MEMORANDUM

New Mexico State Engineer Office
Water Use and Conservation

Date: April 28, 1998

To: Thomas C. Turney, State Engineer

From: Brian C. Wilson, Chief, Water Use and Conservation

Subject: Review and comparison of consumptive irrigation requirements in the Upper Colorado River Basin in New Mexico presented in OSE 1938 hydrographic survey report and 1948 Engineering Advisory Committee report.

1938 OSE REPORT ON SAN JUAN RIVER HYDROGRAPHIC SURVEY

(1) The 1938 aggregated cropping pattern for the Upper Colorado River Basin in New Mexico is presented in a table on page 47. The cropping pattern for each individual ditch is not given. Because the consumptive irrigation requirement calculations for each ditch are not included in the documentation, it is unclear as to what cropping pattern was used to calculate irrigation requirements for each of the ditch systems.

(2) Mean monthly temperature and precipitation data, and frost date data, for selected weather stations for the 1895-1938 period of record are included in an appendix of the report.

(3) Irrigation seasons for crops were defined by the frost-free period (p. 17). In some areas, allowance was also made for irrigation outside the frost-free period (p. 34).

(4) Consumptive use (CU) or evapotranspiration (ET) was calculated using the Lowry-Johnson method (p. 16). The original Blaney-Criddle method had not been developed yet.

(5) The consumptive irrigation requirement (CIR) for each crop was calculated by subtracting effective rainfall (Re) from the CU, i.e, CIR=CU-Re. Rainfall (R) in excess of 0.50 inches per day was assumed to run off and was not considered as effective rainfall in the calculations (p. 18). The monthly percentage of the total annual CIR is presented on page 28. CIRs were calculated assuming a full water supply was available.

(6) Farm delivery requirements (FDR) were calculated by dividing the CIR by an on-farm irrigation efficiency (Ef) of 63% (p. 20).

(7) Project diversion requirements (PDR) were calculated by dividing the FDR by an off-farm conveyance efficiency (Ec) of 60% (p. 21).

(8) The weighted CIR for the cropping pattern in each of the stream systems is presented in the attached table.

(9) Project (i.e., stream) diversion requirements expressed in cubic feet per second (cfs) were generally determined as follows (p. 29;32). These criteria were developed on the basis of measured ditch capacities.

   (a) For ditches supplying water to 80 acres or more, one cfs was allowed for each 40 acres.

$$Q = 1 \text{ cfs (Total acres/40 acres)}$$

   (b) For ditches supplying water to less than 80 acres, a minimum of one cfs was allowed to provide adequate hydraulic head for efficient irrigation plus an additional one cfs per 80 acres. The calculation of the required flowrate in cfs can be expressed as:

$$Q = 1 \text{ cfs } [1 + (\text{Total acres/80 acres})]$$

(10) To check the validity of the above criteria the following analysis may be applied (Wilson, 1998). The maximum CIR for any of the study areas in the 1938 analysis was 2.00 afy (Jewett Valley, San Juan River). The month of June accounts for the largest portion of the annual CIR at 25%. Thus the CIR for the month of June would be:

$$\text{CIR(June)} = (2.00 \text{ afy})(0.25) = 0.5 \text{ af/m}$$

The required flowrate (Q) in cfs to irrigate a field for one month is given by the following equation:

$$Q = (\text{CIR})/\text{EfEc})(A)(43{,}560 \text{ sf/a})/(\text{Seconds per month})$$

where Ef is the on-farm irrigation efficiency; Ec is the off-farm conveyance efficiency; and A is the number of acres irrigated;

Rearranging the above equation yields the following:

$$A = Q(\text{EfEc/CIR})/[(43{,}560 \text{ sf/a})(\text{Seconds per month})]$$

If the CIR for the month of June is 0.5 af/a and Ef is 0.63 and Ec is 0.60, then the number of acres (A) that could be irrigated with one cfs would be:

A = (1 cfs)[(0.63)(0.60)/0.5 afa]/[(43,560 sf/a)(30 d/m)(86,400 s/d)

A = 0.756/0.0168 = 45.00 acres

1948 REPORT OF THE ENGINEERING ADVISORY COMMITTEE TO THE UPPER COLORADO RIVER BASIN COMPACT COMMISSION

(1) Five separate cropping patterns representing the average for the 1914-45 period of record are presented (p. 44) including: Navajo River, Los Pinos, La Plata River, Animas and San Juan Rivers, and Chaco.

(2) Mean monthly temperature and precipitation data for selected weather stations for the 1914-1945 period of record is included in Appendix B, Tables F and G, pages 46-48.

(3) Frost free periods are presented in Appendix B, Table 1, page 6.

(4) Irrigation seasons for crops are discussed in Appendix B, page 14 and were generally defined by the frost-free period. In some areas, allowance was also made for irrigation outside the frost-free period for two to three weeks for perennial crops such as alfalfa and pasture grasses.

(5) Consumptive use (CU) or evapotranspiration (ET) was calculated using the original Blaney-Criddle method as described in Appendix B, page 8.

(6) Seasonal consumptive use coefficients (K) that were used to calculate CU are presented in Appendix B, Table 2. K for alfalfa outside the frost-free period is greater than the K recommended by Blaney in reports published later (0.70 vs. 0.50); the same also applies to pasture grasses (0.60 vs. 0.50). No K is given for orchards outside the frost free-period, however, 0.40 is recommended in later publications. K for spring small grains inside the frost-free period is greater than the K published in later reports (0.75 vs. 0.70).

(7) The CIR for each crop was calculated by subtracting recorded rainfall (R) from CU, i.e., CIR=CU-R. Monthly rainfall was not reduced to reflect effective rainfall (Re). In later publications, Blaney adopted a method for calculating effective rainfall that was published by the Bureau of Reclamation about 1951. CIRs for the Navajo River, LaPlata River, and Chaco, were reduced to reflect normal water supply shortages based upon streamflow records.

SUMMARY

(1) The cropping pattern in the 1938 report reflected the 1938 calendar year, whereas in the 1948 report the cropping pattern represented an average for the 1914-45 period.

(2) The period of weather record used in the 1938 report was 1895-1938, whereas in the 1948 report the period of record was 1914-1945.

(3) Irrigation seasons were generally defined by the frost-free period in both reports, however, because the same period of weather records were not used, the growing seasons are slightly different.

(4) CU was calculated in the 1938 report using the Lowry-Johnson method, whereas in the 1948 report the original Blaney-Criddle method was used.

(5) The methodology for calculating effective rainfall (Re) in the 1938 report scalped R greater than 0.5 inches per day, whereas in the 1948 report R was not reduced.

(6) CIRs in the 1938 report reflect a full water supply, whereas in the 1948 report CIRs for the Navajo River, LaPlata River, and Chaco were reduced to reflect normal water supply shortages.

(7) The 1938 report quantifies CIRs, FDRs, and PDRs for crops, whereas the 1948 report only quantifies CIRs. However, the 1948 report also quantifies CIRs for native vegetation and other depletions.

REFERENCES

Engineering Advisory Committee. (1948). Report of Engineering Advisory Committee to the Upper Colorado Basin Compact Commission (1948).

McClure, Thomas M. (1938). Report on the San Juan River hydrographic survey within San Juan, McKinley, and Rio Arriba counties, New Mexico. Office of the State Engineer, Santa Fe, NM.

Comparison of consumptive irrigation requirements (CIR) in the 1938 OSE *Report on San Juan River Hydrographic Survey* and 1948 *Engineering Advisory Committee Report to the Upper Colorado Basin Compact Commission.*

Location	1938 OSE Report		1948 EAC Report	
	Water Supply (Full/Short)	CIR (ac-ft/ac)	Water Supply (Full/Short)	CIR (ac-ft/ac)
Navajo River	F	1.10	S	1.01
Los Pinos (Pine River)	F	1.58	F	1.04
La Plata River	F	1.89	S	1.00
Animas River	F	1.88	F	1.67
San Juan River	F	1.83	F	1.67
Jewett Valley	F	2.00	F	1.67
Chaco	F	-----	S	0.85

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Table 1. Calculation of average annual surface water depletions 1914-1945 in the Upper Colorado River Basin in New Mexico based on data published in the "Report of Engineering Advisory Committee to the Upper Colorado River Compact Commission (1948). Prepared by B.C. Wils , P.E., New Mexico Office of the State Engineer, 04/ 98.

Location and crop	Water Supply (Full/Short)	Acres	CDR	CIR (ac-Ft/ac)	WCIR (ac-Ft/ac)	SW Depletion (ac-Ft)	Published Depletion
Navajo River							
Alfalfa	S	216	0.745	1.09	0.81		
Hay and pasture	S	42	0.145	0.86	0.13		
Grains and beans	S	32	0.110	0.66	0.07		
Subtotal		290	1.000	–	1.01	293	292
Native vegetation and other							
Trees and bush		45	0.750	1.44	1.08		
Seeped lands		15	0.250	0.95	0.24		
Subtotal		60	1.000	–	1.32	79	79
Total		350	–	–	–	372	371
Los Pinos (Pine River)							
Alfalfa	F	397	0.415	1.29	0.54		
Hay and pasture	F	151	0.158	1.06	0.17		
Grains and beans	F	304	0.317	0.78	0.25		
Corn and other annuals	F	100	0.104	0.85	0.08		
Orchard	F	6	0.006	0.66	0.00		
Subtotal		958	1.000	–	1.04	996	998
Native vegetation and other							
Trees and bush		150	0.955	1.33	1.27		
Seeped lands		5	0.032	1.14	0.04		
Ponds		2	0.013	2.07	0.03		
Subtotal		157	1.000	–	1.34	210	210
Total						1206	1208

Table 1 (continued). Calculation of average annual surface water depletions 1914-1945 in the Upper Colorado River Basin in New Mexico based on data published in the "Report of Engineering Advisory Committee" (1948).

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Location and crop	Water Supply (Full/Short)	Acres	CDR	CIR (ac-ft/ac)	WCIR (ac-ft/ac)	SW Depletion (ac-ft)	Published Depletion
	1	2	3	4	5	6	7
La Plata River							
Alfalfa	S	2198	0.444	0.98	0.44		
Hay and pasture	S	503	0.102	0.78	0.08		
Grains and beans	S	1392	0.282	0.88	0.25		
Corn and other annuals	S	767	0.155	1.37	0.21		
Orchard	S	83	0.017	1.36	0.02		
Subtotal		4943	1.000	–	1.00	4943	4935
Native vegetation and other							
Trees and bush		290	0.389	1.74	0.68		
Seeped lands		355	0.477	1.52	0.72		
Ponds		35	0.047	1.63	0.08		
Swamp		65	0.087	2.19	0.19		
Subtotal		745	1.000	–	1.67	1244	1244
Total		5688	–	–	–	6187	6179
Animas and San Juan Rivers							
Alfalfa	F	8229	0.305	2.25	0.69		
Hay and pasture	F	2513	0.093	1.93	0.18		
Grains and beans	F	5048	0.187	1.12	0.21		
Corn and other annuals	F	8654	0.321	1.43	0.46		
Orchard	F	2543	0.094	1.43	0.13		
Subtotal		26987	1.000	–	1.67	45068	45030
Native vegetation and other							
Trees and bush		3645	0.660	2.42	1.60		
Seeped lands		1095	0.199	2.14	0.42		
Ponds		40	0.007	2.28	0.02		
Swamp		740	0.134	2.98	0.40		
Subtotal		5520	1.000	–	2.44	13469	13460
Total		32507	–	–		58537	58490

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Table 1 (continued). Calculation of average annual surface water depletions 1914-1945 in the upper Colorado River Basin in New Mexico based on data published in the "Report of Engineering Advisory Committee" (1948).

Location and crop	Water Supply (Full/Short)	Acres	CDR	CIR (ac-ft/ac)	WCIR (ac-ft/ac)	SW Depletions (ac-ft)	Published Depletion
Chaco							
Alfalfa	S	1641	0.282	0.98	0.28		
Hay and pasture	S	3680	0.632	0.78	0.49		
Grains and beans	S	501	0.086	0.88	0.08		
Total		5822	1.000	-	0.85	4949	4919

Key: CDR is the crop distribution ratio; CIR is the consumptive irrigation requirement; WCIR is the weighted CIR.

Notes on the Engineering Advisory Committee report.

(1) The cropping pattern in New Mexico is presented in the table on p. 44.

(2) Mean monthly temperature and precipitation data for the 1914-1945 period of record is included in Appendix B, Table F and pp. 46-48.

(3) Frost-free periods are presented in Appendix B, Table 1, p. 6.

(4) Irrigation seasons for crop are discussed in Appendix B, p. 14. Threshold temperatures for defining growing seasons were not available.

(5) Consumptive use (CU) or evapotranspiration (ET) of crops was calculated using the original Blaney-Criddle method as described in Appendix B, p. 8.

(6) Seasonal consumptive use coefficients (K) inside and outside the frost-free period that were used to calculate CU are presented in Appendix B, Table 2. K for alfalfa outside the frost free period is greater than the value published by Blaney in later reports (0.70 vs. 0.50). The same also applies to hay and pasture (0.60 vs. 0.50). The K for spring small grains inside the frost-free period is greater than the value published by Blaney in later reports (0.75 vs. 0.70). No K value is given for orchards outside the frost-free period (0.40 is used outside the FFP today).

(7) The CIR for each crop was calculated by subtracting recorded rainfall (R) during the irrigation season from CU, i.e., CIR = CU - R. Recorded rainfall was not reduced to reflect effective rainfall (Re). A methodology for calculating Re was later published by the Bureau of Reclamation about 1951. CIRs for each crop are presented in the table on p. 44. CIRs in some areas were reduced to reflect water supply shortages based on the historical record of streamflows.

Table 2. Summary of average annual surface water depletions 1914-45 in the Upper Colorado River Basin in New Mexico based on data published in the "Report of Engineering Advisory Committee to the Upper Colorado River Basin Compact Commission (1948). Prepared by B. C. Wilson, P. , New Mexico Office of the State Engineer, 04/22/98.

Location	Water Supply (Full/Short)	Acres	WCIR (ac-Ft/ac)	SW Depletions (ac-Ft)	Published Depletion
Navajo River					
Irrigated crops	S	290	1.01	293	292
Native vegetation	-	60	1.32	79	79
Subtotal		350	-	372	371
Los Pinos					
Irrigated crops	F	958	1.04	996	998
Native vegetation	-	157	1.34	210	210
Subtotal		1115	-	1206	1208
LaPlata River					
Irrigated crops	S	4943	1.00	4943	4935
Native vegetation	-	745	1.67	1244	1244
Subtotal		5688	-	6187	6179
Animas and San Juan Rivers					
Irrigated crops	F	26987	1.67	45068	45030
Native vegetation	-	5520	2.44	13469	13460
Subtotal		32507	-	58537	58490
Chaco					
Irrigated crops	S	5822	0.85	4949	4919
Total, New Mexico					
Irrigated crops		39000	-	56249	56174
Native vegetation		6482	-	15002	14993
Other		-	-	1000	1000
Total		45482	-	72251	72167

Average monthly temperatures and total precipitation for the 1914-1945 period of record. (Source: Report of Engineering Advisory Committee, 1948

Initials	Date
Prepared By		
Approved By		

	Bloomfield (1063) Elev 5798 ft		Shiprock (8284) Elev 4972 ft		Bloomfield/Shiprock Two Station Average	
Month	Temp	Precip	Temp	Precip	Temp	Precip
Jan	26.0	0.55	28.6	0.34	27.3	0.44
Feb	34.1	0.72	35.4	0.55	34.8	0.64
Mar	41.1	0.62	44.7	0.73	42.9	0.68
Apr	49.6	0.62	53.1	0.67	51.4	0.64
May	58.9	0.66	61.7	0.59	60.3	0.62
Jun	68.2	0.50	69.6	0.29	68.9	0.40
Jul	74.9	1.11	76.3	0.74	75.6	0.92
Aug	72.6	1.23	74.4	1.02	73.5	1.12
Sep	64.6	1.14	67.0	1.49	65.8	1.32
Oct	52.2	0.76	55.0	0.52	53.6	0.64
Nov	38.9	0.55	41.2	0.46	40.0	0.50
Dec	29.0	0.64	30.2	0.56	29.6	0.60
Avg/Tot	50.9	9.11	53.1	7.96	52.0	8.52

Frost Dates

	Spr Min 32°	Fall Min 32°	Fall Min 28°
Bloomfield	05/01	10/19	10/29
Shiprock	05/02	10/12	10/19
Avg	05/01	10/15	10/24

OSE-0024

Average monthly temperature and total precipitation for the 1914-1945 period of record. (Source: SEO TR 5 & 6, Climatological Summary, New Mexico)

	Initials	Date
Prepared By		
Approved By		

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	Aztec (C692)		Bloomfield (C1063)		Aztec / Bloomfield	
	1920-1945	1914-1945			Two station Average	
Month	Temp	Precip	Temp	Precip	Temp	Precip
Jan	27.7	0.67	26.6	0.56	27.2	0.62
Feb	34.7	0.66	34.3	0.70	34.5	0.68
Mar	41.2	0.88	41.1	0.59	41.2	0.74
Apr	49.0	0.71	49.4	0.63	49.2	0.67
May	58.1	0.66	59.4	0.65	58.8	0.66
Jun	66.6	0.50	68.3	0.51	67.4	0.50
Jul	73.7	1.07	75.0	1.08	74.4	1.07
Aug	71.4	1.15	72.6	1.14	72.0	1.14
Sep	63.5	1.28	64.6	1.13	64.0	1.20
Oct	52.7	0.78	52.2	0.75	52.4	0.76
Nov	39.2	0.60	38.6	0.51	38.9	0.56
Dec	30.0	0.81	29.0	0.62	29.5	0.72
Avg/Tot	50.7	9.77	50.9	8.87	50.8	9.32

Frost Dates

	Spr Min 32°	Fall Min 32°	Fall Min 28°
Aztec	05/20	10/14	10/24

OSE-0025

REPORT OF ENGINEERING ADVISORY COMMITTEE

TO THE

UPPER COLORADO RIVER BASIN COMPACT COMMISSION

Engineer Advisors

J. R. Riter, Chairman	Federal
R. Gail Baker	Arizona
R. I. Meeker	Arizona
F. C. Merriell	Colorado
R. M. Gildersleeve	Colorado
R. J. Tipton	Colorado
J. H. Bliss	New Mexico
J. R. Erickson	New Mexico
C. O. Roskelley	Utah
R. D. Goodrich	Wyoming
H. T. Person	Wyoming
H. P. Dugan	Federal

Denver, Colorado

November 29, 1948

Upper Colorado River Basin Compact Commission

Gentlemen:

Pursuant to instructions given at your September 17, 1946, meeting, and subsequent meetings, a final report on the activities and findings of your Engineering Advisory Committee in regard to the water supply of the Upper Colorado River Basin has been prepared and is enclosed herewith.

Respectfully submitted,

(Signed) J. R. Riter, Chairman, Federal
J. R. Riter

(Signed) R. Gail Baker, Arizona
R. Gail Baker

(Signed) R. I. Meeker, Arizona
R. I. Meeker

(Signed) R. J. Tipton, Colorado
R. J. Tipton

(Signed) R. M. Gildersleeve, Colorado
R. M. Gildersleeve

(Signed) F. C. Merriell, Colorado
F. C. Merriell

(Signed) J. H. Bliss, New Mexico
J. H. Bliss

(Signed) J. R. Erickson, New Mexico
J. R. Erickson

(Signed) C. O. Roskelley, Utah
C. O. Roskelley

(Signed) R. D. Goodrich, Wyoming
R. D. Goodrich

(Signed) H. T. Person, Wyoming
H. T. Person

(Signed) H. P. Dugan, Federal
H. P. Dugan

SYNOPSIS

A temporary Engineering Advisory Committee met in Cheyenne, Wyoming, on August 30 and 31, 1946. This Committee prepared a report which embodied the engineering problems which it believed should be studied and reported upon in order that the Upper Colorado River Basin Compact Commission might be adequately informed on these matters during the negotiation of the Compact. The report was presented and accepted by the Compact Commission in Santa Fe, New Mexico, on September 17, 1946. A permanent Engineering Advisory Committee was appointed at that time and was instructed to proceed with the solution of problems outlined in the report of the temporary Engineering Advisory Committee.

Assignments

The work assigned to the Engineering Committee was:

a. Preparation of base maps to show the locations of present and potential irrigation developments within the limit of the Colorado River system upstream from Lee Ferry and stream gaging stations and drainage areas.

b. Determination of water contributions by states, involving the tabulation of streamflow records at key gaging stations, the extension of records by estimates, and estimation of runoff from unmeasured areas.

c. Estimation of present depletions above key gaging stations, state lines and Lee Ferry.

d. Estimation of channel losses along the main Colorado River and principal tributaries above Lee Ferry.

e. Determination of the extent to which the Upper Basin can make its apportioned water uses during drought cycles and the Upper Division still meet its compact obligation at Lee Ferry.

In addition to the above items the Compact Commission has asked the Engineering Advisory Committee to report on special problems from time to time. These items have been reported on, and have been made a matter of record in the proceedings of the Compact Commission.

Specifically these items were as follows:

a. Prepare a formula for incorporation in Article III pertaining to the Yampa River.

b. Prepare a formula for incorporation in Article XIV pertaining to the San Juan River.

c. Prepare a study of the future flows of the Green River at Linwood, Utah, above the mouth of Henry's Fork as requested by Commissioner Watson of Utah.

A report on these items was presented to the Compact Commissioner at Santa Fe, New Mexico, October 4, 1948, and a copy is included in Appendix D.

Maps

Maps of the states of Arizona, Colorado, New Mexico, Utah and Wyoming, showing the locations of present irrigated areas and potential irrigation projects, as envisioned by the Bureau of Reclamation within the Colorado River Basin and published as a part of the report on "The Colorado River" (House Document 419, 80th Congress, first session) have been mounted on cloth and distributed to the Compact Commissioners. This report contains a general map of the Upper Colorado River Basin, prepared for the Committee by the Colorado Water Conservation Board.

Water Contributions by States

Water contributions by states were determined by the Committee for the period 1914-45 at key gaging stations, state lines and Lee Ferry. The period 1914-45 was chosen because it was found to be most reliable from the standpoint of available records, and was believed to be representative of the longtime water supply to be expected from the Upper Colorado River Basin. During this 32-year period the irrigated acreage has remained substantially constant. In order to complete this portion of the assignment it was necessary to tabulate historic streamflow records at selected gaging stations, estimate missing portions of historic records, determine present water uses in the Upper Colorado River Basin, and determine channel losses on certain sections of stream channels. It was also necessary to determine drainage areas above certain key gaging stations to a greater degree of refinement. The table on page 3 summarizes by states and at Lee Ferry the water contributions and drainage areas tributary to the Colorado River as determined by the Engineering Advisory Committee. The table on page 4 summarizes the mean historic flow for key gaging stations and gives the drainage areas which lie above them. Tables of streamflow are given in Appendix A.

Present Depletions

Determination of present depletions by man in the Upper Colorado River Basin consisted of the evaluation of the use of water by cropped lands, non-cropped lands consuming irrigation water incidental to the irrigation of the cropped lands, transmountain diversions, reservoir evaporation losses and domestic uses. Adjustment was made for one small importation. One problem encountered by the Committee was the determination of cropped and non-cropped land areas, and their rates of use of irrigation water. The areas of cropped and non-cropped lands were estimated by inspections of the Bureau of Reclamation land classification sheets, field condition, available aerial surveys and other detail and general maps of the irrigated areas. Rates of consumptive use of irrigation water were determined through transfer of experimental consumptive use data to various sites of use within the Colorado River Basin through empirical relationships between experimental and climatological data. The services of Mr. H. F. Blaney and Mr. W. D. Criddle of the Department of Agriculture, who are authorities on consumptive use, were secured to study the problem. The method developed by H. F. Blaney was adopted. A field inspection trip over the Colorado River Basin was arranged so they could inspect the various areas and interview local water masters, water commissioners, water users, personnel of the Soil Conservation Service, personnel of the Bureau of Reclamation, and others regarding irrigation practices and adequacy of water supply in the various areas of the basin. Using these data appropriate rates of consumptive use of irrigation water at the sites of use were computed. The rates of consumptive use of irrigation water for various crops and types of native vegetation were applied by the Engineering Advisory Committee to the irrigated and incidental areas to secure the past man-made depletions at sites of use. The following tabulation shows the average irrigated and non-cropped areas consuming irrigation water for the study period 1914-45, and the present irrigated areas as determined and adopted by the Engineering Committee:

Water Consuming Land Areas-Acres

Type of Area	Arizona	Colorado	New Mex.	Utah	Wyoming	Total
Irrigated Areas Average (1914-45)	3,770	790,606	39,000	288,520	228,700	1,350,596
Irrigated Areas (Present)	9,840	790,600*	43,620	303,977	236,675	1,384,712
Non-cropped Areas Average (1914-45)	Negligible	106,812	6,482	48,625	29,100	191,019

* Assumed to be same as rounded average for period 1914-45.

The depletions at sites of use were computed and routed downstream to state lines and to Lee Ferry to determine the changes in channel losses resulting from man-made depletions. The differences between average historic channel losses and the channel losses under virgin conditions represent "salvaged" channel losses. The following table shows man-made depletions at sites of use, state lines, Lee Ferry, and the estimated salvaged channel losses.

Location		Alfalfa Acres	Alfalfa Rate Feet	Alfalfa Depletion Acre-feet	Grass, Hay & Pasture Acres	Grass, Hay & Pasture Rate Feet	Grass, Hay & Pasture Depletion Acre-feet	Grains and Beans Acres	Grains and Beans Rate Feet	Grains and Beans Depletion Acre-feet	Corn and Other Annuals Acres	Corn and Other Annuals Rate Feet	Corn and Other Annuals Depletion Acre-feet	Orchard Acres	Orchard Rate Feet	Orchard Depletion Acre-feet	Incidental Areas Acres	Incidental Areas Rate Feet	Incidental Areas Depletion Acre-feet	Other b, c, & d	Total Acre-feet
24. Montezuma and McElmo below Cortez	F	4330	1.57	6798	640	1.33	851	2470	.97	2396				160	.97	155	1000	1.71	1710	2700	14610
25. Upper San Juan Piedra	F F	2000 2000	.92 1.29	1840 2580	7362 2186	.73 1.06	5374 2317										500 200	.83 1.33	415 266	735	13527
26. Los Pinos (Pine) River	F	13014	1.29	16788	9647	1.06	10226	8838	.77	6805	421	.77	324	453	.69	313	5000	1.33	6650	660	41766
27. Animas River	F	4461	1.24	5532	2984	1.01	3014	2711	.73	1979	122	.85	104				1000	1.32	1320	3420	15369
28. Florida River	S	5500	.82	4510	4400	.65	2860	4053	.73	2959	200	.85	170	347	.66	229	3000	1.32	3960		14688
29. LaPlata River	S	8279	.93	7699	2590	.73	1891	10240	.82	8397				50	.77	38	1600	1.36	2176	160	20361
30. Mancos River	S	4790	1.00	4790	2164	.81	1753	3300	.97	3201				100	.97	97	1000	1.76	1760	100	11701
Total Colorado		309522		396180	244054		175686	178047		170393	33333		45371	25650		33748	106812		178662	62713	1062753
NEW MEXICO																					
1. Navajo River	S	216	1.09	235	42	.86	36	32	.66	21							e 45 f 15	1.44 .95	65 14		371
2. Los Pinos (Pine River)	F	397	1.29	512	151	1.06	160	304	.78	237	100	.85	85	6	.66	4	e 150 f 5 g 2	1.33 1.14 2.07	200 6 4		1208
3. LaPlata River	S	2198	.98	2154	503	.78	392	1392	.88	1225	767	1.37	1051	83	1.36	113	e 290 f 355 g 35 h 65	1.74 1.52 1.63 2.19	505 540 57 142		6179
4. Animas and San Juan Rivers	F	8229	2.25	18515	2513	1.93	4850	5048	1.12	5654	8654	1.43	12375	2543	1.43	3636	e 3645 f 1095 g 40 h 740	2.42 2.14 2.28 2.98	8821 2343 91 2205	1000	59490
5. Chaco	S	1641	.98	1608	3680	.78	2870	501	.88	441											4919
Total New Mexico		12681		23024	6889		8308	7277		7578	9521		13511	2632		3753	6482		14993	1000	72167
UTAH																					
1. Henrys Fork	S	5650 i 320	1.16	6554	1550	.94	1457	1750	.94	1645							800 f 450 j 250	1.02 1.18 1.34	816 531 335		11338
2. Ashley Valley and Brush Creek	F	12250 i 720	1.56	19110	5620	1.34	7531	9260	1.09	10093							3490 f 1290 j 620	1.30 1.49 1.30	4537 1922 806	2000	45999
3. Ouray	S	3260 i 180	1.26	4108	350	1.02	357	3840	1.10	4224							560 j 300	1.64 1.64	918 492		10099
4. Unita Basin Bench Lands	S	15730	1.61	25325	51930	1.31	68028	7600	.97	7372	1665	1.18	1965				8900 f 1750 j 1540	1.68 1.48 1.28	14952 2590 1971	79000	201203
5. Unita Basin Valley Lands	S	22165	1.82	40340	25800	1.50	38700	7570	1.10	8327	2430	1.38	3353				8800 f 2500 g 1100 j 910	2.00 1.78 1.89 1.73	17600 4450 2079 1574	9800	126223
6. Price River	F	6550 i 450	1.81	11855	1560	1.54	2402	5760	1.06	6106	1590	1.32	2099	60	1.17	70	900 f 950 j 360	1.91 2.15 2.40	1719 2042 864	4300	31457
7. Green River	F	1260 i 200	2.40	3024	290	2.08	603	1794	1.22	2189	1070	1.61	1723	6	1.64	10	200 f 180 j 140	2.08 2.38 2.67	416 428 374		8767
8. Moab	S	620	2.07	1283	650	1.70	1105	540	1.09	589	300	1.48	444	30	1.69	51	160 f 80 j 20	2.17 2.49 2.17	347 199 43		4061
9. LaSal	S	1620 i 620	1.08	1750	940	.86	808	2750	.92	2530							580 f 80	1.22 1.43	708 114		5910

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Table 1 - Average annual precipitation, mean annual temperature and frost-free period at Weather Bureau stations used in computing consumptive use in the Upper Colorado River Basin.

(Based on Weather Bureau records from 1914-1945, except as noted.)

No.	Station Location	Average annual precipitation Inches	Mean annual temperature °F.	Elevation Feet	Average frost-free period: Years of record	From	To	Total Days
	ARIZONA							
1	Chinle	9.50	51.3	5,538	22	May 16	Oct. 7	144
4	Kayenta	8.35	52.9	5,640	21	Apr.28	Oct.13	168
	COLORADO							
5	Aspen	19.11	39.8	7,913	17	June 10	Sep.15	97
7	Collbran	15.90	45.6	6,200	31	May 26	Sep.29	126
8	Cortez 1/	13.34	48.1	6,177	28	May 26	Sep.29	126
11	Delta 1/	8.45	50.4	5,115	32	May 5	Oct. 6	154
13	Durango 1/	19.70	45.5	6,554	32	June 1	Sep.26	117
[illegible]	Eagle 2/	14.44	42.0	6,598	8	June 19	Sep. 6	79
16	Fruita	9.75	50.9	4,525	32	May 6	Oct.10	157
17	Glenwood Sprgs.	18.37	47.3	5,823	30	May 17	Sep.29	135
18	Grand Junction	9.07	52.8	4,668	32	Apr.13	Oct.26	196
19	Gunnison 1/	10.52	37.4	7,683	28	June 18	Sep. 2	76
20	Hayden 1/	15.62	42.2	6,337	24	June 11	Sep.13	94
21	Ignacio 1/	16.36	45.7	6,425	32	June 5	Sep.23	110
25	Montrose	9.76	48.9	5,830	32	May 6	Oct. 6	153
27	Norwood	17.94	45.2	7,017	14	June 8	Sep.26	110
28	Pagosa Sprgs. 1/	24.22	41.1	7,108	15	June 23	Sep.13	82
30	Paonia	16.04	48.4	6,200	31	May 5	Oct.12	160
31	Rifle 1/	11.00	47.9	5,300	28	May 15	Oct. 3	141
33	Steamboat Spr. 1/	24.07	38.4	6,770	31	June 27	Aug.25	59
	NEW MEXICO							
37	Bloomfield	9.11	50.9	5,794	28	May 7	Oct.11	157
41	Dulce	18.83	43.6	6,767	26	June 11	Sep.20	101
47	Shiprock	7.96	53.1	4,945	14	May 3	Oct.15	165
	UTAH							
50	Blanding	13.46	49.4	6,035	32	May 11	Oct.13	155
52	Castledale	8.63	45.2	5,500	27	May 22	Sep.27	128
53	Duchesne	9.66	44.0	5,520	32	May 26	Sep.23	120
54	Emery	7.61	45.8	6,260	30	May 24	Sep.27	126
55	Escalante	12.56	47.5	5,258	24	May 15	Oct. 1	139
56	Ft. Duchesne	7.01	44.3	4,941	28	May 23	Sep.24	124
58	Green River	6.45	52.3	4,087	31	May 2	Oct. 9	160
59	Hanksville	5.16	52.4	4,200	29	May 2	Oct. 4	155

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Table 2 - Coefficients used in computing consumptive use of water in the Upper Colorado River Basin.

Classification	Growing season or period	Consumptive use coefficient (K) 1/ Growing period:	Annual
IRRIGATED LAND			
Alfalfa	Frost-free period	0.85	
Alfalfa	Pre-frost free period	.70	
Grass, hay and pasture	Frost-free period	.75	
Grass, hay and pasture	Pre-frost free period	.60	
Beans and small grains	3 months	.75	
Corn and other annuals	4 months	.75	
Orchard (deciduous)	Frost-free period	.65	
INCIDENTAL AREAS			
Water surfaces	Frost-free period	0.95	0.85
Native vegetation	Frost-free period		
Very dense 2/	" " "	1.35	1.10
Dense 3/	" " "	1.20	1.00
Medium 4/	" " "	1.00	.90
Light 5/	" " "	.80	.65
Sparse 6/	" " "	(Precipitation only)	
Seeped areas 7/	" " "	.90	.75

1/ $K = \frac{U}{F} = \frac{\text{Consumptive use}}{\text{Consumptive use factor}}$ = Consumptive use coefficient.

2/ Large cottonwood trees, willows and grass. Adequate moisture available from high water table (or ground water).

3/ Willows, tamarisk, or small cottonwood trees. Adequate moisture available from high water table (or ground water).

4/ Small willows or tamarisk. Moisture available from high water table (or ground water).

5/ Salt grass, brush or weeds. Moisture available from ground water.

6/ Sage brush, grass and weeds. Moisture available from precipitation only. (Rainfall during the growing season plus 50 percent of winter precipitation stored in the root zone, not to exceed 3 inches.)

7/ Moist areas caused by seepage from canal, over-irrigation, ground water or poor drainage.

New Mexico.- The greater part of the New Mexico irrigated land within the Upper Colorado River Basin is irrigated from the San Juan and Animos rivers and has a water supply adequate to mature crops. Elevation of this area is slightly over 5,000 feet and the frost-free growing period about [illegible] days. Alfalfa is irrigated at least four or five times a year and the yields vary between four and five tons per acre. Irrigation ordinarily begins by April 10 and continues until the middle of September. Small grains receive two or more irrigations per year, the first one the middle of May and the second one toward the end of June. Orchards receive five or more irrigations each year beginning the middle of May and extending pretty well through September with some farmers even irrigating later. The only other two areas in New Mexico considered were the La Plata and the Dulce, in each of which the irrigation supply is extremely short in the latter part of the summer. This shortage tends to move the beginning date of irrigation ahead and to increase the amount of water applied per application while the high flows are still in the rivers.

Arizona.- A large portion of the Arizona irrigated land within the Upper Colorado River Basin is located in the vicinity of Chinle and Kayenta and is farmed by Indians. The Weather Bureau frost-free period varies from about 140 days to over 200 days. The crops consist of about 65 percent corn and cereals, 10 percent alfalfa and 25 percent beans and miscellaneous. Of the 9,840 acres of irrigated land, 5,600 acres have an adequate water supply and 4,240 acres are irrigated only when flood waters are available (16).

ESTIMATES OF RATES OF CONSUMPTIVE USE

In computing rates of consumptive use of water, the Blaney-Criddle method and formula $U = KF$ are used. The values of coefficient (K) are shown in Table 2. A consumptive use factor (F) for the growing, frost-free or irrigation period is used. Mean monthly temperature, precipitation records are shown in the appendix.

Irrigated crops

Rates of consumptive use of water by alfalfa and grass hay are established for three types of irrigation practice, which are different because of the character of the water supply, one or more of which is applicable to each area. These three types of irrigation practice are: (1) A water supply adequate to satisfy the requirements of crops and acreages now irrigated. (2) A definitely short late-season irrigation water supply, usually found on the smaller unregulated streams. It is assumed that the period of use of irrigation water is from the date of first irrigation to the date of last irrigation, plus two weeks for grass hay and pasture and three weeks for alfalfa. These periods after the last irrigation are added to take care of residual soil moisture which is used by the crops. However, in no case was the period extended beyond the end of the frost-free period. (3) Irrigation of crop lands normally flooded during the period of high run-off each year. This practice generally applies only to grass hay or pasture land. After the flow in the rivers declines, irrigation water is applied throughout the

Table 3 (Cont'd) - Irrigated areas, Weather Bureau stations, and irrigation periods used in computing consumptive use of irrigation water - Wyoming, Colorado, Utah, New Mexico and Arizona.

No.	Unit / Area	Weather Bureau station	Water 1/ supply	Frost-free 2/ period	Alfalfa irrigation season
	UTAH (Cont'd)				
7	Green River	Green River	F	5/2 - 10/9	4/10 - 10/9
8	Moab	Moab	S	4/18 - 10/17	4/1 - 8/31
9	La Sal	La Sal	S	5/25 - 10/1	4/15 - 7/25
10	Monticello	La Sal	S	5/25 - 10/1	4/15 - 7/31
11	Huntington, Castle Dale, Ferron	Castle Dale	S	5/22 - 9/27	4/15 - 8/3
12	Emery - Hanksville	Emery	S	5/24 - 9/27	4/15 - 8/31
13	Loa	Loa	S	6/12 - 9/9	5/1 - 8/1
14	Escalante	Escalante	S	5/15 - 10/1	4/15 - 8/1
15	Blanding	Blanding	S	5/11 - 10/13	4/15 - 7/3
16	Paria River	Tropic	S	5/25 - 10/6	4/15 - 8/1
	NEW MEXICO				
1	Dulce - Upper Navajo	Dulce	S	6/11 - 9/20	5/15 - 9/1
2	La Plata	Ft. Lewis and Bloomfield	S	5/21 - 10/1	5/15 - 8/8
3	Bloomfield - Shiprock	Bloomfield and Shiprock	F	5/5 - 10/13	4/10 - 10/
	ARIZONA				
1	Chinle	Chinle	F	5/16 - 10/7	5/1 - 10/
			S		5/1 - 7/1
2	Kayenta	Kayenta	F	4/28 - 10/13	4/10 - 10/
					4/10 - 7/1

1/ F = Full water supply for all crops.
S = Short water supply for alfalfa, grass hay and pasture.
N.O.= Natural overflow on grass hay meadows and pasture during flood stage of river or stream, provides moisture before irrigation begins.

2/ From U. S. Weather Bureau records.

3/ From interviews with farmers, county agents, water masters, river commissioners, and others. The end of the irrigation season is assumed to be the end of the frost free period in areas of full water supply. Where the water supply is short it is assumed that alfalfa would continue to use residual moisture in the soil for three weeks after the last irrigation. Grass hay and pasture are assumed to use residual irrigation water from the soil two weeks after the last irrigation.

Table 7 (Continued) - Summary of estimates of normal unit "consumptive use of water rates minus precipitation" for irrigated crops for the irrigation period for areas in the Upper Colorado River Basin.

No.	Unit / Area	Water supply	Normal rate consumptive use 1/ Alfalfa	Grass hay and pasture	Grains and beans	Corn and other annuals	Orchard
			Inches	Inches	Inches	Inches	Inches
	COLORADO (Continued)						
24	Pine River and Piedra Area	F	15.5	12.7	9.3	9.3	8.3
25	Animas River	F	14.9	12.1	8.8	10.2	7.9
26	Florida Area	S	9.8	7.8	8.8	10.2	7.9
27	La Plata - (Colorado Portion)	S	11.2	8.8	9.9	11.4	9.2
28	Mancos Area	S	12.0	9.7	11.6	13.9	11.6
	NEW MEXICO						
1	Dulce	S	13.1	10.3	7.9	-	-
2	La Plata	S	11.8	9.3	10.5	-	-
3	Bloomfield Shiprock	F	27.0	23.2	13.4	17.2	17.2
	UTAH						
1	Henry's Fork	S	13.9	11.3	11.3	-	-
2	Ashley Valley and Brush Creek	F	18.7	16.1	13.1	-	-
3	Ouray	S	15.1	12.3	13.2	-	-
4	Benchlands-Uinta Basin	S	19.0	15.7	11.6	14.2	11.7
5	Valleylands-Uinta Basin	S	21.9	18.9	13.2	16.6	14.6
6	Price River	F	21.7	18.5	12.7	15.8	14.1
7	Green River	F	28.8	25.0	14.7	19.3	19.7
8	Moab	S	24.8	20.4	13.1	17.8	20.3
9	La Sal	S	13.0	10.3	11.1	-	-
10	Monticello	S	13.9	11.0	11.1	-	-
11	Huntington-Castle Dale-Ferron	S	19.6	16.1	12.1	15.1	13.0
12	Emery-Hanksville	S	19.1	15.6	11.8	14.7	14.2
13	Loa	S	15.0	12.9	10.3	-	-
14	Escalante	S	16.3	13.3	11.0	13.6	12.1
15	Blanding	S	15.4	12.2	12.3	15.6	14.8
16	Paria River	S	16.4	13.3	11.1	13.5	12.0
	WYOMING						
1	Pinedale	F	11.4	9.6	-	-	-
	Pinedale	N.O.	-	7.5	-	-	-
2	Big Piney	S	11.9	9.3	-	-	-
	Big Piney	N.O.	-	5.7	-	-	-
3	Eden Valley	F	14.5	12.4	11.1	-	-
4	Ham's Fork	F	15.6	13.4	11.0	-	-
	Ham's Fork	N.O.	-	10.2	-	-	-
5	Black's Fork	S	12.9	9.9	10.9	-	-
	Black's Fork	N.O.	-	5.8	-	-	-
6	Henry's Fork	S	13.8	10.9	11.3	-	-
7	Little Snake	S	13.3	10.5	10.7	-	-
	Little Snake	N.O.	-	3.8	-	-	-

1/ Includes irrigation water only (consumptive use minus rainfall).
F = Full water supply for all crops.
S = Short water supply for alfalfa, grass hay and pasture.
N.O. = Natural over-flow on grass hay, meadows and pasture during flood stage of river or streams.

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Table E - Summary of tentative estimates of normal unit "consumptive use rates minus rainfall" for irrigated crops and native vegetation and evaporation for the frost-free period at typical stations in the Upper Colorado River Basin (Continued)

Station		Rate of consumptive use - inches 1/							
		IRRIGATED CROPS						NATIVE VEGETATION	
No.	Location	Alfalfa	Hay pasture	Small grain and beans	Corn and other annuals	Orchards	Water surface	Dense	Medium and seeped land
	COLORADO (Cont.)								
28	Pagosa Springs	7.7	6.1				9.2	13.1	6.9
29	Palisade	27.2	23.3	12.8	17.4	19.4	31.1	40.8	25.3
30	Paonia	20.6	17.4	11.4	14.8	14.2	23.7	31.6	19.0
31	Rifle	20.1	17.2	12.4	15.7	14.3	22.9	30.1	18.6
32	Sapinero	9.8	8.0	7.5			11.6	16.2	8.9
33	Steamboat Springs	6.6	5.5				7.8	10.6	6.0
New	Eagle	9.7	8.2				11.3	15.1	8.9
	NEW MEXICO								
37	Bloomfield	22.8	19.6	12.8	16.5	16.3	26.1	34.2	21.2
41	Dulce	10.4	8.4	7.9			12.3	17.3	9.4
47	Shiprock	25.2	21.7	13.9	18.0	18.2	28.7	37.3	23.4
	UTAH								
50	Blanding	21.0	17.9	12.3	15.6	14.8	24.1	31.8	19.5
52	Castledale	18.2	15.6	12.1	15.1	13.0	20.7	27.2	16.9
53	Duchesne	16.6	14.2	11.7	14.2	11.7	19.0	25.1	15.4
54	Emery	19.9	17.1	11.8	14.7	14.2	22.8	29.9	18.5
55	Escalante	17.6	14.8	11.0	13.6	12.1	20.3	27.2	16.2
56	Ft. Duchesne	19.0	16.5	13.2	16.4	13.9	21.6	28.0	17.8

Table [illegible] (Cont'd) — Mean monthly [illegible] in the Upper Colorado River Basin, recorded or estimated from Weather Bureau records for the period 1914 to 1945.

No.	Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Mean Annual
	NEW MEXICO													
37	Bloomfield	26.0	34.1	41.1	49.6	58.9	68.2	74.9	72.6	64.6	52.2	38.9	29.0	50.9
41	Dulce	17.8	25.7	34.5	43.7	51.8	60.7	66.6	64.6	57.2	45.6	33.4	21.5	43.6
47	Shiprock	28.6	35.4	44.7	53.1	61.7	69.6	76.3	74.4	67.0	55.0	41.2	30.2	53.1
	UTAH													
50	Blanding	26.6	32.5	39.7	47.8	55.9	65.8	71.9	70.3	62.1	51.4	39.1	29.1	49.4
52	Castledale	18.5	26.2	36.9	45.3	54.3	63.3	69.2	67.1	58.3	46.8	34.9	22.0	45.2
53	Duchesne	15.6	23.4	35.3	45.2	54.0	61.7	68.9	66.8	57.8	46.5	32.5	20.6	44.0
54	Emery	24.0	29.0	36.7	44.5	53.1	61.2	67.3	65.6	57.7	47.5	36.5	26.8	45.8
55	Escalante	25.5	31.3	38.8	46.2	54.4	63.5	69.1	67.2	59.2	49.1	37.5	27.9	47.5
56	Ft. Duchesne	13.2	20.5	35.3	46.6	55.1	63.7	70.3	68.2	59.4	46.7	32.8	19.4	44.3
58	Green River	21.8	32.6	43.2	53.2	62.9	72.0	79.8	76.9	67.0	53.1	38.1	27.4	52.3
59	Hanksville	23.9	34.0	44.1	53.2	62.3	71.9	78.1	74.7	65.5	53.1	39.4	28.5	52.4
61	La Sal	24.7	29.3	35.7	45.2	53.9	63.1	69.4	67.8	59.5	48.3	36.8	25.3	46.6
62	Loa	21.8	26.1	33.6	41.9	51.2	59.8	66.5	64.0	55.0	43.8	32.7	22.8	43.3
63	Manila	21.3	25.8	33.6	41.6	51.1	59.7	67.4	64.8	56.8	46.4	33.5	19.3	43.5
64	Moab	29.0	36.9	46.7	55.6	64.6	72.8	79.0	76.3	67.5	54.0	41.6	31.3	54.6
67	Myton	15.4	24.4	37.0	47.6	57.2	65.5	72.2	70.4	61.5	49.4	33.6	20.9	46.2
68	Price	23.8	30.0	39.1	47.7	57.4	66.8	73.0	71.2	62.1	51.2	37.2	26.4	48.8
71	Tropic	28.2	31.2	38.8	45.9	53.7	62.6	68.7	66.5	59.3	49.2	38.7	30.0	47.7
72	Vernal	16.6	23.0	34.9	46.4	54.5	63.8	69.4	67.1	57.7	45.6	33.9	18.2	44.3
	WYOMING													
74	Big Piney	8.8	10.9	22.7	36.6	44.5	51.7	59.9	55.9	47.4	37.9	23.0	15.0	34.5
75	Dixon	16.5	21.6	29.4	40.9	50.2	58.2	65.4	63.3	54.4	44.0	30.4	19.7	41.2
76	Eden	9.8	15.6	26.7	38.4	48.1	56.9	64.0	61.7	52.1	41.4	27.0	12.8	37.9
78	Green River	18.3	23.8	32.2	42.8	52.9	61.7	69.9	67.2	57.1	45.3	32.2	20.9	43.7
79	Kemmerer	17.2	18.4	27.1	39.1	48.1	55.1	62.4	60.6	51.8	42.5	28.5	22.1	39.4
81	Lyman	17.0	21.7	28.9	38.1	49.7	58.7	65.3	62.2	52.4	43.1	29.4	22.2	40.7
82	Pinedale	11.7	15.3	23.0	35.0	44.9	53.2	60.8	57.9	49.3	39.0	23.3	14.5	35.7

Table [illegible] (Cont'd) — [illegible] Upper Colorado River Basin, recorded or estimated from Weather Bureau records for the period 1914 to 1945.

No.	Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
	NEW MEXICO													
37	Bloomfield	0.55	0.72	0.62	0.62	0.66	0.50	1.11	1.23	1.14	0.76	0.55	0.64	9.11
41	Dulce	1.40	1.58	1.63	1.39	1.24	0.91	2.49	2.09	1.95	1.36	1.21	1.58	18.83
47	Shiprock	0.34	0.55	0.73	0.67	0.59	0.29	0.74	1.02	1.49	0.52	0.46	0.56	7.96
	UTAH													
50	Blanding	1.29	1.40	1.09	0.98	0.75	0.46	1.15	1.23	1.35	1.39	0.97	1.40	13.46
52	Castledale	0.71	0.66	0.57	0.55	0.53	0.52	0.95	1.23	0.95	0.84	0.50	0.62	8.63
53	Duchesne	0.58	0.63	0.81	0.76	0.81	0.70	1.05	1.30	1.07	0.95	0.48	0.52	9.66
54	Emery	0.53	0.49	0.50	0.49	0.62	0.46	0.95	1.16	0.96	0.76	0.24	0.45	7.61
55	Escalante	1.13	1.01	0.97	0.66	0.56	0.49	1.57	2.06	1.38	1.12	0.60	1.01	12.56
56	Ft. Duchesne	0.44	0.37	0.50	0.72	0.70	0.51	0.53	0.65	1.01	0.83	0.38	0.37	7.01
58	Green River	0.45	0.39	0.45	0.54	0.39	0.55	0.60	0.78	0.75	0.76	0.35	0.44	6.45
59	Hanksville	0.41	0.31	0.28	0.32	0.38	0.33	0.69	0.73	0.56	0.53	0.24	0.38	5.16
61	La Sal	0.90	0.91	0.82	1.14	0.89	0.69	1.52	1.51	1.36	1.30	0.74	1.04	12.82
62	Loa	0.51	0.54	0.61	0.50	0.47	0.38	1.12	1.39	0.88	0.60	0.37	0.48	7.85
63	Manila	0.36	0.61	0.85	1.46	1.23	0.69	0.98	0.96	0.86	1.28	0.65	0.42	10.35
64	Moab	0.80	0.71	0.85	0.88	0.74	0.49	1.03	0.87	0.97	1.02	0.66	0.92	9.94
67	Myton	0.32	0.32	0.45	0.66	0.58	0.43	0.80	0.93	0.91	0.79	0.37	0.34	6.90
68	Price	0.83	0.78	0.73	0.79	0.74	0.71	0.95	1.33	1.27	0.96	0.53	0.77	10.39
71	Tropic	1.20	1.08	1.14	0.81	0.58	0.40	1.47	1.75	1.50	1.03	0.63	1.10	12.69
72	Vernal	0.63	0.60	0.55	0.95	0.86	0.43	0.63	0.76	1.15	0.97	0.66	0.58	8.77
	WYOMING													
74	Big Piney	0.36	0.35	0.42	0.84	1.13	0.97	0.70	0.77	1.17	1.06	0.34	0.29	8.40
75	Dixon	0.79	0.71	1.01	1.17	1.24	0.81	1.10	1.28	0.98	1.17	0.81	0.93	12.00
76	Eden	0.42	0.53	0.45	0.76	0.81	0.71	0.76	0.83	0.73	0.67	0.34	0.33	7.34
78	Green River	0.88	0.42	0.32	0.35	0.51	0.54	1.06	1.06	0.65	0.59	0.70	0.82	7.90
79	Kemmerer	0.56	0.61	0.67	0.66	0.76	0.72	0.77	0.77	0.56	0.67	0.59	0.60	7.94
81	Lyman	0.45	0.82	0.79	1.81	1.40	0.57	1.35	0.79	0.80	1.26	0.80	0.65	11.49
82	Pinedale	0.88	0.87	0.71	0.94	1.21	1.13	1.04	0.95	1.08	1.04	0.71	0.86	11.42

STATE OF COLORADO

Colorado Water Conservation Board
Department of Natural Resources
1313 Sherman Street, Room 721
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Phone: (303) 866-3441
FAX: (303) 866-4474
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Bill Owens
Governor

Russell George
Executive Director

Rod Kuharich
CWCB Director

Rick Brown
Acting Deputy
Director

FAX COVER SHEET

Date: 11/2/05

To: Don Ostler
John Whipple

Fax#: 801-531-9705
505-827-6188

Agency: Randy Seaholm

From: Randy Seaholm

Fax#: (303) 866-4474
Phone: (303) 866-3441

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Randy

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OSE-0041

With my thanks,
Ernie

UPSTREAM IRRIGATION IMPACT ON COLUMBIA RIVER FLOWS[a]

Discussion by J. Ernest Flack

J. ERNEST FLACK,[1] A. M. ASCE.—The author's paper is most worthwhile in pointing out some of the benefits of upstream irrigation in reducing peak flows and increasing low flows at downstream locations. An additional benefit of upstream uses (that include transbasin diversions as well as irrigation and storage) is that of water salvage attributable to reduction of flood peaks. This characteristic is probably significant on streams that exhibit considerable overbank flow during floods.

Studies of apparent salvage water attributable to transmountain diversions were reported by the Upper Colorado River Compact Commission in their Fourth Annual Report.(1) These studies covered the Upper Colorado River upstream from Glenwood Springs and Hot Sulphur Springs. At the suggestion of Mr. R. M. Gildersleeve, Chief Engineer of the Colorado Water Conservation Board, the writer reviewed and extended these studies.(2) A brief outline of the methods used in this latter study are presented as an addition to the author's "Modifications of Flow".

The general procedure was the use of the Inflow-Outflow method. Monthly flows at designated Inflow stations were corrected for changes in storage and diversions and then correlated against flow at a designated Outflow station. A significant selection of Inflow stations' flows were summed and plotted by months against the Outflow station's flow. An approximate straight line correlation was made for the early period of record, when upstream diversions and storage were insignificant. Since then, there has been a graduate increase in upstream depletions almost entirely due to storage and diversion by transmountain diversion projects. Marked increases occurred more recently after completion of major transmountain diversion projects such as the Colorado-Big Thompson Project.

In order to illustrate the method more clearly, reference is made to Fig. 1. This is a schematic representation showing the straight line correlation of Inflow versus Outflow as determined for an early period when upstream depletions and storage were insignificant. The point marked A represents the correlation between Inflow and Outflow as recorded for a month when upstream depletions were significant. The shift of the Outflow value to point A' represents the correction for upstream depletions. The amount of apparent salvage water is the distance the point A' falls to the right of the straight line correlation.

Because of a lack of long time records at some Inflow stations, monthly correlations were not always satisfactory. For this reason double mass curve

a. Proc. Paper 1965, March, 1959, by Harold T. Nelson.

1. Asst. Prof., Dept. of Civ. Eng., Univ. of Colorado, Boulder, Colo.

OSE-0042

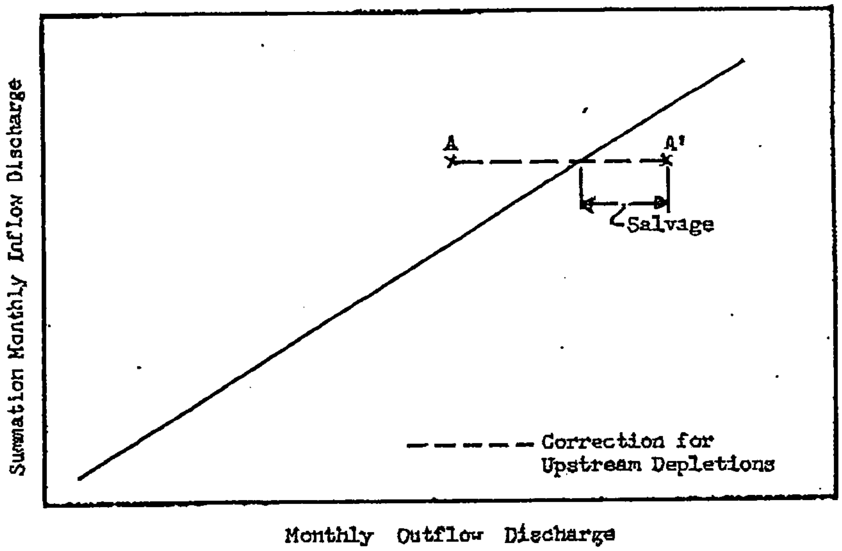

Figure 1 Salvage From Inflow-Outflow Correlation

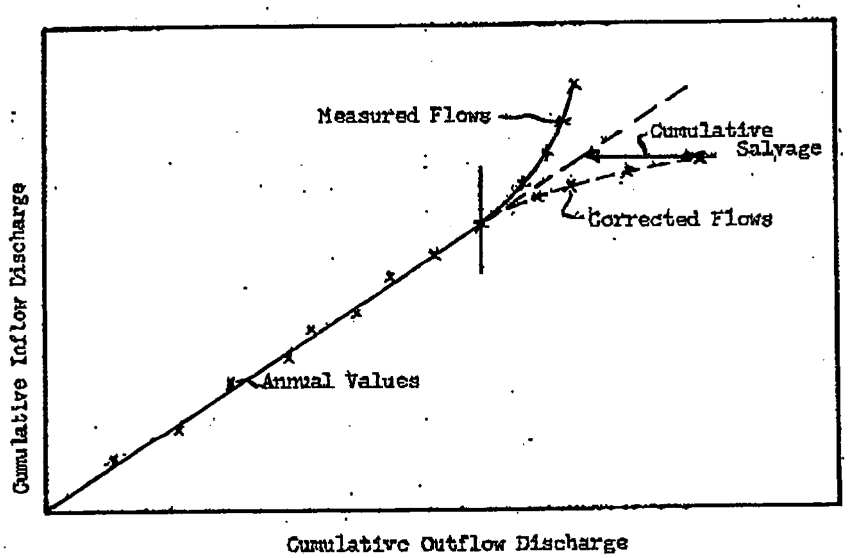

Figure 2 Salvage From Cumulative Discharge Mass Curve

plotting of Summation of Inflow versus Outflow on a successive water year basis was used, as shown schematically, in Fig. 2. For the selected stations a straight line correlation was determined for early period before significant transmountain diversions were made. For the following periods, as upstream depletions increased significantly, the departure of the measured Outflow from the straight line correlation is indicated by the upward swing of the solid line on Fig. 2. The Outflow corrected for upstream depletions is shown as a dashed line curving downward and the departure of this dashed line from the straight line correlation is a measure of the water salvaged.

The following tabulation gives some of the results of a study using the latter of the above methods for the Colorado River above Hot Sulphur Springs.(2)

OUTFLOW STATION - COLORADO RIVER AT HOT SULPHUR SPRINGS

Period	Average Upstream Depletions acre ft/yr	Average Apparent Salvage acre ft/yr
1936-49	50,100	28,400
1950-54	231,900	33,700

These results are only approximate because corrections for bank storage and evaporation in newly constructed reservoirs have not been made.

Corrections for effects of bank storage & evaporation need to be considered. Since bank storage in reservoir operations is a catch all unknown any salvage by use will be very difficult to evaluate in a meaningful manner. 10/21/05 RPt.

It is believed that on streams which have considerable losses during floods or spring snow-melt periods from overbank flow that reduction of the peaks will show significant salvage benefits. A brief summarization of the benefits of upstream depletions by irrigation, storage, and diversions could then be:

(1) Increase of low seasonal flows.
(2) Reduction of flood peaks.
(3) Salvage due to reduction of losses.
(4) Regulation by underground storage.

As the author has so aptly pointed out, the upstream irrigator has not depended on downstream benefits in the financing of irrigation projects, but now and in the future "the identification, evaluation, and allocation of downstream benefits from upstream river regulation" will be most necessary if upstream projects are to progress at a reasonable rate to their ultimate development in the face of conflicting demands by downstream water users.

REFERENCES

1. Fourth Annual Report, Upper Colorado River Commission, March 30, 1953, p. 33.
2. Flack, J. E., Salvage Attributable to Transmountain Diversions at Selected Stations on the Upper Colorado River, Colorado Water Conservation Board, August 10, 1956 (Unpublished office memorandum).

032357

M E M O R A N D U M

August 10, 1956

To: R. M. Gildersleeve

From: J. E. Flack

Subject: Salvage Attributal to Transmountain Diversions at Selected Stations on the Upper Colorado River above Cameo, Colorado.

This series of studies was undertaken to determine salvage water that is attributal to transmountain diversion of Colorado River water. This salvage is due to reduced river stages, decreased evaporation because of less water surface, reduced evapo-transpiration by channel bank growth, and reduction or elimination of over-bank flow. Most diversions are made in such a manner as to reduce high flows of the upper Colorado River and its tributaries.

Utilizing the period of water years from 1911 through 1954, it was attempted to determine the relationship between the annual (water year) discharge, the amount of the historic transmountain diversion, and the salvage attributal to the diversion. This was done by analyzing the same basic data with two different approaches. The basic procedure was to compare the change in the relationship of Inflow and Outflow with change in transmountain diversion for a portion of the drainage area of the upper Colorado River. A measure of the inflow was made by using Inflow Index Stations (also called Index Supply) corrected for any transmountain diversions above the station gage, and compare it with the discharge at an Outflow station.

FIND N. Mex version.

John Whipple called NMSEO

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For the early years of the period studied, when transmountain diversions were small, the correlation of Index Supply to Outflow proved to be a straight line relationship (the Base Line). For later periods the plotted values of Index Supply vs. Outflow, where the outflow is the recorded discharge at the outflow station plus diversions, should be to the right of the Base Line by the amount of the salvage.

Two general methods of determining this salvage were used. The first was to compare annual or monthly values of Index Supply vs. Colorado River at the Outflow Station for periods when transmountain diversions were appreciably different. The relative gain of the Outflow for periods of larger diversions over that of smaller diversion when the Index Supply was the same, would be a measure of the salvage. This method was used in Studies A, B, C, I, and II. Monthly values did not give significant results but average gains in salvage for certain categories of depletion could be evaluated by averaging methods.

The second method of evaluating salvage was to find the deviation of the mass curve of Index Supply vs. Outflow discharge from a straight line projected through the values for early years of the period studied, when diver-diversions were quite small.

Comparison of results of the two methods used follows:

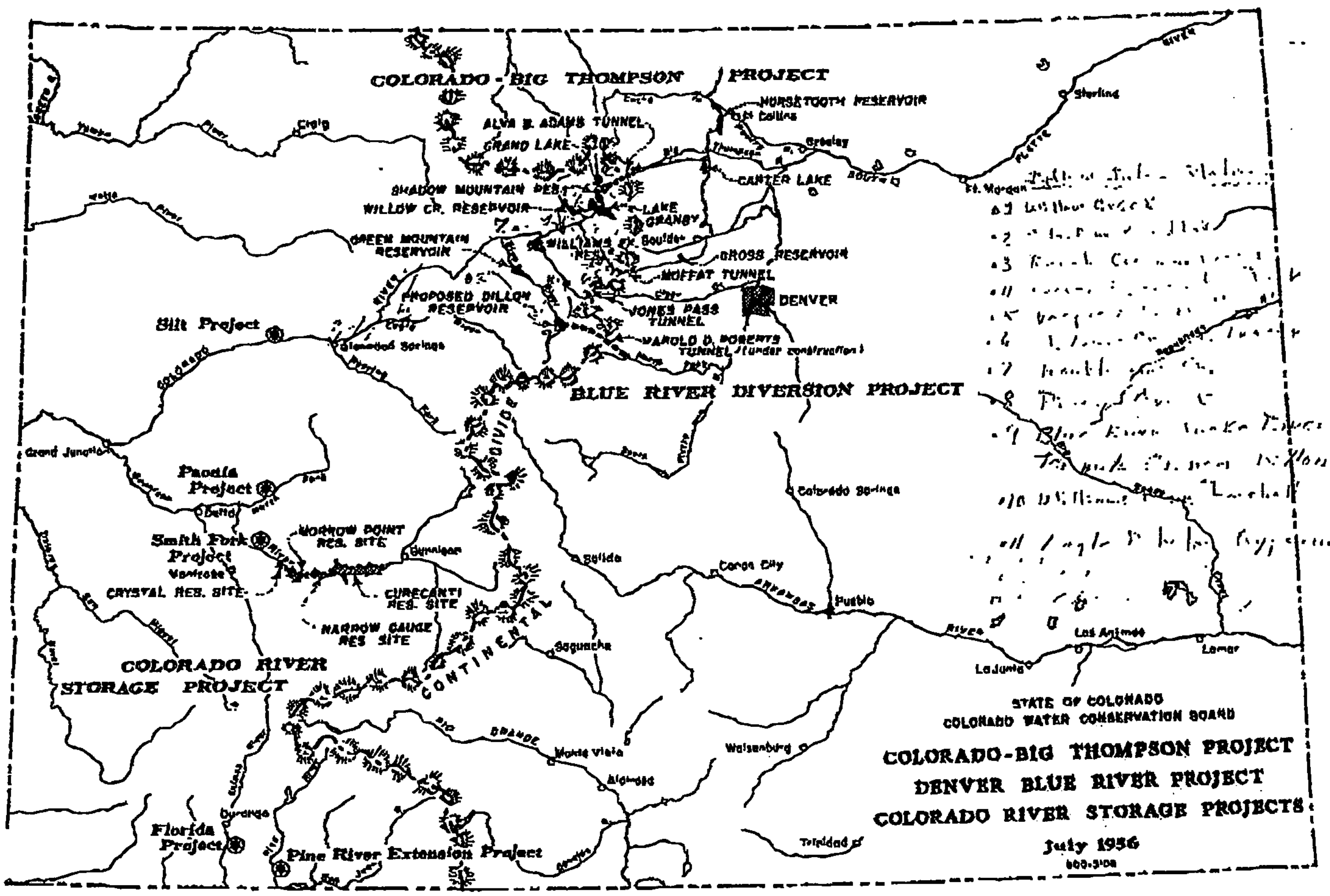
OUTFLOW STATION - COLORADO RIVER AT HOT SULPHUR SPRINGS

Period	Salvage-Method 1	Method 2	Depletions
1911-35	________	______	13,200 a.f./yr.
1936-49	30,700 a.f./yr.	28,400	50,100
1950-54	29,800	33,700	231,900

OUTFLOW STATION - COLORADO RIVER AT GLENWOOD SPRINGS

1911-35	________	______	15,300
1935-49	27,800	6,900	68,100
1950-54	101,000	94,900	226,300

Descriptions of the studies follows with detailed results and analysis.


COLORADO - BIG THOMPSON PROJECT
HORSETOOTH RESERVOIR
ALVA B. ADAMS TUNNEL
GRAND LAKE
SHADOW MOUNTAIN RES.
WILLOW CR. RESERVOIR
LAKE GRANBY
CARTER LAKE
GREEN MOUNTAIN RESERVOIR
WILLIAMS FK. RES.
GROSS RESERVOIR
MOFFAT TUNNEL
DENVER
PROPOSED DILLON RESERVOIR
JONES PASS TUNNEL
HAROLD D. ROBERTS TUNNEL (under construction)
Silt Project
BLUE RIVER DIVERSION PROJECT
Grand Junction
Paonia Project
Smith Fork Project
MORROW POINT RES. SITE
CRYSTAL RES. SITE
CURECANTI RES. SITE
NARROW GAUGE RES SITE
COLORADO RIVER STORAGE PROJECT
CONTINENTAL DIVIDE
Colorado Springs
Salida
Canon City
Pueblo
Gunnison
Saguache
Monte Vista
Alamosa
Walsenburg
Trinidad
La Junta
Las Animas
Lamar
Sterling
Greeley
Ft. Collins
Ft. Morgan
Craig
Glenwood Springs
Montrose
Durango
Florida Project
Pine River Extension Project
STATE OF COLORADO
COLORADO WATER CONSERVATION BOARD
COLORADO-BIG THOMPSON PROJECT
DENVER BLUE RIVER PROJECT
COLORADO RIVER STORAGE PROJECTS
July 1956

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INDEX OF STUDIES

Study A – Salvage above Hot Sulphur Springs using Method 1, by months, for period 1935 – 54.

Study B – Same as Study A except for change in one Index station, by months, period 1935 – 54.

Study C – Salvage above Glenwood Springs using Method 1, annually, total period.

Study 1 – Salvage above Hot Sulphur Springs using Method 1, total period.

Study II – Salvage above Glenwood Springs by Method 1, annual, total period.

Study III – Salvage above Cameo by Method 1, total period.

Summary – Graphical Representation of Salvage vs. Depletion for categories of Index Supply.

Study X – Salvage above Hot Sulphur Springs and Glenwood Springs by Method 2.

Meeting No. 198
Special Meeting

Denver, Colorado
June 2, 1987

the staff will revise, if necessary, the program and distribute copies of the write-up and the program to the Commission and advisers as a staff report and will also make this report available to others at cost. (See pp. 198-51 through 198-63 for the Explanation of the Staff 24-month Operating Plan Program distributed at the meeting of the Engineering and Legal Committees.)

I would ask any members of the Committees now to put me straight if I stated that incorrectly, any part of it. Jerry?

MR. ZIMMERMAN: I was wondering if it was decided that we would distribute it at a later date at cost or whether that was still negotiable or to be determined at a later date.

CHAIRMAN ROSS: That is after the comments have been received and the piece has been reworked to accommodate those comments, a determination may then be made either by staff or the Commission as to how widely shared it may be or at what cost it may be.

MR. ZIMMERMAN: Correct.

MR. SAUNDERS: Thank you, Jerry.

MR. ZIMMERMAN: I was asking that as a question of you and the other committee members.

MR. SAUNDERS: My impression was that we would give copies at cost, or approximate cost, if requested.

COMMISSIONER REYNOLDS: As I understand, Mr. Chairman, if I may, that was to the public.

MR. SAUNDERS: Yes.

COMMISSIONER REYNOLDS: I thought there was some discussion of the question of whether it should be furnished to the Commissioners' advisers at no cost.

MR. SAUNDERS: Yes. I thought I had stated that earlier, that copies would be given to the Commissioners and advisers at no cost.

The last item, which was the first on the agenda, was a discusssion of the Upper Basin Yield and Hydrologic Determination, and the Committees, after deliberations, made a recommendation that the Commission pass a resolution on this issue, a copy of which I will give, when I get it, to the court reporter. Do we have a good copy?

MS. WETMORE: We have a copy.

MR. SAUNDERS: Okay, so she has a copy now. If you would like the resolution read, we can do that. I think all of those present were at the meeting and are now aware of the contents.

11-02-2005 17:40 FROM-COLORADO WATER CONSERVATION BOARD 3038664474 T-848 P.012/018 F-711

CHAIRMAN ROSS: Well, I think the Commission members do have copies of it, and perhaps when we get to the adoption of the resolutions, we can take the matter up then.

MR. SAUNDERS: Okay. Mr. Chairman, that concludes my report of the Engineer and Legal Committees.

CHAIRMAN ROSS: Thank you. Are there questions of Barry from the Commission or others? (No response.) Thank you, Barry.

Jeff, have you anything special to report on behalf of the Budget Committee?

COMMISSIONER FASSETT: No, I don't other than the acceptance of your appointment in that regard. I appreciate that. I have only had a single inquiry in the past month from Commissioner Anderson, but it's a matter that we will just bring up at the next meeting.

CHAIRMAN ROSS: All right, fine. May we hear about the report of the Treasurer, please?

MR. ZIMMERMAN: Mr. Chairman, the Treasurer's Report has been included in the packet of materials given to each of the Commissioners prior to this meeting. The report covers the Fiscal Year 1987 transactions through April 1987. I believe the report shows that the Commission is in good financial condition; and I would answer any questions the Commissioners or others may have concerning the Treasurer's Report.

I would also request that the Treasurer's Report be included in the Official Record of this meeting.

CHAIRMAN ROSS: Without objection, it will be so ordered. Are there questions of Mr. Zimmerman about the Treasurer's Report? (No response.) (See p. 198-64 for the Report of the Treasurer.)

If not, let us turn to the unfinished business or new business. Item 9(a) on the agenda calls for action on reports. I believe the Commission has already, by motion, adopted the personnel regulation change. What's your pleasure with respect to the receipt of the reports that have been given?

COMMISSIONER REYNOLDS: Mr. Chairman, I move that the reports be accepted, with the understanding, of course, that other items on the agenda related to those reports still are pending action before the Commission.

CHAIRMAN ROSS: Is there a second?

COMMISSIONER LOCHHEAD: Second.

COMMISSIONER ROSS: Discussion of the motion? (No response.) All in favor, say aye. (Whereupon a vote was taken and the motion passed.)

CHAIRMAN ROSS: Item 9(b) is identified as the Upper Colorado River Basin Yield Study--Hydrologic Determination. Without objection, I would suggest that we take that matter up in conjunction with the proposed resolution which was a part of the report of the Engineering and Legal Committee, and ask the Commission what its pleasure in that regard is.

COMMISSIONER LOCHHEAD: Mr. Chairman, there was a substantial discussion at the meeting of the Legal and Engineering Committees, and I think there is agreement among the States as to a proposed resolution, and so I therefore move the adoption of the resolution that was forwarded to us by the Engineering and Legal Committees.

COMMISSIONER REYNOLDS: Mr. Chairman, I'll second the motion.

CHAIRMAN ROSS: It's been moved and seconded that the resolution forwarded to the Commission by the Engineering and Legal Committees be adopted. Is there discussion on the motion?

MR. ZIMMERMAN: Mr. Chairman, do you want me to read it for those that may not have attended?

CHAIRMAN ROSS: I think it might be most appropriate.

MR. ZIMMERMAN: "Resolution of the Upper Colorado River Commission regarding 'Upper Colorado River Basin Yield Study--Hydrologic Determination.'

"WHEREAS, the Upper Colorado River commission supports water resource development in the Upper Colorado River Basin to enable the Upper Division States to fully develop their compact apportionments of Colorado River water while meeting their compact water delivery requirements at Lee Ferry; and

"WHEREAS, it is the position of the Upper Colorado River Commission and the Upper Division States that with the delivery at Lee Ferry of 75 million acre-feet of water in each period of ten consecutive years, the water supply available in the Colorado River System below Lee Ferry is sufficient to meet the apportionments to the Lower Basin provided for in Article III(a) and III(b) of the Colorado River Basin Compact and the entire Mexican Water Treaty delivery obligation; and

"WHEREAS, the Upper Colorado River Commission and the Upper Division States will call upon appropriate authorities to take all actions necessary to ensure that all States have access to their respective apportionments as specified in the Upper Colorado River Basin Compact:

OSE-0054

"NOW, THEREFORE, BE IT RESOLVED by the Upper Colorado River Commission at its Special Meeting in Denver, Colorado, on June 2, 1987, that while the Commission does not endorse the projections of depletions, the study assumptions or the analytical methodologies, particularly the assumption of a minimum Upper Basin delivery of 8.23 million acre-feet annually at Lees Ferry, contained in the 'Upper Colorado River Basin Yield Study--Hydrologic Determination' as transmitted by letter dated March 9, 1987, from the Upper Colorado Region of the Bureau of Reclamation, the Commission would not object to a determination by the Bureau that the Upper Basin yield is at least 6.0 million acre-feet annually, rather than 5.8 million acre-feet as previously determined.

"BE IT FURTHER RESOLVED that the Commission encourages the Bureau of Reclamation to redetermine the amount of water available for contract from the Navajo Reservoir supply based on an Upper Basin yield of 6.0 million acre-feet annually.

"BE IT FURTHER RESOLVED that the Commission is not, at this time, taking any position on the amount of water which is reasonably likely to be available from any given Federal reservoir for long-term water service contracts without causing an Upper Division State to exceed its ompact apportionment based upon a determination by the Bureau of .eclamation that the Upper Basin yield is at least 6.0 million acre-feet annually.

"BE IT FURTHER RESOLVED that this resolution be transmitted to the Regional Director, Upper Colorado Region, Bureau of Reclamation, Salt Lake City, Utah, and, as appropriate, to other Federal, State, and congressional officials who may consider the 'Upper Colorado River Basin Yield Study--Hydrologic Determination.'"

CHAIRMAN ROSS: You've heard the resolution read. Is there discussion on the resolution by the Commission members?

COMMISSIONER REYNOLDS: Mr. Chairman, I call for the question.

CHAIRMAN ROSS: The question's been called for. All in favor of the motion, say aye. (Whereupon a vote was taken and the motion passed.) The motion passes and the resolution has been adopted. (See pp. 198-65 through 198-66 for the resolution as transmitted.)

Are there other resolutions to come before us?

COMMISSIONER REYNOLDS: Mr. Chairman, I should like to move a resolution of the Commission honoring Floyd A. Bishop. Mr. Chairman, with your indulgence, I would read it into the record.

CHAIRMAN ROSS: Please.

COMMISSIONER REYNOLDS: "WHEREAS, Floyd A. Bishop has worked for over 40 years in professional engineering in the State of Wyoming, After the Commission approved Mr. Zimmerman's recommendation, written testimony was prepared and approved by the Commission before being sent to both the House and Senate Appropriations Subcommittees on Energy and Water Development on March 27, 1987.

The Commission's testimony supported funding levels for the Colorado River Storage Project and participating projects that were consistent with the funding requests being made by the Upper Division States. The testimony also was consistent with the funding levels being requested by the Colorado River Basin Salinity Control Forum for the Bureau of Reclamation's Title II salinity control program in the Colorado River Basin. On March 30, 1987 copies of the Commission's written testimony were sent to the Commissioners and Advisers. The testimony that was sent to both the House and Senate subcommittees was identical. (Refer to Attachment 1 for a copy of the testimony sent to the Subcommittee on Energy and Water Development of the Senate Appropriations Committee.) (See pp. 198-27 through 198-29 of this volume for Attachment 2.)

Upper Colorado River Basin Yield Study--Hydrologic Determination

The Bureau of Reclamation prepared an "Upper Colorado River Basin Yield Study--Hydrologic Determination" that was transmitted to the Commissioners and Advisers on March 9, 1987. That "Hydrologic Determination" was a major topic of discussion during the meetings of the Legal and Engineering ommittees and the Upper Colorado River Commission held on March 24th in ibuquerque, New Mexico. During those meetings, Committee members and Commissioners requested that the Bureau of Reclamation prepare additional information for their consideration.

The Bureau of Reclamation has prepared the requested supplemental information, and it was sent to the Commissioners and Advisers on April 23, 1987. The Commission Staff has also prepared a draft resolution that supports ". . . a 'Hydrologic Determination' by the Secretary of the Interior using the best available hydrologic data base" and does not object to ". . . a 'Hydrologic Determination' that demonstrates that the Upper Basin yield is 6.1 million acre-feet annually." As you recall, in the past the Upper Colorado River Commission and the Upper Division States have maintained that the Upper Basin yield is at least 6.3 million acre-feet annually.

The draft Resolution will be sent to the Commissioners and Alternates prior to the Special Meeting of the Upper Colorado River Commission being held in Denver, Colorado on June 2, 1987. It is anticipated that the Commission will take appropriate action on the Bureau's "Hydrologic Determination" during its June 2nd meeting.

Briefing Papers Concerning the Settlement Agreement on the Animas-La Plata Project

During the Legal and Engineering Committees meeting held on March 24, 1987 in Albuquerque, New Mexico, Mr. J. William McDonald discussed the Settlement Agreement on the Animas-La Plata Project and distributed a limited

RESOLUTION
OF
UPPER COLORADO RIVER COMMISSION

RE: "UPPER COLORADO RIVER BASIN YIELD STUDY-- HYDROLOGIC DETERMINATION"

WHEREAS, the Upper Colorado River Commission supports water resource development in the Upper Colorado River Basin to enable the Upper Division States to fully develop their compact apportionments of Colorado River water while meeting their compact water delivery requirements at Lee Ferry; and

WHEREAS, it is the position of the Upper Colorado River Commission and the Upper Division States that with the delivery at Lee Ferry of 75 million acre-feet of water in each period of ten consecutive years, the water supply available in the Colorado River System below Lee Ferry is sufficient to meet the apportionments to the Lower Basin provided for in Article III (a) and (b) of the Colorado River Compact and the entire Mexican Water Treaty delivery obligation; and

WHEREAS, the Upper Colorado River Commission and the Upper Division States will call upon appropriate authorities to take all actions necessary to ensure that all States have access to their respective apportionments as specified in the Upper Colorado River Basin Compact:

NOW, THEREFORE, BE IT RESOLVED by the Upper Colorado River Commission at its Special Meeting in Denver, Colorado, on June 2, 1987, that while the Commission does not endorse the projections of depletions, the study assumptions or the analytical methodologies, particularly the assumption of a minimum Upper Basin delivery of 8.23 million acre-feet annually at Lees Ferry, contained in the "Upper Colorado River Basin Yield Study--Hydrologic Determination" as transmitted by letter dated March 9, 1987, from the Upper Colorado Region of the Bureau of Reclamation. the Commission would not object to a determination by the Bureau that the Upper Basin yield is at least 6.0 million acre-feet annually, rather than 5.8 million acre-feet as previously determined.

BE IT FURTHER RESOLVED that the Commission encourages the Bureau of Reclamation to redetermine the amount of water available for contract from the Navajo Reservoir supply based on an Upper Basin yield of 6.0 million acre-feet annually.

BE IT FURTHER RESOLVED that the Commission is not, at this time, taking any position on the amount of water which is reasonably likely to be available from any given Federal reservoir for long-term water service contracts without causing an Upper Division State to exceed its compact apportionment based upon a determination by the Bureau of Reclamation that the Upper Basin yield is at least 6.0 million acre-feet annually.

BE IT FURTHER RESOLVED that this resolution be transmitted to the Regional Director, Upper Colorado Region, Bureau of Reclamation, Salt Lake City, Utah, and, as appropriate, to other Federal, State, and congressional officials who may consider the "Upper Colorado River Basin Yield Study--Hydrologic Determination."

CERTIFICATE

I, GERALD R. ZIMMERMAN, Executive Director and Secretary of the Upper Colorado River Commission, do hereby certify that the above Resolution was adopted by the Upper Colorado River Commission at the Special Meeting held in Denver, Colorado on June 2, 1987.

WITNESS my hand this 4th day of June, 1987.

Gerald R. Zimmerman
Executive Director and Secretary