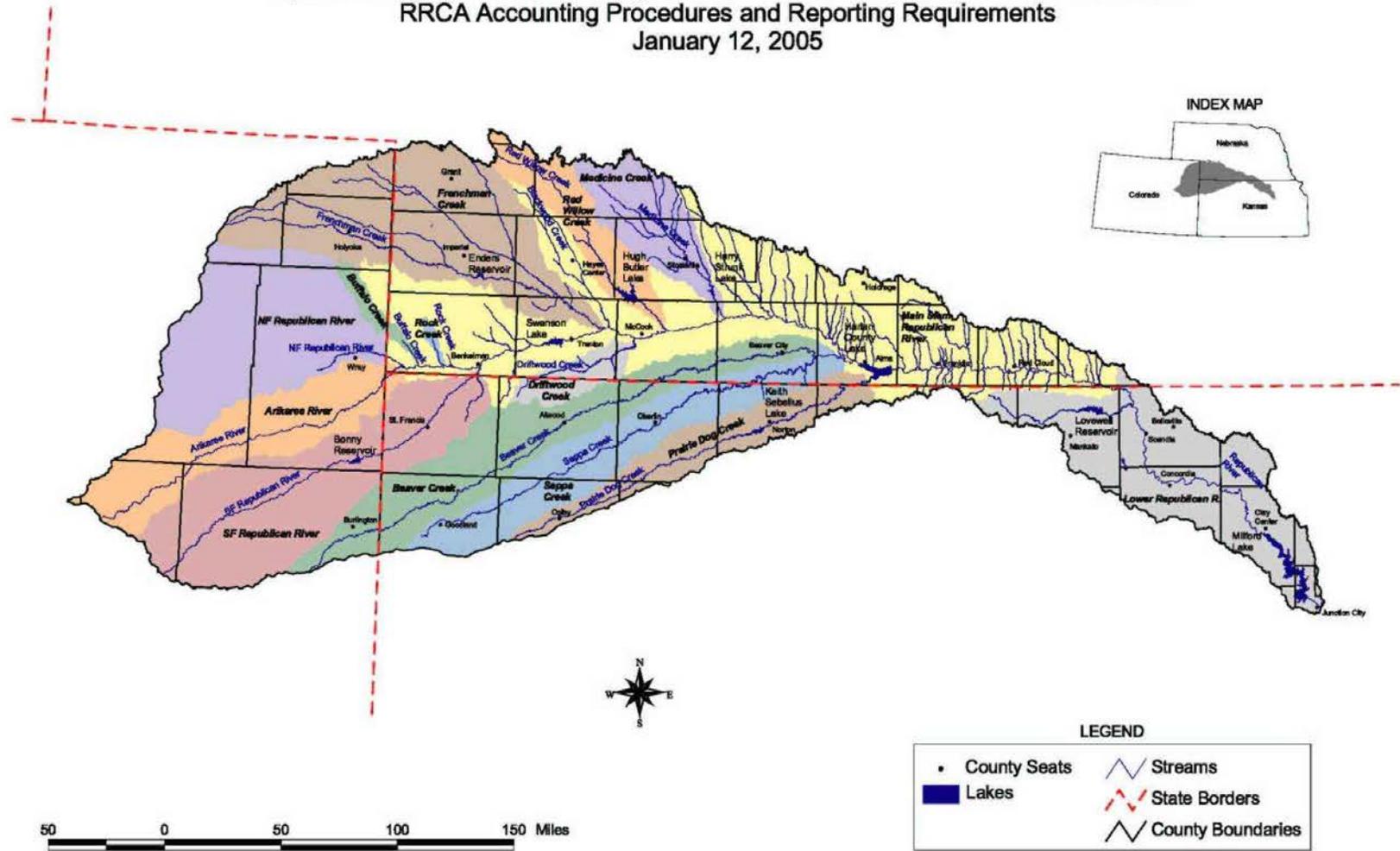
-106  
APPENDIX

Figure 2



Line Diagram of Designated Drainage Basins Showing Federal Reservoirs and Sub-basin Gaging Stations

Update of Figure 3 - Map Showing Sub-basins, Streams, and the Basin Boundaries  
 RRCA Accounting Procedures and Reporting Requirements  
 January 12, 2005



Map Showing Sub-basins, Streams, and the Basin Boundaries

## Attachment 1: Sub-basin Flood Flow Thresholds

Sub-basin	Sub-basin Flood Flow Threshold Acre-feet per Year <sup>3</sup>
Arikaree River	16,400
North Fork of Republican River	33,900
Buffalo Creek	4,800
Rock Creek	9,800
South Fork of Republican River	30,400
Frenchman Creek	51,900
Driftwood Creek	9,400
Red Willow Creek	15,100
Medicine Creek	55,100
Beaver Creek	13,900
Sappa Creek	26,900
Prairie Dog	15,700

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<sup>3</sup> Flows considered to be Flood Flows are flows in excess of the 94% flow based on a flood frequency analysis for the years 1971-2000. The Gaged Flows are measured after depletions by Beneficial Consumptive Use and change in reservoir storage.

## Attachment 2: Description of the Consensus Plan for Harlan County Lake

The Consensus Plan for operating Harlan County Lake was conceived after extended discussions and negotiations between Reclamation and the Corps. The agreement shaped at these meetings provides for sharing the decreasing water supply into Harlan County Lake. The agreement provides a consistent procedure for: updating the reservoir elevation/storage relationship, sharing the reduced inflow and summer evaporation, and providing a January forecast of irrigation water available for the following summer.

During the interagency discussions the two agencies found agreement in the following areas:

- The operating plan would be based on current sediment accumulation in the irrigation pool and other zones of the project.
- Evaporation from the lake affects all the various lake uses in proportion to the amount of water in storage for each use.
- During drought conditions, some water for irrigation could be withdrawn from the sediment pool.
- Water shortage would be shared between the different beneficial uses of the project, including fish, wildlife, recreation and irrigation.

To incorporate these areas of agreement into an operation plan for Harlan County Lake, a mutually acceptable procedure addressing each of these items was negotiated and accepted by both agencies.

### 1. Sediment Accumulation.

The most recent sedimentation survey for Harlan County project was conducted in 1988, 37 years after lake began operation. Surveys were also performed in 1962 and 1972; however, conclusions reached after the 1988 survey indicate that the previous calculations are unreliable. The 1988 survey indicates that, since closure of the dam in 1951, the accumulated sediment is distributed in each of the designated pools as follows:

Flood Pool	2,387 Acre-feet
Irrigation Pool	4,853 Acre-feet
Sedimentation Pool	33,527 Acre-feet

To insure that the irrigation pool retained 150,000 Acre-feet of storage, the bottom of the irrigation pool was lowered to 1,932.4 feet, msl, after the 1988 survey.

To estimate sediment accumulation in the lake since 1988, we assumed similar conditions have occurred at the project during the past 11 years. Assuming a consistent rate of deposition since 1988, the irrigation pool has trapped an additional 1,430 Acre-feet.

A similar calculation of the flood control pool indicates that the flood control pool has captured an additional 704 Acre-feet for a total of 3,090 Acre-feet since construction.

The lake elevations separating the different pools must be adjusted to maintain a 150,000-acre-foot irrigation pool and a 500,000-acre-foot flood control pool. Adjusting these elevations results in the following new elevations for the respective pools (using the 1988 capacity tables).

Top of Irrigation Pool	1,945.70 feet, msl
Top of Sediment Pool	1,931.75 feet, msl

Due to the variability of sediment deposition, we have determined that the elevation capacity relationship should be updated to reflect current conditions. We will complete a new sedimentation survey of Harlan County Lake this summer, and new area capacity tables should be available by early next year. The new tables may alter the pool elevations achieved in the Consensus Plan for Harlan County Lake.

## 2. Summer Evaporation.

Evaporation from a lake is affected by many factors including vapor pressure, wind, solar radiation, and salinity of the water. Total water loss from the lake through evaporation is also affected by the size of the lake. When the lake is lower, the surface area is smaller and less water loss occurs. Evaporation at Harlan County Lake has been estimated since the lake's construction using a Weather Service Class A pan which is 4 feet in diameter and 10 inches deep. We and Reclamation have jointly reviewed this information and assumed future conditions to determine an equitable method of distributing the evaporation loss from the project between irrigation and the other purposes.

During those years when the irrigation purpose expected a summer water yield of 119,000 Acre-feet or more, it was determined that an adequate water supply existed and no sharing of evaporation was necessary. Therefore, evaporation evaluation focused on the lower pool elevations when water was scarce. Times of water shortage would also generally be times of higher evaporation rates from the lake.

Reclamation and we agreed that evaporation from the lake during the summer (June through September) would be distributed between the irrigation and sediment pools based on their relative percentage of the total storage at the time of evaporation. If the sediment pool held 75 percent of the total storage, it would be charged 75 percent of the evaporation. If the sediment pool held 50 percent of the total storage, it would be charged 50 percent of the evaporation. At the bottom of the irrigation pool (1,931.75 feet, msl) all of the evaporation would be charged to the sediment pool.

Due to downstream water rights for summer inflow, neither the irrigation nor the sediment pool is credited with summer inflow to the lake. The summer inflows would be

assumed passed through the lake to satisfy the water right holders. Therefore, Reclamation and we did not distribute the summer inflow between the project purposes.

As a result of numerous lake operation model computer runs by Reclamation, it became apparent that total evaporation from the project during the summer averaged about 25,000 Acre-feet during times of lower lake elevations. These same models showed that about 20 percent of the evaporation should be charged to the irrigation pool, based on percentage in storage during the summer months. About 20 percent of the total lake storage is in the irrigation pool when the lake is at elevation 1,935.0 feet, msl. As a result of the joint study, Reclamation and we agreed that the irrigation pool would be credited with 20,000 Acre-feet of water during times of drought to share the summer evaporation loss.

Reclamation and we further agreed that the sediment pool would be assumed full each year. In essence, if the actual pool elevation were below 1,931.75 feet, msl, in January, the irrigation pool would contain a negative storage for the purpose of calculating available water for irrigation, regardless of the prior year's summer evaporation from sediment storage.

### 3. Irrigation withdrawal from sediment storage.

During drought conditions, occasional withdrawal of water from the sediment pool for irrigation is necessary. Such action is contemplated in the Field Working Agreement and the Harlan County Lake Regulation Manual: "Until such time as sediment fully occupies the allocated reserve capacity, it will be used for irrigation and various conservation purposes, including public health, recreation, and fish and wildlife preservation."

To implement this concept into an operation plan for Harlan County Lake, Reclamation and we agreed to estimate the net spring inflow to Harlan County Lake. The estimated inflow would be used by the Reclamation to provide a firm projection of water available for irrigation during the next season.

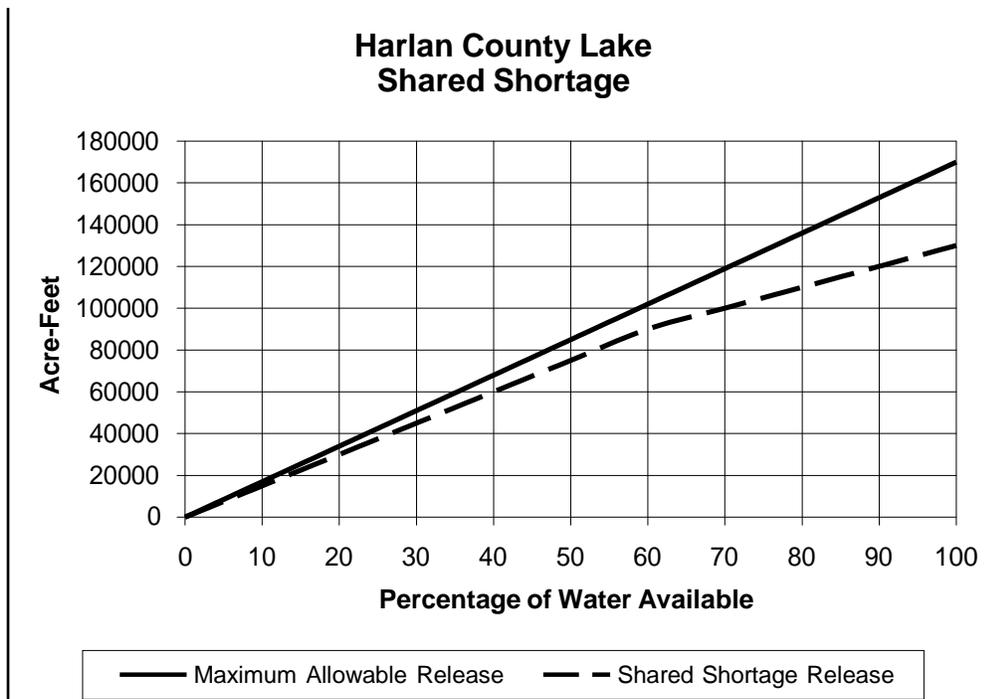
Since the construction of Harlan County Lake, inflows to the lake have been depleted by upstream irrigation wells and farming practices. Reclamation has recently completed an in-depth study of these depleted flows as a part of their contract renewal process. The study concluded that if the current conditions had existed in the basin since 1931, the average spring inflow to the project would have been 57,600 Acre-feet of water. The study further concluded that the evaporation would have been 8,800 Acre-feet of water during the same period. Reclamation and we agreed to use these values to calculate the net inflow to the project under the current conditions.

In addition, both agencies also recognized that the inflow to the project could continue to decrease with further upstream well development and water conservation farming. Due to these concerns, Reclamation and we determined that the previous 5-year inflow values would be averaged each year and compared to 57,600 Acre-feet. The inflow estimate for Harlan County Lake would be the smaller of these two values.

The estimated inflow amount would be used in January of each year to forecast the amount of water stored in the lake at the beginning of the irrigation season. Based on this forecast, the irrigation districts would be provided a firm estimate of the amount of water available for the next season. The actual storage in the lake on May 31 would be reviewed each year. When the actual water in storage is less than the January forecast, Reclamation may draw water from sediment storage to make up the difference.

4. Water Shortage Sharing.

A final component of the agreement involves a procedure for sharing the water available during times of shortage. Under the shared shortage procedure, the irrigation purpose of the project would remove less water than otherwise allowed and alleviate some of the adverse effects to the other purposes. The procedure would also extend the water supply during times of drought by “banking” some water for the next irrigation season. The following graph illustrates the shared shortage releases.



5. Calculation of Irrigation Water Available

Each January, the Reclamation would provide the Bostwick irrigation districts a firm estimate of the quantity of water available for the following season. The firm estimate of water available for irrigation would be calculated by using the following equation and shared shortage adjustment:

$$\text{Storage} + \text{Summer Sediment Pool Evaporation} + \text{Inflow} - \text{Spring Evaporation} = \text{Maximum Irrigation Water Available}$$

The variables in the equation are defined as:

- **Maximum Irrigation Water Available.** Maximum irrigation supply from Harlan County Lake for that irrigation season.
- **Storage.** Actual storage in the irrigation pool at the end of December. The sediment pool is assumed full. If the pool elevation is below the top of the sediment pool, a negative irrigation storage value would be used.
- **Inflow.** The inflow would be the smaller of the past 5-year average inflow to the project from January through May, or 57,600 Acre-feet.
- **Spring Evaporation.** Evaporation from the project would be 8,800 Acre-feet which is the average January through May evaporation.
- **Summer Sediment Pool Evaporation.** Summer evaporation from the sediment pool during June through September would be 20,000 Acre-feet. This is an estimate based on lower pool elevations, which characterize the times when it would be critical to the computations.

#### 6. Shared Shortage Adjustment

To ensure that an equitable distribution of the available water occurs during short-term drought conditions, and provide for a “banking” procedure to increase the water stored for subsequent years, a shared shortage plan would be implemented. The maximum water available for irrigation according to the above equation would be reduced according to the following table. Linear interpolation of values will occur between table values.

Shared Shortage Adjustment Table

Irrigation Water Available (Acre-feet)	Irrigation Water Released (Acre-feet)
0	0
17,000	15,000
34,000	30,000
51,000	45,000
68,000	60,000
85,000	75,000
102,000	90,000
119,000	100,000
136,000	110,000
153,000	120,000
170,000	130,000

## 7. Annual Shutoff Elevation for Harlan County Lake

The annual shutoff elevation for Harlan County Lake would be estimated each January and finally established each June.

The annual shutoff elevation for irrigation releases will be estimated by Reclamation each January in the following manner:

1. Estimate the May 31 Irrigation Water Storage (IWS) (Maximum 150,000 Acre-feet) by taking the December 31 irrigation pool storage plus the January-May inflow estimate (57,600 Acre-feet or the average inflow for the last 5-year period, whichever is less) minus the January-May evaporation estimate (8,800 Acre-feet).
2. Calculate the estimated Irrigation Water Available, including all summer evaporation, by adding the Estimated Irrigation Water Storage (from item 1) to the estimated sediment pool summer evaporation (20,000 AF).
3. Use the above Shared Shortage Adjustment Table to determine the acceptable Irrigation Water Release from the Irrigation Water Available.
4. Subtract the Irrigation Water Release (from item 3) from the Estimated IWS (from item 1). The elevation of the lake corresponding to the resulting irrigation storage is the Estimated Shutoff Elevation. The shutoff elevation will not be below the bottom of the irrigation pool if over 119,000 AF of water is supplied to the districts, nor below 1,927.0 feet, msl. If the shutoff elevation is below the irrigation pool, the maximum irrigation release is 119,000 AF.

The annual shutoff elevation for irrigation releases would be finalized each June in accordance with the following procedure:

1. Compare the estimated May 31 IWS with the actual May 31 IWS.
2. If the actual end of May IWS is less than the estimated May IWS, lower the shutoff elevation to account for the reduced storage.
3. If the actual end of May IWS is equal to or greater than the estimated end of May IWS, the estimated shutoff elevation is the annual shutoff elevation.
4. The shutoff elevation will never be below elevation 1,927.0 feet, msl, and will not be below the bottom of the irrigation pool if more than 119,000 Acre-feet of water is supplied to the districts.

## Attachment 3: Inflows to Harlan County Lake 1993 Level of Development

BASELINE RUN - 1993 LEVEL INFLOW TO HARLAN COUNTY RESERVOIR													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1931	10.2	10.8	13.4	5.0	18.8	15.8	4.3	1.8	1.8	0.0	0.1	0.1	82.1
1932	6.8	16.6	18.5	4.6	3.8	47.6	3.8	2.8	4.8	0.0	0.0	0.4	109.7
1933	0.4	0.0	3.9	30.2	31.0	5.4	1.8	0.0	10.4	0.0	2.6	5.5	91.2
1934	2.1	0.0	3.2	1.8	0.7	7.3	0.8	0.0	1.3	0.0	2.2	0.0	19.4
1935	0.3	0.1	0.7	4.2	0.8	389.3	6.1	19.1	26.1	2.4	5.2	0.9	455.2
1936	0.3	0.0	11.9	0.0	35.9	4.7	0.4	0.0	1.8	0.0	1.6	3.8	60.4
1937	4.8	12.9	6.0	2.5	0.0	12.6	6.3	6.9	2.4	0.0	0.0	12.4	66.8
1938	9.9	7.8	8.7	10.4	18.7	8.6	7.3	7.8	4.9	0.2	0.0	4.7	89.0
1939	2.7	7.5	9.6	12.2	6.6	13.3	5.0	4.1	0.0	0.0	0.0	0.0	61.0
1940	0.0	0.0	12.2	5.2	4.6	23.7	2.8	3.2	0.0	3.6	0.0	1.4	56.7
1941	0.0	10.6	10.6	7.7	17.2	67.1	28.9	19.7	14.9	8.3	6.7	7.1	198.8
1942	3.3	10.6	0.5	34.1	30.8	83.9	11.7	10.9	36.5	3.1	8.7	0.3	234.4
1943	1.2	11.2	14.6	31.4	4.7	28.3	4.8	0.3	0.9	0.0	0.0	11.8	109.2
1944	0.1	4.3	9.0	43.1	31.9	63.9	26.6	15.4	0.5	0.3	3.0	4.5	202.6
1945	4.3	7.8	5.7	9.5	4.1	53.5	5.0	0.9	1.5	5.0	6.0	6.3	109.6
1946	5.9	11.2	9.3	4.9	7.0	3.1	1.6	11.4	28.1	129.9	25.0	12.1	249.5
1947	1.1	3.2	10.4	8.2	11.9	195.4	22.3	5.9	2.9	0.2	0.3	0.3	262.1
1948	6.2	9.8	24.1	5.4	0.2	39.8	13.5	6.8	4.2	0.0	0.1	0.1	110.2
1949	2.0	1.5	25.2	16.3	49.0	57.4	9.2	5.5	2.1	3.0	2.8	0.3	174.3
1950	0.3	5.7	10.8	10.9	28.9	10.1	12.7	9.3	7.8	7.2	3.8	3.1	110.6
1951	3.8	3.4	7.1	5.3	42.0	39.9	42.1	10.1	36.0	15.5	14.8	8.9	228.9
1952	16.4	21.4	26.3	23.8	34.6	4.0	9.3	3.1	1.5	11.7	4.3	0.1	156.5
1953	1.8	4.6	5.3	3.3	15.1	9.5	1.8	0.2	0.0	0.0	2.8	0.1	44.5
1954	1.0	6.8	1.9	3.2	7.1	2.4	0.0	1.2	0.0	0.0	0.0	0.0	23.6
1955	0.0	4.0	6.3	4.8	2.9	6.4	2.7	0.0	1.4	0.0	0.0	0.0	28.5
1956	1.6	3.4	2.9	2.4	1.3	1.5	0.0	0.6	0.0	0.0	0.0	0.0	13.7
1957	0.0	4.1	6.2	12.8	3.5	62.4	21.3	1.2	2.0	3.4	4.5	4.7	126.1
1958	0.8	3.0	14.2	14.0	18.7	1.3	3.4	2.2	0.0	0.4	0.0	0.6	58.6
1959	1.9	15.4	16.4	8.5	13.6	4.2	1.4	1.2	0.0	4.3	1.0	4.5	72.4
1960	1.4	12.3	71.4	23.9	21.7	53.7	14.1	3.2	0.0	0.0	0.2	2.8	204.7
1961	2.3	6.4	7.7	7.4	26.5	24.0	7.2	4.9	0.0	2.3	4.8	1.7	95.2

## Attachment 3: Inflows to Harlan County Lake 1993 Level of Development

BASELINE RUN - 1993 LEVEL INFLOW TO HARLAN COUNTY RESERVOIR													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1962	4.5	9.1	16.2	9.9	14.4	42.6	41.6	21.1	2.3	8.7	8.3	5.7	184.4
1963	3.4	18.2	18.2	15.0	12.7	14.7	3.4	6.1	8.7	0.8	5.3	1.8	108.3
1964	5.4	7.6	8.3	8.4	9.9	11.9	7.2	6.5	2.4	1.9	1.4	2.3	73.2
1965	6.0	8.1	11.1	12.8	32.8	40.0	22.9	6.5	37.2	53.7	19.5	11.0	261.6
1966	8.9	21.4	15.7	11.4	12.0	34.7	12.4	2.5	3.5	5.4	6.8	5.7	140.4
1967	7.2	11.5	11.5	12.9	9.1	75.3	43.7	15.3	4.4	7.3	6.9	5.4	210.5
1968	3.9	10.2	8.5	11.6	10.8	12.5	3.1	2.7	1.6	2.0	4.3	3.4	74.6
1969	4.2	10.8	24.5	15.1	18.9	17.5	17.0	12.6	16.6	9.2	11.8	9.9	168.1
1970	3.5	8.7	8.5	10.5	11.1	7.7	4.6	3.2	0.5	3.3	4.7	4.5	70.8
1971	4.1	10.3	12.4	12.8	18.3	7.2	8.4	6.2	1.9	4.2	7.3	7.1	100.2
1972	5.5	8.1	9.2	8.3	14.8	8.5	6.5	4.4	0.1	2.9	7.6	4.1	80.0
1973	11.4	14.2	19.0	16.2	17.4	20.9	9.1	1.9	8.4	19.6	11.9	13.2	163.2
1974	13.2	13.4	12.0	14.3	15.4	17.2	5.5	0.0	0.0	0.0	4.9	5.5	101.4
1975	7.2	8.2	13.6	14.8	12.0	48.1	11.6	7.4	0.1	3.0	6.2	7.3	139.5
1976	7.0	10.2	10.1	16.0	12.1	3.5	2.2	1.8	0.9	1.0	3.2	3.1	71.1
1977	4.4	9.6	12.9	21.2	31.5	12.1	5.9	1.9	10.6	4.1	5.5	5.3	125.0
1978	5.0	6.5	20.6	12.9	11.8	3.8	0.0	1.0	0.0	0.0	0.3	1.6	63.5
1979	1.3	7.6	21.5	18.8	15.9	5.4	10.4	10.6	1.6	0.9	3.6	6.2	103.8
1980	5.7	9.3	11.6	15.2	10.4	2.1	2.5	0.0	0.0	0.0	2.5	2.2	61.5
1981	5.5	6.0	11.6	14.9	22.5	6.4	11.5	16.3	4.3	2.5	6.7	6.2	114.4
1982	5.3	12.5	17.9	14.3	26.8	27.1	8.9	2.7	0.0	6.5	6.3	15.5	143.8
1983	6.5	9.7	27.2	16.4	41.4	74.2	10.7	7.6	3.8	3.1	6.7	5.2	212.5
1984	6.8	14.6	17.2	32.9	40.6	15.5	8.1	4.5	0.0	5.5	4.8	6.2	156.7
1985	6.9	14.1	13.6	11.9	27.4	9.9	10.0	2.0	6.0	8.5	5.6	5.8	121.7
1986	9.1	9.4	12.2	11.7	34.3	13.0	13.5	4.6	3.3	5.9	5.4	7.1	129.5
1987	5.9	9.2	19.7	24.1	24.3	11.7	19.0	5.7	2.3	2.7	8.2	7.0	139.8
1988	6.2	13.7	11.6	15.2	15.2	7.0	17.9	10.4	0.6	2.0	5.9	5.4	111.1
1989	5.4	5.9	10.5	9.1	11.4	11.8	14.0	6.2	0.2	3.1	3.1	3.5	84.2
1990	6.6	7.7	13.2	9.7	15.5	1.4	4.3	10.7	0.6	3.2	2.0	2.7	77.6
1991	2.4	8.0	9.0	10.6	15.2	3.9	1.9	0.5	0.0	0.0	2.7	4.8	59.0
1992	8.0	8.8	12.7	8.5	4.5	6.1	6.5	9.4	2.4	6.9	6.7	5.2	85.7
1993	5.2	14.4	71.6	22.7	21.0	17.0	68.0	37.5	23.3	16.8	30.1	17.7	345.3
Avg	4.5	8.8	14.1	13.0	17.2	30.6	11.0	6.2	5.4	6.3	5.0	4.7	126.8

## BASELINE - 1993 LEVEL FLOWS - HARLAN COUNTY EVAPORATION

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1931	0.7	0.9	1.6	2.9	4.2	7.4	6.9	5.2	2.7	2.1	1.2	0.4	36.2
1932	0.6	0.8	1.5	2.7	4.1	5.0	6.8	5.0	2.7	2.1	1.2	0.4	32.9
1933	0.6	0.8	1.4	2.5	3.8	7.8	6.1	4.2	2.7	2.1	1.2	0.4	33.6
1934	0.6	0.8	1.4	2.4	4.5	6.5	8.0	6.2	2.7	2.0	1.2	0.4	36.7
1935	0.6	0.8	1.3	2.3	2.2	3.6	9.7	6.2	3.1	2.5	1.4	0.5	34.2
1936	0.7	0.9	1.6	2.9	5.5	6.8	8.7	6.5	2.7	2.1	1.2	0.4	40.0
1937	0.6	0.8	1.4	2.5	3.6	4.0	6.2	6.5	2.7	2.1	1.2	0.4	32.0
1938	0.6	0.9	1.5	2.7	3.4	4.9	6.5	5.7	2.7	2.1	1.2	0.4	32.6
1939	0.6	0.8	1.4	2.6	4.3	4.9	6.8	4.6	2.7	2.1	1.2	0.4	32.4
1940	0.6	0.8	1.4	2.4	3.5	5.0	6.5	4.6	2.7	2.1	1.2	0.4	31.2
1941	0.6	0.8	1.4	2.5	3.9	4.2	6.7	5.3	2.8	2.1	1.3	0.5	32.1
1942	0.6	0.9	1.5	2.8	4.0	5.2	8.3	5.1	3.2	2.5	1.5	0.5	36.1
1943	0.7	1.0	1.8	3.2	4.3	5.7	7.9	6.3	2.7	2.1	1.2	0.4	37.3
1944	0.6	0.8	1.4	2.7	4.2	5.3	7.0	5.8	3.5	2.6	1.5	0.5	35.9
1945	0.7	1.0	1.8	3.1	3.8	3.0	6.7	5.7	2.9	2.2	1.3	0.5	32.7
1946	0.6	0.9	1.6	2.8	3.5	5.1	5.6	4.4	2.9	2.7	1.8	0.6	32.5
1947	1.0	1.5	2.9	3.2	3.4	-1.2	5.8	5.3	3.7	1.7	0.5	0.1	27.9
1948	0.8	0.7	1.5	3.6	3.1	2.4	4.2	4.7	3.0	2.7	0.8	0.3	27.8
1949	0.1	0.9	0.7	1.8	1.1	0.7	6.5	4.1	3.1	1.7	1.5	0.4	22.6
1950	0.7	0.1	0.8	2.8	2.0	5.6	0.8	2.8	4.5	2.3	1.6	0.6	24.6
1951	0.5	0.2	2.1	0.7	-0.1	1.9	3.5	4.1	0.4	3.1	2.2	0.9	19.5
1952	1.1	1.2	1.9	2.5	5.2	6.2	1.5	3.4	3.6	2.9	1.1	-0.1	30.5
1953	0.5	1.0	1.5	2.9	4.7	4.5	4.6	6.6	5.3	3.3	0.1	0.0	35.0
1954	0.7	0.6	2.2	3.6	0.3	4.9	6.7	1.6	3.6	1.6	1.5	0.6	27.9
1955	0.5	1.0	2.1	4.6	3.4	-0.5	7.3	6.9	2.7	2.6	1.4	0.4	32.4
1956	0.6	1.1	1.9	2.8	3.9	4.5	5.0	3.7	4.7	3.7	1.3	0.5	33.7
1957	0.7	1.0	1.3	0.5	-0.6	-1.1	6.1	3.7	2.3	1.7	1.2	0.4	17.2
1958	0.7	0.1	1.0	0.6	2.3	4.4	1.0	1.9	3.3	3.3	1.0	0.6	20.2
1959	0.4	1.0	1.1	2.1	1.0	3.5	5.0	4.8	2.3	0.7	1.5	0.6	24.0
1960	0.1	0.7	2.0	2.7	0.9	0.1	4.9	3.6	3.9	2.0	1.3	0.4	22.6
1961	0.9	1.0	1.4	2.7	-1.1	0.6	5.1	2.9	1.2	2.4	0.7	0.1	17.9

## Attachment 4: Evaporation Loss Harlan County Lake 1993 Level of Development

## BASELINE - 1993 LEVEL FLOWS - HARLAN COUNTY EVAPORATION

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1962	0.6	0.6	0.9	3.7	3.4	1.5	0.3	1.6	2.0	2.0	1.7	0.3	18.6
1963	0.7	1.4	1.3	4.5	4.6	6.3	6.1	3.1	-0.8	2.7	1.5	0.4	31.8
1964	0.8	0.8	1.7	3.2	5.6	1.2	6.9	3.0	3.0	3.3	1.2	0.6	31.3
1965	0.4	0.7	1.2	2.8	1.5	-0.5	2.0	2.8	-3.9	1.7	2.1	0.4	11.2
1966	0.9	0.8	2.9	2.7	7.5	2.8	5.8	3.7	2.7	2.8	1.5	0.4	34.5
1967	0.7	1.2	2.5	3.0	2.0	-2.9	1.6	4.5	3.5	2.0	1.6	0.4	20.1
1968	0.9	1.2	2.8	2.6	3.2	4.9	4.7	1.8	2.3	0.7	1.2	0.2	26.5
1969	0.4	0.6	2.4	3.3	0.1	3.8	-0.7	2.9	2.2	-1.0	1.5	0.4	15.9
1970	0.7	1.4	2.3	2.8	4.7	4.4	6.5	5.9	0.9	1.0	1.5	0.7	32.8
1971	0.7	0.2	2.0	2.9	0.7	5.1	3.4	4.5	1.4	1.5	0.2	0.5	23.1
1972	0.8	1.3	2.0	1.7	1.1	0.0	3.3	1.8	2.1	1.7	-0.4	0.1	15.5
1973	0.5	1.1	-0.7	2.5	3.4	6.7	-1.7	4.2	-3.0	0.2	0.2	0.2	13.6
1974	0.7	1.5	2.6	1.5	3.7	2.5	9.1	2.6	3.4	1.4	1.1	0.3	30.4
1975	0.7	0.7	2.0	2.1	0.8	1.1	4.3	2.7	3.0	3.4	0.7	0.6	22.1
1976	0.8	1.2	1.7	0.7	1.5	5.0	5.9	5.7	-0.2	1.4	1.4	0.7	25.8
1977	0.7	1.3	0.2	1.1	0.0	4.6	4.0	0.6	2.0	1.6	1.0	0.4	17.5
1978	0.5	0.7	1.2	3.4	3.9	6.2	7.1	4.5	4.5	3.0	1.1	0.5	36.6
1979	0.5	0.6	1.1	3.9	4.4	4.6	3.5	5.1	4.1	2.8	1.4	0.7	32.7
1980	0.5	0.6	1.2	3.4	3.7	4.7	6.8	6.0	3.9	2.7	1.3	0.6	35.4
1981	0.5	0.6	1.2	3.8	3.2	4.8	4.2	3.7	2.9	1.7	1.3	0.7	28.6
1982	0.5	0.7	1.2	3.9	3.8	3.9	5.1	3.8	2.9	2.2	1.4	0.8	30.2
1983	0.5	0.7	1.4	2.9	4.2	5.3	8.6	7.2	4.6	1.8	1.5	0.6	39.3
1984	0.6	0.8	1.4	2.9	4.2	5.8	7.2	5.7	4.7	1.4	1.4	0.7	36.8
1985	0.5	0.7	1.3	2.3	4.0	4.5	5.6	3.5	3.8	1.5	1.5	0.7	29.9
1986	0.6	0.7	1.3	2.8	4.4	5.8	6.7	4.0	2.7	1.3	1.4	0.7	32.4
1987	0.5	0.8	1.3	3.1	4.2	6.2	6.9	3.5	3.1	2.2	1.4	0.7	33.9
1988	0.5	0.7	1.3	3.5	4.9	6.6	4.6	4.8	3.5	2.2	1.4	0.7	34.7
1989	0.5	0.7	1.2	4.2	4.5	4.4	4.8	3.6	3.0	2.5	1.4	0.7	31.5
1990	0.5	0.7	1.2	3.0	3.5	5.6	6.4	4.0	5.0	3.4	1.4	0.6	35.3
1991	0.5	0.7	1.2	2.8	3.3	5.5	6.0	5.0	5.1	3.2	1.3	0.6	35.2
1992	0.6	0.7	1.2	1.8	3.2	2.2	4.1	3.5	4.2	2.9	1.9	1.0	27.3
1993	0.6	0.5	1.0	2.2	3.1	4.6	4.2	4.9	4.5	4.4	3.1	1.2	34.3
Avg	0.6	0.8	1.5	2.7	3.2	3.9	5.3	4.3	2.8	2.2	1.3	0.5	29.1

Attachment 5: Projected Water Supply Spread Sheet Calculations

<b>Trigger Calculations Based on Harlan County Lake Irrigation Supply</b>	Units-1000 Acre-feet		Irrigation Trigger		119.0		Assume that during irrigation release season HCL Inflow = Evaporation Loss						
			Total Irrigation Supply		130.0								
			Bottom Irrigation		164.1								
			Evaporation Adjust		20.0								
	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Total</b>
1993 Level AVE inflow	6.3	5	4.7	4.5	8.8	14.1	13.0	17.2	30.6	11.0	6.2	5.4	126.8
1993 Level AVE evap (1931-93)	2.2	1.3	0.5	0.6	0.8	1.5	2.7	3.2	3.9	5.3	4.3	2.8	29.1
Avg. Inflow Last 5 Years	10.8	13.0	12.3	12.9	16.6	22.4	19.4	18.1	14.8	16.5	11.0	4.7	172.6

<b>Year 2001-2002 Oct - Jun Trigger and Irrigation Supply Calculation</b>									
Calculation Month	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>
Previous EOM Content	236.5	235.9	238.6	242.9	248.1	255.1	263.8	269.6	276.2
Inflow to May 31	73.6	67.3	62.3	57.6	53.1	44.3	30.2	17.2	0.0
Last 5 Yrs Avg Inflow to May 31	125.6	114.8	101.7	89.5	76.6	59.9	37.5	18.1	0.0
Evap to May 31	12.8	10.6	9.3	8.8	8.2	7.4	5.9	3.2	0.0
Est. Cont May 31	297.3	292.6	291.6	291.7	293.0	292.0	288.1	283.6	276.2
Est. Elevation May 31	1944.44	1944.08	1944.00	1944.01	1944.11	1944.03	1943.72	1943.37	1942.77
Max. Irrigation Available	153.2	148.5	147.5	147.6	148.9	147.9	144.0	139.5	132.1
Irrigation Release Est.	120.1	117.4	116.8	116.8	118.1	117.1	116.8	116.8	116.8
Trigger - Yes/No	NO	YES							
130 kAF Irrigation Supply - Yes/No	NO								

## Attachment 5: Projected Water Supply Spread Sheet Calculations

<b>Year 2002</b>				
<b>Jul - Sep</b>				
<b>Final Trigger and</b>				
<b>Total Irrigation Supply</b>				
<b>Calculation</b>				
Calculation Month		<b>Jul</b>	<b>Aug</b>	<b>Sep</b>
Previous EOM Irrigation Release Est.		116.8	116.0	109.7
Previous Month Inflow		5.5	0.5	1.3
Previous Month Evap		6.3	6.8	6.6
Irrigation Release Estimate		116.0	109.7	104.4
Final Trigger - Yes/No		YES		
130 kAF Irrigation Supply - Yes/No		NO	NO	NO

Republican River Compact Administration

Accounting Procedures and Reporting Requirements  
Revised August 2010

Attachment 6: Computing Water Supplies and Consumptive Use Above Guide Rock

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Total Main Stem VWS	Hardy gage	Superior-Courtland Diversion Dam Gage	Courtland Canal Diversions	Superior Canal Diversions	Courtland Canal Returns	Superior Canal Returns	Total Bostwick Returns Below Guide Rock	NE CBCU Below Guide Rock	KS CBCU Below Guide Rock	Total CBCU Below Guide Rock	Gain Guide Rock to Hardy	VWS Guide Rock to Hardy	Main Stem Virgin Water Supply Above Guide Rock	Nebraska Main Stem Allocation Above Hardy	Kansas Main Stem Allocation Above Hardy	Nebraska Guide Rock to Hardy Allocation	Kansas Guide Rock to Hardy Allocation
							Col F+ Col G			Col I + Col J	+ Col B - Col C+ Col K - Col H	+ Col L + Col K	Col A - Col M	.489 x Col N	.511 x Col N	.489 x Col M	.511 x Col M

Republican River Compact Administration

Accounting Procedures and Reporting Requirements  
Revised August 2010

Attachment 7: Calculations of Return Flows from Bureau of Reclamation Canals

Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11
Canal	Canal Diversion	Spill to Waste-way	Field Deliveries	Canal Loss	Average Field Loss Factor	Field Loss	Total Loss from District	Percent Field and Canal Loss That Returns to the Stream	Total Return to Stream from Canal and Field Loss	Return as Percent of Canal Diversion
Name Canal	Headgate Diversion	Sum of measured spills to river	Sum of deliveries to the field	+Col 2 - Col 4	1 -Weighted Average Efficiency of Application System for the District*	Col 4 x Col 6	Col 5 + Col 7	Estimated Percent Loss*	Columns 8 x Col 9	Col 10/Col 2
Example	100	5	60	40	30%	18	58	82%	48	48%
Culbertson					30%					
Culbertson Extension					30%					
Meeker-Driftwood					30%					
Red Willow					30%					
Bartley					30%					
Cambridge					30%					
Naponne					35%					
Franklin					35%					
Franklin Pump					35%					
Almena					30%					
Superior					31%					
Nebraska Courtland					23%					
Courtland Canal Above Lovewell (KS)					23%					
Courtland Canal Below Lovewell					23%					

\*The average field efficiencies for each district and percent loss that returns to the stream may be reviewed and, if necessary, changed by the RRCA to improve the accuracy of the estimates.

# Attachment E

# Republican River Compact Administration

## ACCOUNTING PROCEDURES

### AND

## REPORTING REQUIREMENTS

Revised August 12, 2010

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## **I. Introduction**

This document describes the definitions, procedures, basic formulas, specific formulas, and data requirements and reporting formats to be used by the RRCA to compute the Virgin Water Supply, Computed Water Supply, Allocations, Imported Water Supply Credit and Computed Beneficial Consumptive Use. These computations shall be used to determine supply, allocations, use and compliance with the Compact according to the Stipulation. These definitions, procedures, basic and specific formulas, data requirements and attachments may be changed by consent of the RRCA consistent with Subsection I.F of the Stipulation. This document will be referred to as the RRCA Accounting Procedures. Attached to these RRCA Accounting Procedures as Figure 1 is the map attached to the Compact that shows the Basin, its streams and the Basin boundaries.

## **II. Definitions**

The following words and phrases as used in these RRCA Accounting Procedures are defined as follows:

**Additional Water Administration Year** - a year when the projected or actual irrigation water supply is less than 130,000 Acre-feet of storage available for use from Harlan County Lake as determined by the Bureau of Reclamation using the methodology described in the Harlan County Lake Operation Consensus Plan attached as Appendix K to the Stipulation.

**Allocation(s)**: the water supply allocated to each State from the Computed Water Supply;

**Annual**: yearly from January 1 through December 31;

**Basin**: the Republican River Basin as defined in Article II of the Compact;

**Beneficial Consumptive Use**: that use by which the Water Supply of the Basin is consumed through the activities of man, and shall include water consumed by evaporation from any reservoir, canal, ditch, or irrigated area;

**Change in Federal Reservoir Storage**: the difference between the amount of water in storage in the reservoir on December 31 of each year and the amount of water in storage on December 31 of the previous year. The current area capacity table supplied by the appropriate federal operating agency shall be used to determine the contents of the reservoir on each date;

**Compact**: the Republican River Compact, Act of February 22, 1943, 1943 Kan. Sess. Laws 612, codified at Kan. Stat. Ann. § 82a-518 (1997); Act of February 24, 1943, 1943 Neb. Laws 377, codified at 2A Neb. Rev. Stat. App. § 1-106 (1995), Act of March 15, 1943, 1943 Colo. Sess. Laws 362, codified at Colo. Rev. Stat. §§ 37-67-101 and 37-67-102 (2001); Republican River Compact, Act of May 26, 1943, ch. 104, 57 Stat. 86;

**Computed Beneficial Consumptive Use:** for purposes of Compact accounting, the stream flow depletion resulting from the following activities of man:

- Irrigation of lands in excess of two acres;
- Any non-irrigation diversion of more than 50 Acre-feet per year;
- Multiple diversions of 50 Acre-feet or less that are connected or otherwise combined to serve a single project will be considered as a single diversion for accounting purposes if they total more than 50 Acre-feet;
- Net evaporation from Federal Reservoirs;
- Net evaporation from Non-federal Reservoirs within the surface boundaries of the Basin;
- Any other activities that may be included by amendment of these formulas by the RRCA;

**Computed Water Supply:** the Virgin Water Supply less the Change in Federal Reservoir Storage in any Designated Drainage Basin, and less the Flood Flows;

**Designated Drainage Basins:** the drainage basins of the specific tributaries and the Main Stem of the Republican River as described in Article III of the Compact. Attached hereto as Figure 3 is a map of the Sub-basins and Main Stem;

**Dewatering Well:** a Well constructed solely for the purpose of lowering the groundwater elevation;

**Federal Reservoirs:**

- Bonny Reservoir
- Swanson Lake
- Enders Reservoir
- Hugh Butler Lake
- Harry Strunk Lake
- Keith Sebelius Lake
- Harlan County Lake
- Lovewell Reservoir

**Flood Flows:** the amount of water deducted from the Virgin Water Supply as part of the computation of the Computed Water Supply due to a flood event as determined by the methodology described in Subsection III.B.1.;

**Gaged Flow:** the measured flow at the designated stream gage;

**Guide Rock:** a point at the Superior-Courtland Diversion Dam on the Republican River near Guide Rock, Nebraska; the Superior-Courtland Diversion Dam gage plus any flows through the sluice gates of the dam, specifically excluding any diversions to the Superior and Courtland Canals, shall be the measure of flows at Guide Rock;

**Historic Consumptive Use:** that amount of water that has been consumed under appropriate and reasonably efficient practices to accomplish without waste the purposes for which the appropriation or other legally permitted use was lawfully made;

**Imported Water Supply:** the water supply imported by a State from outside the Basin resulting from the activities of man;

**Imported Water Supply Credit:** the accretions to stream flow due to water imports from outside of the Basin as computed by the RRCA Groundwater Model. The Imported Water Supply Credit of a State shall not be included in the Virgin Water Supply and shall be counted as a credit/offset against the Computed Beneficial Consumptive Use of water allocated to that State, except as provided in Subsection V.B.2. of the Stipulation and Subsections III.I. – J. of these RRCA Accounting Procedures;

**Main Stem:** the Designated Drainage Basin identified in Article III of the Compact as the North Fork of the Republican River in Nebraska and the main stem of the Republican River between the junction of the North Fork and the Arikaree River and the lowest crossing of the river at the Nebraska-Kansas state line and the small tributaries thereof, and also including the drainage basin Blackwood Creek;

**Main Stem Allocation:** the portion of the Computed Water Supply derived from the Main Stem and the Unallocated Supply derived from the Sub-basins as shared by Kansas and Nebraska;

**Meeting(s):** a meeting of the RRCA, including any regularly scheduled annual meeting or any special meeting;

**Modeling Committee:** the modeling committee established in Subsection IV.C. of the Stipulation;

**Moratorium:** the prohibition and limitations on construction of new Wells in the geographic area described in Section III. of the Stipulation;

**Non-federal Reservoirs:** reservoirs other than Federal Reservoirs that have a storage capacity of 15 Acre-feet or greater at the principal spillway elevation;

**Northwest Kansas:** those portions of the Sub-basins within Kansas;

**Replacement Well:** a Well that replaces an existing Well that a) will not be used after construction of the new Well and b) will be abandoned within one year after such construction or is used in a manner that is excepted from the Moratorium pursuant to Subsections III.B.1.c.-f. of the Stipulation;

**RRCA:** Republican River Compact Administration, the administrative body composed of the State officials identified in Article IX of the Compact;

**RRCA Accounting Procedures:** this document and all attachments hereto;

**RRCA Groundwater Model:** the groundwater model developed under the provisions of Subsection IV.C. of the Stipulation and as subsequently adopted and revised through action of the RRCA;

**State:** any of the States of Colorado, Kansas, and Nebraska;

**States:** the States of Colorado, Kansas and Nebraska;

**Stipulation:** the Final Settlement Stipulation to be filed in *Kansas v. Nebraska and Colorado*, No. 126, Original, including all Appendices attached thereto;

**Sub-basin:** the Designated Drainage Basins, except for the Main Stem, identified in Article III of the Compact. For purposes of Compact accounting the following Sub-basins will be defined as described below:

North Fork of the Republican River in Colorado drainage basin is that drainage area above USGS gaging station number 06823000, North Fork Republican River at the Colorado-Nebraska State Line,

Arikaree River drainage basin is that drainage area above USGS gaging station number 06821500, Arikaree River at Haigler, Nebraska,

Buffalo Creek drainage basin is that drainage area above USGS gaging station number 06823500, Buffalo Creek near Haigler, Nebraska,

Rock Creek drainage basin is that drainage area above USGS gaging station number 06824000, Rock Creek at Parks, Nebraska,

South Fork of the Republican River drainage basin is that drainage area above USGS gaging station number 06827500, South Fork Republican River near Benkelman, Nebraska,

Frenchman Creek (River) drainage basin in Nebraska is that drainage area above USGS gaging station number 06835500, Frenchman Creek in Culbertson, Nebraska,

Driftwood Creek drainage basin is that drainage area above USGS gaging station number 06836500, Driftwood Creek near McCook, Nebraska,

Red Willow Creek drainage basin is that drainage area above USGS gaging station number 06838000, Red Willow Creek near Red Willow, Nebraska,

Medicine Creek drainage basin is that drainage area above the Medicine Creek below Harry Strunk Lake, State of Nebraska gaging station number 06842500; and the drainage area between the gage and the confluence with the Main Stem,

Sappa Creek drainage basin is that drainage area above USGS gaging station number 06847500, Sappa Creek near Stamford, Nebraska and the drainage area between the gage and the confluence with the Main Stem; and excluding the Beaver Creek drainage basin area downstream from the State of Nebraska gaging station number 06847000 Beaver Creek near Beaver City, Nebraska to the confluence with Sappa Creek,

Beaver Creek drainage basin is that drainage area above State of Nebraska gaging station number 06847000, Beaver Creek near Beaver City, Nebraska, and the drainage area between the gage and the confluence with Sappa Creek,

Prairie Dog Creek drainage basin is that drainage area above USGS gaging station number 06848500, Prairie Dog Creek near Woodruff, Kansas, and the drainage area between the gage and the confluence with the Main Stem;

Attached hereto as Figure 2 is a line diagram depicting the streams, Federal Reservoirs and gaging stations;

**Test hole:** a hole designed solely for the purpose of obtaining information on hydrologic and/or geologic conditions;

**Trenton Dam:** a dam located at 40 degrees, 10 minutes, 10 seconds latitude and 101 degrees, 3 minutes, 35 seconds longitude, approximately two and one-half miles west of the town of Trenton, Nebraska;

**Unallocated Supply:** the “water supplies of upstream basins otherwise unallocated” as set forth in Article IV of the Compact;

**Upstream of Guide Rock, Nebraska:** those areas within the Basin lying west of a line proceeding north from the Nebraska-Kansas state line and following the western edge of Webster County, Township 1, Range 9, Sections 34, 27, 22, 15, 10 and 3 through Webster County, Township 2, Range 9, Sections 34, 27 and 22; then proceeding west along the southern edge of Webster County, Township 2, Range 9, Sections 16, 17 and 18; then proceeding north following the western edge of Webster County, Township 2, Range 9, Sections 18, 7 and 6, through Webster County, Township 3, Range 9, Sections 31, 30, 19, 18, 7 and 6 to its intersection with the northern boundary of Webster County. Upstream of Guide Rock, Nebraska shall not include that area in Kansas east of the 99° meridian and south of the Kansas-Nebraska state line;

**Virgin Water Supply:** the Water Supply within the Basin undepleted by the activities of man;

**Water Short Year Administration:** administration in a year when the projected or actual irrigation water supply is less than 119,000 acre feet of storage available for use from Harlan County Lake as determined by the Bureau of Reclamation using the methodology described in the Harlan County Lake Operation Consensus Plan attached as Appendix K to the Stipulation.

**Water Supply of the Basin or Water Supply within the Basin:** the stream flows within the Basin, excluding Imported Water Supply;

**Well:** any structure, device or excavation for the purpose or with the effect of obtaining groundwater for beneficial use from an aquifer, including wells, water wells, or groundwater wells as further defined and used in each State’s laws, rules, and regulations.

**III. Basic Formulas**

The basic formulas for calculating Virgin Water Supply, Computed Water Supply, Imported Water Supply, Allocations and Computed Beneficial Consumptive Use are set forth below. The results of these calculations shall be shown in a table format as shown in Table 1.

Basic Formulas for Calculating Virgin Water Supply, Computed Water Supply, Allocations and Computed Beneficial Consumptive Use	
Sub-basin VWS	= Gage + All CBCU + ΔS – IWS
Main Stem VWS	= Hardy Gage – Σ Sub-basin gages + All CBCU in the Main Stem + ΔS – IWS
CWS	= VWS - Δ S – FF
Allocation for each State in each Sub-basin And Main Stem	= CWS x %
State's Allocation	= Σ Allocations for Each State
State's CBCU	= Σ State's CBCUs in each Sub-basin and Main Stem

Abbreviations:

- CBCU = Computed Beneficial Consumptive Use
- FF = Flood Flows
- Gage = Gaged Flow
- IWS = Imported Water Supply Credit
- CWS = Computed Water Supply
- VWS = Virgin Water Supply

% = the ratio used to allocate the Computed Water Supply between the States. This ratio is based on the allocations in the Compact  
 $\Delta S$  = Change in Federal Reservoir Storage

## **A. Calculation of Annual Virgin Water Supply**

### **1. Sub-basin calculation:**

The annual Virgin Water Supply for each Sub-basin will be calculated by adding: a) the annual stream flow in that Sub-basin at the Sub-basin stream gage designated in Section II., b) the annual Computed Beneficial Consumptive Use above that gaging station, and c) the Change in Federal Reservoir Storage in that Sub-basin; and from that total subtract any Imported Water Supply Credit. The Computed Beneficial Consumptive Use will be calculated as described in Subsection III. D. Adjustments for flows diverted around stream gages and for Computed Beneficial Consumptive Uses in the Sub-basin between the Sub-basin stream gage and the confluence of the Sub-basin tributary and the Main Stem shall be made as described in Subsections III. D. 1 and 2 and IV. B.

### **2. Main Stem Calculation:**

The annual Virgin Water Supply for the Main Stem will be calculated by adding: a) the flow at the Hardy gage minus the flows from the Sub-basin gages listed in Section II, b) the annual Computed Beneficial Consumptive Use in the Main Stem, and c) the Change in Federal Reservoir Storage from Swanson Lake and Harlan County Lake; and from that total subtract any Imported Water Supply Credit for the Main Stem. Adjustments for flows diverted around Sub-basin stream gages and for Computed Beneficial Consumptive Uses in a Sub-basin between the Sub-basin stream gage and the confluence of the Sub-basin tributary and the Mains Stem shall be made as described in Subsections III. D. 1 and 2 and IV.B.,

### **3. Imported Water Supply Credit Calculation:**

The amount of Imported Water Supply Credit shall be determined by the RRCA Groundwater Model. The Imported Water Supply Credit of a State shall not be included in the Virgin Water Supply and shall be counted as a credit/offset against the Computed Beneficial Consumptive Use of water allocated to that State. Currently, the Imported Water Supply Credits shall be determined using two runs of the RRCA Groundwater Model:

- a. The “base” run shall be the run with all groundwater pumping, groundwater pumping recharge, and surface water recharge within the model study

boundary for the current accounting year turned “on.” ~~This will be the same “base” run used to determine groundwater Computed Beneficial Consumptive Uses.~~

- b. The “no NE import” run shall be the run with the same model inputs as the base run with the exception that surface water recharge associated with Nebraska’s Imported Water Supply shall be turned “off.” This will be the same “no NE import” run used to determine groundwater Computed Beneficial Consumptive Uses.

The Imported Water Supply Credit shall be the difference in stream flows between these two model runs. Differences in stream flows shall be determined at the same locations as identified in Subsection III.D.1. for the “no pumping” runs. Should another State import water into the Basin in the future, the RRCA will develop a similar procedure to determine Imported Water Supply Credits.

## **B. Calculation of Computed Water Supply**

On any Designated Drainage Basin without a Federal Reservoir, the Computed Water Supply will be equal to the Virgin Water Supply of that Designated Drainage Basin minus Flood Flows.

On any Designated Drainage Basin with a Federal Reservoir, the Computed Water Supply will be equal to the Virgin Water Supply minus the Change in Federal Reservoir Storage in that Designated Drainage Basin and minus Flood Flows.

### **1. Flood Flows**

If in any calendar year there are five consecutive months in which the total actual stream flow<sup>1</sup> at the Hardy gage is greater than 325,000 Acre-feet, or any two consecutive months in which the total actual stream flow is greater than 200,000 Acre-feet, the annual flow in excess of 400,000 Acre-feet at the Hardy gage will be considered to be Flood Flows that will be subtracted from the Virgin Water Supply to calculate the Computed Water Supply, and Allocations. The Flood Flow in excess of 400,000 Acre-feet at the Hardy gage will be subtracted from the Virgin Water Supply of the Main Stem to compute the Computed Water Supply unless the Annual Gaged Flows from a Sub-basin were in excess of the flows shown for that Sub-basin in Attachment 1. These excess Sub-basin flows shall be considered to be Sub-basin Flood Flows.

If there are Sub-basin Flood Flows, the total of all Sub-basin Flood Flows shall be compared to the amount of Flood Flows at the Hardy gage. If the sum of the Sub-basin Flood Flows are in excess of the Flood Flow at the Hardy gage, the flows to

<sup>1</sup> These actual stream flows reflect Gaged Flows after depletions by Beneficial Consumptive Use and change in reservoir storage above the gage.

be deducted from each Sub-basin shall be the product of the Flood Flows for each Sub-basin times the ratio of the Flood Flows at the Hardy gage divided by the sum of the Flood Flows of the Sub-basin gages. If the sum of the Sub-basin Flood Flows is less than the Flood Flow at the Hardy gage, the entire amount of each Sub-basin Flood Flow shall be deducted from the Virgin Water Supply to compute the Computed Water Supply of that Sub-basin for that year. The remainder of the Flood Flows will be subtracted from the flows of the Main Stem.

### C. Calculation of Annual Allocations

Article IV of the Compact allocates 54,100 Acre-feet for Beneficial Consumptive Use in Colorado, 190,300 Acre-feet for Beneficial Consumptive Use in Kansas and 234,500 Acre-feet for Beneficial Consumptive Use in Nebraska. The Compact provides that the Compact totals are to be derived from the sources and in the amounts specified in Table 2.

The Allocations derived from each Sub-basin to each State shall be the Computed Water Supply multiplied by the percentages set forth in Table 2. In addition, Kansas shall receive 51.1% of the Main Stem Allocation and the Unallocated Supply and Nebraska shall receive 48.9% of the Main Stem Allocation and the Unallocated Supply.

### D. Calculation of Annual Computed Beneficial Consumptive Use

#### 1. Groundwater

Computed Beneficial Consumptive Use of groundwater shall be determined by use of the RRCA Groundwater Model. The Computed Beneficial Consumptive Use of groundwater for each State shall be determined as the difference in streamflows using two runs of the model:

The “baseno NE import” run shall be the run with all groundwater pumping, groundwater pumping recharge, and surface water recharge within the model study boundary for the current accounting year “on”, with the exception that surface water recharge associated with Nebraska’s Imported Water Supply shall be turned “off.”

The “no State pumping” run shall be the run with the same model inputs as the base “no NE import” run with the exception that all groundwater pumping and pumping recharge of that State shall be turned “off.”

An output of the model is baseflows at selected stream cells. Changes in the baseflows predicted by the model between the “baseno NE import” run and the “no-State- pumping” model run is assumed to be the depletions to streamflows.

i.e., groundwater computed beneficial consumptive use, due to State groundwater pumping at that location. The values for each Sub-basin will include all depletions and accretions upstream of the confluence with the Main Stem. The values for the Main Stem will include all depletions and accretions in stream reaches not otherwise accounted for in a Sub-basin. The values for the Main Stem will be computed separately for the reach above Guide Rock, and the reach below Guide Rock.

## **2. Surface Water**

The Computed Beneficial Consumptive Use of surface water for irrigation and non-irrigation uses shall be computed by taking the diversions from the river and subtracting the return flows to the river resulting from those diversions, as described in Subsections IV.A.2.a.-d. The Computed Beneficial Consumptive Use of surface water from Federal Reservoir and Non-Federal Reservoir evaporation shall be the net reservoir evaporation from the reservoirs, as described in Subsections IV.A.2.e.-f.

For Sub-basins where the gage designated in Section II. is near the confluence with the Main Stem, each State's Sub-basin Computed Beneficial Consumptive Use of surface water shall be the State's Computed Beneficial Consumptive Use of surface water above the Sub-basin gage. For Medicine Creek, Sappa Creek, Beaver Creek and Prairie Dog Creek, where the gage is not near the confluence with the Main Stem, each State's Computed Beneficial Consumptive Use of surface water shall be the sum of the State's Computed Beneficial Consumptive Use of surface water above the gage, and its Computed Beneficial Consumptive Use of surface water between the gage and the confluence with the Main Stem.

## **E. Calculation to Determine Compact Compliance Using Five-Year Running Averages**

Each year, using the procedures described herein, the RRCA will calculate the Annual Allocations by Designated Drainage Basin and total for each State, the Computed Beneficial Consumptive Use by Designated Drainage Basin and total for each State and the Imported Water Supply Credit that a State may use for the preceding year. These results for the current Compact accounting year as well as the results of the previous four accounting years and the five-year average of these results will be displayed in the format shown in Table 3.

## **F. Calculations To Determine Colorado's and Kansas's Compliance with the Sub-basin Non-Impairment Requirement**

The data needed to determine Colorado's and Kansas's compliance with the Sub-basin non-impairment requirement in Subsection IV.B.2. of the Stipulation are shown in Tables 4.A. and B.

## **G. Calculations To Determine Projected Water Supply**

### **1. Procedures to Determine Water Short Years**

The Bureau of Reclamation will provide each of the States with a monthly or, if requested by any one of the States, a more frequent update of the projected or actual irrigation supply from Harlan County Lake for that irrigation season using the methodology described in the Harlan County Lake Operation Consensus Plan, attached as Appendix K to the Stipulation. The steps for the calculation are as follows:

Step 1. At the beginning of the calculation month (1) the total projected inflow for the calculation month and each succeeding month through the end of May shall be added to the previous end of month Harlan County Lake content and (2) the total projected 1993 level evaporation loss for the calculation month and each succeeding month through the end of May shall then be subtracted. The total projected inflow shall be the 1993 level average monthly inflow or the running average monthly inflow for the previous five years, whichever is less.

Step 2. Determine the maximum irrigation water available by subtracting the sediment pool storage (currently 164,111 Acre-feet) and adding the summer sediment pool evaporation (20,000 Acre-feet) to the result from Step 1.

Step 3. For October through January calculations, take the result from Step 2 and using the Shared Shortage Adjustment Table in Attachment 2 hereto, determine the preliminary irrigation water available for release. The calculation using the end of December content (January calculation month) indicates the minimum amount of irrigation water available for release at the end of May. For February through June calculations, subtract the maximum irrigation water available for the January calculation month from the maximum irrigation water available for the calculation month. If the result is negative, the irrigation water available for release (January calculation month) stays the same. If the result is positive the preliminary irrigation

water available for release (January calculation month) is increased by the positive amount.

Step 4. Compare the result from Step 3 to 119,000 Acre-feet. If the result from Step 3 is less than 119,000 Acre-feet Water Short Year Administration is in effect.

Step 5. The final annual Water-Short Year Administration calculation determines the total estimated irrigation supply at the end of June (calculated in July). Use the result from Step 3 for the end of May irrigation release estimate, add the June computed inflow to Harlan County Lake and subtract the June computed gross evaporation loss from Harlan County Lake.

## **2. Procedures to Determine 130,000 Acre Feet Projected Water Supply**

To determine the preliminary irrigation supply for the October through June calculation months, follow the procedure described in steps 1 through 4 of the “Procedures to determine Water Short Years” Subsection III. G. 1. The result from step 4 provides the forecasted water supply, which is compared to 130,000 Acre-feet. For the July through September calculation months, use the previous end of calculation month preliminary irrigation supply, add the previous month’s Harlan County Lake computed inflow and subtract the previous month’s computed gross evaporation loss from Harlan County Lake to determine the current preliminary irrigation supply. The result is compared to 130,000 Acre-feet.

### **H. Calculation of Computed Water Supply, Allocations and Computed Beneficial Consumptive Use Above and Below Guide Rock During Water-Short Administration Years.**

For Water-Short-Administration Years, in addition to the normal calculations, the Computed Water Supply, Allocations, Computed Beneficial Consumptive Use and Imported Water Supply Credits shall also be calculated above Guide Rock as shown in Table 5C. These calculations shall be done in the same manner as in non-Water-Short Administration years except that water supplies originating below Guide Rock shall not be included in the calculations of water supplies originating above Guide Rock. The calculations of Computed Beneficial Consumptive Uses shall be also done in the same manner as in non-Water-Short Administration years except that Computed Beneficial Consumptive Uses from diversions below Guide Rock shall not be included. The depletions from the water diverted by the Superior and Courtland Canals at the Superior-Courtland Diversion Dam shall be included in the calculations of Computed Beneficial Consumptive Use above Guide Rock. Imported Water Supply Credits above Guide Rock, as described in Sub-section III.I., may be used as offsets against the Computed Beneficial Consumptive Use above Guide Rock by the State providing the Imported Water Supply Credits.

The Computed Water Supply of the Main Stem reach between Guide Rock and the Hardy gage shall be determined by taking the difference in stream flow at Hardy and Guide Rock, adding Computed Beneficial Consumptive Uses in the reach (this does not include the Computed Beneficial Consumptive Use from the Superior and Courtland Canal diversions), and subtracting return flows from the Superior and Courtland Canals in the reach. The Computed Water Supply above Guide Rock shall be determined by subtracting the Computed Water Supply of the Main Stem reach between Guide Rock and the Hardy gage from the total Computed Water Supply. Nebraska's Allocation above Guide Rock shall be determined by subtracting 48.9% of the Computed Water Supply of the Main Stem reach between Guide Rock and the Hardy gage from Nebraska's total Allocation. Nebraska's Computed Beneficial Consumptive Uses above Guide Rock shall be determined by subtracting Nebraska's Computed Beneficial Consumptive Uses below Guide Rock from Nebraska's total Computed Beneficial Consumptive Use.

### **I. Calculation of Imported Water Supply Credits During Water-Short Year Administration Years.**

Imported Water Supply Credit during Water-Short Year Administration years shall be calculated consistent with Subsection V.B.2.b. of the Stipulation.

The following methodology shall be used to determine the extent to which Imported Water Supply Credit, as calculated by the RRCA Groundwater Model, can be credited to the State importing the water during Water-Short Year Administration years.

#### **1. Monthly Imported Water Supply Credits**

The RRCA Groundwater Model will be used to determine monthly Imported Water Supply Credits by State in each Sub-basin and for the Main Stem. The values for each Sub-basin will include all depletions and accretions upstream of the confluence with the Main Stem. The values for the Main Stem will include all depletions and accretions in stream reaches not otherwise accounted for in a Sub-basin. The values for the Main Stem will be computed separately for the reach 1) above Harlan County Dam, 2) between Harlan County Dam and Guide Rock, and 3) between Guide Rock and the Hardy gage. The Imported Water Supply Credit shall be the difference in stream flow for two runs of the model: a) the "base" run and b) the "no State import" run.

During Water-Short Year Administration years, Nebraska's credits in the Sub-basins shall be determined as described in Section III. A. 3.

## **2. Imported Water Supply Credits Above Harlan County Dam**

Nebraska's Imported Water Supply Credits above Harlan County Dam shall be the sum of all the credits in the Sub-basins and the Main Stem above Harlan County Dam.

## **3. Imported Water Supply Credits Between Harlan County Dam and Guide Rock During the Irrigation Season**

a. During Water-Short Year Administration years, monthly credits in the reach between Harlan County Dam and Guide Rock shall be determined as the differences in the stream flows between the two runs at Guide Rock.

b. The irrigation season shall be defined as starting on the first day of release of water from Harlan County Lake for irrigation use and ending on the last day of release of water from Harlan County Lake for irrigation use.

c. Credit as an offset for a State's Computed Beneficial Consumptive Use above Guide Rock will be given to all the Imported Water Supply accruing in the reach between Harlan County Dam and Guide Rock during the irrigation season. If the period of the irrigation season does not coincide with the period of modeled flows, the amount of the Imported Water Supply credited during the irrigation season for that month shall be the total monthly modeled Imported Water Supply Credit times the number of days in the month occurring during the irrigation season divided by the total number of days in the month.

## **4. Imported Water Supply Credits Between Harlan County Dam and Guide Rock During the Non-Irrigation Season**

a. Imported Water Supply Credit shall be given between Harlan County Dam and Guide Rock during the period that flows are diverted to fill Lovewell Reservoir to the extent that imported water was needed to meet Lovewell Reservoir target elevations.

b. Fall and spring fill periods shall be established during which credit shall be given for the Imported Water Supply Credit accruing in the reach. The fall period shall extend from the end of the irrigation season to December 1. The spring period shall extend from March 1 to May 31. The Lovewell target elevations for these fill periods are the projected end of November reservoir level and the projected end of May reservoir level for most

probable inflow conditions as indicated in Table 4 in the current Annual Operating Plan prepared by the Bureau of Reclamation.

c. The amount of water needed to fill Lovewell Reservoir for each period shall be calculated as the storage content of the reservoir at its target elevation at the end of the fill period minus the reservoir content at the start of the fill period plus the amount of net evaporation during this period minus White Rock Creek inflows for the same period.

d. If the fill period as defined above does not coincide with the period of modeled flows, the amount of the Imported Water Supply Credit during the fill period for that month shall be the total monthly modeled Imported Water Supply Credit times the number of days in the month occurring during the fill season divided by the total number of days in the month.

e. The amount of non-imported water available to fill Lovewell Reservoir to the target elevation shall be the amount of water available at Guide Rock during the fill period minus the amount of the Imported Water Supply Credit accruing in the reach during the same period.

f. The amount of the Imported Water Supply Credit that shall be credited against a State's Consumptive Use shall be the amount of water imported by that State that is available in the reach during the fill period or the amount of water needed to reach Lovewell Reservoir target elevations minus the amount of non-imported water available during the fill period, whichever is less.

## 5. Other Credits

Kansas and Nebraska will explore crediting Imported Water Supply that is otherwise useable by Kansas.

## J. Calculations of Compact Compliance in Water-Short Year Administration Years

During Water-Short Year Administration, using the procedures described in Subsections III.A-D, the RRCA will calculate the Annual Allocations for each State, the Computed Beneficial Consumptive Use by each State, and Imported Water Supply Credit that a State may use to offset Computed Beneficial Consumptive Use in that year. The resulting annual and average values will be calculated as displayed in Tables 5 A-C and E.

If Nebraska is implementing an Alternative Water-Short-Year Administration Plan, data to determine Compact compliance will be shown in Table 5D. Nebraska's compliance with the Compact will be determined in the same manner as Nebraska's Above Guide Rock

compliance except that compliance will be based on a three-year running average of the current year and previous two year calculations. In addition, Table 5 D. will display the sum of the previous two-year difference in Allocations above Guide Rock and Computed Beneficial Consumptive Uses above Guide Rock minus any Imported Water Credits and compare the result with the Alternative Water-Short-Year Administration Plan's expected decrease in Computed Beneficial Consumptive Use above Guide Rock. Nebraska will be within compliance with the Compact as long as the three-year running average difference in Column 8 is positive and the sum of the previous year and current year deficits above Guide Rock are not greater than the expected decrease in Computed Beneficial Consumptive Use under the plan.

#### **IV. Specific Formulas**

##### **A. Computed Beneficial Consumptive Use**

###### **1. Computed Beneficial Consumptive Use of Groundwater:**

The Computed Beneficial Consumptive Use caused by groundwater diversion shall be determined by the RRCA Groundwater Model as described in Subsection III.D.1.

###### **2. Computed Beneficial Consumptive Use of Surface Water:**

The Computed Beneficial Consumptive Use of surface water shall be calculated as follows:

###### a) Non-Federal Canals

Computed Beneficial Consumptive Use from diversions by non- federal canals shall be 60 percent of the diversion; the return flow shall be 40 percent of the diversion

###### b) Individual Surface Water Pumps

Computed Beneficial Consumptive Use from small individual surface water pumps shall be 75 percent of the diversion; return flows will be 25 percent of the diversion unless a state provides data on the amount of different system types in a Sub-basin, in which case the following percentages will be used for each system type:

Gravity Flow.	30%
---------------	-----

Center Pivot	17%
LEPA	10%

c) Federal Canals

Computed Beneficial Consumptive Use of diversions by Federal canals will be calculated as shown in Attachment 7. For each Bureau of Reclamation Canal the field deliveries shall be subtracted from the diversion from the river to determine the canal losses. The field delivery shall be multiplied by one minus an average system efficiency for the district to determine the loss of water from the field. Eighty-two percent of the sum of the field loss plus the canal loss shall be considered to be the return flow from the canal diversion. The assumed field efficiencies and the amount of the field and canal loss that reaches the stream may be reviewed by the RRCA and adjusted as appropriate to insure their accuracy.

d) Non-irrigation Uses

Any non-irrigation uses diverting or pumping more than 50 acre-feet per year will be required to measure diversions. Non-irrigation uses diverting more than 50 Acre-feet per year will be assessed a Computed Beneficial Consumptive Use of 50% of what is pumped or diverted, unless the entity presents evidence to the RRCA demonstrating a different percentage should be used.

e) Evaporation from Federal Reservoirs

Net Evaporation from Federal Reservoirs will be calculated as follows:

(1) Harlan County Lake, Evaporation Calculation

April 1 through October 31:

Evaporation from Harlan County Lake is calculated by the Corps of Engineers on a daily basis from April 1 through October 31. Daily readings are taken from a Class A evaporation pan maintained near the project office. Any precipitation recorded at the project office is added to the pan reading to obtain the actual evaporation amount. The pan value is multiplied by a pan coefficient that varies by month. These values are:

March	.56
April	.52
May	.53
June	.60
July	.68
August	.78
September	.91
October	1.01

The pan coefficients were determined by studies the Corps of Engineers conducted a number of years ago. The result is the evaporation in inches. It is divided by 12 and multiplied by the daily lake surface area in acres to obtain the evaporation in Acre-feet. The lake surface area is determined by the 8:00 a.m. elevation reading applied to the lake's area-capacity data. The area-capacity data is updated periodically through a sediment survey. The last survey was completed in December 2000.

November 1 through March 31

During the winter season, a monthly total evaporation in inches has been determined. The amount varies with the percent of ice cover. The values used are:

HARLAN COUNTY LAKE

Estimated Evaporation in Inches  
Winter Season -- Monthly Total

PERCENTAGE OF ICE COVER

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
JAN	0.88	0.87	0.85	0.84	0.83	0.82	0.81	0.80	0.78	0.77	0.76
FEB	0.90	0.88	0.87	0.86	0.85	0.84	0.83	0.82	0.81	0.80	0.79
MAR	1.29	1.28	1.27	1.26	1.25	1.24	1.23	1.22	1.21	1.20	1.19
OCT	4.87			NO ICE							
NOV	2.81			NO ICE							
DEC	1.31	1.29	1.27	1.25	1.24	1.22	1.20	1.18	1.17	1.16	1.14

The monthly total is divided by the number of days in the month to obtain a daily evaporation value in inches. It is divided by 12 and

multiplied by the daily lake surface area in acres to obtain the evaporation in Acre-feet. The lake surface area is determined by the 8:00 a.m. elevation reading applied to the lake's area-capacity data. The area-capacity data is updated periodically through a sediment survey. The last survey was completed in December 2000.

To obtain the net evaporation, the monthly precipitation on the lake is subtracted from the monthly gross evaporation. The monthly precipitation is calculated by multiplying the sum of the month's daily precipitation in inches by the average of the end of the month lake surface area for the previous month and the end of the month lake surface area for the current month in acres and dividing the result by 12 to obtain the precipitation for the month in acre feet.

The total annual net evaporation (Acre-feet) will be charged to Kansas and Nebraska in proportion to the annual diversions made by the Kansas Bostwick Irrigation District and the Nebraska Bostwick Irrigation District during the time period each year when irrigation releases are being made from Harlan County Lake. For any year in which no irrigation releases were made from Harlan County Lake, the annual net evaporation charged to Kansas and Nebraska will be based on the average of the above calculation for the most recent three years in which irrigation releases from Harlan County Lake were made. In the event Nebraska chooses to substitute supply for the Superior Canal from Nebraska's allocation below Guide Rock in Water-Short Year Administration years, the amount of the substitute supply will be included in the calculation of the split as if it had been diverted to the Superior Canal at Guide Rock.

## (2) Evaporation Computations for Bureau of Reclamation Reservoirs

The Bureau of Reclamation computes the amount of evaporation loss on a monthly basis at Reclamation reservoirs. The following procedure is utilized in calculating the loss in Acre-feet.

An evaporation pan reading is taken each day at the dam site. This measurement is the amount of water lost from the pan over a 24-hour period in inches. The evaporation pan reading is adjusted for any precipitation recorded during the 24-hour period. Instructions for determining the daily pan evaporation are found in the "National Weather Service Observing Handbook No. 2 – Substation Observations." All dams located in the Kansas River Basin with the exception of Bonny Dam are National Weather Service Cooperative Observers. The daily evaporation pan readings are totaled at the end

of each month and converted to a “free water surface” (FWS) evaporation, also referred to as “lake” evaporation. The FWS evaporation is determined by multiplying the observed pan evaporation by a coefficient of .70 at each of the reservoirs. This coefficient can be affected by several factors including water and air temperatures. The National Oceanic and Atmospheric Administration (NOAA) has published technical reports describing the determination of pan coefficients. The coefficient used is taken from the “NOAA Technical Report NWS 33, Map of coefficients to convert class A pan evaporation to free water surface evaporation”. This coefficient is used for the months of April through October when evaporation pan readings are recorded at the dams. The monthly FWS evaporation is then multiplied by the average surface area of the reservoir during the month in acres. Dividing this value by twelve will result in the amount of water lost to evaporation in Acre-feet during the month.

During the winter months when the evaporation pan readings are not taken, monthly evaporation tables based on the percent of ice cover are used. The tables used were developed by the Corps of Engineers and were based on historical average evaporation rates. A separate table was developed for each of the reservoirs. The monthly evaporation rates are multiplied by the .70 coefficient for pan to free water surface adjustment, divided by twelve to convert inches to feet and multiplied by the average reservoir surface area during the month in acres to obtain the total monthly evaporation loss in Acre-feet.

To obtain the net evaporation, the monthly precipitation on the lake is subtracted from the monthly gross evaporation. The monthly precipitation is calculated by multiplying the sum of the month's daily precipitation in inches by the average of the end of the month lake surface area for the previous month and the end of the month lake surface area for the current month in acres and dividing the result by 12 to obtain the precipitation for the month in acre feet.

f) Non-Federal Reservoir Evaporation:

For Non-Federal Reservoirs with a storage capacity less than 200 Acre-feet, the presumptive average annual surface area is 25% of the area at the principal spillway elevation. Net evaporation for each such Non-Federal Reservoir will be calculated by multiplying the presumptive average annual surface area by the net evaporation from the nearest climate and evaporation

station to the Non-Federal Reservoir. A State may provide actual data in lieu of the presumptive criteria.

Net evaporation from Non-Federal Reservoirs with 200 Acre-feet of storage or greater will be calculated by multiplying the average annual surface area (obtained from the area-capacity survey) and the net evaporation from the nearest evaporation and climate station to the reservoir. If the average annual surface area is not available, the Non-Federal Reservoirs with 200 Acre-feet of storage or greater will be presumed to be full at the principal spillway elevation.

## **B. Specific Formulas for Each Sub-basin and the Main Stem**

All calculations shall be based on the calendar year and shall be rounded to the nearest 10 Acre-feet using the conventional rounding formula of rounding up for all numbers equal to five or higher and otherwise rounding down.

### Abbreviations:

CBCU	= Computed Beneficial Consumptive Use
CWS	= Computed Water Supply
D	= Non-Federal Canal Diversions for Irrigation
Ev	= Evaporation from Federal Reservoirs
EvNFR	= Evaporation from Non-Federal Reservoirs
FF	= Flood Flow
GW	= Groundwater Computed Beneficial Consumptive Use (includes irrigation and non-irrigation uses)
IWS	= Imported Water Supply Credit from Nebraska
M&I	= Non-Irrigation Surface Water Diversions (Municipal and Industrial)
P	= Small Individual Surface Water Pump Diversions for Irrigation
RF	= Return Flow
VWS	= Virgin Water Supply
c	= Colorado
k	= Kansas
n	= Nebraska
$\Delta S$	= Change in Federal Reservoir Storage
%	= Average system efficiency for individual pumps in the Sub-basin
% BRF	= Percent of Diversion from Bureau Canals that returns to the stream
###	= Value expected to be zero

### 3. North Fork of Republican River in Colorado <sup>2</sup>

$$\text{CBCU Colorado} = 0.6 \times \text{Haigler Canal Diversion Colorado} + 0.6 \times D_c + \% \times P_c + 0.5 \times M\&I_c + EvNFR_c + GW_c$$

$$\text{CBCU Kansas} = GW_k$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Haigler Canal Diversion Nebraska} + GW_n$$

Note: The diversion for Haigler Canal is split between Colorado and Nebraska based on the percentage of land irrigated in each state

$$\text{VWS} = \text{North Fork of the Republican River at the State Line, Stn. No. 06823000} + \text{CBCU}_c + \text{CBCU}_k + \text{CBCU}_n + \text{Nebraska Haigler Canal RF} - \text{IWS}$$

Note: The Nebraska Haigler Canal RF returns to the Main Stem

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Colorado} = 0.224 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.246 \times \text{CWS}$$

$$\text{Unallocated} = 0.53 \times \text{CWS}$$

### 4. Arikaree River <sup>2</sup>

$$\text{CBCU Colorado} = 0.6 \times D_c + \% \times P_c + 0.5 \times M\&I_c + EvNFR_c + GW_c$$

$$\text{CBCU Kansas} = 0.6 \times D_k + \% \times P_k + 0.5 \times M\&I_k + EvNFR_k + GW_k$$

$$\text{CBCU Nebraska} = 0.6 \times D_n + \% \times P_n + 0.5 \times M\&I_n + EvNFR_n + GW_n$$

$$\text{VWS} = \text{Arikaree Gage at Haigler Stn. No. 06821500} + \text{CBCU}_c + \text{CBCU}_k + \text{CBCU}_n - \text{IWS}$$

<sup>2</sup> The RRCA will investigate whether return flows from the Haigler Canal diversion in Colorado may return to the Arikaree River, not the North Fork of the Republican River, as indicated in the formulas. If there are return flows from the Haigler Canal to the Arikaree River, these formulas will be changed to recognize those returns.

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Colorado} = 0.785 \times \text{CWS}$$

$$\text{Allocation Kansas} = 0.051 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.168 \times \text{CWS}$$

$$\text{Unallocated} = -0.004 \times \text{CWS}$$

### 5. Buffalo Creek

$$\text{CBCU Colorado} = 0.6 \times \text{Dc} + \% \times \text{Pc} + 0.5 \times \text{M\&In} + \text{EvNFRc} + \text{GWc}$$

$$\text{CBCU Kansas} = \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + \text{GWn}$$

$$\text{VWS} = \text{Buffalo Creek near Haigler Gage Stn. No. 06823500} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} - \text{IWS}$$

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Nebraska} = 0.330 \times \text{CWS}$$

$$\text{Unallocated} = 0.670 \times \text{CWS}$$

### 6. Rock Creek

$$\text{CBCU Colorado} = \text{GWc}$$

$$\text{CBCU Kansas} = \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + \text{GWn}$$

$$\text{VWS} = \text{Rock Creek at Parks Gage Stn. No. 06824000} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} - \text{IWS}$$

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Nebraska} = 0.400 \times \text{CWS}$$

$$\text{Unallocated} = 0.600 \times \text{CWS}$$

## 7. South Fork Republican River

$$\text{CBCU Colorado} = 0.6 \times \text{Hale Ditch Diversion} + 0.6 \times \text{Dc} + \% \times \text{Pc} + 0.5 \times \text{M\&Ic} + \text{EvNFRc} + \text{Bonny Reservoir Ev} + \text{GWc}$$

$$\text{CBCU Kansas} = 0.6 \times \text{Dk} + \% \times \text{Pk} + 0.5 \times \text{M\&Ik} + \text{EvNFRk} + \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + \text{GWn}$$

$$\text{VWS} = \text{South Fork Republican River near Benkelman Gage Stn. No. 06827500} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} + \Delta \text{S Bonny Reservoir} - \text{IWS}$$

$$\text{CWS} = \text{VWS} - \Delta \text{S Bonny Reservoir} - \text{FF}$$

$$\text{Allocation Colorado} = 0.444 \times \text{CWS}$$

$$\text{Allocation Kansas} = 0.402 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.014 \times \text{CWS}$$

$$\text{Unallocated} = 0.140 \times \text{CWS}$$

## 8. Frenchman Creek in Nebraska

$$\text{CBCU Colorado} = \text{GWc}$$

$$\text{CBCU Kansas} = \text{GWk}$$

$$\text{CBCU Nebraska} = \text{Culbertson Canal Diversions} \times (1 - \% \text{BRF}) + \text{Culbertson Extension} \times (1 - \% \text{BRF}) + 0.6 \times \text{Champion Canal Diversion} + 0.6 \times \text{Riverside Canal Diversion} + 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + \text{Enders Reservoir Ev} + \text{GWn}$$

$$\text{VWS} = \text{Frenchman Creek in Culbertson, Nebraska Gage Stn. No. 06835500} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} + 0.17 \times \text{Culbertson Diversion RF} + \text{Culbertson Extension RF} + 0.78 \times \text{Riverside Diversion RF} + \Delta \text{S Enders Reservoir} - \text{IWS}$$

Note: 17% of the Culbertson Diversion RF and 100% of the Culbertson Extension RF return to the Main Stem

$$\text{CWS} = \text{VWS} - \Delta S \text{ Enders Reservoir} - \text{FF}$$

$$\text{Allocation Nebraska} = 0.536 \times \text{CWS}$$

$$\text{Unallocated} = 0.464 \times \text{CWS}$$

### 9. Driftwood Creek

$$\text{CBCU Colorado} = \text{GWc}$$

$$\text{CBCU Kansas} = 0.6 \times \text{Dk} + \% \times \text{Pk} + 0.5 \times \text{M\&Ik} + \text{EvNFRk} + \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + \text{GWn}$$

$$\text{VWS} = \text{Driftwood Creek near McCook Gage Stn. No. 06836500} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} - 0.24 \times \text{Meeker Driftwood Canal RF} - \text{IWS}$$

Note: 24 % of the Meeker Driftwood Canal RF returns to Driftwood Creek

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Kansas} = 0.069 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.164 \times \text{CWS}$$

$$\text{Unallocated} = 0.767 \times \text{CWS}$$

### 10. Red Willow Creek in Nebraska

$$\text{CBCU Colorado} = \text{GWc}$$

$$\text{CBCU Kansas} = \text{GWk}$$

$$\text{CBCU Nebraska} = 0.1 \times \text{Red Willow Canal CBCU} + 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + 0.1 \times \text{Hugh Butler Lake Ev} + \text{GWn}$$

Note:

Red Willow Canal CBCU = Red Willow Canal Diversion x (1- % BRF)

90% of the Red Willow Canal CBCU and 90% of Hugh Butler Lake Ev charged to Nebraska's CBCU in the Main Stem

VWS = Red Willow Creek near Red Willow Gage Stn. No. 06838000 + CBCUc + CBCUk + CBCUn + 0.9 x Red Willow Canal CBCU + 0.9 x Hugh Butler Lake Ev + 0.9 x Red Willow Canal RF + ΔS Hugh Butler Lake – IWS

Note: 90% of the Red Willow Canal RF returns to the Main Stem

CWS = VWS - ΔS Hugh Butler Lake - FF

Allocation Nebraska = 0.192 x CWS

Unallocated = 0.808 x CWS

**11. Medicine Creek**

CBCU Colorado = GWc

CBCU Kansas = GWk

CBCU Nebraska = 0.6 x Dn above and below gage + % x Pn above and below gage + 0.5 x M&In above and below gage + EvNFRn above and below gage + GWn

Note: Harry Strunk Lake Ev charged to Nebraska's CBCU in the Main Stem.

CU from Harry Strunk releases in the Cambridge Canal is charged to the Main stem (no adjustment to the VWS formula is needed as this water shows up in the Medicine Creek gage).

VWS = Medicine Creek below Harry Strunk Lake Gage Stn. No.

$06842500 + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} - 0.6 \times \text{Dn below gage} - \% \times \text{Pn below gage} - 0.5 * \text{M\&In below gage} - \text{EvNFRn below gage} + \text{Harry Strunk Lake Ev} + \Delta\text{S Harry Strunk Lake} - \text{IWS}$

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

CWS = VWS -  $\Delta\text{S Harry Strunk Lake}$  - FF

Allocation Nebraska =  $0.091 \times \text{CWS}$

Unallocated =  $0.909 \times \text{CWS}$

**12. Beaver Creek**

CBCU Colorado =  $0.6 \times \text{Dc} + \% \times \text{Pc} + 0.5 \times \text{M\&Ic} + \text{EvNFRc} + \text{Gwc}$

CBCU Kansas =  $0.6 \times \text{Dk} + \% \times \text{Pk} + 0.5 \times \text{M\&Ik} + \text{EvNFRk} + \text{Gwk}$

CBCU Nebraska =  $0.6 \times \text{Dn above and below gage} + \% \times \text{Pn above and below gage} + 0.5 \times \text{M\&In above and below gage} + \text{EvNFRn above and below gage} + \text{Gwn}$

VWS = Beaver Creek near Beaver City gage Stn. No. 06847000 +  $\text{BCUc} + \text{CBCUk} + \text{CBCUn} - 0.6 \times \text{Dn below gage} - \% \times \text{Pn below gage} - 0.5 * \text{M\&In below gage} - \text{EvNFRn below gage} - \text{IWS}$

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

CWS = VWS - FF

Allocation Colorado =  $0.200 \times \text{CWS}$

Allocation Kansas =  $0.388 \times \text{CWS}$

Allocation Nebraska =  $0.406 \times \text{CWS}$

$$\text{Unallocated} = 0.006 \times \text{CWS}$$

### 13. Sappa Creek

$$\text{CBCU Colorado} = \text{GWc}$$

$$\text{CBCU Kansas} = 0.6 \times \text{Dk} + \% \times \text{Pk} + 0.5 \times \text{M\&Ik} + \text{EvNFRk} + \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn above and below gage} + \% \times \text{Pn above and below gage} + 0.5 \times \text{M\&In above and below gage} + \text{EvNFRn above and below gage} + \text{GWn}$$

$$\begin{aligned} \text{VWS} &= \text{Sappa Creek near Stamford gage Stn. No. 06847500} - \\ &\text{Beaver Creek near Beaver City gage Stn. No. 06847000} + \\ &\text{CBCUc} + \text{CBCUk} + \text{CBCUn} - 0.6 \times \text{Dn below gage} - \% \times \\ &\text{Pn below gage} - 0.5 \times \text{M\&In below gage} - \text{EvNFRn below gage} - \text{IWS} \end{aligned}$$

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Kansas} = 0.411 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.411 \times \text{CWS}$$

$$\text{Unallocated} = 0.178 \times \text{CWS}$$

### 14. Prairie Dog Creek

$$\text{CBCU Colorado} = \text{GWc}$$

$$\begin{aligned} \text{CBCU Kansas} &= \text{Almena Canal Diversion} \times (1 - \% \text{BRF}) + 0.6 \times \text{Dk} + \% \times \text{Pk} \\ &+ 0.5 \times \text{M\&Ik} + \text{EvNFRk} + \text{Keith Sebelius Lake Ev} + \text{GWk} \end{aligned}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn below gage} + \% \times \text{Pn below gage} + 0.5 \times \text{M\&In below gage} + \text{EvNFRn} + \text{GWn below gage}$$

$$\text{VWS} = \text{Prairie Dog Creek near Woodruff, Kansas USGS Stn. No.}$$

$$06848500 + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} - 0.6 \times \text{Dn below gage} - \% \times \text{Pn below gage} - 0.5 \times \text{M\&In below gage} - \text{EvNFRn below gage} + \Delta\text{S Keith Sebelius Lake} - \text{IWS}$$

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

$$\text{CWS} = \text{VWS} - \Delta\text{S Keith Sebelius Lake} - \text{FF}$$

$$\text{Allocation Kansas} = 0.457 \times \text{CSW}$$

$$\text{Allocation Nebraska} = 0.076 \times \text{CWS}$$

$$\text{Unallocated} = 0.467 \times \text{CWS}$$

**15. The North Fork of the Republican River in Nebraska and the Main Stem of the Republican River between the junction of the North Fork and the Arikaree River and the Republican River near Hardy**

$$\text{CBCU Colorado} = \text{GWc}$$

$$\begin{aligned} \text{CBCU Kansas} = & \\ & (\text{Deliveries from the Courtland Canal to Kansas above Lovewell}) \times (1 - \% \text{BRF}) \\ & + \text{Amount of transportation loss of Courtland Canal deliveries to Lovewell that does not return to the river, charged to Kansas} \\ & + (\text{Diversion of Republican River water from Lovewell Reservoir by the Courtland Canal below Lovewell}) \times (1 - \% \text{BRF}) \\ & + 0.6 \times \text{Dk} \\ & + \% \times \text{Pk} \\ & + 0.5 \times \text{M\&Ik} \\ & + \text{EvNFRk} \\ & + \text{Harlan County Lake Ev charged to Kansas} \\ & + \text{Lovewell Reservoir Ev charged to the Republican River} \\ & + \text{GWk} \end{aligned}$$

$$\begin{aligned} \text{CBCU Nebraska} = & \\ & \text{Deliveries from Courtland Canal to Nebraska lands} \times (1 - \% \text{BRF}) \end{aligned}$$

- + Superior Canal x (1- %BRF)
- + Franklin Pump Canal x (1- %BRF)
- + Franklin Canal x (1- %BRF)
- + Naponee Canal x (1- %BRF)
- + Cambridge Canal x (1- %BRF)
- + Bartley Canal x (1- %BRF)
- + Meeker-Driftwood Canal x (1- %BRF)
- + 0.9 x Red Willow Canal CBCU
- + 0.6 x Dn
- + % x Pn
- + 0.5 x M&In
- + EvNFRn
- + 0.9 x Hugh Butler Lake Ev
- + Harry Strunk Lake Ev
- + Swanson Lake Ev
- + Harlan County Lake Ev charged to Nebraska
- + GWn

Notes:

The allocation of transportation losses in the Courtland Canal above Lovewell between Kansas and Nebraska shall be done by the Bureau of Reclamation and reported in their “Courtland Canal Above Lovewell” spreadsheet. Deliveries and losses associated with deliveries to both Nebraska and Kansas above Lovewell shall be reflected in the Bureau’s Monthly Water District reports. Losses associated with delivering water to Lovewell shall be separately computed.

Amount of transportation loss of the Courtland Canal deliveries to Lovewell that does not return to the river, charged to Kansas shall be 18% of the Bureau’s estimate of losses associated with these deliveries.

Red Willow Canal CBCU = Red Willow Canal Diversion x (1- % BRF)

10% of the Red Willow Canal CBCU is charged to Nebraska’s CBCU in Red Willow Creek sub-basin

10% of Hugh Butler Lake Ev is charged to Nebraska’s CBCU in the Red Willow Creek sub-basin

None of the Harry Strunk Lake EV is charged to Nebraska’s CBCU in the Medicine Creek sub-basin

VWS

=

- Republican River near Hardy Gage Stn. No. 06853500
- North Fork of the Republican River at the State Line, Stn. No. 06823000
- Arikaree Gage at Haigler Stn. No. 06821500
- Buffalo Creek near Haigler Gage Stn. No. 06823500
- Rock Creek at Parks Gage Stn. No. 06824000
- South Fork Republican River near Benkelman Gage Stn. No. 06827500
- Frenchman Creek in Culbertson Stn. No. 06835500
- Driftwood Creek near McCook Gage Stn. No. 06836500
- Red Willow Creek near Red Willow Gage Stn. No. 06838000
- Medicine Creek below Harry Strunk Lake Gage Stn. No. 06842500
- Sappa Creek near Stamford Gage Stn. No. 06847500
- Prairie Dog Creek near Woodruff, Kansas Stn. No. 68-485000

- + CBCUc
- + CBCUn

- + 0.6 x Dk
- + % x Pk
- + 0.5 x M&Ik
- + EvNFRk

- + Harlan County Lake Ev charged to Kansas
- +Amount of transportation loss of the Courtland Canal above the Stateline that does not return to the river, charged to Kansas
- +GWk

- 0.9 x Red Willow Canal CBCU
  - 0.9 x Hugh Butler Ev
  - Harry Strunk Ev

- + 0.6 x Dn below Medicine Creek gage
- + % x Pn below Medicine Creek gage
- + 0.5 \* M&In below Medicine Creek gage
- + EvNFRn below Medicine Creek gage

- + 0.6 x Dn below Beaver Creek gage
- + % x Pn below Beaver Creek gage
- + 0.5 \* M&In below Beaver Creek gage
- + EvNFRn below Beaver Creek gage
  
- + 0.6 x Dn below Sappa Creek gage
- + % x Pn below Sappa Creek gage
- + 0.5 \* M&In below Sappa Creek gage
- + EvNFRn below Sappa Creek gage
  
- + 0.6 x Dn below Prairie Dog Creek gage
- + % x Pn below Prairie Dog Creek gage
- + 0.5 \* M&In below Prairie Dog Creek gage
- + EvNFRn below Prairie Dog Creek gage
  
- + Change in Storage Harlan County Lake
- + Change in Storage Swanson Lake

- Nebraska Haigler Canal RF
- 0.78 x Riverside Canal RF
- 0.17 x Culbertson Canal RF
- Culbertson Canal Extension RF to Main Stem
- + 0.24 x Meeker Driftwood Canal RF which returns to Driftwood Creek
- 0.9 x Red Willow Canal RF

+ Courtland Canal at Kansas-Nebraska State Line Gage Stn No. 06852500

- Courtland Canal RF in Kansas above Lovewell Reservoir

-IWS

Notes:

None of the Nebraska Haigler Canal RF returns to the North Fork of the Republican River

83% of the Culbertson Diversion RF and none of the Culbertson Extension RF return to Frenchman Creek

24 % of the Meeker Driftwood Canal RF returns to Driftwood Creek.

10% of the Red Willow Canal RF returns to Red Willow Creek

Courtland Canal RF in Kansas above Lovewell Reservoir =  $0.015 \times$  (Courtland Canal at Kansas-Nebraska State Line Gage Stn No. 06852500)

CWS = VWS - Change in Storage Harlan County Lake - Change in Storage Swanson Lake - FF

Allocation Kansas =  $0.511 \times$  CWS

Allocation Nebraska =  $0.489 \times$  CWS

**V. Annual Data/ Information Requirements, Reporting, and Verification**

The following information for the previous calendar year shall be provided to the members of the RRCA Engineering Committee by April 15<sup>th</sup> of each year, unless otherwise specified.

All information shall be provided in electronic format, if available.

Each State agrees to provide all information from their respective State that is needed for the RRCA Groundwater Model and RRCA Accounting Procedures and Reporting Requirements, including but not limited to the following:

**A. Annual Reporting**

**1. Surface water diversions and irrigated acreage:**

Each State will tabulate the canal, ditch, and other surface water diversions that are required by RRCA annual compact accounting and the RRCA Groundwater Model on a monthly format (or a procedure to distribute annual data to a monthly basis) and will forward the surface water diversions to the other States. This will include available diversion, wasteway, and farm delivery data for canals diverting from the Platte River that contribute to Imported Water Supply into the Basin. Each State will provide the water right number, type of use, system type, location, diversion amount, and acres irrigated.

## 2. Groundwater pumping and irrigated acreage:

Each State will tabulate and provide all groundwater well pumping estimates that are required for the RRCA Groundwater Model to the other States.

**Colorado** – will provide an estimate of pumping based on a county format that is based upon system type, Crop Irrigation Requirement (CIR), irrigated acreage, crop distribution, and irrigation efficiencies. Colorado will require installation of a totalizing flow meter, installation of an hours meter with a measurement of the pumping rate, or determination of a power conversion coefficient for 10% of the active wells in the Basin by December 31, 2005. Colorado will also provide an annual tabulation for each groundwater well that measures groundwater pumping by a totalizing flow meter, hours meter or power conversion coefficient that includes: the groundwater well permit number, location, reported hours, use, and irrigated acreage.

**Kansas** - will provide an annual tabulation by each groundwater well that includes: water right number, groundwater pumping determined by a meter on each well (or group of wells in a manifold system) or by reported hours of use and rate; location; system type (gravity, sprinkler, LEPA, drip, etc.); and irrigated acreage. Crop distribution will be provided on a county basis.

**Nebraska** – will provide an annual tabulation through the representative Natural Resource District (NRD) in Nebraska that includes: the well registration number or other ID number; groundwater pumping determined by a meter on each well (or group of wells in a manifold system) or by reported hours of use and rate; wells will be identified by; location; system type (gravity, sprinkler, LEPA, drip, etc.); and irrigated acreage. Crop distribution will be provided on a county basis.

## 3. Climate information:

Each State will tabulate and provide precipitation, temperature, relative humidity or dew point, and solar radiation for the following climate stations:

State	Identification	Name
Colorado		
Colorado	C050109	Akron 4 E
Colorado	C051121	Burlington
Colorado	C054413	Julesburg
Colorado	C059243	Wray
Kansas	C140439	Atwood 2 SW
Kansas	C141699	Colby 1SW
Kansas	C143153	Goodland
Kansas	C143837	Hoxie

Kansas	C145856	Norton 9 SSE
Kansas	C145906	Oberlin1 E
Kansas	C147093	Saint Francis
Kansas	C148495	Wakeeny
Nebraska	C250640	Beaver City
Nebraska	C250810	Bertrand
Nebraska	C252065	Culbertson
Nebraska	C252690	Elwood 8 S
Nebraska	C253365	Gothenburg
Nebraska	C253735	Hebron
Nebraska	C253910	Holdredge
Nebraska	C254110	Imperial
Nebraska	C255090	Madrid
Nebraska	C255310	McCook
Nebraska	C255565	Minden
Nebraska	C256480	Palisade
Nebraska	C256585	Paxton
Nebraska	C257070	Red Cloud
Nebraska	C258255	Stratton
Nebraska	C258320	Superior
Nebraska	C258735	Upland
Nebraska	C259020	Wauneta 3 NW

**4. Crop Irrigation Requirements:**

Each State will tabulate and provide estimates of crop irrigation requirement information on a county format. Each State will provide the percentage of the crop irrigation requirement met by pumping; the percentage of groundwater irrigated lands served by sprinkler or flood irrigation systems, the crop irrigation requirement; crop distribution; crop coefficients; gain in soil moisture from winter and spring precipitation, net crop irrigation requirement; and/or other information necessary to compute a soil/water balance.

**5. Streamflow Records from State-Maintained Gaging Records:**

Streamflow gaging records from the following State maintained gages will be provided:

Station No	Name
00126700	Republican River near Trenton
06831500	Frenchman Creek near Imperial
06832500	Frenchman Creek near Enders

06835000	Stinking Water Creek near Palisade
06837300	Red Willow Creek above Hugh Butler Lake
06837500	Red Willow Creek near McCook
06841000	Medicine Creek above Harry Strunk Lake
06842500	Medicine Creek below Harry Strunk Lake
06844000	Muddy Creek at Arapahoe
06844210	Turkey Creek at Edison
06847000	Beaver Creek near Beaver City
	Republican River at Riverton
06851500	Thompson Creek at Riverton
06852000	Elm Creek at Amboy
	Republican River at the Superior-Courtland Diversion Dam

#### **6. Platte River Reservoirs:**

The State of Nebraska will provide the end-of-month contents, inflow data, outflow data, area-capacity data, and monthly net evaporation, if available, from Johnson Lake; Elwood Reservoir; Sutherland Reservoir; Maloney Reservoir; and Jeffrey Lake.

#### **7. Water Administration Notification:**

The State of Nebraska will provide the following information that describes the protection of reservoir releases from Harlan County Lake and for the administration of water rights junior in priority to February 26, 1948:

Date of notification to Nebraska water right owners to curtail their diversions, the amount of curtailment, and length of time for curtailment.

The number of notices sent.

The number of diversions curtailed and amount of curtailment in the Harlan County Lake to Guide Rock reach of the Republican River.

#### **8. Moratorium:**

Each State will provide a description of all new Wells constructed in the Basin Upstream of Guide Rock including the owner, location (legal description), depth and diameter or dimension of the constructed water well, casing and screen information, static water level, yield of the water well in gallons per minute or gallons per hour, and intended use of the water well.

Designation whether the Well is a:

- a. Test hole;
- b. Dewatering Well with an intended use of one year or less;
- c. Well designed and constructed to pump fifty gallons per minute or less;
- d. Replacement Water Well, including a description of the Well that is replaced providing the information described above for new Wells and a description of the historic use of the Well that is replaced;
- e. Well necessary to alleviate an emergency situation involving provision of water for human consumption, including a brief description of the nature of the emergency situation and the amount of water intended to be pumped by and the length of time of operation of the new Well;
- f. Transfer Well, including a description of the Well that is transferred providing the information described above for new Wells and a description of the Historic Consumptive Use of the Well that is transferred;
- g. Well for municipal and/or industrial expansion of use;

Wells in the Basin in Northwest Kansas or Colorado. Kansas and Colorado will provide the information described above for new Wells along with copies of any other information that is required to be filed with either State of local agencies under the laws, statutes, rules and regulations in existence as of April 30, 2002, and;

Any changes in State law in the previous year relating to existing Moratorium.

#### **9. Non-Federal Reservoirs:**

Each State will conduct an inventory of Non Federal Reservoirs by December 31, 2004, for inclusion in the annual Compact Accounting. The inventory shall include the following information: the location, capacity (in Acre-feet) and area (in acres) at the principal spillway elevation of each Non-Federal Reservoir. The States will annually provide any updates to the initial inventory of Non-Federal Reservoirs, including enlargements that are constructed in the previous year.

Owners/operators of Non-Federal Reservoirs with 200 Acre-feet of storage capacity or greater at the principal spillway elevation will be required to provide an area-capacity survey from State-approved plans or prepared by a licensed professional engineer or land surveyor.

## B. RRCA Groundwater Model Data Input Files

1. Monthly groundwater pumping, surface water recharge, groundwater recharge, and precipitation recharge provided by county and indexed to the one square mile cell size.
2. Potential Evapotranspiration rate is set as a uniform rate for all phreatophyte vegetative classes – the amount is X at Y climate stations and is interpolated spatially using kriging.

## C. Inputs to RRCA Accounting

### 1. Surface Water Information

- a. Streamflow gaging station records: obtained as preliminary USGS or Nebraska streamflow records, with adjustments to reflect a calendar year, at the following locations:

Arikaree River at Haigler, Nebraska  
 North Fork Republican River at Colorado-Nebraska state line  
 Buffalo Creek near Haigler, Nebraska  
 Rock Creek at Parks, Nebraska  
 South Fork Republican River near Benkelman, Nebraska  
 Frenchman Creek at Culbertson, Nebraska  
 Red Willow Creek near Red Willow, Nebraska  
 Medicine Creek below Harry Strunk Lake, Nebraska\*  
 Beaver Creek near Beaver City, Nebraska\*  
 Sappa Creek near Stamford, Nebraska  
 Prairie Dog Creek near Woodruff, Kansas  
 Courtland Canal at Nebraska-Kansas state line  
 Republican River near Hardy, Nebraska  
 Republican River at Superior-Courtland Diversion Dam near Guide Rock,  
 Nebraska (new)\*

- b. Federal reservoir information: obtained from the United States Bureau of Reclamation:

Daily free water surface evaporation, storage, precipitation, reservoir release information, and updated area-capacity tables.

Federal Reservoirs:  
 Bonny Reservoir

Swanson Lake  
Harry Strunk Lake  
Hugh Butler Lake  
Enders Reservoir  
Keith Sebelius Lake  
Harlan County Lake  
Lovewell Reservoir

c. Non-federal reservoirs obtained by each state: an updated inventory of reservoirs that includes the location, surface area (acres), and capacity (in Acre-feet), of each non-federal reservoir with storage capacity of fifteen (15) Acre-feet or greater at the principal spillway elevation. Supporting data to substantiate the average surface water areas that are different than the presumptive average annual surface area may be tendered by the offering State.

d. Diversions and related data from USBR

Irrigation diversions by canal, ditch, and pumping station that irrigate more than two (2) acres  
Diversions for non-irrigation uses greater than 50 Acre-feet  
Farm Deliveries  
Wasteway measurements  
Irrigated acres

e. Diversions and related data – from each respective State

Irrigation diversions by canal, ditch, and pumping station that irrigate more than two (2) acres  
Diversions for non-irrigation uses greater than 50 Acre-feet  
Wasteway measurements, if available

## 2. Groundwater Information

(From the RRCA Groundwater model as output files as needed for the accounting procedures)

a. Imported water - mound credits in amount and time that occur in defined streamflow points/reaches of measurement or compliance – ex: gaging stations near confluence or state lines

- b. Groundwater depletions to streamflow (above points of measurement or compliance – ex: gaging stations near confluence or state lines)

### **3. Summary**

The aforementioned data will be aggregated by Sub-basin as needed for RRCA accounting.

## **D. Verification**

### **1. Documentation to be Available for Inspection Upon Request**

- a. Well permits/ registrations database
- b. Copies of well permits/ registrations issued in calendar year
- c. Copies of surface water right permits or decrees
- d. Change in water right/ transfer historic use analyses
- e. Canal, ditch, or other surface water diversion records
- f. Canal, ditch, or other surface water measurements
- g. Reservoir storage and release records
- h. Irrigated acreage

### **2. Site Inspection**

- a. Accompanied – reasonable and mutually acceptable schedule among representative state and/or federal officials.
- b. Unaccompanied – inspection parties shall comply with all laws and regulations of the State in which the site inspection occurs.

**Table 1: Annual Virgin and Computed Water Supply, Allocations and Computed Beneficial Consumptive Uses by State, Main Stem and Sub-basin**

Designated Drainage Basin	Col. 1: Virgin Water Supply	Col. 2: Computed Water Supply	Col. 3: Allocations				Col. 4: Computed Beneficial Consumptive Use		
			Colorado	Nebraska	Kansas	Unallocated	Colorado	Nebraska	Kansas
North Fork in Colorado									
Arikaree									
Buffalo									
Rock									
South Fork of Republican River									
Frenchman									
Driftwood									
Red Willow									
Medicine									
Beaver									
Sappa									
Prairie Dog									
North Fork of Republican River in Nebraska and Main Stem									
Total All Basins									
North Fork Of Republican River in Nebraska and Mainstem Including Unallocated Water									
Total									

Table 2: Original Compact Virgin Water Supply and Allocations

Designated Drainage Basin	Virgin Water Supply	Colorado Allocation	% of Total Drainage Basin Supply	Kansas Allocation	% of Total Drainage Basin Supply	Nebraska Allocation	% of Total Drainage Basin Supply	Unallocated	% of Total Drainage Basin Supply
North Fork - CO	44,700	10,000	22.4			11,000	24.6	23,700	53.0
Arikaree River	19,610	15,400	78.5	1,000	5.1	3,300	16.8	-90	-0.4
Buffalo Creek	7,890					2,600	33.0	5,290	67.0
Rock Creek	11,000					4,400	40.0	6,600	60.0
South Fork	57,200	25,400	44.4	23,000	40.2	800	1.4	8,000	14.0
Frenchman Creek	98,500					52,800	53.6	45,700	46.4
Driftwood Creek	7,300			500	6.9	1,200	16.4	5,600	76.7
Red Willow Creek	21,900					4,200	19.2	17,700	80.8
Medicine Creek	50,800					4,600	9.1	46,200	90.9
Beaver Creek	16,500	3,300	20.0	6,400	38.8	6,700	40.6	100	0.6
Sappa Creek	21,400			8,800	41.1	8,800	41.1	3,800	17.8
Prairie Dog Creek	27,600			12,600	45.7	2,100	7.6	12,900	46.7
Sub-total Tributaries	384,400							175,500	
Main Stem + Blackwood Creek	94,500								
Main Stem + Unallocated	270,000			138,000	51.1	132,000	48.9		
Total	478,900	54,100		190,300		234,500			

Table 3A: Table to Be Used to Calculate Colorado's Five-Year Running Average Allocation and Computed Beneficial Consumptive Use for Determining Compact Compliance

Colorado				
	Col. 1	Col. 2	Col. 3	Col. 4
Year	Allocation	Computed Beneficial Consumptive	Imported Water Supply Credit	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Col 1 – (Col 2- Col 3)
Year t= -4				
Year t= -3				
Year t= -2				
Year t= -1				
Current Year t= 0				
Average				

Table 3B. Table to Be Used to Calculate Kansas's Five-Year Running Average Allocation and Computed Beneficial Consumptive Use for Determining Compact Compliance

Kansas				
	Col. 1	Col. 2	Col. 3	Col. 4
Year	Allocation	Computed Beneficial Consumptive	Imported Water Supply Credit	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Col 1 – (Col 2- Col 3)
Year t= -4				
Year t= -3				
Year t= -2				
Year t= -1				
Current Year t= 0				
Average				

Table 3C. Table to Be Used to Calculate Nebraska's Five-Year Running Average Allocation and Computed Beneficial Consumptive Use for Determining Compact Compliance

Nebraska				
	Col. 1	Col. 2	Col. 3	Col. 4
Year	Allocation	Computed Beneficial Consumptive	Imported Water Supply Credit	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Col 1 – (Col 2- Col 3)
Year T= -4				
Year T= -3				
Year T= -2				
Year T= -1				
Current Year T= 0				
Average				

Republican River Compact Administration

Accounting Procedures and Reporting Requirements  
Revised August 2010

Table 4A: Colorado Compliance with the Sub-basin Non-impairment Requirement

	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
Sub-basin	Colorado Sub-basin Allocation (5-year running average)	Unallocated Supply (5-year running average)	Credits from Imported Water Supply (5-year running average)	Total Supply Available = Col 1+ Col 2 + Col 3 (5-year running average)	Colorado Computed Beneficial Consumptive Use (5-year running average)	Difference Between Available Supply and Computed Beneficial Consumptive Use = Col 4 – Col 5 (5-year running average)
North Fork Republican River Colorado						
Arikaree River						
South Fork Republican River						
Beaver Creek						

Table 4B: Kansas Compliance with the Sub-basin Non-impairment Requirement

	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7
Sub-basin	Kansas Sub-basin Allocation (5-year running average)	Unallocated Supply (5-year running average)	Unused Allocation from Colorado (5-year running average)	Credits from Imported Water Supply (5-year running average)	Total Supply Available = Col 1+ Col 2+ Col 3 + Col 4 (5-year running average)	Kansas Computed Beneficial Consumptive Use (5-year running average)	Difference Between Available Supply and Computed Beneficial Consumptive Use = Col 5 – Col 6 (5-year running average)
Arikaree River							
South Fork Republican River							
Driftwood Creek							
Beaver Creek							
Sappa Creek							
Prairie Dog Creek							

Revised August 2010

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

Colorado				
	Col. 1	Col. 2	Col. 3	Col 4
Year	Allocation minus Allocation for Beaver Creek	Computed Beneficial Consumptive minus Computed Beneficial Consumptive Use for Beaver Creek	Imported Water Supply Credit excluding Beaver Creek	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit for All Basins Except Beaver Creek Col 1 – (Col 2 – Col 3)
Year T= -4				
Year T= -3				
Year T= -2				
Year T= -1				
Current Year T= 0				
Average				

Table 5B: Kansas Compliance During Water-Short Year Administration

Kansas						
Year	Allocation			Computed Beneficial Consumptive Use`	Imported Water Supply Credit	Difference Between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit
Column	1	2	3	4	5	6
	Sum Sub-basins	Kansas's Share of the Unallocated Supply	Total Col 1 + Col 2			Col 3 – (Col 4 – Col 5)
Previous Year						
Current Year						
Average						

Revised August 2010

Table 5C: Nebraska Compliance During Water-Short Year Administration

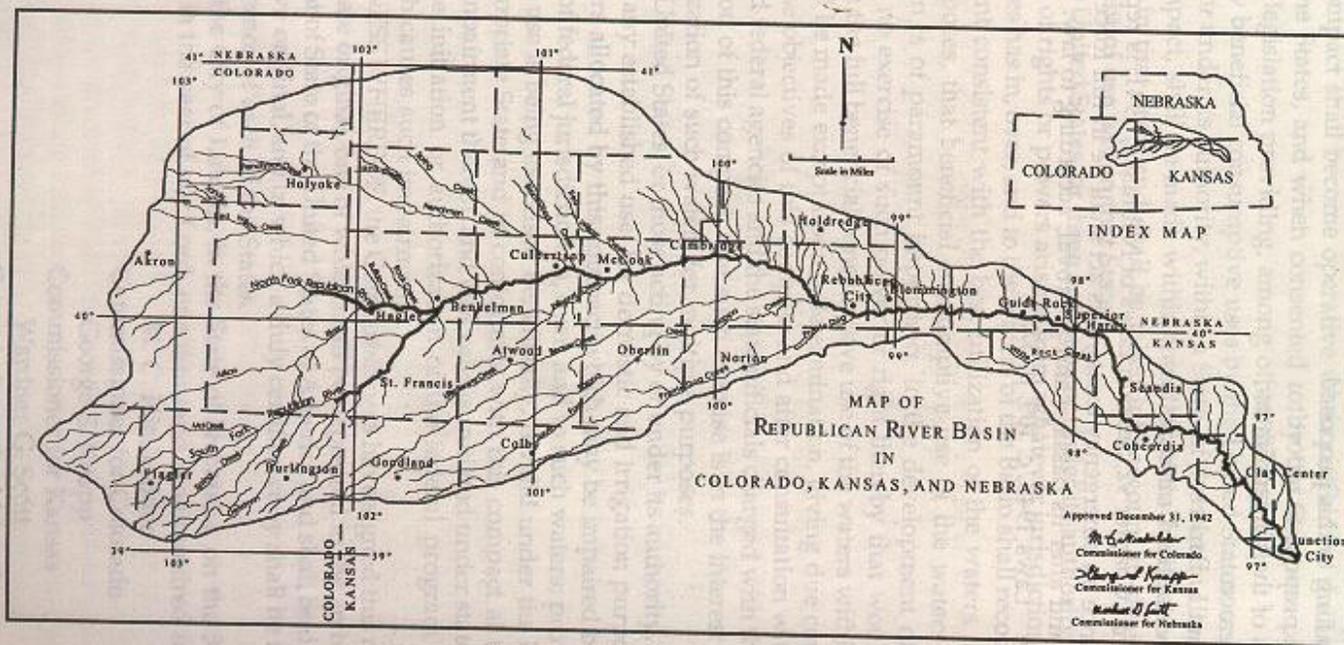
Nebraska								
Year	Allocation			Computed Beneficial Consumptive Use			Imported Water Supply Credit	Difference Between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Above Guide Rock
Column	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
	State Wide Allocation	Allocation below Guide Rock	State Wide Allocation above Guide Rock	State Wide CBCU	CBCU below Guide Rock	State Wide CBCU above Guide Rock	Credits above Guide Rock	Col 3 – (Col 6 – Col 7)
Previous Year								
Current Year								
Average								

Year	Allocation			Computed Beneficial Consumptive Use			Imported Water Supply Credit	Difference Between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Above Guide Rock
Column	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
	State Wide Allocation	Allocation below Guide Rock	State Wide Allocation above Guide Rock	State Wide CBCU	CBCU below Guide Rock	State Wide CBCU above Guide Rock	Credits above Guide Rock	Col 3 – (Col 6- Col 7)
Year = -2								
Year = -1								
Current Year								
Three-Year Average								
Sum of Previous Two-year Difference								
Expected Decrease in CBCU Under Plan								

Table 5E: Nebraska Tributary Compliance During Water-Short Year Administration

Year	Sum of Nebraska Sub-basin Allocations	Sum of Nebraska's Share of Sub-basin Unallocated Supplies	Total Available Water Supply for Nebraska	Computed Beneficial Consumptive Use	Imported Water Supply Credit	Difference between Allocation And the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
Previous Year						Col 3 -(Col 4-Col 5)
Current Year						
Average						

Figure 1



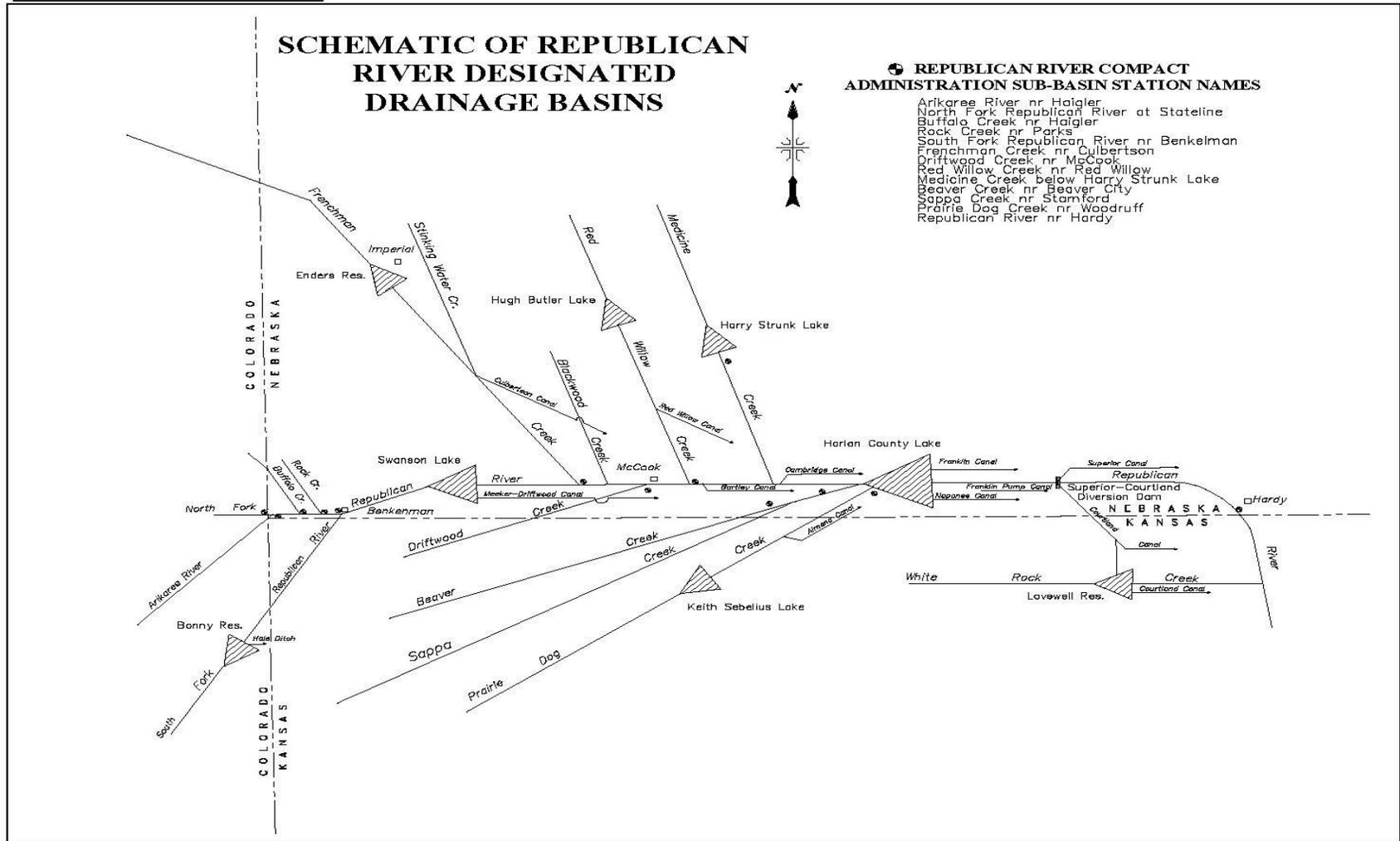
Basin Map Attached to Compact that Shows the Streams and the Basin Boundaries

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APPENDIX

Figure 2



Line Diagram of Designated Drainage Basins Showing Federal Reservoirs and Sub-basin Gaging Stations



## Attachment 1: Sub-basin Flood Flow Thresholds

Sub-basin	Sub-basin Flood Flow Threshold Acre-feet per Year <sup>3</sup>
Arikaree River	16,400
North Fork of Republican River	33,900
Buffalo Creek	4,800
Rock Creek	9,800
South Fork of Republican River	30,400
Frenchman Creek	51,900
Driftwood Creek	9,400
Red Willow Creek	15,100
Medicine Creek	55,100
Beaver Creek	13,900
Sappa Creek	26,900
Prairie Dog	15,700

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<sup>3</sup> Flows considered to be Flood Flows are flows in excess of the 94% flow based on a flood frequency analysis for the years 1971-2000. The Gaged Flows are measured after depletions by Beneficial Consumptive Use and change in reservoir storage.

## Attachment 2: Description of the Consensus Plan for Harlan County Lake

The Consensus Plan for operating Harlan County Lake was conceived after extended discussions and negotiations between Reclamation and the Corps. The agreement shaped at these meetings provides for sharing the decreasing water supply into Harlan County Lake. The agreement provides a consistent procedure for: updating the reservoir elevation/storage relationship, sharing the reduced inflow and summer evaporation, and providing a January forecast of irrigation water available for the following summer.

During the interagency discussions the two agencies found agreement in the following areas:

- The operating plan would be based on current sediment accumulation in the irrigation pool and other zones of the project.
- Evaporation from the lake affects all the various lake uses in proportion to the amount of water in storage for each use.
- During drought conditions, some water for irrigation could be withdrawn from the sediment pool.
- Water shortage would be shared between the different beneficial uses of the project, including fish, wildlife, recreation and irrigation.

To incorporate these areas of agreement into an operation plan for Harlan County Lake, a mutually acceptable procedure addressing each of these items was negotiated and accepted by both agencies.

### 1. Sediment Accumulation.

The most recent sedimentation survey for Harlan County project was conducted in 1988, 37 years after lake began operation. Surveys were also performed in 1962 and 1972; however, conclusions reached after the 1988 survey indicate that the previous calculations are unreliable. The 1988 survey indicates that, since closure of the dam in 1951, the accumulated sediment is distributed in each of the designated pools as follows:

Flood Pool	2,387 Acre-feet
Irrigation Pool	4,853 Acre-feet
Sedimentation Pool	33,527 Acre-feet

To insure that the irrigation pool retained 150,000 Acre-feet of storage, the bottom of the irrigation pool was lowered to 1,932.4 feet, msl, after the 1988 survey.

To estimate sediment accumulation in the lake since 1988, we assumed similar conditions have occurred at the project during the past 11 years. Assuming a consistent rate of deposition since 1988, the irrigation pool has trapped an additional 1,430 Acre-feet.

A similar calculation of the flood control pool indicates that the flood control pool has captured an additional 704 Acre-feet for a total of 3,090 Acre-feet since construction.

The lake elevations separating the different pools must be adjusted to maintain a 150,000-acre-foot irrigation pool and a 500,000-acre-foot flood control pool. Adjusting these elevations results in the following new elevations for the respective pools (using the 1988 capacity tables).

Top of Irrigation Pool	1,945.70 feet, msl
Top of Sediment Pool	1,931.75 feet, msl

Due to the variability of sediment deposition, we have determined that the elevation capacity relationship should be updated to reflect current conditions. We will complete a new sedimentation survey of Harlan County Lake this summer, and new area capacity tables should be available by early next year. The new tables may alter the pool elevations achieved in the Consensus Plan for Harlan County Lake.

## 2. Summer Evaporation.

Evaporation from a lake is affected by many factors including vapor pressure, wind, solar radiation, and salinity of the water. Total water loss from the lake through evaporation is also affected by the size of the lake. When the lake is lower, the surface area is smaller and less water loss occurs. Evaporation at Harlan County Lake has been estimated since the lake's construction using a Weather Service Class A pan which is 4 feet in diameter and 10 inches deep. We and Reclamation have jointly reviewed this information and assumed future conditions to determine an equitable method of distributing the evaporation loss from the project between irrigation and the other purposes.

During those years when the irrigation purpose expected a summer water yield of 119,000 Acre-feet or more, it was determined that an adequate water supply existed and no sharing of evaporation was necessary. Therefore, evaporation evaluation focused on the lower pool elevations when water was scarce. Times of water shortage would also generally be times of higher evaporation rates from the lake.

Reclamation and we agreed that evaporation from the lake during the summer (June through September) would be distributed between the irrigation and sediment pools based on their relative percentage of the total storage at the time of evaporation. If the sediment pool held 75 percent of the total storage, it would be charged 75 percent of the evaporation. If the sediment pool held 50 percent of the total storage, it would be charged 50 percent of the evaporation. At the bottom of the irrigation pool (1,931.75 feet, msl) all of the evaporation would be charged to the sediment pool.

Due to downstream water rights for summer inflow, neither the irrigation nor the sediment pool is credited with summer inflow to the lake. The summer inflows would be

assumed passed through the lake to satisfy the water right holders. Therefore, Reclamation and we did not distribute the summer inflow between the project purposes.

As a result of numerous lake operation model computer runs by Reclamation, it became apparent that total evaporation from the project during the summer averaged about 25,000 Acre-feet during times of lower lake elevations. These same models showed that about 20 percent of the evaporation should be charged to the irrigation pool, based on percentage in storage during the summer months. About 20 percent of the total lake storage is in the irrigation pool when the lake is at elevation 1,935.0 feet, msl. As a result of the joint study, Reclamation and we agreed that the irrigation pool would be credited with 20,000 Acre-feet of water during times of drought to share the summer evaporation loss.

Reclamation and we further agreed that the sediment pool would be assumed full each year. In essence, if the actual pool elevation were below 1,931.75 feet, msl, in January, the irrigation pool would contain a negative storage for the purpose of calculating available water for irrigation, regardless of the prior year's summer evaporation from sediment storage.

### 3. Irrigation withdrawal from sediment storage.

During drought conditions, occasional withdrawal of water from the sediment pool for irrigation is necessary. Such action is contemplated in the Field Working Agreement and the Harlan County Lake Regulation Manual: "Until such time as sediment fully occupies the allocated reserve capacity, it will be used for irrigation and various conservation purposes, including public health, recreation, and fish and wildlife preservation."

To implement this concept into an operation plan for Harlan County Lake, Reclamation and we agreed to estimate the net spring inflow to Harlan County Lake. The estimated inflow would be used by the Reclamation to provide a firm projection of water available for irrigation during the next season.

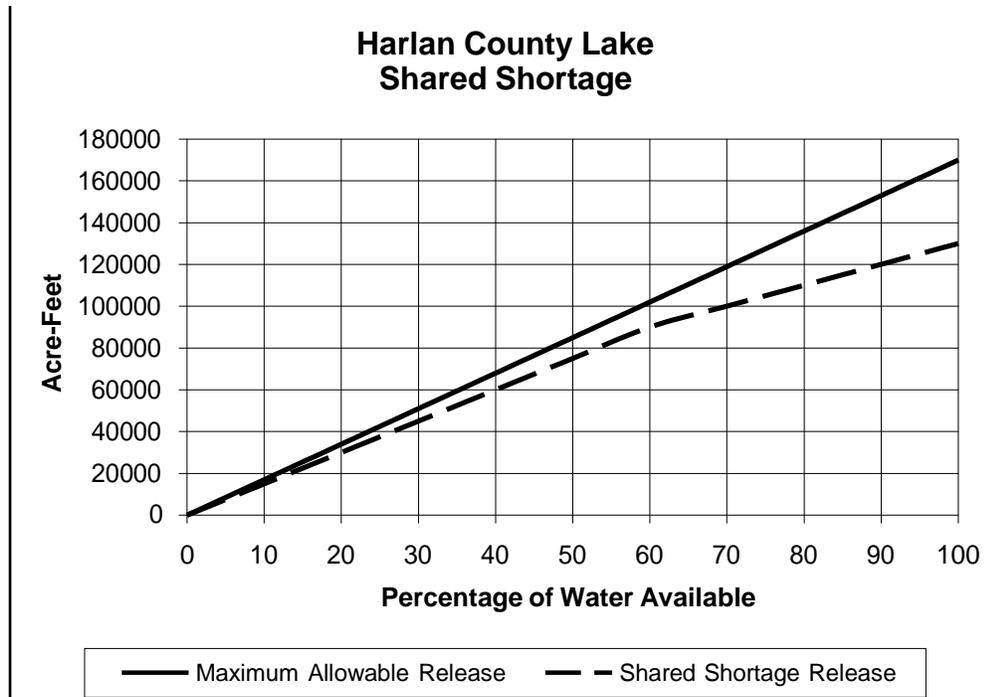
Since the construction of Harlan County Lake, inflows to the lake have been depleted by upstream irrigation wells and farming practices. Reclamation has recently completed an in-depth study of these depleted flows as a part of their contract renewal process. The study concluded that if the current conditions had existed in the basin since 1931, the average spring inflow to the project would have been 57,600 Acre-feet of water. The study further concluded that the evaporation would have been 8,800 Acre-feet of water during the same period. Reclamation and we agreed to use these values to calculate the net inflow to the project under the current conditions.

In addition, both agencies also recognized that the inflow to the project could continue to decrease with further upstream well development and water conservation farming. Due to these concerns, Reclamation and we determined that the previous 5-year inflow values would be averaged each year and compared to 57,600 Acre-feet. The inflow estimate for Harlan County Lake would be the smaller of these two values.

The estimated inflow amount would be used in January of each year to forecast the amount of water stored in the lake at the beginning of the irrigation season. Based on this forecast, the irrigation districts would be provided a firm estimate of the amount of water available for the next season. The actual storage in the lake on May 31 would be reviewed each year. When the actual water in storage is less than the January forecast, Reclamation may draw water from sediment storage to make up the difference.

4. Water Shortage Sharing.

A final component of the agreement involves a procedure for sharing the water available during times of shortage. Under the shared shortage procedure, the irrigation purpose of the project would remove less water than otherwise allowed and alleviate some of the adverse effects to the other purposes. The procedure would also extend the water supply during times of drought by “banking” some water for the next irrigation season. The following graph illustrates the shared shortage releases.



5. Calculation of Irrigation Water Available

Each January, the Reclamation would provide the Bostwick irrigation districts a firm estimate of the quantity of water available for the following season. The firm estimate of water available for irrigation would be calculated by using the following equation and shared shortage adjustment:

$$\text{Storage} + \text{Summer Sediment Pool Evaporation} + \text{Inflow} - \text{Spring Evaporation} = \text{Maximum Irrigation Water Available}$$

The variables in the equation are defined as:

- **Maximum Irrigation Water Available.** Maximum irrigation supply from Harlan County Lake for that irrigation season.
- **Storage.** Actual storage in the irrigation pool at the end of December. The sediment pool is assumed full. If the pool elevation is below the top of the sediment pool, a negative irrigation storage value would be used.
- **Inflow.** The inflow would be the smaller of the past 5-year average inflow to the project from January through May, or 57,600 Acre-feet.
- **Spring Evaporation.** Evaporation from the project would be 8,800 Acre-feet which is the average January through May evaporation.
- **Summer Sediment Pool Evaporation.** Summer evaporation from the sediment pool during June through September would be 20,000 Acre-feet. This is an estimate based on lower pool elevations, which characterize the times when it would be critical to the computations.

#### 6. Shared Shortage Adjustment

To ensure that an equitable distribution of the available water occurs during short-term drought conditions, and provide for a “banking” procedure to increase the water stored for subsequent years, a shared shortage plan would be implemented. The maximum water available for irrigation according to the above equation would be reduced according to the following table. Linear interpolation of values will occur between table values.

Shared Shortage Adjustment Table

Irrigation Water Available (Acre-feet)	Irrigation Water Released (Acre-feet)
0	0
17,000	15,000
34,000	30,000
51,000	45,000
68,000	60,000
85,000	75,000
102,000	90,000
119,000	100,000
136,000	110,000
153,000	120,000
170,000	130,000

## 7. Annual Shutoff Elevation for Harlan County Lake

The annual shutoff elevation for Harlan County Lake would be estimated each January and finally established each June.

The annual shutoff elevation for irrigation releases will be estimated by Reclamation each January in the following manner:

1. Estimate the May 31 Irrigation Water Storage (IWS) (Maximum 150,000 Acre-feet) by taking the December 31 irrigation pool storage plus the January-May inflow estimate (57,600 Acre-feet or the average inflow for the last 5-year period, whichever is less) minus the January-May evaporation estimate (8,800 Acre-feet).
2. Calculate the estimated Irrigation Water Available, including all summer evaporation, by adding the Estimated Irrigation Water Storage (from item 1) to the estimated sediment pool summer evaporation (20,000 AF).
3. Use the above Shared Shortage Adjustment Table to determine the acceptable Irrigation Water Release from the Irrigation Water Available.
4. Subtract the Irrigation Water Release (from item 3) from the Estimated IWS (from item 1). The elevation of the lake corresponding to the resulting irrigation storage is the Estimated Shutoff Elevation. The shutoff elevation will not be below the bottom of the irrigation pool if over 119,000 AF of water is supplied to the districts, nor below 1,927.0 feet, msl. If the shutoff elevation is below the irrigation pool, the maximum irrigation release is 119,000 AF.

The annual shutoff elevation for irrigation releases would be finalized each June in accordance with the following procedure:

1. Compare the estimated May 31 IWS with the actual May 31 IWS.
2. If the actual end of May IWS is less than the estimated May IWS, lower the shutoff elevation to account for the reduced storage.
3. If the actual end of May IWS is equal to or greater than the estimated end of May IWS, the estimated shutoff elevation is the annual shutoff elevation.
4. The shutoff elevation will never be below elevation 1,927.0 feet, msl, and will not be below the bottom of the irrigation pool if more than 119,000 Acre-feet of water is supplied to the districts.

## Attachment 3: Inflows to Harlan County Lake 1993 Level of Development

BASELINE RUN - 1993 LEVEL INFLOW TO HARLAN COUNTY RESERVOIR													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1931	10.2	10.8	13.4	5.0	18.8	15.8	4.3	1.8	1.8	0.0	0.1	0.1	82.1
1932	6.8	16.6	18.5	4.6	3.8	47.6	3.8	2.8	4.8	0.0	0.0	0.4	109.7
1933	0.4	0.0	3.9	30.2	31.0	5.4	1.8	0.0	10.4	0.0	2.6	5.5	91.2
1934	2.1	0.0	3.2	1.8	0.7	7.3	0.8	0.0	1.3	0.0	2.2	0.0	19.4
1935	0.3	0.1	0.7	4.2	0.8	389.3	6.1	19.1	26.1	2.4	5.2	0.9	455.2
1936	0.3	0.0	11.9	0.0	35.9	4.7	0.4	0.0	1.8	0.0	1.6	3.8	60.4
1937	4.8	12.9	6.0	2.5	0.0	12.6	6.3	6.9	2.4	0.0	0.0	12.4	66.8
1938	9.9	7.8	8.7	10.4	18.7	8.6	7.3	7.8	4.9	0.2	0.0	4.7	89.0
1939	2.7	7.5	9.6	12.2	6.6	13.3	5.0	4.1	0.0	0.0	0.0	0.0	61.0
1940	0.0	0.0	12.2	5.2	4.6	23.7	2.8	3.2	0.0	3.6	0.0	1.4	56.7
1941	0.0	10.6	10.6	7.7	17.2	67.1	28.9	19.7	14.9	8.3	6.7	7.1	198.8
1942	3.3	10.6	0.5	34.1	30.8	83.9	11.7	10.9	36.5	3.1	8.7	0.3	234.4
1943	1.2	11.2	14.6	31.4	4.7	28.3	4.8	0.3	0.9	0.0	0.0	11.8	109.2
1944	0.1	4.3	9.0	43.1	31.9	63.9	26.6	15.4	0.5	0.3	3.0	4.5	202.6
1945	4.3	7.8	5.7	9.5	4.1	53.5	5.0	0.9	1.5	5.0	6.0	6.3	109.6
1946	5.9	11.2	9.3	4.9	7.0	3.1	1.6	11.4	28.1	129.9	25.0	12.1	249.5
1947	1.1	3.2	10.4	8.2	11.9	195.4	22.3	5.9	2.9	0.2	0.3	0.3	262.1
1948	6.2	9.8	24.1	5.4	0.2	39.8	13.5	6.8	4.2	0.0	0.1	0.1	110.2
1949	2.0	1.5	25.2	16.3	49.0	57.4	9.2	5.5	2.1	3.0	2.8	0.3	174.3
1950	0.3	5.7	10.8	10.9	28.9	10.1	12.7	9.3	7.8	7.2	3.8	3.1	110.6
1951	3.8	3.4	7.1	5.3	42.0	39.9	42.1	10.1	36.0	15.5	14.8	8.9	228.9
1952	16.4	21.4	26.3	23.8	34.6	4.0	9.3	3.1	1.5	11.7	4.3	0.1	156.5
1953	1.8	4.6	5.3	3.3	15.1	9.5	1.8	0.2	0.0	0.0	2.8	0.1	44.5
1954	1.0	6.8	1.9	3.2	7.1	2.4	0.0	1.2	0.0	0.0	0.0	0.0	23.6
1955	0.0	4.0	6.3	4.8	2.9	6.4	2.7	0.0	1.4	0.0	0.0	0.0	28.5
1956	1.6	3.4	2.9	2.4	1.3	1.5	0.0	0.6	0.0	0.0	0.0	0.0	13.7
1957	0.0	4.1	6.2	12.8	3.5	62.4	21.3	1.2	2.0	3.4	4.5	4.7	126.1
1958	0.8	3.0	14.2	14.0	18.7	1.3	3.4	2.2	0.0	0.4	0.0	0.6	58.6
1959	1.9	15.4	16.4	8.5	13.6	4.2	1.4	1.2	0.0	4.3	1.0	4.5	72.4
1960	1.4	12.3	71.4	23.9	21.7	53.7	14.1	3.2	0.0	0.0	0.2	2.8	204.7
1961	2.3	6.4	7.7	7.4	26.5	24.0	7.2	4.9	0.0	2.3	4.8	1.7	95.2

## Attachment 3: Inflows to Harlan County Lake 1993 Level of Development

BASELINE RUN - 1993 LEVEL INFLOW TO HARLAN COUNTY RESERVOIR													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1962	4.5	9.1	16.2	9.9	14.4	42.6	41.6	21.1	2.3	8.7	8.3	5.7	184.4
1963	3.4	18.2	18.2	15.0	12.7	14.7	3.4	6.1	8.7	0.8	5.3	1.8	108.3
1964	5.4	7.6	8.3	8.4	9.9	11.9	7.2	6.5	2.4	1.9	1.4	2.3	73.2
1965	6.0	8.1	11.1	12.8	32.8	40.0	22.9	6.5	37.2	53.7	19.5	11.0	261.6
1966	8.9	21.4	15.7	11.4	12.0	34.7	12.4	2.5	3.5	5.4	6.8	5.7	140.4
1967	7.2	11.5	11.5	12.9	9.1	75.3	43.7	15.3	4.4	7.3	6.9	5.4	210.5
1968	3.9	10.2	8.5	11.6	10.8	12.5	3.1	2.7	1.6	2.0	4.3	3.4	74.6
1969	4.2	10.8	24.5	15.1	18.9	17.5	17.0	12.6	16.6	9.2	11.8	9.9	168.1
1970	3.5	8.7	8.5	10.5	11.1	7.7	4.6	3.2	0.5	3.3	4.7	4.5	70.8
1971	4.1	10.3	12.4	12.8	18.3	7.2	8.4	6.2	1.9	4.2	7.3	7.1	100.2
1972	5.5	8.1	9.2	8.3	14.8	8.5	6.5	4.4	0.1	2.9	7.6	4.1	80.0
1973	11.4	14.2	19.0	16.2	17.4	20.9	9.1	1.9	8.4	19.6	11.9	13.2	163.2
1974	13.2	13.4	12.0	14.3	15.4	17.2	5.5	0.0	0.0	0.0	4.9	5.5	101.4
1975	7.2	8.2	13.6	14.8	12.0	48.1	11.6	7.4	0.1	3.0	6.2	7.3	139.5
1976	7.0	10.2	10.1	16.0	12.1	3.5	2.2	1.8	0.9	1.0	3.2	3.1	71.1
1977	4.4	9.6	12.9	21.2	31.5	12.1	5.9	1.9	10.6	4.1	5.5	5.3	125.0
1978	5.0	6.5	20.6	12.9	11.8	3.8	0.0	1.0	0.0	0.0	0.3	1.6	63.5
1979	1.3	7.6	21.5	18.8	15.9	5.4	10.4	10.6	1.6	0.9	3.6	6.2	103.8
1980	5.7	9.3	11.6	15.2	10.4	2.1	2.5	0.0	0.0	0.0	2.5	2.2	61.5
1981	5.5	6.0	11.6	14.9	22.5	6.4	11.5	16.3	4.3	2.5	6.7	6.2	114.4
1982	5.3	12.5	17.9	14.3	26.8	27.1	8.9	2.7	0.0	6.5	6.3	15.5	143.8
1983	6.5	9.7	27.2	16.4	41.4	74.2	10.7	7.6	3.8	3.1	6.7	5.2	212.5
1984	6.8	14.6	17.2	32.9	40.6	15.5	8.1	4.5	0.0	5.5	4.8	6.2	156.7
1985	6.9	14.1	13.6	11.9	27.4	9.9	10.0	2.0	6.0	8.5	5.6	5.8	121.7
1986	9.1	9.4	12.2	11.7	34.3	13.0	13.5	4.6	3.3	5.9	5.4	7.1	129.5
1987	5.9	9.2	19.7	24.1	24.3	11.7	19.0	5.7	2.3	2.7	8.2	7.0	139.8
1988	6.2	13.7	11.6	15.2	15.2	7.0	17.9	10.4	0.6	2.0	5.9	5.4	111.1
1989	5.4	5.9	10.5	9.1	11.4	11.8	14.0	6.2	0.2	3.1	3.1	3.5	84.2
1990	6.6	7.7	13.2	9.7	15.5	1.4	4.3	10.7	0.6	3.2	2.0	2.7	77.6
1991	2.4	8.0	9.0	10.6	15.2	3.9	1.9	0.5	0.0	0.0	2.7	4.8	59.0
1992	8.0	8.8	12.7	8.5	4.5	6.1	6.5	9.4	2.4	6.9	6.7	5.2	85.7
1993	5.2	14.4	71.6	22.7	21.0	17.0	68.0	37.5	23.3	16.8	30.1	17.7	345.3
Avg	4.5	8.8	14.1	13.0	17.2	30.6	11.0	6.2	5.4	6.3	5.0	4.7	126.8

## BASELINE - 1993 LEVEL FLOWS - HARLAN COUNTY EVAPORATION

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1931	0.7	0.9	1.6	2.9	4.2	7.4	6.9	5.2	2.7	2.1	1.2	0.4	36.2
1932	0.6	0.8	1.5	2.7	4.1	5.0	6.8	5.0	2.7	2.1	1.2	0.4	32.9
1933	0.6	0.8	1.4	2.5	3.8	7.8	6.1	4.2	2.7	2.1	1.2	0.4	33.6
1934	0.6	0.8	1.4	2.4	4.5	6.5	8.0	6.2	2.7	2.0	1.2	0.4	36.7
1935	0.6	0.8	1.3	2.3	2.2	3.6	9.7	6.2	3.1	2.5	1.4	0.5	34.2
1936	0.7	0.9	1.6	2.9	5.5	6.8	8.7	6.5	2.7	2.1	1.2	0.4	40.0
1937	0.6	0.8	1.4	2.5	3.6	4.0	6.2	6.5	2.7	2.1	1.2	0.4	32.0
1938	0.6	0.9	1.5	2.7	3.4	4.9	6.5	5.7	2.7	2.1	1.2	0.4	32.6
1939	0.6	0.8	1.4	2.6	4.3	4.9	6.8	4.6	2.7	2.1	1.2	0.4	32.4
1940	0.6	0.8	1.4	2.4	3.5	5.0	6.5	4.6	2.7	2.1	1.2	0.4	31.2
1941	0.6	0.8	1.4	2.5	3.9	4.2	6.7	5.3	2.8	2.1	1.3	0.5	32.1
1942	0.6	0.9	1.5	2.8	4.0	5.2	8.3	5.1	3.2	2.5	1.5	0.5	36.1
1943	0.7	1.0	1.8	3.2	4.3	5.7	7.9	6.3	2.7	2.1	1.2	0.4	37.3
1944	0.6	0.8	1.4	2.7	4.2	5.3	7.0	5.8	3.5	2.6	1.5	0.5	35.9
1945	0.7	1.0	1.8	3.1	3.8	3.0	6.7	5.7	2.9	2.2	1.3	0.5	32.7
1946	0.6	0.9	1.6	2.8	3.5	5.1	5.6	4.4	2.9	2.7	1.8	0.6	32.5
1947	1.0	1.5	2.9	3.2	3.4	-1.2	5.8	5.3	3.7	1.7	0.5	0.1	27.9
1948	0.8	0.7	1.5	3.6	3.1	2.4	4.2	4.7	3.0	2.7	0.8	0.3	27.8
1949	0.1	0.9	0.7	1.8	1.1	0.7	6.5	4.1	3.1	1.7	1.5	0.4	22.6
1950	0.7	0.1	0.8	2.8	2.0	5.6	0.8	2.8	4.5	2.3	1.6	0.6	24.6
1951	0.5	0.2	2.1	0.7	-0.1	1.9	3.5	4.1	0.4	3.1	2.2	0.9	19.5
1952	1.1	1.2	1.9	2.5	5.2	6.2	1.5	3.4	3.6	2.9	1.1	-0.1	30.5
1953	0.5	1.0	1.5	2.9	4.7	4.5	4.6	6.6	5.3	3.3	0.1	0.0	35.0
1954	0.7	0.6	2.2	3.6	0.3	4.9	6.7	1.6	3.6	1.6	1.5	0.6	27.9
1955	0.5	1.0	2.1	4.6	3.4	-0.5	7.3	6.9	2.7	2.6	1.4	0.4	32.4
1956	0.6	1.1	1.9	2.8	3.9	4.5	5.0	3.7	4.7	3.7	1.3	0.5	33.7
1957	0.7	1.0	1.3	0.5	-0.6	-1.1	6.1	3.7	2.3	1.7	1.2	0.4	17.2
1958	0.7	0.1	1.0	0.6	2.3	4.4	1.0	1.9	3.3	3.3	1.0	0.6	20.2
1959	0.4	1.0	1.1	2.1	1.0	3.5	5.0	4.8	2.3	0.7	1.5	0.6	24.0
1960	0.1	0.7	2.0	2.7	0.9	0.1	4.9	3.6	3.9	2.0	1.3	0.4	22.6
1961	0.9	1.0	1.4	2.7	-1.1	0.6	5.1	2.9	1.2	2.4	0.7	0.1	17.9

## Attachment 4: Evaporation Loss Harlan County Lake 1993 Level of Development

## BASELINE - 1993 LEVEL FLOWS - HARLAN COUNTY EVAPORATION

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1962	0.6	0.6	0.9	3.7	3.4	1.5	0.3	1.6	2.0	2.0	1.7	0.3	18.6
1963	0.7	1.4	1.3	4.5	4.6	6.3	6.1	3.1	-0.8	2.7	1.5	0.4	31.8
1964	0.8	0.8	1.7	3.2	5.6	1.2	6.9	3.0	3.0	3.3	1.2	0.6	31.3
1965	0.4	0.7	1.2	2.8	1.5	-0.5	2.0	2.8	-3.9	1.7	2.1	0.4	11.2
1966	0.9	0.8	2.9	2.7	7.5	2.8	5.8	3.7	2.7	2.8	1.5	0.4	34.5
1967	0.7	1.2	2.5	3.0	2.0	-2.9	1.6	4.5	3.5	2.0	1.6	0.4	20.1
1968	0.9	1.2	2.8	2.6	3.2	4.9	4.7	1.8	2.3	0.7	1.2	0.2	26.5
1969	0.4	0.6	2.4	3.3	0.1	3.8	-0.7	2.9	2.2	-1.0	1.5	0.4	15.9
1970	0.7	1.4	2.3	2.8	4.7	4.4	6.5	5.9	0.9	1.0	1.5	0.7	32.8
1971	0.7	0.2	2.0	2.9	0.7	5.1	3.4	4.5	1.4	1.5	0.2	0.5	23.1
1972	0.8	1.3	2.0	1.7	1.1	0.0	3.3	1.8	2.1	1.7	-0.4	0.1	15.5
1973	0.5	1.1	-0.7	2.5	3.4	6.7	-1.7	4.2	-3.0	0.2	0.2	0.2	13.6
1974	0.7	1.5	2.6	1.5	3.7	2.5	9.1	2.6	3.4	1.4	1.1	0.3	30.4
1975	0.7	0.7	2.0	2.1	0.8	1.1	4.3	2.7	3.0	3.4	0.7	0.6	22.1
1976	0.8	1.2	1.7	0.7	1.5	5.0	5.9	5.7	-0.2	1.4	1.4	0.7	25.8
1977	0.7	1.3	0.2	1.1	0.0	4.6	4.0	0.6	2.0	1.6	1.0	0.4	17.5
1978	0.5	0.7	1.2	3.4	3.9	6.2	7.1	4.5	4.5	3.0	1.1	0.5	36.6
1979	0.5	0.6	1.1	3.9	4.4	4.6	3.5	5.1	4.1	2.8	1.4	0.7	32.7
1980	0.5	0.6	1.2	3.4	3.7	4.7	6.8	6.0	3.9	2.7	1.3	0.6	35.4
1981	0.5	0.6	1.2	3.8	3.2	4.8	4.2	3.7	2.9	1.7	1.3	0.7	28.6
1982	0.5	0.7	1.2	3.9	3.8	3.9	5.1	3.8	2.9	2.2	1.4	0.8	30.2
1983	0.5	0.7	1.4	2.9	4.2	5.3	8.6	7.2	4.6	1.8	1.5	0.6	39.3
1984	0.6	0.8	1.4	2.9	4.2	5.8	7.2	5.7	4.7	1.4	1.4	0.7	36.8
1985	0.5	0.7	1.3	2.3	4.0	4.5	5.6	3.5	3.8	1.5	1.5	0.7	29.9
1986	0.6	0.7	1.3	2.8	4.4	5.8	6.7	4.0	2.7	1.3	1.4	0.7	32.4
1987	0.5	0.8	1.3	3.1	4.2	6.2	6.9	3.5	3.1	2.2	1.4	0.7	33.9
1988	0.5	0.7	1.3	3.5	4.9	6.6	4.6	4.8	3.5	2.2	1.4	0.7	34.7
1989	0.5	0.7	1.2	4.2	4.5	4.4	4.8	3.6	3.0	2.5	1.4	0.7	31.5
1990	0.5	0.7	1.2	3.0	3.5	5.6	6.4	4.0	5.0	3.4	1.4	0.6	35.3
1991	0.5	0.7	1.2	2.8	3.3	5.5	6.0	5.0	5.1	3.2	1.3	0.6	35.2
1992	0.6	0.7	1.2	1.8	3.2	2.2	4.1	3.5	4.2	2.9	1.9	1.0	27.3
1993	0.6	0.5	1.0	2.2	3.1	4.6	4.2	4.9	4.5	4.4	3.1	1.2	34.3
Avg	0.6	0.8	1.5	2.7	3.2	3.9	5.3	4.3	2.8	2.2	1.3	0.5	29.1

Attachment 5: Projected Water Supply Spread Sheet Calculations

<b>Trigger Calculations Based on Harlan County Lake Irrigation Supply</b>	Units-1000 Acre-feet		Irrigation Trigger		119.0		Assume that during irrigation release season HCL Inflow = Evaporation Loss						
			Total Irrigation Supply		130.0								
			Bottom Irrigation		164.1								
			Evaporation Adjust		20.0								
	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Total</b>
1993 Level AVE inflow	6.3	5	4.7	4.5	8.8	14.1	13.0	17.2	30.6	11.0	6.2	5.4	126.8
1993 Level AVE evap (1931-93)	2.2	1.3	0.5	0.6	0.8	1.5	2.7	3.2	3.9	5.3	4.3	2.8	29.1
Avg. Inflow Last 5 Years	10.8	13.0	12.3	12.9	16.6	22.4	19.4	18.1	14.8	16.5	11.0	4.7	172.6

<b>Year 2001-2002 Oct - Jun Trigger and Irrigation Supply Calculation</b>									
Calculation Month	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>
Previous EOM Content	236.5	235.9	238.6	242.9	248.1	255.1	263.8	269.6	276.2
Inflow to May 31	73.6	67.3	62.3	57.6	53.1	44.3	30.2	17.2	0.0
Last 5 Yrs Avg Inflow to May 31	125.6	114.8	101.7	89.5	76.6	59.9	37.5	18.1	0.0
Evap to May 31	12.8	10.6	9.3	8.8	8.2	7.4	5.9	3.2	0.0
Est. Cont May 31	297.3	292.6	291.6	291.7	293.0	292.0	288.1	283.6	276.2
Est. Elevation May 31	1944.44	1944.08	1944.00	1944.01	1944.11	1944.03	1943.72	1943.37	1942.77
Max. Irrigation Available	153.2	148.5	147.5	147.6	148.9	147.9	144.0	139.5	132.1
Irrigation Release Est.	120.1	117.4	116.8	116.8	118.1	117.1	116.8	116.8	116.8
Trigger - Yes/No	NO	YES							
130 kAF Irrigation Supply - Yes/No	NO								

## Attachment 5: Projected Water Supply Spread Sheet Calculations

<b>Year 2002</b>				
<b>Jul - Sep</b>				
<b>Final Trigger and</b>				
<b>Total Irrigation Supply</b>				
<b>Calculation</b>				
Calculation Month		<b>Jul</b>	<b>Aug</b>	<b>Sep</b>
Previous EOM Irrigation Release Est.		116.8	116.0	109.7
Previous Month Inflow		5.5	0.5	1.3
Previous Month Evap		6.3	6.8	6.6
Irrigation Release Estimate		116.0	109.7	104.4
Final Trigger - Yes/No		YES		
130 kAF Irrigation Supply - Yes/No		NO	NO	NO

Republican River Compact Administration

Accounting Procedures and Reporting Requirements  
Revised August 2010

Attachment 6: Computing Water Supplies and Consumptive Use Above Guide Rock

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Total Main Stem VWS	Hardy gage	Superior-Courtland Diversion Dam Gage	Courtland Canal Diversions	Superior Canal Diversions	Courtland Canal Returns	Superior Canal Returns	Total Bostwick Returns Below Guide Rock	NE CBCU Below Guide Rock	KS CBCU Below Guide Rock	Total CBCU Below Guide Rock	Gain Guide Rock to Hardy	VWS Guide Rock to Hardy	Main Stem Virgin Water Supply Above Guide Rock	Nebraska Main Stem Allocation Above Hardy	Kansas Main Stem Allocation Above Hardy	Nebraska Guide Rock to Hardy Allocation	Kansas Guide Rock to Hardy Allocation
							Col F+ Col G			Col I + Col J	+ Col B - Col C+ Col K - Col H	+ Col L + Col K	Col A - Col M	.489 x Col N	.511 x Col N	.489 x Col M	.511 x Col M

## Attachment 7: Calculations of Return Flows from Bureau of Reclamation Canals

Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12
Canal	Canal Diversion	Spill to Waste- Way	Canal Initial Volume	Field Deliveries	Canal Loss	Average Field Loss Factor	Field Loss	Total Loss from District	Percent Field and Canal Loss That Returns to the Stream	Total return to Stream from Canal and Field Loss	Return as Percent of Canal Diversion
Name Canal	Headgate Diversion	Sum of measured spills to river	Col 2 - Col 3	Sum of Deliveries to the field	Col 2 - Col 5 + Col 3	1 -Weighted Average Efficiency of Application System for the District*	Col 5 x Col 7	Col 6 + Col 8	Estimated Percent Loss*	Col 9 x Col 10 + (Col 3 * 0.18)	Col 11/Col 2
Example	100	5	95	60	45	30%	18	63	82%	53	53%
Culbertson						30%			82%		
Culbertson Extension						30%			82%		
Meeker - Driftwood						30%			82%		
Red Willow						30%			82%		
Bartley						30%			82%		
Cambridge						30%			82%		
Naponee						35%			82%		
Franklin						35%			82%		
Franklin Pump						35%			82%		
Almena						30%			82%		
Superior						31%			82%		
Nebraska Courtland						23%			82%		
Courtland Canal Above Lovewell (KS)						23%			82%		
Courtland Canal Below Lovewell						23%			82%		

\*The average field efficiencies for each district and percent loss that returns to the stream may be reviewed and, if necessary, changed by the RRCA to improve the accuracy of the estimates.

# Attachment F

# Republican River Compact Administration

## ACCOUNTING PROCEDURES

### AND

## REPORTING REQUIREMENTS

Revised August 12, 2010

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## **I. Introduction**

This document describes the definitions, procedures, basic formulas, specific formulas, and data requirements and reporting formats to be used by the RRCA to compute the Virgin Water Supply, Computed Water Supply, Allocations, Imported Water Supply Credit and Computed Beneficial Consumptive Use. These computations shall be used to determine supply, allocations, use and compliance with the Compact according to the Stipulation. These definitions, procedures, basic and specific formulas, data requirements and attachments may be changed by consent of the RRCA consistent with Subsection I.F of the Stipulation. This document will be referred to as the RRCA Accounting Procedures. Attached to these RRCA Accounting Procedures as Figure 1 is the map attached to the Compact that shows the Basin, its streams and the Basin boundaries.

## **II. Definitions**

The following words and phrases as used in these RRCA Accounting Procedures are defined as follows:

**Additional Water Administration Year** - a year when the projected or actual irrigation water supply is less than 130,000 Acre-feet of storage available for use from Harlan County Lake as determined by the Bureau of Reclamation using the methodology described in the Harlan County Lake Operation Consensus Plan attached as Appendix K to the Stipulation.

**Allocation(s)**: the water supply allocated to each State from the Computed Water Supply;

**Annual**: yearly from January 1 through December 31;

**Basin**: the Republican River Basin as defined in Article II of the Compact;

**Beneficial Consumptive Use**: that use by which the Water Supply of the Basin is consumed through the activities of man, and shall include water consumed by evaporation from any reservoir, canal, ditch, or irrigated area;

**Change in Federal Reservoir Storage**: the difference between the amount of water in storage in the reservoir on December 31 of each year and the amount of water in storage on December 31 of the previous year. The current area capacity table supplied by the appropriate federal operating agency shall be used to determine the contents of the reservoir on each date;

**Compact**: the Republican River Compact, Act of February 22, 1943, 1943 Kan. Sess. Laws 612, codified at Kan. Stat. Ann. § 82a-518 (1997); Act of February 24, 1943, 1943 Neb. Laws 377, codified at 2A Neb. Rev. Stat. App. § 1-106 (1995), Act of March 15, 1943, 1943 Colo. Sess. Laws 362, codified at Colo. Rev. Stat. §§ 37-67-101 and 37-67-102 (2001); Republican River Compact, Act of May 26, 1943, ch. 104, 57 Stat. 86;

**Computed Beneficial Consumptive Use:** for purposes of Compact accounting, the stream flow depletion resulting from the following activities of man:

- Irrigation of lands in excess of two acres;
- Any non-irrigation diversion of more than 50 Acre-feet per year;
- Multiple diversions of 50 Acre-feet or less that are connected or otherwise combined to serve a single project will be considered as a single diversion for accounting purposes if they total more than 50 Acre-feet;
- Net evaporation from Federal Reservoirs;
- Net evaporation from Non-federal Reservoirs within the surface boundaries of the Basin;
- Any other activities that may be included by amendment of these formulas by the RRCA;

**Computed Water Supply:** the Virgin Water Supply less the Change in Federal Reservoir Storage in any Designated Drainage Basin, and less the Flood Flows;

**Designated Drainage Basins:** the drainage basins of the specific tributaries and the Main Stem of the Republican River as described in Article III of the Compact. Attached hereto as Figure 3 is a map of the Sub-basins and Main Stem;

**Dewatering Well:** a Well constructed solely for the purpose of lowering the groundwater elevation;

**Federal Reservoirs:**

- Bonny Reservoir
- Swanson Lake
- Enders Reservoir
- Hugh Butler Lake
- Harry Strunk Lake
- Keith Sebelius Lake
- Harlan County Lake
- Lovewell Reservoir

**Flood Flows:** the amount of water deducted from the Virgin Water Supply as part of the computation of the Computed Water Supply due to a flood event as determined by the methodology described in Subsection III.B.1.;

**Gaged Flow:** the measured flow at the designated stream gage;

**Guide Rock:** a point at the Superior-Courtland Diversion Dam on the Republican River near Guide Rock, Nebraska; the Superior-Courtland Diversion Dam gage plus any flows through the sluice gates of the dam, specifically excluding any diversions to the Superior and Courtland Canals, shall be the measure of flows at Guide Rock;

**Historic Consumptive Use:** that amount of water that has been consumed under appropriate and reasonably efficient practices to accomplish without waste the purposes for which the appropriation or other legally permitted use was lawfully made;

**Imported Water Supply:** the water supply imported by a State from outside the Basin resulting from the activities of man;

**Imported Water Supply Credit:** the accretions to stream flow due to water imports from outside of the Basin as computed by the RRCA Groundwater Model. The Imported Water Supply Credit of a State shall not be included in the Virgin Water Supply and shall be counted as a credit/offset against the Computed Beneficial Consumptive Use of water allocated to that State, except as provided in Subsection V.B.2. of the Stipulation and Subsections III.I. – J. of these RRCA Accounting Procedures;

**Main Stem:** the Designated Drainage Basin identified in Article III of the Compact as the North Fork of the Republican River in Nebraska and the main stem of the Republican River between the junction of the North Fork and the Arikaree River and the lowest crossing of the river at the Nebraska-Kansas state line and the small tributaries thereof, and also including the drainage basin Blackwood Creek;

**Main Stem Allocation:** the portion of the Computed Water Supply derived from the Main Stem and the Unallocated Supply derived from the Sub-basins as shared by Kansas and Nebraska;

**Meeting(s):** a meeting of the RRCA, including any regularly scheduled annual meeting or any special meeting;

**Modeling Committee:** the modeling committee established in Subsection IV.C. of the Stipulation;

**Moratorium:** the prohibition and limitations on construction of new Wells in the geographic area described in Section III. of the Stipulation;

**Non-federal Reservoirs:** reservoirs other than Federal Reservoirs that have a storage capacity of 15 Acre-feet or greater at the principal spillway elevation;

**Northwest Kansas:** those portions of the Sub-basins within Kansas;

**Replacement Well:** a Well that replaces an existing Well that a) will not be used after construction of the new Well and b) will be abandoned within one year after such construction or is used in a manner that is excepted from the Moratorium pursuant to Subsections III.B.1.c.-f. of the Stipulation;

**RRCA:** Republican River Compact Administration, the administrative body composed of the State officials identified in Article IX of the Compact;

**RRCA Accounting Procedures:** this document and all attachments hereto;

**RRCA Groundwater Model:** the groundwater model developed under the provisions of Subsection IV.C. of the Stipulation and as subsequently adopted and revised through action of the RRCA;

**State:** any of the States of Colorado, Kansas, and Nebraska;

**States:** the States of Colorado, Kansas and Nebraska;

**Stipulation:** the Final Settlement Stipulation to be filed in *Kansas v. Nebraska and Colorado*, No. 126, Original, including all Appendices attached thereto;

**Sub-basin:** the Designated Drainage Basins, except for the Main Stem, identified in Article III of the Compact. For purposes of Compact accounting the following Sub-basins will be defined as described below:

North Fork of the Republican River in Colorado drainage basin is that drainage area above USGS gaging station number 06823000, North Fork Republican River at the Colorado-Nebraska State Line,

Arikaree River drainage basin is that drainage area above USGS gaging station number 06821500, Arikaree River at Haigler, Nebraska,

Buffalo Creek drainage basin is that drainage area above USGS gaging station number 06823500, Buffalo Creek near Haigler, Nebraska,

Rock Creek drainage basin is that drainage area above USGS gaging station number 06824000, Rock Creek at Parks, Nebraska,

South Fork of the Republican River drainage basin is that drainage area above USGS gaging station number 06827500, South Fork Republican River near Benkelman, Nebraska,

Frenchman Creek (River) drainage basin in Nebraska is that drainage area above USGS gaging station number 06835500, Frenchman Creek in Culbertson, Nebraska,

Driftwood Creek drainage basin is that drainage area above USGS gaging station number 06836500, Driftwood Creek near McCook, Nebraska,

Red Willow Creek drainage basin is that drainage area above USGS gaging station number 06838000, Red Willow Creek near Red Willow, Nebraska,

Medicine Creek drainage basin is that drainage area above the Medicine Creek below Harry Strunk Lake, State of Nebraska gaging station number 06842500; and the drainage area between the gage and the confluence with the Main Stem,

Sappa Creek drainage basin is that drainage area above USGS gaging station number 06847500, Sappa Creek near Stamford, Nebraska and the drainage area between the gage and the confluence with the Main Stem; and excluding the Beaver Creek drainage basin area downstream from the State of Nebraska gaging station number 06847000 Beaver Creek near Beaver City, Nebraska to the confluence with Sappa Creek,

Beaver Creek drainage basin is that drainage area above State of Nebraska gaging station number 06847000, Beaver Creek near Beaver City, Nebraska, and the drainage area between the gage and the confluence with Sappa Creek,

Prairie Dog Creek drainage basin is that drainage area above USGS gaging station number 06848500, Prairie Dog Creek near Woodruff, Kansas, and the drainage area between the gage and the confluence with the Main Stem;

Attached hereto as Figure 2 is a line diagram depicting the streams, Federal Reservoirs and gaging stations;

**Test hole:** a hole designed solely for the purpose of obtaining information on hydrologic and/or geologic conditions;

**Trenton Dam:** a dam located at 40 degrees, 10 minutes, 10 seconds latitude and 101 degrees, 3 minutes, 35 seconds longitude, approximately two and one-half miles west of the town of Trenton, Nebraska;

**Unallocated Supply:** the “water supplies of upstream basins otherwise unallocated” as set forth in Article IV of the Compact;

**Upstream of Guide Rock, Nebraska:** those areas within the Basin lying west of a line proceeding north from the Nebraska-Kansas state line and following the western edge of Webster County, Township 1, Range 9, Sections 34, 27, 22, 15, 10 and 3 through Webster County, Township 2, Range 9, Sections 34, 27 and 22; then proceeding west along the southern edge of Webster County, Township 2, Range 9, Sections 16, 17 and 18; then proceeding north following the western edge of Webster County, Township 2, Range 9, Sections 18, 7 and 6, through Webster County, Township 3, Range 9, Sections 31, 30, 19, 18, 7 and 6 to its intersection with the northern boundary of Webster County. Upstream of Guide Rock, Nebraska shall not include that area in Kansas east of the 99° meridian and south of the Kansas-Nebraska state line;

**Virgin Water Supply:** the Water Supply within the Basin undepleted by the activities of man;

**Water Short Year Administration:** administration in a year when the projected or actual irrigation water supply is less than 119,000 acre feet of storage available for use from Harlan County Lake as determined by the Bureau of Reclamation using the methodology described in the Harlan County Lake Operation Consensus Plan attached as Appendix K to the Stipulation.

**Water Supply of the Basin or Water Supply within the Basin:** the stream flows within the Basin, excluding Imported Water Supply;

**Well:** any structure, device or excavation for the purpose or with the effect of obtaining groundwater for beneficial use from an aquifer, including wells, water wells, or groundwater wells as further defined and used in each State’s laws, rules, and regulations.

**III. Basic Formulas**

The basic formulas for calculating Virgin Water Supply, Computed Water Supply, Imported Water Supply, Allocations and Computed Beneficial Consumptive Use are set forth below. The results of these calculations shall be shown in a table format as shown in Table 1.

Basic Formulas for Calculating Virgin Water Supply, Computed Water Supply, Allocations and Computed Beneficial Consumptive Use	
Sub-basin VWS	= Gage + All CBCU + ΔS – IWS
Main Stem VWS	= Hardy Gage – Σ Sub-basin gages + All CBCU in the Main Stem + ΔS – IWS
CWS	= VWS - Δ S – FF
Allocation for each State in each Sub-basin And Main Stem	= CWS x %
State's Allocation	= Σ Allocations for Each State
State's CBCU	= Σ State's CBCUs in each Sub-basin and Main Stem

Abbreviations:

- CBCU = Computed Beneficial Consumptive Use
- FF = Flood Flows
- Gage = Gaged Flow
- IWS = Imported Water Supply Credit
- CWS = Computed Water Supply
- VWS = Virgin Water Supply

% = the ratio used to allocate the Computed Water Supply between the States. This ratio is based on the allocations in the Compact  
 $\Delta S$  = Change in Federal Reservoir Storage

## **A. Calculation of Annual Virgin Water Supply**

### **1. Sub-basin calculation:**

The annual Virgin Water Supply for each Sub-basin will be calculated by adding: a) the annual stream flow in that Sub-basin at the Sub-basin stream gage designated in Section II., b) the annual Computed Beneficial Consumptive Use above that gaging station, and c) the Change in Federal Reservoir Storage in that Sub-basin; and from that total subtract any Imported Water Supply Credit. The Computed Beneficial Consumptive Use will be calculated as described in Subsection III. D. Adjustments for flows diverted around stream gages and for Computed Beneficial Consumptive Uses in the Sub-basin between the Sub-basin stream gage and the confluence of the Sub-basin tributary and the Main Stem shall be made as described in Subsections III. D. 1 and 2 and IV. B.

### **2. Main Stem Calculation:**

The annual Virgin Water Supply for the Main Stem will be calculated by adding: a) the flow at the Hardy gage minus the flows from the Sub-basin gages listed in Section II, b) the annual Computed Beneficial Consumptive Use in the Main Stem, and c) the Change in Federal Reservoir Storage from Swanson Lake and Harlan County Lake; and from that total subtract any Imported Water Supply Credit for the Main Stem. Adjustments for flows diverted around Sub-basin stream gages and for Computed Beneficial Consumptive Uses in a Sub-basin between the Sub-basin stream gage and the confluence of the Sub-basin tributary and the Mains Stem shall be made as described in Subsections III. D. 1 and 2 and IV.B.,

### **3. Imported Water Supply Credit Calculation:**

The amount of Imported Water Supply Credit shall be determined by the RRCA Groundwater Model. The Imported Water Supply Credit of a State shall not be included in the Virgin Water Supply and shall be counted as a credit/offset against the Computed Beneficial Consumptive Use of water allocated to that State. Currently, the Imported Water Supply Credits shall be determined using two runs of the RRCA Groundwater Model:

- a. The “base” run shall be the run with all groundwater pumping, groundwater pumping recharge, and surface water recharge within the model study

boundary for the current accounting year turned “on.” ~~This will be the same “base” run used to determine groundwater Computed Beneficial-Consumptive Uses.~~

- b. The “no NE import” run shall be the run with the same model inputs as the base run with the exception that surface water recharge associated with Nebraska’s Imported Water Supply shall be turned “off.” ~~This will be the same “no NE import” run used to determine groundwater Computed Beneficial Consumptive Uses.~~

The Imported Water Supply Credit shall be the difference in stream flows between these two model runs. Differences in stream flows shall be determined at the same locations as identified in Subsection III.D.1. for the “no pumping” runs.

Should another State import water into the Basin in the future, the RRCA will develop a similar procedure to determine Imported Water Supply Credits.

## **B. Calculation of Computed Water Supply**

On any Designated Drainage Basin without a Federal Reservoir, the Computed Water Supply will be equal to the Virgin Water Supply of that Designated Drainage Basin minus Flood Flows.

On any Designated Drainage Basin with a Federal Reservoir, the Computed Water Supply will be equal to the Virgin Water Supply minus the Change in Federal Reservoir Storage in that Designated Drainage Basin and minus Flood Flows.

### **1. Flood Flows**

If in any calendar year there are five consecutive months in which the total actual stream flow<sup>1</sup> at the Hardy gage is greater than 325,000 Acre-feet, or any two consecutive months in which the total actual stream flow is greater than 200,000 Acre-feet, the annual flow in excess of 400,000 Acre-feet at the Hardy gage will be considered to be Flood Flows that will be subtracted from the Virgin Water Supply to calculate the Computed Water Supply, and Allocations. The Flood Flow in excess of 400,000 Acre-feet at the Hardy gage will be subtracted from the Virgin Water Supply of the Main Stem to compute the Computed Water Supply unless the Annual Gaged Flows from a Sub-basin were in excess of the flows shown for that Sub-basin in Attachment 1. These excess Sub-basin flows shall be considered to be Sub-basin Flood Flows.

If there are Sub-basin Flood Flows, the total of all Sub-basin Flood Flows shall be compared to the amount of Flood Flows at the Hardy gage. If the sum of the Sub-basin Flood Flows are in excess of the Flood Flow at the Hardy gage, the flows to

<sup>1</sup> These actual stream flows reflect Gaged Flows after depletions by Beneficial Consumptive Use and change in reservoir storage above the gage.

be deducted from each Sub-basin shall be the product of the Flood Flows for each Sub-basin times the ratio of the Flood Flows at the Hardy gage divided by the sum of the Flood Flows of the Sub-basin gages. If the sum of the Sub-basin Flood Flows is less than the Flood Flow at the Hardy gage, the entire amount of each Sub-basin Flood Flow shall be deducted from the Virgin Water Supply to compute the Computed Water Supply of that Sub-basin for that year. The remainder of the Flood Flows will be subtracted from the flows of the Main Stem.

### C. Calculation of Annual Allocations

Article IV of the Compact allocates 54,100 Acre-feet for Beneficial Consumptive Use in Colorado, 190,300 Acre-feet for Beneficial Consumptive Use in Kansas and 234,500 Acre-feet for Beneficial Consumptive Use in Nebraska. The Compact provides that the Compact totals are to be derived from the sources and in the amounts specified in Table 2.

The Allocations derived from each Sub-basin to each State shall be the Computed Water Supply multiplied by the percentages set forth in Table 2. In addition, Kansas shall receive 51.1% of the Main Stem Allocation and the Unallocated Supply and Nebraska shall receive 48.9% of the Main Stem Allocation and the Unallocated Supply.

### D. Calculation of Annual Computed Beneficial Consumptive Use

#### 1. Groundwater

Computed Beneficial Consumptive Use of groundwater shall be determined by use of the RRCA Groundwater Model. The Computed Beneficial Consumptive Use of groundwater for each State shall be determined as the difference in streamflows using two runs of the model:

The “baseno NE import” run shall be the run with all groundwater pumping, groundwater pumping recharge, and surface water recharge within the model study boundary for the current accounting year “on”, with the exception that surface water recharge associated with Nebraska’s Imported Water Supply shall be turned “off.”

The “no State pumping” run shall be the run with the same model inputs as the base “no NE import” run with the exception that all groundwater pumping and pumping recharge of that State shall be turned “off.”

An output of the model is baseflows at selected stream cells. Changes in the baseflows predicted by the model between the “baseno NE import” run and the “no-State- pumping” model run is assumed to be the depletions to streamflows. i.e.,

groundwater computed beneficial consumptive use, due to State groundwater pumping at that location. The values for each Sub-basin will include all depletions and accretions upstream of the confluence with the Main Stem. The values for the Main Stem will include all depletions and accretions in stream reaches not otherwise accounted for in a Sub-basin. The values for the Main Stem will be computed separately for the reach above Guide Rock, and the reach below Guide Rock.

## **2. Surface Water**

The Computed Beneficial Consumptive Use of surface water for irrigation and non-irrigation uses shall be computed by taking the diversions from the river and subtracting the return flows to the river resulting from those diversions, as described in Subsections IV.A.2.a.-d. The Computed Beneficial Consumptive Use of surface water from Federal Reservoir and Non-Federal Reservoir evaporation shall be the net reservoir evaporation from the reservoirs, as described in Subsections IV.A.2.e.-f.

For Sub-basins where the gage designated in Section II. is near the confluence with the Main Stem, each State's Sub-basin Computed Beneficial Consumptive Use of surface water shall be the State's Computed Beneficial Consumptive Use of surface water above the Sub-basin gage. For Medicine Creek, Sappa Creek, Beaver Creek and Prairie Dog Creek, where the gage is not near the confluence with the Main Stem, each State's Computed Beneficial Consumptive Use of surface water shall be the sum of the State's Computed Beneficial Consumptive Use of surface water above the gage, and its Computed Beneficial Consumptive Use of surface water between the gage and the confluence with the Main Stem.

### **E. Calculation to Determine Compact Compliance Using Five-Year Running Averages**

Each year, using the procedures described herein, the RRCA will calculate the Annual Allocations by Designated Drainage Basin and total for each State, the Computed Beneficial Consumptive Use by Designated Drainage Basin and total for each State and the Imported Water Supply Credit that a State may use for the preceding year. These results for the current Compact accounting year as well as the results of the previous four accounting years and the five-year average of these results will be displayed in the format shown in Table 3.

## **F. Calculations To Determine Colorado's and Kansas's Compliance with the Sub-basin Non-Impairment Requirement**

The data needed to determine Colorado's and Kansas's compliance with the Sub-basin non-impairment requirement in Subsection IV.B.2. of the Stipulation are shown in Tables 4.A. and B.

## **G. Calculations To Determine Projected Water Supply**

### **1. Procedures to Determine Water Short Years**

The Bureau of Reclamation will provide each of the States with a monthly or, if requested by any one of the States, a more frequent update of the projected or actual irrigation supply from Harlan County Lake for that irrigation season using the methodology described in the Harlan County Lake Operation Consensus Plan, attached as Appendix K to the Stipulation. The steps for the calculation are as follows:

Step 1. At the beginning of the calculation month (1) the total projected inflow for the calculation month and each succeeding month through the end of May shall be added to the previous end of month Harlan County Lake content and (2) the total projected 1993 level evaporation loss for the calculation month and each succeeding month through the end of May shall then be subtracted. The total projected inflow shall be the 1993 level average monthly inflow or the running average monthly inflow for the previous five years, whichever is less.

Step 2. Determine the maximum irrigation water available by subtracting the sediment pool storage (currently 164,111 Acre-feet) and adding the summer sediment pool evaporation (20,000 Acre-feet) to the result from Step 1.

Step 3. For October through January calculations, take the result from Step 2 and using the Shared Shortage Adjustment Table in Attachment 2 hereto, determine the preliminary irrigation water available for release. The calculation using the end of December content (January calculation month) indicates the minimum amount of irrigation water available for release at the end of May. For February through June calculations, subtract the maximum irrigation water available for the January calculation month from the maximum irrigation water available for the calculation month. If the result is negative, the irrigation water available for release (January calculation month) stays the same. If the result is positive the preliminary irrigation

water available for release (January calculation month) is increased by the positive amount.

Step 4. Compare the result from Step 3 to 119,000 Acre-feet. If the result from Step 3 is less than 119,000 Acre-feet Water Short Year Administration is in effect.

Step 5. The final annual Water-Short Year Administration calculation determines the total estimated irrigation supply at the end of June (calculated in July). Use the result from Step 3 for the end of May irrigation release estimate, add the June computed inflow to Harlan County Lake and subtract the June computed gross evaporation loss from Harlan County Lake.

## **2. Procedures to Determine 130,000 Acre Feet Projected Water Supply**

To determine the preliminary irrigation supply for the October through June calculation months, follow the procedure described in steps 1 through 4 of the “Procedures to determine Water Short Years” Subsection III. G. 1. The result from step 4 provides the forecasted water supply, which is compared to 130,000 Acre-feet. For the July through September calculation months, use the previous end of calculation month preliminary irrigation supply, add the previous month’s Harlan County Lake computed inflow and subtract the previous month’s computed gross evaporation loss from Harlan County Lake to determine the current preliminary irrigation supply. The result is compared to 130,000 Acre-feet.

### **H. Calculation of Computed Water Supply, Allocations and Computed Beneficial Consumptive Use Above and Below Guide Rock During Water-Short Administration Years.**

For Water-Short-Administration Years, in addition to the normal calculations, the Computed Water Supply, Allocations, Computed Beneficial Consumptive Use and Imported Water Supply Credits shall also be calculated above Guide Rock as shown in Table 5C. These calculations shall be done in the same manner as in non-Water-Short Administration years except that water supplies originating below Guide Rock shall not be included in the calculations of water supplies originating above Guide Rock. The calculations of Computed Beneficial Consumptive Uses shall be also done in the same manner as in non-Water-Short Administration years except that Computed Beneficial Consumptive Uses from diversions below Guide Rock shall not be included. The depletions from the water diverted by the Superior and Courtland Canals at the Superior-Courtland Diversion Dam shall be included in the calculations of Computed Beneficial Consumptive Use above Guide Rock. Imported Water Supply Credits above Guide Rock, as described in Sub-section III.I., may be used as offsets against the Computed Beneficial Consumptive Use above Guide Rock by the State providing the Imported Water Supply Credits.

The Computed Water Supply of the Main Stem reach between Guide Rock and the Hardy gage shall be determined by taking the difference in stream flow at Hardy and Guide Rock, adding Computed Beneficial Consumptive Uses in the reach (this does not include the Computed Beneficial Consumptive Use from the Superior and Courtland Canal diversions), and subtracting return flows from the Superior and Courtland Canals in the reach. The Computed Water Supply above Guide Rock shall be determined by subtracting the Computed Water Supply of the Main Stem reach between Guide Rock and the Hardy gage from the total Computed Water Supply. Nebraska's Allocation above Guide Rock shall be determined by subtracting 48.9% of the Computed Water Supply of the Main Stem reach between Guide Rock and the Hardy gage from Nebraska's total Allocation. Nebraska's Computed Beneficial Consumptive Uses above Guide Rock shall be determined by subtracting Nebraska's Computed Beneficial Consumptive Uses below Guide Rock from Nebraska's total Computed Beneficial Consumptive Use.

### **I. Calculation of Imported Water Supply Credits During Water-Short Year Administration Years.**

Imported Water Supply Credit during Water-Short Year Administration years shall be calculated consistent with Subsection V.B.2.b. of the Stipulation.

The following methodology shall be used to determine the extent to which Imported Water Supply Credit, as calculated by the RRCA Groundwater Model, can be credited to the State importing the water during Water-Short Year Administration years.

#### **1. Monthly Imported Water Supply Credits**

The RRCA Groundwater Model will be used to determine monthly Imported Water Supply Credits by State in each Sub-basin and for the Main Stem. The values for each Sub-basin will include all depletions and accretions upstream of the confluence with the Main Stem. The values for the Main Stem will include all depletions and accretions in stream reaches not otherwise accounted for in a Sub-basin. The values for the Main Stem will be computed separately for the reach 1) above Harlan County Dam, 2) between Harlan County Dam and Guide Rock, and 3) between Guide Rock and the Hardy gage. The Imported Water Supply Credit shall be the difference in stream flow for two runs of the model: a) the "base" run and b) the "no State import" run.

During Water-Short Year Administration years, Nebraska's credits in the Sub-basins shall be determined as described in Section III. A. 3.

## **2. Imported Water Supply Credits Above Harlan County Dam**

Nebraska's Imported Water Supply Credits above Harlan County Dam shall be the sum of all the credits in the Sub-basins and the Main Stem above Harlan County Dam.

## **3. Imported Water Supply Credits Between Harlan County Dam and Guide Rock During the Irrigation Season**

a. During Water-Short Year Administration years, monthly credits in the reach between Harlan County Dam and Guide Rock shall be determined as the differences in the stream flows between the two runs at Guide Rock.

b. The irrigation season shall be defined as starting on the first day of release of water from Harlan County Lake for irrigation use and ending on the last day of release of water from Harlan County Lake for irrigation use.

c. Credit as an offset for a State's Computed Beneficial Consumptive Use above Guide Rock will be given to all the Imported Water Supply accruing in the reach between Harlan County Dam and Guide Rock during the irrigation season. If the period of the irrigation season does not coincide with the period of modeled flows, the amount of the Imported Water Supply credited during the irrigation season for that month shall be the total monthly modeled Imported Water Supply Credit times the number of days in the month occurring during the irrigation season divided by the total number of days in the month.

## **4. Imported Water Supply Credits Between Harlan County Dam and Guide Rock During the Non-Irrigation Season**

a. Imported Water Supply Credit shall be given between Harlan County Dam and Guide Rock during the period that flows are diverted to fill Lovewell Reservoir to the extent that imported water was needed to meet Lovewell Reservoir target elevations.

b. Fall and spring fill periods shall be established during which credit shall be given for the Imported Water Supply Credit accruing in the reach. The fall period shall extend from the end of the irrigation season to December 1. The spring period shall extend from March 1 to May 31. The Lovewell target elevations for these fill periods are the projected end of November reservoir level and the projected end of May reservoir level for most

probable inflow conditions as indicated in Table 4 in the current Annual Operating Plan prepared by the Bureau of Reclamation.

c. The amount of water needed to fill Lovewell Reservoir for each period shall be calculated as the storage content of the reservoir at its target elevation at the end of the fill period minus the reservoir content at the start of the fill period plus the amount of net evaporation during this period minus White Rock Creek inflows for the same period.

d. If the fill period as defined above does not coincide with the period of modeled flows, the amount of the Imported Water Supply Credit during the fill period for that month shall be the total monthly modeled Imported Water Supply Credit times the number of days in the month occurring during the fill season divided by the total number of days in the month.

e. The amount of non-imported water available to fill Lovewell Reservoir to the target elevation shall be the amount of water available at Guide Rock during the fill period minus the amount of the Imported Water Supply Credit accruing in the reach during the same period.

f. The amount of the Imported Water Supply Credit that shall be credited against a State's Consumptive Use shall be the amount of water imported by that State that is available in the reach during the fill period or the amount of water needed to reach Lovewell Reservoir target elevations minus the amount of non-imported water available during the fill period, whichever is less.

## 5. Other Credits

Kansas and Nebraska will explore crediting Imported Water Supply that is otherwise useable by Kansas.

## J. Calculations of Compact Compliance in Water-Short Year Administration Years

During Water-Short Year Administration, using the procedures described in Subsections III.A-D, the RRCA will calculate the Annual Allocations for each State, the Computed Beneficial Consumptive Use by each State, and Imported Water Supply Credit that a State may use to offset Computed Beneficial Consumptive Use in that year. The resulting annual and average values will be calculated as displayed in Tables 5 A-C and E.

If Nebraska is implementing an Alternative Water-Short-Year Administration Plan, data to determine Compact compliance will be shown in Table 5D. Nebraska's compliance with the Compact will be determined in the same manner as Nebraska's Above Guide Rock

compliance except that compliance will be based on a three-year running average of the current year and previous two year calculations. In addition, Table 5 D. will display the sum of the previous two-year difference in Allocations above Guide Rock and Computed Beneficial Consumptive Uses above Guide Rock minus any Imported Water Credits and compare the result with the Alternative Water-Short-Year Administration Plan's expected decrease in Computed Beneficial Consumptive Use above Guide Rock. Nebraska will be within compliance with the Compact as long as the three-year running average difference in Column 8 is positive and the sum of the previous year and current year deficits above Guide Rock are not greater than the expected decrease in Computed Beneficial Consumptive Use under the plan.

#### **IV. Specific Formulas**

##### **A. Computed Beneficial Consumptive Use**

###### **1. Computed Beneficial Consumptive Use of Groundwater:**

The Computed Beneficial Consumptive Use caused by groundwater diversion shall be determined by the RRCA Groundwater Model as described in Subsection III.D.1.

###### **2. Computed Beneficial Consumptive Use of Surface Water:**

The Computed Beneficial Consumptive Use of surface water shall be calculated as follows:

###### a) Non-Federal Canals

Computed Beneficial Consumptive Use from diversions by non- federal canals shall be 60 percent of the diversion; the return flow shall be 40 percent of the diversion

###### b) Individual Surface Water Pumps

Computed Beneficial Consumptive Use from small individual surface water pumps shall be 75 percent of the diversion; return flows will be 25 percent of the diversion unless a state provides data on the amount of different system types in a Sub-basin, in which case the following percentages will be used for each system type:

Gravity Flow.	30%
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Center Pivot	17%
LEPA	10%

c) Federal Canals

Computed Beneficial Consumptive Use of diversions by Federal canals will be calculated as shown in Attachment 7. For each Bureau of Reclamation Canal the field deliveries shall be subtracted from the diversion from the river to determine the canal losses. The field delivery shall be multiplied by one minus an average system efficiency for the district to determine the loss of water from the field. Eighty-two percent of the sum of the field loss plus the canal loss shall be considered to be the return flow from the canal diversion. The assumed field efficiencies and the amount of the field and canal loss that reaches the stream may be reviewed by the RRCA and adjusted as appropriate to insure their accuracy.

d) Non-irrigation Uses

Any non-irrigation uses diverting or pumping more than 50 acre-feet per year will be required to measure diversions. Non-irrigation uses diverting more than 50 Acre-feet per year will be assessed a Computed Beneficial Consumptive Use of 50% of what is pumped or diverted, unless the entity presents evidence to the RRCA demonstrating a different percentage should be used.

e) Evaporation from Federal Reservoirs

Net Evaporation from Federal Reservoirs will be calculated as follows:

(1) Harlan County Lake, Evaporation Calculation

April 1 through October 31:

Evaporation from Harlan County Lake is calculated by the Corps of Engineers on a daily basis from April 1 through October 31. Daily readings are taken from a Class A evaporation pan maintained near the project office. Any precipitation recorded at the project office is added to the pan reading to obtain the actual evaporation amount. The pan value is multiplied by a pan coefficient that varies by month. These values are:

March	.56
April	.52
May	.53
June	.60
July	.68
August	.78
September	.91
October	1.01

The pan coefficients were determined by studies the Corps of Engineers conducted a number of years ago. The result is the evaporation in inches. It is divided by 12 and multiplied by the daily lake surface area in acres to obtain the evaporation in Acre-feet. The lake surface area is determined by the 8:00 a.m. elevation reading applied to the lake's area-capacity data. The area-capacity data is updated periodically through a sediment survey. The last survey was completed in December 2000.

November 1 through March 31

During the winter season, a monthly total evaporation in inches has been determined. The amount varies with the percent of ice cover. The values used are:

HARLAN COUNTY LAKE

Estimated Evaporation in Inches  
Winter Season -- Monthly Total

PERCENTAGE OF ICE COVER

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
JAN	0.88	0.87	0.85	0.84	0.83	0.82	0.81	0.80	0.78	0.77	0.76
FEB	0.90	0.88	0.87	0.86	0.85	0.84	0.83	0.82	0.81	0.80	0.79
MAR	1.29	1.28	1.27	1.26	1.25	1.24	1.23	1.22	1.21	1.20	1.19
OCT	4.87			NO ICE							
NOV	2.81			NO ICE							
DEC	1.31	1.29	1.27	1.25	1.24	1.22	1.20	1.18	1.17	1.16	1.14

The monthly total is divided by the number of days in the month to obtain a daily evaporation value in inches. It is divided by 12 and

multiplied by the daily lake surface area in acres to obtain the evaporation in Acre-feet. The lake surface area is determined by the 8:00 a.m. elevation reading applied to the lake's area-capacity data. The area-capacity data is updated periodically through a sediment survey. The last survey was completed in December 2000.

To obtain the net evaporation, the monthly precipitation on the lake is subtracted from the monthly gross evaporation. The monthly precipitation is calculated by multiplying the sum of the month's daily precipitation in inches by the average of the end of the month lake surface area for the previous month and the end of the month lake surface area for the current month in acres and dividing the result by 12 to obtain the precipitation for the month in acre feet.

The total annual net evaporation (Acre-feet) will be charged to Kansas and Nebraska in proportion to the annual diversions made by the Kansas Bostwick Irrigation District and the Nebraska Bostwick Irrigation District during the time period each year when irrigation releases are being made from Harlan County Lake. For any year in which no irrigation releases were made from Harlan County Lake, the annual net evaporation charged to Kansas and Nebraska will be based on the average of the above calculation for the most recent three years in which irrigation releases from Harlan County Lake were made. In the event Nebraska chooses to substitute supply for the Superior Canal from Nebraska's allocation below Guide Rock in Water-Short Year Administration years, the amount of the substitute supply will be included in the calculation of the split as if it had been diverted to the Superior Canal at Guide Rock.

## (2) Evaporation Computations for Bureau of Reclamation Reservoirs

The Bureau of Reclamation computes the amount of evaporation loss on a monthly basis at Reclamation reservoirs. The following procedure is utilized in calculating the loss in Acre-feet.

An evaporation pan reading is taken each day at the dam site. This measurement is the amount of water lost from the pan over a 24-hour period in inches. The evaporation pan reading is adjusted for any precipitation recorded during the 24-hour period. Instructions for determining the daily pan evaporation are found in the "National Weather Service Observing Handbook No. 2 – Substation Observations." All dams located in the Kansas River Basin with the exception of Bonny Dam are National Weather Service Cooperative Observers. The daily evaporation pan readings are totaled at the end

of each month and converted to a “free water surface” (FWS) evaporation, also referred to as “lake” evaporation. The FWS evaporation is determined by multiplying the observed pan evaporation by a coefficient of .70 at each of the reservoirs. This coefficient can be affected by several factors including water and air temperatures. The National Oceanic and Atmospheric Administration (NOAA) has published technical reports describing the determination of pan coefficients. The coefficient used is taken from the “NOAA Technical Report NWS 33, Map of coefficients to convert class A pan evaporation to free water surface evaporation”. This coefficient is used for the months of April through October when evaporation pan readings are recorded at the dams. The monthly FWS evaporation is then multiplied by the average surface area of the reservoir during the month in acres. Dividing this value by twelve will result in the amount of water lost to evaporation in Acre-feet during the month.

During the winter months when the evaporation pan readings are not taken, monthly evaporation tables based on the percent of ice cover are used. The tables used were developed by the Corps of Engineers and were based on historical average evaporation rates. A separate table was developed for each of the reservoirs. The monthly evaporation rates are multiplied by the .70 coefficient for pan to free water surface adjustment, divided by twelve to convert inches to feet and multiplied by the average reservoir surface area during the month in acres to obtain the total monthly evaporation loss in Acre-feet.

To obtain the net evaporation, the monthly precipitation on the lake is subtracted from the monthly gross evaporation. The monthly precipitation is calculated by multiplying the sum of the month's daily precipitation in inches by the average of the end of the month lake surface area for the previous month and the end of the month lake surface area for the current month in acres and dividing the result by 12 to obtain the precipitation for the month in acre feet.

#### f) Non-Federal Reservoir Evaporation:

For Non-Federal Reservoirs with a storage capacity less than 200 Acre-feet, the presumptive average annual surface area is 25% of the area at the principal spillway elevation. Net evaporation for each such Non-Federal Reservoir will be calculated by multiplying the presumptive average annual surface area by the net evaporation from the nearest climate and evaporation

station to the Non-Federal Reservoir. A State may provide actual data in lieu of the presumptive criteria.

Net evaporation from Non-Federal Reservoirs with 200 Acre-feet of storage or greater will be calculated by multiplying the average annual surface area (obtained from the area-capacity survey) and the net evaporation from the nearest evaporation and climate station to the reservoir. If the average annual surface area is not available, the Non-Federal Reservoirs with 200 Acre-feet of storage or greater will be presumed to be full at the principal spillway elevation.

## **B. Specific Formulas for Each Sub-basin and the Main Stem**

All calculations shall be based on the calendar year and shall be rounded to the nearest 10 Acre-feet using the conventional rounding formula of rounding up for all numbers equal to five or higher and otherwise rounding down.

### Abbreviations:

CBCU	= Computed Beneficial Consumptive Use
CWS	= Computed Water Supply
D	= Non-Federal Canal Diversions for Irrigation
Ev	= Evaporation from Federal Reservoirs
EvNFR	= Evaporation from Non-Federal Reservoirs
FF	= Flood Flow
GW	= Groundwater Computed Beneficial Consumptive Use (includes irrigation and non-irrigation uses)
IWS	= Imported Water Supply Credit from Nebraska
M&I	= Non-Irrigation Surface Water Diversions (Municipal and Industrial)
P	= Small Individual Surface Water Pump Diversions for Irrigation
RF	= Return Flow
VWS	= Virgin Water Supply
c	= Colorado
k	= Kansas
n	= Nebraska
$\Delta S$	= Change in Federal Reservoir Storage
%	= Average system efficiency for individual pumps in the Sub-basin
% BRF	= Percent of Diversion from Bureau Canals that returns to the stream
###	= Value expected to be zero

### 3. North Fork of Republican River in Colorado <sup>2</sup>

$$\text{CBCU Colorado} = 0.6 \times \text{Haigler Canal Diversion Colorado} + 0.6 \times D_c + \% \times P_c + 0.5 \times M\&I_c + EvNFR_c + GW_c$$

$$\text{CBCU Kansas} = GW_k$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Haigler Canal Diversion Nebraska} + GW_n$$

Note: The diversion for Haigler Canal is split between Colorado and Nebraska based on the percentage of land irrigated in each state

$$\text{VWS} = \text{North Fork of the Republican River at the State Line, Stn. No. 06823000} + \text{CBCU}_c + \text{CBCU}_k + \text{CBCU}_n + \text{Nebraska Haigler Canal RF} - \text{IWS}$$

Note: The Nebraska Haigler Canal RF returns to the Main Stem

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Colorado} = 0.224 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.246 \times \text{CWS}$$

$$\text{Unallocated} = 0.53 \times \text{CWS}$$

### 4. Arikaree River <sup>2</sup>

$$\text{CBCU Colorado} = 0.6 \times D_c + \% \times P_c + 0.5 \times M\&I_c + EvNFR_c + GW_c$$

$$\text{CBCU Kansas} = 0.6 \times D_k + \% \times P_k + 0.5 \times M\&I_k + EvNFR_k + GW_k$$

$$\text{CBCU Nebraska} = 0.6 \times D_n + \% \times P_n + 0.5 \times M\&I_n + EvNFR_n + GW_n$$

$$\text{VWS} = \text{Arikaree Gage at Haigler Stn. No. 06821500} + \text{CBCU}_c + \text{CBCU}_k + \text{CBCU}_n - \text{IWS}$$

<sup>2</sup> The RRCA will investigate whether return flows from the Haigler Canal diversion in Colorado may return to the Arikaree River, not the North Fork of the Republican River, as indicated in the formulas. If there are return flows from the Haigler Canal to the Arikaree River, these formulas will be changed to recognize those returns.

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Colorado} = 0.785 \times \text{CWS}$$

$$\text{Allocation Kansas} = 0.051 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.168 \times \text{CWS}$$

$$\text{Unallocated} = -0.004 \times \text{CWS}$$

### 5. Buffalo Creek

$$\text{CBCU Colorado} = 0.6 \times \text{Dc} + \% \times \text{Pc} + 0.5 \times \text{M\&In} + \text{EvNFRc} + \text{GWc}$$

$$\text{CBCU Kansas} = \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + \text{GWn}$$

$$\text{VWS} = \text{Buffalo Creek near Haigler Gage Stn. No. 06823500} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} - \text{IWS}$$

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Nebraska} = 0.330 \times \text{CWS}$$

$$\text{Unallocated} = 0.670 \times \text{CWS}$$

### 6. Rock Creek

$$\text{CBCU Colorado} = \text{GWc}$$

$$\text{CBCU Kansas} = \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + \text{GWn}$$

$$\text{VWS} = \text{Rock Creek at Parks Gage Stn. No. 06824000} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} - \text{IWS}$$

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Nebraska} = 0.400 \times \text{CWS}$$

$$\text{Unallocated} = 0.600 \times \text{CWS}$$

## 7. South Fork Republican River

$$\text{CBCU Colorado} = 0.6 \times \text{Hale Ditch Diversion} + 0.6 \times \text{Dc} + \% \times \text{Pc} + 0.5 \times \text{M\&Ic} + \text{EvNFRc} + \text{Bonny Reservoir Ev} + \text{GWc}$$

$$\text{CBCU Kansas} = 0.6 \times \text{Dk} + \% \times \text{Pk} + 0.5 \times \text{M\&Ik} + \text{EvNFRk} + \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + \text{GWn}$$

$$\text{VWS} = \text{South Fork Republican River near Benkelman Gage Stn. No. 06827500} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} + \Delta \text{S Bonny Reservoir} - \text{IWS}$$

$$\text{CWS} = \text{VWS} - \Delta \text{S Bonny Reservoir} - \text{FF}$$

$$\text{Allocation Colorado} = 0.444 \times \text{CWS}$$

$$\text{Allocation Kansas} = 0.402 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.014 \times \text{CWS}$$

$$\text{Unallocated} = 0.140 \times \text{CWS}$$

## 8. Frenchman Creek in Nebraska

$$\text{CBCU Colorado} = \text{GWc}$$

$$\text{CBCU Kansas} = \text{GWk}$$

$$\begin{aligned} \text{CBCU Nebraska} = & \text{Culbertson Canal Diversions (IRR Season)} \times (1 - \% \text{BRF}) + \\ & \text{Culbertson Canal Diversions (Non-IRR Season)} \times (1 - \\ & 92.2857\%) + \text{Culbertson Extension (IRR Season)} \times (1 - \\ & \% \text{BRF}) + \text{Culbertson Extension (Non-IRR Season)} \times (1 - \\ & 92.2857\%) + 0.6 \times \text{Champion Canal Diversion} + 0.6 \times \\ & \text{Riverside Canal Diversion} + 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \\ & \text{M\&In} + \text{EvNFRn} + \text{Enders Reservoir Ev} + \text{GWn} \end{aligned}$$

$$\text{VWS} = \text{Frenchman Creek in Culbertson, Nebraska Gage Stn. No. 06835500} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} + 0.17 \times$$

Culbertson Diversion RF + Culbertson Extension RF + 0.78  
x Riverside Diversion RF + ΔS Enders Reservoir – IWS

Note: 17% of the Culbertson Diversion RF and 100% of the  
Culbertson Extension RF return to the Main Stem

CWS = VWS - ΔS Enders Reservoir – FF

Allocation Nebraska = 0.536 x CWS

Unallocated = 0.464 x CWS

### 9. Driftwood Creek

CBCU Colorado = GWc

CBCU Kansas = 0.6 x Dk + % x Pk + 0.5 x M&Ik + EvNFRk + GWk

CBCU Nebraska = 0.6 x Dn + % x Pn + 0.5 x M&In + EvNFRn + GWn

VWS = Driftwood Creek near McCook Gage Stn. No. 06836500 +  
CBCUc + CBCUk + CBCUn – 0.24 x Meeker Driftwood  
Canal RF - IWS

Note: 24 % of the Meeker Driftwood Canal RF returns to  
Driftwood Creek

CWS = VWS – FF

Allocation Kansas = 0.069 x CWS

Allocation Nebraska = 0.164 x CWS

Unallocated = 0.767 x CWS

### 10. Red Willow Creek in Nebraska

CBCU Colorado = GWc

CBCU Kansas = GWk

CBCU Nebraska = 0.1 x Red Willow Canal CBCU + 0.6 x Dn + % x Pn + 0.5

$$x \text{ M\&In} + \text{EvNFRn} + 0.1 \times \text{Hugh Butler Lake Ev} + \text{GWn}$$

Note:

Red Willow Canal CBCU = Red Willow Canal Diversion (IRR Season) x (1- % BRF) + Red Willow Canal Diversion (Non-IRR Season) x (1-92.2857%)

90% of the Red Willow Canal CBCU and 90% of Hugh Butler Lake Ev charged to Nebraska's CBCU in the Main Stem

$$\text{VWS} = \text{Red Willow Creek near Red Willow Gage Stn. No. 06838000} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} + 0.9 \times \text{Red Willow Canal CBCU} + 0.9 \times \text{Hugh Butler Lake Ev} + 0.9 \times \text{Red Willow Canal RF} + \Delta S \text{ Hugh Butler Lake} - \text{IWS}$$

Note: 90% of the Red Willow Canal RF returns to the Main Stem

$$\text{CWS} = \text{VWS} - \Delta S \text{ Hugh Butler Lake} - \text{FF}$$

$$\text{Allocation Nebraska} = 0.192 \times \text{CWS}$$

$$\text{Unallocated} = 0.808 \times \text{CWS}$$

### 11. Medicine Creek

$$\text{CBCU Colorado} = \text{GWc}$$

$$\text{CBCU Kansas} = \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn above and below gage} + \% \times \text{Pn above and below gage} + 0.5 \times \text{M\&In above and below gage} + \text{EvNFRn above and below gage} + \text{GWn}$$

Note: Harry Strunk Lake Ev charged to Nebraska's CBCU in the Main Stem.

CU from Harry Strunk releases in the Cambridge Canal is charged to the Main stem (no adjustment to the VWS formula is needed as this water shows up in the Medicine Creek gage).

$$\text{VWS} = \text{Medicine Creek below Harry Strunk Lake Gage Stn. No. 06842500} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} - 0.6 \times \text{Dn below gage} - \% \times \text{Pn below gage} - 0.5 * \text{M\&In below gage} - \text{EvNFRn below gage} + \text{Harry Strunk Lake Ev} + \Delta \text{S Harry Strunk Lake} - \text{IWS}$$

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

$$\text{CWS} = \text{VWS} - \Delta \text{S Harry Strunk Lake} - \text{FF}$$

$$\text{Allocation Nebraska} = 0.091 \times \text{CWS}$$

$$\text{Unallocated} = 0.909 \times \text{CWS}$$

## 12. Beaver Creek

$$\text{CBCU Colorado} = 0.6 \times \text{Dc} + \% \times \text{Pc} + 0.5 \times \text{M\&Ic} + \text{EvNFRc} + \text{Gwc}$$

$$\text{CBCU Kansas} = 0.6 \times \text{Dk} + \% \times \text{Pk} + 0.5 \times \text{M\&Ik} + \text{EvNFRk} + \text{Gwk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn above and below gage} + \% \times \text{Pn above and below gage} + 0.5 \times \text{M\&In above and below gage} + \text{EvNFRn above and below gage} + \text{Gwn}$$

$$\text{VWS} = \text{Beaver Creek near Beaver City gage Stn. No. 06847000} + \text{BCUc} + \text{CBCUk} + \text{CBCUn} - 0.6 \times \text{Dn below gage} - \% \times \text{Pn below gage} - 0.5 * \text{M\&In below gage} - \text{EvNFRn below gage} - \text{IWS}$$

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Colorado} = 0.200 \times \text{CWS}$$

$$\text{Allocation Kansas} = 0.388 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.406 \times \text{CWS}$$

$$\text{Unallocated} = 0.006 \times \text{CWS}$$

### 13. Sappa Creek

$$\text{CBCU Colorado} = \text{GWc}$$

$$\text{CBCU Kansas} = 0.6 \times \text{Dk} + \% \times \text{Pk} + 0.5 \times \text{M\&Ik} + \text{EvNFRk} + \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn above and below gage} + \% \times \text{Pn above and below gage} + 0.5 \times \text{M\&In above and below gage} + \text{EvNFRn above and below gage} + \text{GWn}$$

$$\begin{aligned} \text{VWS} &= \text{Sappa Creek near Stamford gage Stn. No. 06847500} - \\ &\text{Beaver Creek near Beaver City gage Stn. No. 06847000} + \\ &\text{CBCUc} + \text{CBCUk} + \text{CBCUn} - 0.6 \times \text{Dn below gage} - \% \times \\ &\text{Pn below gage} - 0.5 \times \text{M\&In below gage} - \text{EvNFRn below gage} - \text{IWS} \end{aligned}$$

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Kansas} = 0.411 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.411 \times \text{CWS}$$

$$\text{Unallocated} = 0.178 \times \text{CWS}$$

### 14. Prairie Dog Creek

$$\text{CBCU Colorado} = \text{GWc}$$

$$\begin{aligned} \text{CBCU Kansas} &= \text{Almena Canal Diversion (IRR Season)} \times (1 - \% \text{BRF}) + \\ &\text{Almena Canal Diversion (Non-IRR Season)} \times (1 - 92.2857\%) \\ &+ 0.6 \times \text{Dk} + \% \times \text{Pk} + 0.5 \times \text{M\&Ik} + \text{EvNFRk} + \text{Keith} \\ &\text{Sebelius Lake Ev} + \text{GWk} \end{aligned}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn below gage} + \% \times \text{Pn below gage} + 0.5 \times \text{M\&In below gage} + \text{EvNFRn} + \text{GWn below gage}$$

VWS = Prairie Dog Creek near Woodruff, Kansas USGS Stn. No. 06848500 + CBCUc + CBCUk + CBCUn - 0.6 x Dn below gage - % x Pn below gage - 0.5 x M&In below gage –

EvNFRn below gage + ΔS Keith Sebelius Lake – IWS

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

CWS = VWS- ΔS Keith Sebelius Lake - FF

Allocation Kansas = 0.457 x CWS

Allocation Nebraska = 0.076 x CWS

Unallocated = 0.467 x CWS

### 15. The North Fork of the Republican River in Nebraska and the Main Stem of the Republican River between the junction of the North Fork and the Arikaree River and the Republican River near Hardy

CBCU Colorado = GWc

CBCU Kansas =  
 (Deliveries from the Courtland Canal to Kansas above Lovewell) (IRR Season) x (1-%BRF) + (Deliveries from the Courtland Canal to Kansas above Lovewell) (Non-IRR Season) x (1-92.2857%)  
 + Amount of transportation loss of Courtland Canal deliveries to Lovewell that does not return to the river, charged to Kansas  
 + (Diversion of Republican River water from Lovewell Reservoir by the Courtland Canal below Lovewell) x (1-%BRF)  
 + 0.6 x Dk  
 + % x Pk  
 + 0.5 x M&Ik  
 + EvNFRk  
 + Harlan County Lake Ev charged to Kansas  
 + Lovewell Reservoir Ev charged to the Republican River  
 + GWk

CBCU Nebraska

=  
 Deliveries from Courtland Canal to Nebraska lands (IRR Season) x (1-%BRF) + Deliveries from Courtland Canal to Nebraska lands (Non-IRR Season) x (1- 92.2857%)  
 + Superior Canal (IRR Season) x (1- %BRF) + Superior Canal (Non-IRR Season) x (1-92,2857%)  
 + Franklin Pump Canal (IRR Season) x (1- %BRF) + Franklin Pump Canal (Non-IRR Season) x (1-92,2857%)  
 + Franklin Canal (IRR Season) x (1- %BRF) + Franklin Canal (Non-IRR Season) x (1-92,2857%)  
 + Naponee Canal (IRR Season) x (1- %BRF) + Naponee Canal (Non-IRR Season) x (1-92,2857%)  
 + Cambridge Canal (IRR Season) x (1- %BRF) + Cambridge Canal (Non-IRR Season) x (1-92,2857%)  
 + Bartley Canal (IRR Season) x (1- %BRF) + Bartley Canal (Non-IRR Season) x (1-92,2857%)  
 + Meeker-Driftwood Canal (IRR Season) x (1- %BRF) + Meeker-Driftwood Canal (Non-IRR Season) x (1-92,2857%)  
 + 0.9 x Red Willow Canal CBCU  
 + 0.6 x Dn  
 + % x Pn  
 + 0.5 x M&In  
 + EvNFRn  
 + 0.9 x Hugh Butler Lake Ev  
 + Harry Strunk Lake Ev  
 + Swanson Lake Ev  
 + Harlan County Lake Ev charged to Nebraska  
 + GWn

Notes:

The allocation of transportation losses in the Courtland Canal above Lovewell between Kansas and Nebraska shall be done by the Bureau of Reclamation and reported in their “Courtland Canal Above Lovewell” spreadsheet. Deliveries and losses associated with deliveries to both Nebraska and Kansas above Lovewell shall be reflected in the Bureau’s Monthly Water District reports. Losses associated with delivering water to Lovewell shall be separately computed.

Amount of transportation loss of the Courtland Canal

deliveries to Lovewell that does not return to the river, charged to Kansas shall be 18% of the Bureau’s estimate of

losses associated with these deliveries.

Red Willow Canal CBCU = Red Willow Canal Diversion  
(IRR Season) x (1- % BRF) + Red Willow Canal Diversion  
(Non-IRR Season) x (1-92,2857%)

10% of the Red Willow Canal CBCU is charged to  
 Nebraska's CBCU in Red Willow Creek sub-basin

10% of Hugh Butler Lake Ev is charged to Nebraska's  
 CBCU in the Red Willow Creek sub-basin

None of the Harry Strunk Lake EV is charged to Nebraska's  
 CBCU in the Medicine Creek sub-basin

VWS

=  
 Republican River near Hardy Gage Stn. No. 06853500  
 - North Fork of the Republican River at the State Line, Stn.  
 No. 06823000  
 - Arikaree Gage at Haigler Stn. No. 06821500  
 - Buffalo Creek near Haigler Gage Stn. No. 06823500  
 - Rock Creek at Parks Gage Stn. No. 06824000  
 -South Fork Republican River near Benkelman Gage Stn.  
 No. 06827500  
 - Frenchman Creek in Culbertson Stn. No. 06835500  
 - Driftwood Creek near McCook Gage Stn. No. 06836500  
 - Red Willow Creek near Red Willow Gage Stn. No.  
 06838000  
 - Medicine Creek below Harry Strunk Lake Gage Stn. No.  
 06842500  
 - Sappa Creek near Stamford Gage Stn. No. 06847500  
 - Prairie Dog Creek near Woodruff, Kansas Stn. No. 68-  
 485000  
 + CBCUc  
 + CBCUn  
 + 0.6 x Dk  
 + % x Pk  
 + 0.5 x M&Ik  
 + EvNFRk  
 + Harlan County Lake Ev charged to Kansas  
 +Amount of transportation loss of the Courtland Canal above  
 the Stateline that does not return to the river, charged to  
 Kansas  
 +GWk

- 0.9 x Red Willow Canal CBCU
  - 0.9 x Hugh Butler Ev
  - Harry Strunk Ev
  
- + 0.6 x Dn below Medicine Creek gage
- + % x Pn below Medicine Creek gage
- + 0.5 \* M&In below Medicine Creek gage
- + EvNFRn below Medicine Creek gage
- + 0.6 x Dn below Beaver Creek gage
- + % x Pn below Beaver Creek gage
- + 0.5 \* M&In below Beaver Creek gage
- + EvNFRn below Beaver Creek gage
  
- + 0.6 x Dn below Sappa Creek gage
- + % x Pn below Sappa Creek gage
- + 0.5 \* M&In below Sappa Creek gage
- + EvNFRn below Sappa Creek gage
  
- + 0.6 x Dn below Prairie Dog Creek gage
- + % x Pn below Prairie Dog Creek gage
- + 0.5 \* M&In below Prairie Dog Creek gage
- + EvNFRn below Prairie Dog Creek gage
  
- + Change in Storage Harlan County Lake
- + Change in Storage Swanson Lake
  
- Nebraska Haigler Canal RF
- 0.78 x Riverside Canal RF
- 0.17 x Culbertson Canal RF
- Culbertson Canal Extension RF to Main Stem
- + 0.24 x Meeker Driftwood Canal RF which returns to Driftwood Creek
- 0.9 x Red Willow Canal RF
  
- + Courtland Canal at Kansas-Nebraska State Line Gage Stn No. 06852500
- Courtland Canal RF in Kansas above Lovewell Reservoir
  
- IWS

Notes:  
 None of the Nebraska Haigler Canal RF returns to the North Fork of the Republican River

83% of the Culbertson Diversion RF and none of the Culbertson Extension RF return to Frenchman Creek

24 % of the Meeker Driftwood Canal RF returns to Driftwood Creek.

10% of the Red Willow Canal RF returns to Red Willow Creek

Courtland Canal RF in Kansas above Lovewell Reservoir =  $0.015 \times$  (Courtland Canal at Kansas-Nebraska State Line Gage Stn No. 06852500)

CWS = VWS - Change in Storage Harlan County Lake - Change in Storage Swanson Lake - FF

Allocation Kansas =  $0.511 \times$  CWS

Allocation Nebraska =  $0.489 \times$  CWS

## **V. Annual Data/ Information Requirements, Reporting, and Verification**

The following information for the previous calendar year shall be provided to the members of the RRCA Engineering Committee by April 15<sup>th</sup> of each year, unless otherwise specified.

All information shall be provided in electronic format, if available.

Each State agrees to provide all information from their respective State that is needed for the RRCA Groundwater Model and RRCA Accounting Procedures and Reporting Requirements, including but not limited to the following:

### **A. Annual Reporting**

#### **1. Surface water diversions and irrigated acreage:**

Each State will tabulate the canal, ditch, and other surface water diversions that are required by RRCA annual compact accounting and the RRCA Groundwater Model on a monthly format (or a procedure to distribute annual data to a monthly basis) and will forward the surface water diversions to the other States. This will include available diversion, wasteway, and farm delivery data for canals diverting from the Platte River that contribute to Imported Water Supply into the Basin. Each State will provide the water right number, type of use, system type, location, diversion

amount, and acres irrigated.

**2. Groundwater pumping and irrigated acreage:**

Each State will tabulate and provide all groundwater well pumping estimates that are required for the RRCA Groundwater Model to the other States.

**Colorado** – will provide an estimate of pumping based on a county format that is based upon system type, Crop Irrigation Requirement (CIR), irrigated acreage, crop distribution, and irrigation efficiencies. Colorado will require installation of a totalizing flow meter, installation of an hours meter with a measurement of the pumping rate, or determination of a power conversion coefficient for 10% of the active wells in the Basin by December 31, 2005. Colorado will also provide an annual tabulation for each groundwater well that measures groundwater pumping by a totalizing flow meter, hours meter or power conversion coefficient that includes: the groundwater well permit number, location, reported hours, use, and irrigated acreage.

**Kansas** - will provide an annual tabulation by each groundwater well that includes: water right number, groundwater pumping determined by a meter on each well (or group of wells in a manifold system) or by reported hours of use and rate; location; system type (gravity, sprinkler, LEPA, drip, etc.); and irrigated acreage. Crop distribution will be provided on a county basis.

**Nebraska** – will provide an annual tabulation through the representative Natural Resource District (NRD) in Nebraska that includes: the well registration number or other ID number; groundwater pumping determined by a meter on each well (or group of wells in a manifold system) or by reported hours of use and rate; wells will be identified by; location; system type (gravity, sprinkler, LEPA, drip, etc.); and irrigated acreage. Crop distribution will be provided on a county basis.

**3. Climate information:**

Each State will tabulate and provide precipitation, temperature, relative humidity or dew point, and solar radiation for the following climate stations:

State	Identification	Name
Colorado		
Colorado	C050109	Akron 4 E
Colorado	C051121	Burlington
Colorado	C054413	Julesburg
Colorado	C059243	Wray
Kansas	C140439	Atwood 2 SW
Kansas	C141699	Colby 1SW
Kansas	C143153	Goodland
Kansas	C143837	Hoxie

Kansas	C145856	Norton 9 SSE
Kansas	C145906	Oberlin1 E
Kansas	C147093	Saint Francis
Kansas	C148495	Wakeeny
Nebraska	C250640	Beaver City
Nebraska	C250810	Bertrand
Nebraska	C252065	Culbertson
Nebraska	C252690	Elwood 8 S
Nebraska	C253365	Gothenburg
Nebraska	C253735	Hebron
Nebraska	C253910	Holdredge
Nebraska	C254110	Imperial
Nebraska	C255090	Madrid
Nebraska	C255310	McCook
Nebraska	C255565	Minden
Nebraska	C256480	Palisade
Nebraska	C256585	Paxton
Nebraska	C257070	Red Cloud
Nebraska	C258255	Stratton
Nebraska	C258320	Superior
Nebraska	C258735	Upland
Nebraska	C259020	Wauneta 3 NW

**4. Crop Irrigation Requirements:**

Each State will tabulate and provide estimates of crop irrigation requirement information on a county format. Each State will provide the percentage of the crop irrigation requirement met by pumping; the percentage of groundwater irrigated lands served by sprinkler or flood irrigation systems, the crop irrigation requirement; crop distribution; crop coefficients; gain in soil moisture from winter and spring precipitation, net crop irrigation requirement; and/or other information necessary to compute a soil/water balance.

**5. Streamflow Records from State-Maintained Gaging Records:**

Streamflow gaging records from the following State maintained gages will be provided:

Station No	Name
00126700	Republican River near Trenton
06831500	Frenchman Creek near Imperial
06832500	Frenchman Creek near Enders

06835000	Stinking Water Creek near Palisade
06837300	Red Willow Creek above Hugh Butler Lake
06837500	Red Willow Creek near McCook
06841000	Medicine Creek above Harry Strunk Lake
06842500	Medicine Creek below Harry Strunk Lake
06844000	Muddy Creek at Arapahoe
06844210	Turkey Creek at Edison
06847000	Beaver Creek near Beaver City
	Republican River at Riverton
06851500	Thompson Creek at Riverton
06852000	Elm Creek at Amboy
	Republican River at the Superior-Courtland Diversion Dam

#### **6. Platte River Reservoirs:**

The State of Nebraska will provide the end-of-month contents, inflow data, outflow data, area-capacity data, and monthly net evaporation, if available, from Johnson Lake; Elwood Reservoir; Sutherland Reservoir; Maloney Reservoir; and Jeffrey Lake.

#### **7. Water Administration Notification:**

The State of Nebraska will provide the following information that describes the protection of reservoir releases from Harlan County Lake and for the administration of water rights junior in priority to February 26, 1948:

Date of notification to Nebraska water right owners to curtail their diversions, the amount of curtailment, and length of time for curtailment.

The number of notices sent.

The number of diversions curtailed and amount of curtailment in the Harlan County Lake to Guide Rock reach of the Republican River.

#### **8. Moratorium:**

Each State will provide a description of all new Wells constructed in the Basin Upstream of Guide Rock including the owner, location (legal description), depth and diameter or dimension of the constructed water well, casing and screen information, static water level, yield of the water well in gallons per minute or gallons per hour, and intended use of the water well.

Designation whether the Well is a:

- a. Test hole;
- b. Dewatering Well with an intended use of one year or less;
- c. Well designed and constructed to pump fifty gallons per minute or less;
- d. Replacement Water Well, including a description of the Well that is replaced providing the information described above for new Wells and a description of the historic use of the Well that is replaced;
- e. Well necessary to alleviate an emergency situation involving provision of water for human consumption, including a brief description of the nature of the emergency situation and the amount of water intended to be pumped by and the length of time of operation of the new Well;
- f. Transfer Well, including a description of the Well that is transferred providing the information described above for new Wells and a description of the Historic Consumptive Use of the Well that is transferred;
- g. Well for municipal and/or industrial expansion of use;

Wells in the Basin in Northwest Kansas or Colorado. Kansas and Colorado will provide the information described above for new Wells along with copies of any other information that is required to be filed with either State of local agencies under the laws, statutes, rules and regulations in existence as of April 30, 2002, and;

Any changes in State law in the previous year relating to existing Moratorium.

#### **9. Non-Federal Reservoirs:**

Each State will conduct an inventory of Non Federal Reservoirs by December 31, 2004, for inclusion in the annual Compact Accounting. The inventory shall include the following information: the location, capacity (in Acre-feet) and area (in acres) at the principal spillway elevation of each Non-Federal Reservoir. The States will annually provide any updates to the initial inventory of Non-Federal Reservoirs, including enlargements that are constructed in the previous year.

Owners/operators of Non-Federal Reservoirs with 200 Acre-feet of storage capacity or greater at the principal spillway elevation will be required to provide an area-capacity survey from State-approved plans or prepared by a licensed professional engineer or land surveyor.

## B. RRCA Groundwater Model Data Input Files

1. Monthly groundwater pumping, surface water recharge, groundwater recharge, and precipitation recharge provided by county and indexed to the one square mile cell size.
2. Potential Evapotranspiration rate is set as a uniform rate for all phreatophyte vegetative classes – the amount is X at Y climate stations and is interpolated spatially using kriging.

## C. Inputs to RRCA Accounting

### 1. Surface Water Information

- a. Streamflow gaging station records: obtained as preliminary USGS or Nebraska streamflow records, with adjustments to reflect a calendar year, at the following locations:

Arikaree River at Haigler, Nebraska  
 North Fork Republican River at Colorado-Nebraska state line  
 Buffalo Creek near Haigler, Nebraska  
 Rock Creek at Parks, Nebraska  
 South Fork Republican River near Benkelman, Nebraska  
 Frenchman Creek at Culbertson, Nebraska  
 Red Willow Creek near Red Willow, Nebraska  
 Medicine Creek below Harry Strunk Lake, Nebraska\*  
 Beaver Creek near Beaver City, Nebraska\*  
 Sappa Creek near Stamford, Nebraska  
 Prairie Dog Creek near Woodruff, Kansas  
 Courtland Canal at Nebraska-Kansas state line  
 Republican River near Hardy, Nebraska  
 Republican River at Superior-Courtland Diversion Dam near Guide Rock,  
 Nebraska (new)\*

- b. Federal reservoir information: obtained from the United States Bureau of Reclamation:

Daily free water surface evaporation, storage, precipitation, reservoir release information, and updated area-capacity tables.  
 Federal Reservoirs:  
 Bonny Reservoir

Swanson Lake  
Harry Strunk Lake  
Hugh Butler Lake  
Enders Reservoir  
Keith Sebelius Lake  
Harlan County Lake  
Lovewell Reservoir

- c. Non-federal reservoirs obtained by each state: an updated inventory of reservoirs that includes the location, surface area (acres), and capacity (in Acre-feet), of each non-federal reservoir with storage capacity of fifteen (15) Acre-feet or greater at the principal spillway elevation. Supporting data to substantiate the average surface water areas that are different than the presumptive average annual surface area may be tendered by the offering State.

- d. Diversions and related data from USBR

Irrigation diversions by canal, ditch, and pumping station that irrigate more than two (2) acres  
Diversions for non-irrigation uses greater than 50 Acre-feet  
Farm Deliveries  
Wasteway measurements  
Irrigated acres

- e. Diversions and related data – from each respective State

Irrigation diversions by canal, ditch, and pumping station that irrigate more than two (2) acres  
Diversions for non-irrigation uses greater than 50 Acre-feet  
Wasteway measurements, if available

## 2. Groundwater Information

(From the RRCA Groundwater model as output files as needed for the accounting procedures)

- a. Imported water - mound credits in amount and time that occur in defined streamflow points/reaches of measurement or compliance – ex: gaging stations near confluence or state lines

- b. Groundwater depletions to streamflow (above points of measurement or compliance – ex: gaging stations near confluence or state lines)

### **3. Summary**

The aforementioned data will be aggregated by Sub-basin as needed for RRCA accounting.

## **D. Verification**

### **1. Documentation to be Available for Inspection Upon Request**

- a. Well permits/ registrations database
- b. Copies of well permits/ registrations issued in calendar year
- c. Copies of surface water right permits or decrees
- d. Change in water right/ transfer historic use analyses
- e. Canal, ditch, or other surface water diversion records
- f. Canal, ditch, or other surface water measurements
- g. Reservoir storage and release records
- h. Irrigated acreage

### **2. Site Inspection**

- a. Accompanied – reasonable and mutually acceptable schedule among representative state and/or federal officials.
- b. Unaccompanied – inspection parties shall comply with all laws and regulations of the State in which the site inspection occurs.

Table 1: Annual Virgin and Computed Water Supply, Allocations and Computed Beneficial Consumptive Uses by State, Main Stem and Sub-basin

Designated Drainage Basin	Col. 1: Virgin Water Supply	Col. 2: Computed Water Supply	Col. 3: Allocations				Col. 4: Computed Beneficial Consumptive Use		
			Colorado	Nebraska	Kansas	Unallocated	Colorado	Nebraska	Kansas
North Fork in Colorado									
Arikaree									
Buffalo									
Rock									
South Fork of Republican River									
Frenchman									
Driftwood									
Red Willow									
Medicine									
Beaver									
Sappa									
Prairie Dog									
North Fork of Republican River in Nebraska and Main Stem									
Total All Basins									
North Fork Of Republican River in Nebraska and Mainstem Including Unallocated Water									
Total									

Table 2: Original Compact Virgin Water Supply and Allocations

Designated Drainage Basin	Virgin Water Supply	Colorado Allocation	% of Total Drainage Basin Supply	Kansas Allocation	% of Total Drainage Basin Supply	Nebraska Allocation	% of Total Drainage Basin Supply	Unallocated	% of Total Drainage Basin Supply
North Fork - CO	44,700	10,000	22.4			11,000	24.6	23,700	53.0
Arikaree River	19,610	15,400	78.5	1,000	5.1	3,300	16.8	-90	-0.4
Buffalo Creek	7,890					2,600	33.0	5,290	67.0
Rock Creek	11,000					4,400	40.0	6,600	60.0
South Fork	57,200	25,400	44.4	23,000	40.2	800	1.4	8,000	14.0
Frenchman Creek	98,500					52,800	53.6	45,700	46.4
Driftwood Creek	7,300			500	6.9	1,200	16.4	5,600	76.7
Red Willow Creek	21,900					4,200	19.2	17,700	80.8
Medicine Creek	50,800					4,600	9.1	46,200	90.9
Beaver Creek	16,500	3,300	20.0	6,400	38.8	6,700	40.6	100	0.6
Sappa Creek	21,400			8,800	41.1	8,800	41.1	3,800	17.8
Prairie Dog Creek	27,600			12,600	45.7	2,100	7.6	12,900	46.7
Sub-total Tributaries	384,400							175,500	
Main Stem + Blackwood Creek	94,500								
Main Stem + Unallocated	270,000			138,000	51.1	132,000	48.9		
Total	478,900	54,100		190,300		234,500			

Table 3A: Table to Be Used to Calculate Colorado's Five-Year Running Average Allocation and Computed Beneficial Consumptive Use for Determining Compact Compliance

Colorado				
	Col. 1	Col. 2	Col. 3	Col. 4
Year	Allocation	Computed Beneficial Consumptive	Imported Water Supply Credit	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Col 1 – (Col 2- Col 3)
Year t= -4				
Year t= -3				
Year t= -2				
Year t= -1				
Current Year t= 0				
Average				

Table 3B. Table to Be Used to Calculate Kansas's Five-Year Running Average Allocation and Computed Beneficial Consumptive Use for Determining Compact Compliance

Kansas				
	Col. 1	Col. 2	Col. 3	Col. 4
Year	Allocation	Computed Beneficial Consumptive	Imported Water Supply Credit	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Col 1 – (Col 2- Col 3)
Year t= -4				
Year t= -3				
Year t= -2				
Year t= -1				
Current Year t= 0				
Average				

Table 3C. Table to Be Used to Calculate Nebraska's Five-Year Running Average Allocation and Computed Beneficial Consumptive Use for Determining Compact Compliance

Nebraska				
	Col. 1	Col. 2	Col. 3	Col. 4
Year	Allocation	Computed Beneficial Consumptive	Imported Water Supply Credit	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Col 1 – (Col 2- Col 3)
Year T= -4				
Year T= -3				
Year T= -2				
Year T= -1				
Current Year T= 0				
Average				

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Table 4A: Colorado Compliance with the Sub-basin Non-impairment Requirement

	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
Sub-basin	Colorado Sub-basin Allocation (5-year running average)	Unallocated Supply (5-year running average)	Credits from Imported Water Supply (5-year running average)	Total Supply Available = Col 1+ Col 2 + Col 3 (5-year running average)	Colorado Computed Beneficial Consumptive Use (5-year running average)	Difference Between Available Supply and Computed Beneficial Consumptive Use = Col 4 – Col 5 (5-year running average)
North Fork Republican River Colorado						
Arikaree River						
South Fork Republican River						
Beaver Creek						

Table 4B: Kansas Compliance with the Sub-basin Non-impairment Requirement

	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7
Sub-basin	Kansas Sub-basin Allocation (5-year running average)	Unallocated Supply (5-year running average)	Unused Allocation from Colorado (5-year running average)	Credits from Imported Water Supply (5-year running average)	Total Supply Available = Col 1+ Col 2+ Col 3 + Col 4 (5-year running average)	Kansas Computed Beneficial Consumptive Use (5-year running average)	Difference Between Available Supply and Computed Beneficial Consumptive Use = Col 5 – Col 6 (5-year running average)
Arikaree River							
South Fork Republican River							
Driftwood Creek							
Beaver Creek							
Sappa Creek							
Prairie Dog Creek							

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

Colorado				
	Col. 1	Col. 2	Col. 3	Col 4
Year	Allocation minus Allocation for Beaver Creek	Computed Beneficial Consumptive minus Computed Beneficial Consumptive Use for Beaver Creek	Imported Water Supply Credit excluding Beaver Creek	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit for All Basins Except Beaver Creek Col 1 – (Col 2 – Col 3)
Year T= -4				
Year T= -3				
Year T= -2				
Year T= -1				
Current Year T= 0				
Average				

Table 5B: Kansas Compliance During Water-Short Year Administration

Kansas						
Year	Allocation			Computed Beneficial Consumptive Use`	Imported Water Supply Credit	Difference Between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit
Column	1	2	3	4	5	6
	Sum Sub-basins	Kansas's Share of the Unallocated Supply	Total Col 1 + Col 2			Col 3 – (Col 4 – Col 5)
Previous Year						
Current Year						
Average						

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Table 5C: Nebraska Compliance During Water-Short Year Administration

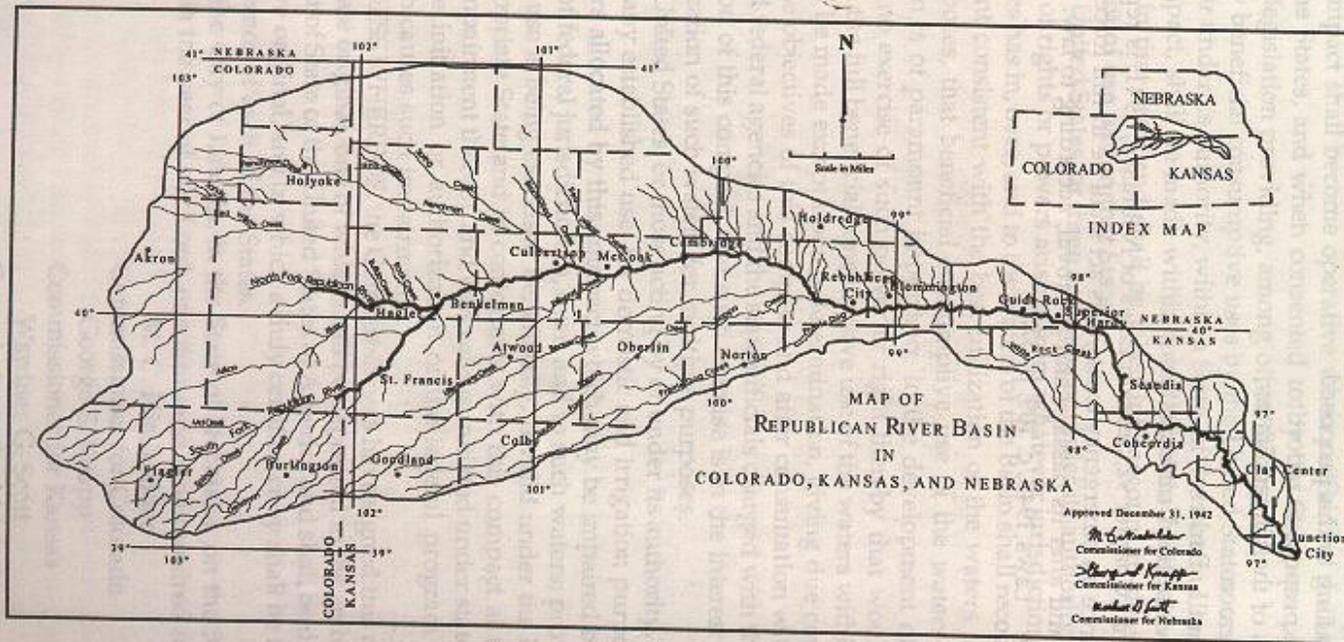
Nebraska								
Year	Allocation			Computed Beneficial Consumptive Use			Imported Water Supply Credit	Difference Between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Above Guide Rock
Column	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
	State Wide Allocation	Allocation below Guide Rock	State Wide Allocation above Guide Rock	State Wide CBCU	CBCU below Guide Rock	State Wide CBCU above Guide Rock	Credits above Guide Rock	Col 3 – (Col 6 – Col 7)
Previous Year								
Current Year								
Average								

Year	Allocation			Computed Beneficial Consumptive Use			Imported Water Supply Credit	Difference Between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Above Guide Rock
Column	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
	State Wide Allocation	Allocation below Guide Rock	State Wide Allocation above Guide Rock	State Wide CBCU	CBCU below Guide Rock	State Wide CBCU above Guide Rock	Credits above Guide Rock	Col 3 – (Col 6- Col 7)
Year = -2								
Year = -1								
Current Year								
Three-Year Average								
Sum of Previous Two-year Difference								
Expected Decrease in CBCU Under Plan								

Table 5E: Nebraska Tributary Compliance During Water-Short Year Administration

Year	Sum of Nebraska Sub-basin Allocations	Sum of Nebraska's Share of Sub-basin Unallocated Supplies	Total Available Water Supply for Nebraska	Computed Beneficial Consumptive Use	Imported Water Supply Credit	Difference between Allocation And the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
Previous Year						Col 3 -(Col 4-Col 5)
Current Year						
Average						

Figure 1



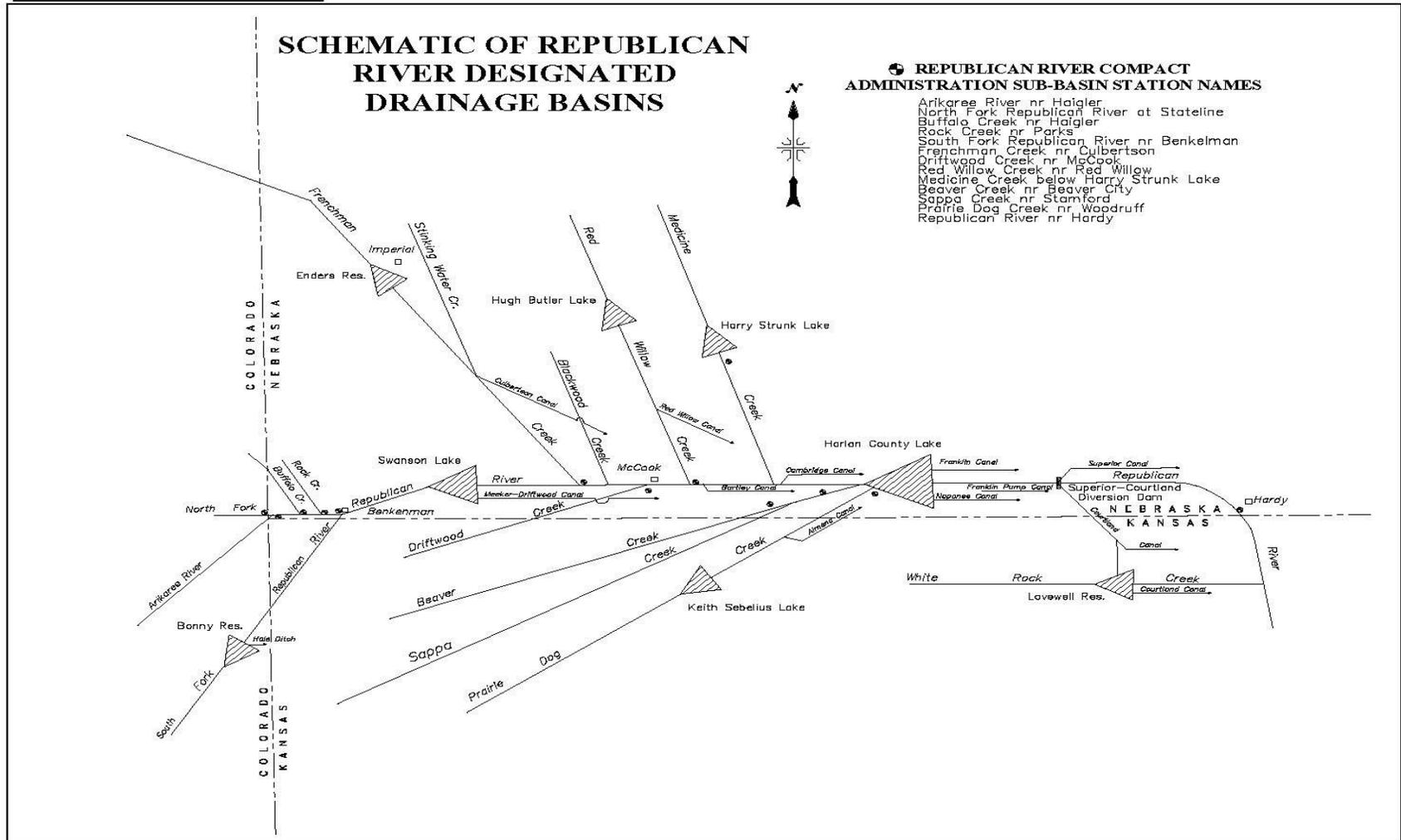
Basin Map Attached to Compact that Shows the Streams and the Basin Boundaries

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APPENDIX

Figure 2



Line Diagram of Designated Drainage Basins Showing Federal Reservoirs and Sub-basin Gaging Stations



## Attachment 1: Sub-basin Flood Flow Thresholds

Sub-basin	Sub-basin Flood Flow Threshold Acre-feet per Year <sup>3</sup>
Arikaree River	16,400
North Fork of Republican River	33,900
Buffalo Creek	4,800
Rock Creek	9,800
South Fork of Republican River	30,400
Frenchman Creek	51,900
Driftwood Creek	9,400
Red Willow Creek	15,100
Medicine Creek	55,100
Beaver Creek	13,900
Sappa Creek	26,900
Prairie Dog	15,700

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<sup>3</sup> Flows considered to be Flood Flows are flows in excess of the 94% flow based on a flood frequency analysis for the years 1971-2000. The Gaged Flows are measured after depletions by Beneficial Consumptive Use and change in reservoir storage.

## Attachment 2: Description of the Consensus Plan for Harlan County Lake

The Consensus Plan for operating Harlan County Lake was conceived after extended discussions and negotiations between Reclamation and the Corps. The agreement shaped at these meetings provides for sharing the decreasing water supply into Harlan County Lake. The agreement provides a consistent procedure for: updating the reservoir elevation/storage relationship, sharing the reduced inflow and summer evaporation, and providing a January forecast of irrigation water available for the following summer.

During the interagency discussions the two agencies found agreement in the following areas:

- The operating plan would be based on current sediment accumulation in the irrigation pool and other zones of the project.
- Evaporation from the lake affects all the various lake uses in proportion to the amount of water in storage for each use.
- During drought conditions, some water for irrigation could be withdrawn from the sediment pool.
- Water shortage would be shared between the different beneficial uses of the project, including fish, wildlife, recreation and irrigation.

To incorporate these areas of agreement into an operation plan for Harlan County Lake, a mutually acceptable procedure addressing each of these items was negotiated and accepted by both agencies.

### 1. Sediment Accumulation.

The most recent sedimentation survey for Harlan County project was conducted in 1988, 37 years after lake began operation. Surveys were also performed in 1962 and 1972; however, conclusions reached after the 1988 survey indicate that the previous calculations are unreliable. The 1988 survey indicates that, since closure of the dam in 1951, the accumulated sediment is distributed in each of the designated pools as follows:

Flood Pool	2,387 Acre-feet
Irrigation Pool	4,853 Acre-feet
Sedimentation Pool	33,527 Acre-feet

To insure that the irrigation pool retained 150,000 Acre-feet of storage, the bottom of the irrigation pool was lowered to 1,932.4 feet, msl, after the 1988 survey.

To estimate sediment accumulation in the lake since 1988, we assumed similar conditions have occurred at the project during the past 11 years. Assuming a consistent rate of deposition since 1988, the irrigation pool has trapped an additional 1,430 Acre-feet.

A similar calculation of the flood control pool indicates that the flood control pool has captured an additional 704 Acre-feet for a total of 3,090 Acre-feet since construction.

The lake elevations separating the different pools must be adjusted to maintain a 150,000-acre-foot irrigation pool and a 500,000-acre-foot flood control pool. Adjusting these elevations results in the following new elevations for the respective pools (using the 1988 capacity tables).

Top of Irrigation Pool	1,945.70 feet, msl
Top of Sediment Pool	1,931.75 feet, msl

Due to the variability of sediment deposition, we have determined that the elevation capacity relationship should be updated to reflect current conditions. We will complete a new sedimentation survey of Harlan County Lake this summer, and new area capacity tables should be available by early next year. The new tables may alter the pool elevations achieved in the Consensus Plan for Harlan County Lake.

## 2. Summer Evaporation.

Evaporation from a lake is affected by many factors including vapor pressure, wind, solar radiation, and salinity of the water. Total water loss from the lake through evaporation is also affected by the size of the lake. When the lake is lower, the surface area is smaller and less water loss occurs. Evaporation at Harlan County Lake has been estimated since the lake's construction using a Weather Service Class A pan which is 4 feet in diameter and 10 inches deep. We and Reclamation have jointly reviewed this information and assumed future conditions to determine an equitable method of distributing the evaporation loss from the project between irrigation and the other purposes.

During those years when the irrigation purpose expected a summer water yield of 119,000 Acre-feet or more, it was determined that an adequate water supply existed and no sharing of evaporation was necessary. Therefore, evaporation evaluation focused on the lower pool elevations when water was scarce. Times of water shortage would also generally be times of higher evaporation rates from the lake.

Reclamation and we agreed that evaporation from the lake during the summer (June through September) would be distributed between the irrigation and sediment pools based on their relative percentage of the total storage at the time of evaporation. If the sediment pool held 75 percent of the total storage, it would be charged 75 percent of the evaporation. If the sediment pool held 50 percent of the total storage, it would be charged 50 percent of the evaporation. At the bottom of the irrigation pool (1,931.75 feet, msl) all of the evaporation would be charged to the sediment pool.

Due to downstream water rights for summer inflow, neither the irrigation nor the sediment pool is credited with summer inflow to the lake. The summer inflows would be

assumed passed through the lake to satisfy the water right holders. Therefore, Reclamation and we did not distribute the summer inflow between the project purposes.

As a result of numerous lake operation model computer runs by Reclamation, it became apparent that total evaporation from the project during the summer averaged about 25,000 Acre-feet during times of lower lake elevations. These same models showed that about 20 percent of the evaporation should be charged to the irrigation pool, based on percentage in storage during the summer months. About 20 percent of the total lake storage is in the irrigation pool when the lake is at elevation 1,935.0 feet, msl. As a result of the joint study, Reclamation and we agreed that the irrigation pool would be credited with 20,000 Acre-feet of water during times of drought to share the summer evaporation loss.

Reclamation and we further agreed that the sediment pool would be assumed full each year. In essence, if the actual pool elevation were below 1,931.75 feet, msl, in January, the irrigation pool would contain a negative storage for the purpose of calculating available water for irrigation, regardless of the prior year's summer evaporation from sediment storage.

### 3. Irrigation withdrawal from sediment storage.

During drought conditions, occasional withdrawal of water from the sediment pool for irrigation is necessary. Such action is contemplated in the Field Working Agreement and the Harlan County Lake Regulation Manual: "Until such time as sediment fully occupies the allocated reserve capacity, it will be used for irrigation and various conservation purposes, including public health, recreation, and fish and wildlife preservation."

To implement this concept into an operation plan for Harlan County Lake, Reclamation and we agreed to estimate the net spring inflow to Harlan County Lake. The estimated inflow would be used by the Reclamation to provide a firm projection of water available for irrigation during the next season.

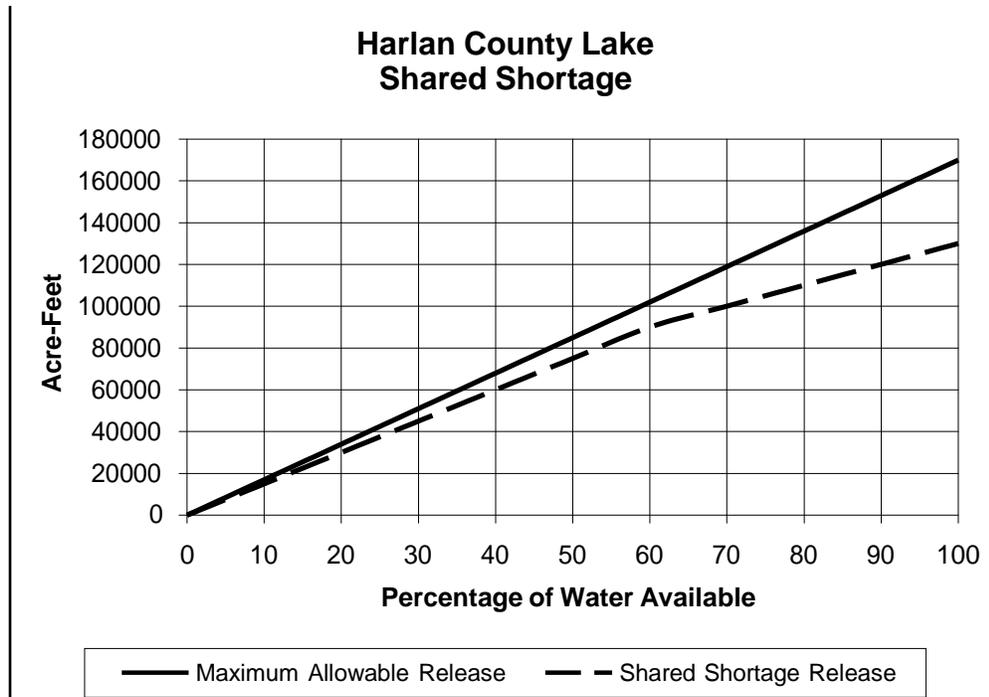
Since the construction of Harlan County Lake, inflows to the lake have been depleted by upstream irrigation wells and farming practices. Reclamation has recently completed an in-depth study of these depleted flows as a part of their contract renewal process. The study concluded that if the current conditions had existed in the basin since 1931, the average spring inflow to the project would have been 57,600 Acre-feet of water. The study further concluded that the evaporation would have been 8,800 Acre-feet of water during the same period. Reclamation and we agreed to use these values to calculate the net inflow to the project under the current conditions.

In addition, both agencies also recognized that the inflow to the project could continue to decrease with further upstream well development and water conservation farming. Due to these concerns, Reclamation and we determined that the previous 5-year inflow values would be averaged each year and compared to 57,600 Acre-feet. The inflow estimate for Harlan County Lake would be the smaller of these two values.

The estimated inflow amount would be used in January of each year to forecast the amount of water stored in the lake at the beginning of the irrigation season. Based on this forecast, the irrigation districts would be provided a firm estimate of the amount of water available for the next season. The actual storage in the lake on May 31 would be reviewed each year. When the actual water in storage is less than the January forecast, Reclamation may draw water from sediment storage to make up the difference.

4. Water Shortage Sharing.

A final component of the agreement involves a procedure for sharing the water available during times of shortage. Under the shared shortage procedure, the irrigation purpose of the project would remove less water than otherwise allowed and alleviate some of the adverse effects to the other purposes. The procedure would also extend the water supply during times of drought by “banking” some water for the next irrigation season. The following graph illustrates the shared shortage releases.



5. Calculation of Irrigation Water Available

Each January, the Reclamation would provide the Bostwick irrigation districts a firm estimate of the quantity of water available for the following season. The firm estimate of water available for irrigation would be calculated by using the following equation and shared shortage adjustment:

$$\text{Storage} + \text{Summer Sediment Pool Evaporation} + \text{Inflow} - \text{Spring Evaporation} = \text{Maximum Irrigation Water Available}$$

The variables in the equation are defined as:

- **Maximum Irrigation Water Available.** Maximum irrigation supply from Harlan County Lake for that irrigation season.
- **Storage.** Actual storage in the irrigation pool at the end of December. The sediment pool is assumed full. If the pool elevation is below the top of the sediment pool, a negative irrigation storage value would be used.
- **Inflow.** The inflow would be the smaller of the past 5-year average inflow to the project from January through May, or 57,600 Acre-feet.
- **Spring Evaporation.** Evaporation from the project would be 8,800 Acre-feet which is the average January through May evaporation.
- **Summer Sediment Pool Evaporation.** Summer evaporation from the sediment pool during June through September would be 20,000 Acre-feet. This is an estimate based on lower pool elevations, which characterize the times when it would be critical to the computations.

#### 6. Shared Shortage Adjustment

To ensure that an equitable distribution of the available water occurs during short-term drought conditions, and provide for a “banking” procedure to increase the water stored for subsequent years, a shared shortage plan would be implemented. The maximum water available for irrigation according to the above equation would be reduced according to the following table. Linear interpolation of values will occur between table values.

Shared Shortage Adjustment Table

Irrigation Water Available (Acre-feet)	Irrigation Water Released (Acre-feet)
0	0
17,000	15,000
34,000	30,000
51,000	45,000
68,000	60,000
85,000	75,000
102,000	90,000
119,000	100,000
136,000	110,000
153,000	120,000
170,000	130,000

## 7. Annual Shutoff Elevation for Harlan County Lake

The annual shutoff elevation for Harlan County Lake would be estimated each January and finally established each June.

The annual shutoff elevation for irrigation releases will be estimated by Reclamation each January in the following manner:

1. Estimate the May 31 Irrigation Water Storage (IWS) (Maximum 150,000 Acre-feet) by taking the December 31 irrigation pool storage plus the January-May inflow estimate (57,600 Acre-feet or the average inflow for the last 5-year period, whichever is less) minus the January-May evaporation estimate (8,800 Acre-feet).
2. Calculate the estimated Irrigation Water Available, including all summer evaporation, by adding the Estimated Irrigation Water Storage (from item 1) to the estimated sediment pool summer evaporation (20,000 AF).
3. Use the above Shared Shortage Adjustment Table to determine the acceptable Irrigation Water Release from the Irrigation Water Available.
4. Subtract the Irrigation Water Release (from item 3) from the Estimated IWS (from item 1). The elevation of the lake corresponding to the resulting irrigation storage is the Estimated Shutoff Elevation. The shutoff elevation will not be below the bottom of the irrigation pool if over 119,000 AF of water is supplied to the districts, nor below 1,927.0 feet, msl. If the shutoff elevation is below the irrigation pool, the maximum irrigation release is 119,000 AF.

The annual shutoff elevation for irrigation releases would be finalized each June in accordance with the following procedure:

1. Compare the estimated May 31 IWS with the actual May 31 IWS.
2. If the actual end of May IWS is less than the estimated May IWS, lower the shutoff elevation to account for the reduced storage.
3. If the actual end of May IWS is equal to or greater than the estimated end of May IWS, the estimated shutoff elevation is the annual shutoff elevation.
4. The shutoff elevation will never be below elevation 1,927.0 feet, msl, and will not be below the bottom of the irrigation pool if more than 119,000 Acre-feet of water is supplied to the districts.

## Attachment 3: Inflows to Harlan County Lake 1993 Level of Development

BASELINE RUN - 1993 LEVEL INFLOW TO HARLAN COUNTY RESERVOIR													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1931	10.2	10.8	13.4	5.0	18.8	15.8	4.3	1.8	1.8	0.0	0.1	0.1	82.1
1932	6.8	16.6	18.5	4.6	3.8	47.6	3.8	2.8	4.8	0.0	0.0	0.4	109.7
1933	0.4	0.0	3.9	30.2	31.0	5.4	1.8	0.0	10.4	0.0	2.6	5.5	91.2
1934	2.1	0.0	3.2	1.8	0.7	7.3	0.8	0.0	1.3	0.0	2.2	0.0	19.4
1935	0.3	0.1	0.7	4.2	0.8	389.3	6.1	19.1	26.1	2.4	5.2	0.9	455.2
1936	0.3	0.0	11.9	0.0	35.9	4.7	0.4	0.0	1.8	0.0	1.6	3.8	60.4
1937	4.8	12.9	6.0	2.5	0.0	12.6	6.3	6.9	2.4	0.0	0.0	12.4	66.8
1938	9.9	7.8	8.7	10.4	18.7	8.6	7.3	7.8	4.9	0.2	0.0	4.7	89.0
1939	2.7	7.5	9.6	12.2	6.6	13.3	5.0	4.1	0.0	0.0	0.0	0.0	61.0
1940	0.0	0.0	12.2	5.2	4.6	23.7	2.8	3.2	0.0	3.6	0.0	1.4	56.7
1941	0.0	10.6	10.6	7.7	17.2	67.1	28.9	19.7	14.9	8.3	6.7	7.1	198.8
1942	3.3	10.6	0.5	34.1	30.8	83.9	11.7	10.9	36.5	3.1	8.7	0.3	234.4
1943	1.2	11.2	14.6	31.4	4.7	28.3	4.8	0.3	0.9	0.0	0.0	11.8	109.2
1944	0.1	4.3	9.0	43.1	31.9	63.9	26.6	15.4	0.5	0.3	3.0	4.5	202.6
1945	4.3	7.8	5.7	9.5	4.1	53.5	5.0	0.9	1.5	5.0	6.0	6.3	109.6
1946	5.9	11.2	9.3	4.9	7.0	3.1	1.6	11.4	28.1	129.9	25.0	12.1	249.5
1947	1.1	3.2	10.4	8.2	11.9	195.4	22.3	5.9	2.9	0.2	0.3	0.3	262.1
1948	6.2	9.8	24.1	5.4	0.2	39.8	13.5	6.8	4.2	0.0	0.1	0.1	110.2
1949	2.0	1.5	25.2	16.3	49.0	57.4	9.2	5.5	2.1	3.0	2.8	0.3	174.3
1950	0.3	5.7	10.8	10.9	28.9	10.1	12.7	9.3	7.8	7.2	3.8	3.1	110.6
1951	3.8	3.4	7.1	5.3	42.0	39.9	42.1	10.1	36.0	15.5	14.8	8.9	228.9
1952	16.4	21.4	26.3	23.8	34.6	4.0	9.3	3.1	1.5	11.7	4.3	0.1	156.5
1953	1.8	4.6	5.3	3.3	15.1	9.5	1.8	0.2	0.0	0.0	2.8	0.1	44.5
1954	1.0	6.8	1.9	3.2	7.1	2.4	0.0	1.2	0.0	0.0	0.0	0.0	23.6
1955	0.0	4.0	6.3	4.8	2.9	6.4	2.7	0.0	1.4	0.0	0.0	0.0	28.5
1956	1.6	3.4	2.9	2.4	1.3	1.5	0.0	0.6	0.0	0.0	0.0	0.0	13.7
1957	0.0	4.1	6.2	12.8	3.5	62.4	21.3	1.2	2.0	3.4	4.5	4.7	126.1
1958	0.8	3.0	14.2	14.0	18.7	1.3	3.4	2.2	0.0	0.4	0.0	0.6	58.6
1959	1.9	15.4	16.4	8.5	13.6	4.2	1.4	1.2	0.0	4.3	1.0	4.5	72.4
1960	1.4	12.3	71.4	23.9	21.7	53.7	14.1	3.2	0.0	0.0	0.2	2.8	204.7
1961	2.3	6.4	7.7	7.4	26.5	24.0	7.2	4.9	0.0	2.3	4.8	1.7	95.2

## Attachment 3: Inflows to Harlan County Lake 1993 Level of Development

BASELINE RUN - 1993 LEVEL INFLOW TO HARLAN COUNTY RESERVOIR													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1962	4.5	9.1	16.2	9.9	14.4	42.6	41.6	21.1	2.3	8.7	8.3	5.7	184.4
1963	3.4	18.2	18.2	15.0	12.7	14.7	3.4	6.1	8.7	0.8	5.3	1.8	108.3
1964	5.4	7.6	8.3	8.4	9.9	11.9	7.2	6.5	2.4	1.9	1.4	2.3	73.2
1965	6.0	8.1	11.1	12.8	32.8	40.0	22.9	6.5	37.2	53.7	19.5	11.0	261.6
1966	8.9	21.4	15.7	11.4	12.0	34.7	12.4	2.5	3.5	5.4	6.8	5.7	140.4
1967	7.2	11.5	11.5	12.9	9.1	75.3	43.7	15.3	4.4	7.3	6.9	5.4	210.5
1968	3.9	10.2	8.5	11.6	10.8	12.5	3.1	2.7	1.6	2.0	4.3	3.4	74.6
1969	4.2	10.8	24.5	15.1	18.9	17.5	17.0	12.6	16.6	9.2	11.8	9.9	168.1
1970	3.5	8.7	8.5	10.5	11.1	7.7	4.6	3.2	0.5	3.3	4.7	4.5	70.8
1971	4.1	10.3	12.4	12.8	18.3	7.2	8.4	6.2	1.9	4.2	7.3	7.1	100.2
1972	5.5	8.1	9.2	8.3	14.8	8.5	6.5	4.4	0.1	2.9	7.6	4.1	80.0
1973	11.4	14.2	19.0	16.2	17.4	20.9	9.1	1.9	8.4	19.6	11.9	13.2	163.2
1974	13.2	13.4	12.0	14.3	15.4	17.2	5.5	0.0	0.0	0.0	4.9	5.5	101.4
1975	7.2	8.2	13.6	14.8	12.0	48.1	11.6	7.4	0.1	3.0	6.2	7.3	139.5
1976	7.0	10.2	10.1	16.0	12.1	3.5	2.2	1.8	0.9	1.0	3.2	3.1	71.1
1977	4.4	9.6	12.9	21.2	31.5	12.1	5.9	1.9	10.6	4.1	5.5	5.3	125.0
1978	5.0	6.5	20.6	12.9	11.8	3.8	0.0	1.0	0.0	0.0	0.3	1.6	63.5
1979	1.3	7.6	21.5	18.8	15.9	5.4	10.4	10.6	1.6	0.9	3.6	6.2	103.8
1980	5.7	9.3	11.6	15.2	10.4	2.1	2.5	0.0	0.0	0.0	2.5	2.2	61.5
1981	5.5	6.0	11.6	14.9	22.5	6.4	11.5	16.3	4.3	2.5	6.7	6.2	114.4
1982	5.3	12.5	17.9	14.3	26.8	27.1	8.9	2.7	0.0	6.5	6.3	15.5	143.8
1983	6.5	9.7	27.2	16.4	41.4	74.2	10.7	7.6	3.8	3.1	6.7	5.2	212.5
1984	6.8	14.6	17.2	32.9	40.6	15.5	8.1	4.5	0.0	5.5	4.8	6.2	156.7
1985	6.9	14.1	13.6	11.9	27.4	9.9	10.0	2.0	6.0	8.5	5.6	5.8	121.7
1986	9.1	9.4	12.2	11.7	34.3	13.0	13.5	4.6	3.3	5.9	5.4	7.1	129.5
1987	5.9	9.2	19.7	24.1	24.3	11.7	19.0	5.7	2.3	2.7	8.2	7.0	139.8
1988	6.2	13.7	11.6	15.2	15.2	7.0	17.9	10.4	0.6	2.0	5.9	5.4	111.1
1989	5.4	5.9	10.5	9.1	11.4	11.8	14.0	6.2	0.2	3.1	3.1	3.5	84.2
1990	6.6	7.7	13.2	9.7	15.5	1.4	4.3	10.7	0.6	3.2	2.0	2.7	77.6
1991	2.4	8.0	9.0	10.6	15.2	3.9	1.9	0.5	0.0	0.0	2.7	4.8	59.0
1992	8.0	8.8	12.7	8.5	4.5	6.1	6.5	9.4	2.4	6.9	6.7	5.2	85.7
1993	5.2	14.4	71.6	22.7	21.0	17.0	68.0	37.5	23.3	16.8	30.1	17.7	345.3
Avg	4.5	8.8	14.1	13.0	17.2	30.6	11.0	6.2	5.4	6.3	5.0	4.7	126.8

## BASELINE - 1993 LEVEL FLOWS - HARLAN COUNTY EVAPORATION

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1931	0.7	0.9	1.6	2.9	4.2	7.4	6.9	5.2	2.7	2.1	1.2	0.4	36.2
1932	0.6	0.8	1.5	2.7	4.1	5.0	6.8	5.0	2.7	2.1	1.2	0.4	32.9
1933	0.6	0.8	1.4	2.5	3.8	7.8	6.1	4.2	2.7	2.1	1.2	0.4	33.6
1934	0.6	0.8	1.4	2.4	4.5	6.5	8.0	6.2	2.7	2.0	1.2	0.4	36.7
1935	0.6	0.8	1.3	2.3	2.2	3.6	9.7	6.2	3.1	2.5	1.4	0.5	34.2
1936	0.7	0.9	1.6	2.9	5.5	6.8	8.7	6.5	2.7	2.1	1.2	0.4	40.0
1937	0.6	0.8	1.4	2.5	3.6	4.0	6.2	6.5	2.7	2.1	1.2	0.4	32.0
1938	0.6	0.9	1.5	2.7	3.4	4.9	6.5	5.7	2.7	2.1	1.2	0.4	32.6
1939	0.6	0.8	1.4	2.6	4.3	4.9	6.8	4.6	2.7	2.1	1.2	0.4	32.4
1940	0.6	0.8	1.4	2.4	3.5	5.0	6.5	4.6	2.7	2.1	1.2	0.4	31.2
1941	0.6	0.8	1.4	2.5	3.9	4.2	6.7	5.3	2.8	2.1	1.3	0.5	32.1
1942	0.6	0.9	1.5	2.8	4.0	5.2	8.3	5.1	3.2	2.5	1.5	0.5	36.1
1943	0.7	1.0	1.8	3.2	4.3	5.7	7.9	6.3	2.7	2.1	1.2	0.4	37.3
1944	0.6	0.8	1.4	2.7	4.2	5.3	7.0	5.8	3.5	2.6	1.5	0.5	35.9
1945	0.7	1.0	1.8	3.1	3.8	3.0	6.7	5.7	2.9	2.2	1.3	0.5	32.7
1946	0.6	0.9	1.6	2.8	3.5	5.1	5.6	4.4	2.9	2.7	1.8	0.6	32.5
1947	1.0	1.5	2.9	3.2	3.4	-1.2	5.8	5.3	3.7	1.7	0.5	0.1	27.9
1948	0.8	0.7	1.5	3.6	3.1	2.4	4.2	4.7	3.0	2.7	0.8	0.3	27.8
1949	0.1	0.9	0.7	1.8	1.1	0.7	6.5	4.1	3.1	1.7	1.5	0.4	22.6
1950	0.7	0.1	0.8	2.8	2.0	5.6	0.8	2.8	4.5	2.3	1.6	0.6	24.6
1951	0.5	0.2	2.1	0.7	-0.1	1.9	3.5	4.1	0.4	3.1	2.2	0.9	19.5
1952	1.1	1.2	1.9	2.5	5.2	6.2	1.5	3.4	3.6	2.9	1.1	-0.1	30.5
1953	0.5	1.0	1.5	2.9	4.7	4.5	4.6	6.6	5.3	3.3	0.1	0.0	35.0
1954	0.7	0.6	2.2	3.6	0.3	4.9	6.7	1.6	3.6	1.6	1.5	0.6	27.9
1955	0.5	1.0	2.1	4.6	3.4	-0.5	7.3	6.9	2.7	2.6	1.4	0.4	32.4
1956	0.6	1.1	1.9	2.8	3.9	4.5	5.0	3.7	4.7	3.7	1.3	0.5	33.7
1957	0.7	1.0	1.3	0.5	-0.6	-1.1	6.1	3.7	2.3	1.7	1.2	0.4	17.2
1958	0.7	0.1	1.0	0.6	2.3	4.4	1.0	1.9	3.3	3.3	1.0	0.6	20.2
1959	0.4	1.0	1.1	2.1	1.0	3.5	5.0	4.8	2.3	0.7	1.5	0.6	24.0
1960	0.1	0.7	2.0	2.7	0.9	0.1	4.9	3.6	3.9	2.0	1.3	0.4	22.6
1961	0.9	1.0	1.4	2.7	-1.1	0.6	5.1	2.9	1.2	2.4	0.7	0.1	17.9

## Attachment 4: Evaporation Loss Harlan County Lake 1993 Level of Development

## BASELINE - 1993 LEVEL FLOWS - HARLAN COUNTY EVAPORATION

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1962	0.6	0.6	0.9	3.7	3.4	1.5	0.3	1.6	2.0	2.0	1.7	0.3	18.6
1963	0.7	1.4	1.3	4.5	4.6	6.3	6.1	3.1	-0.8	2.7	1.5	0.4	31.8
1964	0.8	0.8	1.7	3.2	5.6	1.2	6.9	3.0	3.0	3.3	1.2	0.6	31.3
1965	0.4	0.7	1.2	2.8	1.5	-0.5	2.0	2.8	-3.9	1.7	2.1	0.4	11.2
1966	0.9	0.8	2.9	2.7	7.5	2.8	5.8	3.7	2.7	2.8	1.5	0.4	34.5
1967	0.7	1.2	2.5	3.0	2.0	-2.9	1.6	4.5	3.5	2.0	1.6	0.4	20.1
1968	0.9	1.2	2.8	2.6	3.2	4.9	4.7	1.8	2.3	0.7	1.2	0.2	26.5
1969	0.4	0.6	2.4	3.3	0.1	3.8	-0.7	2.9	2.2	-1.0	1.5	0.4	15.9
1970	0.7	1.4	2.3	2.8	4.7	4.4	6.5	5.9	0.9	1.0	1.5	0.7	32.8
1971	0.7	0.2	2.0	2.9	0.7	5.1	3.4	4.5	1.4	1.5	0.2	0.5	23.1
1972	0.8	1.3	2.0	1.7	1.1	0.0	3.3	1.8	2.1	1.7	-0.4	0.1	15.5
1973	0.5	1.1	-0.7	2.5	3.4	6.7	-1.7	4.2	-3.0	0.2	0.2	0.2	13.6
1974	0.7	1.5	2.6	1.5	3.7	2.5	9.1	2.6	3.4	1.4	1.1	0.3	30.4
1975	0.7	0.7	2.0	2.1	0.8	1.1	4.3	2.7	3.0	3.4	0.7	0.6	22.1
1976	0.8	1.2	1.7	0.7	1.5	5.0	5.9	5.7	-0.2	1.4	1.4	0.7	25.8
1977	0.7	1.3	0.2	1.1	0.0	4.6	4.0	0.6	2.0	1.6	1.0	0.4	17.5
1978	0.5	0.7	1.2	3.4	3.9	6.2	7.1	4.5	4.5	3.0	1.1	0.5	36.6
1979	0.5	0.6	1.1	3.9	4.4	4.6	3.5	5.1	4.1	2.8	1.4	0.7	32.7
1980	0.5	0.6	1.2	3.4	3.7	4.7	6.8	6.0	3.9	2.7	1.3	0.6	35.4
1981	0.5	0.6	1.2	3.8	3.2	4.8	4.2	3.7	2.9	1.7	1.3	0.7	28.6
1982	0.5	0.7	1.2	3.9	3.8	3.9	5.1	3.8	2.9	2.2	1.4	0.8	30.2
1983	0.5	0.7	1.4	2.9	4.2	5.3	8.6	7.2	4.6	1.8	1.5	0.6	39.3
1984	0.6	0.8	1.4	2.9	4.2	5.8	7.2	5.7	4.7	1.4	1.4	0.7	36.8
1985	0.5	0.7	1.3	2.3	4.0	4.5	5.6	3.5	3.8	1.5	1.5	0.7	29.9
1986	0.6	0.7	1.3	2.8	4.4	5.8	6.7	4.0	2.7	1.3	1.4	0.7	32.4
1987	0.5	0.8	1.3	3.1	4.2	6.2	6.9	3.5	3.1	2.2	1.4	0.7	33.9
1988	0.5	0.7	1.3	3.5	4.9	6.6	4.6	4.8	3.5	2.2	1.4	0.7	34.7
1989	0.5	0.7	1.2	4.2	4.5	4.4	4.8	3.6	3.0	2.5	1.4	0.7	31.5
1990	0.5	0.7	1.2	3.0	3.5	5.6	6.4	4.0	5.0	3.4	1.4	0.6	35.3
1991	0.5	0.7	1.2	2.8	3.3	5.5	6.0	5.0	5.1	3.2	1.3	0.6	35.2
1992	0.6	0.7	1.2	1.8	3.2	2.2	4.1	3.5	4.2	2.9	1.9	1.0	27.3
1993	0.6	0.5	1.0	2.2	3.1	4.6	4.2	4.9	4.5	4.4	3.1	1.2	34.3
Avg	0.6	0.8	1.5	2.7	3.2	3.9	5.3	4.3	2.8	2.2	1.3	0.5	29.1

Attachment 5: Projected Water Supply Spread Sheet Calculations

<b>Trigger Calculations Based on Harlan County Lake Irrigation Supply</b>	Units-1000 Acre-feet		Irrigation Trigger		119.0		Assume that during irrigation release season HCL Inflow = Evaporation Loss						
			Total Irrigation Supply		130.0								
			Bottom Irrigation		164.1								
			Evaporation Adjust		20.0								
	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Total</b>
1993 Level AVE inflow	6.3	5	4.7	4.5	8.8	14.1	13.0	17.2	30.6	11.0	6.2	5.4	126.8
1993 Level AVE evap (1931-93)	2.2	1.3	0.5	0.6	0.8	1.5	2.7	3.2	3.9	5.3	4.3	2.8	29.1
Avg. Inflow Last 5 Years	10.8	13.0	12.3	12.9	16.6	22.4	19.4	18.1	14.8	16.5	11.0	4.7	172.6

<b>Year 2001-2002 Oct - Jun Trigger and Irrigation Supply Calculation</b>									
Calculation Month	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>
Previous EOM Content	236.5	235.9	238.6	242.9	248.1	255.1	263.8	269.6	276.2
Inflow to May 31	73.6	67.3	62.3	57.6	53.1	44.3	30.2	17.2	0.0
Last 5 Yrs Avg Inflow to May 31	125.6	114.8	101.7	89.5	76.6	59.9	37.5	18.1	0.0
Evap to May 31	12.8	10.6	9.3	8.8	8.2	7.4	5.9	3.2	0.0
Est. Cont May 31	297.3	292.6	291.6	291.7	293.0	292.0	288.1	283.6	276.2
Est. Elevation May 31	1944.44	1944.08	1944.00	1944.01	1944.11	1944.03	1943.72	1943.37	1942.77
Max. Irrigation Available	153.2	148.5	147.5	147.6	148.9	147.9	144.0	139.5	132.1
Irrigation Release Est.	120.1	117.4	116.8	116.8	118.1	117.1	116.8	116.8	116.8
Trigger - Yes/No	NO	YES							
130 kAF Irrigation Supply - Yes/No	NO								

## Attachment 5: Projected Water Supply Spread Sheet Calculations

<b>Year 2002</b>				
<b>Jul - Sep</b>				
<b>Final Trigger and</b>				
<b>Total Irrigation Supply</b>				
<b>Calculation</b>				
Calculation Month		<b>Jul</b>	<b>Aug</b>	<b>Sep</b>
Previous EOM Irrigation Release Est.		116.8	116.0	109.7
Previous Month Inflow		5.5	0.5	1.3
Previous Month Evap		6.3	6.8	6.6
Irrigation Release Estimate		116.0	109.7	104.4
Final Trigger - Yes/No		YES		
130 kAF Irrigation Supply - Yes/No		NO	NO	NO

Republican River Compact Administration

Accounting Procedures and Reporting Requirements  
Revised August 2010

Attachment 6: Computing Water Supplies and Consumptive Use Above Guide Rock

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Total Main Stem VWS	Hardy gage	Superior-Courtland Diversion Dam Gage	Courtland Canal Diversions	Superior Canal Diversions	Courtland Canal Returns	Superior Canal Returns	Total Bostwick Returns Below Guide Rock	NE CBCU Below Guide Rock	KS CBCU Below Guide Rock	Total CBCU Below Guide Rock	Gain Guide Rock to Hardy	VWS Guide Rock to Hardy	Main Stem Virgin Water Supply Above Guide Rock	Nebraska Main Stem Allocation Above Hardy	Kansas Main Stem Allocation Above Hardy	Nebraska Guide Rock to Hardy Allocation	Kansas Guide Rock to Hardy Allocation
							Col F+ Col G			Col I + Col J	+ Col B - Col C+ Col K - Col H	+ Col L + Col K	Col A - Col M	.489 x Col N	.511 x Col N	.489 x Col M	.511 x Col M

Republican River Compact Administration  
 Attachment 7: Calculations of Return Flows from Bureau of Reclamation Canals

Accounting Procedures and Reporting Requirements  
 Revised August 2010

Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11
Canal	Canal Diversion	Spill to Waste-Way	Field Deliveries	Canal Loss	Average Field Loss Factor	Field Loss	Total Loss from District	Percent Field and Canal Loss That Returns to the Stream	Total return to Stream from Canal and Field Loss	Return as Percent of Canal Diversion
Name Canal	Headgate Diversion	Sum of measured spills to river	Sum of Deliveries to the field	Col 2 - Col 4	1 -Weighted Average Efficiency of Application System for the District*	Col 4 x Col 6	Col 5 + Col 7	Estimated Percent Loss*	Col 8 x Col 9	Col 10/Col 2
∑ Irrigation Season										
∑ Non-Irrigation Season										
Example	100	5	60	40	30%	18	58	82%	48	48%
	100	0	0	100	30%	0	100	92%	92	92%
Culbertson					30%			82%		
					30%			92%		
Culbertson Extension					30%			82%		
					30%			92%		
Meeker - Driftwood					30%			82%		
					30%			92%		
Red Willow					30%			82%		
					30%			92%		
Bartley					30%			82%		
					30%			92%		
Cambridge					30%			82%		
					30%			92%		
Naponee					35%			82%		
					35%			92%		
Franklin					35%			82%		
					35%			92%		
Franklin Pump					35%			82%		
					35%			92%		
Almena					30%			82%		
					30%			92%		
Superior					31%			82%		
					31%			92%		
Nebraska Courtland					23%			82%		

Attachment 7: Calculations of Return Flows from Bureau of Reclamation Canals (continued)

					23%			92%		
Courtland Canal Above Lovewell (KS)					23%			82%		
					23%			92%		
Courtland Canal Below Lovewell					23%			82%		
					23%			92%		

\*The average field efficiencies for each district and percent loss that returns to the stream may be reviewed and, if necessary, changed by the RRCA to improve the accuracy of the estimates.

# Attachment G

# Republican River Compact Administration

## ACCOUNTING PROCEDURES

AND

## REPORTING REQUIREMENTS

Revised August 12, 2010

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## **I. Introduction**

This document describes the definitions, procedures, basic formulas, specific formulas, and data requirements and reporting formats to be used by the RRCA to compute the Virgin Water Supply, Computed Water Supply, Allocations, Imported Water Supply Credit and Computed Beneficial Consumptive Use. These computations shall be used to determine supply, allocations, use and compliance with the Compact according to the Stipulation. These definitions, procedures, basic and specific formulas, data requirements and attachments may be changed by consent of the RRCA consistent with Subsection I.F of the Stipulation. This document will be referred to as the RRCA Accounting Procedures. Attached to these RRCA Accounting Procedures as Figure 1 is the map attached to the Compact that shows the Basin, its streams and the Basin boundaries.

## **II. Definitions**

The following words and phrases as used in these RRCA Accounting Procedures are defined as follows:

**Additional Water Administration Year** - a year when the projected or actual irrigation water supply is less than 130,000 Acre-feet of storage available for use from Harlan County Lake as determined by the Bureau of Reclamation using the methodology described in the Harlan County Lake Operation Consensus Plan attached as Appendix K to the Stipulation.

**Allocation(s)**: the water supply allocated to each State from the Computed Water Supply;

**Annual**: yearly from January 1 through December 31;

**Basin**: the Republican River Basin as defined in Article II of the Compact;

**Beneficial Consumptive Use**: that use by which the Water Supply of the Basin is consumed through the activities of man, and shall include water consumed by evaporation from any reservoir, canal, ditch, or irrigated area;

**Change in Federal Reservoir Storage**: the difference between the amount of water in storage in the reservoir on December 31 of each year and the amount of water in storage on December 31 of the previous year. The current area capacity table supplied by the appropriate federal operating agency shall be used to determine the contents of the reservoir on each date;

**Compact**: the Republican River Compact, Act of February 22, 1943, 1943 Kan. Sess. Laws 612, codified at Kan. Stat. Ann. § 82a-518 (1997); Act of February 24, 1943, 1943 Neb. Laws 377, codified at 2A Neb. Rev. Stat. App. § 1-106 (1995), Act of March 15, 1943, 1943 Colo. Sess. Laws 362, codified at Colo. Rev. Stat. §§ 37-67-101 and 37-67-102 (2001); Republican River Compact, Act of May 26, 1943, ch. 104, 57 Stat. 86;

**Computed Beneficial Consumptive Use:** for purposes of Compact accounting, the stream flow depletion resulting from the following activities of man:

- Irrigation of lands in excess of two acres;
- Any non-irrigation diversion of more than 50 Acre-feet per year;
- Multiple diversions of 50 Acre-feet or less that are connected or otherwise combined to serve a single project will be considered as a single diversion for accounting purposes if they total more than 50 Acre-feet;
- Net evaporation from Federal Reservoirs;
- Net evaporation from Non-federal Reservoirs within the surface boundaries of the Basin;
- Any other activities that may be included by amendment of these formulas by the RRCA;

**Computed Water Supply:** the Virgin Water Supply less the Change in Federal Reservoir Storage in any Designated Drainage Basin, and less the Flood Flows;

**Designated Drainage Basins:** the drainage basins of the specific tributaries and the Main Stem of the Republican River as described in Article III of the Compact. Attached hereto as Figure 3 is a map of the Sub-basins and Main Stem;

**Dewatering Well:** a Well constructed solely for the purpose of lowering the groundwater elevation;

**Federal Reservoirs:**

- Bonny Reservoir
- Swanson Lake
- Enders Reservoir
- Hugh Butler Lake
- Harry Strunk Lake
- Keith Sebelius Lake
- Harlan County Lake
- Lovewell Reservoir

**Flood Flows:** the amount of water deducted from the Virgin Water Supply as part of the computation of the Computed Water Supply due to a flood event as determined by the methodology described in Subsection III.B.1.;

**Gaged Flow:** the measured flow at the designated stream gage;

**Guide Rock:** a point at the Superior-Courtland Diversion Dam on the Republican River near Guide Rock, Nebraska; the Superior-Courtland Diversion Dam gage plus any flows through the sluice gates of the dam, specifically excluding any diversions to the Superior and Courtland Canals, shall be the measure of flows at Guide Rock;

**Historic Consumptive Use:** that amount of water that has been consumed under appropriate and reasonably efficient practices to accomplish without waste the purposes for which the appropriation or other legally permitted use was lawfully made;

**Imported Water Supply:** the water supply imported by a State from outside the Basin resulting from the activities of man;

**Imported Water Supply Credit:** the accretions to stream flow due to water imports from outside of the Basin as computed by the RRCA Groundwater Model. The Imported Water Supply Credit of a State shall not be included in the Virgin Water Supply and shall be counted as a credit/offset against the Computed Beneficial Consumptive Use of water allocated to that State, except as provided in Subsection V.B.2. of the Stipulation and Subsections III.I. – J. of these RRCA Accounting Procedures;

**Main Stem:** the Designated Drainage Basin identified in Article III of the Compact as the North Fork of the Republican River in Nebraska and the main stem of the Republican River between the junction of the North Fork and the Arikaree River and the lowest crossing of the river at the Nebraska-Kansas state line and the small tributaries thereof, and also including the drainage basin Blackwood Creek;

**Main Stem Allocation:** the portion of the Computed Water Supply derived from the Main Stem and the Unallocated Supply derived from the Sub-basins as shared by Kansas and Nebraska;

**Meeting(s):** a meeting of the RRCA, including any regularly scheduled annual meeting or any special meeting;

**Modeling Committee:** the modeling committee established in Subsection IV.C. of the Stipulation;

**Moratorium:** the prohibition and limitations on construction of new Wells in the geographic area described in Section III. of the Stipulation;

**Non-federal Reservoirs:** reservoirs other than Federal Reservoirs that have a storage capacity of 15 Acre-feet or greater at the principal spillway elevation;

**Northwest Kansas:** those portions of the Sub-basins within Kansas;

**Replacement Well:** a Well that replaces an existing Well that a) will not be used after construction of the new Well and b) will be abandoned within one year after such construction or is used in a manner that is excepted from the Moratorium pursuant to Subsections III.B.1.c.-f. of the Stipulation;

**RRCA:** Republican River Compact Administration, the administrative body composed of the State officials identified in Article IX of the Compact;

**RRCA Accounting Procedures:** this document and all attachments hereto;

**RRCA Groundwater Model:** the groundwater model developed under the provisions of Subsection IV.C. of the Stipulation and as subsequently adopted and revised through action of the RRCA;

**State:** any of the States of Colorado, Kansas, and Nebraska;

**States:** the States of Colorado, Kansas and Nebraska;

**Stipulation:** the Final Settlement Stipulation to be filed in *Kansas v. Nebraska and Colorado*, No. 126, Original, including all Appendices attached thereto;

**Sub-basin:** the Designated Drainage Basins, except for the Main Stem, identified in Article III of the Compact. For purposes of Compact accounting the following Sub-basins will be defined as described below:

North Fork of the Republican River in Colorado drainage basin is that drainage area above USGS gaging station number 06823000, North Fork Republican River at the Colorado-Nebraska State Line,

Arikaree River drainage basin is that drainage area above USGS gaging station number 06821500, Arikaree River at Haigler, Nebraska,

Buffalo Creek drainage basin is that drainage area above USGS gaging station number 06823500, Buffalo Creek near Haigler, Nebraska,

Rock Creek drainage basin is that drainage area above USGS gaging station number 06824000, Rock Creek at Parks, Nebraska,

South Fork of the Republican River drainage basin is that drainage area above USGS gaging station number 06827500, South Fork Republican River near Benkelman, Nebraska,

Frenchman Creek (River) drainage basin in Nebraska is that drainage area above USGS gaging station number 06835500, Frenchman Creek in Culbertson, Nebraska,

Driftwood Creek drainage basin is that drainage area above USGS gaging station number 06836500, Driftwood Creek near McCook, Nebraska,

Red Willow Creek drainage basin is that drainage area above USGS gaging station number 06838000, Red Willow Creek near Red Willow, Nebraska,

Medicine Creek drainage basin is that drainage area above the Medicine Creek below Harry Strunk Lake, State of Nebraska gaging station number 06842500; and the drainage area between the gage and the confluence with the Main Stem,

Sappa Creek drainage basin is that drainage area above USGS gaging station number 06847500, Sappa Creek near Stamford, Nebraska and the drainage area between the gage and the confluence with the Main Stem; and excluding the Beaver Creek drainage basin area downstream from the State of Nebraska gaging station number 06847000 Beaver Creek near Beaver City, Nebraska to the confluence with Sappa Creek,

Beaver Creek drainage basin is that drainage area above State of Nebraska gaging station number 06847000, Beaver Creek near Beaver City, Nebraska, and the drainage area between the gage and the confluence with Sappa Creek,

Prairie Dog Creek drainage basin is that drainage area above USGS gaging station number 06848500, Prairie Dog Creek near Woodruff, Kansas, and the drainage area between the gage and the confluence with the Main Stem;

Attached hereto as Figure 2 is a line diagram depicting the streams, Federal Reservoirs and gaging stations;

**Test hole:** a hole designed solely for the purpose of obtaining information on hydrologic and/or geologic conditions;

**Trenton Dam:** a dam located at 40 degrees, 10 minutes, 10 seconds latitude and 101 degrees, 3 minutes, 35 seconds longitude, approximately two and one-half miles west of the town of Trenton, Nebraska;

**Unallocated Supply:** the “water supplies of upstream basins otherwise unallocated” as set forth in Article IV of the Compact;

**Upstream of Guide Rock, Nebraska:** those areas within the Basin lying west of a line proceeding north from the Nebraska-Kansas state line and following the western edge of Webster County, Township 1, Range 9, Sections 34, 27, 22, 15, 10 and 3 through Webster County, Township 2, Range 9, Sections 34, 27 and 22; then proceeding west along the southern edge of Webster County, Township 2, Range 9, Sections 16, 17 and 18; then proceeding north following the western edge of Webster County, Township 2, Range 9, Sections 18, 7 and 6, through Webster County, Township 3, Range 9, Sections 31, 30, 19, 18, 7 and 6 to its intersection with the northern boundary of Webster County. Upstream of Guide Rock, Nebraska shall not include that area in Kansas east of the 99° meridian and south of the Kansas-Nebraska state line;

**Virgin Water Supply:** the Water Supply within the Basin undepleted by the activities of man;

**Water Short Year Administration:** administration in a year when the projected or actual irrigation water supply is less than 119,000 acre feet of storage available for use from Harlan County Lake as determined by the Bureau of Reclamation using the methodology described in the Harlan County Lake Operation Consensus Plan attached as Appendix K to the Stipulation.

**Water Supply of the Basin or Water Supply within the Basin:** the stream flows within the Basin, excluding Imported Water Supply;

**Well:** any structure, device or excavation for the purpose or with the effect of obtaining groundwater for beneficial use from an aquifer, including wells, water wells, or groundwater wells as further defined and used in each State’s laws, rules, and regulations.

**III. Basic Formulas**

The basic formulas for calculating Virgin Water Supply, Computed Water Supply, Imported Water Supply, Allocations and Computed Beneficial Consumptive Use are set forth below. The results of these calculations shall be shown in a table format as shown in Table 1.

Basic Formulas for Calculating Virgin Water Supply, Computed Water Supply, Allocations and Computed Beneficial Consumptive Use	
Sub-basin VWS	= Gage + All CBCU + ΔS – IWS
Main Stem VWS	= Hardy Gage – Σ Sub-basin gages + All CBCU in the Main Stem + ΔS – IWS
CWS	= VWS - Δ S – FF
Allocation for each State in each Sub-basin And Main Stem	= CWS x %
State's Allocation	= Σ Allocations for Each State
State's CBCU	= Σ State's CBCUs in each Sub-basin and Main Stem

Abbreviations:

- CBCU = Computed Beneficial Consumptive Use
- FF = Flood Flows
- Gage = Gaged Flow
- IWS = Imported Water Supply Credit
- CWS = Computed Water Supply
- VWS = Virgin Water Supply

% = the ratio used to allocate the Computed Water Supply between the States. This ratio is based on the allocations in the Compact  
 $\Delta S$  = Change in Federal Reservoir Storage

## **A. Calculation of Annual Virgin Water Supply**

### **1. Sub-basin calculation:**

The annual Virgin Water Supply for each Sub-basin will be calculated by adding: a) the annual stream flow in that Sub-basin at the Sub-basin stream gage designated in Section II., b) the annual Computed Beneficial Consumptive Use above that gaging station, and c) the Change in Federal Reservoir Storage in that Sub-basin; and from that total subtract any Imported Water Supply Credit. The Computed Beneficial Consumptive Use will be calculated as described in Subsection III. D. Adjustments for flows diverted around stream gages and for Computed Beneficial Consumptive Uses in the Sub-basin between the Sub-basin stream gage and the confluence of the Sub-basin tributary and the Main Stem shall be made as described in Subsections III. D. 1 and 2 and IV. B.

### **2. Main Stem Calculation:**

The annual Virgin Water Supply for the Main Stem will be calculated by adding: a) the flow at the Hardy gage minus the flows from the Sub-basin gages listed in Section II, b) the annual Computed Beneficial Consumptive Use in the Main Stem, and c) the Change in Federal Reservoir Storage from Swanson Lake and Harlan County Lake; and from that total subtract any Imported Water Supply Credit for the Main Stem. Adjustments for flows diverted around Sub-basin stream gages and for Computed Beneficial Consumptive Uses in a Sub-basin between the Sub-basin stream gage and the confluence of the Sub-basin tributary and the Mains Stem shall be made as described in Subsections III. D. 1 and 2 and IV.B.,

### **3. Imported Water Supply Credit Calculation:**

The amount of Imported Water Supply Credit shall be determined by the RRCA Groundwater Model. The Imported Water Supply Credit of a State shall not be included in the Virgin Water Supply and shall be counted as a credit/offset against the Computed Beneficial Consumptive Use of water allocated to that State. Currently, the Imported Water Supply Credits shall be determined using two runs of the RRCA Groundwater Model:

- a. The “base” run shall be the run with all groundwater pumping, groundwater pumping recharge, and surface water recharge within the model study

boundary for the current accounting year turned “on.” ~~This will be the same “base” run used to determine groundwater Computed Beneficial-Consumptive Uses.~~

- b. The “no NE import” run shall be the run with the same model inputs as the base run with the exception that surface water recharge associated with Nebraska’s Imported Water Supply shall be turned “off.” ~~This will be the same “no NE import” run used to determine groundwater Computed Beneficial Consumptive Uses.~~

The Imported Water Supply Credit shall be the difference in stream flows between these two model runs. Differences in stream flows shall be determined at the same locations as identified in Subsection III.D.1. for the “no pumping” runs.

Should another State import water into the Basin in the future, the RRCA will develop a similar procedure to determine Imported Water Supply Credits.

## **B. Calculation of Computed Water Supply**

On any Designated Drainage Basin without a Federal Reservoir, the Computed Water Supply will be equal to the Virgin Water Supply of that Designated Drainage Basin minus Flood Flows.

On any Designated Drainage Basin with a Federal Reservoir, the Computed Water Supply will be equal to the Virgin Water Supply minus the Change in Federal Reservoir Storage in that Designated Drainage Basin and minus Flood Flows.

### **1. Flood Flows**

If in any calendar year there are five consecutive months in which the total actual stream flow<sup>1</sup> at the Hardy gage is greater than 325,000 Acre-feet, or any two consecutive months in which the total actual stream flow is greater than 200,000 Acre-feet, the annual flow in excess of 400,000 Acre-feet at the Hardy gage will be considered to be Flood Flows that will be subtracted from the Virgin Water Supply to calculate the Computed Water Supply, and Allocations. The Flood Flow in excess of 400,000 Acre-feet at the Hardy gage will be subtracted from the Virgin Water Supply of the Main Stem to compute the Computed Water Supply unless the Annual Gaged Flows from a Sub-basin were in excess of the flows shown for that Sub-basin in Attachment 1. These excess Sub-basin flows shall be considered to be Sub-basin Flood Flows.

If there are Sub-basin Flood Flows, the total of all Sub-basin Flood Flows shall be compared to the amount of Flood Flows at the Hardy gage. If the sum of the Sub-basin Flood Flows are in excess of the Flood Flow at the Hardy gage, the flows to

<sup>1</sup> These actual stream flows reflect Gaged Flows after depletions by Beneficial Consumptive Use and change in reservoir storage above the gage.

be deducted from each Sub-basin shall be the product of the Flood Flows for each Sub-basin times the ratio of the Flood Flows at the Hardy gage divided by the sum of the Flood Flows of the Sub-basin gages. If the sum of the Sub-basin Flood Flows is less than the Flood Flow at the Hardy gage, the entire amount of each Sub-basin Flood Flow shall be deducted from the Virgin Water Supply to compute the Computed Water Supply of that Sub-basin for that year. The remainder of the Flood Flows will be subtracted from the flows of the Main Stem.

### C. Calculation of Annual Allocations

Article IV of the Compact allocates 54,100 Acre-feet for Beneficial Consumptive Use in Colorado, 190,300 Acre-feet for Beneficial Consumptive Use in Kansas and 234,500 Acre-feet for Beneficial Consumptive Use in Nebraska. The Compact provides that the Compact totals are to be derived from the sources and in the amounts specified in Table 2.

The Allocations derived from each Sub-basin to each State shall be the Computed Water Supply multiplied by the percentages set forth in Table 2. In addition, Kansas shall receive 51.1% of the Main Stem Allocation and the Unallocated Supply and Nebraska shall receive 48.9% of the Main Stem Allocation and the Unallocated Supply.

### D. Calculation of Annual Computed Beneficial Consumptive Use

#### 1. Groundwater

Computed Beneficial Consumptive Use of groundwater shall be determined by use of the RRCA Groundwater Model. The Computed Beneficial Consumptive Use of groundwater for each State shall be determined as the difference in streamflows using two runs of the model:

The “baseno NE import” run shall be the run with all groundwater pumping, groundwater pumping recharge, and surface water recharge within the model study boundary for the current accounting year “on”, with the exception that surface water recharge associated with Nebraska’s Imported Water Supply shall be turned “off.”

The “no State pumping” run shall be the run with the same model inputs as the base “no NE import” run with the exception that all groundwater pumping and pumping recharge of that State shall be turned “off.”

An output of the model is baseflows at selected stream cells. Changes in the baseflows predicted by the model between the “baseno NE import” run and the “no-State- pumping” model run is assumed to be the depletions to streamflows. i.e.,

groundwater computed beneficial consumptive use, due to State groundwater pumping at that location. The values for each Sub-basin will include all depletions and accretions upstream of the confluence with the Main Stem. The values for the Main Stem will include all depletions and accretions in stream reaches not otherwise accounted for in a Sub-basin. The values for the Main Stem will be computed separately for the reach above Guide Rock, and the reach below Guide Rock.

## **2. Surface Water**

The Computed Beneficial Consumptive Use of surface water for irrigation and non-irrigation uses shall be computed by taking the diversions from the river and subtracting the return flows to the river resulting from those diversions, as described in Subsections IV.A.2.a.-d. The Computed Beneficial Consumptive Use of surface water from Federal Reservoir and Non-Federal Reservoir evaporation shall be the net reservoir evaporation from the reservoirs, as described in Subsections IV.A.2.e.-f.

For Sub-basins where the gage designated in Section II. is near the confluence with the Main Stem, each State's Sub-basin Computed Beneficial Consumptive Use of surface water shall be the State's Computed Beneficial Consumptive Use of surface water above the Sub-basin gage. For Medicine Creek, Sappa Creek, Beaver Creek and Prairie Dog Creek, where the gage is not near the confluence with the Main Stem, each State's Computed Beneficial Consumptive Use of surface water shall be the sum of the State's Computed Beneficial Consumptive Use of surface water above the gage, and its Computed Beneficial Consumptive Use of surface water between the gage and the confluence with the Main Stem.

## **E. Calculation to Determine Compact Compliance Using Five-Year Running Averages**

Each year, using the procedures described herein, the RRCA will calculate the Annual Allocations by Designated Drainage Basin and total for each State, the Computed Beneficial Consumptive Use by Designated Drainage Basin and total for each State and the Imported Water Supply Credit that a State may use for the preceding year. These results for the current Compact accounting year as well as the results of the previous four accounting years and the five-year average of these results will be displayed in the format shown in Table 3.

## **F. Calculations To Determine Colorado's and Kansas's Compliance with the Sub-basin Non-Impairment Requirement**

The data needed to determine Colorado's and Kansas's compliance with the Sub-basin non-impairment requirement in Subsection IV.B.2. of the Stipulation are shown in Tables 4.A. and B.

## **G. Calculations To Determine Projected Water Supply**

### **1. Procedures to Determine Water Short Years**

The Bureau of Reclamation will provide each of the States with a monthly or, if requested by any one of the States, a more frequent update of the projected or actual irrigation supply from Harlan County Lake for that irrigation season using the methodology described in the Harlan County Lake Operation Consensus Plan, attached as Appendix K to the Stipulation. The steps for the calculation are as follows:

Step 1. At the beginning of the calculation month (1) the total projected inflow for the calculation month and each succeeding month through the end of May shall be added to the previous end of month Harlan County Lake content and (2) the total projected 1993 level evaporation loss for the calculation month and each succeeding month through the end of May shall then be subtracted. The total projected inflow shall be the 1993 level average monthly inflow or the running average monthly inflow for the previous five years, whichever is less.

Step 2. Determine the maximum irrigation water available by subtracting the sediment pool storage (currently 164,111 Acre-feet) and adding the summer sediment pool evaporation (20,000 Acre-feet) to the result from Step 1.

Step 3. For October through January calculations, take the result from Step 2 and using the Shared Shortage Adjustment Table in Attachment 2 hereto, determine the preliminary irrigation water available for release. The calculation using the end of December content (January calculation month) indicates the minimum amount of irrigation water available for release at the end of May. For February through June calculations, subtract the maximum irrigation water available for the January calculation month from the maximum irrigation water available for the calculation month. If the result is negative, the irrigation water available for release (January calculation month) stays the same. If the result is positive the preliminary irrigation

water available for release (January calculation month) is increased by the positive amount.

Step 4. Compare the result from Step 3 to 119,000 Acre-feet. If the result from Step 3 is less than 119,000 Acre-feet Water Short Year Administration is in effect.

Step 5. The final annual Water-Short Year Administration calculation determines the total estimated irrigation supply at the end of June (calculated in July). Use the result from Step 3 for the end of May irrigation release estimate, add the June computed inflow to Harlan County Lake and subtract the June computed gross evaporation loss from Harlan County Lake.

## **2. Procedures to Determine 130,000 Acre Feet Projected Water Supply**

To determine the preliminary irrigation supply for the October through June calculation months, follow the procedure described in steps 1 through 4 of the “Procedures to determine Water Short Years” Subsection III. G. 1. The result from step 4 provides the forecasted water supply, which is compared to 130,000 Acre-feet. For the July through September calculation months, use the previous end of calculation month preliminary irrigation supply, add the previous month’s Harlan County Lake computed inflow and subtract the previous month’s computed gross evaporation loss from Harlan County Lake to determine the current preliminary irrigation supply. The result is compared to 130,000 Acre-feet.

### **H. Calculation of Computed Water Supply, Allocations and Computed Beneficial Consumptive Use Above and Below Guide Rock During Water-Short Administration Years.**

For Water-Short-Administration Years, in addition to the normal calculations, the Computed Water Supply, Allocations, Computed Beneficial Consumptive Use and Imported Water Supply Credits shall also be calculated above Guide Rock as shown in Table 5C. These calculations shall be done in the same manner as in non-Water-Short Administration years except that water supplies originating below Guide Rock shall not be included in the calculations of water supplies originating above Guide Rock. The calculations of Computed Beneficial Consumptive Uses shall be also done in the same manner as in non-Water-Short Administration years except that Computed Beneficial Consumptive Uses from diversions below Guide Rock shall not be included. The depletions from the water diverted by the Superior and Courtland Canals at the Superior-Courtland Diversion Dam shall be included in the calculations of Computed Beneficial Consumptive Use above Guide Rock. Imported Water Supply Credits above Guide Rock, as described in Sub-section III.I., may be used as offsets against the Computed Beneficial Consumptive Use above Guide Rock by the State providing the Imported Water Supply Credits.

The Computed Water Supply of the Main Stem reach between Guide Rock and the Hardy gage shall be determined by taking the difference in stream flow at Hardy and Guide Rock, adding Computed Beneficial Consumptive Uses in the reach (this does not include the Computed Beneficial Consumptive Use from the Superior and Courtland Canal diversions), and subtracting return flows from the Superior and Courtland Canals in the reach. The Computed Water Supply above Guide Rock shall be determined by subtracting the Computed Water Supply of the Main Stem reach between Guide Rock and the Hardy gage from the total Computed Water Supply. Nebraska's Allocation above Guide Rock shall be determined by subtracting 48.9% of the Computed Water Supply of the Main Stem reach between Guide Rock and the Hardy gage from Nebraska's total Allocation. Nebraska's Computed Beneficial Consumptive Uses above Guide Rock shall be determined by subtracting Nebraska's Computed Beneficial Consumptive Uses below Guide Rock from Nebraska's total Computed Beneficial Consumptive Use.

### **I. Calculation of Imported Water Supply Credits During Water-Short Year Administration Years.**

Imported Water Supply Credit during Water-Short Year Administration years shall be calculated consistent with Subsection V.B.2.b. of the Stipulation.

The following methodology shall be used to determine the extent to which Imported Water Supply Credit, as calculated by the RRCA Groundwater Model, can be credited to the State importing the water during Water-Short Year Administration years.

#### **1. Monthly Imported Water Supply Credits**

The RRCA Groundwater Model will be used to determine monthly Imported Water Supply Credits by State in each Sub-basin and for the Main Stem. The values for each Sub-basin will include all depletions and accretions upstream of the confluence with the Main Stem. The values for the Main Stem will include all depletions and accretions in stream reaches not otherwise accounted for in a Sub-basin. The values for the Main Stem will be computed separately for the reach 1) above Harlan County Dam, 2) between Harlan County Dam and Guide Rock, and 3) between Guide Rock and the Hardy gage. The Imported Water Supply Credit shall be the difference in stream flow for two runs of the model: a) the "base" run and b) the "no State import" run.

During Water-Short Year Administration years, Nebraska's credits in the Sub-basins shall be determined as described in Section III. A. 3.

## **2. Imported Water Supply Credits Above Harlan County Dam**

Nebraska's Imported Water Supply Credits above Harlan County Dam shall be the sum of all the credits in the Sub-basins and the Main Stem above Harlan County Dam.

## **3. Imported Water Supply Credits Between Harlan County Dam and Guide Rock During the Irrigation Season**

a. During Water-Short Year Administration years, monthly credits in the reach between Harlan County Dam and Guide Rock shall be determined as the differences in the stream flows between the two runs at Guide Rock.

b. The irrigation season shall be defined as starting on the first day of release of water from Harlan County Lake for irrigation use and ending on the last day of release of water from Harlan County Lake for irrigation use.

c. Credit as an offset for a State's Computed Beneficial Consumptive Use above Guide Rock will be given to all the Imported Water Supply accruing in the reach between Harlan County Dam and Guide Rock during the irrigation season. If the period of the irrigation season does not coincide with the period of modeled flows, the amount of the Imported Water Supply credited during the irrigation season for that month shall be the total monthly modeled Imported Water Supply Credit times the number of days in the month occurring during the irrigation season divided by the total number of days in the month.

## **4. Imported Water Supply Credits Between Harlan County Dam and Guide Rock During the Non-Irrigation Season**

a. Imported Water Supply Credit shall be given between Harlan County Dam and Guide Rock during the period that flows are diverted to fill Lovewell Reservoir to the extent that imported water was needed to meet Lovewell Reservoir target elevations.

b. Fall and spring fill periods shall be established during which credit shall be given for the Imported Water Supply Credit accruing in the reach. The fall period shall extend from the end of the irrigation season to December 1. The spring period shall extend from March 1 to May 31. The Lovewell target elevations for these fill periods are the projected end of November reservoir level and the projected end of May reservoir level for most

probable inflow conditions as indicated in Table 4 in the current Annual Operating Plan prepared by the Bureau of Reclamation.

c. The amount of water needed to fill Lovewell Reservoir for each period shall be calculated as the storage content of the reservoir at its target elevation at the end of the fill period minus the reservoir content at the start of the fill period plus the amount of net evaporation during this period minus White Rock Creek inflows for the same period.

d. If the fill period as defined above does not coincide with the period of modeled flows, the amount of the Imported Water Supply Credit during the fill period for that month shall be the total monthly modeled Imported Water Supply Credit times the number of days in the month occurring during the fill season divided by the total number of days in the month.

e. The amount of non-imported water available to fill Lovewell Reservoir to the target elevation shall be the amount of water available at Guide Rock during the fill period minus the amount of the Imported Water Supply Credit accruing in the reach during the same period.

f. The amount of the Imported Water Supply Credit that shall be credited against a State's Consumptive Use shall be the amount of water imported by that State that is available in the reach during the fill period or the amount of water needed to reach Lovewell Reservoir target elevations minus the amount of non-imported water available during the fill period, whichever is less.

## **5. Other Credits**

Kansas and Nebraska will explore crediting Imported Water Supply that is otherwise useable by Kansas.

## **J. Calculations of Compact Compliance in Water-Short Year Administration Years**

During Water-Short Year Administration, using the procedures described in Subsections III.A-D, the RRCA will calculate the Annual Allocations for each State, the Computed Beneficial Consumptive Use by each State, and Imported Water Supply Credit that a State may use to offset Computed Beneficial Consumptive Use in that year. The resulting annual and average values will be calculated as displayed in Tables 5 A-C and E.

If Nebraska is implementing an Alternative Water-Short-Year Administration Plan, data to determine Compact compliance will be shown in Table 5D. Nebraska's compliance with the Compact will be determined in the same manner as Nebraska's Above Guide Rock

compliance except that compliance will be based on a three-year running average of the current year and previous two year calculations. In addition, Table 5 D. will display the sum of the previous two-year difference in Allocations above Guide Rock and Computed Beneficial Consumptive Uses above Guide Rock minus any Imported Water Credits and compare the result with the Alternative Water-Short-Year Administration Plan's expected decrease in Computed Beneficial Consumptive Use above Guide Rock. Nebraska will be within compliance with the Compact as long as the three-year running average difference in Column 8 is positive and the sum of the previous year and current year deficits above Guide Rock are not greater than the expected decrease in Computed Beneficial Consumptive Use under the plan.

#### **IV. Specific Formulas**

##### **A. Computed Beneficial Consumptive Use**

###### **1. Computed Beneficial Consumptive Use of Groundwater:**

The Computed Beneficial Consumptive Use caused by groundwater diversion shall be determined by the RRCA Groundwater Model as described in Subsection III.D.1.

###### **2. Computed Beneficial Consumptive Use of Surface Water:**

The Computed Beneficial Consumptive Use of surface water shall be calculated as follows:

###### a) Non-Federal Canals

Computed Beneficial Consumptive Use from diversions by non- federal canals shall be 60 percent of the diversion; the return flow shall be 40 percent of the diversion

###### b) Individual Surface Water Pumps

Computed Beneficial Consumptive Use from small individual surface water pumps shall be 75 percent of the diversion; return flows will be 25 percent of the diversion unless a state provides data on the amount of different system types in a Sub-basin, in which case the following percentages will be used for each system type:

Gravity Flow.	30%
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Center Pivot	17%
LEPA	10%

c) Federal Canals

Computed Beneficial Consumptive Use of diversions by Federal canals will be calculated as shown in Attachment 7. For each Bureau of Reclamation Canal the field deliveries shall be subtracted from the diversion from the river to determine the canal losses. The field delivery shall be multiplied by one minus an average system efficiency for the district to determine the loss of water from the field. Eighty-two percent of the sum of the field loss plus the canal loss shall be considered to be the return flow from the canal diversion. The assumed field efficiencies and the amount of the field and canal loss that reaches the stream may be reviewed by the RRCA and adjusted as appropriate to insure their accuracy.

d) Non-irrigation Uses

Any non-irrigation uses diverting or pumping more than 50 acre-feet per year will be required to measure diversions. Non-irrigation uses diverting more than 50 Acre-feet per year will be assessed a Computed Beneficial Consumptive Use of 50% of what is pumped or diverted, unless the entity presents evidence to the RRCA demonstrating a different percentage should be used.

e) Evaporation from Federal Reservoirs

Net Evaporation from Federal Reservoirs will be calculated as follows:

(1) Harlan County Lake, Evaporation Calculation

April 1 through October 31:

Evaporation from Harlan County Lake is calculated by the Corps of Engineers on a daily basis from April 1 through October 31. Daily readings are taken from a Class A evaporation pan maintained near the project office. Any precipitation recorded at the project office is added to the pan reading to obtain the actual evaporation amount. The pan value is multiplied by a pan coefficient that varies by month. These values are:

March	.56
April	.52
May	.53
June	.60
July	.68
August	.78
September	.91
October	1.01

The pan coefficients were determined by studies the Corps of Engineers conducted a number of years ago. The result is the evaporation in inches. It is divided by 12 and multiplied by the daily lake surface area in acres to obtain the evaporation in Acre-feet. The lake surface area is determined by the 8:00 a.m. elevation reading applied to the lake's area-capacity data. The area-capacity data is updated periodically through a sediment survey. The last survey was completed in December 2000.

November 1 through March 31

During the winter season, a monthly total evaporation in inches has been determined. The amount varies with the percent of ice cover. The values used are:

HARLAN COUNTY LAKE

Estimated Evaporation in Inches  
Winter Season -- Monthly Total

PERCENTAGE OF ICE COVER

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
JAN	0.88	0.87	0.85	0.84	0.83	0.82	0.81	0.80	0.78	0.77	0.76
FEB	0.90	0.88	0.87	0.86	0.85	0.84	0.83	0.82	0.81	0.80	0.79
MAR	1.29	1.28	1.27	1.26	1.25	1.24	1.23	1.22	1.21	1.20	1.19
OCT	4.87			NO ICE							
NOV	2.81			NO ICE							
DEC	1.31	1.29	1.27	1.25	1.24	1.22	1.20	1.18	1.17	1.16	1.14

The monthly total is divided by the number of days in the month to obtain a daily evaporation value in inches. It is divided by 12 and

multiplied by the daily lake surface area in acres to obtain the evaporation in Acre-feet. The lake surface area is determined by the 8:00 a.m. elevation reading applied to the lake's area-capacity data. The area-capacity data is updated periodically through a sediment survey. The last survey was completed in December 2000.

To obtain the net evaporation, the monthly precipitation on the lake is subtracted from the monthly gross evaporation. The monthly precipitation is calculated by multiplying the sum of the month's daily precipitation in inches by the average of the end of the month lake surface area for the previous month and the end of the month lake surface area for the current month in acres and dividing the result by 12 to obtain the precipitation for the month in acre feet.

The total annual net evaporation (Acre-feet) will be charged to Kansas and Nebraska in proportion to the annual diversions made by the Kansas Bostwick Irrigation District and the Nebraska Bostwick Irrigation District during the time period each year when irrigation releases are being made from Harlan County Lake. For any year in which no irrigation releases were made from Harlan County Lake, the annual net evaporation charged to Kansas and Nebraska will be based on the average of the above calculation for the most recent three years in which irrigation releases from Harlan County Lake were made. In the event Nebraska chooses to substitute supply for the Superior Canal from Nebraska's allocation below Guide Rock in Water-Short Year Administration years, the amount of the substitute supply will be included in the calculation of the split as if it had been diverted to the Superior Canal at Guide Rock.

## (2) Evaporation Computations for Bureau of Reclamation Reservoirs

The Bureau of Reclamation computes the amount of evaporation loss on a monthly basis at Reclamation reservoirs. The following procedure is utilized in calculating the loss in Acre-feet.

An evaporation pan reading is taken each day at the dam site. This measurement is the amount of water lost from the pan over a 24-hour period in inches. The evaporation pan reading is adjusted for any precipitation recorded during the 24-hour period. Instructions for determining the daily pan evaporation are found in the "National Weather Service Observing Handbook No. 2 – Substation Observations." All dams located in the Kansas River Basin with the exception of Bonny Dam are National Weather Service Cooperative Observers. The daily evaporation pan readings are totaled at the end

of each month and converted to a “free water surface” (FWS) evaporation, also referred to as “lake” evaporation. The FWS evaporation is determined by multiplying the observed pan evaporation by a coefficient of .70 at each of the reservoirs. This coefficient can be affected by several factors including water and air temperatures. The National Oceanic and Atmospheric Administration (NOAA) has published technical reports describing the determination of pan coefficients. The coefficient used is taken from the “NOAA Technical Report NWS 33, Map of coefficients to convert class A pan evaporation to free water surface evaporation”. This coefficient is used for the months of April through October when evaporation pan readings are recorded at the dams. The monthly FWS evaporation is then multiplied by the average surface area of the reservoir during the month in acres. Dividing this value by twelve will result in the amount of water lost to evaporation in Acre-feet during the month.

During the winter months when the evaporation pan readings are not taken, monthly evaporation tables based on the percent of ice cover are used. The tables used were developed by the Corps of Engineers and were based on historical average evaporation rates. A separate table was developed for each of the reservoirs. The monthly evaporation rates are multiplied by the .70 coefficient for pan to free water surface adjustment, divided by twelve to convert inches to feet and multiplied by the average reservoir surface area during the month in acres to obtain the total monthly evaporation loss in Acre-feet.

To obtain the net evaporation, the monthly precipitation on the lake is subtracted from the monthly gross evaporation. The monthly precipitation is calculated by multiplying the sum of the month's daily precipitation in inches by the average of the end of the month lake surface area for the previous month and the end of the month lake surface area for the current month in acres and dividing the result by 12 to obtain the precipitation for the month in acre feet.

#### f) Non-Federal Reservoir Evaporation:

For Non-Federal Reservoirs with a storage capacity less than 200 Acre-feet, the presumptive average annual surface area is 25% of the area at the principal spillway elevation. Net evaporation for each such Non-Federal Reservoir will be calculated by multiplying the presumptive average annual surface area by the net evaporation from the nearest climate and evaporation

station to the Non-Federal Reservoir. A State may provide actual data in lieu of the presumptive criteria.

Net evaporation from Non-Federal Reservoirs with 200 Acre-feet of storage or greater will be calculated by multiplying the average annual surface area (obtained from the area-capacity survey) and the net evaporation from the nearest evaporation and climate station to the reservoir. If the average annual surface area is not available, the Non-Federal Reservoirs with 200 Acre-feet of storage or greater will be presumed to be full at the principal spillway elevation.

## **B. Specific Formulas for Each Sub-basin and the Main Stem**

All calculations shall be based on the calendar year and shall be rounded to the nearest 10 Acre-feet using the conventional rounding formula of rounding up for all numbers equal to five or higher and otherwise rounding down.

### Abbreviations:

CBCU	= Computed Beneficial Consumptive Use
CWS	= Computed Water Supply
D	= Non-Federal Canal Diversions for Irrigation
Ev	= Evaporation from Federal Reservoirs
EvNFR	= Evaporation from Non-Federal Reservoirs
FF	= Flood Flow
GW	= Groundwater Computed Beneficial Consumptive Use (includes irrigation and non-irrigation uses)
IWS	= Imported Water Supply Credit from Nebraska
M&I	= Non-Irrigation Surface Water Diversions (Municipal and Industrial)
P	= Small Individual Surface Water Pump Diversions for Irrigation
RF	= Return Flow
VWS	= Virgin Water Supply
c	= Colorado
k	= Kansas
n	= Nebraska
$\Delta S$	= Change in Federal Reservoir Storage
%	= Average system efficiency for individual pumps in the Sub-basin
% BRF	= Percent of Diversion from Bureau Canals that returns to the stream
###	= Value expected to be zero

### 3. North Fork of Republican River in Colorado <sup>2</sup>

$$\text{CBCU Colorado} = 0.6 \times \text{Haigler Canal Diversion Colorado} + 0.6 \times D_c + \% \times P_c + 0.5 \times M\&I_c + E_vNFR_c + GWC$$

$$\text{CBCU Kansas} = GW_k$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Haigler Canal Diversion Nebraska} + GW_n$$

Note: The diversion for Haigler Canal is split between Colorado and Nebraska based on the percentage of land irrigated in each state

$$\text{VWS} = \text{North Fork of the Republican River at the State Line, Stn. No. 06823000} + \text{CBCU}_c + \text{CBCU}_k + \text{CBCU}_n + \text{Nebraska Haigler Canal RF} - \text{IWS}$$

Note: The Nebraska Haigler Canal RF returns to the Main Stem

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Colorado} = 0.224 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.246 \times \text{CWS}$$

$$\text{Unallocated} = 0.53 \times \text{CWS}$$

### 4. Arikaree River <sup>2</sup>

$$\text{CBCU Colorado} = 0.6 \times D_c + \% \times P_c + 0.5 \times M\&I_c + E_vNFR_c + GWC$$

$$\text{CBCU Kansas} = 0.6 \times D_k + \% \times P_k + 0.5 \times M\&I_k + E_vNFR_k + GW_k$$

$$\text{CBCU Nebraska} = 0.6 \times D_n + \% \times P_n + 0.5 \times M\&I_n + E_vNFR_n + GW_n$$

$$\text{VWS} = \text{Arikaree Gage at Haigler Stn. No. 06821500} + \text{CBCU}_c + \text{CBCU}_k + \text{CBCU}_n - \text{IWS}$$

<sup>2</sup> The RRCA will investigate whether return flows from the Haigler Canal diversion in Colorado may return to the Arikaree River, not the North Fork of the Republican River, as indicated in the formulas. If there are return flows from the Haigler Canal to the Arikaree River, these formulas will be changed to recognize those returns.

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Colorado} = 0.785 \times \text{CWS}$$

$$\text{Allocation Kansas} = 0.051 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.168 \times \text{CWS}$$

$$\text{Unallocated} = -0.004 \times \text{CWS}$$

### 5. Buffalo Creek

$$\text{CBCU Colorado} = 0.6 \times \text{Dc} + \% \times \text{Pc} + 0.5 \times \text{M\&In} + \text{EvNFRc} + \text{GWc}$$

$$\text{CBCU Kansas} = \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + \text{GWn}$$

$$\text{VWS} = \text{Buffalo Creek near Haigler Gage Stn. No. 06823500} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} - \text{IWS}$$

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Nebraska} = 0.330 \times \text{CWS}$$

$$\text{Unallocated} = 0.670 \times \text{CWS}$$

### 6. Rock Creek

$$\text{CBCU Colorado} = \text{GWc}$$

$$\text{CBCU Kansas} = \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + \text{GWn}$$

$$\text{VWS} = \text{Rock Creek at Parks Gage Stn. No. 06824000} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} - \text{IWS}$$

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Nebraska} = 0.400 \times \text{CWS}$$

$$\text{Unallocated} = 0.600 \times \text{CWS}$$

## 7. South Fork Republican River

$$\text{CBCU Colorado} = 0.6 \times \text{Hale Ditch Diversion} + 0.6 \times \text{Dc} + \% \times \text{Pc} + 0.5 \times \text{M\&Ic} + \text{EvNFRc} + \text{Bonny Reservoir Ev} + \text{GWc}$$

$$\text{CBCU Kansas} = 0.6 \times \text{Dk} + \% \times \text{Pk} + 0.5 \times \text{M\&Ik} + \text{EvNFRk} + \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \text{M\&In} + \text{EvNFRn} + \text{GWn}$$

$$\text{VWS} = \text{South Fork Republican River near Benkelman Gage Stn. No. 06827500} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} + \Delta \text{S Bonny Reservoir} - \text{IWS}$$

$$\text{CWS} = \text{VWS} - \Delta \text{S Bonny Reservoir} - \text{FF}$$

$$\text{Allocation Colorado} = 0.444 \times \text{CWS}$$

$$\text{Allocation Kansas} = 0.402 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.014 \times \text{CWS}$$

$$\text{Unallocated} = 0.140 \times \text{CWS}$$

## 8. Frenchman Creek in Nebraska

$$\text{CBCU Colorado} = \text{GWc}$$

$$\text{CBCU Kansas} = \text{GWk}$$

$$\begin{aligned} \text{CBCU Nebraska} = & \text{Culbertson Canal Diversions (IRR Season)} \times (1 - \% \text{BRF}) + \\ & \text{Culbertson Canal Diversions (Non-IRR Season)} \times (1 - \\ & 92.2857\%) + \text{Culbertson Extension (IRR Season)} \times (1 - \\ & \% \text{BRF}) + \text{Culbertson Extension (Non-IRR Season)} \times (1 - \\ & 92.2857\%) + 0.6 \times \text{Champion Canal Diversion} + 0.6 \times \\ & \text{Riverside Canal Diversion} + 0.6 \times \text{Dn} + \% \times \text{Pn} + 0.5 \times \\ & \text{M\&In} + \text{EvNFRn} + \text{Enders Reservoir Ev} + \text{GWn} \end{aligned}$$

$$\text{VWS} = \text{Frenchman Creek in Culbertson, Nebraska Gage Stn. No. 06835500} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} + 0.17 \times$$

Culbertson Diversion RF + Culbertson Extension RF + 0.78  
x Riverside Diversion RF +  $\Delta$ S Enders Reservoir – IWS

Note: 17% of the Culbertson Diversion RF and 100% of the  
Culbertson Extension RF return to the Main Stem

CWS = VWS -  $\Delta$ S Enders Reservoir – FF

Allocation Nebraska = 0.536 x CWS

Unallocated = 0.464 x CWS

### 9. Driftwood Creek

CBCU Colorado = GWc

CBCU Kansas = 0.6 x Dk + % x Pk + 0.5 x M&Ik + EvNFRk + GWk

CBCU Nebraska = 0.6 x Dn + % x Pn + 0.5 x M&In + EvNFRn + GWn

VWS = Driftwood Creek near McCook Gage Stn. No. 06836500 +  
CBCUc + CBCUk + CBCUn – 0.24 x Meeker Driftwood  
Canal RF - IWS

Note: 24 % of the Meeker Driftwood Canal RF returns to  
Driftwood Creek

CWS = VWS – FF

Allocation Kansas = 0.069 x CWS

Allocation Nebraska = 0.164 x CWS

Unallocated = 0.767 x CWS

### 10. Red Willow Creek in Nebraska

CBCU Colorado = GWc

CBCU Kansas = GWk

CBCU Nebraska = 0.1 x Red Willow Canal CBCU + 0.6 x Dn + % x Pn + 0.5

$$x \text{ M\&In} + \text{EvNFRn} + 0.1 \times \text{Hugh Butler Lake Ev} + \text{GWn}$$

Note:

Red Willow Canal CBCU = Red Willow Canal Diversion (IRR Season) x (1- % BRF) + Red Willow Canal Diversion (Non-IRR Season) x (1-92,2857%)

90% of the Red Willow Canal CBCU and 90% of Hugh Butler Lake Ev charged to Nebraska's CBCU in the Main Stem

$$\text{VWS} = \text{Red Willow Creek near Red Willow Gage Stn. No. 06838000} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} + 0.9 \times \text{Red Willow Canal CBCU} + 0.9 \times \text{Hugh Butler Lake Ev} + 0.9 \times \text{Red Willow Canal RF} + \Delta S \text{ Hugh Butler Lake} - \text{IWS}$$

Note: 90% of the Red Willow Canal RF returns to the Main Stem

$$\text{CWS} = \text{VWS} - \Delta S \text{ Hugh Butler Lake} - \text{FF}$$

$$\text{Allocation Nebraska} = 0.192 \times \text{CWS}$$

$$\text{Unallocated} = 0.808 \times \text{CWS}$$

### 11. Medicine Creek

$$\text{CBCU Colorado} = \text{GWc}$$

$$\text{CBCU Kansas} = \text{GWk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn above and below gage} + \% \times \text{Pn above and below gage} + 0.5 \times \text{M\&In above and below gage} + \text{EvNFRn above and below gage} + \text{GWn}$$

Note: Harry Strunk Lake Ev charged to Nebraska's CBCU in the Main Stem.

CU from Harry Strunk releases in the Cambridge Canal is charged to the Main stem (no adjustment to the VWS formula is needed as this water shows up in the Medicine Creek gage).

$$\text{VWS} = \text{Medicine Creek below Harry Strunk Lake Gage Stn. No. 06842500} + \text{CBCUc} + \text{CBCUk} + \text{CBCUn} - 0.6 \times \text{Dn below gage} - \% \times \text{Pn below gage} - 0.5 * \text{M\&In below gage} - \text{EvNFRn below gage} + \text{Harry Strunk Lake Ev} + \Delta \text{S Harry Strunk Lake} - \text{IWS}$$

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

$$\text{CWS} = \text{VWS} - \Delta \text{S Harry Strunk Lake} - \text{FF}$$

$$\text{Allocation Nebraska} = 0.091 \times \text{CWS}$$

$$\text{Unallocated} = 0.909 \times \text{CWS}$$

## 12. Beaver Creek

$$\text{CBCU Colorado} = 0.6 \times \text{Dc} + \% \times \text{Pc} + 0.5 \times \text{M\&Ic} + \text{EvNFRc} + \text{Gwc}$$

$$\text{CBCU Kansas} = 0.6 \times \text{Dk} + \% \times \text{Pk} + 0.5 \times \text{M\&Ik} + \text{EvNFRk} + \text{Gwk}$$

$$\text{CBCU Nebraska} = 0.6 \times \text{Dn above and below gage} + \% \times \text{Pn above and below gage} + 0.5 \times \text{M\&In above and below gage} + \text{EvNFRn above and below gage} + \text{Gwn}$$

$$\text{VWS} = \text{Beaver Creek near Beaver City gage Stn. No. 06847000} + \text{BCUc} + \text{CBCUk} + \text{CBCUn} - 0.6 \times \text{Dn below gage} - \% \times \text{Pn below gage} - 0.5 * \text{M\&In below gage} - \text{EvNFRn below gage} - \text{IWS}$$

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

$$\text{CWS} = \text{VWS} - \text{FF}$$

$$\text{Allocation Colorado} = 0.200 \times \text{CWS}$$

$$\text{Allocation Kansas} = 0.388 \times \text{CWS}$$

$$\text{Allocation Nebraska} = 0.406 \times \text{CWS}$$

Unallocated = 0.006 x CWS

**13. Sappa Creek**

CBCU Colorado = GWc

CBCU Kansas = 0.6 x Dk + % x Pk + 0.5 x M&Ik + EvNFRk + GWk

CBCU Nebraska = 0.6 x Dn above and below gage + % x Pn above and below gage + 0.5 x M&In above and below gage + EvNFRn above and below gage + GWn

VWS = Sappa Creek near Stamford gage Stn. No. 06847500 – Beaver Creek near Beaver City gage Stn. No. 06847000 + CBCUc + CBCUk + CBCUn – 0.6 x Dn below gage - % x Pn below gage – 0.5 \* M&In below gage - EvNFRn below gage – IWS

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

CWS = VWS - FF

Allocation Kansas = 0.411 x CWS

Allocation Nebraska = 0.411 x CWS

Unallocated = 0.178 x CWS

**14. Prairie Dog Creek**

CBCU Colorado = GWc

CBCU Kansas = Almena Canal Diversion (IRR Season) x (1-%BRF) + Almena Canal Diversion (Non-IRR Season) x (1-92.2857%) + 0.6 x Dk + % x Pk + 0.5 x M&Ik + EvNFRk + Keith Sebelius Lake Ev + GWk

CBCU Nebraska = 0.6 x Dn below gage + % x Pn below gage + 0.5 x M&In below gage + EvNFRn + GWn below gage

VWS = Prairie Dog Creek near Woodruff, Kansas USGS Stn. No. 06848500 + CBCUc + CBCUk + CBCUn - 0.6 x Dn below gage - % x Pn below gage - 0.5 x M&In below gage –

EvNFRn below gage + ΔS Keith Sebelius Lake – IWS

Note: The CBCU surface water terms for Nebraska which occur below the gage are added in the VWS for the Main Stem

CWS = VWS- ΔS Keith Sebelius Lake - FF

Allocation Kansas = 0.457 x CSW

Allocation Nebraska = 0.076 x CWS

Unallocated = 0.467 x CWS

**15. The North Fork of the Republican River in Nebraska and the Main Stem of the Republican River between the junction of the North Fork and the Arikaree River and the Republican River near Hardy**

CBCU Colorado = GWc

CBCU Kansas =  
 (Deliveries from the Courtland Canal to Kansas above Lovewell) (IRR Season) x (1-%BRF) + (Deliveries from the Courtland Canal to Kansas above Lovewell) (Non-IRR Season) x (1-92.2857%)  
 + Amount of transportation loss of Courtland Canal deliveries to Lovewell that does not return to the river, charged to Kansas  
 + (Diversion of Republican River water from Lovewell Reservoir by the Courtland Canal below Lovewell) x (1-%BRF)  
 + 0.6 x Dk  
 + % x Pk  
 + 0.5 x M&Ik  
 + EvNFRk  
 + Harlan County Lake Ev charged to Kansas  
 + Lovewell Reservoir Ev charged to the Republican River  
 + GWk

CBCU Nebraska

=  
 Deliveries from Courtland Canal to Nebraska lands (IRR Season) x (1-%BRF) + Deliveries from Courtland Canal to Nebraska lands (Non-IRR Season) x (1- 92.2857%)  
 + Superior Canal (IRR Season) x (1- %BRF) + Superior Canal (Non-IRR Season) x (1-92,2857%)  
 + Franklin Pump Canal (IRR Season) x (1- %BRF) + Franklin Pump Canal (Non-IRR Season) x (1-92,2857%)  
 + Franklin Canal (IRR Season) x (1- %BRF) + Franklin Canal (Non-IRR Season) x (1-92,2857%)  
 + Naponee Canal (IRR Season) x (1- %BRF) + Naponee Canal (Non-IRR Season) x (1-92,2857%)  
 + Cambridge Canal (IRR Season) x (1- %BRF) + Cambridge Canal (Non-IRR Season) x (1-92,2857%)  
 + Bartley Canal (IRR Season) x (1- %BRF) + Bartley Canal (Non-IRR Season) x (1-92,2857%)  
 + Meeker-Driftwood Canal (IRR Season) x (1- %BRF) + Meeker-Driftwood Canal (Non-IRR Season) x (1-92,2857%)  
 + 0.9 x Red Willow Canal CBCU  
 + 0.6 x Dn  
 + % x Pn  
 + 0.5 x M&In  
 + EvNFRn  
 + 0.9 x Hugh Butler Lake Ev  
 + Harry Strunk Lake Ev  
 + Swanson Lake Ev  
 + Harlan County Lake Ev charged to Nebraska  
 + GWn

Notes:

The allocation of transportation losses in the Courtland Canal above Lovewell between Kansas and Nebraska shall be done by the Bureau of Reclamation and reported in their “Courtland Canal Above Lovewell” spreadsheet. Deliveries and losses associated with deliveries to both Nebraska and Kansas above Lovewell shall be reflected in the Bureau’s Monthly Water District reports. Losses associated with delivering water to Lovewell shall be separately computed.

Amount of transportation loss of the Courtland Canal

deliveries to Lovewell that does not return to the river, charged to Kansas shall be 18% of the Bureau’s estimate of

losses associated with these deliveries.

Red Willow Canal CBCU = Red Willow Canal Diversion  
(IRR Season) x (1- % BRF) + Red Willow Canal Diversion  
(Non-IRR Season) x (1-92,2857%)

10% of the Red Willow Canal CBCU is charged to  
 Nebraska's CBCU in Red Willow Creek sub-basin

10% of Hugh Butler Lake Ev is charged to Nebraska's  
 CBCU in the Red Willow Creek sub-basin

None of the Harry Strunk Lake EV is charged to Nebraska's  
 CBCU in the Medicine Creek sub-basin

VWS

=  
 Republican River near Hardy Gage Stn. No. 06853500  
 - North Fork of the Republican River at the State Line, Stn.  
 No. 06823000  
 - Arikaree Gage at Haigler Stn. No. 06821500  
 - Buffalo Creek near Haigler Gage Stn. No. 06823500  
 - Rock Creek at Parks Gage Stn. No. 06824000  
 -South Fork Republican River near Benkelman Gage Stn.  
 No. 06827500  
 - Frenchman Creek in Culbertson Stn. No. 06835500  
 - Driftwood Creek near McCook Gage Stn. No. 06836500  
 - Red Willow Creek near Red Willow Gage Stn. No.  
 06838000  
 - Medicine Creek below Harry Strunk Lake Gage Stn. No.  
 06842500  
 - Sappa Creek near Stamford Gage Stn. No. 06847500  
 - Prairie Dog Creek near Woodruff, Kansas Stn. No. 68-  
 485000  
 + CBCUc  
 + CBCUn  
 + 0.6 x Dk  
 + % x Pk  
 + 0.5 x M&Ik  
 + EvNFRk  
 + Harlan County Lake Ev charged to Kansas  
 +Amount of transportation loss of the Courtland Canal above  
 the Stateline that does not return to the river, charged to  
 Kansas  
 +GWk

- 0.9 x Red Willow Canal CBCU
  - 0.9 x Hugh Butler Ev
  - Harry Strunk Ev
  
- + 0.6 x Dn below Medicine Creek gage
- + % x Pn below Medicine Creek gage
- + 0.5 \* M&In below Medicine Creek gage
- + EvNFRn below Medicine Creek gage
- + 0.6 x Dn below Beaver Creek gage
- + % x Pn below Beaver Creek gage
- + 0.5 \* M&In below Beaver Creek gage
- + EvNFRn below Beaver Creek gage
  
- + 0.6 x Dn below Sappa Creek gage
- + % x Pn below Sappa Creek gage
- + 0.5 \* M&In below Sappa Creek gage
- + EvNFRn below Sappa Creek gage
  
- + 0.6 x Dn below Prairie Dog Creek gage
- + % x Pn below Prairie Dog Creek gage
- + 0.5 \* M&In below Prairie Dog Creek gage
- + EvNFRn below Prairie Dog Creek gage
  
- + Change in Storage Harlan County Lake
- + Change in Storage Swanson Lake
  
- Nebraska Haigler Canal RF
- 0.78 x Riverside Canal RF
- 0.17 x Culbertson Canal RF
- Culbertson Canal Extension RF to Main Stem
- + 0.24 x Meeker Driftwood Canal RF which returns to Driftwood Creek
- 0.9 x Red Willow Canal RF
  
- + Courtland Canal at Kansas-Nebraska State Line Gage Stn No. 06852500
- Courtland Canal RF in Kansas above Lovewell Reservoir
  
- IWS

Notes:  
 None of the Nebraska Haigler Canal RF returns to the North Fork of the Republican River

83% of the Culbertson Diversion RF and none of the Culbertson Extension RF return to Frenchman Creek

24 % of the Meeker Driftwood Canal RF returns to Driftwood Creek.

10% of the Red Willow Canal RF returns to Red Willow Creek

Courtland Canal RF in Kansas above Lovewell Reservoir =  $0.015 \times$  (Courtland Canal at Kansas-Nebraska State Line Gage Stn No. 06852500)

CWS = VWS - Change in Storage Harlan County Lake - Change in Storage Swanson Lake - FF

Allocation Kansas =  $0.511 \times$  CWS

Allocation Nebraska =  $0.489 \times$  CWS

## **V. Annual Data/ Information Requirements, Reporting, and Verification**

The following information for the previous calendar year shall be provided to the members of the RRCA Engineering Committee by April 15<sup>th</sup> of each year, unless otherwise specified.

All information shall be provided in electronic format, if available.

Each State agrees to provide all information from their respective State that is needed for the RRCA Groundwater Model and RRCA Accounting Procedures and Reporting Requirements, including but not limited to the following:

### **A. Annual Reporting**

#### **1. Surface water diversions and irrigated acreage:**

Each State will tabulate the canal, ditch, and other surface water diversions that are required by RRCA annual compact accounting and the RRCA Groundwater Model on a monthly format (or a procedure to distribute annual data to a monthly basis) and will forward the surface water diversions to the other States. This will include available diversion, wasteway, and farm delivery data for canals diverting from the Platte River that contribute to Imported Water Supply into the Basin. Each State will provide the water right number, type of use, system type, location, diversion

amount, and acres irrigated.

## 2. Groundwater pumping and irrigated acreage:

Each State will tabulate and provide all groundwater well pumping estimates that are required for the RRCA Groundwater Model to the other States.

**Colorado** – will provide an estimate of pumping based on a county format that is based upon system type, Crop Irrigation Requirement (CIR), irrigated acreage, crop distribution, and irrigation efficiencies. Colorado will require installation of a totalizing flow meter, installation of an hours meter with a measurement of the pumping rate, or determination of a power conversion coefficient for 10% of the active wells in the Basin by December 31, 2005. Colorado will also provide an annual tabulation for each groundwater well that measures groundwater pumping by a totalizing flow meter, hours meter or power conversion coefficient that includes: the groundwater well permit number, location, reported hours, use, and irrigated acreage.

**Kansas** - will provide an annual tabulation by each groundwater well that includes: water right number, groundwater pumping determined by a meter on each well (or group of wells in a manifold system) or by reported hours of use and rate; location; system type (gravity, sprinkler, LEPA, drip, etc.); and irrigated acreage. Crop distribution will be provided on a county basis.

**Nebraska** – will provide an annual tabulation through the representative Natural Resource District (NRD) in Nebraska that includes: the well registration number or other ID number; groundwater pumping determined by a meter on each well (or group of wells in a manifold system) or by reported hours of use and rate; wells will be identified by; location; system type (gravity, sprinkler, LEPA, drip, etc.); and irrigated acreage. Crop distribution will be provided on a county basis.

## 3. Climate information:

Each State will tabulate and provide precipitation, temperature, relative humidity or dew point, and solar radiation for the following climate stations:

State	Identification	Name
Colorado		
Colorado	C050109	Akron 4 E
Colorado	C051121	Burlington
Colorado	C054413	Julesburg
Colorado	C059243	Wray
Kansas	C140439	Atwood 2 SW
Kansas	C141699	Colby 1SW
Kansas	C143153	Goodland
Kansas	C143837	Hoxie

Kansas	C145856	Norton 9 SSE
Kansas	C145906	Oberlin1 E
Kansas	C147093	Saint Francis
Kansas	C148495	Wakeeny
Nebraska	C250640	Beaver City
Nebraska	C250810	Bertrand
Nebraska	C252065	Culbertson
Nebraska	C252690	Elwood 8 S
Nebraska	C253365	Gothenburg
Nebraska	C253735	Hebron
Nebraska	C253910	Holdredge
Nebraska	C254110	Imperial
Nebraska	C255090	Madrid
Nebraska	C255310	McCook
Nebraska	C255565	Minden
Nebraska	C256480	Palisade
Nebraska	C256585	Paxton
Nebraska	C257070	Red Cloud
Nebraska	C258255	Stratton
Nebraska	C258320	Superior
Nebraska	C258735	Upland
Nebraska	C259020	Wauneta 3 NW

**4. Crop Irrigation Requirements:**

Each State will tabulate and provide estimates of crop irrigation requirement information on a county format. Each State will provide the percentage of the crop irrigation requirement met by pumping; the percentage of groundwater irrigated lands served by sprinkler or flood irrigation systems, the crop irrigation requirement; crop distribution; crop coefficients; gain in soil moisture from winter and spring precipitation, net crop irrigation requirement; and/or other information necessary to compute a soil/water balance.

**5. Streamflow Records from State-Maintained Gaging Records:**

Streamflow gaging records from the following State maintained gages will be provided:

Station No	Name
00126700	Republican River near Trenton
06831500	Frenchman Creek near Imperial
06832500	Frenchman Creek near Enders

06835000	Stinking Water Creek near Palisade
06837300	Red Willow Creek above Hugh Butler Lake
06837500	Red Willow Creek near McCook
06841000	Medicine Creek above Harry Strunk Lake
06842500	Medicine Creek below Harry Strunk Lake
06844000	Muddy Creek at Arapahoe
06844210	Turkey Creek at Edison
06847000	Beaver Creek near Beaver City
	Republican River at Riverton
06851500	Thompson Creek at Riverton
06852000	Elm Creek at Amboy
	Republican River at the Superior-Courtland Diversion Dam

#### **6. Platte River Reservoirs:**

The State of Nebraska will provide the end-of-month contents, inflow data, outflow data, area-capacity data, and monthly net evaporation, if available, from Johnson Lake; Elwood Reservoir; Sutherland Reservoir; Maloney Reservoir; and Jeffrey Lake.

#### **7. Water Administration Notification:**

The State of Nebraska will provide the following information that describes the protection of reservoir releases from Harlan County Lake and for the administration of water rights junior in priority to February 26, 1948:

Date of notification to Nebraska water right owners to curtail their diversions, the amount of curtailment, and length of time for curtailment.

The number of notices sent.

The number of diversions curtailed and amount of curtailment in the Harlan County Lake to Guide Rock reach of the Republican River.

#### **8. Moratorium:**

Each State will provide a description of all new Wells constructed in the Basin Upstream of Guide Rock including the owner, location (legal description), depth and diameter or dimension of the constructed water well, casing and screen information, static water level, yield of the water well in gallons per minute or gallons per hour, and intended use of the water well.

Designation whether the Well is a:

- a. Test hole;
- b. Dewatering Well with an intended use of one year or less;
- c. Well designed and constructed to pump fifty gallons per minute or less;
- d. Replacement Water Well, including a description of the Well that is replaced providing the information described above for new Wells and a description of the historic use of the Well that is replaced;
- e. Well necessary to alleviate an emergency situation involving provision of water for human consumption, including a brief description of the nature of the emergency situation and the amount of water intended to be pumped by and the length of time of operation of the new Well;
- f. Transfer Well, including a description of the Well that is transferred providing the information described above for new Wells and a description of the Historic Consumptive Use of the Well that is transferred;
- g. Well for municipal and/or industrial expansion of use;

Wells in the Basin in Northwest Kansas or Colorado. Kansas and Colorado will provide the information described above for new Wells along with copies of any other information that is required to be filed with either State of local agencies under the laws, statutes, rules and regulations in existence as of April 30, 2002, and;

Any changes in State law in the previous year relating to existing Moratorium.

#### **9. Non-Federal Reservoirs:**

Each State will conduct an inventory of Non Federal Reservoirs by December 31, 2004, for inclusion in the annual Compact Accounting. The inventory shall include the following information: the location, capacity (in Acre-feet) and area (in acres) at the principal spillway elevation of each Non-Federal Reservoir. The States will annually provide any updates to the initial inventory of Non-Federal Reservoirs, including enlargements that are constructed in the previous year.

Owners/operators of Non-Federal Reservoirs with 200 Acre-feet of storage capacity or greater at the principal spillway elevation will be required to provide an area-capacity survey from State-approved plans or prepared by a licensed professional engineer or land surveyor.

## B. RRCA Groundwater Model Data Input Files

1. Monthly groundwater pumping, surface water recharge, groundwater recharge, and precipitation recharge provided by county and indexed to the one square mile cell size.
2. Potential Evapotranspiration rate is set as a uniform rate for all phreatophyte vegetative classes – the amount is X at Y climate stations and is interpolated spatially using kriging.

## C. Inputs to RRCA Accounting

### 1. Surface Water Information

- a. Streamflow gaging station records: obtained as preliminary USGS or Nebraska streamflow records, with adjustments to reflect a calendar year, at the following locations:

Arikaree River at Haigler, Nebraska  
 North Fork Republican River at Colorado-Nebraska state line  
 Buffalo Creek near Haigler, Nebraska  
 Rock Creek at Parks, Nebraska  
 South Fork Republican River near Benkelman, Nebraska  
 Frenchman Creek at Culbertson, Nebraska  
 Red Willow Creek near Red Willow, Nebraska  
 Medicine Creek below Harry Strunk Lake, Nebraska\*  
 Beaver Creek near Beaver City, Nebraska\*  
 Sappa Creek near Stamford, Nebraska  
 Prairie Dog Creek near Woodruff, Kansas  
 Courtland Canal at Nebraska-Kansas state line  
 Republican River near Hardy, Nebraska  
 Republican River at Superior-Courtland Diversion Dam near  
 Guide Rock,  
 Nebraska (new)\*

- b. Federal reservoir information: obtained from the United States Bureau of Reclamation:

Daily free water surface evaporation, storage, precipitation, reservoir release information, and updated area-capacity tables.

Federal Reservoirs:  
 Bonny Reservoir

Swanson Lake  
 Harry Strunk Lake  
 Hugh Butler Lake  
 Enders Reservoir  
 Keith Sebelius Lake  
 Harlan County Lake  
 Lovewell Reservoir

c. Non-federal reservoirs obtained by each state: an updated inventory of reservoirs that includes the location, surface area (acres), and capacity (in Acre-feet), of each non-federal reservoir with storage capacity of fifteen (15) Acre-feet or greater at the principal spillway elevation. Supporting data to substantiate the average surface water areas that are different than the presumptive average annual surface area may be tendered by the offering State.

d. Diversions and related data from USBR

Irrigation diversions by canal, ditch, and pumping station that irrigate more than two (2) acres  
 Diversions for non-irrigation uses greater than 50 Acre-feet  
 Farm Deliveries  
 Wasteway measurements  
 Irrigated acres

e. Diversions and related data – from each respective State

Irrigation diversions by canal, ditch, and pumping station that irrigate more than two (2) acres  
 Diversions for non-irrigation uses greater than 50 Acre-feet  
 Wasteway measurements, if available

**2. Groundwater Information**

(From the RRCA Groundwater model as output files as needed for the accounting procedures)

a. Imported water - mound credits in amount and time that occur in defined streamflow points/reaches of measurement or compliance – ex: gaging stations near confluence or state lines

- b. Groundwater depletions to streamflow (above points of measurement or compliance – ex: gaging stations near confluence or state lines)

### **3. Summary**

The aforementioned data will be aggregated by Sub-basin as needed for RRCA accounting.

## **D. Verification**

### **1. Documentation to be Available for Inspection Upon Request**

- a. Well permits/ registrations database
- b. Copies of well permits/ registrations issued in calendar year
- c. Copies of surface water right permits or decrees
- d. Change in water right/ transfer historic use analyses
- e. Canal, ditch, or other surface water diversion records
- f. Canal, ditch, or other surface water measurements
- g. Reservoir storage and release records
- h. Irrigated acreage

### **2. Site Inspection**

- a. Accompanied – reasonable and mutually acceptable schedule among representative state and/or federal officials.
- b. Unaccompanied – inspection parties shall comply with all laws and regulations of the State in which the site inspection occurs.

Table 1: Annual Virgin and Computed Water Supply, Allocations and Computed Beneficial Consumptive Uses by State, Main Stem and Sub-basin

Designated Drainage Basin	Col. 1: Virgin Water Supply	Col. 2: Computed Water Supply	Col. 3: Allocations				Col. 4: Computed Beneficial Consumptive Use		
			Colorado	Nebraska	Kansas	Unallocated	Colorado	Nebraska	Kansas
North Fork in Colorado									
Arikaree									
Buffalo									
Rock									
South Fork of Republican River									
Frenchman									
Driftwood									
Red Willow									
Medicine									
Beaver									
Sappa									
Prairie Dog									
North Fork of Republican River in Nebraska and Main Stem									
Total All Basins									
North Fork Of Republican River in Nebraska and Mainstem Including Unallocated Water									
Total									

Table 2: Original Compact Virgin Water Supply and Allocations

Designated Drainage Basin	Virgin Water Supply	Colorado Allocation	% of Total Drainage Basin Supply	Kansas Allocation	% of Total Drainage Basin Supply	Nebraska Allocation	% of Total Drainage Basin Supply	Unallocated	% of Total Drainage Basin Supply
North Fork - CO	44,700	10,000	22.4			11,000	24.6	23,700	53.0
Arikaree River	19,610	15,400	78.5	1,000	5.1	3,300	16.8	-90	-0.4
Buffalo Creek	7,890					2,600	33.0	5,290	67.0
Rock Creek	11,000					4,400	40.0	6,600	60.0
South Fork	57,200	25,400	44.4	23,000	40.2	800	1.4	8,000	14.0
Frenchman Creek	98,500					52,800	53.6	45,700	46.4
Driftwood Creek	7,300			500	6.9	1,200	16.4	5,600	76.7
Red Willow Creek	21,900					4,200	19.2	17,700	80.8
Medicine Creek	50,800					4,600	9.1	46,200	90.9
Beaver Creek	16,500	3,300	20.0	6,400	38.8	6,700	40.6	100	0.6
Sappa Creek	21,400			8,800	41.1	8,800	41.1	3,800	17.8
Prairie Dog Creek	27,600			12,600	45.7	2,100	7.6	12,900	46.7
Sub-total Tributaries	384,400							175,500	
Main Stem + Blackwood Creek	94,500								
Main Stem + Unallocated	270,000			138,000	51.1	132,000	48.9		
Total	478,900	54,100		190,300		234,500			

Table 3A: Table to Be Used to Calculate Colorado's Five-Year Running Average Allocation and Computed Beneficial Consumptive Use for Determining Compact Compliance

Colorado				
	Col. 1	Col. 2	Col. 3	Col. 4
Year	Allocation	Computed Beneficial Consumptive	Imported Water Supply Credit	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Col 1 – (Col 2- Col 3)
Year t= -4				
Year t= -3				
Year t= -2				
Year t= -1				
Current Year t= 0				
Average				

Table 3B. Table to Be Used to Calculate Kansas's Five-Year Running Average Allocation and Computed Beneficial Consumptive Use for Determining Compact Compliance

Kansas				
	Col. 1	Col. 2	Col. 3	Col. 4
Year	Allocation	Computed Beneficial Consumptive	Imported Water Supply Credit	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Col 1 – (Col 2- Col 3)
Year t= -4				
Year t= -3				
Year t= -2				
Year t= -1				
Current Year t= 0				
Average				

Table 3C. Table to Be Used to Calculate Nebraska's Five-Year Running Average Allocation and Computed Beneficial Consumptive Use for Determining Compact Compliance

Nebraska				
	Col. 1	Col. 2	Col. 3	Col. 4
Year	Allocation	Computed Beneficial Consumptive	Imported Water Supply Credit	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Col 1 – (Col 2- Col 3)
Year T= -4				
Year T= -3				
Year T= -2				
Year T= -1				
Current Year T= 0				
Average				

Republican River Compact Administration

Accounting Procedures and Reporting Requirements  
Revised August 2010

Table 4A: Colorado Compliance with the Sub-basin Non-impairment Requirement

	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
Sub-basin	Colorado Sub-basin Allocation (5-year running average)	Unallocated Supply (5-year running average)	Credits from Imported Water Supply (5-year running average)	Total Supply Available = Col 1+ Col 2 + Col 3 (5-year running average)	Colorado Computed Beneficial Consumptive Use (5-year running average)	Difference Between Available Supply and Computed Beneficial Consumptive Use = Col 4 – Col 5 (5-year running average)
North Fork Republican River Colorado						
Arikaree River						
South Fork Republican River						
Beaver Creek						

Table 4B: Kansas Compliance with the Sub-basin Non-impairment Requirement

	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7
Sub-basin	Kansas Sub-basin Allocation (5-year running average)	Unallocated Supply (5-year running average)	Unused Allocation from Colorado (5-year running average)	Credits from Imported Water Supply (5-year running average)	Total Supply Available = Col 1+ Col 2+ Col 3 + Col 4 (5-year running average)	Kansas Computed Beneficial Consumptive Use (5-year running average)	Difference Between Available Supply and Computed Beneficial Consumptive Use = Col 5 – Col 6 (5-year running average)
Arikaree River							
South Fork Republican River							
Driftwood Creek							
Beaver Creek							
Sappa Creek							
Prairie Dog Creek							

Revised August 2010

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

Colorado				
	Col. 1	Col. 2	Col. 3	Col 4
Year	Allocation minus Allocation for Beaver Creek	Computed Beneficial Consumptive minus Computed Beneficial Consumptive Use for Beaver Creek	Imported Water Supply Credit excluding Beaver Creek	Difference between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit for All Basins Except Beaver Creek Col 1 – (Col 2 – Col 3)
Year T= -4				
Year T= -3				
Year T= -2				
Year T= -1				
Current Year T= 0				
Average				

Table 5B: Kansas Compliance During Water-Short Year Administration

Kansas						
Year	Allocation			Computed Beneficial Consumptive Use`	Imported Water Supply Credit	Difference Between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit
Column	1	2	3	4	5	6
	Sum Sub-basins	Kansas's Share of the Unallocated Supply	Total Col 1 + Col 2			Col 3 – (Col 4 – Col 5)
Previous Year						
Current Year						
Average						

Revised August 2010

Table 5C: Nebraska Compliance During Water-Short Year Administration

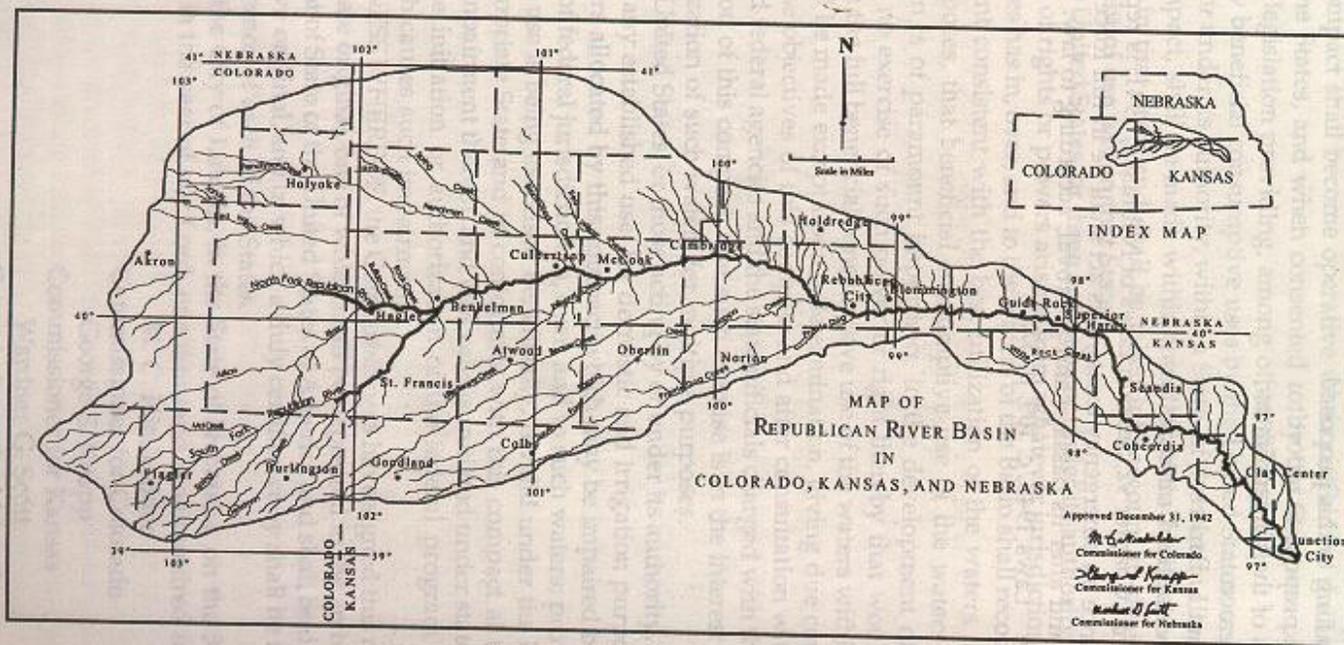
Nebraska								
Year	Allocation			Computed Beneficial Consumptive Use			Imported Water Supply Credit	Difference Between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Above Guide Rock
Column	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
	State Wide Allocation	Allocation below Guide Rock	State Wide Allocation above Guide Rock	State Wide CBCU	CBCU below Guide Rock	State Wide CBCU above Guide Rock	Credits above Guide Rock	Col 3 – (Col 6 – Col 7)
Previous Year								
Current Year								
Average								

Year	Allocation			Computed Beneficial Consumptive Use			Imported Water Supply Credit	Difference Between Allocation and the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit Above Guide Rock
Column	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8
	State Wide Allocation	Allocation below Guide Rock	State Wide Allocation above Guide Rock	State Wide CBCU	CBCU below Guide Rock	State Wide CBCU above Guide Rock	Credits above Guide Rock	Col 3 – (Col 6- Col 7)
Year = -2								
Year = -1								
Current Year								
Three-Year Average								
Sum of Previous Two-year Difference								
Expected Decrease in CBCU Under Plan								

Table 5E: Nebraska Tributary Compliance During Water-Short Year Administration

Year	Sum of Nebraska Sub-basin Allocations	Sum of Nebraska's Share of Sub-basin Unallocated Supplies	Total Available Water Supply for Nebraska	Computed Beneficial Consumptive Use	Imported Water Supply Credit	Difference between Allocation And the Computed Beneficial Consumptive Use offset by Imported Water Supply Credit
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6
Previous Year						Col 3 -(Col 4-Col 5)
Current Year						
Average						

Figure 1



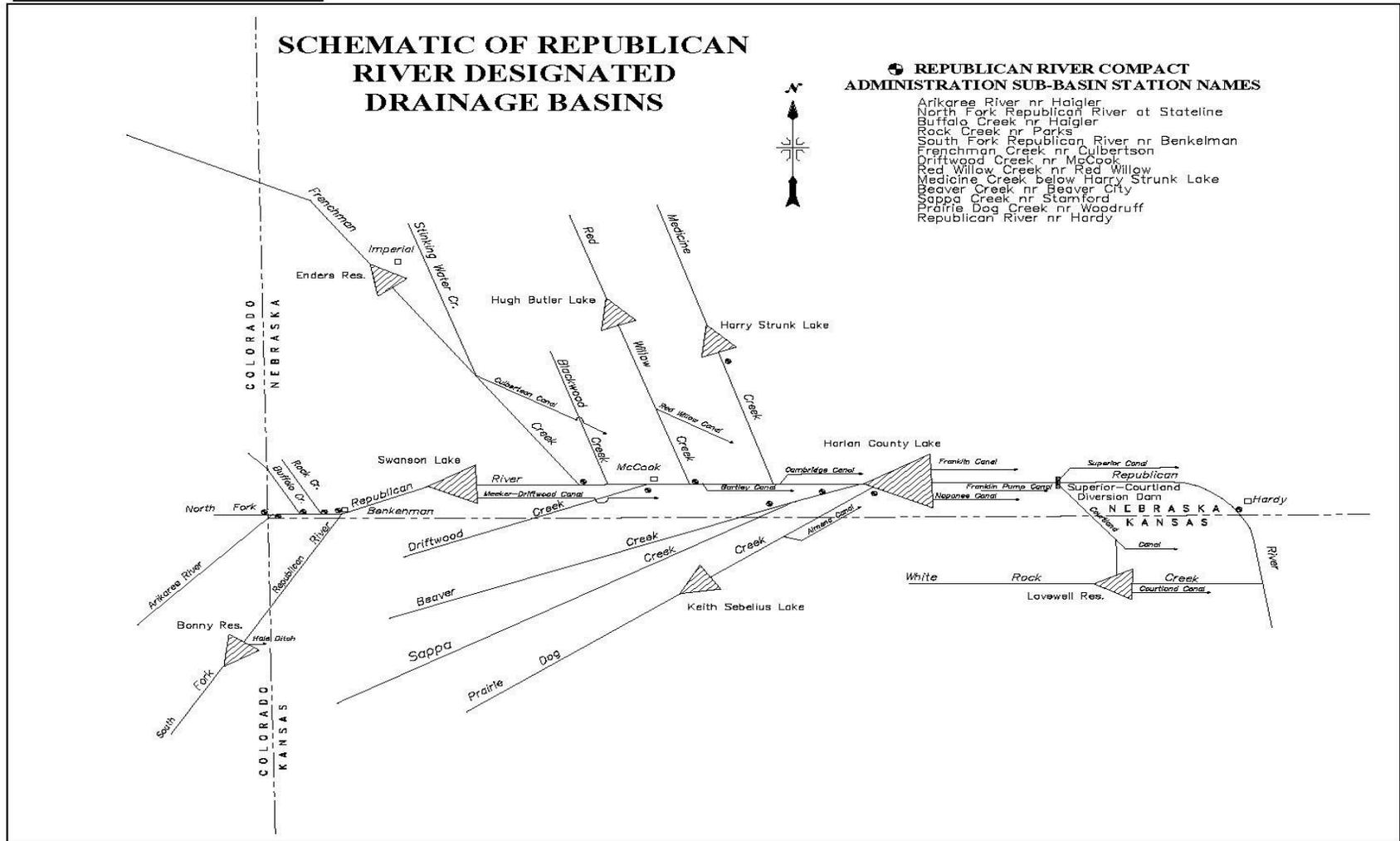
Basin Map Attached to Compact that Shows the Streams and the Basin Boundaries

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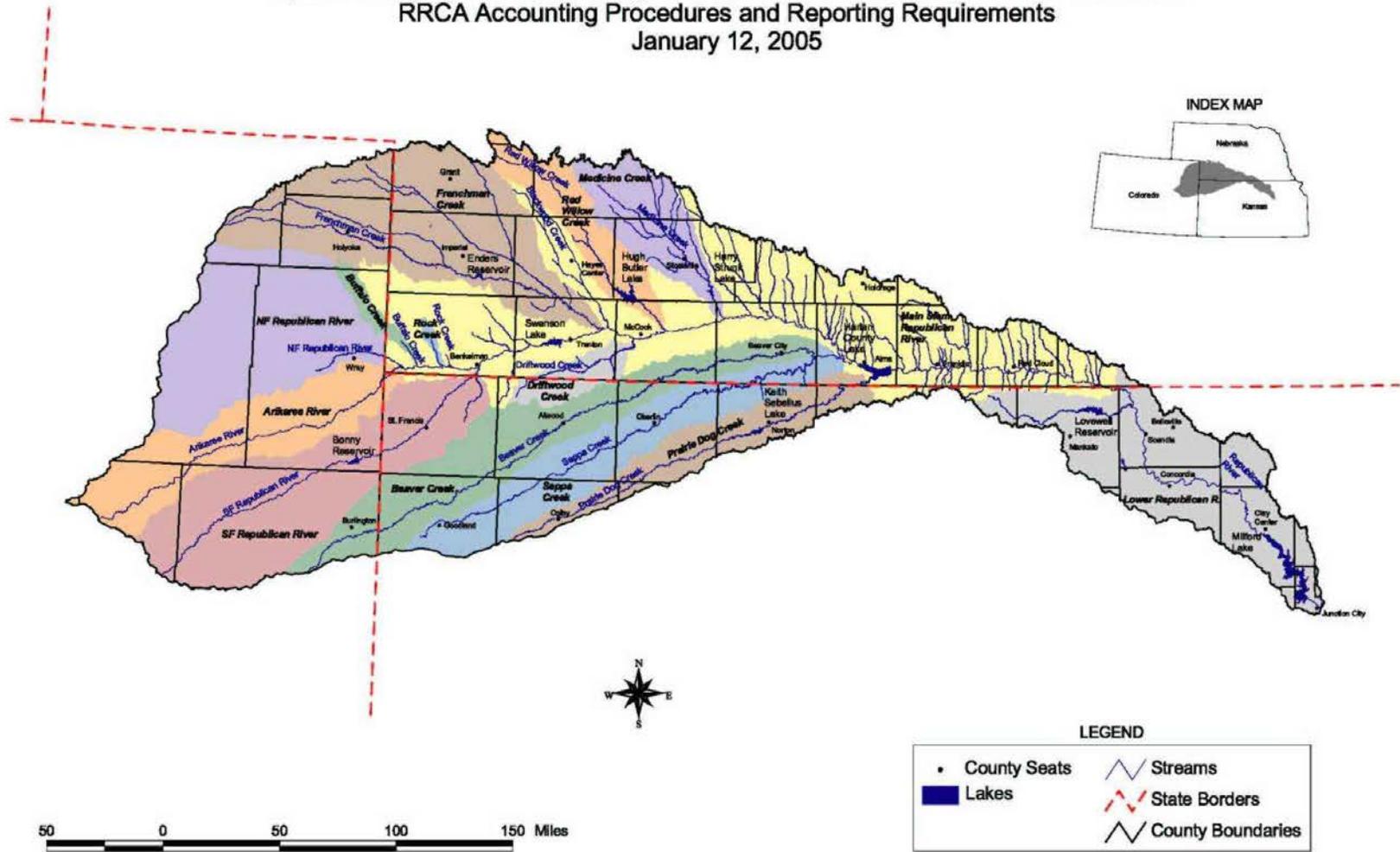
APPENDIX

Figure 2



Line Diagram of Designated Drainage Basins Showing Federal Reservoirs and Sub-basin Gaging Stations

Update of Figure 3 - Map Showing Sub-basins, Streams, and the Basin Boundaries  
 RRCA Accounting Procedures and Reporting Requirements  
 January 12, 2005



Map Showing Sub-basins, Streams, and the Basin Boundaries

## Attachment 1: Sub-basin Flood Flow Thresholds

Sub-basin	Sub-basin Flood Flow Threshold Acre-feet per Year <sup>3</sup>
Arikaree River	16,400
North Fork of Republican River	33,900
Buffalo Creek	4,800
Rock Creek	9,800
South Fork of Republican River	30,400
Frenchman Creek	51,900
Driftwood Creek	9,400
Red Willow Creek	15,100
Medicine Creek	55,100
Beaver Creek	13,900
Sappa Creek	26,900
Prairie Dog	15,700

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<sup>3</sup> Flows considered to be Flood Flows are flows in excess of the 94% flow based on a flood frequency analysis for the years 1971-2000. The Gaged Flows are measured after depletions by Beneficial Consumptive Use and change in reservoir storage.

## Attachment 2: Description of the Consensus Plan for Harlan County Lake

The Consensus Plan for operating Harlan County Lake was conceived after extended discussions and negotiations between Reclamation and the Corps. The agreement shaped at these meetings provides for sharing the decreasing water supply into Harlan County Lake. The agreement provides a consistent procedure for: updating the reservoir elevation/storage relationship, sharing the reduced inflow and summer evaporation, and providing a January forecast of irrigation water available for the following summer.

During the interagency discussions the two agencies found agreement in the following areas:

- The operating plan would be based on current sediment accumulation in the irrigation pool and other zones of the project.
- Evaporation from the lake affects all the various lake uses in proportion to the amount of water in storage for each use.
- During drought conditions, some water for irrigation could be withdrawn from the sediment pool.
- Water shortage would be shared between the different beneficial uses of the project, including fish, wildlife, recreation and irrigation.

To incorporate these areas of agreement into an operation plan for Harlan County Lake, a mutually acceptable procedure addressing each of these items was negotiated and accepted by both agencies.

### 1. Sediment Accumulation.

The most recent sedimentation survey for Harlan County project was conducted in 1988, 37 years after lake began operation. Surveys were also performed in 1962 and 1972; however, conclusions reached after the 1988 survey indicate that the previous calculations are unreliable. The 1988 survey indicates that, since closure of the dam in 1951, the accumulated sediment is distributed in each of the designated pools as follows:

Flood Pool	2,387 Acre-feet
Irrigation Pool	4,853 Acre-feet
Sedimentation Pool	33,527 Acre-feet

To insure that the irrigation pool retained 150,000 Acre-feet of storage, the bottom of the irrigation pool was lowered to 1,932.4 feet, msl, after the 1988 survey.

To estimate sediment accumulation in the lake since 1988, we assumed similar conditions have occurred at the project during the past 11 years. Assuming a consistent rate of deposition since 1988, the irrigation pool has trapped an additional 1,430 Acre-feet.

A similar calculation of the flood control pool indicates that the flood control pool has captured an additional 704 Acre-feet for a total of 3,090 Acre-feet since construction.

The lake elevations separating the different pools must be adjusted to maintain a 150,000-acre-foot irrigation pool and a 500,000-acre-foot flood control pool. Adjusting these elevations results in the following new elevations for the respective pools (using the 1988 capacity tables).

Top of Irrigation Pool	1,945.70 feet, msl
Top of Sediment Pool	1,931.75 feet, msl

Due to the variability of sediment deposition, we have determined that the elevation capacity relationship should be updated to reflect current conditions. We will complete a new sedimentation survey of Harlan County Lake this summer, and new area capacity tables should be available by early next year. The new tables may alter the pool elevations achieved in the Consensus Plan for Harlan County Lake.

## 2. Summer Evaporation.

Evaporation from a lake is affected by many factors including vapor pressure, wind, solar radiation, and salinity of the water. Total water loss from the lake through evaporation is also affected by the size of the lake. When the lake is lower, the surface area is smaller and less water loss occurs. Evaporation at Harlan County Lake has been estimated since the lake's construction using a Weather Service Class A pan which is 4 feet in diameter and 10 inches deep. We and Reclamation have jointly reviewed this information and assumed future conditions to determine an equitable method of distributing the evaporation loss from the project between irrigation and the other purposes.

During those years when the irrigation purpose expected a summer water yield of 119,000 Acre-feet or more, it was determined that an adequate water supply existed and no sharing of evaporation was necessary. Therefore, evaporation evaluation focused on the lower pool elevations when water was scarce. Times of water shortage would also generally be times of higher evaporation rates from the lake.

Reclamation and we agreed that evaporation from the lake during the summer (June through September) would be distributed between the irrigation and sediment pools based on their relative percentage of the total storage at the time of evaporation. If the sediment pool held 75 percent of the total storage, it would be charged 75 percent of the evaporation. If the sediment pool held 50 percent of the total storage, it would be charged 50 percent of the evaporation. At the bottom of the irrigation pool (1,931.75 feet, msl) all of the evaporation would be charged to the sediment pool.

Due to downstream water rights for summer inflow, neither the irrigation nor the sediment pool is credited with summer inflow to the lake. The summer inflows would be

assumed passed through the lake to satisfy the water right holders. Therefore, Reclamation and we did not distribute the summer inflow between the project purposes.

As a result of numerous lake operation model computer runs by Reclamation, it became apparent that total evaporation from the project during the summer averaged about 25,000 Acre-feet during times of lower lake elevations. These same models showed that about 20 percent of the evaporation should be charged to the irrigation pool, based on percentage in storage during the summer months. About 20 percent of the total lake storage is in the irrigation pool when the lake is at elevation 1,935.0 feet, msl. As a result of the joint study, Reclamation and we agreed that the irrigation pool would be credited with 20,000 Acre-feet of water during times of drought to share the summer evaporation loss.

Reclamation and we further agreed that the sediment pool would be assumed full each year. In essence, if the actual pool elevation were below 1,931.75 feet, msl, in January, the irrigation pool would contain a negative storage for the purpose of calculating available water for irrigation, regardless of the prior year's summer evaporation from sediment storage.

### 3. Irrigation withdrawal from sediment storage.

During drought conditions, occasional withdrawal of water from the sediment pool for irrigation is necessary. Such action is contemplated in the Field Working Agreement and the Harlan County Lake Regulation Manual: "Until such time as sediment fully occupies the allocated reserve capacity, it will be used for irrigation and various conservation purposes, including public health, recreation, and fish and wildlife preservation."

To implement this concept into an operation plan for Harlan County Lake, Reclamation and we agreed to estimate the net spring inflow to Harlan County Lake. The estimated inflow would be used by the Reclamation to provide a firm projection of water available for irrigation during the next season.

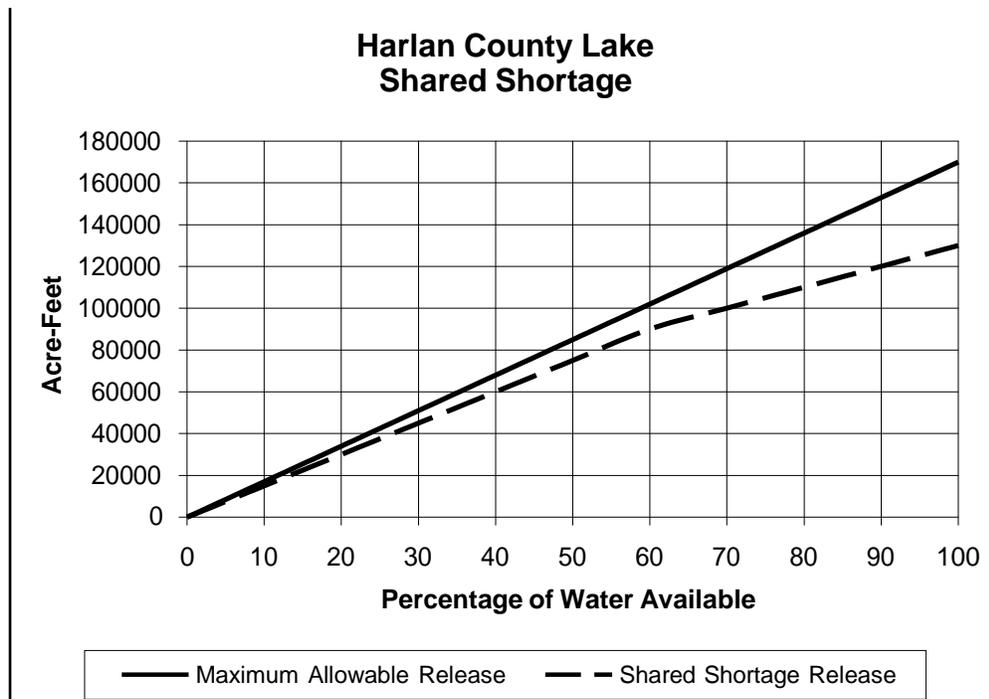
Since the construction of Harlan County Lake, inflows to the lake have been depleted by upstream irrigation wells and farming practices. Reclamation has recently completed an in-depth study of these depleted flows as a part of their contract renewal process. The study concluded that if the current conditions had existed in the basin since 1931, the average spring inflow to the project would have been 57,600 Acre-feet of water. The study further concluded that the evaporation would have been 8,800 Acre-feet of water during the same period. Reclamation and we agreed to use these values to calculate the net inflow to the project under the current conditions.

In addition, both agencies also recognized that the inflow to the project could continue to decrease with further upstream well development and water conservation farming. Due to these concerns, Reclamation and we determined that the previous 5-year inflow values would be averaged each year and compared to 57,600 Acre-feet. The inflow estimate for Harlan County Lake would be the smaller of these two values.

The estimated inflow amount would be used in January of each year to forecast the amount of water stored in the lake at the beginning of the irrigation season. Based on this forecast, the irrigation districts would be provided a firm estimate of the amount of water available for the next season. The actual storage in the lake on May 31 would be reviewed each year. When the actual water in storage is less than the January forecast, Reclamation may draw water from sediment storage to make up the difference.

4. Water Shortage Sharing.

A final component of the agreement involves a procedure for sharing the water available during times of shortage. Under the shared shortage procedure, the irrigation purpose of the project would remove less water than otherwise allowed and alleviate some of the adverse effects to the other purposes. The procedure would also extend the water supply during times of drought by “banking” some water for the next irrigation season. The following graph illustrates the shared shortage releases.



5. Calculation of Irrigation Water Available

Each January, the Reclamation would provide the Bostwick irrigation districts a firm estimate of the quantity of water available for the following season. The firm estimate of water available for irrigation would be calculated by using the following equation and shared shortage adjustment:

$$\text{Storage} + \text{Summer Sediment Pool Evaporation} + \text{Inflow} - \text{Spring Evaporation} = \text{Maximum Irrigation Water Available}$$

The variables in the equation are defined as:

- **Maximum Irrigation Water Available.** Maximum irrigation supply from Harlan County Lake for that irrigation season.
- **Storage.** Actual storage in the irrigation pool at the end of December. The sediment pool is assumed full. If the pool elevation is below the top of the sediment pool, a negative irrigation storage value would be used.
- **Inflow.** The inflow would be the smaller of the past 5-year average inflow to the project from January through May, or 57,600 Acre-feet.
- **Spring Evaporation.** Evaporation from the project would be 8,800 Acre-feet which is the average January through May evaporation.
- **Summer Sediment Pool Evaporation.** Summer evaporation from the sediment pool during June through September would be 20,000 Acre-feet. This is an estimate based on lower pool elevations, which characterize the times when it would be critical to the computations.

#### 6. Shared Shortage Adjustment

To ensure that an equitable distribution of the available water occurs during short-term drought conditions, and provide for a “banking” procedure to increase the water stored for subsequent years, a shared shortage plan would be implemented. The maximum water available for irrigation according to the above equation would be reduced according to the following table. Linear interpolation of values will occur between table values.

Shared Shortage Adjustment Table

Irrigation Water Available (Acre-feet)	Irrigation Water Released (Acre-feet)
0	0
17,000	15,000
34,000	30,000
51,000	45,000
68,000	60,000
85,000	75,000
102,000	90,000
119,000	100,000
136,000	110,000
153,000	120,000
170,000	130,000

## 7. Annual Shutoff Elevation for Harlan County Lake

The annual shutoff elevation for Harlan County Lake would be estimated each January and finally established each June.

The annual shutoff elevation for irrigation releases will be estimated by Reclamation each January in the following manner:

1. Estimate the May 31 Irrigation Water Storage (IWS) (Maximum 150,000 Acre-feet) by taking the December 31 irrigation pool storage plus the January-May inflow estimate (57,600 Acre-feet or the average inflow for the last 5-year period, whichever is less) minus the January-May evaporation estimate (8,800 Acre-feet).
2. Calculate the estimated Irrigation Water Available, including all summer evaporation, by adding the Estimated Irrigation Water Storage (from item 1) to the estimated sediment pool summer evaporation (20,000 AF).
3. Use the above Shared Shortage Adjustment Table to determine the acceptable Irrigation Water Release from the Irrigation Water Available.
4. Subtract the Irrigation Water Release (from item 3) from the Estimated IWS (from item 1). The elevation of the lake corresponding to the resulting irrigation storage is the Estimated Shutoff Elevation. The shutoff elevation will not be below the bottom of the irrigation pool if over 119,000 AF of water is supplied to the districts, nor below 1,927.0 feet, msl. If the shutoff elevation is below the irrigation pool, the maximum irrigation release is 119,000 AF.

The annual shutoff elevation for irrigation releases would be finalized each June in accordance with the following procedure:

1. Compare the estimated May 31 IWS with the actual May 31 IWS.
2. If the actual end of May IWS is less than the estimated May IWS, lower the shutoff elevation to account for the reduced storage.
3. If the actual end of May IWS is equal to or greater than the estimated end of May IWS, the estimated shutoff elevation is the annual shutoff elevation.
4. The shutoff elevation will never be below elevation 1,927.0 feet, msl, and will not be below the bottom of the irrigation pool if more than 119,000 Acre-feet of water is supplied to the districts.

## Attachment 3: Inflows to Harlan County Lake 1993 Level of Development

BASELINE RUN - 1993 LEVEL INFLOW TO HARLAN COUNTY RESERVOIR													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1931	10.2	10.8	13.4	5.0	18.8	15.8	4.3	1.8	1.8	0.0	0.1	0.1	82.1
1932	6.8	16.6	18.5	4.6	3.8	47.6	3.8	2.8	4.8	0.0	0.0	0.4	109.7
1933	0.4	0.0	3.9	30.2	31.0	5.4	1.8	0.0	10.4	0.0	2.6	5.5	91.2
1934	2.1	0.0	3.2	1.8	0.7	7.3	0.8	0.0	1.3	0.0	2.2	0.0	19.4
1935	0.3	0.1	0.7	4.2	0.8	389.3	6.1	19.1	26.1	2.4	5.2	0.9	455.2
1936	0.3	0.0	11.9	0.0	35.9	4.7	0.4	0.0	1.8	0.0	1.6	3.8	60.4
1937	4.8	12.9	6.0	2.5	0.0	12.6	6.3	6.9	2.4	0.0	0.0	12.4	66.8
1938	9.9	7.8	8.7	10.4	18.7	8.6	7.3	7.8	4.9	0.2	0.0	4.7	89.0
1939	2.7	7.5	9.6	12.2	6.6	13.3	5.0	4.1	0.0	0.0	0.0	0.0	61.0
1940	0.0	0.0	12.2	5.2	4.6	23.7	2.8	3.2	0.0	3.6	0.0	1.4	56.7
1941	0.0	10.6	10.6	7.7	17.2	67.1	28.9	19.7	14.9	8.3	6.7	7.1	198.8
1942	3.3	10.6	0.5	34.1	30.8	83.9	11.7	10.9	36.5	3.1	8.7	0.3	234.4
1943	1.2	11.2	14.6	31.4	4.7	28.3	4.8	0.3	0.9	0.0	0.0	11.8	109.2
1944	0.1	4.3	9.0	43.1	31.9	63.9	26.6	15.4	0.5	0.3	3.0	4.5	202.6
1945	4.3	7.8	5.7	9.5	4.1	53.5	5.0	0.9	1.5	5.0	6.0	6.3	109.6
1946	5.9	11.2	9.3	4.9	7.0	3.1	1.6	11.4	28.1	129.9	25.0	12.1	249.5
1947	1.1	3.2	10.4	8.2	11.9	195.4	22.3	5.9	2.9	0.2	0.3	0.3	262.1
1948	6.2	9.8	24.1	5.4	0.2	39.8	13.5	6.8	4.2	0.0	0.1	0.1	110.2
1949	2.0	1.5	25.2	16.3	49.0	57.4	9.2	5.5	2.1	3.0	2.8	0.3	174.3
1950	0.3	5.7	10.8	10.9	28.9	10.1	12.7	9.3	7.8	7.2	3.8	3.1	110.6
1951	3.8	3.4	7.1	5.3	42.0	39.9	42.1	10.1	36.0	15.5	14.8	8.9	228.9
1952	16.4	21.4	26.3	23.8	34.6	4.0	9.3	3.1	1.5	11.7	4.3	0.1	156.5
1953	1.8	4.6	5.3	3.3	15.1	9.5	1.8	0.2	0.0	0.0	2.8	0.1	44.5
1954	1.0	6.8	1.9	3.2	7.1	2.4	0.0	1.2	0.0	0.0	0.0	0.0	23.6
1955	0.0	4.0	6.3	4.8	2.9	6.4	2.7	0.0	1.4	0.0	0.0	0.0	28.5
1956	1.6	3.4	2.9	2.4	1.3	1.5	0.0	0.6	0.0	0.0	0.0	0.0	13.7
1957	0.0	4.1	6.2	12.8	3.5	62.4	21.3	1.2	2.0	3.4	4.5	4.7	126.1
1958	0.8	3.0	14.2	14.0	18.7	1.3	3.4	2.2	0.0	0.4	0.0	0.6	58.6
1959	1.9	15.4	16.4	8.5	13.6	4.2	1.4	1.2	0.0	4.3	1.0	4.5	72.4
1960	1.4	12.3	71.4	23.9	21.7	53.7	14.1	3.2	0.0	0.0	0.2	2.8	204.7
1961	2.3	6.4	7.7	7.4	26.5	24.0	7.2	4.9	0.0	2.3	4.8	1.7	95.2

## Attachment 3: Inflows to Harlan County Lake 1993 Level of Development

BASELINE RUN - 1993 LEVEL INFLOW TO HARLAN COUNTY RESERVOIR													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1962	4.5	9.1	16.2	9.9	14.4	42.6	41.6	21.1	2.3	8.7	8.3	5.7	184.4
1963	3.4	18.2	18.2	15.0	12.7	14.7	3.4	6.1	8.7	0.8	5.3	1.8	108.3
1964	5.4	7.6	8.3	8.4	9.9	11.9	7.2	6.5	2.4	1.9	1.4	2.3	73.2
1965	6.0	8.1	11.1	12.8	32.8	40.0	22.9	6.5	37.2	53.7	19.5	11.0	261.6
1966	8.9	21.4	15.7	11.4	12.0	34.7	12.4	2.5	3.5	5.4	6.8	5.7	140.4
1967	7.2	11.5	11.5	12.9	9.1	75.3	43.7	15.3	4.4	7.3	6.9	5.4	210.5
1968	3.9	10.2	8.5	11.6	10.8	12.5	3.1	2.7	1.6	2.0	4.3	3.4	74.6
1969	4.2	10.8	24.5	15.1	18.9	17.5	17.0	12.6	16.6	9.2	11.8	9.9	168.1
1970	3.5	8.7	8.5	10.5	11.1	7.7	4.6	3.2	0.5	3.3	4.7	4.5	70.8
1971	4.1	10.3	12.4	12.8	18.3	7.2	8.4	6.2	1.9	4.2	7.3	7.1	100.2
1972	5.5	8.1	9.2	8.3	14.8	8.5	6.5	4.4	0.1	2.9	7.6	4.1	80.0
1973	11.4	14.2	19.0	16.2	17.4	20.9	9.1	1.9	8.4	19.6	11.9	13.2	163.2
1974	13.2	13.4	12.0	14.3	15.4	17.2	5.5	0.0	0.0	0.0	4.9	5.5	101.4
1975	7.2	8.2	13.6	14.8	12.0	48.1	11.6	7.4	0.1	3.0	6.2	7.3	139.5
1976	7.0	10.2	10.1	16.0	12.1	3.5	2.2	1.8	0.9	1.0	3.2	3.1	71.1
1977	4.4	9.6	12.9	21.2	31.5	12.1	5.9	1.9	10.6	4.1	5.5	5.3	125.0
1978	5.0	6.5	20.6	12.9	11.8	3.8	0.0	1.0	0.0	0.0	0.3	1.6	63.5
1979	1.3	7.6	21.5	18.8	15.9	5.4	10.4	10.6	1.6	0.9	3.6	6.2	103.8
1980	5.7	9.3	11.6	15.2	10.4	2.1	2.5	0.0	0.0	0.0	2.5	2.2	61.5
1981	5.5	6.0	11.6	14.9	22.5	6.4	11.5	16.3	4.3	2.5	6.7	6.2	114.4
1982	5.3	12.5	17.9	14.3	26.8	27.1	8.9	2.7	0.0	6.5	6.3	15.5	143.8
1983	6.5	9.7	27.2	16.4	41.4	74.2	10.7	7.6	3.8	3.1	6.7	5.2	212.5
1984	6.8	14.6	17.2	32.9	40.6	15.5	8.1	4.5	0.0	5.5	4.8	6.2	156.7
1985	6.9	14.1	13.6	11.9	27.4	9.9	10.0	2.0	6.0	8.5	5.6	5.8	121.7
1986	9.1	9.4	12.2	11.7	34.3	13.0	13.5	4.6	3.3	5.9	5.4	7.1	129.5
1987	5.9	9.2	19.7	24.1	24.3	11.7	19.0	5.7	2.3	2.7	8.2	7.0	139.8
1988	6.2	13.7	11.6	15.2	15.2	7.0	17.9	10.4	0.6	2.0	5.9	5.4	111.1
1989	5.4	5.9	10.5	9.1	11.4	11.8	14.0	6.2	0.2	3.1	3.1	3.5	84.2
1990	6.6	7.7	13.2	9.7	15.5	1.4	4.3	10.7	0.6	3.2	2.0	2.7	77.6
1991	2.4	8.0	9.0	10.6	15.2	3.9	1.9	0.5	0.0	0.0	2.7	4.8	59.0
1992	8.0	8.8	12.7	8.5	4.5	6.1	6.5	9.4	2.4	6.9	6.7	5.2	85.7
1993	5.2	14.4	71.6	22.7	21.0	17.0	68.0	37.5	23.3	16.8	30.1	17.7	345.3
Avg	4.5	8.8	14.1	13.0	17.2	30.6	11.0	6.2	5.4	6.3	5.0	4.7	126.8

## BASELINE - 1993 LEVEL FLOWS - HARLAN COUNTY EVAPORATION

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1931	0.7	0.9	1.6	2.9	4.2	7.4	6.9	5.2	2.7	2.1	1.2	0.4	36.2
1932	0.6	0.8	1.5	2.7	4.1	5.0	6.8	5.0	2.7	2.1	1.2	0.4	32.9
1933	0.6	0.8	1.4	2.5	3.8	7.8	6.1	4.2	2.7	2.1	1.2	0.4	33.6
1934	0.6	0.8	1.4	2.4	4.5	6.5	8.0	6.2	2.7	2.0	1.2	0.4	36.7
1935	0.6	0.8	1.3	2.3	2.2	3.6	9.7	6.2	3.1	2.5	1.4	0.5	34.2
1936	0.7	0.9	1.6	2.9	5.5	6.8	8.7	6.5	2.7	2.1	1.2	0.4	40.0
1937	0.6	0.8	1.4	2.5	3.6	4.0	6.2	6.5	2.7	2.1	1.2	0.4	32.0
1938	0.6	0.9	1.5	2.7	3.4	4.9	6.5	5.7	2.7	2.1	1.2	0.4	32.6
1939	0.6	0.8	1.4	2.6	4.3	4.9	6.8	4.6	2.7	2.1	1.2	0.4	32.4
1940	0.6	0.8	1.4	2.4	3.5	5.0	6.5	4.6	2.7	2.1	1.2	0.4	31.2
1941	0.6	0.8	1.4	2.5	3.9	4.2	6.7	5.3	2.8	2.1	1.3	0.5	32.1
1942	0.6	0.9	1.5	2.8	4.0	5.2	8.3	5.1	3.2	2.5	1.5	0.5	36.1
1943	0.7	1.0	1.8	3.2	4.3	5.7	7.9	6.3	2.7	2.1	1.2	0.4	37.3
1944	0.6	0.8	1.4	2.7	4.2	5.3	7.0	5.8	3.5	2.6	1.5	0.5	35.9
1945	0.7	1.0	1.8	3.1	3.8	3.0	6.7	5.7	2.9	2.2	1.3	0.5	32.7
1946	0.6	0.9	1.6	2.8	3.5	5.1	5.6	4.4	2.9	2.7	1.8	0.6	32.5
1947	1.0	1.5	2.9	3.2	3.4	-1.2	5.8	5.3	3.7	1.7	0.5	0.1	27.9
1948	0.8	0.7	1.5	3.6	3.1	2.4	4.2	4.7	3.0	2.7	0.8	0.3	27.8
1949	0.1	0.9	0.7	1.8	1.1	0.7	6.5	4.1	3.1	1.7	1.5	0.4	22.6
1950	0.7	0.1	0.8	2.8	2.0	5.6	0.8	2.8	4.5	2.3	1.6	0.6	24.6
1951	0.5	0.2	2.1	0.7	-0.1	1.9	3.5	4.1	0.4	3.1	2.2	0.9	19.5
1952	1.1	1.2	1.9	2.5	5.2	6.2	1.5	3.4	3.6	2.9	1.1	-0.1	30.5
1953	0.5	1.0	1.5	2.9	4.7	4.5	4.6	6.6	5.3	3.3	0.1	0.0	35.0
1954	0.7	0.6	2.2	3.6	0.3	4.9	6.7	1.6	3.6	1.6	1.5	0.6	27.9
1955	0.5	1.0	2.1	4.6	3.4	-0.5	7.3	6.9	2.7	2.6	1.4	0.4	32.4
1956	0.6	1.1	1.9	2.8	3.9	4.5	5.0	3.7	4.7	3.7	1.3	0.5	33.7
1957	0.7	1.0	1.3	0.5	-0.6	-1.1	6.1	3.7	2.3	1.7	1.2	0.4	17.2
1958	0.7	0.1	1.0	0.6	2.3	4.4	1.0	1.9	3.3	3.3	1.0	0.6	20.2
1959	0.4	1.0	1.1	2.1	1.0	3.5	5.0	4.8	2.3	0.7	1.5	0.6	24.0
1960	0.1	0.7	2.0	2.7	0.9	0.1	4.9	3.6	3.9	2.0	1.3	0.4	22.6
1961	0.9	1.0	1.4	2.7	-1.1	0.6	5.1	2.9	1.2	2.4	0.7	0.1	17.9

## Attachment 4: Evaporation Loss Harlan County Lake 1993 Level of Development

## BASELINE - 1993 LEVEL FLOWS - HARLAN COUNTY EVAPORATION

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1962	0.6	0.6	0.9	3.7	3.4	1.5	0.3	1.6	2.0	2.0	1.7	0.3	18.6
1963	0.7	1.4	1.3	4.5	4.6	6.3	6.1	3.1	-0.8	2.7	1.5	0.4	31.8
1964	0.8	0.8	1.7	3.2	5.6	1.2	6.9	3.0	3.0	3.3	1.2	0.6	31.3
1965	0.4	0.7	1.2	2.8	1.5	-0.5	2.0	2.8	-3.9	1.7	2.1	0.4	11.2
1966	0.9	0.8	2.9	2.7	7.5	2.8	5.8	3.7	2.7	2.8	1.5	0.4	34.5
1967	0.7	1.2	2.5	3.0	2.0	-2.9	1.6	4.5	3.5	2.0	1.6	0.4	20.1
1968	0.9	1.2	2.8	2.6	3.2	4.9	4.7	1.8	2.3	0.7	1.2	0.2	26.5
1969	0.4	0.6	2.4	3.3	0.1	3.8	-0.7	2.9	2.2	-1.0	1.5	0.4	15.9
1970	0.7	1.4	2.3	2.8	4.7	4.4	6.5	5.9	0.9	1.0	1.5	0.7	32.8
1971	0.7	0.2	2.0	2.9	0.7	5.1	3.4	4.5	1.4	1.5	0.2	0.5	23.1
1972	0.8	1.3	2.0	1.7	1.1	0.0	3.3	1.8	2.1	1.7	-0.4	0.1	15.5
1973	0.5	1.1	-0.7	2.5	3.4	6.7	-1.7	4.2	-3.0	0.2	0.2	0.2	13.6
1974	0.7	1.5	2.6	1.5	3.7	2.5	9.1	2.6	3.4	1.4	1.1	0.3	30.4
1975	0.7	0.7	2.0	2.1	0.8	1.1	4.3	2.7	3.0	3.4	0.7	0.6	22.1
1976	0.8	1.2	1.7	0.7	1.5	5.0	5.9	5.7	-0.2	1.4	1.4	0.7	25.8
1977	0.7	1.3	0.2	1.1	0.0	4.6	4.0	0.6	2.0	1.6	1.0	0.4	17.5
1978	0.5	0.7	1.2	3.4	3.9	6.2	7.1	4.5	4.5	3.0	1.1	0.5	36.6
1979	0.5	0.6	1.1	3.9	4.4	4.6	3.5	5.1	4.1	2.8	1.4	0.7	32.7
1980	0.5	0.6	1.2	3.4	3.7	4.7	6.8	6.0	3.9	2.7	1.3	0.6	35.4
1981	0.5	0.6	1.2	3.8	3.2	4.8	4.2	3.7	2.9	1.7	1.3	0.7	28.6
1982	0.5	0.7	1.2	3.9	3.8	3.9	5.1	3.8	2.9	2.2	1.4	0.8	30.2
1983	0.5	0.7	1.4	2.9	4.2	5.3	8.6	7.2	4.6	1.8	1.5	0.6	39.3
1984	0.6	0.8	1.4	2.9	4.2	5.8	7.2	5.7	4.7	1.4	1.4	0.7	36.8
1985	0.5	0.7	1.3	2.3	4.0	4.5	5.6	3.5	3.8	1.5	1.5	0.7	29.9
1986	0.6	0.7	1.3	2.8	4.4	5.8	6.7	4.0	2.7	1.3	1.4	0.7	32.4
1987	0.5	0.8	1.3	3.1	4.2	6.2	6.9	3.5	3.1	2.2	1.4	0.7	33.9
1988	0.5	0.7	1.3	3.5	4.9	6.6	4.6	4.8	3.5	2.2	1.4	0.7	34.7
1989	0.5	0.7	1.2	4.2	4.5	4.4	4.8	3.6	3.0	2.5	1.4	0.7	31.5
1990	0.5	0.7	1.2	3.0	3.5	5.6	6.4	4.0	5.0	3.4	1.4	0.6	35.3
1991	0.5	0.7	1.2	2.8	3.3	5.5	6.0	5.0	5.1	3.2	1.3	0.6	35.2
1992	0.6	0.7	1.2	1.8	3.2	2.2	4.1	3.5	4.2	2.9	1.9	1.0	27.3
1993	0.6	0.5	1.0	2.2	3.1	4.6	4.2	4.9	4.5	4.4	3.1	1.2	34.3
Avg	0.6	0.8	1.5	2.7	3.2	3.9	5.3	4.3	2.8	2.2	1.3	0.5	29.1

Attachment 5: Projected Water Supply Spread Sheet Calculations

<b>Trigger Calculations Based on Harlan County Lake Irrigation Supply</b>	Units-1000 Acre-feet		Irrigation Trigger		119.0		Assume that during irrigation release season HCL Inflow = Evaporation Loss						
			Total Irrigation Supply		130.0								
			Bottom Irrigation		164.1								
			Evaporation Adjust		20.0								
	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Total</b>
1993 Level AVE inflow	6.3	5	4.7	4.5	8.8	14.1	13.0	17.2	30.6	11.0	6.2	5.4	126.8
1993 Level AVE evap (1931-93)	2.2	1.3	0.5	0.6	0.8	1.5	2.7	3.2	3.9	5.3	4.3	2.8	29.1
Avg. Inflow Last 5 Years	10.8	13.0	12.3	12.9	16.6	22.4	19.4	18.1	14.8	16.5	11.0	4.7	172.6

<b>Year 2001-2002 Oct - Jun Trigger and Irrigation Supply Calculation</b>									
Calculation Month	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>
Previous EOM Content	236.5	235.9	238.6	242.9	248.1	255.1	263.8	269.6	276.2
Inflow to May 31	73.6	67.3	62.3	57.6	53.1	44.3	30.2	17.2	0.0
Last 5 Yrs Avg Inflow to May 31	125.6	114.8	101.7	89.5	76.6	59.9	37.5	18.1	0.0
Evap to May 31	12.8	10.6	9.3	8.8	8.2	7.4	5.9	3.2	0.0
Est. Cont May 31	297.3	292.6	291.6	291.7	293.0	292.0	288.1	283.6	276.2
Est. Elevation May 31	1944.44	1944.08	1944.00	1944.01	1944.11	1944.03	1943.72	1943.37	1942.77
Max. Irrigation Available	153.2	148.5	147.5	147.6	148.9	147.9	144.0	139.5	132.1
Irrigation Release Est.	120.1	117.4	116.8	116.8	118.1	117.1	116.8	116.8	116.8
Trigger - Yes/No	NO	YES							
130 kAF Irrigation Supply - Yes/No	NO								

Attachment 5: Projected Water Supply Spread Sheet Calculations

<b>Year 2002</b>				
<b>Jul - Sep</b>				
<b>Final Trigger and</b>				
<b>Total Irrigation Supply</b>				
<b>Calculation</b>				
Calculation Month		<b>Jul</b>	<b>Aug</b>	<b>Sep</b>
Previous EOM Irrigation Release Est.		116.8	116.0	109.7
Previous Month Inflow		5.5	0.5	1.3
Previous Month Evap		6.3	6.8	6.6
Irrigation Release Estimate		116.0	109.7	104.4
Final Trigger - Yes/No		YES		
130 kAF Irrigation Supply - Yes/No		NO	NO	NO

Republican River Compact Administration

Accounting Procedures and Reporting Requirements  
Revised August 2010

Attachment 6: Computing Water Supplies and Consumptive Use Above Guide Rock

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Total Main Stem VWS	Hardy gage	Superior-Courtland Diversion Dam Gage	Courtland Canal Diversions	Superior Canal Diversions	Courtland Canal Returns	Superior Canal Returns	Total Bostwick Returns Below Guide Rock	NE CBCU Below Guide Rock	KS CBCU Below Guide Rock	Total CBCU Below Guide Rock	Gain Guide Rock to Hardy	VWS Guide Rock to Hardy	Main Stem Virgin Water Supply Above Guide Rock	Nebraska Main Stem Allocation Above Hardy	Kansas Main Stem Allocation Above Hardy	Nebraska Guide Rock to Hardy Allocation	Kansas Guide Rock to Hardy Allocation
							Col F+ Col G			Col I + Col J	+ Col B - Col C+ Col K - Col H	+ Col L + Col K	Col A - Col M	.489 x Col N	.511 x Col N	.489 x Col M	.511 x Col M

Attachment 7: Calculations of Return Flows from Bureau of Reclamation Canals

Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12
Canal	Canal Diversion	Spill to Waste-Way		Field Deliveries	Canal Loss	Average Field Loss Factor	Field Loss	Total Loss from District	Percent Field and Canal Loss That Returns to the Stream	Total return to Stream from Canal and Field Loss	Return as Percent of Canal Diversion
Name Canal	Headgate Diversion	Sum of measured spills to river	Col 2 - Col 3	Sum of Deliveries to the field	Col 2 - Col 5 + Col 3	1 -Weighted Average Efficiency of Application System for the District*	Col 5 x Col 7	Col 6 + Col 8	Estimated Percent Loss*	Col 9 x Col 10 + (Col 3 * 0.18)	Col 11/Col 2
Irrigation Season											
Non-Irrigation Season											
Example	100	5	95	60	45	30%	18	63	82%	53	53%
	100	0	100	0	100	30%	0	100	92%	92	92%
Culbertson											
Culbertson Extension											
Meeker - Driftwood											
Red Willow											
Bartley											
Cambridge											
Naponee											
Franklin											
Franklin Pump											
Almena											
Superior											
Nebraska Courtland											
Courtland Canal Above Lovewell (KS)											
Courtland Canal Below Lovewell											

\*The average field efficiencies for each district and percent loss that returns to the stream may be reviewed and, if necessary,

changed by the RRCA to improve the accuracy of the estimates.

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Meeting Notes for the  
**QUARTERLY MEETING of the  
ENGINEERING COMMITTEE of the  
REPUBLICAN RIVER COMPACT ADMINISTRATION**  
August 19th, 2015, 1:00 PM Central Time, 12:00 PM Mountain Time

## Attendees:

Jim Schneider	Nebraska	Chris Beightel	Kansas
Jennifer Schellpeper	Nebraska	Ginger Pugh	Kansas
Amy Zoller	Nebraska	Sam	Kansas
Ryan Werner	Nebraska	Ivan Franco	Colorado
Kathy Benson	Nebraska	Willem Schreuder	Principia Mathematica
David Kracman	The Flatwater Group	Craig Scott	BOR
Chance Thayer	The Flatwater Group		

1. Introductions
2. Review/Modify Agenda
  - a. No changes
3. Publication of RRCA Annual Reports
  - a. 2013 Reports (Kansas)
    - i. Beightel reported that they continue to review reports and the hope is to get the completed minutes on CD's for the annual meeting.
  - b. 2014 Reports (Nebraska); Benson reported that:
    - i. The December 2013 Special Meeting minutes are being reviewed by Colorado.
    - ii. The August 2014 Annual Meeting minutes are being reviewed by Colorado.
  - c. 2015 Reports (Nebraska); Benson reported that:
    - i. The October 2014 Special Meeting summary is with Colorado for review.
    - ii. The November 2014 Special Meeting summary is with Colorado for review.
    - iii. The March 2015 Special Meeting summary is drafted and in internal review with Nebraska.
4. Modeling and Data Tasks for Principia Mathematica
  - a. Documentation
    - i. Schreuder reported that he sent out the model runs for review on August 4<sup>th</sup> which covered 2007 to 2014 as well as a preview of 2015. He continues to work on surface water inputs. **Schellpeper stated DNR will be sending out revised data on surface water delivery pumping and augmentation well project pumping for 2014 before next week.** Willem completed the new 2014 IMPACTS run with the updated information from Nebraska's augmentation

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wells on August 20, 2015 (Attachment 1). Schreuder stated there has not been an update on the documentation tasks. He suggested that it needed to be decided who has the best data and they would then be responsible to populate the fields to eliminate discrepancies in the numbers given. **Schneider suggested including this as a recommended task for the Engineering Committee for the upcoming year. Beightel and Franco both agreed.**

5. Conservation Committee Terraces Study
  - a. Posting of final data from BOR to website
    - i. Schreuder reported the GIS data on the Conservation Study was posted to the website.
  - b. Draft Author Page
    - i. Beightel reported that Erickson is waiting for States' approval on the author page and then will post it to the website. Both Schneider and Franco gave their consent on the author page. Schneider stated that Item #5 can now be removed from the Agenda.
6. Non-Federal Reservoir Tracking
  - a. Updated Methodology
    - i. Zoller reported past activities for tracking reservoirs by using digital technology and pan evaporation estimates from the nearest federal reservoir and applied the rate to the area of the digitized reservoirs. The NDNR Dam Safety Division has been using Lidar and field investigations to track dams/reservoirs and this data has been accessed for use in collecting presumptive criteria which covers what is outlined in the RRCA Compact. Field crews do go out and look at reservoirs that are 200 acre-feet and over and have been categorized as either full or dry (nearly full are considered full). This information is set up by sub-basin. The reference number is Pages 24 & 25 of the Accounting Procedures, Section IV.A.2f. The work done this year is for 2014. **Schneider stated he would get a write-up of the methodology to send out.**
7. Data Exchange
  - a. 2014 Accounting
    - i. There was no other accounting input other than what Schellpeper referred to earlier in that revised data would be sent out in the next week. Schreuder reported that Colorado's data is final for this year with the CIR method for one last year and next year the hope is to use meters.
    - ii. Franco reported that Colorado now has 2012, 2013, and 2014 meter data available on the website.

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- b. 2015 Accounting
    - i. Per an RRCA resolution, Nebraska has been sending out preliminary estimates for 2015 accounting by the 10<sup>th</sup> of each month. A model run for 2015 from Schreuder was used showing the CBCU was much different than what was used (showing a lower number) and the IWSC credit higher so at this point it is still under review. Two spreadsheets were sent out for others to review. Schneider explained the difference between the two spreadsheets and asked for questions. No questions were posed.
  - c. Finalization of 2014 and previous years accounting (2007-2014)
    - i. Schreuder sent out a spreadsheet to the EC on accounting inputs for 1995 to 2014 for discussion (Attachment 2). Schneider stated that the Flatwater Group reviewed the data and found potential discrepancies which they sent out for review. Beightel stated that they started to look over the data and found some discrepancies. They need to continue their review. Schneider asked if it was reasonable to pursue this at the meeting next week or consider it an assignment next year for the Engineering Committee. Beightel asked if he could make that decision next week. There was discussion about requesting that the USGS have their stream gage data ready in a timely fashion for accounting purposes.
8. Estimating Ground and Surface Water Irrigation Recharge and Return Flows
- a. Draft scope and needs document regarding changes in irrigation efficiency.
    - i. **Beightel reported no update at this time.**
9. Accounting changes for Nebraska Groundwater Recharge Project
- a. Discussion on how accounting procedures address evaporation and diversion at different times of the year
    - i. Accounting change proposal (Nebraska) – Schneider asked if there were any questions on the proposal that was discussed in the last EC meeting. Beightel’s concerns were about the 18% charged to the canal loss being considered all evaporation and felt there may be other considerations and the percentage wouldn’t be as high. Schneider reminded the committee this was a pilot project and not pressing. Due to the remaining questions, this issue will not be taken to the RRCA for action next week.
10. Accounting for Direct Return Data from Canals
- a. Accounting change proposal (Nebraska). Frenchmen-Cambridge Irrigation District had a payback for the Nebraska Bostwick Irrigation District so water was deliberately

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discharged down a waste-way back to the Republican River. Beightel asked about how the data was collected on situations of this nature. Beightel did call Scott at the BOR to gain some insight on the procedure and asked for back-up data. Schneider stated that NDNR would do what was necessary to get the best data collected. Beightel asked for reassurance that this would be handled fairly. Franco stated he did not have questions or concerns about this. Schneider stated a resolution has been prepared for a new version of the accounting procedures as a result of the court ruling and including accounting for discharge down a waste-way. These accounting changes will be brought forward to the Annual Meeting next week. The EC agreed that it would be best to start using the new direct return accounting data in 2015 and this will be stated in the resolution. **Schneider asked if further changes need to be made to Page 43 of the accounting. The resolution will be out by the end of the week.**

11. Future Augmentation Plans – Application and Approval Process
  - a. Ongoing discussions at the Three-States Meeting
    - i. Schneider stated **this item will be discussed at the Three-States Meeting.**
  
12. Harlan County Lake – Evaporation Charges and Compact Accounting Adjustments
  - a. Examples for calculating the incremental increase in reservoir areas
    - i. Schneider stated **this item will be discussed at the Three-States Meetings.**
  
13. Beginning and Ending Meter Data
  - a. Review of Colorado Data (Kansas)
    - i. Beightel stated that review has been done on 2012 to 2014 of CIR versus the meter data. The meter data indicates more pumping than the CIR data. Kansas continues to review the data and is **putting together analyses that will be sent out by the end of the week.** The data before 2012 is still under consideration.
  
14. Modeling Bonny Reservoir
  - a. Kansas and Colorado discussions
    - i. No update at this time.
  
15. Creating a New RRCA-oriented Website
  - a. Draft administrative website (Kansas). Pugh reported that an outline is written and asked for updated files for irrigation districts. **The outline needs to be sent out for review.**
  
16. DRAFT Engineering Committee Report to the RRCA

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- a. Beightel asked questions about Assignments #6 and #3. Franco suggested Assignment #3b be dropped and this was agreed upon by all. In regards to the rest of the assignments, it was agreed that Assignments on the Draft EC Report that need to be ongoing are #3a, #4, #5, part of #6. It was agreed by all to drop #7, #8, #9.
17. Summary of Meeting Actions/Assignments
- a. **DNR will send out revised data on surface water delivery pumping and augmentation well project pumping for 2014 before next week.**
  - b. **Engineering Committee will recommend that the RRCA make an assignment to the EC to designate responsible parties for generation of specific input data**
  - c. **The 2015 EC Report to the RRCA will be drafted by Nebraska and discussed at the RRCA workshop meeting**
  - d. **DNR will get write-up on methodology of Non-Federal Reservoir Tracking**
  - e. **DNR will prepare accounting resolution for Annual Meeting next week**
  - f. **Kansas will continue to review Colorado data and email their analysis by next week.**
18. Future Meeting Schedule
- a. The next meeting of the RRCA Engineering Committee is scheduled for Wednesday, August 26th, 2015, at 1:00 p.m. Central Time, Lower Level F, in the Nebraska State Office Building, Lincoln, NE. The hosting of the EC meetings will then go to Colorado.
19. Adjournment
- a. The meeting adjourned at 2:20 p.m.

# Impact 2014 (acre-feet)

Location	Colorado Pumping			Kansas Pumping			Nebraska Pumping			Nebraska Mound			CCP Credit		
	Dry Bonny CCP	Full Bonny CCP	Dry Bonny Kansas Method	Dry Bonny CCP	Full Bonny CCP	Dry Bonny Kansas Method	Dry Bonny CCP	Full Bonny CCP	Dry Bonny Kansas Method	Dry Bonny CCP	Full Bonny CCP	Dry Bonny Kansas Method	Dry Bonny CCP	Full Bonny CCP	Dry Bonny Kansas Method
Arikaree	1138	1141	1141	225	225	225	128	128	128	0	0	0	0	0	33
Beaver	0	0	0	3462	3462	3462	2054	2054	2054	0	0	0	0	0	0
Buffalo	446	446	446	0	0	0	3393	3393	3393	0	0	0	0	0	0
Driftwood	0	0	0	0	0	0	1023	1023	1023	0	0	0	0	0	0
Frenchman	927	927	927	0	0	0	77055	77055	77055	0	0	0	0	0	0
North Fork	16283	16283	16283	0	0	0	1096	1096	1096	0	0	0	7000	7000	0
Above Swanson	-871	-1157	-1143	139	60	108	9840	9693	9673	0	0	0	0	0	5206
Swanson - Harlan	-22	-22	-22	-2302	-2302	-2302	23207	23209	23108	1824	1824	1813	0	0	0
Harlan - Guide Rock	0	0	0	0	0	0	24693	24693	24676	371	371	371	0	0	0
Guide Rock - Hardy	0	0	0	31	31	31	1922	1922	1919	-11	-11	-11	0	0	0
Medicine	0	0	0	0	0	0	20485	20485	20485	10718	10718	10718	0	0	0
Prairie Dog	0	0	0	524	524	524	0	0	0	0	0	0	0	0	0
Red Willow	0	0	0	0	0	0	6435	6435	6432	29	29	29	0	0	0
Rock	107	108	108	0	0	0	4587	4587	4587	0	0	0	0	0	0
Sappa	0	0	0	-1047	-1047	-1047	909	909	909	0	0	0	0	0	0
South Fork	7033	12405	7043	3752	8547	3751	488	783	495	0	0	0	0	0	117
Hugh Butler	0	0	0	0	0	0	2003	2003	2003	0	0	0	0	0	0
Bonny	-1459	1408	-1459	0	14	0	0	0	0	0	0	0	0	0	0
Keith Sebelius	0	0	0	460	460	460	0	0	0	0	0	0	0	0	0
Enders	0	0	0	0	0	0	4761	4761	4761	0	0	0	0	0	0
Harlan	0	0	0	83	83	83	793	793	793	26	26	26	0	0	0
Harry Strunk	0	0	0	0	0	0	296	296	296	0	0	0	0	0	0
Swanson	20	19	20	0	0	0	252	253	253	0	0	0	0	0	0
<b>Mainstem</b>	<b>-893</b>	<b>-1179</b>	<b>-1165</b>	<b>-2124</b>	<b>-2203</b>	<b>-2156</b>	<b>59662</b>	<b>59516</b>	<b>59377</b>	<b>2184</b>	<b>2184</b>	<b>2172</b>	<b>0</b>	<b>0</b>	<b>5206</b>
<b>Total</b>	<b>23611</b>	<b>31568</b>	<b>23353</b>	<b>5342</b>	<b>10071</b>	<b>5309</b>	<b>185421</b>	<b>185571</b>	<b>185140</b>	<b>12971</b>	<b>12971</b>	<b>12959</b>	<b>7000</b>	<b>7000</b>	<b>5363</b>

Excel File Name: SWinput.xls Tab Name:SWuse

Subbasin	Area	Quantity	Variable	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
North Fork	Colorado	Irrigation – Non-Federal Canals	NFDc	1929	2454	3084	2866	2884	3350	2964	3776	2410	2888	2790	2496	2376	570	394	474	530	886	553	412	412	
		Irrigation – Small Pumps	NFPc	0	0	0	0	0	0	0	0	0	0	0	0	0	73	21	0	0	0	0	0	0	0
		M&I	NFMlc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arikaree	Colorado	Irrigation – Non-Federal Canals	ARDc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	81	55	105	75	35	35	
		Irrigation – Small Pumps	ARPC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		M&I	ARMlc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arikaree	Kansas	Irrigation – Non-Federal Canals	ARDk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Irrigation – Small Pumps	ARPk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		M&I	ARMIk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arikaree	Nebraska	Irrigation – Non-Federal Canals	ARDn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Irrigation – Small Pumps	ARPn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		M&I	ARMIn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Buffalo Creek	Colorado	Irrigation – Non-Federal Canals	BODc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Irrigation – Small Pumps	BOPc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		M&I	BOMlc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Buffalo Creek	Nebraska	Irrigation – Non-Federal Canals	BODn	0	0	0	0	0	769	517	584	587	334	171	170	271	361	248	354	446	542	416	481	481	
		Irrigation – Small Pumps	BOPn	0	970	780	804	804	0	58	70	56	34	0	0	0	0	0	0	0	0	0	0	0	
		M&I	BOMIn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rock Creek	Nebraska	Irrigation – Non-Federal Canals	RCDn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Irrigation – Small Pumps	RCPn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		M&I	RCMIn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South Fork	Colorado	Irrigation – Non-Federal Canals	SFDc	2437	2457	2071	2100	0	2836	542	3814	996	1283	458	864	401	87	0	14	16	0	0	0	0	
		Irrigation – Small Pumps	SFPc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		M&I	SFMlc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South Fork	Kansas	Irrigation – Non-Federal Canals	SFDk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Irrigation – Small Pumps	SFPk	94	94	0	0	111	13	65	41	39	25	13	0	0	0	0	0	0	0	0	0	0	0
		M&I	SFMk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South Fork	Nebraska	Irrigation – Non-Federal Canals	SFDn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Irrigation – Small Pumps	SFPn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		M&I	SFMIn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Frenchman C	Nebraska	Irrigation – Non-Federal Canals	FCDn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Irrigation – Small Pumps	FCPn	0	760	1110	798	798	53	81	36	3	21	1	0	3	1	5	0	0	18	0	19	19	
		M&I	FCMIn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Driftwood Cre	Kansas	Irrigation – Non-Federal Canals	DCDk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Irrigation – Small Pumps	DCPk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		M&I	DCMIk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Driftwood Cre	Nebraska	Irrigation – Non-Federal Canals	DCDn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Irrigation – Small Pumps	DCPn	0	100	130	51	51	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0
		M&I	DCMIn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow C	Nebraska	Irrigation – Non-Federal Canals	RWDn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Irrigation – Small Pumps	RWPn	0	960	1450	645	645	129	164	303	341	167	123	121	0	0	6	0	1	18	35	41	41	
		M&I	RWMIn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medicine Cree	Nebraska	Irrigation – Non-Federal Canals	MCDn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Irrigation – Small Pumps	MCPn	0	1890	2730	1293	1293	455	684	657	291	255	259	305	25	91	34	43	94	609	65	35	35	
		M&I	MCMIn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medicine Cree	Nebraska below gage	Irrigation – Non-Federal Canals	MCDnb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Irrigation – Small Pumps	MCPnb	0	340	1110	625	625	0	0	0	106	58	78	94	25	40	37	18	4	14	24	38	38	
		M&I	MCMInb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beaver Creek	Colorado	Irrigation – Non-Federal Canals	BRDc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Irrigation – Small Pumps	BRPc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		M&I	BRMlc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Beaver Creek	Kansas	Irrigation – Non-Federal Canals	BRDk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Irrigation – Small Pumps	BRPk	46	77	0	5	14	0	8	25	26	22	12	7	0	0	3	2	2	11	8	6	6	
		M&I	BRMIk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Beaver Creek	Nebraska	Irrigation – Non-Federal Canals	BRDn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Irrigation – Small Pumps	BRPn	0	260	600	180	180	0	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	
		M&I	BRMIn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

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Nebraska below gage	Irrigation – Non-Federal Canals	BRDnb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Irrigation – Small Pumps	BRPnb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	M&I	BRMInb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kansas	Irrigation – Non-Federal Canals	SCDk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Irrigation – Small Pumps	SCPk	104	64	105	163	63	99	108	75	14	28	3	0	6	0	0	0	0	0	0	0	0
	M&I	SCMIk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sappa Creek	Irrigation – Non-Federal Canals	SCDn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Irrigation – Small Pumps	SCPn	0	1280	3840	1781	1781	398	488	138	0	20	54	22	189	0	115	221	58	552	0	135	135
	M&I	SCMIn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nebraska below gage	Irrigation – Non-Federal Canals	SCDnb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Irrigation – Small Pumps	SCPnb	0	240	550	168	168	11	100	102	20	0	0	0	0	0	0	0	0	0	0	0	0
	M&I	SCMInb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kansas	Irrigation – Non-Federal Canals	PDDk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Irrigation – Small Pumps	PDPk	728	255	637	279	416	460	452	517	273	87	159	94	165	300	560	360	328	419	489	296	296
	M&I	PDMIk	450	426	454	511	488	518	525	586	548	496	382	420	362	203	354	327	158	203	365	352	352
Nebraska below gage	Irrigation – Non-Federal Canals	PDDnb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Irrigation – Small Pumps	PDPnb	0	150	500	293	293	88	224	102	59	44	21	22	43	63	149	9	52	166	15	29	29
	M&I	PDMIb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kansas	Irrigation – Non-Federal Canals	MSDk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Irrigation – Small Pumps	MSPk	1341	1057	1163	1386	1471	1169	1165	1405	1064	668	767	776	518	449	688	872	539	949	776	776	776
	M&I	MSMIk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mainstem	Irrigation – Non-Federal Canals	MSDn	0	11060	21310	11464	11464	967	2380	1674	3719	3066	1661	2460	835	682	1683	2146	2387	1524	1600	1423	1423
	Irrigation – Small Pumps	MSPn	0	0	0	0	0	5687	5070	6163	1401	1931	1918	590	1033	1053	848	846	1078	2997	568	314	314
	M&I	MSMIn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nebraska below Guide Rock	Irrigation – Non-Federal Canals	MSDnb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Irrigation – Small Pumps	MSPnb	0	0	0	0	0	1502	1041	1860	1562	689	1278	697	358	244	456	350	496	1271	850	476	476
	M&I	MSMInb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Subbasin	Area	Variable	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
North Fork	Colorado	NFNFREVC	0	0	0	0	0	0	0	0	0	46	43	50	38	37	28	41	36	51	45	38	38	
	Colorado	ARNFREVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arikaree	Kansas	ARNFREVK	0	0	0	0	0	0	0	0	0	41	41	46	18	14	7	11	14	24	17	11	11	
	Nebraska	ARNFREVN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Buffalo	Colorado	BONFREVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nebraska	BONFREVN	0	0	0	0	0	0	0	0	0	22	21	0	18	15	10	21	24	15	3	2	2	2
Rock Creek	Nebraska	RCNFREVN	0	0	0	0	0	0	0	0	0	64	82	79	55	46	20	57	64	125	102	97	97	97
	Colorado	SFNFREVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	117	154	107	51	51	51	51
South Fork	Kansas	SFNFREVK	0	0	0	0	0	0	0	0	0	285	285	325	143	121	65	98	119	213	147	100	100	100
	Nebraska	SFNFREVN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Frenchman Creek	Nebraska	FCNFREVN	0	0	0	0	0	0	0	0	0	244	135	21	152	126	32	217	238	243	66	50	50	50
Driftwood Creek	Kansas	DWNFREVK	0	0	0	0	0	0	0	0	0	7	7	11	13	11	6	11	11	17	13	10	10	10
	Nebraska	DWNFREVN	0	0	0	0	0	0	0	0	0	8	2	0	5	3	2	10	10	17	8	0	0	0
Red Willow Creek	Nebraska	RWNFREVN	0	0	0	0	0	0	0	0	0	155	182	23	75	40	48	118	118	159	269	209	209	209
Medicine Creek	Nebraska	MCNFREVN	0	0	0	0	0	0	0	0	0	233	292	139	251	155	104	321	314	313	315	241	241	241
	Nebraska - Below Gage	MCNFREVNb	0	0	0	0	0	0	0	0	0	4	7	0	6	5	3	8	8	0	0	0	0	0
	Colorado	BRNFREVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beaver Creek	Kansas	BRNFREVK	0	0	0	0	0	0	0	0	0	135	135	234	254	260	141	251	253	409	313	223	223	223
	Nebraska	BRNFREVN	0	0	0	0	0	0	0	0	0	23	51	23	59	47	38	65	64	51	110	92	92	92
	Nebraska - Below Gage	BRNFREVNb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sappa Creek	Kansas	SCNFREVK	0	0	0	0	0	0	0	0	0	278	278	483	351	279	152	269	272	439	336	240	240	240
	Nebraska	SCNFREVN	0	0	0	0	0	0	0	0	0	22	43	22	32	28	32	60	63	77	51	46	46	46
	Nebraska - Below Gage	SCNFREVNb	0	0	0	0	0	0	0	0	0	7	5	1	3	2	6	4	5	13	15	5	5	5
Prairie Dog Creek	Kansas	PDNFREVK	0	0	0	0	0	0	0	0	0	371	371	333	260	114	90	217	137	442	294	293	293	293
	Nebraska	PDNFREVN	0	0	0	0	0	0	0	0	0	17	21	11	44	39	25	17	23	58	27	21	21	21
Mainstem	Kansas	MSNFREVK	0	0	0	0	0	0	0	0	0	148	148	122	84	84	64	85	80	150	145	111	111	111
	Nebraska - Above Guide Rock	MSNFREVN	0	0	0	0	0	0	0	0	0	2331	1891	830	1524	1287	1269	1867	2127	2149	1477	1159	1159	1159
	Nebraska - Below Guide Rock Gage	MSNFREVNb	0	0	0	0	0	0	0	0	0	340	137	115	163	147	209	180	244	299	50	60	60	60

Excel File Name:SWinput.xls Tab Name:Gage

Gage Name	Variable	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
North Fork Republican River At Colorado-Nebraska State Line	06823000	29133	25548	22232	20747	21588	19435	19752	15904	17700	19759	21060	17280	20333	21638	24405	20418	19722	14376	18433	26707	32707	
Arikaree River At Haigler	06821500	6440	5667	2950	2699	6805	3631	553	231	1060	341	1151	404	1308	1567	779	2358	1074	494	91	0	110	
Buffalo Creek Near Haigler	06823500	3160	3179	2419	1910	3138	2255	2999	2049	2090	2276	2227	1731	2007	2190	2353	2374	1972	1045	1268	1463	1463	
Rock Creek At Parks	06824000	7327	6811	6608	6335	6292	5609	5658	6316	4710	5419	5466	5355	4764	4852	4916	5253	4345	4173	19724	23088	3691	
South Fork Republican River Near Benkelman	06827500	15639	15944	10276	9967	9005	4855	3097	1579	905	0	0	0	674	1397	8407	12756	9916	6441	0	0	5000	
Frenchman Creek At Culbertson	06835500	35491	38281	29992	27128	31703	21497	20878	12266	13360	19926	23235	22606	44910	33174	27522	33840	31148	16825	22287	31021	31021	
Driftwood Creek Near McCook	06836500	4448	7568	4551	4147	4944	2870	2589	2007	1100	1201	1911	1714	4312	2528	1874	3436	2389	4658	1159	1232	1232	
Red Willow Creek Near Red Willow	06838000	6141	7472	7445	6006	6259	9265	12045	8453	3970	3555	3791	10018	6453	12411	26873	24790	18297	8682	6408	7643	7643	
Medicine Creek Below Harry Strunk	06842500	38482	25897	43331	35981	21225	37974	31373	24794	19850	23300	19992	22648	50356	65150	36450	44469	37420	37444	26198	40561	40561	
Beaver Creek Near Beaver City	06847000	2091	13904	6650	2153	2369	1561	844	331	220	163	173	303	1227	1118	1154	1438	899	461	224	412	412	
Sappa Creek Near Stamford	06847500	20412	57959	25513	17825	16196	9191	7219	2893	179	84	262	0	4450	7732	10673	21762	15587	7656	1316	1687	1687	
Prairie Dog Creek Near Woodruff	06848500	15542	29650	15702	12319	11032	7415	9916	2807	1087	147	3436	153	5457	7571	6871	25698	15864	5066	2596	1363	1363	
Republican River At Guide Rock	06853020	178231	332655	169431	144713	108368	66134	118877	24614	21346	15019	1779	2711	61470	229144	105400	284800	214462	116248	24835	35041	35041	
Republican River Near Hardy	06853500	239242	395103	213775	198251	161652	94757	178140	50620	52394	41964	16980	14089	100257	272571	130578	340610	274226	139460	44745	50362	50362	
Colorado North Fork Augmentation Water Supply	CNFAWS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7000	13000
Nebraska Rock Creek Augmentation Water Supply	NRCAWS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15766	19397	0
Nebraska N-CORPE Augmentation Water Supply	NMCAWS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40878	20000
Water Short Year	WSY	0	0	0	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	0	2	2	2

Excel File Name:SWinput.xls Tab Name:FloodFlow

Subbasin	Variable	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
North Fork	NFFF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arikaree	ARFF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Buffalo Creek	BOFF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rock Creek	RCFF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South Fork	SFFF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Frenchman Creek	FCFF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Driftwood Creek	DCFF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red Willow Creek	RWFF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medicine Creek	MCFF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beaver Creek	BRFF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sappa Creek	SCFF	0	31059	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prairie Dog Creek	PDFF	0	13950	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mainstem	MSFF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Excel File Name:SWinput.xls Tab Name:Reservoir

Reservoir	Quantity	Variable	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Bonny	Evaporation	BONNYe	3732	3498	4523	4963	5236	5557	3972	5750	3375	3158	3430	3031	2428	1766	1020	1921	1965	67	0	0	0
	Change in Storage	BONNYs	-1000	400	-2500	-2300	-700	-4900	-3200	-4300	-2226	-2900	-1500	-2400	-1743	1161	836	449	-11360	-100	0	0	0
Enders	Evaporation	ENDERSe	1699	1340	2092	2051	1331	2023	1448	2118	1485	967	1248	1366	1589	1217	428	1135	1342	2796	1761	1332	1332
	Change in Storage	ENDERSs	-1400	3800	-2800	-4200	-1000	-6000	-1200	-400	-218	300	0	-500	5800	-1500	262	1081	757	-2378	-1802	-4170	-4170
High Butler	Evaporation	BUTLRe	3198	1994	3413	3958	3013	3822	2447	3433	2377	2026	2230	2494	2369	1205	1458	1069	1089	2101	1580	1275	1275
	Change in Storage	BUTLRS	-1300	4400	-3600	-3300	-500	-5000	-5500	-5400	2947	2800	1800	-7100	11900	1500	-20143	-323	-34	98	863	1180	1180
Harry Strunk	Evaporation	STRUNKe	2677	2052	3736	3950	2396	3372	2850	4423	3755	2059	2772	3035	1549	1591	1096	3139	2809	4550	2688	2044	2044
	Change in Storage	STRUNKs	-6500	13200	-6200	-5800	11400	-8900	100	-7200	3385	-300	5600	-3000	10400	-1000	430	306	-836	-13161	443	17602	17602
Keith Sebelius	Evaporation	SEBELIUSe	2804	970	4175	4068	3265	5000	3115	5806	2823	2089	1727	1791	2213	1224	1004	2765	1772	5416	2991	2423	2423
	Change in Storage	SEBELIUSs	-700	15700	-7000	-2400	-2600	-5300	-800	-8600	-4338	-1000	100	-200	1600	6600	1086	3214	2600	-6738	-3960	-2826	-2826
Swanson	Evaporation	SWANSONe	6920	3783	9082	8774	6255	8599	4816	7044	6086	2588	5638	5381	6444	5527	2599	6676	6850	9924	6078	3625	3625
	Change in Storage	SWANSONs	-3900	18100	-21400	-21900	-2600	-27600	-1800	-2100	4735	3900	4600	1200	8900	6800	3314	6771	115	-24403	-8920	-1189	-1189
Harlan County	Evaporation	HARLANe	14944	2534	19720	16677	15242	20786	12341	29081	23664	17017	17706	16182	14701	12239	14439	10475	14831	31127	25919	18541	18541
	Change in Storage	HARLANs	-21700	42700	-20600	-15700	22300	-77300	27900	-82400	-47110	-6200	21000	-11800	139100	63900	958	-1858	4700	-131975	-66603	24230	24230
Lovewell – Republican River Portion	Evaporation	LOVEWELLE	170	310	370	320	270	900	320	0	670	1110	2020	1770	130	10	130	330	-160	760	800	160	160
Harlan County Split	Evaporation Charged to Kansas	HARLANeK	7353	1440	10505	8879	7611	11233	6079	15433	11463	8598	8946	16182	14701	6863	7567	7025	7305	17783	14887	18541	18541
	Evaporation Charged to Nebraska	HARLANeN	7591	1094	9215	7798	7631	9553	6262	13648	12201	8419	8760	0	0	5376	6873	3451	7526	13344	11032	0	0

**DO NOT EXPORT THIS SHEET**

Quantity	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Haigler Canal Diversions - Colorado	1276	1207	1749	1520	1714	1853	1718	1510	1948	2071	2423	2654	2512	465	0	0	0	0	0	0	0
Haigler Canal Diversions - Nebraska	3836	5099	5533	6079	6479	5921	5011	5646	4965	3732	4745	4418	4522	4995	4193	5041	4826	6129	3839	3110	3110
<b>Haigler Canal Diversions</b>	<b>5112</b>	<b>6306</b>	<b>7282</b>	<b>7599</b>	<b>8193</b>	<b>7774</b>	<b>6729</b>	<b>7156</b>	<b>6913</b>	<b>5803</b>	<b>7168</b>	<b>7072</b>	<b>7034</b>	<b>5460</b>	<b>4193</b>	<b>5041</b>	<b>4826</b>	<b>6129</b>	<b>3839</b>	<b>3110</b>	<b>3110</b>
Hale Ditch Diversions	523	705	2022	1804	1864	1718	1092	0	0	0	89	0	43	0	169	1322	23	0	0	184	700
Champion Canal Diversions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Riverside Canal Diversions	2217	2539	2698	2113	1454	3743	3042	805	1838	1443	2096	0	0	0	2336	2471	2419	0	0	0	0
Culbertson Canal Diversions	9527	10179	10082	9786	8089	9340	6964	8964	8002	8674	6562	0	0	0	9624	9609	9889	5470	0	0	0
Culbertson Canal Extension Diversions	12024	12016	13722	11504	13056	10002	7098	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Culbertson Canal % Return Flow	55.9%	57.3%	53.5%	56.0%	45.7%	54.4%	59.5%	63.5%	56.0%	65.8%	78.1%	100.0%	100.0%	100.0%	78.8%	77.4%	75.6%	76.6%	100.0%	100.0%	100.0%
Culbertson Canal Extension % Return Flow	56.5%	59.5%	57.3%	58.5%	63.0%	57.5%	60.9%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Meeker-Driftwood Canal Diversions	35371	26998	32218	30144	23202	27529	17816	9894	0	0	0	0	0	0	23274	19469	21538	32955	9210	8035	8035
Meeker-Driftwood Canal % Return Flow	50.4%	51.5%	48.5%	49.3%	45.7%	43.4%	48.7%	48.6%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	68.2%	62.2%	60.7%	63.2%	67.1%	72.2%	72.2%
Red Willow Canal Diversions	8974	5217	8628	8247	6121	7785	5355	3429	0	0	0	0	0	4089	5166	0	0	0	0	0	0
Red Willow Canal % Return Flow	43.7%	43.2%	41.2%	44.0%	47.3%	46.5%	50.1%	49.2%	100.0%	100.0%	100.0%	100.0%	100.0%	64.9%	68.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Almena Canal Diversions	4965	4860	8781	4697	5455	4517	5321	4065	3379	0	0	0	1099	2217	1551	3330	2277	3172	2274	1385	1385
Almena Canal % Return Flow	58.4%	61.7%	59.2%	62.0%	60.5%	58.3%	61.1%	55.3%	52.0%	100.0%	100.0%	100.0%	61.0%	60.6%	70.9%	66.9%	63.8%	49.3%	49.0%	57.3%	57.3%
Bartley Canal Diversion	10677	6250	10245	9181	7258	8608	5872	3584	0	0	0	5830	0	0	10711	8589	9718	8137	0	0	0
Bartley Canal % Return Flow	41.9%	44.2%	48.9%	45.6%	49.1%	48.2%	47.1%	30.5%	100.0%	100.0%	100.0%	56.2%	100.0%	100.0%	70.8%	65.5%	65.6%	56.0%	100.0%	100.0%	100.0%
Cambridge Canal Diversion	31748	14542	29527	27464	21536	26292	19629	21152	18332	21964	19732	19692	0	19387	23961	24280	28850	27618	12575	12242	12242
Cambridge Canal % Return Flow	45.4%	60.0%	43.1%	46.8%	46.1%	49.7%	48.1%	46.7%	51.0%	52.5%	53.6%	55.2%	100.0%	56.1%	60.8%	61.9%	60.5%	51.7%	56.3%	62.8%	62.8%
Naponee Canal Diversion	3185	1462	3202	2319	2829	3638	2988	2444	2162	0	0	0	0	316	1095	690	1182	1985	755	0	0
Naponee Canal % Return Flow	54.9%	62.9%	56.4%	54.0%	55.8%	56.1%	53.3%	51.4%	53.0%	100.0%	100.0%	100.0%	100.0%	55.2%	70.0%	68.8%	50.2%	51.6%	65.2%	100.0%	100.0%
Franklin Canal Diversion	35712	27440	33031	31605	32368	38479	28544	24631	15262	0	0	0	0	16085	23246	13879	18853	30870	15796	0	0
Franklin Canal % Return Flow	63.3%	70.2%	63.9%	66.1%	65.1%	64.4%	63.9%	58.1%	64.0%	100.0%	100.0%	100.0%	100.0%	70.9%	65.4%	67.5%	65.9%	56.3%	58.2%	100.0%	100.0%
Franklin Pump Canal Diversions	3963	2224	3025	2630	2962	3946	3409	3273	1687	0	0	0	0	576	909	751	729	1648	1206	0	0
Franklin Pump Canal % Return Flow	54.5%	53.0%	50.0%	49.3%	46.9%	48.1%	49.6%	47.2%	57.0%	100.0%	100.0%	100.0%	100.0%	67.9%	67.3%	69.8%	58.9%	56.8%	52.3%	100.0%	100.0%
Superior Canal Diversions	17272	14234	12307	14200	15283	18466	11303	11252	8174	5800	4712	0	0	5666	6336	6489	7070	9744	6161	0	0
Superior Canal % Return Flow	61.6%	62.3%	64.4%	59.5%	60.1%	58.5%	59.0%	54.2%	57.0%	67.8%	64.2%	100.0%	100.0%	71.4%	59.5%	57.9%	64.6%	57.6%	58.4%	100.0%	100.0%
Courtland Canal Diversions At Headgate	62772	72949	67626	65785	62291	126839	61217	87742	66500	31501	48737	50631	65851	32224	51647	47290	35907	74730	70402	59654	59654
Diversions to Nebraska Courtland	2082	1404	1556	2381	2355	3463	1982	2263	1591	0	0	0	0	311	718	202	428	884	558	0	0
Nebraska Courtland % Return Flow	36.2%	31.8%	35.1%	35.9%	32.6%	35.4%	39.3%	27.5%	32.6%	100.0%	100.0%	100.0%	100.0%	34.7%	28.4%	32.3%	50.0%	27.6%	25.8%	0.0%	0.0%
Courtland Canal, Loss in NE assigned to upper Courtland KS	3505	2317	3485	3333	3866	2687	4064	3704	2841	184	415	2242	2087	3671	2852	3794	2014	4545	1998	1099	1099
Courtland Canal, Loss in NE assigned to delivery to Lovewell	86	3498	4516	4259	3044	9574	4419	8002	10116	5877	8236	9916	7628	2945	5385	4558	2215	5663	2956	4346	4346
Courtland Canal At Kansas-Nebraska State Line	57099	65730	58070	55812	53026	111115	50752	73315	51952	25440	40086	38472.587	56136	25297	42692	38736	31250	63637	65021	54209	54209
Courtland Canal Diversions to the Upper Courtland District	33179	24996	26085	26444	30593	32417	25456	26077	17511	779	1864	10595	14748	17433	18833	20190	17889	26777	20093	15525	15525
Courtland Canal Above Lovewell % Return Flow	53.1%	46.8%	53.2%	51.6%	52.3%	46.3%	52.3%	49.6%	51.8%	79.2%	63.0%	62.0%	57.2%	65.3%	61.5%	54.3%	58.0%	51.4%	51.1%	51.7%	51.7%
Courtland Canal, Loss assigned to deliveries of water to Lovewell, Stateline to Lovewell	4537	4202	6624	4131	5448	7906	3243	5986	10687	10715	9372	11026	8788	3878	9103	4310	5059	4052	8108	3334	3334
Courtland Canal Deliveries To Lovewell Reservoir	14130	14130	14130	14130	14130	14130	14130	14130	26596	14130	29265	19093	34688	7657	17608	18030	10316	37353	38432	36450	36450
Diversions of Republican River water from Lovewell Reservoir to the Courtland Canal below Lovewell	18200	36510	26310	31720	49000	41250	25920	32420	21270	25590	25590	28066	35960	11280	12560	20410	12710	26840	37250	32108	32108
Courtland Canal Below Lovewell % Return Flow	45.3%	45.3%	44.7%	45.4%	43.5%	42.1%	45.6%	40.5%	45.7%	49.6%	52.7%	48.9%	51.1%	53.8%	52.2%	42.7%	50.5%	45.1%	46.4%	45.7%	45.7%
<b>To allocate Harlan County evaporation:</b>																					
Kansas Bostwick Diversions During Irrigation Season	60164	61454	60455	60401	55556	79822	46739	49425	27100	41084	41084	11535	30156	29253	35504	44732	26097	59938	32966	40605	40605
Nebraska Bostwick Diversions During Irrigation Season	62111	46685	53031	53044	55701	67880	48146	43706	28844	40232	40232	0	0	22915	32248	21973	26884	44974	24430	0	0
Percent of Harlan Evap Charged to Kansas	49.2%	56.8%	53.3%	53.2%	49.9%	54.0%	49.3%	53.1%	48.4%	50.5%	50.5%	100.0%	100.0%	56.1%	52.4%	67.1%	49.3%	57.1%	57.4%	100.0%	100.0%
Percent of Harlan Evap Charged to Nebraska	50.8%	43.2%	46.7%	46.8%	50.1%	46.0%	50.7%	46.9%	51.6%	49.5%	49.5%	0.0%	0.0%	43.9%	47.6%	32.9%	50.7%	42.9%	42.6%	0.0%	0.0%

Excel File Name:SWinput.xls Tab Name:Canal

Canal	Quantity	Variable	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Haigler Canal	Diversions-Colorad	HAIGLERc	1276	1207	1749	1520	1714	1853	1718	1510	1948	2071	2423	2654	2512	465	0	0	0	0	0	0	0
	Diversions-Nebrask	HAIGLERn	3836	5099	5533	6079	6479	5921	5011	5646	4965	3732	4745	4418	4522	4995	4193	5041	4826	6129	3839	3110	3110
Hale Ditch	Diversions-Colorad	HAIGLER	5112	6306	7282	7599	8193	7774	6729	7156	6913	5803	7168	7072	7034	5460	4193	5041	4826	6129	3839	3110	3110
	Diversions	HALE	523	705	2022	1804	1864	1718	1092	0	0	0	89	0	43	0	169	1322	23	0	0	184	700
Champion Cana	Diversions	CHAMPION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Riverside Cana	Diversions	RIVERSIDE	2217	2539	2698	2113	1454	3743	3042	805	1838	1443	2096	0	0	0	2336	2471	2419	0	0	0	0
Culbertson Canal	Diversions	CULBERTSON	9527	10179	10082	9786	8089	9340	6964	8964	8002	8674	6562	0	0	0	9624	9609	9889	5470	0	0	0
	Return Flow	CULBERTSONr	5330	5831	5395	5479	3696	5076	4142	5690	4481	5712	5124	0	0	0	7583	7437	7480	4190	0	0	0
Culbertson Canal Extension	Diversions	CULBERTEXT	12024	12016	13722	11504	13056	10002	7098	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Return Flow	CULBERTEXTr	6793	7155	7864	6727	8225	5753	4319	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Meeker-Driftwood Canal	Diversions	MEEKER	35371	26998	32218	30144	23202	27529	17816	9894	0	0	0	0	0	0	23274	19469	21538	32955	9210	8035	8035
	Return Flow	MEEKERr	17840	13895	15624	14847	10613	11955	8676	4810	0	0	0	0	0	0	0	15869	12116	13070	20833	6184	5801
Red Willow Canal	Diversions	RWCANAL	8974	5217	8628	8247	6121	7785	5355	3429	0	0	0	0	0	4089	5166	0	0	0	0	0	0
	Return Flow	RWCANALr	3924	2255	3551	3630	2895	3620	2682	1687	0	0	0	0	0	0	2656	3515	0	0	0	0	0
Almena Canal	Diversions	ALMENA	4965	4860	8781	4697	5455	4517	5321	4065	3379	0	0	0	1099	2217	1551	3330	2277	3172	2274	1385	1385
	Return Flow	ALMENAr	2901	2998	5202	2911	3298	2634	3251	2249	1757	0	0	0	0	670	1343	1100	2227	1453	1564	1115	794
Bartley Canal	Diversions	BARTLEY	10677	6250	10245	9181	7258	8608	5872	3584	0	0	0	5830	0	0	10711	8589	9718	8137	0	0	0
	Return Flow	BARTLEYr	4472	2761	5006	4188	3561	4150	2764	1093	0	0	0	3277	0	0	7585	5622	6374	4554	0	0	0
Cambridge Canal	Diversions	CAMBRIDGE	31748	14542	29527	27464	21536	26292	19629	21152	18332	21964	19732	19692	0	19387	23961	24280	28850	27618	12575	12242	12242
	Return Flow	CAMBRIDGEr	14416	8723	12732	12840	9929	13074	9447	9877	9349	11522	10579	10879	0	10870	14570	15038	17457	14285	7075	7688	7688
Naponee Canal	Diversions	NAPONEE	3185	1462	3202	2319	2829	3638	2988	2444	2162	0	0	0	0	316	1095	690	1182	1985	755	0	0
	Return Flow	NAPONEEr	1749	920	1805	1251	1577	2042	1593	1255	1146	0	0	0	0	174	767	475	593	1024	492	0	0
Franklin Canal	Diversions	FRANKLIN	35712	27440	33031	31605	32368	38479	28544	24631	15262	0	0	0	0	16085	23246	13879	18853	30870	15796	0	0
	Return Flow	FRANKLINr	22593	19265	21105	20898	21079	24790	18251	14308	9768	0	0	0	0	11405	15210	9369	12421	17370	9195	0	0
Franklin Pump Canal	Diversions	FRANKLINPMP	3963	2224	3025	2630	2962	3946	3409	3273	1687	0	0	0	0	576	909	751	729	1648	1206	0	0
	Return Flow	FRANKLINPMPr	2161	1179	1513	1296	1388	1898	1690	1545	962	0	0	0	0	391	612	524	429	936	630	0	0
Superior Canal	Diversions	SUPERIOR	17272	14234	12307	14200	15283	18466	11303	11252	8174	5800	4712	0	0	5666	6336	6489	7070	9744	6161	0	0
	Return Flow	SUPERIORr	10639	8864	7927	8452	9182	10794	6671	6095	4659	3932	3025	0	0	4046	3768	3754	4570	5617	3600	0	0
Courtland Canal	Headgate Diversior	COURTLANDhg	62772	72949	67626	65785	62291	126839	61217	87742	66500	31501	48737	50631	65851	32224	51647	47290	35907	74730	70402	59654	59654
	Diversions to Nebrask	COURTLANDn	2082	1404	1556	2381	2355	3463	1982	2263	1591	0	0	0	0	311	718	202	428	884	558	0	0
	Returns from Nebrask	COURTLANDnr	754	447	545	854	767	1226	779	622	519	0	0	0	0	108	204	65	214	244	144	0	0
	Flow at Kansas-Nebraska State Lin	COURTLANDsl	57099	65730	58070	55812	53026	111115	50752	73315	51952	25440	40086	38473	56136	25297	42692	38736	31250	63637	65021	54209	54209
	Loss in Nebraska assigned to upper Courtland Kansa	COURTLANDclUC	3505	2317	3485	3333	3866	2687	4064	3704	2841	184	415	2242	2087	3671	2852	3794	2014	4545	1998	1099	1099
	Loss in Nebraska assigned to delivery to Lovewel	COURTLANDclLW	86	3498	4516	4259	3044	9574	4419	8002	10116	5877	8236	9916	7628	2945	5385	4558	2215	5663	2956	4346	4346
	Diversions to the Upper Courtland Distric	COURTLANDa	33179	24996	26085	26444	30593	32417	25456	26077	17511	779	1864	10595	14748	17433	18833	20190	17889	26777	20093	15525	15525
	Courtland Canal Above Lovewell Return Flov	COURTLANDar	17602	11700	13884	13655	15994	15000	13301	12931	9071	617	1174	6571	8438	11385	11580	10957	10369	13757	10263	8026	8026
	Loss assigned to deliveries of water to Lovewell Stateline to Lovew	COURTLANDclSL	4537	4202	6624	4131	5448	7906	3243	5986	10687	10715	9372	11026	8788	3878	9103	4310	5059	4052	8108	3334	3334
	Diversions of Republican River water from Lovewell Reservoir to the Courtland Canal below Lovewell	COURTLANDb	18200	36510	26310	31720	49000	41250	25920	32420	21270	25590	25590	28066	35960	11280	12560	20410	12710	26840	37250	32108	32108
Courtland Canal Below Lovewell Return Flov	COURTLANDbr	8237	16524	11770	14385	21323	17357	11818	13145	9713	12696	13477	13718	18385	6072	6557	8710	6420	12114	17268	14673	14673	

Excel File Name:SWinput.xls Tab Name:CanalsAltData

Quantity	Quantity	Variable	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Haigler Canal	Diversions-Colorado	HAIGLERc	1276	1207	1749	1520	1714	1853	1718	1510	1948	2071	2423	2654	2512	465	0	0	0	0	0	0	0
	Diversions-Nebraska	HAIGLERn	3836	5099	5533	6079	6479	5921	5011	5646	4965	3732	4745	4418	4522	4995	4193	5041	4826	6129	3839	3110	3110
	Diversions-Colorado	HAIGLER	5112	6306	7282	7599	8193	7774	6729	7156	6913	5803	7168	7072	7034	5460	4193	5041	4826	6129	3839	3110	3110
Hale Ditch	Diversions	HALE	523	705	2022	1804	1864	1718	1092	0	0	0	89	0	43	0	169	1322	23	0	0	184	700
Champion Cana	Diversions	CHAMPION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Riverside Cana	Diversions	RIVERSIDE	2217	2539	2698	2113	1454	3743	3042	805	1838	1443	2096	0	0	0	2336	2471	2419	0	0	0	0
	Diversions	CULBERTSON	9527	10179	10082	9786	8089	9340	6964	8964	8002	8674	6562	0	0	0	9624	9609	9889	5470	0	0	0
Culbertson Canal	Deliveries	CULBERTSONd	4324	4383	5004	4435	5117	4499	2733	2892	3188	2441	447	0	0	0	537	771	1096	515	0	0	0
	Diversions	CULBERTEXT	12024	12016	13722	11504	13056	10002	7098	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Deliveries	CULBERTEXTd	5343	4700	5903	4715	4322	4266	2615	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Culbertson Canal Extension	Diversions	MEEKER	35371	26998	32218	30144	23202	27529	17816	9894	0	0	0	0	0	0	23274	19469	21538	32955	9210	8035	8035
	Deliveries	MEEKERd	19449	14362	18807	17197	14657	18500	10336	5755	0	0	0	0	0	0	5603	6705	7998	10784	2384	1372	1372
Meeker-Driftwood Canal	Diversions	RWCANAL	8974	5217	8628	8247	6121	7785	5355	3429	0	0	0	0	0	4089	5166	0	0	0	0	0	0
	Deliveries	RWCANALd	5984	3525	6139	5458	3700	4814	2977	1960	0	0	0	0	0	1215	1256	0	0	0	0	0	0
Almena Canal	Diversions	ALMENA	4965	4860	8781	4697	5455	4517	5321	4065	3379	0	0	0	1099	2217	1551	3330	2277	3172	2274	1385	1385
	Deliveries	ALMENAd	2038	1719	3482	1639	2048	1864	1938	1889	1759	0	0	0	403	827	300	877	722	1806	1306	595	595
Bartley Canal	Diversions	BARTLEY	10677	6250	10245	9181	7258	8608	5872	3584	0	0	0	5830	0	0	10711	8589	9718	8137	0	0	0
	Deliveries	BARTLEYd	7462	4119	7571	5820	4165	5067	3574	2216	0	0	0	2620	0	0	2088	2475	2778	3691	0	0	0
Cambridge Canal	Diversions	CAMBRIDGE	31748	14542	29527	27464	21536	26292	19629	21152	18332	21964	19732	19692	0	19387	23961	24280	28850	27618	12575	12242	12242
	Deliveries	CAMBRIDGEd	20240	5577	20001	16865	13467	14783	11584	13009	10023	11304	9758	9178	0	8759	8846	8487	10801	14568	5638	4094	4094
Naponee Canal	Diversions	NAPONEE	3185	1462	3202	2319	2829	3638	2988	2444	2162	0	0	0	0	316	1095	690	1182	1985	755	0	0
	Deliveries	NAPONEEd	1619	524	1540	1220	1393	1765	1608	1405	1173	0	0	0	0	159	246	171	705	1132	238	0	0
Franklin Canal	Diversions	FRANKLIN	35712	27440	33031	31605	32368	38479	28544	24631	15262	0	0	0	0	16085	23246	13879	18853	30870	15796	0	0
	Deliveries	FRANKLIND	12553	6070	11220	9414	10250	12689	9671	11049	5144	0	0	0	0	3349	7227	3775	5701	14904	7050	0	0
Franklin Pump Canal	Diversions	FRANKLINPMP	3963	2224	3025	2630	2962	3946	3409	3273	1687	0	0	0	0	576	909	751	729	1648	1206	0	0
	Deliveries	FRANKLINPMPd	2043	1210	1815	1615	1953	2509	2073	2136	793	0	0	0	0	152	250	172	316	779	673	0	0
Superior Canal	Diversions	SUPERIOR	17272	14234	12307	14200	15283	18466	11303	11252	8174	5800	4712	0	0	5666	6336	6489	7070	9744	6161	0	0
	Deliveries	SUPERIORd	6229	4963	3826	5641	5921	7685	4590	5535	3622	1457	1483	0	0	1060	2523	2769	2169	4194	2566	0	0
	Headgate Diversior	COURTLANDhg	62772	72949	67626	65785	62291	126839	61217	87742	66500	31501	48737	50631	65851	32224	51647	47290	35907	74730	70402	59654	59654
	Diversions to Nebraska	COURTLANDn	2082	1404	1556	2381	2355	3463	1982	2263	1591	0	0	0	0	311	718	202	428	884	558	0	0
	Deliveries to Nebraska	COURTLANDnd	1566	1116	1157	1740	1844	2556	1341	1954	1245	0	0	0	0	233	609	159	217	761	497	0	0
	Loss in Nebraska assigned to upper Courtland Kansas	COURTLANDclUC	3505	2317	3485	3333	3866	2687	4064	3704	2841	184	415	2242	2087	3671	2852	3794	2014	4545	1998	1099	1099
	Loss in Nebraska assigned to delivery to Lovewell	COURTLANDclLW	86	3498	4516	4259	3044	9574	4419	8002	10116	5877	8236	9916	7628	2945	5385	4558	2215	5663	2956	4346	4346
	Flow at State Line	COURTLANDsl	57099	65730	58070	55812	53026	111115	50752	73315	51952	25440	40086	38472.587	56136	25297	42692	38736	31250	63637	65021	54209	54209
	Diversions to the Upper Courtland District	COURTLANDa	33179	24996	26085	26444	30593	32417	25456	26077	17511	779	1864	10595	14748	17433	18833	20190	17889	26777	20093	15525	15525
Courtland Canal	Above Lovewell Deliverie	COURTLANDad	15421	13932	11887	12717	14400	18343	11994	13386	8375	144	561	3353	5789	4609	6118	8868	6811	12987	9840	7459	7459
	Loss assigned to deliveries of water to Lovewell Stateline to Lovewell	COURTLANDclSL	4537	4202	6624	4131	5448	7906	3243	5986	10687	10715	9372	11026	8788	3878	9103	4310	5059	4052	8108	3334	3334
	Diversions of Republican River water from Lovewell Reservoir to the Courtland Canal below Lovewell	COURTLANDb	18200	36510	26310	31720	49000	41250	25920	32420	21270	25590	25590	28066	35960	11280	12560	20410	12710	26840	37250	32108	32108
	Delivery of Republican River water from Lovewell Reservoir to the Courtland Canal below Lovewell	COURTLANDbd	8237	16524	11770	14385	21323	17357	11818	13145	9713	12696	13477	13718	18385	6072	6557	8710	6420	12114	17268	14673	14673
<b>To allocate Harlan County evaporation:</b>																							
	Kansas Bostwick Diversions During Irrigation Season		60164	61454	60455	60401	55556	79822	46739	49425	27100	41084	41084	11535	30156	29253	35504	44732	26097	59938	32966	40605	40605
	Nebraska Bostwick Diversions During Irrigation Season		62111	46685	53031	53044	55701	67880	48146	43706	28844	40232	40232	0	0	22915	32248	21973	26884	44974	24430	0	0
	Percent of Harlan Evap Charged to Kansas		49.2%	56.8%	53.3%	53.2%	49.9%	54.0%	49.3%	53.1%	48.4%	50.5%	50.5%	100.0%	100.0%	56.1%	52.4%	67.1%	49.3%	57.1%	57.4%	100.0%	100.0%
	Percent of Harlan Evap Charged to Nebraska		50.8%	43.2%	46.7%	46.8%	50.1%	46.0%	50.7%	46.9%	51.6%	49.5%	49.5%	0.0%	0.0%	43.9%	47.6%	32.9%	50.7%	42.9%	42.6%	0.0%	0.0%

## **Addendum to “Impacts of Non-Federal Reservoirs and Land Terracing on Basin Water Supplies” Final Report**

The purpose of this document is to provide background information for the Final Report, including how to reference the report, location of background documents and listing of authors & staff, study cooperators and Republican River Compact Administration commissioners & staff.

### **Suggested Reference for “Conservation Committee Report”**

Guenthner, R. Scott, James Koelliker and Derrel Martin, 2014. Impacts of Non-Federal Reservoirs and Land Terracing on Basin Water Supplies. Final report, July 2014, 159 p. U.S. Bureau of Reclamation, Great Plains Regional Office, P.O. Box 36900, Billings, MT 59107-6900.

### **Background Documents for the Final Report**

The Final Report along with the following reference documents and backup data are posted on the website of the Republican River Compact Administration: [www.republicanrivercompact.org](http://www.republicanrivercompact.org).

- Plan of Study (Plan Proposal) dated April 28, 2004 including the following appendices:
  - A. Republican River Compact Settlement Conservation Committee Members
  - B. List of Previous Studies Reviewed
  - C. Universities Joint Research Project Proposal
  - Modeling and Field Experimentation to Determine Effects of Terracing and Nonfederal Reservoirs on Water Supplies in the Republican River Basin above Hardy, Nebraska.
  - D. Reservoir Surface Area and Water Level Monitoring
  - E. Available Data
  - F. Inventory Program for Representative Sample of Land Terraces
  - G. Methodology for Assessing Area-Capacity Relationship for Non-Federal Reservoirs
  - H. Study Timeline
  - I. Cooperative Agreements
    - II. Draft Cooperative Agreement with University of Nebraska – Lincoln
    - I2. Draft Cooperative Agreement with Kansas State University
- RRCA approval of Study proposals and modifications, Memorandum of Understanding (MOU) July 2004
- Final approved contracts with Kansas State University and University of Nebraska
- V2 Water Budget Simulation Model User’s Manual by J.K. Koelliker
- 2004 Republican River Compact Administration annual report – Study Approval by RRCA

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