

**Agreement on Determination of Transit Loss under the provisions of Section II E (4) of
the Resolution Concerning an Operating Plan for
John Martin Reservoir
October 2006
Revised December 2006**

Whereas: CRS 37-80-102 provides that the Colorado State Engineer shall be the executive officer in charge of supervising the work of all division engineers and K.S.A. 82a-706e provides that the Kansas Chief Engineer may establish field offices and appoint water commissioners as agents and,

Whereas: the Resolution Concerning an Operating Plan for John Martin Reservoir adopted by the Arkansas River Compact Administration (ARCA) on April 24, 1980 as subsequently revised (the 1980 Operating Plan) Section II.E(4) states, "Releases of Kansas account water shall be measured at the Stateline as provided in Compact Article V E (3) allowing appropriate arrival times. If transit losses occur, those losses shall be determined by the Colorado Division Engineer and a representative of the Kansas Division of Water Resources and shall be replenished from the Kansas transit loss account. In the event that such losses at the end of the delivery are greater than the total in the Kansas transit loss account, then the deficit shall be made up from the next available transfers of other water under Subsection III D." and,

Whereas: the States have previously disputed the meaning of Section II.E(4) of the 1980 Operating Plan with respect to the appropriate operation of the Kansas Transit Loss Account and the determination of transit losses and,

Whereas: on September 30, 2005, the States signed the Agreement Concerning the Offset Account in John Martin Reservoir for Colorado Pumping, Determination of Credits for Delivery of Water Released for Colorado Pumping, and Related Matters (Offset Account Crediting Agreement) which includes a procedure to determine the **Equivalent Stateline flow (ESF)** delivery for determining transit losses associated with **Kansas Section II Account** deliveries that may occur as a result of combined releases of Offset Account and **Kansas Section II Account** water,

Now, **Therefore**, the undersigned Colorado State Engineer and Kansas Chief Engineer do agree to determine **Transit Loss** associated with the release of the **Kansas Section II Account** water on Kansas' demand based on measured Stateline flow in accordance with the criteria describe below and direct their subordinates and agents as follows:

A. Definitions

- i. **Equivalent Stateline flow or ESF** is the flow at the Stateline during **Kansas Section II Account** delivery equivalent to Kansas call from John Martin Reservoir as measured by the methods described in this agreement.
- ii. **Kansas Section II Account** is the Account in John Martin Reservoir established under Subsection II.D of the 1980 Operating Plan.

- iii. **Transit Loss** is the difference between the water volume released from the **Kansas Section II Account** and the volume of **ESF** as measured by the methods described in this agreement.
- iv. **Kansas Transit Loss Account** is the Account in John Martin Reservoir established under Subsection II.E(4) of the 1980 Operating Plan.
- v. **Livingston method** is a method for computing transit loss on the Arkansas River as described in USGS Water Resources Investigation 78-75 (September 1978) or future revised method as approved by ARCA.
- vi. **Muskingum method** is a routing method as described in the following reference: McCarthy, G.T., 1938: 'The Unit Hydrograph and Flood Routing', presented at conference of North Atlantic Division, U.S. Corps of Engineering, June 1938 (see also 'Engineering Construction - Flood Control', pp. 147-156, the Engineer School, Ft. Belvoir, VA, 1940).
- vii. **Predicted Transit Loss** is the percent of transit loss computed using the **Livingston method** using Reach 6 factors or as provided in a revised method approved by ARCA and the antecedent stream flow method as described below in Paragraph G between John Martin Reservoir and the Stateline.

B. Accounting and stream flow data used in the evaluation of **Kansas Section II Account Transit Loss** will be as follows:

- i. Accounting records of the Operations Secretary for **Kansas Section II Account** releases, including hourly records of gate changes identifying the beginning and end of releases.
- ii. Provisional, hourly, and daily satellite data from pertinent gaging stations between John Martin Reservoir and the Stateline. Stateline deliveries for which Colorado will receive credit will be based on the mean daily **Stateline flow**.
- iii. The United States Geological Survey (USGS) provides the State of Colorado with a data feed of shift-corrected discharge values on an hourly basis. The data provided is in a non-aggregated time step, typically 15-minute measurement intervals. Once data is loaded into the Colorado Division of Water Resources database, it is not updated with subsequent data from the USGS. Therefore, data used for water administration remains the same as during the time the water was administered. Colorado will daily extract 15 minute discharge data for the Arkansas River at Granada, the Frontier Ditch, and the Arkansas at Coolidge gages for the previous 24-hour period to update previously transmitted data and export this and previous data for the most recent 7-day period as a delimited text file to an ftp directory accessible by persons designated by the Colorado State Engineer and the Kansas Chief Engineer. **Provisional data** shall be used for all the calculations described in this agreement. Corrections for data omission, erroneous hourly measurements

or mechanical errors discovered in a timely manner and not due to merely a shift change made by USGS following a subsequent measurement should be included in the provisional data. Colorado will provide and maintain the auto-executable program to periodically update databases maintained in their respective offices with this data to ensure identical stream flow data sets to be used to evaluate deliveries of water from John Martin Reservoir to Kansas.

C. For **Kansas Section II Account** releases occurring without consecutive Offset Account releases, the **ESF** delivery for determining transit losses associated with **Kansas Section II Account** deliveries will be determined as follows:

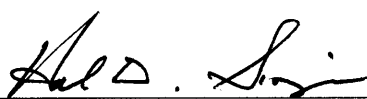
- i. The mean daily release from the **Kansas Section II Account** release will be multiplied by 1.05.
- ii. These adjusted mean daily values will be routed to the Stateline using the **Muskingum method** with the following parameters: $K = 60$ hours, $x = 0.15$ and $t=24$ hours.
- iii. The resulting Muskingum hydrograph will be lagged one day, in addition to the lag included within the Muskingum routing.
- iv. The **ESF** delivery for the purpose of determining **Transit Loss** will be determined as the lesser of: a) the **Stateline flow** or b) the lagged Muskingum hydrograph.
- v. The **ESF** delivery determination will end the sixth day following the end of the release from the reservoir with the last day of the release being day zero and with the delivery for the sixth day being prorated by the ratio of the number of hours of release in day zero divided by 24.
- vi. The **ESF** percentage will be calculated as the **ESF** delivery (determined using Sub-paragraphs C.i through C.v) divided by the total of the release from **Kansas Section II Account**.
- vii. The volume of the **Kansas Section II Account ESF** is the total of the **Kansas Section II Account** release multiplied by the **ESF** percentage.
- viii. If the **ESF** volume for the **Kansas Section II Account** delivery is less than the **Kansas Section II Account** volume released, the resulting difference is **Transit Loss** which will be replenished to the **Kansas Section II Account**.
- ix. Under no circumstances shall more than 100% of the total volume from the **Kansas Section II Account** release be determined to be delivered under these procedures.

D. For combined releases of Offset Account and **Kansas Section II Account** water, the credit component for the Offset Account release at the Stateline for which Colorado will receive 100% credit as a replacement of depletions to usable **Stateline flow** and the **ESF** volume for determining transit losses associated with **Kansas Section II Account** release will be determined as provided in Paragraph 3.D. of the Offset Account Crediting Agreement. Transit losses for releases from the Offset Account shall not be replenished from the **Kansas Transit Loss Account**.

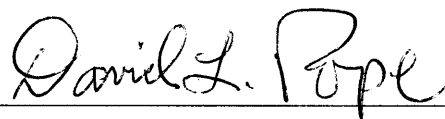
- E. The **Kansas Transit Loss Account** may be released concurrently with the **Kansas Section II Account** release. The concurrent release may occur under the following conditions unless other terms are agreed to by the Colorado Division Engineer and a representative of the Kansas Division of Water Resources:
- i. When antecedent flows at Stateline are less than 150 cubic feet per second and shall be at a rate and quantity determined by the Division Engineer upon consultation with a representative of the Kansas Division of Water Resources;
 - ii. For antecedent flows at Stateline greater than 150 cubic feet per second, not to exceed 5% of the **Kansas Section II Account** release rate or the **Predicted Transit Loss** as determined by the **Livingston method**, whichever is greater, and terminated on the third day from the beginning of the Kansas Section II Account release (with the day zero the beginning day of such release);
 - iii. For antecedent flows at Stateline greater than 150 cubic feet per second, when a subsequent increase in the Kansas release of at least 50 cfs occurs, an additional transit loss account release may be directed by the Division Engineer, not to exceed an amount equal to the increase in release rate times the **Predicted Transit Loss** as determined by the **Livingston method** at the beginning of the release and will be terminated on the third day from the beginning of the Kansas Section II Account release change.
- F. If a **Transit Loss** is determined by the above procedures, any **Kansas Transit Loss Account** water remaining in the account at the end of the **Kansas Section II Account** release will be used to replenish the **Kansas Section II Account**. In the event that transit losses at the end of the delivery are greater than the total in the **Kansas Transit Loss Account**, then the deficit shall be made up from the next available transfers of other water under Subsection III.D of the 1980 Operating Plan.
- G. For the purposes of determining **Predicted Transit Loss** using the **Livingston method** with Reach 6 factors or the revised method approved by ARCA on Kansas Section II releases, the antecedent flow for the three reaches below John Martin Reservoir will be determined as follows:
- i. Use the mean daily flow for the 10 full days preceding the date of delivery arrival, provided that the variability within the period does not depart from the 10-day average by more than 10%. The date of delivery arrival for the purpose of this paragraph shall be:
 - a. Lamar: use the day that the release is initiated as day zero.
 - b. Granada: one day after the initiation of the release with the first day of release being day zero.

- c. Stateline: two days after the initiation of the release with the first day of release being day zero.
 - d. Days of mean daily flow which exceed 110% of the initial average, will be removed until an average base flow with less than +/- 10% variability is achieved to remove interference caused by precipitation or the effect of Colorado ditch operation during the 10-day period. No more than two iterations of antecedent flow calculation will be performed and no fewer than 6 days out of the preceding 10-day period will be used in determining the antecedent flow except as provided in the following two paragraphs.
 - ii. If a Kansas **Section II Account** release follows within 10 days of any other release from a Kansas account (including the Offset Account), the antecedent flow for the current **Kansas Section II Account** release shall be the same as antecedent flows determined for the previous release using the procedures as described above in Paragraph G.i.
 - iii. If the average flow for the 10-day period preceding the 10 days (i.e. days 11 through 20 prior to arrival of the release) used to determine antecedent flow is more than twice the computed antecedent flow computed above in Paragraph G.i., the antecedent flow will be adjusted to be the average of: a) the antecedent flow as described above in Paragraph G.i. and b) the hydrograph flow value using the **Muskingum method** described above in Paragraph C. on the sixth day following the end of the release from John Martin Reservoir with the last day of the release being day zero.
- H. Acceptance of this Agreement by Colorado and Kansas does not prejudice or constitute a waiver of their respective rights under the Arkansas River Compact, the April 24, 1980 Resolution Concerning an Operating Plan for John Martin Reservoir (as revised on May 10, 1984, and December 11, 1984), the March 17, 1997 Stipulation Re Offset Account in John Martin Reservoir in *Kansas v. Colorado*, No. 105 Original, or the Amended March 30, 1998 Resolution Concerning an Offset Account in John Martin Reservoir for Colorado Pumping.
- I. This Agreement is subject to the continued existence of the 1980 Operating Plan. Should the 1980 Operating Plan be terminated as provided in that Plan, this Agreement shall be null and void.

JOINTLY APPROVED ON December 11, 2006:



Hal D. Simpson
Colorado State Engineer



David L. Pope
Kansas Chief Engineer