THE PECOS RIVER MASTER'S MANUAL

July 28, 2003

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FOREWORD

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This revised edition of the Pecos River Master's Manual was compiled from the edition dated November 30, 1987, which was marked as "Texas Exhibit No. 108." In the revised edition, modifications have been added to the text of the Manual and a few minor changes in presentation style have been made. The edition was prepared by the River Master and submitted to the Technical Representatives of New Mexico and Texas for review and approval. Comments received in a joint letter from the states dated May 14, 2003 have been incorporated into the revision.

INTRODUCTION

This manual contains the procedures to be used by the River Master to make the calculations provided for in the decree of the United States Supreme Court in Texas vs. New Mexico, No. 65 Original. These calculations include determination of negative or positive departures from New Mexico's delivery obligation.

The computational procedures and the computer programs required to make the computations are described in detail in Texas Exhibit no. 79.

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MANUAL OF PROCEDURES

TO COMPUTE PECOS RIVER COMPACT COMPLIANCE

A. General

A. General

1. The so–called "annual flood inflow" for the Sumner Dam[1] to state line reach is defined as the sum of the measured flow of the Pecos River below Sumner Dam plus the estimated flood inflows from the Sumner Dam to Artesia, Artesia to Carlsbad, and Carlsbad to state line reaches. The current year's "annual flood inflow" is averaged with the annual flood inflows for the two prior years. This three–year average quantity is termed the "Index Inflow" and is used as "x" in the equation

$$y = 0.0489892\ (x)^{1.42318}$$

in order to determine the "Index Outflow," or "y," New Mexico's three–year average 1947 Condition delivery obligation at the New Mexico–Texas state line. This Index Inflow–Index Outflow equation was approved June 11, 1984 by the U.S. Supreme Court in the Texas vs. New Mexico Pecos River Compact Litigation, No. 65 Original. This equation will be used to determine New Mexico's 1947 condition delivery obligation imposed by the Pecos River Compact. A comparison of the Index Outflow with the three year average historical outflow will identify any delivery depletions from the 1947 Condition which might have occurred.

2. There are several factors which, under terms of the Pecos River Compact, might at times increase or decrease New Mexico's obligation to deliver Pecos River water at the state line. When appropriate, the following factors may need to be employed to adjust the computed departures in the Compact compliance computations:

[1] On October 17, 1974, Alamogordo Dam was renamed Sumner Dam by the U.S. Congress under Public Law 93–447. In the original manual, Sumner Dam was usually referenced as Alamogordo Dam. In the revision dated July 28, 2003, the references were changed to Sumner Dam because data is delivered under that name.

a. Adjustments for Depletions Above Sumner Dam

b. Depletions Due to McMillan Dike

c. Salvage Water in New Mexico

d. Unappropriated Flood Waters

e. Texas Water Stored in New Mexico Reservoirs

f. Beneficial Consumptive Use of Waters of Delaware River by Texas

B. Procedures to Compute Departures of State Line Flows of the Pecos River from the 1947 Condition

1. General

a. Compute Index Inflow, Sumner Dam to New Mexico–Texas state line as follows:[2]

(1). The annual flood inflow is computed as follows:

(a) Gaged flow of the Pecos River below Sumner Dam, plus

(b) Computed flood inflow, Sumner Dam to Artesia reach, plus

(c) Computed flood inflow, Artesia to Carlsbad reach, plus

(d) Computed flood inflow, Carlsbad to state line reach.

[2] All computations are to be performed in units of 1,000 acre–feet rounded to the nearest 1 acre–foot. (Modified by Joint Motion, approved by the River Master, June 6, 2002).

(2). The Index Inflow for one year is the average of the annual flood inflow for that year and the two prior years.

b. Determine New Mexico's 1947 Condition delivery obligation at the New Mexico–Texas state line (Index Outflow). The 1947 Condition Index Outflow is determined by the equation:

$$y = 0.0489892(x)^{1.42318}$$

Where (x) is the Index Inflow and Y is the 1947 Condition outflow in units of 1,000 acre–feet.

c. Determine the three–year running average historical outflow at the New Mexico–Texas state line.

(1). The annual historical outflow is computed as follows:

(a) Gaged flow of the Pecos River at Red Bluff, New Mexico.

(b) Gaged flow of the Delaware River near Red Bluff, New Mexico.

(c) The total annual metered diversions under New Mexico State Engineer Permit Number 3254 into C-2713 (approved April 24, 2001), currently held by the Red Bluff Water Power Control District, not to exceed a total of 845 acre–feet per annum. [3]

(d) Subparagraph B.1.c.(1)(c) will continue in effect for an initial term beginning on the date this amendment is approved by the River Master and extending until the end of Water Year 2007. Thereafter, unless rescinded as provided herein, Subparagraph B.1.c.(1)(c) will continue in effect for successive six (6) year terms coinciding with Water Years. Subparagraph B.1.c.(1)(c) may be rescinded by agreement of Texas and New Mexico, or Subparagraph B.1.c.(1)(c) may be rescinded by either Texas or New Mexico if the Average Daily Brine Inflow of the Pecos River between the United States Geological Survey ("USGS") Gage at Pierce Canyon and the USGS Gage at Malaga exceeds a total dissolved solids load of 367.7 tons per day, i.e., seventy-five percent (75%) of the Base Number.

(e) For purposes of this Paragraph, the Base Number shall be 490.3 tons per day of total dissolved solids.

[3] Sections B.1.c.(1)(c) through B.1.c.(1)(j) were added by Joint Motion of the states as approved by the River Master on June 6, 2002 for use in accounting for Water Year 2002 and thereafter.

(f) For purposes of this Paragraph, the Average Daily Brine Inflow will be determined as follows. A daily average of total dissolved solids in tons per day will be used, calculated by the USGS and based on the difference between measurements at the USGS Gage on the Pecos River at Pierce Canyon Crossing near Malaga, New Mexico (Station No. 08407000) and at the USGS Gage on the Pecos River near Malaga, New Mexico (Station No. 08406500) during the first five (5) years of the current six–year term described in Subparagraph B.1.c.(1)(d) above.

(g) Either Texas or New Mexico may rescind Subparagraph B.1.c.(1)(c) at the end of any Water Year, if during the year the brine well being operated under Permit Number 3254 into C-2713 is not being operated for a period of twenty (20) consecutive calendar days or for more than thirty (30) total (exclusive of holidays and weekends) days in any calendar year.

(h) Either Texas or New Mexico may rescind Subparagraph B.1.c.(1)(c) at the end of any Water Year, if adequate precautions to prevent brine removed from the aquifer from reentering the Pecos River are not being taken.

(i) Either Texas or New Mexico may rescind Subparagraph B.1.c.(1)(c) at the end of any Water Year if the annual diversion exceeds 645 acre–feet.

(j) Any State wishing to rescind Subparagraph B.1.c.(1)(c) must first provide the River Master and the other State with written notice of rescission at least thirty (30) days prior to the Water Year in which the rescission is to be effective.

(2). The three–year average historical outflow for any year is the average of the annual historical outflow for that year and the two prior years.

d. Compute annual departures of state line flows of the Pecos River from the 1947 Condition. Compute each annual departure by subtracting the annual 1947 Condition delivery obligation (Index Outflow) from the corresponding three–year average historical outflow. Add algebraically the adjustments to the computed departures as determined under the provisions of Part C herein. A negative departure indicates an underdelivery at state line and a positive departure indicates an overdelivery.

Figure 1 shows the approximate boundary of the Pecos River Basin from its headwaters in New Mexico to the gaging station of the Pecos River near Girvin, Texas. Figures 2, 3 and 4 are stick diagrams of the main stem of the

Pecos River showing important tributaries, gaging stations, diversion facilities and reservoirs in New Mexico and Texas.

2. Determination of Sumner Reservoir Releases and Spills

Use the monthly United States Geological Survey (USGS) streamflow records for the gaging station, Pecos River below Sumner Dam, as the measure of releases and spills from the reservoir.

3. Determination of Flood Inflows, Sumner Dam to Artesia

The computational items used to estimate the flood inflows to this 197.8 river mile reach of the Pecos River are listed below, followed by an explanation for each computation to be made. Monthly quantities for each item will be measured or computed, and the annual quantity will be the sum of the monthly quantities.

Streamflow below Sumner Dam (see 3.a. below).
Fort Sumner Irrigation District diversion (see 3.b. below)
Fort Sumner Irrigation District return flow (see 3.c. below)
Streamflow past Fort Sumner Irrigation District (see 3.d. below)
Channel loss, Sumner Dam to Acme (see 3.e. below)
Computed residual flow at Acme (see 3.f. below)
Base Inflow, Acme to Artesia (see 3.g. below)
River pump depletions (see 3.h. below)
Residual flow at Artesia (see 3.i. below)
Streamflow, Pecos River near Artesia (see 3.j. below)
Flood inflow, Sumner Dam to Artesia (see 3.k. below)

a. Streamflow below Sumner Dam

Use the monthly USGS streamflow records for the gaging station, Pecos River below Sumner Dam, N.M.

b. Fort Sumner Irrigation District diversion

Use the monthly USGS discharge records for the gaging station, Fort Sumner Main Canal near Fort Sumner, N.M.

c. Fort Sumner Irrigation District return flow

Use 53 percent of the total annual diversion (item b. above) and distribute on a monthly basis as follows:

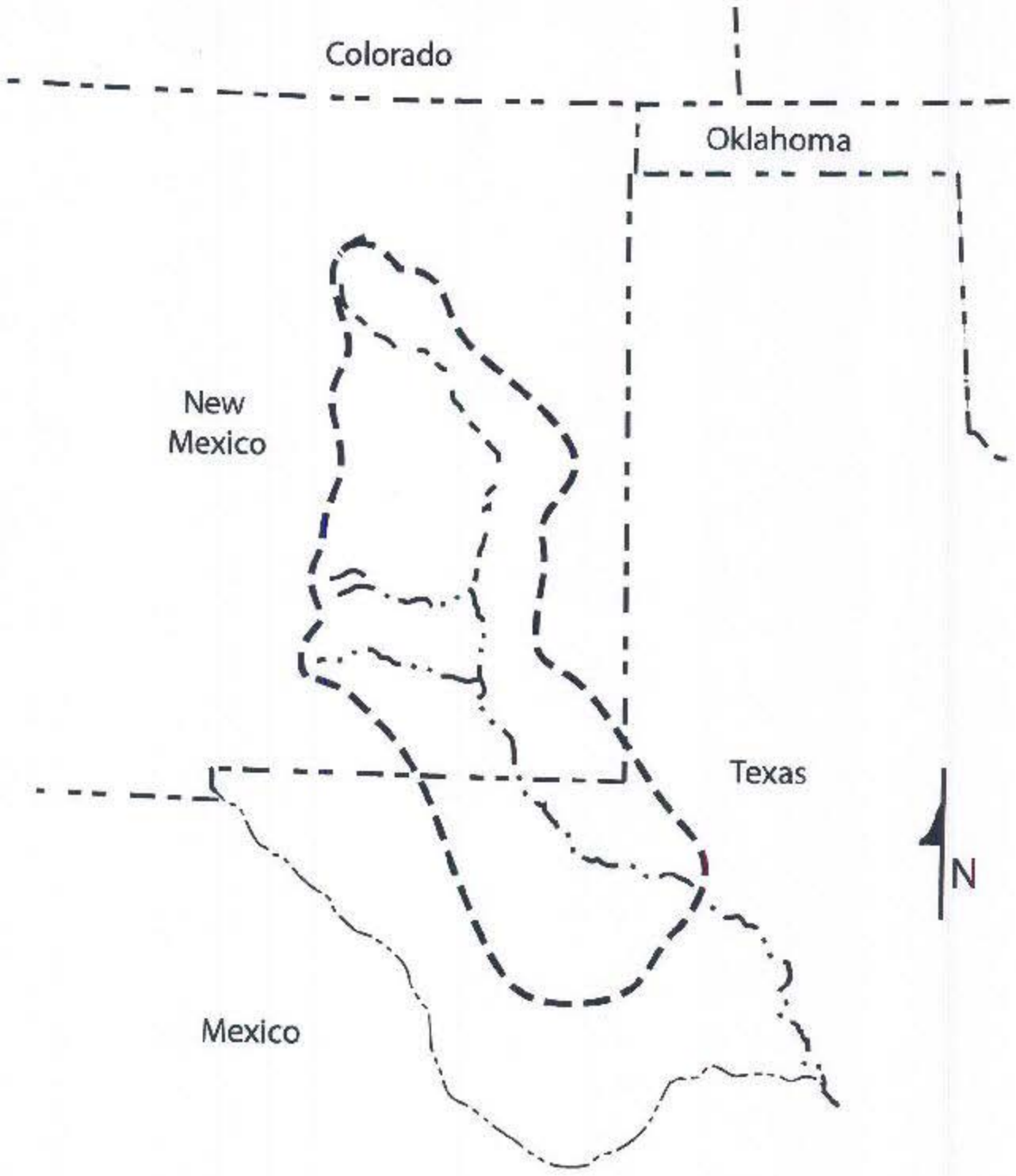

Figure 1
Pecos River Basin
Pecos River Compact
New Mexico -Texas

Figure 2
Diagram of Pecos River Near Pecos
to Sumner Dam

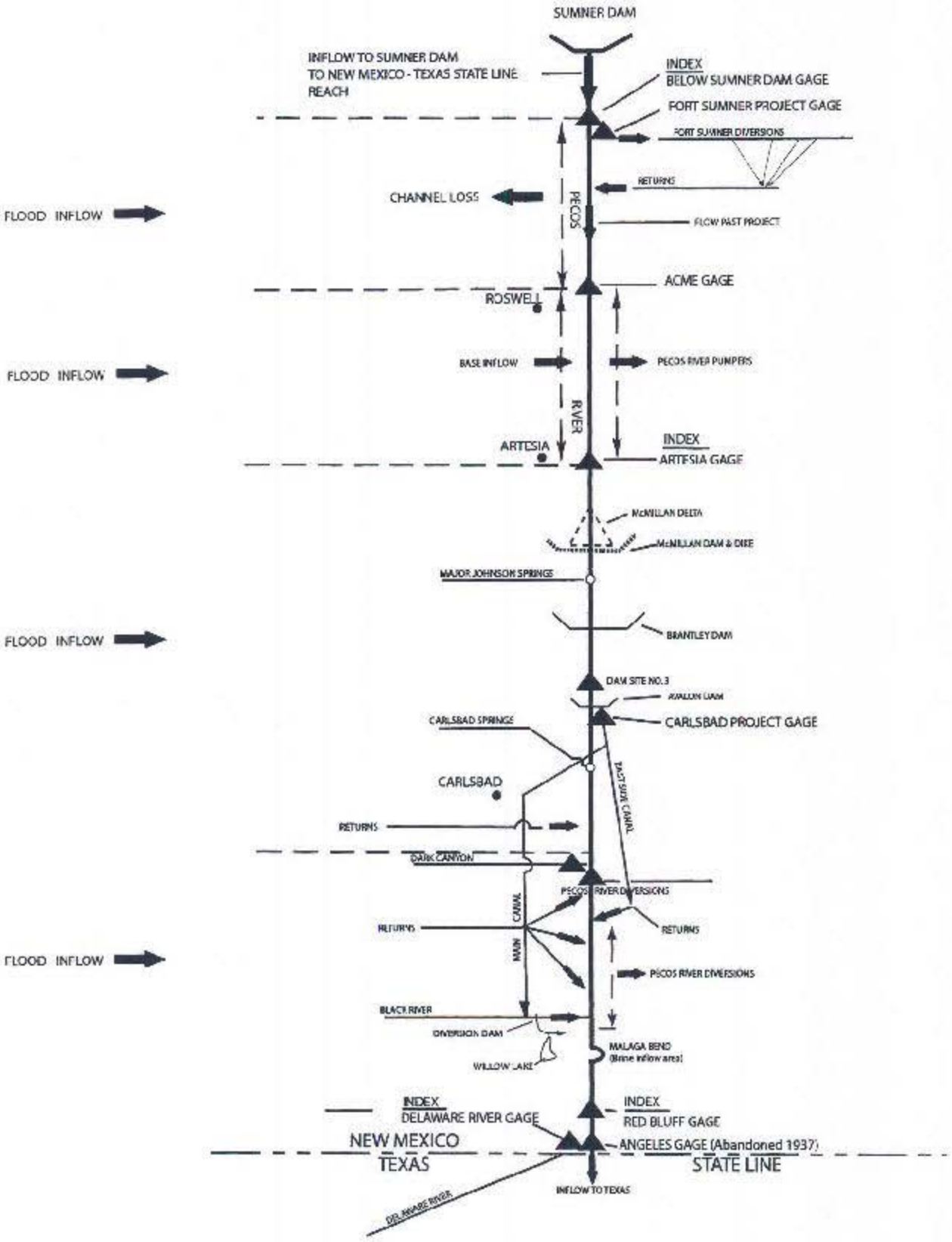

Figure 3
Diagram of Sumner Dam
to New Mexico-Texas State Line Reach

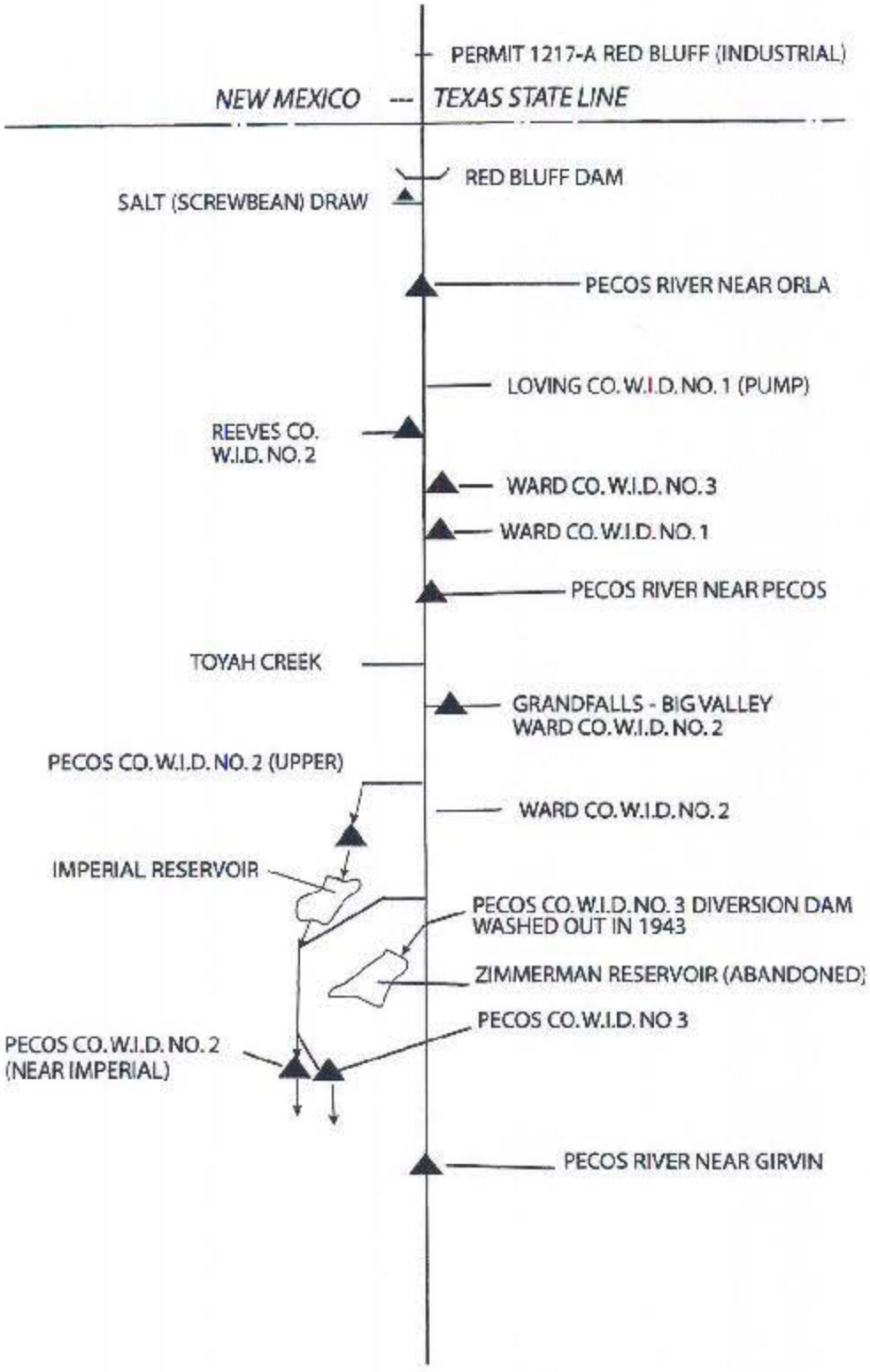

Figure 4
Diagram of Red Bluff - Girvin Area

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
PERCENT	4	3	7	8	12	12	12	12	11	10	5	4

d. Streamflow past Fort Sumner Irrigation District

From the streamflow below Sumner Dam (item 3.a.), subtract the Fort Sumner Irrigation District diversions (item 3.b.), and add the Fort Sumner Irrigation District return flows (item 3.c.). Whenever the computed flow past the District is less than the return flow, set the flow past the District (item 3.d.) equal to the return flow (item 3.c.).

e. Channel loss, Sumner Dam to Acme[4]

Compute the monthly river channel losses using the equations below, where X is the flow past the Fort Sumner Irrigation District in units of 1000 acre–feet (item 3.d.). Whenever the computed loss exceeds the calculated flow past the District, the channel loss (item 3.e.) is set equal to the flow past the District (item 3.d.). Any computed negative channel loss is set equal to zero.

Month	Channel Loss "L" by Month in 1000 Acre–Feet
Jan, Feb, Dec	$L = .057X + 0.097$
Mar	$L = .177X + 0.227$
Apr, May	$L = .118X + 1.098$
Jun	$L = .163X + 0.784$
Jul	$L = .137X + 0.632$
Aug	$L = .088X + 1.350$
Sep, Oct	$L = .127X + 0.499$
Nov	$L = .132X + 0.448$

f. Computed residual flow at Acme

Item 3.d. – Item 3.e.

g. Base Inflow, Acme to Artesia[5]

For the River Master's Preliminary Report use the monthly base inflow quantities determined and furnished by the USGS. USGS will utilize the

[4] Modified by Joint Motion of New Mexico and Texas, October 26, 1993.
[5] Modified through Modification Determination, effective December 26, 1990.

best available data and methods to estimate the total monthly base inflows accruing to the Acme to Artesia reach. In their report USGS will describe the data and methods used to estimate the base inflows and describe any unusual hydrologic events that occurred during the water year. After review of any objections to the USGS estimates by the states the River Master will make any adjustments deemed necessary to the base inflow estimates and determine the base inflow quantities for the Final Report. If no monthly base inflow quantities are determined and furnished by USGS the River Master will prepare the estimates for the Preliminary Report.

h. River pump depletions, Acme to Artesia

Use monthly river pump diversion quantities compiled by USGS based upon river pumping from the Pecos River in the Acme to Artesia reach as reported by the New Mexico Pecos River Water Master.

i. Residual flow at Artesia

Item 3.f. + Item 3.g. – Item 3.h.

j. Streamflow, Pecos River near Artesia

Use the monthly USGS streamflow records for the gaging station, Pecos River near Artesia, N.M.

k. Flood inflow, Sumner Dam to Artesia

Item 3.j. – Item 3.i.

Table 1 shows sample computations for years 1982 and 1983 extracted from Texas Exhibit 79.

Table 1

Pecos River Compact. Sumner Dam to Artesia Reach. Pecos River Basin, New Mexico
Estimated Flood Inflows in 1000 Acre–Feet Units, 1950–1983

Year		Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1982	(1)	Gaged flow below Sumner Dam	0.1	0.1	5.5	44.6	5.9	0.1	36.3	7.1	36.2	4.1	0	0	140.0
	(2)	Ft Sumner Diversions	0	0	4.7	4.7	5.3	4.9	5.1	5.9	5.8	3.6	0.2	0	40.2
	(3)	Ft Sumner Return Flow	0.9	0.6	1.5	1.7	2.6	2.5	2.5	2.6	2.3	2.1	1.1	0.9	21.3
	(4)	Flow Past Project	1	0.7	2.3	41.6	3.2	5.7	33.7	3.8	32.7	2.6	0.9	0.9	129.1
	(5)	Channel Loss, Ft Sumner-Acme	0.4	0.2	0.7	6	1.5	2	5.1	1.7	4.7	0	0.3	0.3	22.9
	(6)	Computed Residual Flow at Acme	0.6	0.5	1.6	35.6	1.7	3.7	28.6	2.1	28	1	0.6	0.6	104.6
	(7)	Base Inflow Acme-Artesia	2.8	2.7	2.2	1.4	1.5	1.1	0	0.8	0.9	1.3	1.6	2.4	18.7
	(8)	River Pump Depletion	0	0.2	0.4	2.3	1.3	0.7	2.4	1.1	1.1	0.2	0.1	0	9.8
	(9)	Residual Flow at Artesia	3.4	3	3.4	34.7	1.9	4.1	27	1.8	27.8	2.9	2.1	3	115.1
	(10)	Pecos River Near Artesia	4.2	3	2.2	24.5	9.3	0.6	29.1	1.2	27.3	7.6	3.2	3.9	116.1
	(11)	Flood Inflow	0.8	0	-1.2	-10.2	7.4	-3.5	2.1	-0.6	-0.5	4.7	1.1	0.9	1.0

Year		Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1983	(1)	Gaged flow below Sumner Dam	0	0	3.2	4.2	39.6	11.4	59.6	14.5	27.7	3.8	0	0	164.0
	(2)	Ft Sumner Diversions	0	0	2.8	3.7	5.8	5.5	6.4	5.7	4.9	2.8	0	0	37.6
	(3)	Ft Sumner Return Flow	0.8	0.6	1.4	1.6	2.4	2.3	2.4	2.4	2.2	2	1	0.8	19.9
	(4)	Flow Past Project	0.8	0.6	1.8	2.1	36.2	8.2	55.6	11.2	25	3	1	0.8	146.3
	(5)	Channel Loss, Ft Sumner-Acme	0.3	0.2	0.6	1.4	5.4	2.4	8.5	2.5	3.7	0.8	0.3	0.3	26.4
	(6)	Computed Residual Flow at Acme	0.5	0.4	1.2	0.7	30.8	5.8	47.1	8.7	21.3	2.2	0.7	0.5	119.9
	(7)	Base Inflow Acme-Artesia	2.6	2.1	1.7	1.2	1.1	0.7	0.6	0.6	0.9	1.5	2	2.5	17.5
	(8)	River Pump Depletion	0	0	0.2	0.5	2	1.2	2.6	1.6	1.9	0.2	0	0	10.2
	(9)	Residual Flow at Artesia	3.1	2.5	2.7	1.4	29.9	5.3	45.1	7.7	20.3	3.5	2.7	3	127.2
	(10)	Pecos River Near Artesia	4	3	2.1	2.1	28.6	1.5	40.8	2.2	25.4	7.7	9.9	4.2	131.5
	(11)	Flood Inflow	0.9	0.5	-0.6	0.7	-1.3	-3.8	-4.3	-5.5	5.1	4.2	7.2	1.2	4.3

Explanation of rows

(1) Gaged streamflow at USGS index gaging station, Pecos River Below Sumner Dam
(2) From Table A-5-3, page S-16, RBD prior Mar 1954, measured diversions thereafter
(3) Computed from 53 percent of annual quantity row (2) times monthly distribution from page 5-11 RBD
(4) Row (1) – Row (2) + Row (3)
(5) Computed from row 4 using monthly stipulated loss equations of July 3, 1985 (page A-5 of Appendix A)
(6) Row (4) – Row (5)
(7) Table A-18-1, page 8-5, RBD 1950-56, and 1957-83 as determined by USGS
(8) Table A-7-6, pages 7-20 & 21, RBD 1950-56, and 1957-83 as tabulated by USGS from New Mexico diversion records
(9) Row (6) + Row (7) – Row (8)
(10) Revised USGS streamflow records Pecos River near Artesia
(11) Row (10)- Row 9

4. Determination of Flood Inflows, Artesia to Carlsbad[6]

The flood Inflows for the Artesia to Carlsbad reach are computed as the sum of the flood inflows to the Artesia to Dam Site #3 reach and the flood Inflows to the Dam Site #3 to Carlsbad reach. Monthly quantities for each item will be measured or computed, and the annual quantities will be the sum of the monthly quantities. The computational items used to estimate the flood inflows for this 45.3 river mile reach of the Pecos River are listed below, followed by an explanation of each computation to be made:

Flood Inflow, Artesia to Dam Site #3
Flood Inflow, Dam Site #3 to Carlsbad
Total inflow to the Dam Site #3 to Carlsbad Reach
Streamflow, Pecos River at Dam Site #3
Carlsbad Springs New Water
Total outflow from the Dam Site #3 to Carlsbad Reach
Lake Avalon Evaporation Loss
Lake Avalon Change in Storage
Net Carlsbad Irrigation District Diversions
Other Depletions
Streamflow, Pecos River at Carlsbad
Flood Inflow, Artesia to Carlsbad

a. Flood Inflow, Artesia to Dam Site #3

Use the sum of the monthly flood flow quantities determined by hydrograph scalping of the daily USGS streamflow records for:

(1) Rio Penasco at Dayton, NM;
(2) Fourmile Draw near Lakewood, NM;
(3) South Seven Rivers near Lakewood, NM;
(4) Rocky Arroyo at Highway Bridge near Carlsbad, NM.

b. Flood Inflow, Dam Site #3 to Carlsbad

Compute the total inflow to the reach (item B.4.c.) and the total outflow from the reach (item B.4.d.). Subtract the total inflow from the reach (item c) from the total outflow (item d).

c. Total inflow to the Dam Site #3 to Carlsbad Reach

Total inflow to the Dam Site #3 to Carlsbad Reach is computed as the sum of items (1) and (2) below:

[6] Modified by Modification Determination dated December 7, 1992.

(1) Use USGS streamflow records for the Pecos River at Dam Site 3, near Carlsbad, N.M.

(2) Carlsbad Springs New Water

Use the following procedure to compute the monthly new water discharge quantities rounded to the nearest 100 acre-feet.

(a) Use the annual streamflow records (expressed in cfs) furnished by the USGS for the gaging station, Pecos River below Dark Canyon, at Carlsbad, N.M.

(b) Subtract tributary inflow from Dark Canyon Draw, furnished by USGS for the Dark Canyon Draw at Carlsbad gaging station.

(c) Subtract releases and spills from Lake Avalon, which are furnished by USGS for gaging station, Pecos River below Avalon Dam, N.M.

(d) Add 2 cfs for the annual depletions from the Pecos River from the Carlsbad canal flume to the Carlsbad gage. These depletions are caused by the power plant consumptive use, evaporation from Tansil and Bataan Lakes, and all diversions including the Carlsbad golf course, F.V. Dowling and E.J. Hines.

(e) Subtract the lagged seepage from the main CID canal in cfs, which is computed to be 7 percent of the CID diversions measured at Avalon Dam by USGS for gaging station, Carlsbad Main Canal at Head, Carlsbad, N.M. This seepage will have a lagged distribution as follows: one-half in the current quarter; one-third in the following quarter; and one-sixth in the next quarter.

(f) Subtract one cfs to represent the average annual return flow from surface water irrigation between Avalon Dam and the gaging station Pecos River at Carlsbad.

(g) Subtract lagged leakage from Lake Avalon. The leakage from Lake Avalon is estimated by using the mean monthly gage height (H) in feet for Lake Avalon (published by USGS for Lake Avalon Near Carlsbad, N.M.), in the equation: Avalon leakage in cfs = 4.78 (H) - 62.0. One half of this leakage is assumed to appear at Carlsbad Springs during the current quarter; with one-third to appear during the following quarter; and one-sixth during the next quarter.

(h) Subtract 3 cfs to represent the average seepage loss from the Pecos River in the reach between Major Johnson Springs and the Dam Site No. 3 gage.

(i) The annual new water in cfs is: (a) - (b) - (c) + (d) - (e) - (f) - (g) - (h).

(j) Convert the new water in cfs, item (i) above, to units of 1000 acre-feet, and distribute equally to each month of the year.

d. Total outflow from the Dam Site #3 to Carlsbad Reach is computed as the sum of items (1) through (5) below:

(1). Lake Avalon Evaporation Loss

(a) Compute the monthly evaporation loss by multiplying the net monthly evaporation rate times the average monthly surface area for Lake Avalon.

(b) Use the USGS elevation, area and capacity relationship for Lake Avalon to estimate the average monthly surface area for the lake. The 1997 area-capacity table based on the 1996 United States Bureau of Reclamation (USBR) sediment survey for Lake Avalon (Table 3) is to be used until a revised area-capacity table based on a new sediment survey performed by the USBR, the U.S. Army Corps of Engineers, USGS, U.S. Soil Conservation Service or a state-registered engineer is available.[7]

(c) For Lake Avalon evaporation and precipitation, use U.S. National Weather Service (USNWS) evaporation and precipitation data for Brantley Dam. When the U.S. National Weather Service data are not available, use USBR evaporation or precipitation data for Brantley Dam. If neither USNWS nor USBR precipitation data are available, use precipitation data from Carlsbad or Carlsbad Federal Aviation Administration Airport in that order.

[7] Table 3 is not included because a revised area–capacity table has been issued by the US Bureau of Reclamation. The following note appeared on the original Table 3: "The gage height of 26.1 feet corresponds to an elevation of 3267.7 feet above the mean sea level with the datum of gage at 3241.6 feet above mean sea level."

(d) Missing monthly evaporation data at Brantley Reservoir are to be computed using the following equation:

$$EL = 2.5*[(p*T/100)*(114-H)/100] - 1.5$$

where EL is the lake evaporation in inches, p is the percentage of daytime hours at the approximate location of Avalon Reservoir, as given in the table below; T is the mean monthly temperature in degrees F, average of Artesia and Carlsbad; H is the average percent humidity for the month computed from the data at 5AM, 11AM, 5PM and 11PM furnished by the National Weather Service.

Table of Percentage of Daytime Hours for Avalon Reservoir

January	7.17	July	9.80
February	6.95	August	9.29
March	8.36	September	8.34
April	8.76	October	7.92
May	9.65	November	7.08
June	9.62	December	7.02

If Brantley Reservoir evaporation data are not available, and humidity data at Roswell and other data are not available for estimating evaporation at Lake Avalon, and there is not more than one month missing between months for which data are available, estimate the evaporation by interpolation between monthly data. If complete evaporation data are missing for more than one month and data for all the above described methods are not available, find the average daily evaporation that is published for that month and estimate total evaporation by multiplying the average daily evaporation times the number of days in the month.

(e) Monthly net evaporation in feet for Lake Avalon is determined by multiplying pan evaporation in inches by 0.77 to determine monthly lake surface evaporation, subtracting the monthly precipitation in inches, then converting to feet by dividing by 12.[8]

[8] In the future, if pan evaporation and precipitation data are available at the Brantley Dam site, use these data in estimating the evaporation rates. If data are not available for Brantley Reservoir, use the procedures described in B.4.d.(1). (Note modified by agreement between the States June 14, 1989. Section B.4.d.(1) was labeled B.4.f. in previous version of the Manual).

(2). Lake Avalon Change in Storage

Use data from USGS gage height records for Lake Avalon near Carlsbad, N.M., and gage height-area-capacity relationships shown in Table 3.[9]

(3). Net Carlsbad Irrigation District Diversions

Use 93 percent of the USGS published records for the gaging station, Carlsbad Main Canal at Head, Near Carlsbad, N.M.

(4). Other Depletions

For other depletions referenced in B.4.c.(1)(d) add 100 acre-feet for all months except July and August and 200 acre-feet for July and August.

(5). Streamflow, Pecos River at Carlsbad

Use the USGS gaging station records for Pecos River below Dark Canyon, at Carlsbad, N.M., minus the gaged streamflow at the USGS gaging station, Dark Canyon Draw at Carlsbad, N.M.

In 1970, the USGS discontinued the gaging station Pecos River at Carlsbad, N.M., and moved it to a new site about 0.8 mile downstream. The new "Carlsbad gage" was renamed Pecos River below Dark Canyon Draw and it now measures tributary inflow from Dark Canyon Draw that was not previously measured at the Carlsbad site. The total flow of Dark Canyon must be subtracted from the total flow Pecos River below Dark Canyon Draw in order to arrive at the equivalent total flow at the old location at Carlsbad.

e. Flood Inflow, Artesia to Carlsbad

Add items (a) and (b) above.

[9] See previous note about Table 3.

B. 5. Determination of Flood Inflows, Carlsbad to New Mexico–Texas State Line[10]

Because of the lack of sufficient data to accurately compute flood inflow in the Carlsbad to State Line reach by the inflow–outflow method, the flood inflow for this reach is to be determined by the hydrograph scalping method. Figure 5 shows the factors to be considered in scalping flood flows from the hydrographs. The computational items used to estimate flood inflows to the 54 river mile reach of the Pecos River are listed below, followed by an explanation of each computation to be made. Monthly quantities for each item will be computed from daily streamflow quantities. The annual quantities will be the sum of the computed monthly flood inflow quantities.

Flood inflow, Carlsbad to State Line not including Delaware River flood inflow (see a. below)
Flood inflow, Delaware River (see b. below)
Total flood inflow, Carlsbad to State Line (see c. below)

a. Flood Inflow, Carlsbad to USGS Gage at Red Bluff, N.M.

Use the following procedure:

(1). Prepare hydrographs for daily flows at the USGS gaging stations Pecos River below Dark Canyon, at Carlsbad, New Mexico, and Pecos River at Red Bluff, New Mexico.

Identify apparent flood inflow events by correlating periods of significant daily precipitation within the reach or its tributaries with distinct hydrograph rises. Normally precipitation is considered significant when 0.05 inches or more has occurred in the Carlsbad - Red Bluff area, but other flood-inducing factors such as total areawide precipitation and antecedent moisture shall also be considered. On the hydrographs plot the rainfall in the area to aid in separating genuine periods of flood inflow from periods of operational rises. Study gaged tributary flows from Dark Canyon Draw at Carlsbad, N.M., Black River above Malaga, N.M., and Delaware River near Red Bluff, N.M. to aid in identifying flood periods caused by rainfall in the tributary drainage areas.

(2). Compute the quantities of flood inflows by hydrograph scalping techniques. Compute the monthly flood inflows occurring between the upstream and downstream gaging stations as the difference between the scalped flood flow quantities of the two hydrographs. If the difference is a negative quantity set the flood inflow to zero.

[10] Modified through Modification Determination dated November 25, 1991.

(3). Identify the periods when gaged inflows from Dark Canyon Draw are greater than zero. Determine for these periods if the difference in scalped flood flow quantities from (2) above is positive, zero or negative. If positive or zero add the gaged flows of Dark Canyon Draw to the difference in scalped flood inflows. If they are negative subtract the daily Dark Canyon Draw flows from the Pecos River Below Dark Canyon hydrograph and perform the scalping operation again to obtain adjusted flood inflows for these periods. If the difference in adjusted flood inflows is still negative set it to zero; if it is positive use it for this period of Dark Canyon Draw inflows.

b. Flood Inflow, Delaware River

Use the daily records furnished by the USGS for the gaging station, Delaware River near Red Bluff, N.M. and select flood inflows by inspection of daily data.

c. Flood Inflow, Carlsbad to State Line

Add the estimated flood inflows from item 5.a. to that quantity determined in item 5.b.

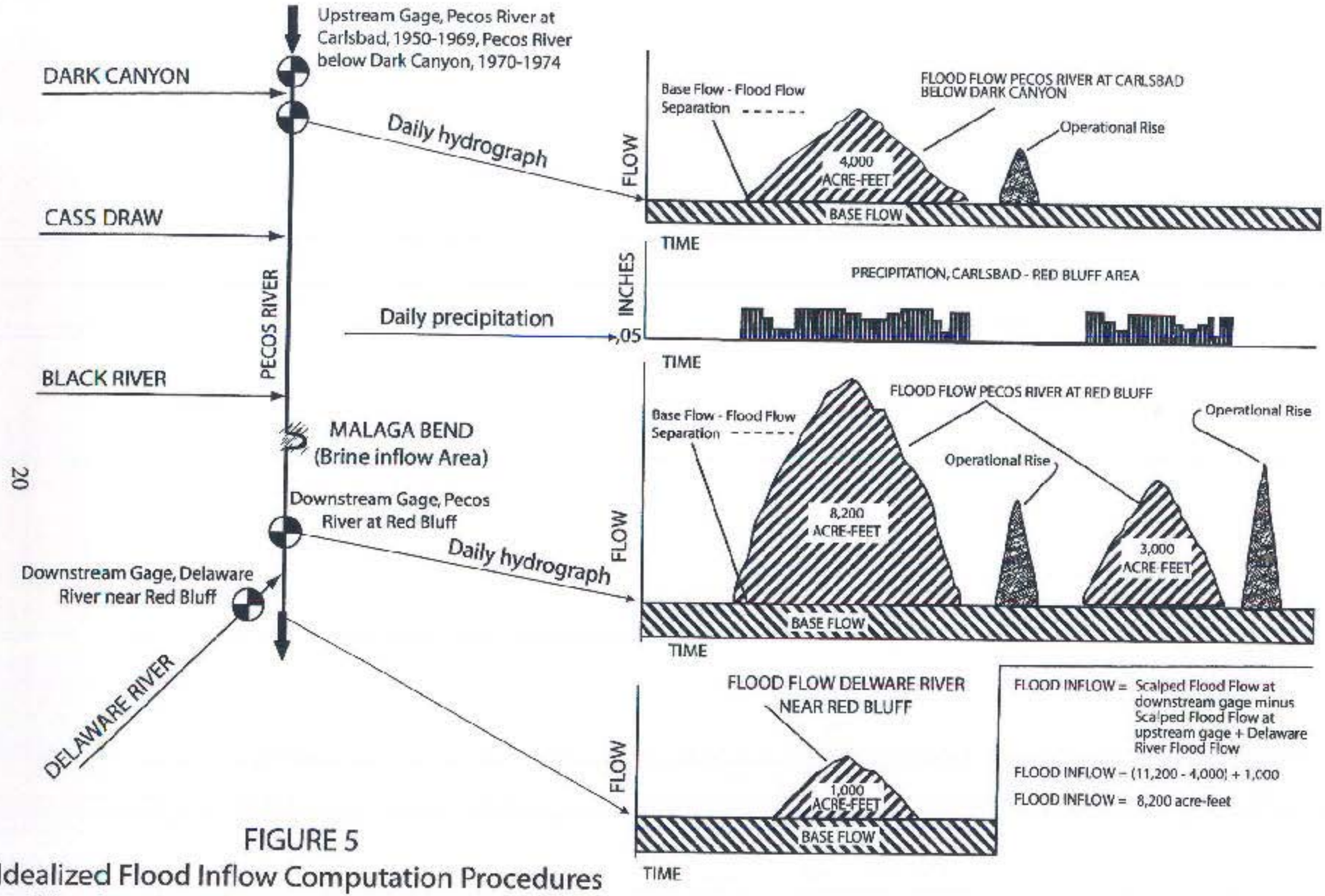

FIGURE 5
Idealized Flood Inflow Computation Procedures
Carlsbad to New Mexico - Texas State Line Reach

C. Adjustments to Computed Departures

1. Adjustments for Depletions above Sumner Dam

a. Adjustments due to irrigation

(1). In computing the total irrigated acreage in the Upper Reach, above Sumner Dam, to which surface and/or groundwater has been applied during any time of the year, use the irrigated acreage shown on the most recent irrigation inventory as reported by New Mexico. If any water right acreage in the Upper Reach is converted to another use, the depletion will be computed as if the use was irrigation use.

(2). Determine the consumptive use of irrigated acreage by multiplying the irrigation acreage determined in 1.a.(1) by the unit depletion rate for the year in question in acre–feet/acre. The unit depletion rate is determined as follows:

(a) Tabulate the monthly precipitation furnished for the Las Vegas Federal Aviation Administration Airport, Pecos Ranger Station and Santa Rosa for the months April through October. Find the effective precipitation for each station for each month using Figure A-7-2, page 7-11, of Stipulated Exhibit No. 8.

(b) Compute the average effective precipitation of the three stations for each month in inches. Convert the monthly effective precipitation in inches to feet.

(c) Using the following distribution of monthly unit consumptive use of 1.77 acre–feet per acre, subtract the estimated effective precipitation determined in Step 2 from the monthly unit consumptive use.

DISTRIBUTION OF MONTHLY UNIT CONSUMPTIVE USE[11]

(acre–feet per acre)

Apr	May	Jun	Jul	Aug	Sep	Oct	TOTAL
.19	.36	.36	.30	.27	.18	.11	1.77

(d) If the monthly effective precipitation estimated in Step 2 equals or exceeds the total monthly consumptive use, set the streamflow depletion equal to zero. If the monthly effective precipitation is less than the consumptive use, the difference is the streamflow depletion. Add the estimated streamflow depletion computed

[11] Monthly distribution of 1.77 acre–feet annual consumptive use calculated from table shown on page 41 of Stipulated Exhibit 11b.

each month April through October to determine the annual streamflow depletion rate to be applied to the historic irrigated acreage for the water year.

(e) Multiply the streamflow depletion rate determined in Step 4 by the irrigated acreage for the water year to determine the total streamflow depletion of the irrigated lands in the upper reach.

(3). Compare the 1947 Condition irrigation consumptive use (14,600 acres x 0.74 acre–feet/acre = 10,804 acre–feet per year) with Item (2). If the 1947 Condition use exceeds the actual use during the year computed in (2), the gaged streamflow below Sumner Dam will be reduced by the difference.

(4). If the actual use computed in (2) exceeds the 1947 Condition use, i.e., 10,804 acre–feet per year, then add the difference to the gaged streamflow below Sumner Dam.

Recompute New Mexico's 1947 Condition delivery obligation and departures at the state line using the revised streamflow of Pecos River below Sumner Dam.

b. Depletions Due to Operation of Santa Rosa Reservoir

(1). Determine the average monthly contents of Santa Rosa and Sumner Reservoirs and add these two contents to obtain the sum of contents. Use the gage height–area–capacity tables for each reservoir as shown in Appendices A-1 and A-3 of this Manual.

(a) Use the latest gage height–area–capacity tables for Sumner Reservoir as published by the U.S. Bureau of Reclamation and in Appendix A-1 to this Manual until another survey is undertaken and area–capacity tables are published by the U.S. Bureau of Reclamation.

(b) Use the latest gage height–area–capacity tables for Santa Rosa Lake (Lake Los Esteros) as published by the U.S. Army Corps of Engineers, Albuquerque District, August 1980, and extracted and shown in Appendix A-3 to this Manual, and currently used by the USGS until another sediment survey is undertaken and area–capacity tables published.

(2). Compute the monthly historic evaporation losses from Sumner Reservoir using the historic average surface area of Sumner Reservoir by multiplying it by the net evaporation rate at Sumner Dam. Compute the monthly net evaporation rate at Sumner Dam as 0.77

times the monthly pan evaporation rate at Sumner Dam minus the monthly precipitation at Sumner Dam.

(3). Compute the monthly historic evaporation losses from Lake Santa Rosa using the historic average surface area of Lake Santa Rosa multiplying it by the net monthly evaporation rate at Lake Santa Rosa. Compute the net monthly evaporation rate at Lake Santa Rosa as 0.77 times the monthly pan evaporation rate at Lake Santa Rosa minus the monthly precipitation at Lake Santa Rosa.

New Mexico is to provide the pan evaporation and precipitation data for Lake Santa Rosa and Sumner Reservoir.

(4). Add the two net monthly historic evaporation losses from Sumner and Santa Rosa Reservoirs computed in (2) and (3) above.

(5). Compute the 1947 Condition net monthly evaporation loss from Sumner Reservoir by assuming its contents equal to the total historic contents of Lake Santa Rosa and Sumner Reservoirs determined in (1) above. Use the same net evaporation rate from Sumner Reservoir as computed in (2) above. (Use Table 3 of Texas Exhibit 68 for Sumner Reservoir). Use a limit of 4,600 acres for the maximum surface area for Sumner Reservoir in calculating the 1947 Condition.[12]

(6). Subtract 1947 Condition net monthly evaporation loss from Sumner Reservoir computed in (5) above from the total historic net monthly evaporation loss from Sumner and Santa Rosa Reservoirs computed in (4) above. Add the 12 monthly values algebraically to make the annual adjustment for excess evaporation.

(7). Compute the excess water held in these two reservoirs during the year over and above the 1947 Condition storage of 129,300 acre–feet by the following procedure:

(a) Determine the end of the year combined contents for Santa Rosa and Sumner Reservoirs for the current year and the previous year. If both quantities are equal or less than 129,300 acre–feet then the adjustment for excess storage is zero;

(b) If both end of year combined contents are in excess of 129,300 acre–feet, then subtract algebraically the previous year's combined end of year contents from the current year's combined end of year contents;

[12] Last sentence added by Joint Motion, October 27, 1992.

(c) If the current year's end of year combined contents are less than 129,300 acre–feet and the previous year's end of year combined contents are in excess of 129,300 acre–feet, then subtract algebraically the previous year's combined end of year contents from 129,300 acre–feet; and

(d) If the current year's end of year combined contents are in excess of 129,300 acre–feet but the previous year's end of year combined contents are less than 129,300 acre–feet, then subtract 129,300 acre–feet from the current year's combined end of year contents.

(8). Add algebraically the adjustment for excess evaporation loss computed in (6) above to the adjustment for excess storage held in these two reservoirs, computed in (7) above.

(9). Add algebraically the adjustment computed in (8) to the annual gaged flow below Sumner Dam for computing the Index Inflows.

(10). Recompute New Mexico's 1947 Condition delivery obligation and departures at the state line using the adjusted Index Inflows.

c. Transfer of Water Use by New Mexico to the Upper Reach Upstream from Sumner Dam

Add to the streamflow of the Pecos River below Sumner Dam, the effect of the amount of water diverted by New Mexico upstream of Sumner Dam transferred from the reach below Sumner Dam to the state line as reported by New Mexico. If the amount of the diversions is not reported by New Mexico by March 1, each year, assume the diversion equals the amount of water authorized for transfer in the permit.

Recompute New Mexico's 1947 Condition delivery obligation and departures at the state line using the revised streamflow of Pecos River below Sumner Dam.

2. Depletions Due to McMillan Dike

Credit the computed departures in B.1.d. with the quantities of depletions caused by the McMillan Dike.

Compute the depletions caused by the McMillan Dike using the following procedures:

a. Use the Sumner Dam to New Mexico–Texas state line Index Inflow computed in B.1.a(2) for the computation year and compute the 1947 Condition outflow with McMillan Dike using the following equation:

$$Y = 0.046399\ (X)^{1.430603}$$

where X is the Index Inflow and Y is the 1947 Condition outflow in units of 1000 acre–feet.

b. Subtract the outflow computed in 2.a. above from the outflow quantity computed in B.1.b.

c. Credit the departures in state line flows computed in B.1.d. by the quantity computed in 2.b. above.

3. Salvage Water Analysis Criteria and Procedures

a. The term "water salvaged" means that quantity of water which may be recovered and made available for beneficial use and which quantity of water under the 1947 Condition was non–beneficially consumed by natural processes.

b. The water salvaged in New Mexico, measured at or near Avalon Dam, through the construction and operation of a project or projects by the United States or by joint undertakings of Texas and New Mexico is apportioned by the Compact as follows:
forty–three percent (43%) to Texas and fifty–seven percent (57%) to New Mexico.

c. Any other water salvaged by New Mexico is apportioned by the Compact to New Mexico but will not have the effect of diminishing the quantity of water available to Texas under the 1947 Condition. Therefore the annual compact compliance computations are only concerned with the water salvage resulting from projects participated in by the United States or from joint Texas–New Mexico projects.

d. Study each water salvage project participated in by the United States and/or each joint Texas–New Mexico project. Determine the amount of water salvaged, if any, and convert it to a three–year running average quantity.

e. Route the water salvaged from place of occurrence to Avalon Dam, considering only non–beneficial consumption by natural processes. Forty–three percent (43%) of the routed water salvaged reaching Avalon Dam is apportioned to Texas. Add the total quantity of water salvaged that is apportioned to Texas to the delivery obligation of New Mexico at the New

Mexico–Texas state line.

4. Unappropriated Flood Waters Analysis Criteria and Procedures

   The River Master shall determine and apportion any unappropriated flood waters using methodologies not inconsistent with applicable provisions of the Compact and this Manual.

5. Texas Water Stored in New Mexico Reservoirs

   If a quantity of the Texas allocation is stored in facilities constructed in New Mexico at the request of Texas, then to the extent not inconsistent with the conditions imposed pursuant to Article IV(e) of the Compact, this quantity will be reduced by the amount of reservoir losses attributable to its storage, and, when released for delivery to Texas, the quantity released less channel losses is to be delivered by New Mexico at the New Mexico–Texas state line.

6. Beneficial Consumptive Use of Waters of Delaware River by Texas

   Add to the computed departures at the New Mexico–Texas state line the amount of beneficial consumptive use of waters of the Delaware River by Texas. These uses shall by furnished by Texas by March 1 each year.

APPENDICES[13]

A–1 Compilation of modifications to the River Master's Manual

Table A-1-1 presents a compilation of modifications made to the River Master's Manual since the original version was published on November 30, 1987.

Effective date	Modification	Summary
June 14, 1989	Joint Motion	Add phrase to Section B.4.f.(3)(c)
Dec 26, 1990	New Mexico's Amended First Motion	Modifies Section B.3.g. as to how River Master computes Base Inflow, Acme to Artesia.
Nov 25, 1991	New Mexico's Sixth Motion	Modifies Section B.5.a., Flood Inflow, Carlsbad to Red Bluff.
Oct 27, 1992	Joint Motion	Modifies Section C.1.b.(5) relating to 1947 Condition of Sumner Reservoir area.
Dec 7, 1992	New Mexico's Third Motion and Texas' Cross Motion	Replaces Section B.4 with language to account for water after construction of Brantley Reservoir.
Oct 26, 1993	Joint Motion to replace New Mexico's Fifth Motion and related motions	Modification of Section B.3.e. for computation of Channel Loss, Sumner Dam to Acme.
June 6, 2002	Agreed Request to Modify Section B.1.c.(1). Also includes modification to footnote in B.1.a.	Provides changes for salt harvesting project near Malaga, NM. Changes footnote to require rounding to 1 acre–foot rather than 100 acre–feet.

[13] The tables listed below were published in the appendices of the River Master's Manual dated November 30, 1987 but not included in this version of the Manual. Tables for Lake Sumner and Lake Santa Rosa are not included in this version because they have been superceded by newer versions, which are updated periodically by the U.S. Bureau of Reclamation and U.S. Army Corps of Engineers. The current tables are incorporated by reference into this River Master's Manual. The tables for Brantley Reservoir are not included because they are not presently used in Compact accounting. Tables included as appendices in the original Manual were:

A–1 Gage Height–Area–Capacity Tables for Lake Sumner (Alamogordo Reservoir). Published by the US Bureau of Reclamation, November 1973.
A–2 Gage Height–Area–Capacity Tables for Brantley Reservoir. Published by the US Bureau of Reclamation, August 1981.
A–3 Gage Height–Area–Capacity Tables for Santa Rosa Reservoir. Published by the US Army Corps of Engineers, August 1980.