

Agreement on Implementation of John Martin Reservoir Revised Elevation-Area-Capacity Tables in the H-I Model

August 2015

I. Introduction

In October 2014, Colorado proposed modifying the H-I Model to recognize the resurveys of John Martin Reservoir (JMR) that have occurred prior to the date of this agreement. Kansas reviewed and has agreed to the proposed changes.

II. Background and Context

The Arkansas River and its tributaries transport a significant sediment load, and the process of sedimentation in JMR has been causing a steady decrease in storage capacity over time. The H-I Model uses a progression of area-capacity (AC) relationships to estimate evaporation and limit the maximum Compact conservation storage volume. Before this agreement, the H-I Model (update6eV1_06_GWEff) contained six different AC relationships and eight different maximum storage values which were applied for different date ranges. Up until this agreement, the latest JMR elevation-area-capacity used in the H-I Model was based on the 1994 resurvey.

JMR was resurveyed in 1999 and the resulting elevation-area-capacity table had been used by the Arkansas River Compact Administration from November 1999 through October 2013. As noted above, the 1999 elevation-area-capacity was not recognized by the H-I Model which will be modified with this agreement.

The U.S. Army Corps of Engineers (USACE) dredged JMR around the outlet works in early 2006, completed a bathymetric survey of the reservoir in March 2006, and completed an aerial survey of the “out of water” areas in 2009. USACE completed the sedimentation resurvey report in 2013 which included a new elevation-area-capacity table. This elevation-area-capacity table was implemented in November of 2013.

The USACE provided both the digital elevation-area-capacity table and survey reports from 1999 and 2013. For the tables received from the USACE, the 1999 and 2006/2013 tables were discretized to 0.01 foot elevations. Although the USACE used a Fortran program in the past, GIS was also used in 2013 to develop areas and volumes from mapped contour lines. To apply AC information in the H-I Model, the following exponential function is used to estimate area as a function of volume for two volume ranges for each dataset using two coefficients that are fit using linear regression.

$$\log(\text{area in acres}) = a \cdot \log(\text{volume in AF}) + b$$

and

$$\text{area} = e^{(\log(\text{area}))} = e^{(a \cdot \log(\text{volume}) + b)}$$

where log = natural (base e) logarithm and e = Euler’s number
(a and b have been referred to as alpha and beta in the Appendix C.1 section 2.2.5)

III. Scope

For JMR, the months when AC and maximum storage variables change are hardwired in the H-I Model. Currently in the H-I Model, applicable date ranges for AC information are generally the midpoint between survey dates. For example, for the July 1986 and June 1994 surveys, the AC data from 1986 study is applicable until June of 1990 while the 1994 data is used beginning in July of 1990. Of the five AC date changes, three are applied in January and two in July. On the other hand, maximum storage changes have been applied either at the time of the survey or when the area capacity information was presumed to be applied to JMR accounting. The new 1999 survey data is applied starting January 1997 for the AC relationships in the model. JMR was dredged in the first months of 2006 before being resurveyed in March of 2006. As this dredging creates a more discrete change in JMR storage, the new 2006/2009 survey data is applied starting January 2006 for the AC relationships in the model. Tables developed from the 1999 and 2006/2009 resurveys were applied to JMR accounting in November 1999 and November 2013, respectively. Therefore, changes in the maximum storage variable in the H-I Model are applied in November 1999 and November 2013.

IV. H-I Model Code Revisions

The States agree to make the following changes to the H-I Model input file, RESR.DAT, and H-I Model code using the data from Table 1 to account for the 1999 and 2006/2009 elevation-area-capacity curves developed by USACE. The updated H-I Model code has been titled “update6eV1_15.for”

Table 1. John Martin Reservoir Data in the H-I Model

Sediment Survey	EAC Table	H-I Model Area Capacity Information for Evaporation							H-I Model Max Cons. Storage		
		Dates (2)	Months (2)	a2 if vol> (2)	a1 (1)	b1 (1)	a2 (1)	b2 (1)	Dates (2)	Months (2)	maxstor (2)
Oct-51	1956	1950-6/59	<115	29216	0.6658	0.9478	0.6319	1.2869	1950-7/57	<92	380858
Aug-57	1958								8/57-2/62	92<147	365706
Mar-62	1962	7/59-12/65	>114<193	29204	0.6765	1.0992	0.6384	1.2034	3/62-7/68	147<224	356038
Sep-66	1967										
Aug-68	1969	1/66-12/70	>192<253	23606	0.8388	-0.2694	0.5825	1.8865	8/68-2/72	224<267	349292
Mar-72	1972	1/71-12/79	>252<361	24187	0.8311	-0.3301	0.5984	1.6973	3/72-5/80	267<366	348101
Jun-80	1980								6/80-5/86	366<438	341945
Jul-86	1988	1/80-6/90	>360<487	18468	0.7161	1.0008	0.5796	1.9503	6/86-5/94	438<534	337166
Jun-94	1994	7/90-12/96	>486<565	18411	0.69	1.2625	0.6061	1.648	6/94-10/99	534<599	335693
May-99	1999	1/97-12/05	>564<673	17808	0.7011	1.0718	0.6131	1.5595	11/99-10/13	599<767	333912
Mar-06	2013	1/06-	>672-	15614	0.6307	1.6871	0.6051	1.6691	11/13-	767-	330703

Notes: (1) implemented in RESR.DAT, (2) implemented in H-I Model code

A. Revisions to the H-I Model Input File and H-I Model Code

1. Additional Lines Added to RESR.DAT for Proposed JMR Information

(added lines shown in red)

0.6658	0.9478	-- COEFFICIENTS FOR JOHN MARTIN AREA-STORAGE
0.6765	1.0992	
0.8388	-0.2694	
0.8311	-0.3301	
0.7161	1.0008	
0.6900	1.2625	
0.7011	1.0718	
0.6307	1.6871	
0.6319	1.2869	
0.6384	1.2034	
0.5825	1.8865	
0.5984	1.6973	
0.5796	1.9503	
0.6061	1.6480	
0.6131	1.5595	
0.6051	1.6691	

2. **Revisions and Additions to H-I Model Code to Incorporate Proposed JRM Information**
(revisions and additions shown in red)

Changes to Dimension

DO 370 I=1, 16	201KTJMR
READ(92,*)	0202
REAL ALPHA(8 ,2),BETA(8 ,2),CFLOW(MAXDVT),DIVTD(MAXDVT),	0295KTJMR
DO 360 IRANGE=1,2	0678
DO 355 IPER=1, 8	0679KTJMR
READ(92,913)ALPHA(IPER,IRANGE),BETA(IPER,IRANGE)	0680

Changes to JMR Area-Capacity Statements

IF (IMONTH.GT.486 .AND. IMONTH .LT. 565) THEN	0926KTJMR
IF (IMONTH.GT.564 .AND. IMONTH .LT. 673) THEN	0933.1KTJMR
IPER=7	0933.2KTJMR
IF (VOL.GT.17808.) THEN	0933.3KTJMR
IRANGE=2	0933.4KTJMR
ELSE	0933.5KTJMR
IRANGE=1	0933.6KTJMR
ENDIF	0933.7KTJMR
ENDIF	0933.8KTJMR
IF (IMONTH.GT.672) THEN	0933.9KTJMR
IPER=8	0933.10KTJMR
IF (VOL.GT.15614.) THEN	0933.11KTJMR
IRANGE=2	0933.12KTJMR
ELSE	0933.13KTJMR
IRANGE=1	0933.14KTJMR
ENDIF	0933.15KTJMR
ENDIF	0933.16KTJMR

Changes to JMR Area-Capacity Statements

IF (IMONTH.GE.534 .AND. IMONTH.LT.599) STRMAX(1)=335693.	1047.1KTJMR
IF (IMONTH.GE.599 .AND. IMONTH.LT.767) STRMAX(1)=333912.	1047.2KTJMR

	1048
C--Actual conservation storage capacity as of November 2013	1049KTJMR
	1050
IF (IMONTH.GE. 767) STRMAX(1)= 330703 .	1051KTJMR

IX. General Terms

The States agree to modify the H-I Model code recognizing the JMR elevation-area-capacity data from 1999 resurvey and the 2006/2009 resurvey as described in this agreement. The States agree that the changes will be implemented with the 2014 H-I Model annual update performed in 2015. The results of the ten year Compact compliance for years prior to the 2014 H-I Model annual update will remain unchanged.

This Agreement shall become effective when both States have approved it by the signatures of their Engineers as provided for below or on counterpart copies, and after telecopies or electronic versions of the same have been received by the other State. Two originals of this Agreement will be circulated for signature, one original to be retained by each State.

STATE OF COLORADO



Dick Wolfe
Colorado State Engineer

Date: 8-26-2015

STATE OF KANSAS



David W. Barfield
Kansas Chief Engineer

Date: 8/26/2015