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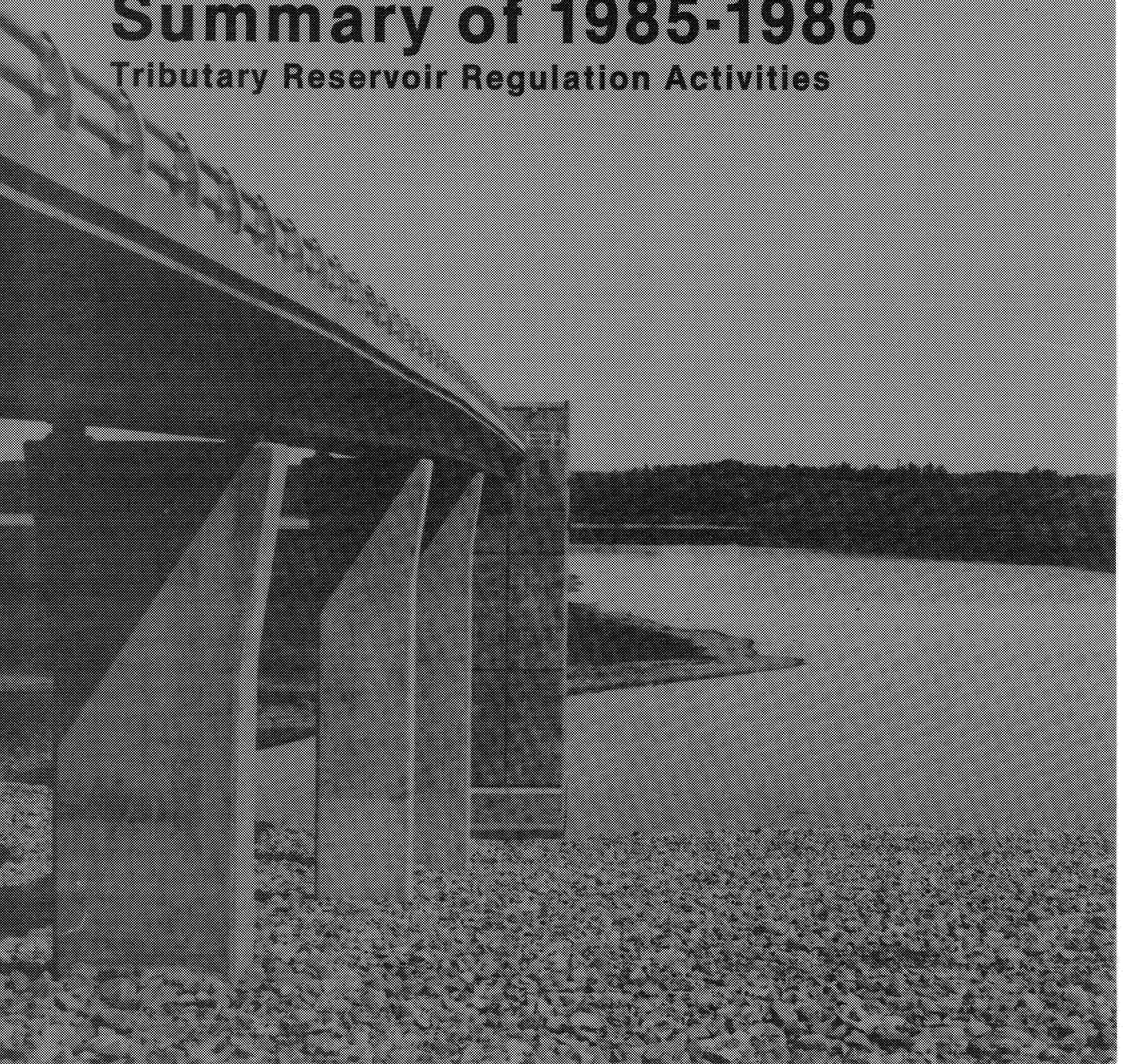
US Army Corps of Engineers
Omaha District

Engineering Division
Hydrologic Engineering Branch
Reservoir Regulation Section

Summary of 1985-1986

Tributary Reservoir Regulation Activities



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Project C13685
Disk No. 729-C

This Report is the Omaha District's portion of the Missouri River Division's 1985-1986 Annual Report on Reservoir Regulation Activities.

November 1986

ON THE COVER: Intake tower at Pipestem Reservoir, near Jamestown, North Dakota

Project C13685
Disk No. 729-C

MISSOURI RIVER DIVISION
OMAHA DISTRICT
SUMMARY OF 1985-1986
RESERVOIR REGULATION ACTIVITIES

ENCLOSURES

BUREAU OF RECLAMATION PHOTO

BOYSEN DAM AND RESERVOIR

WIND RIVER BASIN — WYOMING

Project C13685
Disk No. 729-C

MISSOURI RIVER DIVISION
OMAHA DISTRICT
SUMMARY OF 1985-1986
RESERVOIR REGULATION ACTIVITIES

I. PURPOSE AND SCOPE. This annual report has been prepared in accordance with paragraph 12c of ER 1110-2-1400 to summarize significant tributary reservoir regulation activities of the Omaha District. The period covered is August 1985 through July 1986.

II. RESERVOIRS IN THE OMAHA DISTRICT. The Omaha District of the Corps of Engineers boundaries include 414,900 square miles that compose the Missouri River watershed above Rulo, Nebraska.

a. Reservoirs With Flood Control Storage. There are 35 tributary reservoirs with allocated flood control storage covered in this report. The dams are listed below. Included are 24 Corps of Engineers dams and 11 Bureau of Reclamation dams. The locations of these 35 tributary reservoirs are shown on Enclosure 1 and pertinent data are present in Enclosure 2. Enclosure 3 tabulates the numerical buildup of Corps reservoirs in the Omaha District. Pictured on the preceding page is Boysen Reservoir located near Thermopolis, Wyoming. This Bureau of Reclamation reservoir prevented what would have been considerable flooding during June and July.

Corps of Engineers

1. Bear Creek Dam, CO
2. Bowman-Haley Dam, ND
3. Bull Hook Dam, MT
4. Cedar Canyon Dam, SD
5. Chatfield Dam, CO
6. Cherry Creek Dam, CO
7. Coldbrook Dam, SD
8. Cottonwood Springs Dam, SD
9. Kelly Road Dam, CO
10. Papillion No. 11, NE
11. Papillion No. 16, NE
12. Papillion No. 18, NE
13. Papillion No. 20, NE
14. Papillion Dam, ND
15. Salt Creek No. 2, NE
16. Salt Creek No. 4, NE
17. Salt Creek No. 8, NE
18. Salt Creek No. 9, NE
19. Salt Creek No. 10, NE
20. Salt Creek No. 12, NE
21. Salt Creek No. 13, NE
22. Salt Creek No. 14, NE
23. Salt Creek No. 17, NE
24. Salt Creek No. 18, NE

Bureau of Reclamation

25. Boysen Dam, WY
26. Canyon Ferry Dam, MT
27. Clark Canyon Dam, MT
28. Glendo Dam, WY
29. Heart Butte Dam, ND
30. Jamestown Dam, ND
31. Keyhole Dam, WY
32. Pactola Dam, SD
33. Shadehill Dam, SD
34. Tiber Dam, MT
35. Yellowtail Dam, MT

b. Reservoirs Without Flood Control Storage. There are two Corps of Engineers tributary lakes without allocated flood control storage included in this report. Both are subimpoundments of the Missouri River Main Stem Projects and were formed by the construction of relocations for transportation facilities and utilities. Lake Audubon, a subimpoundment of Lake Sakakawea, is located just northeast of Riverdale, North Dakota. The lake is a key feature of the Bureau of Reclamation's Garrison Diversion Unit Project. Lake Pocasse, subimpoundment of Lake Oahe, is located near Pollock, South Dakota. The Bureau of Reclamation planned to use the lake as a regulating reservoir for the proposed Pollock-Herried Irrigation Unit. The development of this unit, however, has not materialized. Both lakes are used for fish and wildlife and recreational purposes. Their locations are shown on Enclosure 1 and pertinent data are presented in Enclosure 2.

III. WATER SUPPLY.

a. August 1985. Most of the Missouri River Basin recieved average to below average precipitation during the month of August. Precipitation reports ranged from a low of 6% (0.04 inch) of average at Diversion Dam, Wyoming to a high of 231% (2.59 inches) of average at Recluse, Wyoming. Precipitation in the South Platte Basin in Colorado was generally average to much below average. Most of Wyoming had below to well below average August precipitation. Western and central Montana reported average to well above average precipitation in contrast to the remainder of the State where precipitation was below to well below average. Runoff, as indicated by the USGS index stations ranged from 162% of average for the North Platte River near Sinclair to 41% of average on the Marias River near Shelby, Montana.

b. September 1985. Soil moisture increased throughout the basin as precipitation averaged well above normal across the basin with the exception of North Dakota where precipitation averaged 85% of normal. A large cold mass of air moved through the basin on the 28th and 29th establishing record lows in much of the region. Snow fell from Montana to Colorado, being especially heavy along the eastern slopes of the Rocky Mountains. Up to 18 inches were reported along the Front Range in Wyoming and Colorado. Denver received 7 inches which caused a delay of the Denver Broncos football game while the gridiron was plowed. The 3.8 inches of snowfall reported at Grand Island, Nebraska was the earliest measureable snowfall on record for the area. The previous record was 0.1 inch which occurred on October 8, 1970.

c. October 1985. Precipitation in the Omaha District of the Missouri River basin for the month of October was highly variable with the central part of the basin receiving below to well below average precipitation. Precipitation reports ranged from 523% (1.62 inches) of average at Augusta, Montana to a trace at Riverton, Wyoming. Precipitation in Montana was well above average in the northwest and northeastern parts of the state. Central and southern Montana received average to well below average precipitation during October. The Yellowstone Park area and southeastern Wyoming had above average precipitation. The North Platte and Cache La Poudre River basins in Colorado received above average precipitation while the remainder of the Missouri Basin in Colorado had below average precipitation in October.

Streamflow in the Misouri River basin, as indicated by the USGS survey index stations, was as variable as the precipitation. The Marias River near Shelby, Montana had 406% of average October runoff. The Yellowstone River at Corwin Springs and Billings, Montana had 92% of average streamflow. The Tongue River near Dayton, Wyoming had 84% of average October flow. Runoff for the North Platte River near Sinclair, Wyoming was reported at 165% of average.

d. November 1985. November ended up being the coldest ever in the interior of the Northwest and across the northern Plains as temperatures departures ranged from -122F to -36F. Glasgow, Montana dropped its November average to 9.7 degrees, down from the old record of 14.4 in 1955. Lincoln, Nebrasks had a record November average of 29.0 degreees, down from 1898's 32.0. Precipitation in the Omaha District for the month of November was above average to much above average except for a small area in the southwestern mountains of Montana where precipitation was below average. Precipitation reports ranged from 960% (2.40 inches) of average at Powell, Wyoming to 53% (0.28 inch) at Townsend, Montana. Sioux Falls, South Dakota received 21.9 inches of snow, breaking the previous November record of 19.0 inches set in 1983. Monthly streamflow in the basin as indicated by the USGS index stations were near to above average as was the precipitation. The runoff on the Marias River near Shelby, Montana was 226% of average. The Yellowstone River at Corwin Springs and Billings, Montana had 88% of average November flow. Runoff for the North Platte River near Sinclair, Wyoming was reported at 151% of average.

e. December 1985. A blizzard hit the midlands at the onset of December stranding many travelers following the Thanksgiving holiday. In the Dakotas and in Montana, the snowcover on the plains was in the 10 to 12 inch range with the exception of central South Dakota where the snow depth on the ground was as high as 24 inches. Plate 3-1 is a National Weather Service snow cover map for December 2, According to a report in the Omaha World Herald on December 2. Valentine, Nebraska had recorded 54 inches of snow since September.

f. January 1986. In sharp contrast to the record lows of December, in January temperatures soared across the basin causing a thaw. On the 12th, Billings, Montana reported a maximum and minimum temperature of 60F and 40F, respectively. The January thaw reached a peak during the week covering midmonth. From the 12th to 18th, temperatures soared above seasonal norms with temperatures reading 26F degrees above normal in Montana and 21F above in Nebraska. The Omaha District received below to well below average precipitation during January, except for parts of western North Dakota, western South Dakota, and extreme southeastern Montana where precipitation was well above average. Precipitation reports ranged from 350% (1.19 inches) at Bowman, North Dakota to a trace in Pavillion, Wyoming. The high elevation snowpack in the South Platte River basin ranged from slightly below average to above average. The snowpack in the North Platte River basin was above average. Overall, the Yellowstone River basin had a slightly below average snowpack. In general, the high elevation snowpack was below average for the Missouri River basin in Montana.

g. **February 1986.** Except for a few isolated locations, precipitation for the month of February was well above average in the Omaha District. Precipitation reports ranged from 1,517% (4.40 inches) at Sunshine, Wyoming, to 17% at Lemmon, South Dakota. The high elevation snowpack in the South Platte basin ranged from 120% to 160% of average. The overall snowpack in the North Platte basin was about 140% of average. The Wind River basin had about 170% of average snowpack, whereas the remainder of the Bighorn River basin had about 140% of average snowpack. The remainder of the Yellowstone basin had between 100% and 115% of average snow. The Missouri basin above Fort Peck, Montana, had about 95% of average high elevation snowpack. The Milk and St. Mary River basins had below average snowpack at the end of the month. A snowcover map for February 24 is shown on Plate 3-2. A snow water equivalent map for the State of North Dakota is shown on Plate 3-3. Unseasonably warm temperatures during the last days of February caused rapid snowmelt throughout the basin. Reports of localized flooding and ice jamming were commonplace. The most significant flooding occurred in the Helena Valley area of Montana.

h. **March 1986.** The warmer temperatures introduced last month continued across the basin as the monthly departures varied from +8F to +12F degrees. These warm temperatures triggered flood warnings in Montana, Wyoming, and North and South Dakota. Serious flooding was experienced along the Milk River below Malta, Montana as river stages broke records set in 1952. Toward the end of the month flooding was also occurring in southwest Iowa and Southeast South Dakota due to rain falling on the ripe snowcover or rain falling on the saturated soils where snow had previously melted. The high elevations snowpack in the South Platte basin ranged from 115% to 160% of average. The overall mountain snowpack in the North Platte Basin was about 150% of average. The Wind River basin had about 170% of average snowpack, whereas the remainder of the Bighorn had about 140% of average snowpack. The remainder of the Yellowstone River basin had between 100% and 115% of average snow. The Missouri River basin above Fort Peck, Montana, had about 95% of average high elevation snowpack. The Milk and St. Mary Basins had below average mountain snowpack. Streamflow, as indicated by the USGS indexing stations, was well above average for the Marias River near Shelby, Montana, the North Platte River near Sinclair, Wyoming, and the Yellowstone River at Corwin Springs, Montana. The Yellowstone River at Billings, Montana, recorded slightly above average streamflow.

i. **April 1986.** On April 13th and 14th, a major spring storm quickly intensified over the Northern Plains and brought blizzard conditions to a large portion of the area. North Dakota received most of the heavy snow while strong winds were the prominent event in Nebraska. However, the most devastating combination of wind and snow was felt in South Dakota where 30 to 45 mph winds, with up to 90 mph gusts, whipped the snow into drifts as high as 15 feet. Livestock losses were high throughout the 3-state area, accounting for a large portion of the millions of dollars in damage caused by the storm. The storm was termed the worst blizzard ever in many areas. GOES 6 satellite visible images in Figure 3-4 show the storm's spiralling cloud mass as it quickly intensified during the two-day period. Except for a few areas of above average precipitation, the month of April was generally below average in the Omaha District. Precipitation reports ranged from 442% (3.40 inches)

at Kemmerer, Wyoming, to 18% (0.19 inch) at Sunburst, Montana. Aberdeen, South Dakota set a new record for April precipitation (7.88 inches), surpassing the old record by over 2 inches (5.13 inches). This was also the second wettest month on record for Aberdeen along the James River in South Dakota. In Omaha, Nebraska, the April rainfall total of 6.97 inches was the second wettest of record, exceeded only by April 1984 (7.12 inches). The high elevation snowpack in the South Platte Basin ranged from 120% to 160% of average. The overall snowpack in the North Platte Basin was about 150% of average. The Wind River Basin had about 150% of average snowpack, whereas the remainder of the Bighorn basin had about 110% of average snowpack. The remainder of the Yellowstone Basin had above average snow. The Missouri River basin above Fort Peck, Montana, had slightly below average high elevation snowpack. The Milk and St. Mary Basins had below average snowpack at the end of the month.

j. **May 1986.** Except for northern Montana where May precipitation was well above average, most of the Omaha District received below average precipitation for the month of May. Precipitation reports ranged form 289% of average (5.70 inches) at Malta, Montana, to 2% of average (0.04 inches) at Elk Mountain, Wyoming. The high elevation snowpack as of June 1 ranged from much above average in the southern and central part of the Missouri River basin to well below average in the northern part of the Basin. Overall, the snowpack in the Platte and Wind Basins was above to much above average for this time of the year. The remainder of Missouri River basin had average June 1 high elevation snowpack.

k. **June 1986.** June precipitation was highly variable over the Omaha District ranging from 322 percent of average at Casper, Wyoming to 16 percent at Lander, Wyoming. In Montana, precipitation was average or above in south central, southwest, and for the Marias and Milk Basins. A classic snowmelt flood exceeding the former peak of record (May 24, 1956) occurred in the Madison River near West Yellowstone, Montana on June 2. The discharge of 2,240 cfs was rated as a 100 year flood event. The remainder of Montana received less than average precipitation. Southeastern Wyoming was much above average for June precipitation, and the rest of the state was average to below average. Northeastern Colorado experienced above average precipitation for June. Flood warnings were posted for northeastern Nebraska and west-central Iowa on June 14-15. Numerous reports were received from the Decatur, Nebraska area of up to 5 inches of rain. Two to three inches fell on the Elkhorn River below Norfolk, Nebraska. Heavy rains fell in the Sioux Falls, South Dakota region the weekend of the 21st. Weekend totals of over 7 inches of rain were reported just north of Sioux Falls with area rain generally in the 4 to 6 inch range. Flood warnings were posted for the area as this rain fell on soil already saturated.

l. **July 1986.** Streamflows remained above normal throughout most of North Dakota, Nebraska, eastern South Dakota, and southern Wyoming. Rain continued to plague the basin with isolated rainstorms occuring on a regular basis across Montana, North Dakota, western Iowa, and eastern Nebraska. Urban flooding was reported in Williston, North Dakota on the 17th due to 3.22 inches which was a record 24 hour rainfall for that date.

m. Plate 3-5 gives the percent of normal runoff at pertinent locations in the Omaha District.

n. Seasonal runoff in the Platte River Basin was 215% of average at the Wyoming-Nebraska state line gaging station on North Platte River (plate 3-6) and 145% of average on the South Platte River at Kersey, Colorado (plate 3-7). Approximately 894,653 acre-feet of Platte River water passed Brady, Nebraska during the April through September period (plate 3- 8). Plate 3-9 is a tabulation of pertinent peak discharges at selected gaging stations which includes many of the control points used by the Omaha District.

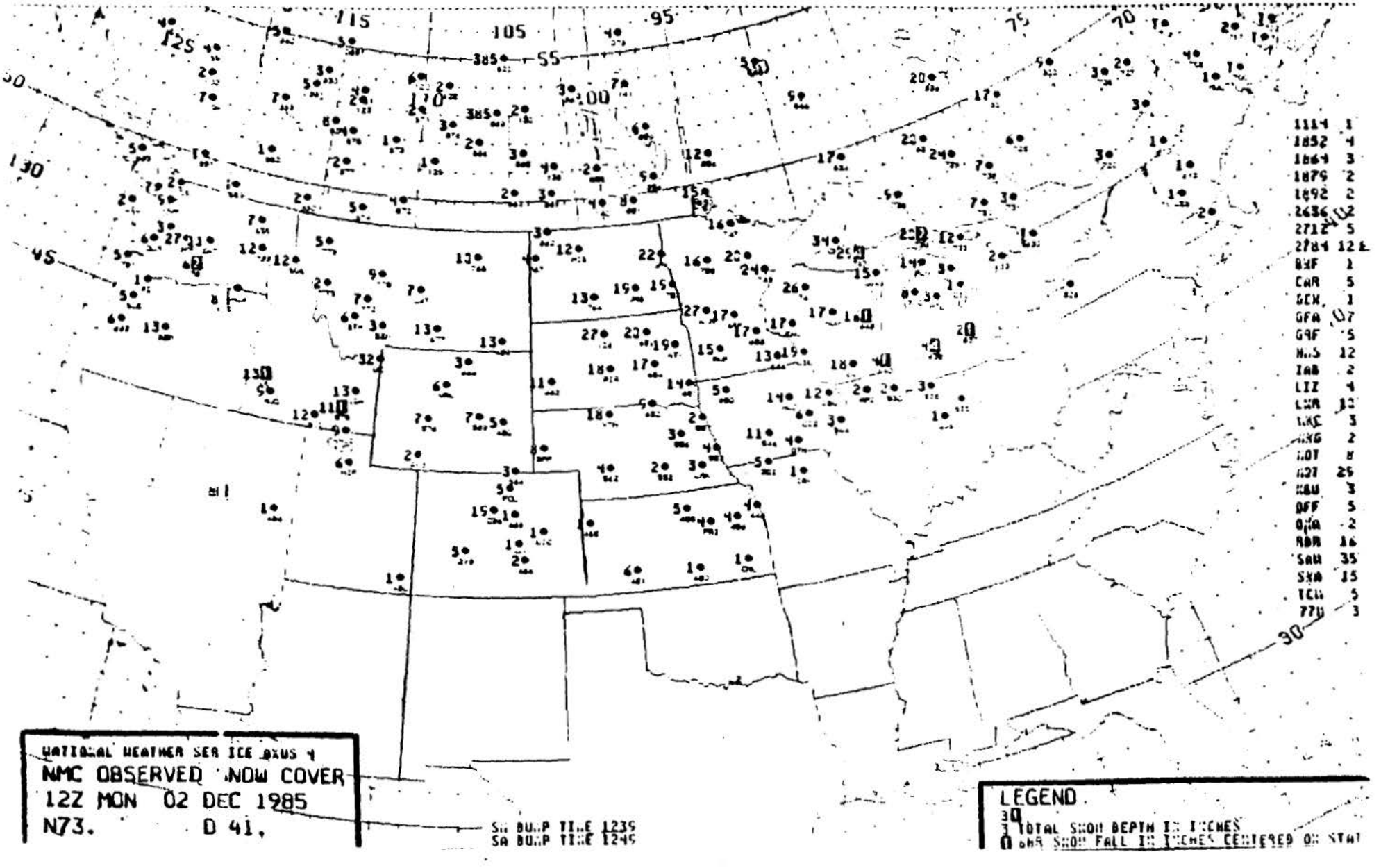
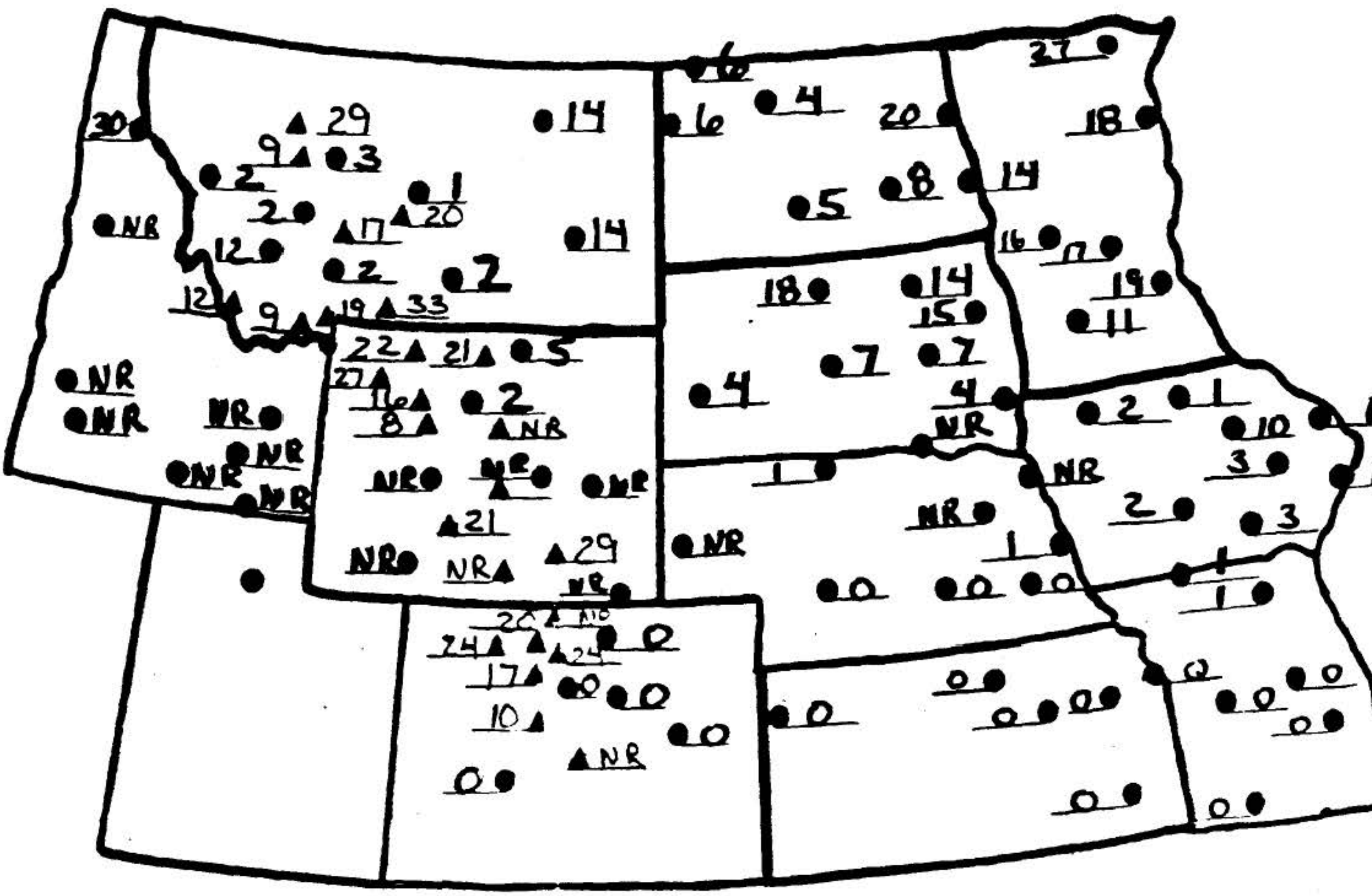

NATIONAL WEATHER SER ICE BRUS 4
NMC OBSERVED SNOW COVER
12Z MON 02 DEC 1985
N73. D 41.
LEGEND
3 TOTAL SNOW DEPTH IN INCHES
0 6HR SNOW FALL IN INCHES CENTERED ON STAT

PLATE 3.1

OMAHA DISTRICT

SNOW-COVER MAP

FEB. 24, 1986



LEGEND :

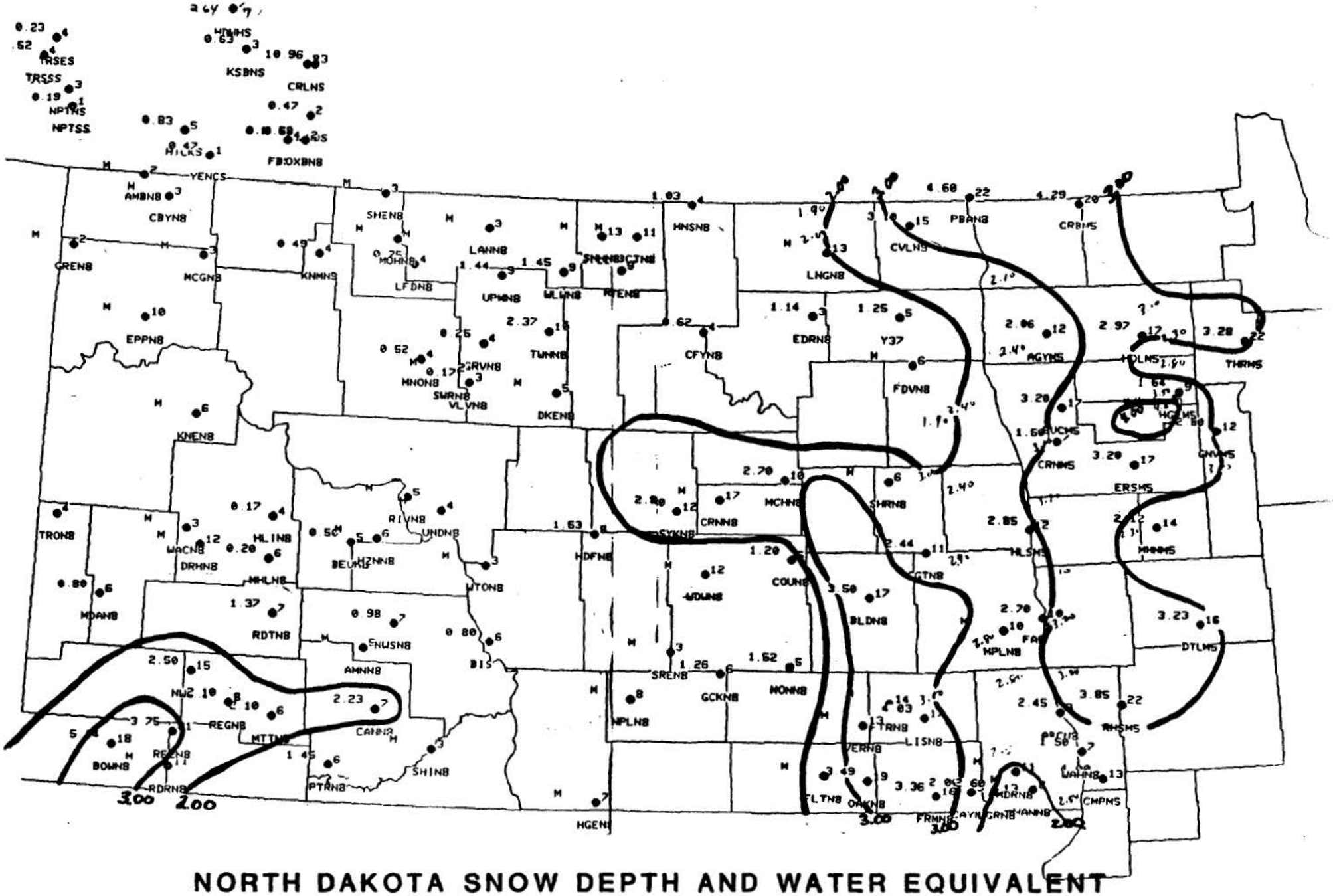
● NONMOUNTAIN STATION

SNOW DEPTH - INCHES

▲ MOUNTAIN STATION

WATER EQUIVALENT - INCHES

PLATE 3.2



NORTH DAKOTA SNOW DEPTH AND WATER EQUIVALENT

AS OF FEBRUARY 18,1986

PLATE 3.3

BLIZZARD in the NORTHERN PLAINS on April 13-14, 1986

GOES 6 satellite, visible images show the storm's spiralling cloud mass as it quickly intensified during the two day period.
--Photo from NESDIS

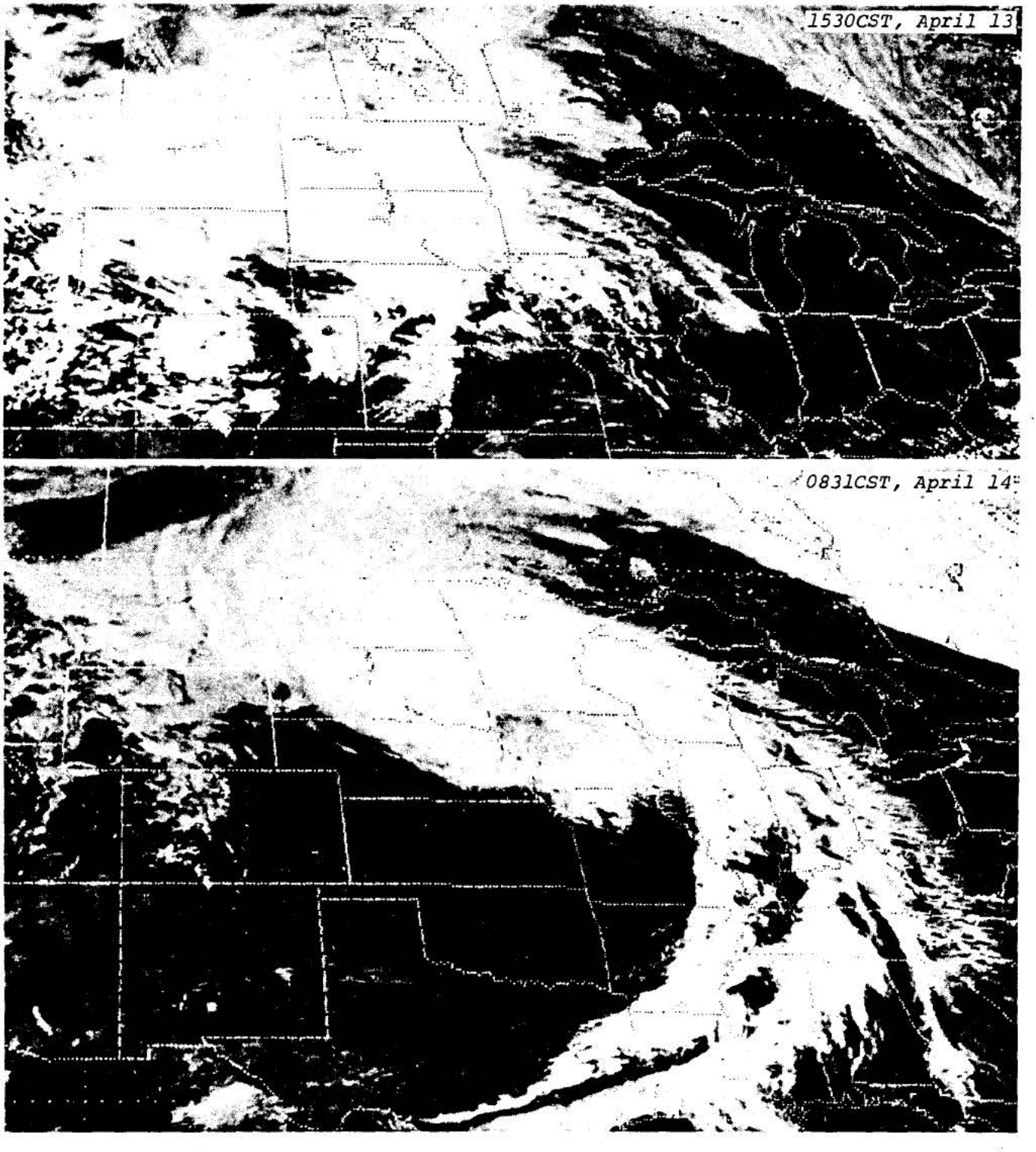
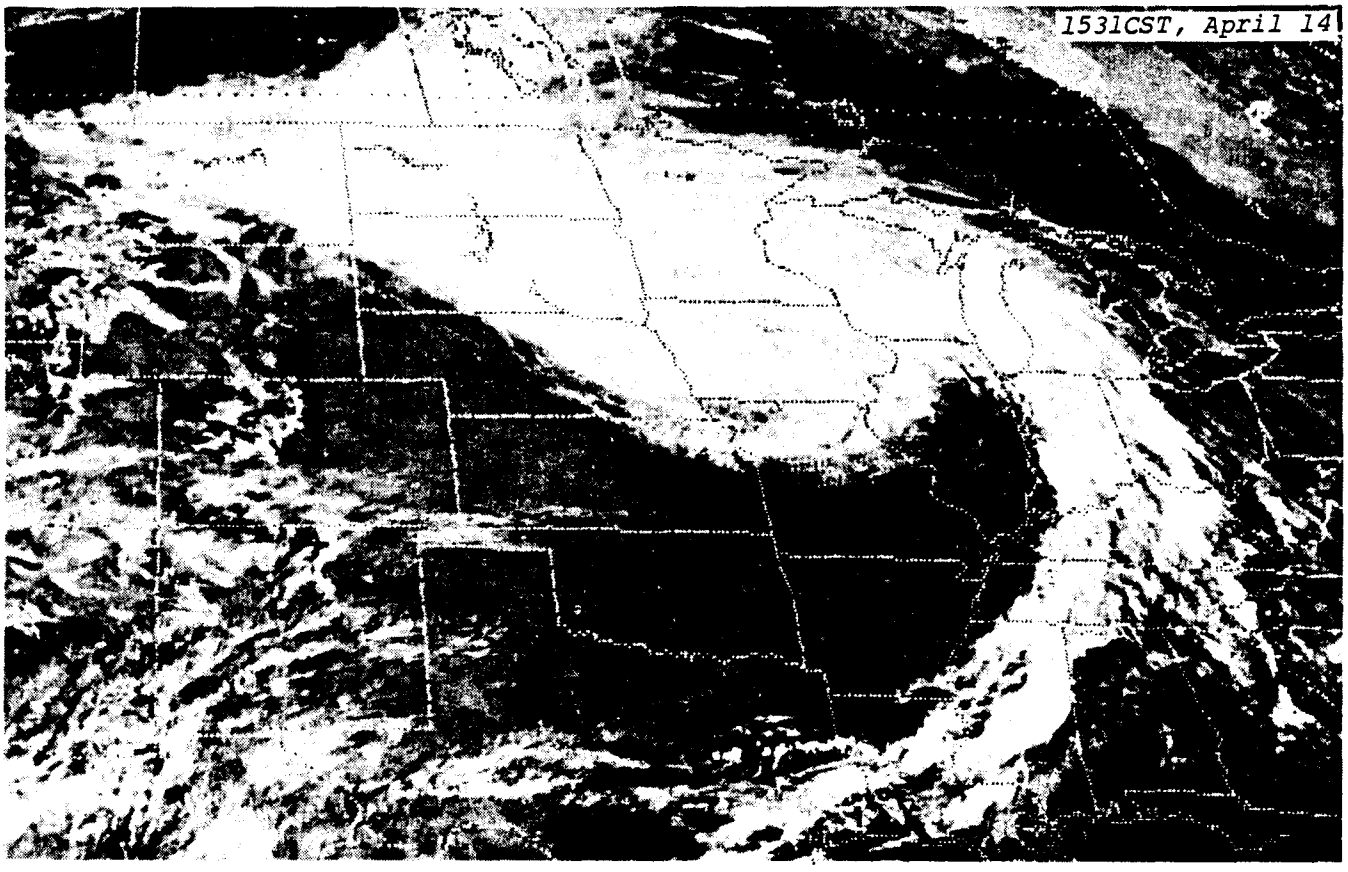
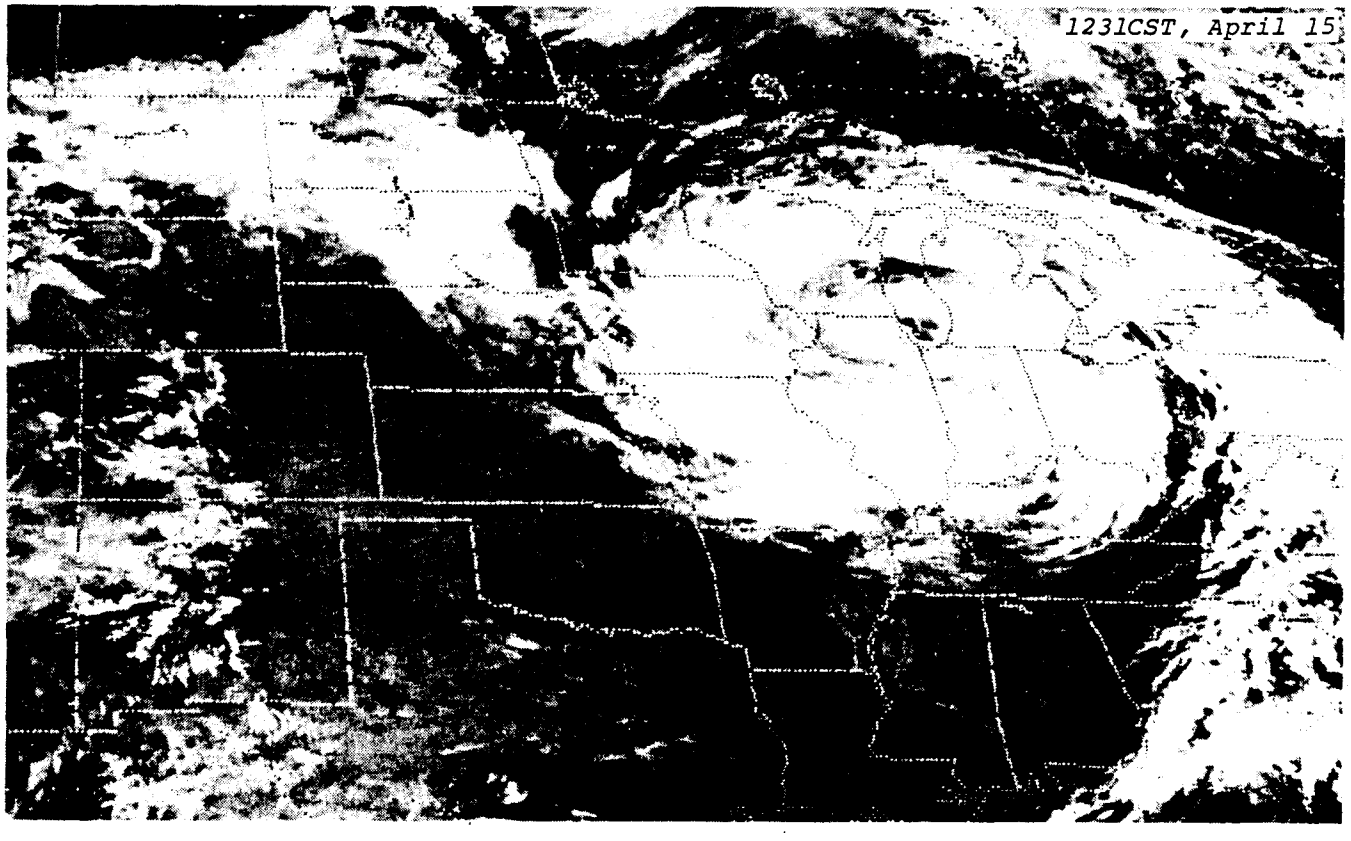
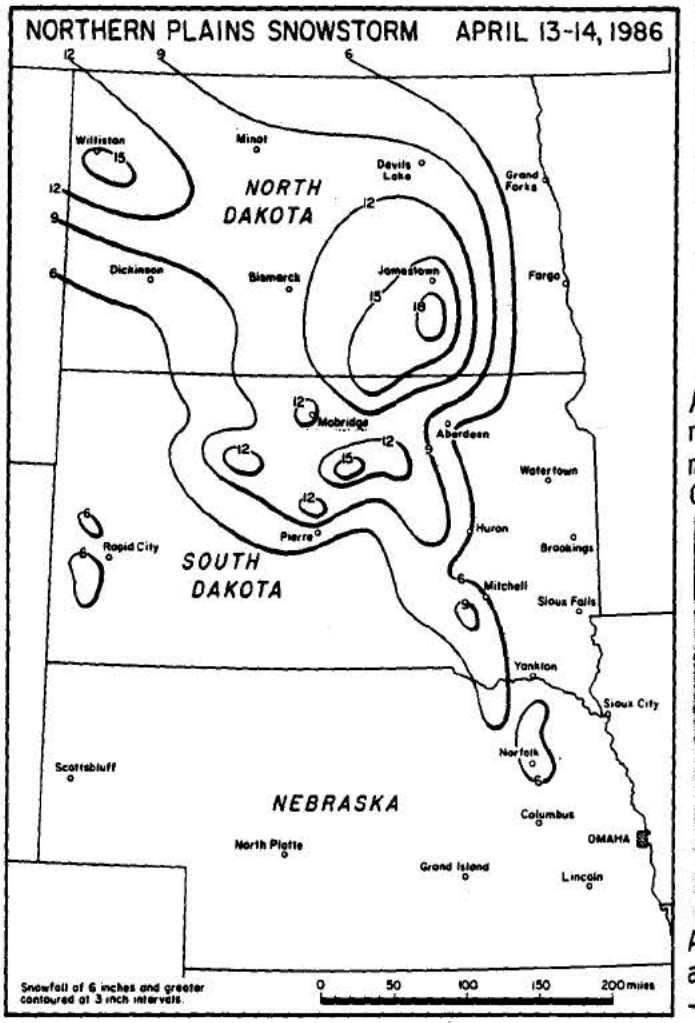


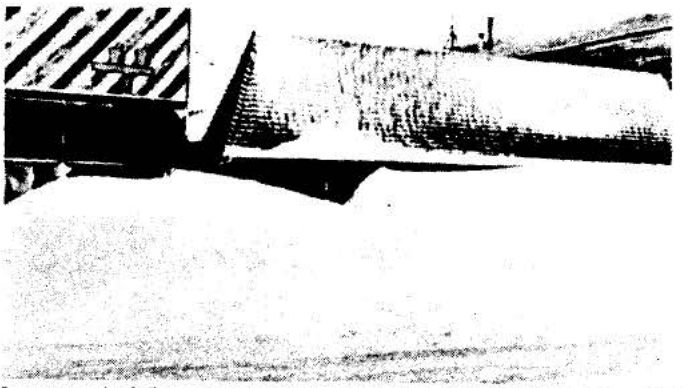
PLATE 3.4

BLIZZARD in the NORTHERN PLAINS ---- continued







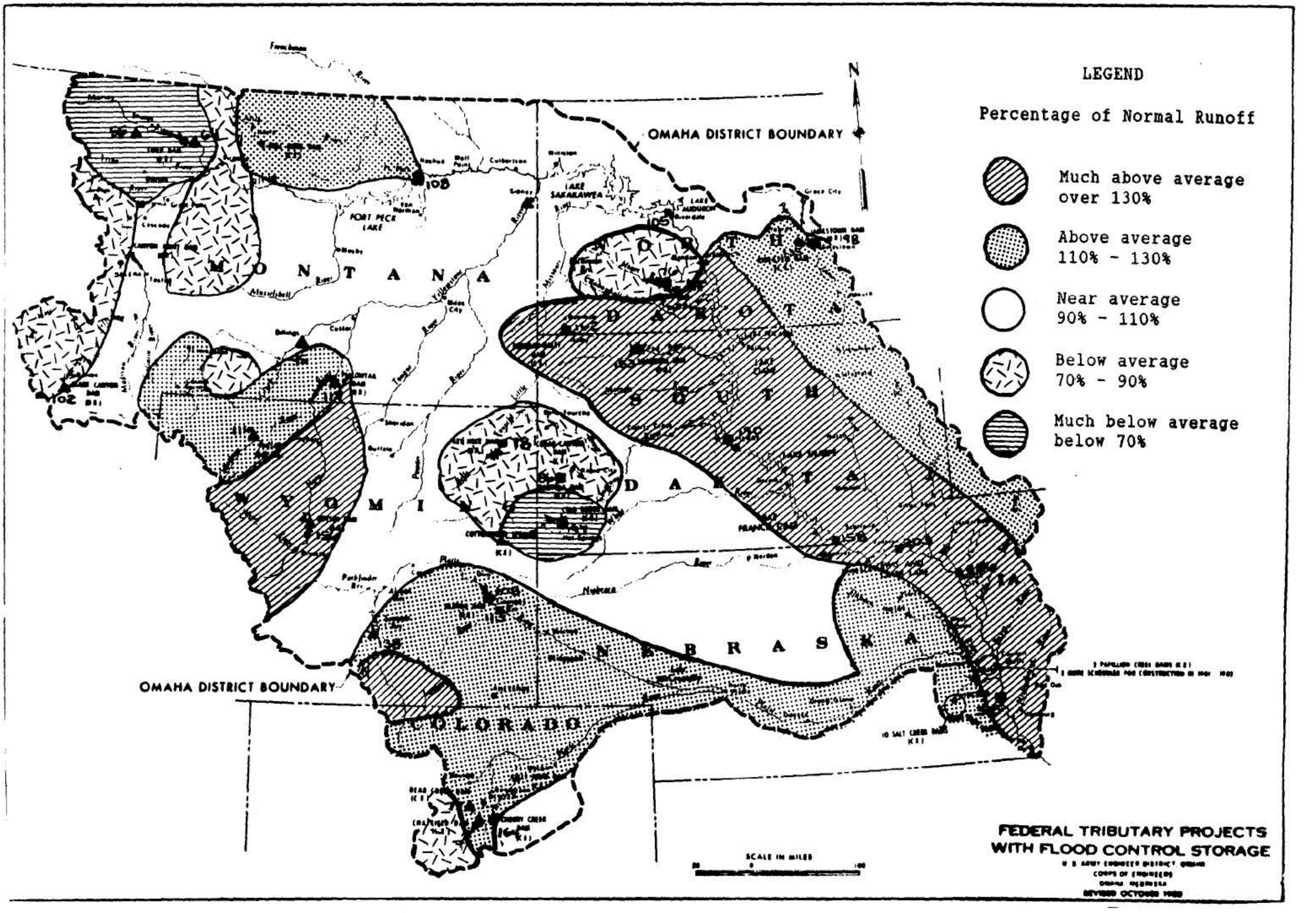


A snowdrift obscures store entrances on the morning of the 15th in Bowdle, SD, about 55 miles west of Aberdeen. ---Photo by Larry Gauer, The Bowdle Pioneer.

A wind-toppled boat house in Faulkton, SD, about 45 miles southwest of Aberdeen. ---Photo from the Faulkton County Record.

Another view of the drift that ran the length of the north side of Bowdle's Main Street. ---Photo by Larry Gauer, The Bowdle Pioneer.

---Map from data supplied by NWSFOs at Bismarck, ND; Sioux Falls, SD; and Omaha, NE. All photos supplied by the NWSFO at Sioux Falls.


OMAHA DISTRICT BOUNDARY
OMAHA DISTRICT BOUNDARY
LEGEND
Percentage of Normal Runoff
Much above average over 130%
Above average 110% - 130%
Near average 90% - 110%
Below average 70% - 90%
Much below average below 70%
MONTANA
WYOMING
COLORADO
NEBRASKA
SOUTH DAKOTA
NORTH DAKOTA
LAKE SAKAKAWEA
FORT PECK LAKE
SCALE IN MILES
FEDERAL TRIBUTARY PROJECTS
WITH FLOOD CONTROL STORAGE

APRIL - SEPTEMBER STREAMFLOW
North Platte River at Wy. - Ne. State Line

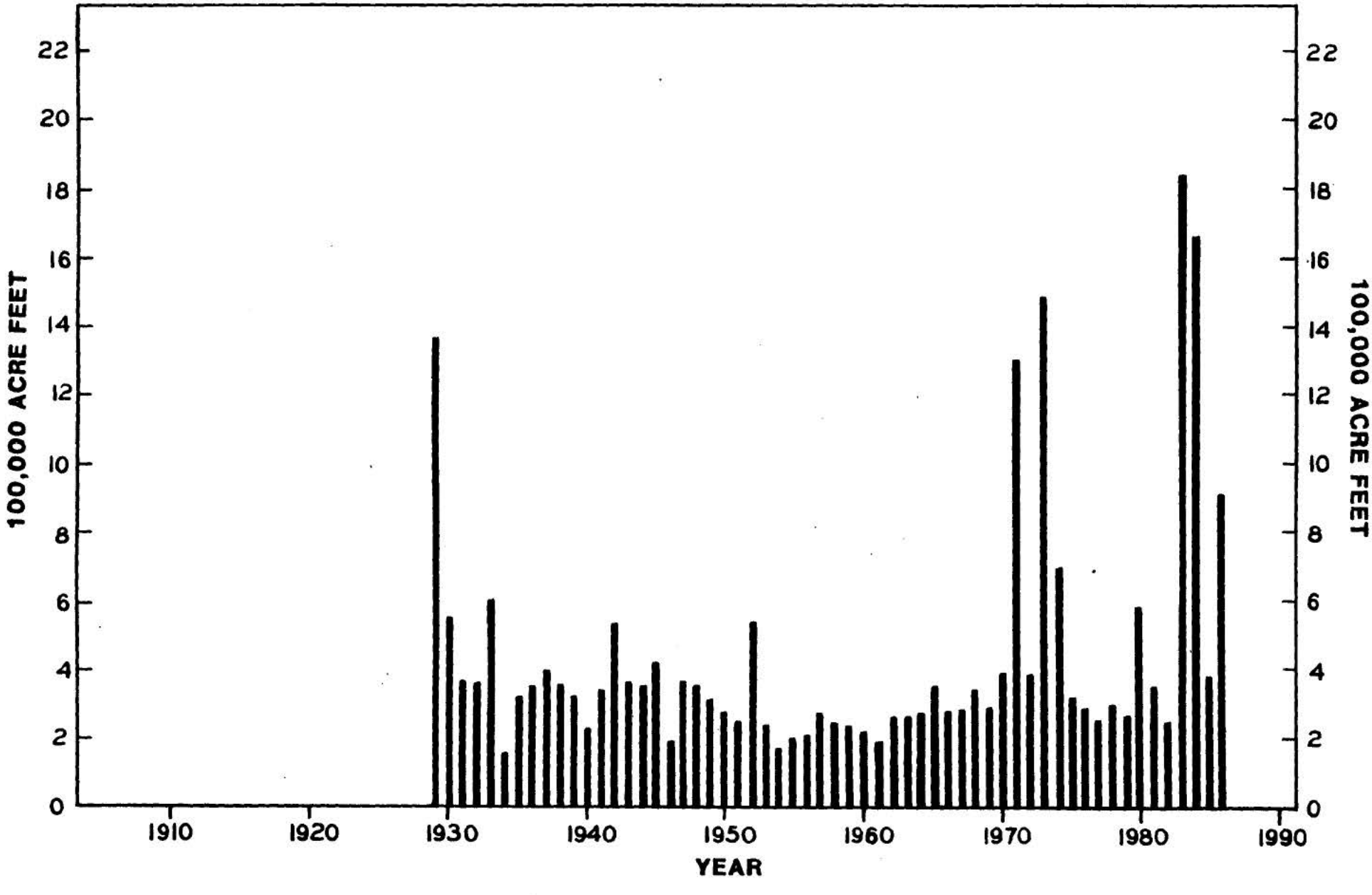


PLATE 3.6

APRIL - JULY STREAMFLOW
South Platte River at Kersey, Co.

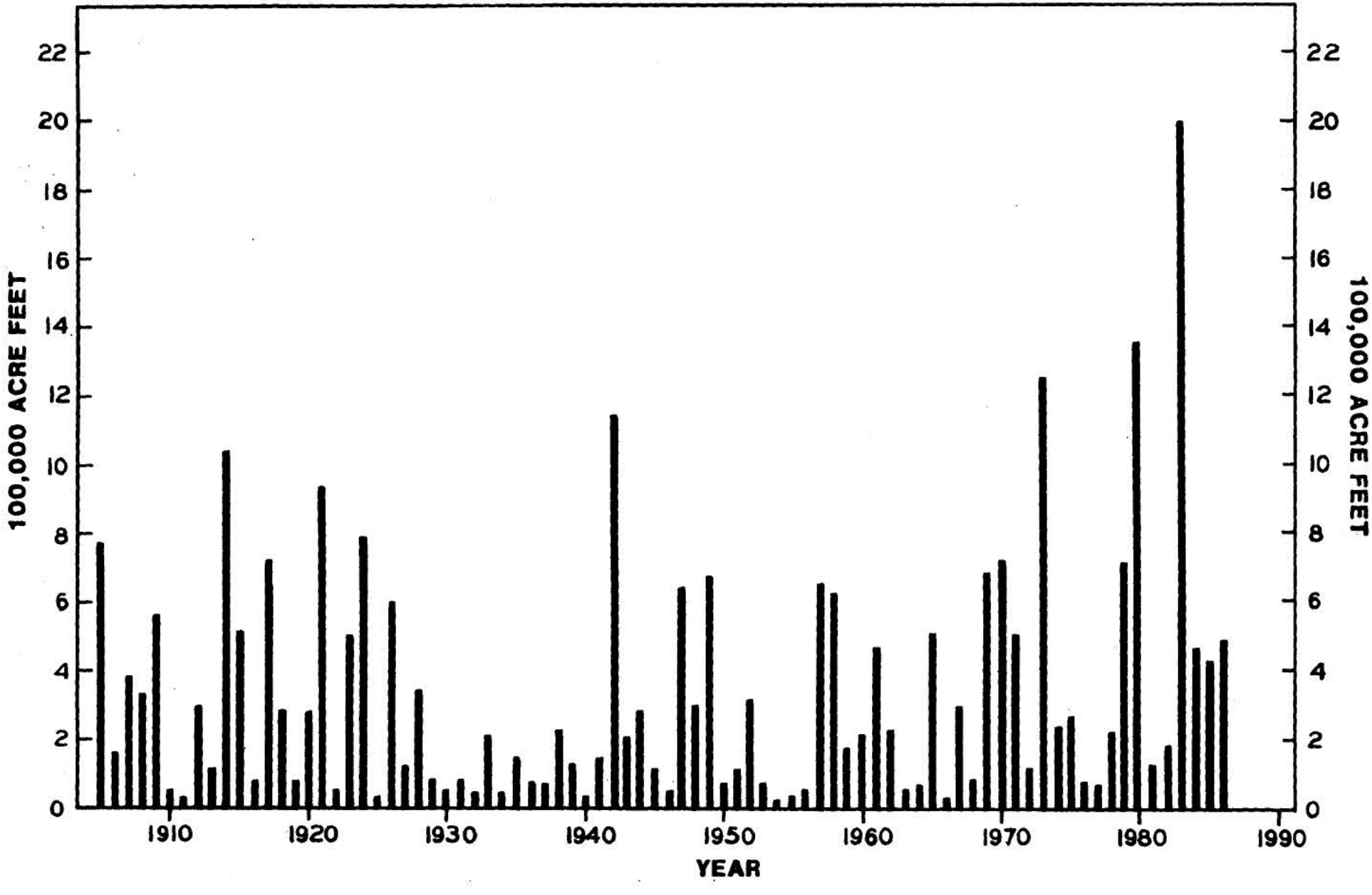


PLATE 3.7

APRIL - SEPTEMBER STREAMFLOW
Platte River at Brady, Ne.

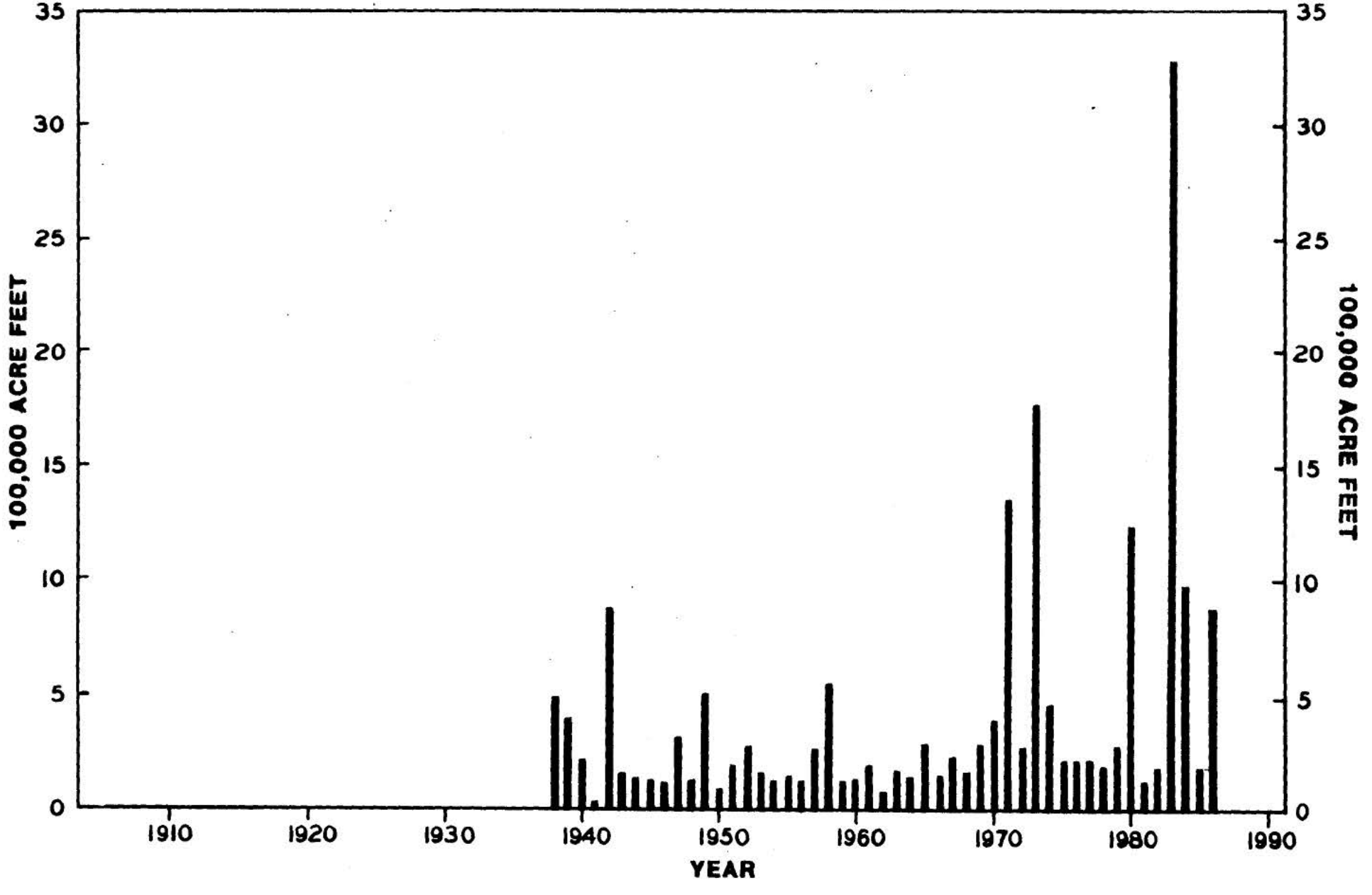


PLATE 3.8

PERTINENT 1986 WY PROVISIONAL PEAK DISCHARGES (C.F.S.)

STREAM	STATION	DRAINAGE AREA (SQ. MILES)	PERIOD OF RECORD (YEARS)	FLOOD STAGE (FEET)	MAXIMUM 1986 DATE	MAXIMUM 1986 STAGE (FEET)	MAXIMUM 1986 DISCHARGE (CFS)	MAXIMUM KNOWN FLOOD DATE	MAXIMUM KNOWN FLOOD STAGE (FEET)	MAXIMUM KNOWN FLOOD DISCHARGE (CFS)	
Red Rock River	Blw. Lima Res., MT	570	68	1.1	June 3	3.82	756	May 15,1933	6.40	2,500	
Beaverhead River	At Barretts, MT.	2,737	79	4.0	June 2	2.70	1,210	June 20,1908	6.10	3,720	
Missouri River	At Toston, MT.	14,669	51	10.0	June 2	10.00	22,400	June 6,1948	11.77	32,000	
Missouri River	Nr. Ulm, MT.	20,941	35	13.0	June 11	9.74	15,300	June 1953	17.00	35,000	
Marias River	Nr. Shelby, MT.	3,242	78	13.0	Feb. 25	12.60	26,000	June 9,1964	23.64	241,000	(A)
Marias River	Nr. Chester, MT.	4,927	33	6.3	Nov. 9, '85	5.28	2,140	March 20,1947	N/A		(B)
Milk River	Nr. Saco, Mt.	17,670	9	20.0	Sept.30,'85	24.26	10,900	April 3,1978	24.20	12,400	(C,D)
Missouri River	Nr. Wolf Point, MT.	82,290	58	11.0	Feb. 27	9.34	31,200	March 25,1939	14.40	66,800	
Wind River	Riverton, WY.	2,309	81	8.0	June 7	19.56	7,320	June 15,1935	10.15	13,300	
Little Wind River	Nr. Riverton, WY.	1,904	45	10.0	June 6	7.99	6,560	June 17,1963	10.85	14,700	
Wind River	Blw. Boysen Res., WY.	7,701	35	N/A	June 17	10.21	7,520	July 7,1967	13.35	13,500	
Big Horn River	At Kane, WY.	15,765	58	9.0	June 9	7.08	12,800	June 16,1935	11.10	25,200	
Big Horn River	Nr. St. Xavier, MT.	19,667	52	7.2	June 18	62.84	7,350	June 16,1935	N/A	37,400	
Yellowstone River	At Miles City, MT.	48,253	59	13.0	June 9	11.02	53,400	May 22,1978	16.50	102,000	
N. Fork Grand River	At Haley, N.D.	509	51	17.0	March 7	11.12	1,000	April 7,1952	17.03	14,100	(I)
Missouri River	At Bismarck, N.D.	186,400	58	16.0	March 9	9.74	35,000	April 6,1952	27.90	500,000	
Fall River	At Hot Springs, S.D.	137	49	13.0	July 9	3.42	331	Sept. 4,1938	18.40	13,100	(E)
Rapid Creek	At Rapid City, S.D.	410	47	6.0	Aug 12	6.52	950	June 9,1972	19.66	50,000	
Belle Fourche River	At. Wy.-S.D. State Line	3,280	40	14.0	May 9	9.18	1,290	June 18,1962	15.59	4,400	(F)
Missouri River	At Sioux City, S.D.	314,600	89	36.0	May 19	23.86	56,200	April 14,1952	24.28	441,000	(G,H)
Pipestem Creek	Nr. Pingree, N.D.	700	13	10.0	March 15	8.05	350	April 20,1979	11.60	2,520	(I)
James River	Nr. Grace City, N.D.	1,060	8	12.0	March 15	10.33	800	April 13,1969	12.00	3,100	(I)
James River	At Jamestown, N.D.	2,820	51	14.0	April 29	5.60	314	May 13,1950	15.82	6,390	(E)

PERTINENT 1986 WY PROVISIONAL PEAK DISCHARGES (C.F.S.)

STREAM	STATION	DRAINAGE AREA (SQ. MILES)	PERIOD OF RECORD (YEARS)	FLOOD STAGE (FEET)	MAXIMUM 1986 DATE	MAXIMUM 1986 STAGE (FEET)	MAXIMUM 1986 DISCHARGE (CFS)	MAXIMUM KNOWN FLOOD DATE	MAXIMUM KNOWN FLOOD STAGE (FEET)	MAXIMUM KNOWN FLOOD DISCHARGE (CFS)	
James River	At LaMoure, N.D.	4,390	36	14.0	April 22	8.44	669	April 14,1969	16.17	6,800	
James River	At Columbia, S.D.	7,050	41	11.0	May 19	14.95	950	May 24,25,1950	16.89	5,420	(J) (K)
James River	At Ashton, S.D.	11,000	41	13.0	May 11	16.73	1,970	April 24,1969	20.63	5,680	(L)
James River	Nr. Scotland, S.D.	21,550	58	13.0	April 19	18.44	12,700	June 23,1984	20.45	29,400	
Vermillion River	Nr. Vermillion, S.D.	1,680	41	21.0	April 23	17.91	2,900	June 23,1984	31.77	21,400	
Big Sioux River	At Akron, IA.	9,030	58	16.0	March 21	21.20	22,600	April 9,1969	22.99	80,800	
Little Sioux River	Nr. Turin, IA.	3,526	28	25.0	March 18	21.01	25,700	June 21,1983	26.54	31,200	
North Platte River	Nr. Sinclair, WY.	4,175	47	4.9	June 11	11.35	16,300	May 26,1984	10.82	15,160	
North Platte River	Blw. Whalen Diversion, WY	16,425	77	4.5	June 12	6.24	6,470	June 26,1955	9.85	22,000	
Laramie River	Nr. Ft. Laramie, WY.	4,564	71	6.5	June 18	6.59	3,460	May 10,1923	9.40	6,260	
North Platte River	At Wy.-Neb. State Line	22,218	57	5.0	June 13	6.33	6,670	June 2,1929	7.04	17,900	
North Platte River	At Bridgeport, NE.	25,300	79	8.0	June 10	10.28	6,950	June 26,1899	5.39	24,900	(E)
North Platte River	At Lewellen, NE.	28,600	46	7.0	June 17	7.18	6,450	June 4,1971	N/A	13,500	
North Platte River	At North Platte, NE.	30,900	91	7.0	Aug. 9	5.02	3,220	June 11,1909	N/A	29,600	
Bear Creek	At Morrison, CO.	164	71	6.5	July 19	5.50	317	July 24,1896	N/A	8,600	
South Platte River	At Waterton, CO.	2,621	60	N/A	July 30	3.47	2,160	April 23,1942	5.68	5,700	
South Platte River	At Denver, CO.	3,804	91	6.0	July 19	7.70	8,280	June 17,1965	18.66	40,300	
Clear Creek	At Derby, CO.	575	72	8.3	Oct. 4,'85	5.28	2,040	July 24,1965	8.97	5,070	
South Platte River	At Henderson, CO.	4,713	60	7.0	July 20	6.74	12,100	May 6,1973	11.67	33,000	(M)
South Platte River	Nr. Kersey, CO.	9,598	83	9.0	Oct. 5,'85	8.04	8,550	May 8,1973	11.73	31,500	
South Platte River	At Julesburg, CO.	23,138	84	8.0	Oct. 10,'85	5.84	3,200	June 20,1965	10.44	37,600	
South Platte River	At North Platte, NE.	24,300	69	12.0	June 16	6.58	1,345	June 3,1935	14.02	37,100	
Platte River	At Brady, NE.	56,200	48	5.0	June 17	5.90	7,500	June 29,1983	N/A	23,500	

PERTINENT 1986 WY PROVISIONAL PEAK DISCHARGES (C.F.S.)

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Platte River	Nr. Grand Island, NE.	58,800	3	4.0	June 20	3.61	6,490	June 6,1935	5.99	30,000	
Elkhorn River	At Waterloo, NE.	6,900	66	17.0	March 19	12.35	20,500	June 12,1944	16.60	100,000	(E)
Salt Creek	At Lincoln, NE.	684	37	20.5	April 28	13.56	7,050	June 2,1951	26.15	28,200	
Salt Creek	At Greenwood, NE.	1,051	35	20.0	April 28	14.55	13,300	June 24,1963	23.46	41,000	
Platte River	At Louisville, NE.	85,800	33	9.0	March 20	8.14	42,200	March 30,1960	12.45	124,000	
Missouri River	At Omaha, NE.	322,800	58	29.0	April 29	23.73	77,300	April 18,1952	40.20	396,000	
Missouri River	At Nebraska City, NE.	410,000	57	18.0	March 19	18.62	99,800	April 19,1952		414,000	(N)
Missouri River	At Rulo, NE.	414,900	37	17.0	July 7	20.00	113,000	April 22,1952	25.60	358,000	(O)

(A) Largely due to failure of Swift Dam
(B) Maximum discharge not determined
(C) Maximum gage height = 24.30 feet on March 21,1979 due to backwater from ice
(D) 1986 Maximum gage height = 26.7 feet due to ice effect
(E) Site and datum then in use
(F) 1986 Maximum gage height = 12.03 feet on Feb. 26 due to ice jam
(G) Datum then in use
(H) 1986 Maximum gage height = 23.91 feet, discharge 55,800 cfs on May 17
(I) Backwater from ice, or ice effected
(J) 1986 Maximum gage height = 16.65 feet on May 1 due to backwater effect
(K) Maximum gage height = 17.09 feet on April 22,1969
(L) Maximum gage height = 21.17 feet on April 13,1969 (backwater from Snake Creek)
(M) Maximum gage height = 12.93 feet on June 17,1965
(N) Maximum gage height = 27.66 feet on April 18,1952
(O) 1986 Maximum gage height = 20.37 on Jan. 12 due to ice jam

IV. RESERVOIR ACCOMPLISHMENTS.

a. Corps of Engineers Dams. Flood damages prevented by the Corps dams in 1986 and accumulative totals are estimated as follows:

FLOOD DAMAGES PREVENTED IN DOLLARS BY CORPS DAMS

Dam	1986	Accumulative Total
Bull Hook (Havre Project)	0	20,664,000
Spring Creek (Lake Pocasse)	0	33,000
Bowman-Haley	0	1,838,000
Cottonwood Springs	0	0
Cold Brook	0	0
Cedar Canyon (Red Dale Gulch)	0	250,000
Pipestem	0	12,601,000
Papillion Creek Project	0	0
Chatfield	0	1,945,000
Bear Creek	0	450,000
Cherry Creek	0	163,267,000
Kelly Road (Aurora)	0	417,000
Salt Creek Project	693,000	26,828,000
TOTAL	693,000	228,293,000

Lake Audubon, Lake Pocasse, and all of the above projects, except the normally dry reservoirs of Bull Hook, Cedar Canyon and Kelly Road, are used for recreation. Visitation days at the projects for CY 1985 and for 1986 to October 1, along with available accumulative totals, are tabulated below.

RECREATION VISITATION IN DAYS

Project	1985	1986(*)	Accumulative To Oct 1 86	Initial Year
Bowman-Haley	35,222	32,331	892,953	1967
Cottowood Springs	11,090	15,158	189,448	1974
Cold Brook	48,648	57,506	1,219,012	1955
Pipestem	119,691	77,217	1,277,508	1974
Papillion Creek #11	817,500	796,250	4,549,550	1977
Papillion Creek #16	550,300	509,450	4,031,450	1977
Chatfield	1,207,618	1,083,576	10,514,294	1976
Cherry Creek	1,607,159	1,526,653	28,774,212	1959
Bear Creek	116,890	102,805	506,495	1982
Salt Creek #2	39,650	50,450	--	--
Salt Creek #4	265,200	298,850	--	--

RECREATION VISITATION IN DAYS (Cont'd)

Project	1985	1986(*)	Accumulative To Oct 1 86	Initial Year
Salt Creek #8	295,800	241,950	--	--
Salt Creek #9	251,050	264,800	--	--
Salt Creek #10	61,310	71,010	--	--
Salt Creek #12	205,440	190,850	--	--
Salt Creek #13	124,650	106,650	--	--
Salt Creek #14	912,333	860,400	--	--
Salt Creek #17	1,111,084	1,029,550	--	--
Salt Creek #18	1,155,600	1,155,150	--	--
Salt Creek Total	4,422,117	4,269,660	47,808,777	1964

*As of October 1, 1986.

b. Bureau of Reclamation Dams. Flood damages prevented (both local and to the Missouri River Main Stem) by the Bureau dams in 1986 and accumulative totals are estimated as follows:

Dam	1986 Local	1986 Main Stem	1986 Total	Accumulative Total
Clark Canyon	0	415,400	415,400	6,781,400
Canyon Ferry	922,000	3,652,000	4,574,000	69,684,000
Tiber	82,000	3,351,200	3,433,200	37,238,200
Boysen	225,000	2,449,700	2,674,700	27,967,700
Yellowtail	0	2,826,700	2,826,700	31,130,700
Heart Butte	136,000	155,100	291,100	11,824,100
Shadehill	107,000	465,300	572,300	7,742,300
Pactola	0	383,200	383,200	1,064,200
Keyhole	0	570,500	570,500	1,780,500
Jamestown	0	0	0	11,957,000
Glendo	0	0	0	19,382,000
TOTAL	1,472,000	14,269,100	15,741,100	226,552,100

All of the projects were used for irrigation, conservation and recreational purposes. Hydroelectric power is generated at Boysen, Canyon Ferry, Glendo and Yellowtail.

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Bowman-Haley	0	1,838,000
Cottonwood Springs	0	0
Cold Brook	0	0
Cedar Canyon (Red Dale Gulch)	0	250,000
Pipestem	0	12,601,000
Papillion Creek Project	0	0
Chatfield	0	1,945,000
Bear Creek	0	450,000
Cherry Creek	0	163,267,000
Kelly Road (Aurora)	0	417,000
Salt Creek Project	693,000	26,828,000
TOTAL	693,000	228,293,000

Lake Audubon, Lake Pocasse, and all of the above projects, except the normally dry reservoirs of Bull Hook, Cedar Canyon and Kelly Road, are used for recreation. Visitation days at the projects for CY 1985 and for 1986 to October 1, along with available accumulative totals, are tabulated below.

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RECREATION VISITATION IN DAYS (Cont'd)

Project	1985	1986(*)	Accumulative To Oct 1 86	Initial Year
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Boysen	225,000	2,449,700	2,674,700	27,967,700
Yellowtail	0	2,826,700	2,826,700	31,130,700
Heart Butte	136,000	155,100	291,100	11,824,100
Shadehill	107,000	465,300	572,300	7,742,300
Pactola	0	383,200	383,200	1,064,200
Keyhole	0	570,500	570,500	1,780,500
Jamestown	0	0	0	11,957,000
Glendo	9,070,500	0	9,070,500	28,452,500
TOTAL	10,542,500	14,269,100	24,811,600	235,622,600

All of the projects were used for irrigation, conservation and recreational purposes. Hydroelectric power is generated at Boysen, Canyon Ferry, Glendo and Yellowtail.

V. RESERVOIR OPERATION. Actual operations for the past year and proposed operations through calendar year 1987 are discussed briefly in the following subsections. Individual project operation summaries are contained in Enclosure 5.

a. Corps of Engineers Lakes - August 1, 1985 through July 31, 1986. All operating Corps' projects within the Omaha District were regulated in accordance with normal procedures during the period covered by this report. With the exception of the Bull Hook, Cedar Canyon, Cold Brook, Cottonwoood Springs and Papio damsites 18 and 20, all Corps' projects in the District stored water in the flood storage zone at some time during the reporting period.

1. Cold Brook Reservoir, South Dakota. During the period from October 7-12 the water right delivery to Larive Lake was curtailled to permit the installation of PVC pipe in the ditch on Corps' property. With the extention provided by the owner of Larive Lake, delivery losses have been virtually eliminated. The desired elevation of the small recreation lake was maintained with a delivery of 0.4 cfs through the resort season.

2. Bowman-Haley Reservoir, North Dakota. The deteriorating water quality and its adverse effects on recreation continued to be a concern at Bowman-Haley reservoir. A meeting was held in Omaha on January 23 between representatives of the local sponsor, water quality unit and the Reservoir Regulation Section to discuss the problem. The recommended plan to improve the water quality was to withdraw water from the reservoir during the winter stagnation period when the poorest quality water is concentrated in the lower zone of the lake and refill the lake to the top of the conservation pool with spring snowmelt runoff. During late October, at the local sponsors request, the low level outlet was opened and the pool was lowered one foot. Because the gated outlet at Bowman-Haley does not permit water to be drawn directly off the bottom of the lake, the local sponsor planned a pumping operation in February to release from that level while the ice cover was on the lake. Unfortunately, an early spring warmup deteriorated the ice conditions before the required pipe and pump could be installed. In lieu of the pumping operation, the low level gate was again opened on February 28 in an effort to evacuate undesirable water. The local sponsor has obtained the necessary pipe and is planning to implement the pumping program in February 1987. The volume of water to be withdrawn will be based on spring snowmelt inflow forecasts. Bowman-Haley Reservoir was drawndown in late July to provide for a dry inspection of the conduit.

3. Pipestem Reservoir, North Dakota. The excessive snowpack followed by above average precipitation in the lower portion of the James River basin once again made the scheduling of releases from Pipestem and Jamestown Reservoir a target for complaint by some downstream landowners. Snow accumulations were the greatest downstream of Jamestown North Dakota. On March 4, LaMoure, N.D. reported 15 inches of snow on the ground with a snow water content of 4.15 inches. In March, the 36 inch low level gate was opened one foot to discharge water from the lower levels of the reservoir in

an effort to improve the water quality in the lake. On May 30, the 4 ft by 7 ft gate was lowered from the normal winter setting of passing flows up to 100 cfs to limiting flows to 50 cfs. This action was taken in an effort to prolong a live downstream flow through Jamestown, N.D. during the late summer and to provide adequate flushing water to assist the City in the evacuation of the local sewage lagoons. Pepestem Reservoir is also being considered in conjunction with the reformulation of the Garrison Diversion Unit. A study to analyze the alternative of delivering water from the New Rockford Canal into Pipestem Creek above the dam is being made by the Bureau.

4. Papillion Creek Basin, Nebraska. The water quality problems induced by the upstream sewage treatment plant at Papio Site 18 has not been eliminated. The project gates will remain open until this problem is rectified. Papio Site 20 has been named Wehrspann Lake in honor of the late director of the Papio Natural Resources District.

5. Salt Creek Basin Projects. At the request of the City of Lincoln's Public Works and Utilities Department, the pool elevation of Holmes Park Lake (Salt Creek #17) was dropped in January and again in March to assist with the reconstruction of 70th Street.

6. Bear Creek Reservoir, Colorado. Bear Creek Reservoir recorded its second lowest pool elevation since its initial fill. The low level occurred on July 9 and was due to an intentional drawdown of the lake to provide a dry conduit for a dam safety inspection. Water quality problems similiar to those at Bowman-Haley Reservoir are being reported at Bear Creek Reservoir. Planning is underway to implement procedures to evacuate low level water in conjunction with the normal overflow operation. One option is to open the lowest level outlet in February, while the lake is still frozen, to release 5 to 30 cfs then close it after the ice is gone and the inflows recede.

7. Chatfield Reservoir, Colorado. On July 31, Chatfield Reservoir was at its second lowest elevation since the initial fill of the reservoir. The drawdown was ordered by the State of Colorado in response to the Denver Water Boards reutilization of water from the Moffitt Tunnel to meet downstream water rights. The issue of water reuse in the accounting system is currently under consideration in the State court. This drawdown action was not in violation of the reservoir regulation contract that exist between the Corps and the State, however, breech of contract did occur between the State Game and Parks Department and the concessioner at Chatfield.

8. Cherry Creek Reservoir, Colorado. In contrast to some previous years, releasing water was the rule for the six month period from October 1985 to April 1986 when releases were made on 77 days. A flushing operation to remove sediment from the conduits was performed on April 16. This operation is detailed in Section X of this report.

b. Bureau of Reclamation Projects - August 1, 1985 through July 31, 1986. Reservoir operations at the eleven Bureau of Reclamation projects in the Omaha District were carried out in accordance with normal regulation procedures during the period covered by this report. Regulation of the flood storage zones was required by the Omaha District at Boysen, Canyon Ferry, Glendo, Jamestown, and Yellowtail. On January 15, 1986, the Missouri River Division, Reservoir Control Center notified the District that due to the record low inflows of 1985, replacement storage would not be required in any of the Bureau of Reclamation projects for 1986.

1. Glendo Reservoir, North Dakota. The operating plan proposed by the Bureau of Reclamation for the 1986 forecasted runoff did not require the use of the Glendo exclusive flood storage zone. However, heavy rainfall in early June caused the pool elevation to rise into this exclusive zone. During the evening of June 11, the left drum gate at Guernsey Reservior dropped 2 to 3 feet and was continuing to drop at a steady rate. To assist the Bureau in the partial evacuation of the Guerney pool, releases at Glendo Reservoir were cut from 2,100 cfs to 500 cfs. By the morning of the 13th, conditions had stabilized and releases from Glendo were increased to 2200 cfs. During this period, Grayrocks Reservoir on the Laramie River entered into a spill operation which restricted the evacuation of water from the North Platte Reservoir system.

2. Jamestown Reservoir, North Dakota. The evacuation of the exclusive flood storage zone at Jamestown Reservoir was coordinated with Jamestown City officials to assist in the replacement construction of the Second Street bridge and to provide adequate downstream flows to assist in the flushing of the City's sewage lagoons.

c. Proposed Operations - August 1986 through July 1987.

1. Corps of Engineers. With the exception of Bear Creek, Cherry Creek, Chatfield and Pipestem Dams, all Corps of Engineers tributary dams have ungated service outlets and no gate operations are normally required except for occassional opening of the low level outlets for various purposes. Evacuation of stored flood water in these projects is scheduled as soon as practicable after each flood event. Flood releases from Pipestem Dam are coordinated with those from the Bureau's Jamestown Dam. At Salt Creek Dam #18, releases of inflow up to 3 cfs are made when required to satisfy downstream water rights for irrigation. At Chatfield, the pool level is expected to remain between elevations 5423 and 5432 feet msl at all time except during prolonged periods of drought when it may fall below elevation 5423 feet msl and during flood periods when it may rise above elevation 5432 feet msl. Each year, from May 1 to August 31, the pool level is expected to be maintained to a minimum elevation of 5426.85 feet msl (20,000 A.F.) for recreational purposes. Storage of water above elevation 5426.85 to elevation 5432 will depend on the availability of free water and/or excessive runoff and/or the desire of the City of Denver to store water. Releases from Cherry Creek Reservoir will be made as practicable under the guideline recommended in the flushing study undertaken in 1986. At Bear Creek, the water quality

problem will be analyzed, and operational procedures will be undertaken as practicable to improve the water quality in this reservoir. At Bowman-Haley, the local sponsor will undertake the proposed winter pumping operation if the ice conditions afford the required safety factor. The amount of water to be withdrawn will be dependent on the spring snowmelt runoff forecast.

2. Bureau of Reclamation. As in the past, the Bureau will continue to operate their reservoirs to meet flood control commitments and to coordinate operations with other interests to achieve optimum use of water resources. Generally, all reservoirs will be operated as close to the top of their conservation pool as possible. Pertinent special operating plans are described as follows: Boysen, Canyon Ferry, Clark Canyon, Tiber and Yellowtail Reservoirs require evacuation and refill of joint-use storage for flood control bases on mountain runoff inflow forecasts.

d. Canyon Ferry Reservoir operating plan requires that releases are adjusted as soon as the storage has peaked, usually in June or July, so the pool will be drawn to near elevation 3780 by the following March 1. In addition, releases will be regulated to maintain Canyon Ferry pool below elevation 3794 after December 1. Storage below elevation 3794 prior to winter freezeup is desired to prevent ice jam problems at the head end of the lake. Beginning near the first of January, releases are set based on the most probable spring inflow forecast to allow the reservoir to fill to elevation 3797 near the end of June.

e. At Tiber Reservoir, in accordance with the Water Control Agreement, the joint-use zone will be vacated to elevation 2976 by March 1. March-June releases are based on forecasted inflows with the objective of filling Lake Elwell to elevation 2993 by the end of June. However, in some years, March-June releases may be based on filling the reservoir to as high as elevation 3008 by the end of June to provide replacement storage and assist the Corps in the operation of the main stem reservoir system.

f. Yellowtail Reservoir is generally regulated to be no higher than elevation 3630 feet msl by November 30 to reduce chances of headwater ice problems. The drawdown will continue through the winter months so that the pool elevation wil be no higher than 3605 feet msl before the beginning of spring runoff based on a normal runoff forecast. March through July releases are based on forecasted inflows with the objective of filling Yellowtail Reservoir to elevation 3640 by the end of July. The special operation to measure seepage between Yellowtail Dam and the downstream afterbay was again scheduled for October. The current seepage flow estimate is 70 cfs.

g. Replacement storage up to a combined total of 1,075,500 acre-feet can be made available in Clark Canyon, Tiber, and Canyon Ferry Reservoirs on a forecast basis. Fresno Reservoir in Montana is lowered each year and regulated to provide flood control in accordance with a June 4, 1957, Letter of Understanding. In addition to the reservoirs covered in this report, other Bureau reservoirs, without allocated flood control storage space, will provide flood control in their normal operation of storing seasonal runoff.

Some of these projects are Gibson Dam in Montana and Bull Lake, Pathfinder, Seminoe, and Buffalo Bill Dams in Wyoming. Construction to raise the height of Buffalo Bill Dam by 25 feet is scheduled to begin in 1987. At Pactola Reservoir in South Dakota construction on widening the spillway and raising the dam by fifteen feet is scheduled for completion during the Fall of 1987.

VI. MAJOR REGULATION PROBLEMS. Regulation problems experienced during the period of this report are discussed briefly in the following paragraphs.

a. Bowman-Haley Water Quality. Alternative methods to withdraw the high nutrient water in the lower elevations of the lake will continue to be explored in conjunction with the State of North Dakota and the local sponsor. The parameters which typically exceed the state standards include: ammonia, boron, mercury, phosphate, percent sodium, and sulfate.

b. Cherry Creek Sedimentation. Based on the April flushing operation a semi-annual gate operation will be implemented to remove sediment from the gate tunnels at Cherry Creek.

c. Downstream Channel Capacity. Inadequate or reduced channel capacity is a problem below many of the tributary reservoirs. Encroachment by the natural plant growth due to low flows, by flood deposits left in place, and by human construction and agriculture are common. In some cases, project design ignored the existing channel capacity. The low-flow channel capacity of the South Platte River below Chatfield Dam has hindered or prevented releases in accordance with the realtime three-reservoir system (Chatfield, Bear Creek, and Cherry Creek) plan of regulation during the evacuation of the flood storage zone at these projects. Compounding this situation is the fact that the reservoir design routings for Chatfield, Cherry Creek, and Bear Creek Reservoirs were made independently of each other and that the individual routings neglected 1) the effect of the releases from the other two dams in the three-reservoir system, 2) the effect of the incremental runoff below the dams, and 3) the actual channel capacity below the three dams.

d. Dam Safety. The spillway design flood criteria for projects in the front range were updated recently utilizing HMR #55. Inadequate freeboard or overtopping was sighted at Bear Creek, Cherry Creek, Cold Brook and Kelly Road Dams.

e. Releases for Purposes other than Authorized Project Functions. Inquiries and requests have been received from states, cities, and other organizations for the release of water from certain projects for other than authorized purposes such as irrigation, water supply, and improvement of water quality. These requests pertained to supplemental discharges from the conservation pool or the retention of water and slowdown of releases from the flood storage zone.

f. Potential Hazardous Conditions. A potential problem exists if water is released over the project spillways where the land below the spillway has not been acquired and urban areas now exist. A hazard-to-life condition

exists if a significant flow of water is discharged over the spillways at Cherry Creek Dam and Kelly Road Dam in Denver, Colorado; Salt Creek Dam No. 17 in Lincoln, Nebraska; and over the service spillway at Cold Brook Dam near Hot Springs, South Dakota.

g. **Data Collection.** The Omaha District covers a large area therefore, only a sparse collection of hydrologic data is possible. As a result, some hydrologic events are undetected or not adequately observed. With the implementation of data collection platforms in the basin, the hydrologic data collection process has been improved.

VII. Reservoir Regulation Manuals. The Reservoir Regulation Section continues to spend as much time as possible on manual writing. However, first priority must be assigned to actual daily reservoir regulation activities and reports to higher authority. During the period covered by this report, the Reservoir Regulation Manual for Pipestem Dam and Reservoir was submitted to MRD for approval on October 30 and returned for revision on May 22. This was the first manual submitted by the District since January 24, 1979, when the Papillion Creek manual was submitted. Submission of the Pipestem manual was made possible by manpower provided by the return of an engineer, who had been on a 3-year assignment in Germany, to the Section in July 1985. Progress was also made on the manuals or reports for Bowman-Haley (submitted to MRD on August 11, 1986), Tiber and Papillion Creek. For Boysen Reservoir, the Seasonal Forecast Procedures and the Instructions to Dam Tender for Flood Control Regulation under both Emergency and Normal Conditions were updated (Appendix A and C of the manual) January 1986. Future estimated manual submittal times are listed in Enclosure 5. In addition to the reservoir regulation manuals or reports that need preparation or updating in the Omaha District, there are numerous forecast and instructions to dam tenders that require revision.

VIII. DATA COLLECTION PROGRAM AND PROCEDURES.

a. **Collection of Water Control Data.** Data from hydrologic gages for water control management is obtained from various sources including: contract observers, project offices, National Weather Service, Geological Survey, Bureau of Reclamation and via Satellite (DCP) Data Collection Platforms. The Reservoir Regulation Section has received much of its streamflow data from the National Weather Service teletype network, however, this service was terminated in March 1986. The data is presently received from a NWS computer in Kansas City through office terminals. The current service is called "Datacol". Early in the report period the Litton Weatherfax service was also discontinued and later replaced by a satellite/microwave transmission network. This network consists of an earth station located at Hummel Park in Omaha. The station receives the satellite transmission and relays the data via microwave circuit to the federal building downtown. Direct transmissions cannot be made because of local frequency interference. The hard copy displays are similar to that previously obtained by the Litton Weatherfax machine. Copies are created by a OKIDATA dot matrix printer. This new weather facsimile service displays real-time surface maps, cloud cover, rainfall and other maps pertinent to reliable forecasting.

The primary Corps of Engineers/Missouri River Division data archiving system is called MRADS (Missouri River Automated Data System). The system resides in the Corps of Engineers/North Pacific Division computer named "Amdahl". The data base is used extensively for various hydromet activities, such as transactions, bulletins, forecasting, graphics and archiving to name a few. MRADS is an efficient network to obtain and distribute data to all water control users.

An additional real-time forecasting tool used by the Omaha District is a radar network acquired in August 1984. The system was purchased from Kavouras, Inc. of Minneapolis, Minnesota. Its primary function is to display real-time precipitation over the continental United States. Radar echoes are received from approximately 100 radar sites strategically located throughout the United States that are dialed up directly. The user has the choice range to receive from each site that varies from 60, 120, 180, 240 nautical mile radius. The real-time weather patterns are displayed on a 19-inch color monitor that is coded in distinct 6-color patterns each designating the precipitation intensity at that particular location. Storm activity can also be tracked and located by the use of satellite imagery. This method uses a color coded scheme that designates cloud heights with respect to a normal atmospheric temperature lapse rate. High altitude clouds represent possibly intense rainfall. The radar system is used in conjunction with other forecasting tools to make reliable forecasts, and track intense rainfall for 1) reservoir regulation in particular, in those areas that have short peaking times and 2) alerting higher authority of threatening conditions.

b. Automated Remote Sensors. State-of-the-art, remote site, satellite data transmissions are utilized by the Reservoir Regulation Section. Satellite equipment being used was purchased from Sutron Corporation in Herndon, Virginia. The equipment called DCP (Data Collection Platform) are located throughout seven states. Currently, there are 21 platforms in Montana, 18 in cColorado, 3 in Wyoming, 7 in North Dakota, 13 in South Dakota, 34 in Nebraska and 15 in Iowa. The latest DCPs installed were at LeFramboise and Farm Island, South Dakota. These were installed in order to study ice progressions downstream of Oahe Dam. The Papio 18 DCP installed in the last report period not yet in operation due to non-fill pool conditions. DCP's transmit real-time river and reservoir levels, precipitation, evaporation, wind and air temperature data. The hourly data collected by these remote sensors is transmitted to two ground receiving sites located in Omaha, Nebraska (Corps of Engineers) and Boise, Idaho (Bureau of Reclamation) via GOES-3 and GOES-6 satellites currently located at 134 degrees West longitude and 98 degrees West longitude, respectively. Another satellite is scheduled for launch on November 13, 1986, to replace the GOES-3 West satellite which is reaching the end of its service life. This satellite named GOES-H will be moved to 75 degrees East longitude by late 1986. If the launch is successful GOES-6 will be moved near the current GOES-3 location at 135 degress West longitude and GOES-5 satellite currently located at 75 degrees West longitude will move westward to 107 degrees West longitude by early 1987. The two ground stations after receiving the satellite transmissions send the data by land lines to the MRADS data base in Portland, Oregon. Once the data is entered in the data base it is available for use by

water control personnel through office terminals. The District can also interrogate approximately 80 telemark sensors from any telephone. These remote sensors have been installed by the Corps of Engineers, Geological Survey and National Weather Service at Geological Survey and Corps of Engineers stream gaging stations.

By the end of the report period, there were 110 DCPs in operation with 8 additional sites proposed for next year. The distribution includes 33 in Nebraska, 20 in Montana, 18 in Colorado, 15 in Iowa, 14 in South Dakota, 7 in North Dakota, and 3 in Wyoming.

Vandalism continues to be an increasing problem at the gaging stations. The most frequently experienced destruction or theft occurs to the solar panels and antennas.

c. Cooperative Hydrologic Programs. Funding for the Corps of Engineers/Omaha District stream gaging activities is furnished through two programs. The Cooperative stream gaging program provides support to seven Geological Survey Districts. The districts are Colorado, Iowa, Montana, Nebraska, North Dakota, South Dakota and Wyoming. Collection and publication of data such as stage, discharge, sediment, water quality and ground water records are the primary functions for the funding supplied by this program. The cooperative program also provides the funding for telephone river reports, as well as DCP and telemark maintenance. During the 1986 fiscal year no increases were experienced over the 1985 fiscal year budget. The National Weather Service Reporting Network (FC-50) program provides financial support for the collection of data from 39 gaging stations within six river district office. Formerly operated by the Corps of Engineers these stations are required for reservoir regulations purposes. The stations are in addition to the regular National Weather Service reporting stations. Approximately a 12 percent decrease was experienced from the 1985 fiscal year budget.

A meeting between the Corps of Engineers and all of the U.S.G.S. districts located in the Missouri River Division was held in Omaha on January 15, 1986. The purpose of the meeting was to discuss new procedures and regulations concerning the operation and maintenance of data collection platforms and to clarify inter-agency policy regarding operation and maintenance agreements involving stream gaging equipment. Funding for the FY 86 Cooperative Stream Gaging Program was also discussed. The U.S.G.S. Central Region Office in Denver, Colorado and their districts' offices from the states of Montana, North Dakota, South Dakota, Colorado, Wyoming, Nebraska, Iowa, Kansas and Missouri had representatives at the meeting. The Corps of Engineers were represented by the Missouri River Division, Omaha District, and the Kansas City District offices. In addition, Mr. Dave Wingerd, from OCE was present and discussed the funding for future COOP programs.

d. Water Quality. The Omaha District Water Quality Unit conducts periodic sampling analysis of physical, chemical, and biological parameters on all small reservoir projects located in the Omaha District. Occasional

surveys and special investigations are also conducted, as necessary, to identify or delineate specific problems. Projects sampled by in-house personnel include the Papillion Creek reservoirs and the Salt Creek reservoirs. The sampling frequency on these reservoirs is six times per year. Bowman-Haley, Coldbrook, Chatfield, Bear Creek, Cherry Creek, Lake Audubon, Lake Pocasse, and the Main Stem reservoirs are currently sampled by area personnel. Pipestem Reservoir is sampled monthly during the summer months under contract with Jamestown College. Sampling of inflows on all of the Omaha District projects can best be classified as variable since many of the feeder streams are intermittent and many of these projects spill only at irregular intervals. Periodic sampling in Cottonwood Springs Reservoir has ceased since this project currently impounds very little water.

e. **Sediment.** All sediment samples collected in the Omaha District are obtained by the Geological Survey under the Cooperative Stream Gaging Agreement. Complete sedimentation surveys of small reservoir projects are made at approximately 8-year intervals. These include aggradation surveys to update water volume storage and sediment accumulation values, and degradation surveys to monitor downstream channel changes.

IX. MILK RIVER FLOOD - SPRING 1986.

a. As a result of a large Pacific Ocean originating storm during mid February, 12-15 inches of heavy wet snow and cool temperatures were experienced across the northcentral portions of Montana. Immediately following the storm, the last two weeks of February turned very mild, warm, and windy. The heavy wet snow melted rapidly, causing flows to suddenly increase. On Wednesday, February 14, the river level at Saco rose from 4 feet in the morning to 14 feet by midnight. On the Marias River, inflows to Tiber Reservoir increased from 200 cfs to over 26,800 cfs on the same date. As the warm weather moved eastward, flows on the tributaries north of the Milk River increased significantly, due to the melting snowcover. The drainage area south of the Milk River did not add significantly to the flooding due to the lack of snow cover. Although this episode did not have the volume of water that is associated with the 1952 flood, record or near record stages were established along the Milk River due to ice jamming. Hydrographs for the Milk River at Nashua and Saco as recorded via the Corps Data Collection Platform are shown on plate 9-1 and 9-2.

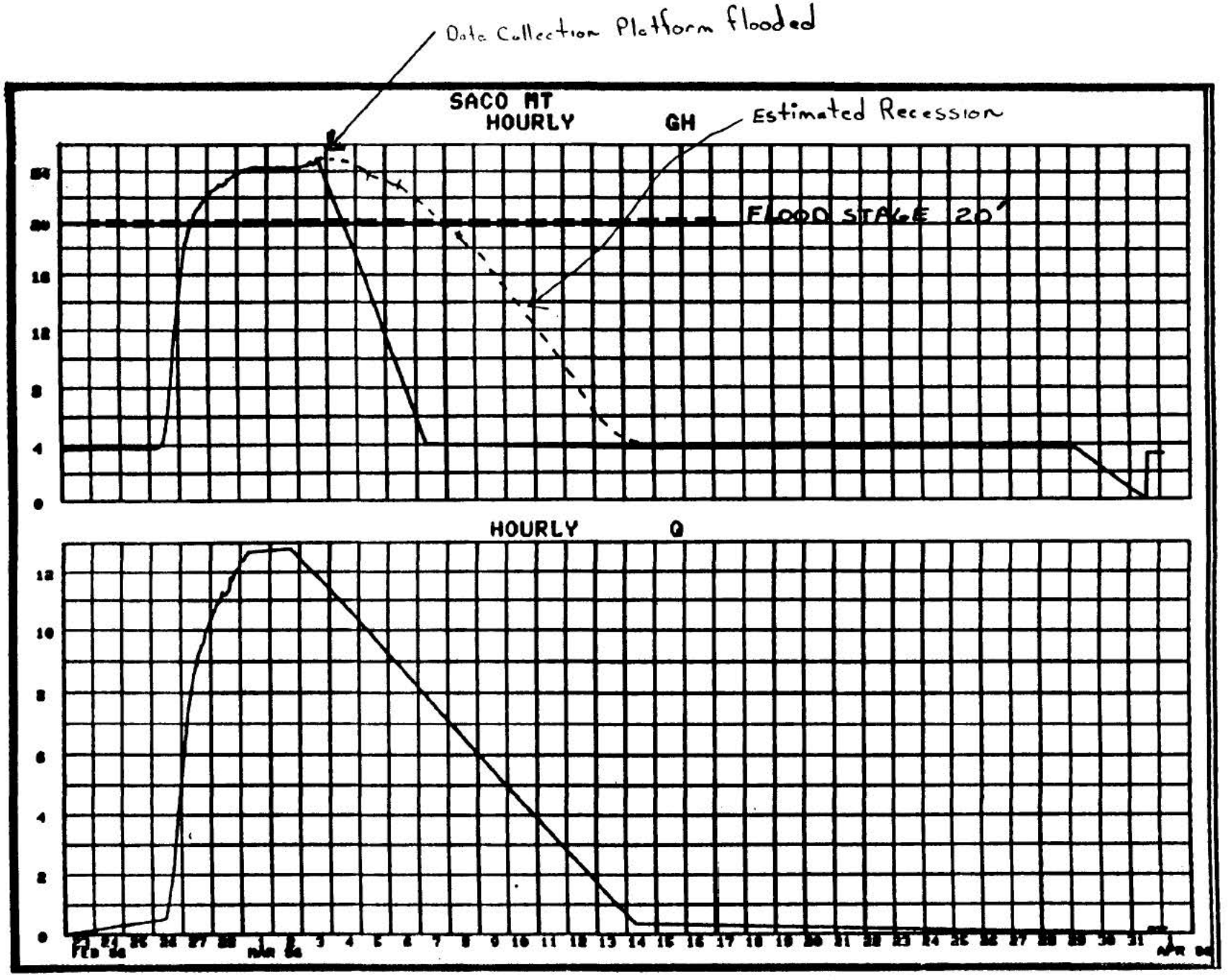

Data Collection Platform flooded
SACO MT
HOURLY
GH
Estimated Recession
FLOOD STAGE 20'
HOURLY
Q

PLATE 9.1

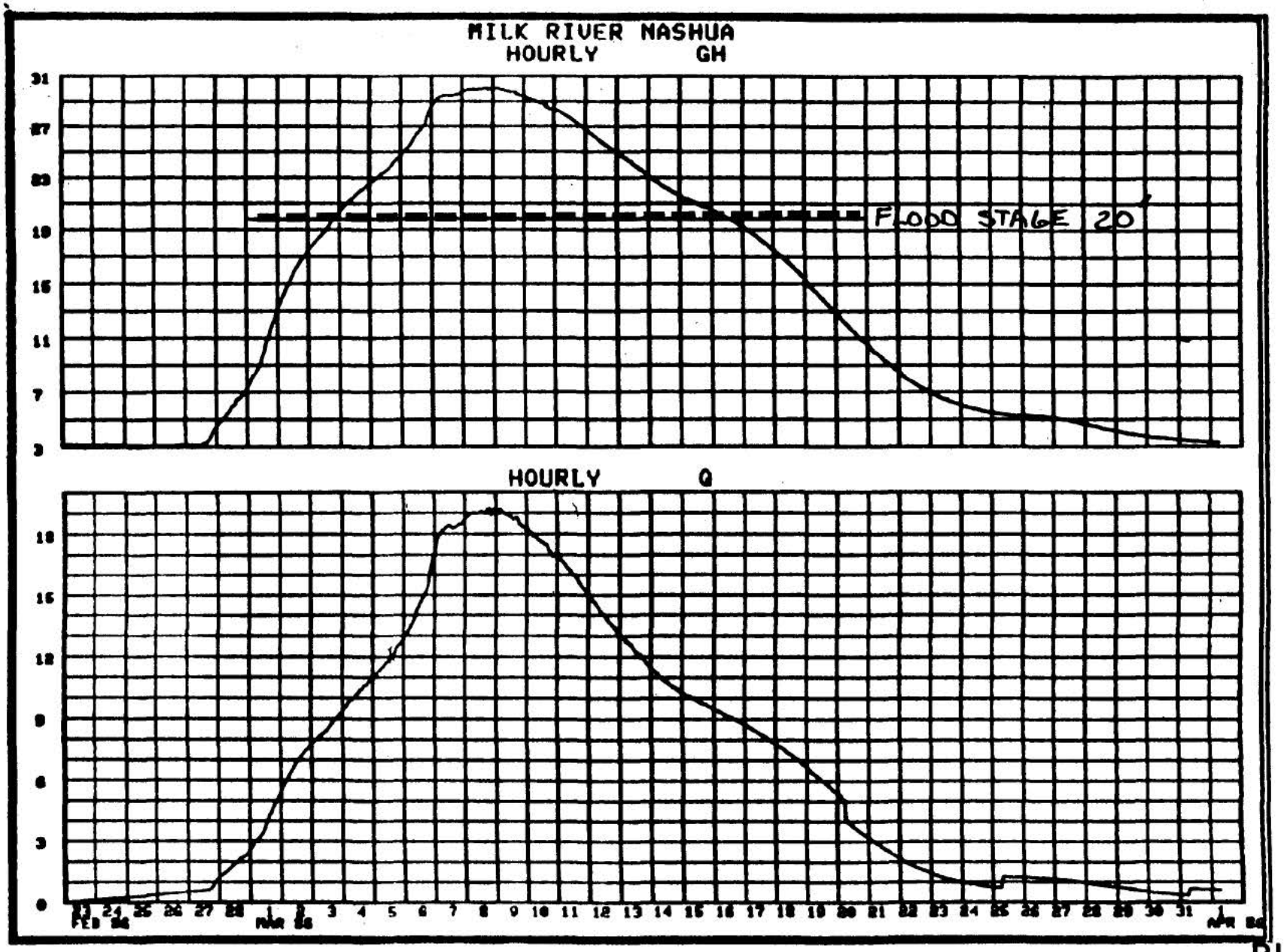
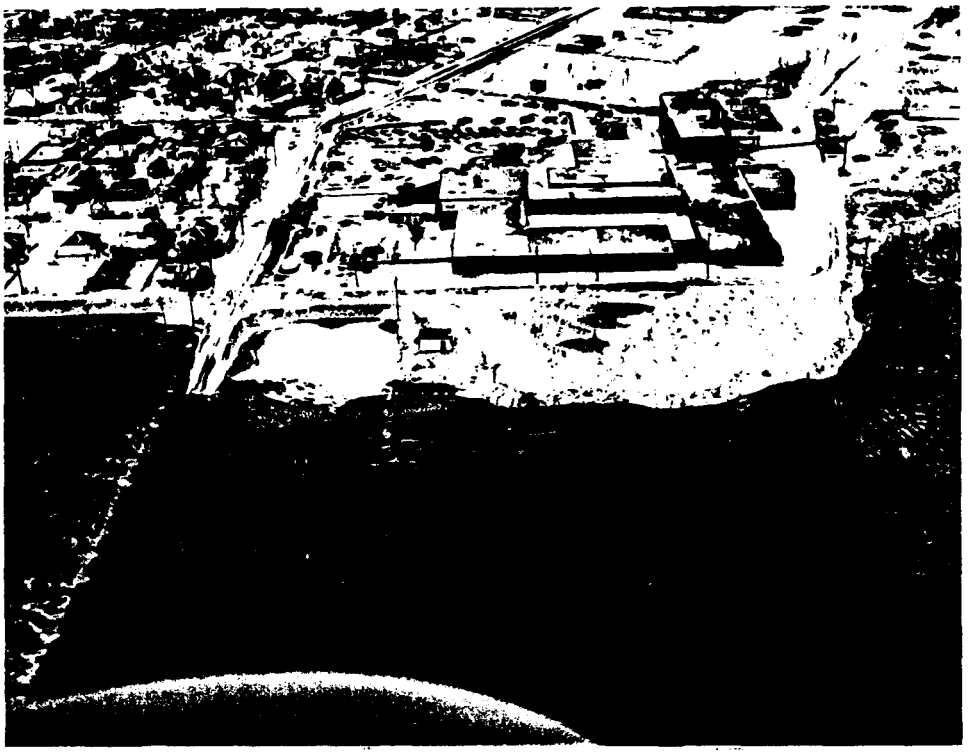


PLATE 9.2



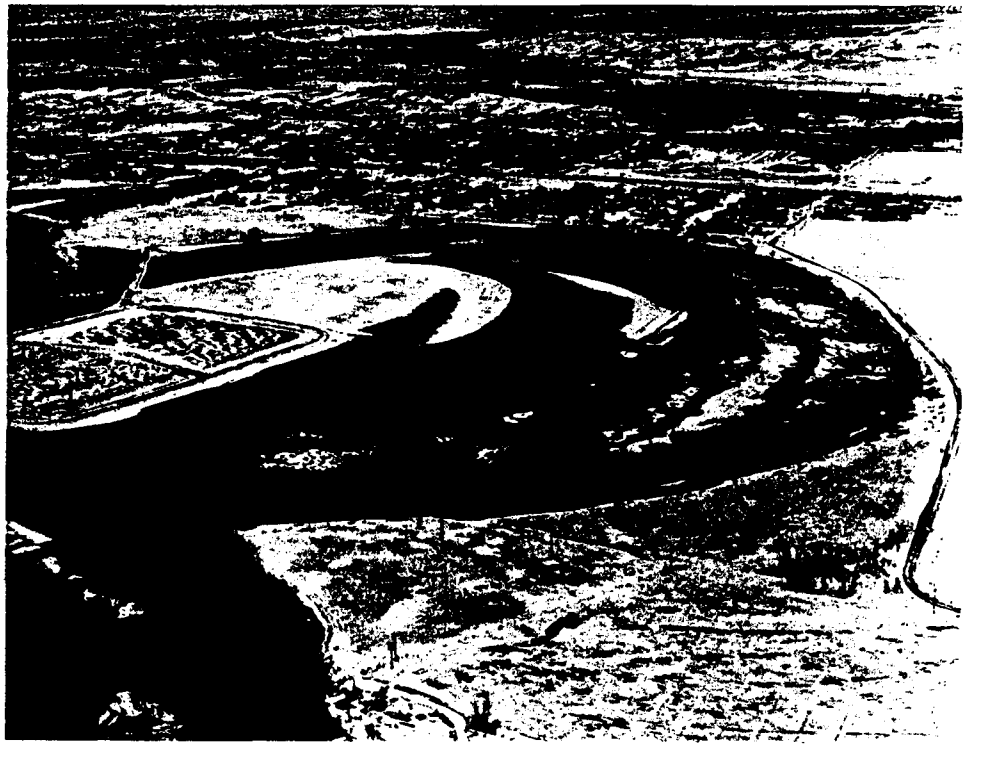
LEVEE NEAR HOSPITAL AT GLASGOW, MONTANA

MILK RIVER NEAR GLASGOW, MONTANA

MILK RIVER FLOOD – GLASGOW, MONTANA

WHATLEY ROAD BRIDGE NEAR GLASGOW, MONTANA

Setting high
Water marks



MILK RIVER FLOOD

VIEW NORTH TOWARD NASHUA, MONTANA

MILK RIVER FLOOD – NASHUA, MONTANA

Downsteam side of Hwy 117 bridge

VIEW SOUTH OF TRUMPER STEET – NASHUA, MONTANA

X. CHERRY CREEK RESERVOIR FLUSHING OPERATION.

a. Purpose of Flushing Operation. In 1983 and 1984, during the installation of the emergency gates at Cherry Creek Dam, it was reaffirmed that 10-20 feet of hard sediment had been deposited just upstream of the outlet gates at the upper end of the outlet tunnels. This sediment was then removed by dredging at a cost of about $180,000. Design Memorandum No. CC-10, published in 1985, looked at various methods for preventing a recurrence of the sediment accumulation which could prevent the emergency gates and/or bulkheads from being lowered in an emergency. The alternatives evaluated included structural solutions, dredging and operational strategies. Since the operational strategies were the least costly and disruptive, it was decided to evaluate various methods which could be used on a routine basis to flush sediment through the intake structure of Cherry Creek Dam.

b. Summary of Events. The depth of sediment within the intake structure was measured by divers on April 14 and 17. The actual flushing operation was conducted on April 16. Four different methods of flushing were evaluated. They were: 1) release of 200 cfs through the service gate, 2) release of about 150 cfs under the emergency gate, 3) release of 800 cfs for 5 minutes and then 600 cfs for 40 minutes through the service gate, and 4) release of 300 cfs through the service gate. The amount of time was relatively short because the previous flushing operation indicated that the majority of the sediment was flushed through the gates within the first few minutes of the gates being opened.

There were two unique aspects to this flushing operation: the abnormally high release of 600 cfs and the use of the emergency gate for flushing. The 600 cfs release was the highest release from Cherry Creek Dam since 1957 when the dam began impounding water. Prolonged releases of about 500 cfs in 1965 reportedly caused damage to the downstream channel and maximum releases had been restricted to less than 375 cfs since then. It was felt that the short duration of the 600 cfs release, about 45 minutes, would not cause problems along the downstream channel because the flow would attenuate as it moved downstream. The release schedule and flushing operation was coordinated with local agencies including the Urban Drainage and Flood Control District, City and County of Denver, Colorado Division of Natural Resources as well as local law enforcement agencies and news media. Downstream home owners were notified of the anticipated high release.

During the flushing operation, the USGS measured the discharge in Cherry Creek at three locations. The three locations were 1) 2000 feet downstream of the dam, 2) at the Glendale gage and 3) at the Wazee Street bridge. Personnel from the Reservoir Regulation Section observed staff gages at the utility crossing downstream of Havanna Street and at Elmira Street where a group of condominiums are located close to the right bank of Cherry Creek. In addition, discharge measurements were made at the Iliff Street bridge by personnel at the Section.

c. **Conclusion and Recommendations.** All release schemes flushed the sediment out of the intake structure from the service gates upstream to beyond the bulkhead slots. It did not appear that much sediment was removed beyond the divider wall between the tunnels. The main objective of a routine flushing operation would be to keep the bulkhead and emergency gate slots free of sediment so the bulkheads and emergency gates could be lowered if needed. See plate 10-1.

Based on this flushing operation, it was recommended that a semi-annual flushing operation be conducted, as practicable, on all four gates in the Cherry Creek intake structure using a release rate of between 200 and 300 cfs for about 1-2 hours for each gate. This would allow all gates to be flushed in one day. Any flood storage evacuation release will take the place of a formal semi-annual flushing release as long as the releases are alternated between the four gates. In conjunction with flood storage releases or a semi-annual flushing operation, it was recommended to periodically raise the service gates to release 600-800 cfs for a period of 5-15 minutes, since the higher release was demonstrated to remove more sediment than the lower releases. It is predicted that this type of routine flushing should remove any sediment that would accumulate within the bulkhead and emergency gate portion of the intake structure.

XI. RESEARCH AND STUDIES. During the report period, studies by the Reservoir Regulation Section and others included the following:

a. **Necessary Real Time Studies.** Numerous studies were made, and data compiled for use in reservoir regulation and briefing of District personnel. Studies were made as needed to compile information for meetings with other Federal and State agencies and to help inform public interest concerning reservoir regulation and streamflow conditions in the District. Inflow estimates, release scheduling, study of river and weather conditions and computer forecasting models were all utilized to aid in complying as efficiently as possible with all authorized uses and water rights involved in the regulation of reservoirs in the District. Review study and comments on various preliminary reports and permits were provided as necessary.

b. **Missouri River Division Water Control Data System Master Plan.** Upgrading of the hardware and software systems for use with the Missouri River Division ground receive site and for the NPD AMDAHL computer continue to improve and expand data collection and management procedures in the Water Control Data System. The new software acquired for the MRD VAX 11/730 computer and the purchase of two Micro computers and assorted software programs make many more features available in the database. More efficient data editing and archiving can now be accomplished as well as the creation of quality graphics for use in displays and reports. A Xerox color ink jet printer purchased for use with the KAVOURAS radar system makes available quality hard copy color radar maps that can be used for displays, reports and for the study of unusual storm events throughout the District.

CHERRY CREEK RESERVOIR OUTLET WORKS

CHERRY CREEK CHANNEL – UTILITY CROSSING

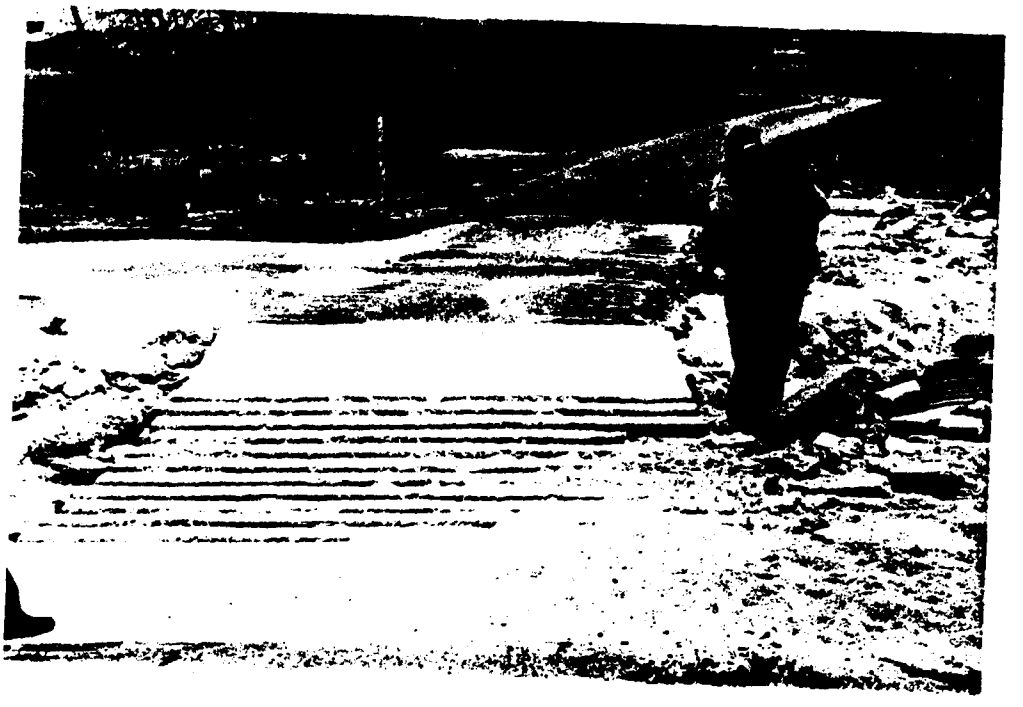
Approximately 1.2 miles below the dam

CHERRY CREEK CHANNEL AT ELMIRA STREET

Looking south toward the dam – Dry channel

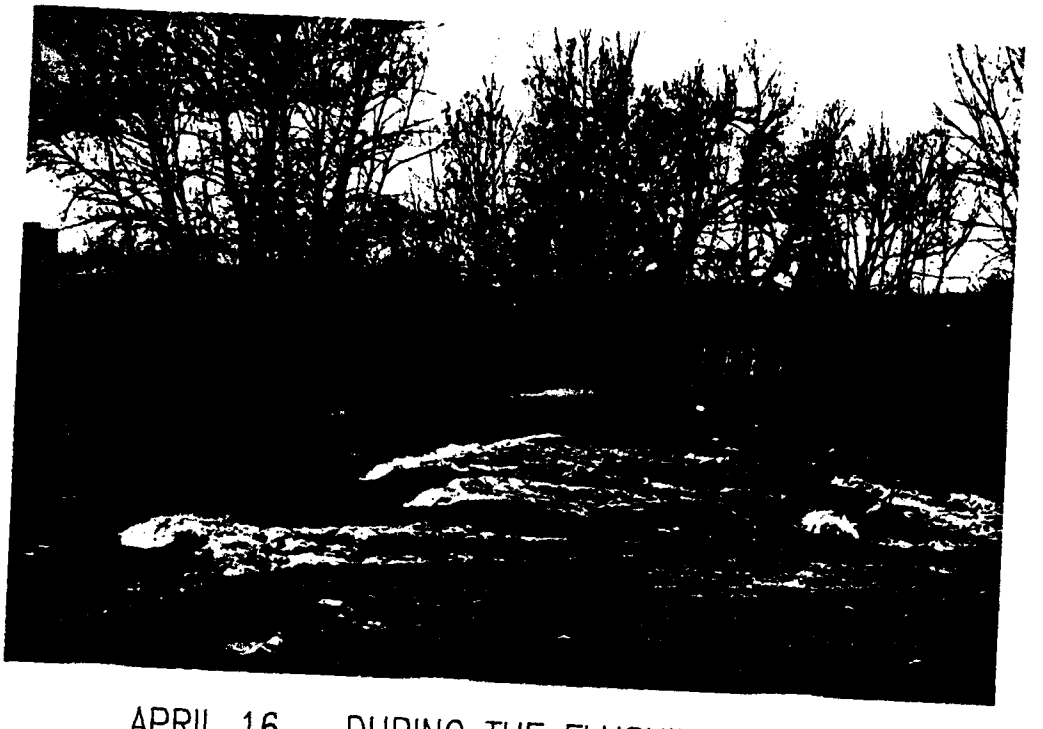
DURING FLUSHING OPERATION

Approximately discharge 300 cfs



CHERRY CREEK BIKE PATH CROSSING

Wooden inverted siphon exposed on the right of the photo



APRIL 16 – DURING THE FLUSHING OPERATION

Discharge approximately 600 cfs

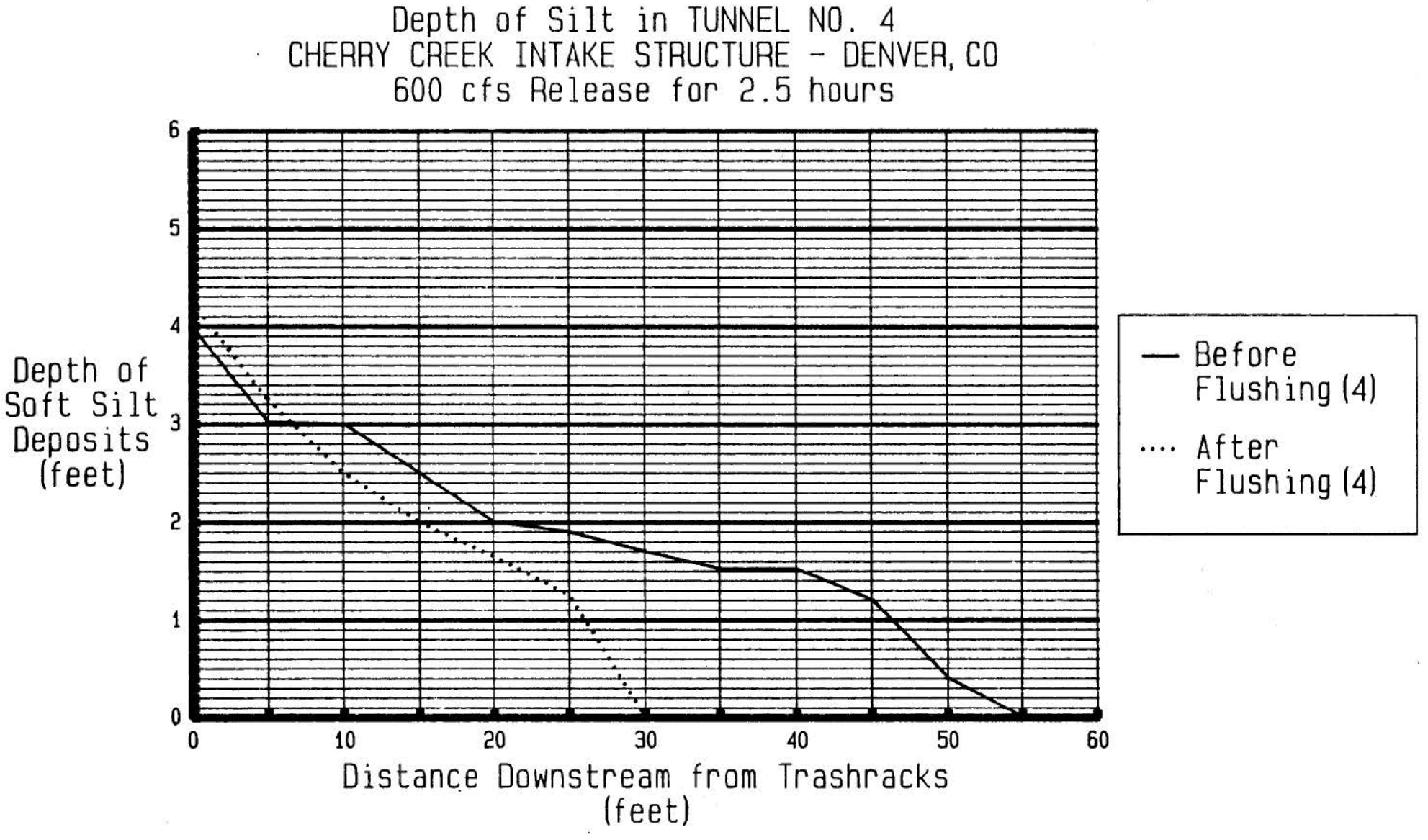

Depth of Silt in TUNNEL NO. 4
CHERRY CREEK INTAKE STRUCTURE - DENVER, CO
600 cfs Release for 2.5 hours
Depth of Soft Silt Deposits (feet)
0
1
2
3
4
5
6
0
10
20
30
40
50
60
Distance Downstream from Trashracks (feet)
Before Flushing (4)
After Flushing (4)

PLATE 10.1

c. **Channel and Project Reconnaissance.** During March 1986, Dan Manning monitored downstream conditions below Bowman-Haley Dam in North Dakota for any adverse effects of releases that were made in an attempt to evacuate poor quality water from the pool prior to and during the snowmelt runoff. During April 1986, personnel from the Reservoir Regulation Section monitored staff gages and took discharge measurements along the first three miles of the channel downstream of Cherry Creek Dam in Colorado. This was to study the effects of flow conditions that resulted from a flushing operation that attempted to remove sediment from around the intake structure. Reservoir Regulation Section personnel made routine visits to various projects during the report period in order to inspect conditions and maintain and recalibrate gaging equipment at these locations.

d. **Supersaturation.** No gas supersaturation studies were conducted on any of the reservoir projects this period due to lack of significant problems caused by releases. These measurements are made in accordance with ETL 1110-2-239, dated September 15, 1978.

e. **FERC Applications.** During the period of this report, 39 applications for preliminary permits, licenses or exemption from licensing were made to the Federal Energy Regulatory Commission by various entities for studies in connection with new hydropower plants within the Omaha District. These applications were reviewed and comments were prepared by the District on the impact of the proposed plant on the responsibilities of the Corps of Engineers.

XII. TRAINING AND METHODS. During the period of this report, employees in the Section attended the Courses listed below:

[redacted]s:
Workers Compensation Workshop (In-house) - 4 hrs
Improving Performance Standards Training (In-house) - 16 hrs
Non-Federal Hydropower Workshop (In-house) - 16 hrs
EEO Update for Supervisors - 4 hrs

[redacted]:
Microcomputer Training Seminar - Smort overview (Peter Kiewit Center) - 8 hrs
Water Resources Data Management Prospect (Davis, CA) - 36 hrs
Hydraulic Engineering (UNO) - 48 hrs

[redacted]n:
Microcomputer Training Seminar - Database III (Peter Kiewit Center) - 16 hrs

[redacted]n:
Federal Acquisition Process (In-house) - 16 hrs
Introduction to Personal Computing (Peter Kiewit Center) - 16 hrs

[redacted]y:
Microcomputer Training Seminar - Database III, Level 2 (Peter Kiewit Center) - 16 hrs

[redacted]: Microcomputer Training Seminar - Multiplan (Peter Kiewit Center) - 16 hrs

[redacted]: Introduction to Personal Computing (Peter Kiewit Center) - 16 hrs

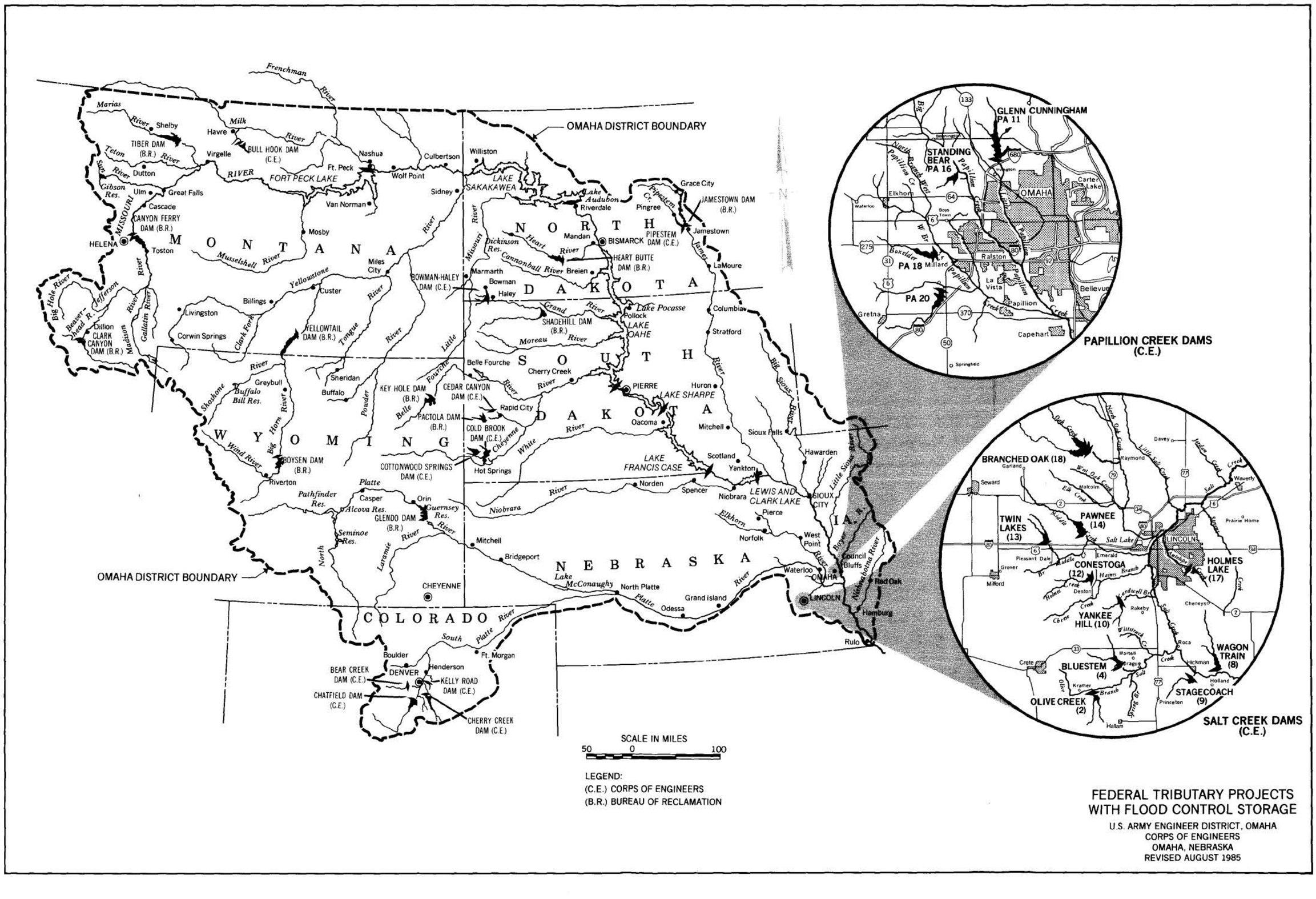
[redacted]: Introduction to Personal Computing (Peter Kiewit Center) - 16 hrs

[redacted]: Real Time Water Control (Davis, CA) - 80 hrs

XIII. PERSONNEL. At the beginning of the period, the work force of the Reservoir Section consisted of five engineers, five technicians, a part-time permanent secretary, and a summer hire student. On May 5, due to a sudden cutback in the Civil Works Full-Time Equivalent (FTE) allocation, detail assignments not to exceed 120 days were made from the Section and Hydrologic Engineering Branch to other District offices. [redacted] was assigned to Superfund and [redacted] were assigned to the Military Branch. [redacted] returned to the Section on July 19. On July 7, [redacted] was assigned to the Hydraulic Section of the Branch. The relationships between the Reservoir Regulation Section and other elements of the Branch, Engineering Division and Omaha District are shown on Enclosure 6. The functions of water quality and sediment studies and hydraulic and hydrology planning are performed by other Sections of the Branch. Flood benefit computations are performed by Planning Division. Project recreation usage studies are performed by Operations Division. An organization chart of the Section, as of July 31, 1986, is shown on Enclosure 7.

MAP OF FLOOD CONTROL DAMS

ENCLOSURE 1



FEDERAL TRIBUTARY PROJECTS WITH FLOOD CONTROL STORAGE

U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA
REVISED AUGUST 1985

PROJECT DATA SHEETS - TRIBUTARY

(4 Sheets)

Corps of Engineers Dams
Salt Creek Basin Dams - C.E.
Papillion Creek Basin Dams - C.E.
Bureau of Reclamation Dams
Subimpoundment Dams (Two) - C.E.

ENCLOSURE 2

SUMMARY OF ENGINEERING DATA — FEDERAL RESERVOIRS WITH AUTHORIZED FLOOD CONTROL
MISSOURI RIVER TRIBUTARIES — U.S. ENGINEER DISTRICT — OMAHA
CORPS OF ENGINEER DAMS

ITEM NO.	SUBJECT	BEAR CREEK	BOWMAN HALEY	BULL HOOK— SCOTT COULEE	CEDAR CANYON	CHATFIELD	CHERRY CREEK	COLD BROOK	COTTONWOOD SPRINGS	KELLY ROAD	PIPESTEM
	GENERAL										
1	Location of dam	3 mi. S.W. of Denver, Colo	6 mi. W. of Haley, N.D.	1 mi. S. of Havre, Mont.	3.5 mi. W. of Rapid City, S.D.	2 mi. S. of Denver, Colo.	10 mi. S.E. of Denver, Colo.	1 mi. N. of Hot Springs, S.D.	4.5 mi. W. of Hot Springs, S.D.	Lowry A.F.B., Denver, Colo.	3 mi. N.W. Jamestown, N.D.
2	River and river mile	Bear Creek R.M. 8	N. Fk. Grand R.M. 100	Bull Hook Cr.-Scott Coulee	Deadman's Gulch	South Platte River R.M. 321	Cherry Creek R.M. 11.4	Cold Brook R.M. 1	Cottonwood Springs Creek	Westerly Creek	Pipestem Creek R.M. 3
3	Drainage area (sq. mi.)	236	446	54	0.4	3,018	386	70.5	26	10.5	594
4	Reservoir length (mi.)	0.5 at el. 5558	2.5 mi. at el. 2755	Normally dry	Normally dry	2.0 at el. 5430	1.5 at el. 5550	1.2 at el. 3646.5	0.6 mi. at el. 3875	Normally dry	5.5 at el. 1442.4
5	Location of Damtender	At Chatfield Dam	Garrison Dam	Ft. Peck Dam	Oahe Dam	On site	At Chatfield Dam	On site	At Cold Brook Dam	Rocky Mt. Area	On site
6	Travel time to Missouri River	2 weeks	1 day to Shadehill Dam	—	—	2 weeks	—	—	—	—	8 weeks
7	Max. discharge of record	8,600 cfs July 1896	14,100 cfs April 1952	—	440 cfs August 1949	110,000 cfs June 1965	58,000 cfs June 1965	8400 cfs Sept. 1938	—	—	6,080 cfs April 1969
8	Project cost (1)	$61,700,000	$4,372,200	$1,837,200	$122,600	$101,130,000	$14,670,000	$1,571,000	$2,885,000	$232,000 (Original Cost)	$9,277,500
	DAM AND EMBANKMENT										
9	Top of dam — ft. MSL	5689.5	2794.0	2613.3 (B.H.) 2613.3 (S.C.)	3554.0	5527	5645.0	3675.0	3955.0	5372.0	1507.5
10	Length of dam — ft.	5,300 — main 2,100 — South	5730	1900 (B.H.) 1500 (S.C.)	1320	13,136	14300	925	1190	4700 5363.0 West Emb.	4000
11	Height of dam — ft.	179.5 — main 65 — South	79	73 (B.H.) 53 (S.C.)	42	147	141	127	123	30	107.5
12	Stream bed — ft. MSL	5,510	2715	2540 (B.H.) 2560 (S.C.)	3512	5380	5504	3545	3832	5342	1400
13	Abutment formation	Clay, shale, siltstone, sandstone	Ludlow, sandy clay, silty sand	Glacial till, lean clay	Minnekahta limestone	Sandy overburden—Dawson Form.	Sandstone, clay, silt	Sandstone, shale, limestone	Minnekahta limestone	Overburden — sandy clay	Sandy overburden — P. Shale
14	Type of fill	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rolled earth
15	Fill quantity in cu. yds.	11,346,000—main 770,000—South	1,750,000	1,300,000	150,000	14,650,000	13,000,000	1,072,000	950,000	200,000	1,990,000
16	Date of closure	Jul. 1977	Aug. 1966	Oct. 1955	Sep. 1959	Aug. 1973	Oct. 1948	Sept. 1952	May 1969	Nov. 1953 Rehab. 1978	Jul. 1973
17	Date of initial fill (base F.C.)	May 1979	Mar. 1969	—		Jun. 1979	March 1960	Jun. 1963 (3584.7)	—	—	May 1974
	SPILLWAY			*Notch in BH to 2583						2900 cfs at el. 5366.21	
18	Discharge capacity — cfs	153,500 cfs at el. 5684.5	62,970 cfs at el. 2789	25,200 cfs at el. 2605	1400 cfs at el. 3550.6	188,000 cfs at el. 5521.6	38,350 cfs at el. 5636.2	80,600 cfs at el. 3667.2	39,600 cfs at el. 3950.3	5362.0	56,200 cfs at el. 1502.8
19	Crest elev. — ft. MSL	5667.0	2777	2593.0 (B.H.)* 2586.0 (S.C.)	3545.0	5500.0	5598.0	3646.5	3936.0	120	1496.3
20	Width — ft.	800	650	—	60	500	67	200	275	Uncontrolled	1500
21	Gates, number, size, type	Ungated earth channel	Ungated earth notch	Ungated earth channels	Ungated rock channel	Ungated converging chute	Ungated earth channel	Ungated sharp crested weir	Ungated broad weir	Concrete U wall and chute	Ungated earth channel
	RESERVOIR ELEV. AND AREA										
22	Maximum pool	5684.5 1237a.	2789.0 7916a.	2605.0 (B.H. & S.C.) 384a.	3550.6 15a.	5521.6 5952a.	5636.2 4542a.	3667.2 279a.	3950.0 257a.	5366.21 43a.	1502.8 7105a.
23	Top of flood control pool	5635.5 715a.	2777.0 5131a.	2593.0 (B.H. & S.C.) 283a.	3545.0 11a.	5500.0 4742a.	5598.0 2634a.	3651.4 198a.	3936.0 214a.	5362.0 38a.	1496.3 4754a.
24	Top of multipurpose pool	5558.0 107a.	2754.8 1732a.	none	none	5432.0 1412a.	5550.0 852a.	3585.0 36a.	3875.0 41a.	none	1442.4 885a.
25	Top of inactive pool	5528.0 17a.	2740.0 565a.	none	3526.0 2a.	none	none	none	3868.0 30a.	none	1415.0 62a.
	STORAGE ZONES (Elev.-Capacity)			Total — (B.H. & S.C.)							
26	Surcharge	5635.5-5684.5 47,350AF	2777.0-2789.0 77,085AF	2593.0-2605.0 4000AF	3545.0-3550.6 74AF	5500-5521.6 115,763AF	5598.0-5636.2 134,470AF	3651.4-3667.2 3,600AF	3936.0-3950.0 3,250AF	5362.0-5366.21 170AF	1496.3-1502.8 36,850AF
27	Flood control	5558.0-5635.5 28,757AF	2754.8-2777.0 72,717AF	2540.0-2593.0 6500AF	3526.0-3545.0 123AF	5432-5500.0 204,737AF	5550.0-5598.0 79,960AF	3585.0-3651.4 6,680AF	3875.0-3936.0 7,730AF	5342.0-5362.0 360AF	1442.4-1496.3 137,010AF
28	Multipurpose	5528.0-5558.0 1,857AF	2740.0-2754.8 15,456AF	none	none	5385-5432 26,661AF	5504.0-5550.0 13,960AF	3548.0-3585.0 520AF	3868.0-3875.0 249AF	none	1415.0-1442.4 9,590AF
29	Inactive	5510-5528.0 70AF	2715.0-2740.0 3,309AF	none	none	5377-5385 31AF	none	none	3832.0-3868.0 406AF	none	1400.0-1415.0 280AF
30	Gross (top of flood control pool)	30,684AF	91,482AF	none 6500AF	3512.0-3526.0 13AF 136AF	231,429AF	93,920AF	7,200AF	8,385AF	360AF	146,880AF
	OUTLET WORKS										
31	Number and size — conduits	1—7 ft. circular—upstream 1—7x10.5 ft.—downstream	1 — 10 ft. circular conduit	1 — 30 in. RCP — Bull Hook 1 — 30 in. RCP — Scott Coulee	1 — 24 in. C.M.P.	2—11x16 ft. oval conduit	2 — 8x12 ft. oval conduit 1 — 12 ft. circular conduit	1—6.67 ft. conduit 1—8 in. supply line	1 — 48 in. concrete	1 — 5.5 ft. circular conduit 1 — 30 in CMP	1 — 8 ft. circular conduit
32	Conduit length — ft.	1690 ft. Ungated drop inlet—el. 5558	341 ft.	393 ft. — Bull Hook 286 ft. — Scott Coulee	230 ft.	1280 ft.	679.5 ft.	907 ft. Ungated drop inlet—el. 3585	580 ft. Ungated drop inlet — el. 3875		675 ft. Ungated drop inlet — el. 1442.4
33	Number — size — type gates	2—3x6 ft. hydraulic slide 2—1x1 ft. slide—gate on gate	Ungated Glory Hole — el. 2754.2 1 — 30 in. valve and slide gate 1 — 8 in. valve	1 — 24 in. valve, Bull Hook 1 — 24 in. valve, Scott Coulee	Ungated inlet — el. 3526	2—6x13.5 ft. hydraulic slide 2—2x2 ft. slide—gate on gate 1—72 in. butterfly	5 — 6x9 ft. — hydraulic slide	3—12 in. gate valves—el. 3548 1—8 in. valve	1 — 3x3 ft. gate — el. 3868	Ungated drop inlet — el. 5358.4 Gated Inlet — el. 5342.0	2 — 4x7 ft. hydraulic slide 1 — 36 in. valve, 1 3x3 ft. slide
34	Discharge capacity	2,160 cfs at el. 5667	Glory Hole—3206 cfs at el. 2789 30 in. valve—140 cfs at el. 2755	123 cfs at 2593 — Bull Hook 103 cfs at 2593 — Scott Coulee	49 cfs at el. 3545	8400 cfs at el. 5500.0	8100 cfs at el. 5598.0	250 cfs at el. 3600.0 1540 cfs at el. 3651.4	560 cfs at el. 3936.0	570 cfs at el. 5362.0	2,300 cfs at el. 1496.3
35	POWER INSTALLATION	none	none	none	none	none	none	none	none	none	none

(1) Costs are as of 9-30-80

SUMMARY OF ENGINEERING DATA — FEDERAL RESERVOIRS WITH AUTHORIZED FLOOD CONTROL
MISSOURI RIVER TRIBUTARIES — U.S. ENGINEER DISTRICT — OMAHA
SALT CREEK BASIN — NEBRASKA

ITEM NO.	SUBJECT	DAM NO. 2 (Olive Creek Lake)	DAM NO. 4 (Blue Stem Lake)	DAM NO. 8 (Wagon Train Lake)	DAM NO. 9 (Stagecoach Lake)	DAM NO. 10 (Yankee Hill Lake)	DAM NO. 12 (Conestoga Lake)	DAM NO. 13 (Twin Lakes)	DAM NO. 14 (Pawnee Lake)	DAM NO. 17 (Holmes Park Lake)	DAM NO. 18 (Branched Oak Lake)
	GENERAL										
1	Location of dam	1.5 mi. E. of Kramer	2.5 mi. W. of Sprague	1.5 mi. N. of Holland	1 mi. S. of Hickman	3.5 mi. E. of Denton	1.5 mi. N. of Denton	2 mi. N.W. of Pleasantdale	2 mi. N.W. of Emerald	S.E. edge of Lincoln	4 mi. W. of Raymond
2	River and mileage	S. Trib. of Olive Br.	N. Trib. of Olive Br.	N. Trib. of Hickman Br.	S. Trib. of Hickman Br.	Cardwell Br.	Holmes Cr.	Middle Cr.	N. Middle Cr.	Antelope Cr.	Oak Cr.
3	Drainage area in square miles	8.2	16.6	15.6	9.7	8.4	15.1	11.0	35.9	5.4	88.7
4	Reservoir length in miles	1.2	1.6	1.8	1.4	0.7	1.4	1.5	3.0	0.7	3.7
5	Location of Damtender	none	none	none	none	none	none	none	none	none	none
6	Travel time to Lincoln, NE	23 hrs.	13 hrs.	14 hrs.	8 hrs.	3 hrs.	8 hrs.	13 hrs.	7 hrs.	3 hrs.	6 hrs.
7	Max. discharge of record	—	—	—	—	—	—	—	—	—	—
8	Project cost	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
	DAM AND EMBANKMENT										
9	Top of dam — ft. MSL	1359.0	1334.0	1312.0	1294.0	1270.0	1260.0	1364.0	1271.0	1273.0	1320.0
10	Length of dam — ft.	3020.0	2760.0	1650.0	2250.0	3100.0	3000.0	2075.0	5000.0	7700.0	5200.0
11	Height of dam — ft.	45.0	57.0	52.0	48.0	52.0	63.0	56.0	65.0	55.0	70.0
12	Stream bed — ft. MSL	1314.0	1277.0	1260.0	1246.0	1218.0	1197.0	1306.0	1206.0	1218.0	1250.0
13	Abutment formation	Clay — sand — silt	Clay — sand	Clay	Clay — sand	Clay — sand	Clay — sand	Clay — sand — silt	Clay — sand	Clay — sand	Clay — sand — silt
14	Type of fill	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rolled earth
15	Fill quantity in cu. yds.	312,000	471,000	376000	374000	502000	658000	610000	870000	900000	2460000
16	Date of closure	20 Sep. 1963	12 Sep. 1962	24 Sep. 1962	27 Aug. 1963	5 Oct. 1965	24 Sep 1963	26 Sep. 1965	16 Jul. 1964	17 Sep. 1962	21 Aug. 1967
17	Date of initial fill	30 Jun. 1965	6 Jul 1963	24 Jun. 1963	25 May 1965	10 Jun. 1967	May 1965	18 Mar. 1969	21 Jun. 1967	2 Jun. 1965	18 Jan. 1973
	SPILLWAY										
18	Discharge capacity — cfs	15875 at el. 1357.1	22925 at el. 1331.7	23210 at el. 1309.8	17565 at el. 1291.6	12100 at el. 1267.8	27220 at el. 1258.2	25200 at el. 1361.6	19875 at el. 1269.1	800 at el. 1269.7	7825 at el. 1317.5
19	Crest elev. — ft. MSL	1350.0	1322.5	1302.0	1285.0	1262.0	1252.0	1353.0	1263.5	1266.0	1311.0
20	Width — ft.	340.0	340.0	430.0	430.0	400.0	750.0	400.0	700.0	50.0	200.0
21	Gates, number, size, type	Ungated earth channel	Ungated earth channel	Ungated earth channel	Ungated earth channel	Ungated earth channel	Ungated earth channel	Ungated earth channel	Ungated earth channel	Ungated earth channel	Ungated earth channel
	RESERVOIR ELEV. AND AREA										
22	Maximum pool	1357.1 470A.	1331.7 995A.	1309.8 875A.	1291.6 645A.	1267.8 620A.	1258.2 755A.	1361.6 645A.	1269.1 1780A.	1269.7 470A.	1317.3 4207A.
23	Top of flood control pool	1350.0 355A.	1322.5 660A.	1302.0 660A.	1285.0 490A.	1262.0 475A.	1252.0 620A.	1355.0 505A.	1263.5 1470A.	1266.0 410A.	1311.0 3640A.
24	Top of joint use pool	none	none	none	none	none	none	none	none	none	none
25	Top of conservation pool	1335.0 174A.	1307.4 315A.	1287.8 303A.	1271.1 196A.	1244.9 208A.	1232.9 230A.	1341.0 255A.	1244.3 728A.	1242.4 100A.	1284.0 1780A.
26	Top of sediment pool	1335.0 174A.	1306.1 290A.	1284.6 225A.	1271.1 196A.	1241.9 175A.	1232.9 230A.	1337.4 205A.	1244.3 728A.	1240.0 75A.	1275.7 1270A.
	STORAGE ZONES (Elev.-Capacity)										
27	Surcharge zone	1350.0-1357.1 2910AF	1322.5-1331.7 9420AF	1302.0-1309.8 5990AF	1285.0-1291.6 3725AF	1262.0-1267.8 3150AF	1252.0-1258.2 4245AF	1355.0-1361.6 3790AF	1263.5-1269.1 9060AF	1266.0-1269.7 1633AF	1311.0-1317.3 24720AF
28	Exclusive flood control zone	1335.0-1350.0 3980AF	1307.4-1322.5 7220AF	1287.8-1302.0 6790AF	1271.1-1285.0 4700AF	1244.9-1262.0 5560AF	1232.9-1252.0 8030AF	1341.0-1355.0 5250AF	1244.3-1263.5 21010AF	1242.4-1266.0 5730AF	1284.0-1311.0 71570AF
29	Joint use zone	none	none	none	none	none	none	none	none	none	none
30	Conservation zone	none	1306.1-1307.4 380AF	1284.6-1287.8 830AF	none	1241.9-1244.9 570AF	none	1337.4-1341.0 810AF	none	1240.0-1242.4 210AF	1275.7-1284.0 12740AF
31	Sediment pool zone	1314.0-1335.0 1490AF	1277.0-1306.1 2660AF	1260.0-1284.6 1660AF	1246.0-1271.1 1940AF	1218.0-1241.9 1430AF	1197.0-1232.9 2610AF	1306.0-1337.4 2020AF	1206.0-1244.3 8510AF	1218.0-1240.0 570AF	1250.0-1275.7 13250AF
32	Gross Storage (Excl. of surcharge)	5470 AF	10260AF	9280AF	6640AF	7560AF	10640AF	8080 AF	29520AF	6510AF	97560AF
	OUTLET WORKS										
33	Number and size — conduits	1—CMP—48" Dia. With 30" RCP lining	1 — CMP — 60" Dia. With 42" RCP lining	1—CMP—60" Dia. With 42" RCP lining	1—CMP—48" Dia. With 30" RCP lining	1—CMP—42" Dia. With 30" RCP Lining	1—CMP—60" Dia. With 42" RCP lining	1—CMP—42" Dia. With 30" RCP lining	1 — CMP — 60" Dia. With 42" RCP lining	1 — CMP — 60" Dia. With 42" RCP lining	1—CMP—concrete Lined—72" Dia.
34	Conduit length — ft.	280	313	299	280	300	318	335	382	320	370
35	Gated outlets (No. — size — type — invert. elev.)	1—36"x36" Lift gate—1330.0	1—36"x36" Lift gate—1303.0	1—36"x36" Lift gate—1282.8	1—36"x36" Lift gate—1266.0	1—36"x36" Lift gate—1237.0	1—36"x36" Lift gate—1228.0	1—42"x54" Lift gate—1333.0	1—42"x60" Lift gate—1236.0	1—36"x36" Lift gate—1239.0	1—48"x72" Lift gate—1274.0
36	Ungated outlets (Openings — size — elev.)	2—24"x72"—1340.9 2—12"x30"—1335.0	2—30"x96"—1313.5 2—12"x54"—1307.4	2—30"x96"—1292.4 2—12"x54"—1287.8	2—24"x72"—1277.1 2—12"x30"—1271.1	2—18"x63"—1250.0 2—12"x30"—1244.9	2—30"x96"—1242.3 2—12"x54"—1232.9	2—24"x63"—1341.0	2—34"x120"—1244.3	2—30"x96"—1249.0 2—12"x36"—1242.5	1—10" Dia. slide gate—1276.3 2—42"x144"—1283.95
37	Disch. capac. — cfs (At base of EFC zone)	80	75	75	80	95	80	145	210	60	300
	POWER INSTALLATION										
38	No. and size of turbines										
39	No. and rating of generators	none	none	none	none	none	none	none	none	none	none
40	Plant capacity										
41	Power Plant disch. capac. (At base of EFC zone)										

(1) Total project financial cost including all dams = $12,075,000 (Costs are as of 9-30-80)

September 1986

SUMMARY OF ENGINEERING DATA — FEDERAL RESERVOIRS WITH AUTHORIZED FLOOD CONTROL
MISSOURI RIVER TRIBUTARIES — U.S. ENGINEER DISTRICT — OMAHA
PAPILLION CREEK BASIN — NEBRASKA

ITEM NO.	SUBJECT	DAM NO. 11 (Glenn Cunningham Lake)	DAM NO. 16 (Standing Bear Lake)	DAM NO. 18	DAM NO. 20
	GENERAL				
1	Location of dam	93rd State Street	132nd and Fort Street	156th and "F" Street	156th and Giles Road
2	River and mileage	Knight Creek —	Tributary Big Papio —	Boxelder Creek —	Trib. South Branch Papio —
3	Drainage area (sq. mi.)	17.8	6	16.4	13.1
4	Reservoir length in miles	2.5	1.0	1.5	1.5
5	Location of Damtender	None	None	None	None
6	Travel time to Missouri River	5-10 Hours	5-10 Hours	5-10 Hours	5-10 Hours
7	Max. discharge of record	—	—	—	—
8	Project cost (1)	$11,800,000	$4,500,000	$17,300,000	$13,300,000
	DAM AND EMBANKMENT				
9	Top of dam — ft. MSL	1152	1130.0	1143.5	1131
10	Length of dam — ft.	1940	1460	1400	1810
11	Height of dam — ft.	67	70	64	59
12	Stream bed — ft. MSL	1085	1060	1079.5	1069
13	Abutment formation	Lean clay loess	Lean clay loess	Lean clay loess	Lean clay loess
14	Type of fill	Rolled earth	Rolled earth	Rolled earth	Rolled earth
15	Fill quantity in cu. yds.	656,000	481,000	1,263,000	767,450
16	Date of closure	5 Aug 1974	3 Oct 1972	15 July 1984	21 Sep 1982
17	Date of initial fill	2 Sep 1977	24 Oct. 1977	—	—
	SPILLWAY				
18	Discharge capacity — cfs (max. pool)	18,700	9,500	30,000	12,000
19	Crest elev. — ft. MSL	1142	1121	1128.2	1120
20	Width — ft.	700	250	400	400
21	Gates, number, size, type	Ungated earth channel	Ungated earth channel	Ungated earth channel	Ungated earth channel
	RESERVOIR ELEV. AND AREA				
22	Maximum pool	1147 1171a.	1127 368a.	1138.2 860a.	1126 812a.
23	Top of flood control pool	1142 992a.	1121 302a.	1128.2 594a.	1113.1 489a.
24	Top of multipurpose pool	1121 392a.	1104 137a.	1110.0 253a.	1096.0 241a.
	STORAGE ZONES (Elev.-Capacity)				
25	Surcharge	1142-1147 5,410AF	1121-1127 2,010AF	1128.2-1138.2 7,225AF	1113.1-1126 8,332AF
26	Flood control	1121-1142 14,000AF	1104-1121 3,720AF	1110.0-1128.2 7,585AF	1096-1113.1 6,034AF
27	Multipurpose	1085-1121 3,910AF	1060-1104 1,500AF	1060.5-1110.0 3,470AF	1069-1096 2,679AF
28	Gross storage (Excl. of surcharge)	17,910AF	5,220AF	11,055AF	8,756AF
	OUTLET WORKS				
29	Number and size — conduits	1 — RCP — 54" diameter	1 — RCP — 36" diameter	1 — RCP — 48" diameter	1 — RCP — 48" diameter
30	Conduit length — ft.	680	736	782	656
31	Discharge capacity of conduit — CFS (at top of F.C. Pool)	570	160	358	490
32	Gated outlets (No. — size — invert elev. of intake in ft. MSL)	1 — 30' diameter 1100	1 — 30" diameter 1080.0	1 — 36" 1090.0 1 — 6" 1104.25	1 — 30" diameter 1077.0
33	Discharge capacity of gated outlets — CFS (at base of F.C. Pool)	90	90	140	90
34	Ungated outlets (No. — size — invert elev. — ft. MSL)	2 — 15'x5.0' 1121 2 — 2.4'x9.0' 1127.5	2 — 1.0'x2.5' 1104.0 2 — 3.0'x6.0' 1109.0	2 — 1.5'x3.5' 1110.0 2 — 3.15'x8.0' 1117.6	2 — 1.25'x3.5' 1096.0 2 — 3.75'x8.0' 1103.4
35	POWER INSTALLATION	None	None	None	None

MRO FORM 1 SEP 74 1590

(1) Cost as of 9-30-83

September 1986

SUMMARY OF ENGINEERING DATA — FEDERAL RESERVOIRS WITH AUTHORIZED FLOOD CONTROL
MISSOURI RIVER TRIBUTARIES — U.S. ENGINEER DISTRICT — OMAHA
BUREAU OF RECLAMATION DAMS

ITEM NO.	SUBJECT	BOYSEN	CANYON FERRY	CLARK CANYON	GLENDO	HEART BUTTE	JAMESTOWN	KEYHOLE	PACTOLA	SHADEHILL	TIBER	YELLOWTAIL
	GENERAL											
1	Location of dam	20 mi. S. of Thermopolis, Wy.	17 mi. N.E. of Helena, Mont.	18 mi. S.W. of Dillon, Mont.	4.5 mi. S.E. of Glendo, Wyo.	15 mi. S. of Glen Ullin, N.D.	1 mi. N. of Jamestown, N.D.	12 mi. N.E. of Moorcraft, Wyo.	15 mi. W. of Rapid City, S.D.	1 mi. W. of Shadehill, S.D.	15 mi. S.W. of Chester, Mont.	45 mi. S.W. of Hardin, Mont.
2	River and mileage	Bighorn R.M. 295	Missouri R.M. 2253	Beaverhead	North Platte R.M. 280	Heart R.M. 103.5	James R.M. 580	Belle Fourche R.M. 289	Rapid Cr. R.M. 110	Grand R.M. 90	Marias R.M. 71	Bighorn
3	Drainage area in square miles	7710	15900	2320	14330	1710	1300	1950	319	3120	4850	19,626
4	Reservoir length in miles	17.5 at el. 4725	25 at el. 3800	5 at el. 5560.4	15 at el. 4635	12 at el. 2094.5	40 at el. 1454	10 at el. 4111.4	4.5 at el. 4621.5	10 at el. 2302	25 at el. 3012.5	71 at el. 3657
5	Location of Damtender	On site	On site	Dillon, Mont.	On site	On site	none	Pactola Dam	On site	On site	On site	On site
6	Travel time to Missouri River	6 days	4.5 days to Ft. Peck	2.5 days to Three Forks	About 3 weeks	2 days	About 7 weeks	5 days	3 days	2 days	1.25 days	4 days
7	Max. discharge of record	29,800 cfs Jul. 1923	47000 cfs Jun. 1908	3720 CFS Jun. 1908	30,000 cfs Jun. 1908	30,500 cfs May 1970	± 8000 cfs Apr. 1969	12,000 cfs Apr. 1924	2200 cfs May 1952	58,000 cfs Apr. 1950	40,000 cfs Jun. 1948	37,400 cfs Jun. 1935
8	Project cost (1)	$33,498,000	$42,546,000	$12,108,000	$44,371,000	$3,576,000	$3,717,000	$4,722,000	$7,861,000	$7,269,000	$44,909,000 (1983)	$95,900,000
	DAM AND EMBANKMENT											
9	Top of dam — ft. MSL	4758.0	3808.5	5578.0	4675.0	2124.0	1471.0	4134.0	4640.0	2318.0	3026.0	3660.0
10	Length of dam — ft.	1143	1000	2950	2096	1850	1418	3420	1300	12,840	4300	1450
11	Height of dam — ft.	150	225	147.5	167	124	85	118	220	122	201	524
12	Stream bed — ft. MSL	4608	3635.5	5446.5	4508	2000	1386	4016	4422	2196	2823.5	3166
13	Abutment formation	Sandstone — shale — limestone	Shale — slate	Sand — bentonitic tuff	Sandstone — shale	Sandstone	Pierre shale	Sandstone and shale	Slate and schist	Sand, silt and clay	Shale and sandstone	Limestone
14	Type of fill	Rolled earth	Concrete gravity	Rolled earth	Rolled earth	Rolled earth	Rolled earth	Rolled earth and rock	Rolled earth and rock	Rolled earth	Rolled earth	Concrete thin-arch
15	Fill quantity in cu. yds.	1,527,000	407,100	1,884,000	2,676,000	1,140,000	963,000	1,329,000	4,225,000	3,391,000	12,049,000	1,546,000
16	Date of closure	Oct. 1951	Mar. 1953	Aug. 1964	Jun. 1956	Aug. 1949	May 1953	Mar. 1952	Aug. 1956	Jul. 1950	Oct. 1950	Dec. 1966
17	Date of initial fill (top of conser. pool)	Jun. 1952	Jul. 1955	Jun. 1965	May 1959	Apr. 1950	Apr. 1965	May 1978	Jun. 1963	Apr. 1952	Aug. 1956	Jun. 1967
	SPILLWAY											
18	Discharge capacity — cfs (Max. pool)	20,000 at el. 4725	150,000	9530	10,300	5650	2930	11000	38,400	(Service) 5700 127,000 cfs	68,470	92000
19	Crest elev. — ft. MSL	4700.0	3766.0	5560.4	4653.0	2064.5	1454	4099.3	4621.5	2271.9 2302.0	2975.0	3593.0
20	Width — ft.	60 (net) 66 (total)	204 (net) 222 (gross)	100	45	27	9.5	19.25	250	— 1500	66	50 (net)
21	Gates, number, size, type	2 (30x25 ft) radial	4 (51x34.5 ft) radial	Ungated chute	Ungated ogee weir	Ungated glory hole	Ungated glory hole	Ungated ogee weir	Ungated ogee weir	Ungated Glory hole Ungated earth channel	3 — 22x38 ft. radial	2 — 25x64.4 ft. radial
	RESERVOIR ELEV. AND AREA											
22	Maximum pool	4752.0 30,860a.	3800.0 33,535a.	5571.9 6600a.	4669.0 23,300a.	2118.2 10,950a.	1464.4 17,430a.	4128.7 10,730a.	4633.7 1,360a.	2312.0 12,150a.	3020.2 25,410a.	3660.0 17,940a.
23	Top of flood control pool	4732.2 22,170a.	3800.0 33,535a.	5560.4 5900a.	4653.0 17,990a.	2094.5 6,580a.	1454.0 13,210a.	4111.5 13,730a.	4621.5 1,230a.	2302.0 9900a.	3012.5 23,150a.	3657.0 17,280a.
24	Top of joint use pool	4725.0 19,560a.	3797.0 32,800a.	5546.1 5160a.	—	—	1432.67 2,560a.	—	—	2272.0 4800a.	2993.0 17,890a.	3640.0 12,600a.
25	Top of conservation pool	4717.0 16,960a.	3770.0 24,125a.	5535.7 4495a.	4635.0 12,370a.	2064.5 3,400a.	1429.8 2,090a.	4099.3 9,410a.	4580.2 860a.	2260.0 3600a.	2976.0 13,790a.	3614.0 6915a.
26	Top of inactive pool	4685.0 9,280a.	3728.0 11,480a.	5470.6 220a.	4570.0 3,130a.	2030.0 800a.	1400.0 160a.	4051.0 820a.	4456.1 100a.	2250.8 2800a.	2966.4 11,710a.	3547.0 4150a.
	STORAGE ZONES (Elev.-Capacity)											
27	Surcharge zone	4732.2-4752.0 520,700AF	none	5560.4-5571.9 71,830AF	4653.0-4669.0 329,300AF	2094.5-2118.2 206,400AF	1454.0-1464.4 158,900AF	4111.5-4128.7 294,800AF	4621.5-4633.7 15,800AF	2302.0-2312.0 111,200AF	3012.5-3020.2 187,740AF	3657.0-3660.0 52,830AF
28	Exclusive flood control zone	4725.0-4732.2 150,400AF	3797.0-3800.0 99,460AF	5546.1-5560.4 79,090AF	4635.0-4653.0 271,900AF	2064.5-2094.5 147,900AF	1432.7-1454.0 185,400AF	4099.3-4111.5 140,500AF	4580.2-4621.5 43,100AF	2271.9-2302.0 218,300AF	2993.0-3012.5 400,900AF	3640.0-3657.0 258,330AF
29	Joint use zone	4717.0-4725.0 146,100AF	3770.0-3797.0 795,135AF	5535.7-5546.1 50,440AF	none	none	1429.8-1432.7 6,600AF	none	none	none	2976.0-2993.0 268,000AF	3614.0-3640.0 240,340AF
30	Conservation zone	4685.0-4717.0 403,800AF	3728.0-3770.0 711,460AF	5470.6-5535.7 126,120AF	4570.0-4635.0 454,300AF	2030.0-2064.5 69,000AF	1400.0-1429.8 28,100AF	4051.0-4099.3 185,800AF	4456.1-4580.2 55,000AF	2250.8-2271.9 80,900AF	2976.0-2993.0 268,000AF	3547.0-3614.0 336,100AF
31	Inactive zone	4608.0-4685.0 252,100AF	3635.5-3728.0 445,455AF	5446.5-5470.6 1,510AF	4508.0-4570.0 63,200AF	2000.0-2030.0 6,800AF	1386.0-1400.0 820AF	4016.0-4051.0 8,000AF	4422.0-4456.1 1,000AF	2196.0-2250.8 58,200AF	2823.5-2966.4 577,620AF	3166.0-3547.0 493,580AF
32	Gross Storage (Excl. of surcharge)	952,400AF	2,051,520AF	257,150AF	789,400AF	223,600AF	221,000AF	334,200AF	99,000AF	357,400AF	1,555,960AF	1,328,360AF
	OUTLET WORKS											
33	Number and size — conduits	1 — 66 in. I.D. 1 — 57 in. I.D.	4 — 84 in. I.D. 1 — 13 ft. I.D. pump intake	1 — 9 ft. I.D.	1 — 21 ft. I.D.	1 — 63 in. I.D.	1 — 9.5 ft. — 13.5 ft.	1 — 9.5x8.25	1 — 6 ft.	1 — 7 ft. I.D.	1 conduit containing 1—72'', 1—22'' pipes	2 — 84 in. 1 — 9.5 ft.
34	Conduit length — ft.	300	84 in. — 115	741	2300	597	443.75	653.4	740	355	72''—1110 22''—1090	289 — 216 — 305
35	No. — size — type gates	2 — 48 in. Jet valves	4 — 77 in. Slide 9500	2 — 3x6.5 ft. Slide	3 — 7.25x7.75 ft. Slide	1 — 4x5 ft. Slide	2 — 5x6 ft. Slide	2 — 3.5x3.5 ft. Slide	2 — 2.75x2.75 ft. Slide	1 — 6x6 ft. radial	1—5x5' Slide, 1—18'' butterfly	3 — bulkhead gates
36	Disch. capac. — cfs (At base of EFC zone)	66 in. — 640 57 in. — 670	1 — 13 ft. dia. 600 3 — 13.5 ft. dia. 5,970	2200	11,300	690	2175 at el. 1429.8	1250	1020	600 at el. 2260	1425 at el. 2993 Auxiliary Outlet (see (2) footnote)	84 in. — 2500 each 9.5 ft. — 862
	POWER INSTALLATION											
37	No. and size of turbines	2 — 10,500 HP	3 — 23,500 HP	none	2 — 16,750 HP	none	none	none	none	none	none	4 — 87,500 HP
38	No. and rating of generators	2 — 7500 KW	3 — 16,667 KW		2 — 12,000 KW							4 — 62,500 KW
39	Plant capacity	15,000 KW	50,000 KW		24,000 KW							250,000 KW
40	Power Plant disch. capac. (At base of EFC zone)	2300 cfs	5200 cfs		3300 cfs							7800 cfs

September 1986

(1) These costs to complete the dam and reservoir, the associated recreation and fish and wildlife facilities and the power plant were applicable. Costs do not include irrigation facilities except those located at the dam. Costs are as of 6-30-76.

(2) TIBER AUXILIARY OUTLET

No. and size of conduits	1 — 10.75 in. I.D.
Conduit length — ft.	1535
No. — Size — Type gates	1 — 7.25x9.25 ft. slide 2 — 7.0x12.0 ft. slide
Discharge capacity — cfs	4250 at el. 3020.2

PERTINENT DATA

SNAKE CREEK DAM
(LAKE AUDUBON)

Location - On Snake Creek arm of Lake Sakakawea, approximately 12 miles northeast of Garrison Dam, North Dakota.

Purpose - The dam and reservoir are a relocation route for transportation facilities and utilities which were inundated by Lake Sakakawea, a regulating reservoir for the Bureau's Garrison Diversion Unit, and provide for fish and wildlife and recreation.

Drainage Area - 250 sq. mi. (110 sq. mi. of which is non-contributing).

Dam and Embankment

Type of Fill - Rolled Earth
Top of Dam Elev. - 1865 ft. m.s.l.
Length of Dam - 12,900 ft.
Height of Dam - 85 ft. maximum
Streambed - 1780 ft. m.s.l.
Date of Closure - 1952
Date of Initial Fill - Not Yet

Spillway - None (An original designated ungated spillway of 3 - 60" culverts with a crest of elevation of 1850 was filled in and closed in 1972 when the embankment was widened to provide for a four lane highway. It was located 180 ft. north of regulating conduit).

Reservoir Elevations, Area and Capacity

	Ft.m.s.l.	Acres	Acre-Feet
Maximum Normal Operating Pool	1850	20,620	396,000
Minimum Normal Operating Pool	1847	18,780	336,870
Top of Inactive Pool	1810	1,450	13,180
Streambed	1780	0	0

Outlet Works - A 7x10 ft. reinforced concrete conduit, invert elev. 1810, regulated by a motor or hand operated 7x10 ft. sluice gate. Located about 3000 ft. south of north end of main embankment. Discharge capacity 2,300 c.f.s. under 15 ft. head differential. Two 7'x10' bulkheads one on each side of sluice gate. Stilling basin on Garrison side.

PERTINENT DATA

SPRING CREEK DAM
(LAKE POCASSE)

Location - On Spring Creek arm of Lake Oahe, at Pollock, South Dakota

Purpose - It is a road relocation route for the area inundated by Lake Oahe. Control structures are provided to regulate Lake Pocasse for fish and wildlife and recreation. In the future it will be used as a regulating reservoir for the Bureau's Pollock Herrid Unit. This unit will pump water from Lake Oahe and use it for irrigation and M & I water for the two towns.

Drainage Area - 660 sq. mi. (330 sq. mi. of which is non-contributing).

Dam and Embankment

Type of Fill - Rolled Earth
Top of Dam Elev. - 1625 ft. m.s.l.
Length of Dam - 3,200 ft.
Height of Dam - 40 ft. maximum
Streambed - 1585 ft. m.s.l.
Date of Closure - 1961
Date of Initial Fill - Between 1961 and 1964

Spillway - Nine 6x8 ft. uncontrolled box culverts with a crest elevation of 1617 ft. m.s.l.

Reservoir Elevations, Area and Capacity

	Ft.m.s.l.	Acres	Acre-Feet
Spillway Crest	1617	-	11,000
Top of Conservation	1616	-	9,500
Bottom of Conservation	1613	-	6,000
Top of Inactive Pool	1602	-	1,000
Streambed	1585	-	0

Outlet Works - One 5 ft. CMP conduit with a 5x5 ft. sluice gate, invert elev. 1602 and a 5x12 ft. overflow roller gate, invert elev. 1609.

TOTAL NUMBER OF FLOOD CONTROL RESERVOIRS IN THE OMAHA DISTRICT
MONITORED AND/OR REGULATED AND REPORTED BY THE RESERVOIR REGULATION SECTION

AS OF 1 JAN	MAIN STEM	TRIBUTARY C.E.	TRIBUTARY U.S.B.R.	TOTAL**
1937	0	0	0	0
1938	1 (Ft.Peck)	0	0	1
1939	1	0	0	1
1940	1	0	0	1
1941	1	0	0	1
1942	1	0	0	1
1943	1	0	0	1
1944	1	0	0	1
1945	1	0	0	1
1946	1	0	0	1
1947	1	0	0	1
1948	1	0	0	1
1949	1	1 (Cherry Creek)	0	2
1950	1	1	1 (Heart Butte)	3
1951	1	1	3 (Shadehill, Tiber)	5
1952	1	1	4 (Boysen)	6
1953	2 (Ft.Randall)	2 (Cold Brook)	5 (Keyhole)	9
1954	3 (Garrison)	3 (Kelly Road)	6 (Jamestown)	12
1955	3	3	6	12
1956	4 (Gavins Pt.)	4 (Bull Hook-Scott Coulee)	6	14
1957	4	4	8 (Glendo, Pactola)	16
1958	4	4	8	16
1959	5 (Oahe)	4	8	17
1960	5	5 (Cedar Canyon)	8	18
1961	5	5	8	18
1962	5	5	8	18
1963	5	8 (Salt Creek)	8	21
1964	6 (Big Bend)	11 (Salt Creek)	8	25
1965	6	12 (Salt Creek)	9 (Clark Canyon)	27
1966	6	14 (Salt Creek)	9	29
1967	6	15 (Bowman-Haley)	11 (Yellowtail,Canyon Ferry)	32
1968	6	16 (Salt Creek)	11	33
1969	6	16	11	33
1970	6	17 (Cottonwood Springs)	11	34
1971	6	17	11	34
1972	6	17	11	34
1973	6	17	11	34
1974	6	20 (Pipestem,Chatfield,Papio)	11	37
1975	6	21 (Papio)	11	38
1976	6	21	11	38
1977	6	21	11	38
1978	6	22 (Bear Creek)	11	39
1979	6	22	11	39
1980	6	22	11	39
1981	6	22	11	39
1982	6	22	11	39
1983	6	23 (Papio)	11	40
1984	6	24 (Papio)	11	41
1985	6	24	11	41
1986	6	24	11	41

*Prior to 1960 most projects were in the Ft. Peck or Garrison Districts)
** Two Subimpoundments (Lake Pocasse and Snake Creek) are not included.

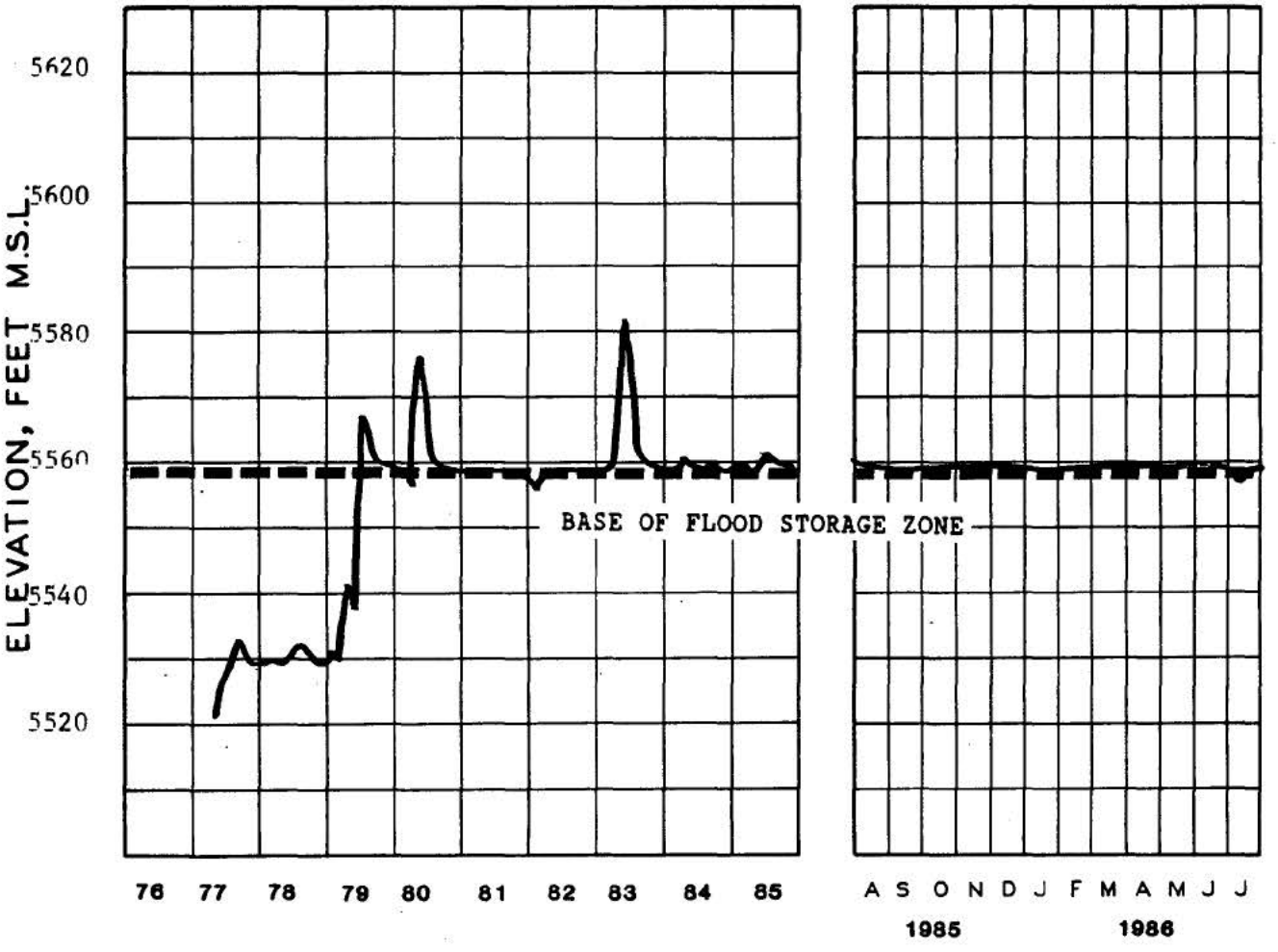
ENCLOSURE 3

REGULATION SHEETS FOR PAST YEARS

ENCLOSURE 4

BEAR CREEK DAM AND LAKE
BEAR CREEK, COLORADO
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



Bear Creek outlet works is normally operated to pass streamflow of 500 cfs when pool elevations are above the drop inlet-outlet weir crest of 5558 feet MSL. If conditions warrant, higher releases are obtainable by opening two slide service gates in the dome type gated control structure buried under the embankment. A maximum discharge of 2,160 cfs is obtainable at a reservoir elevation of 5667 MSL. In a Memorandum of Understanding dated May 11, 1977, the Colorado State Engineer is responsible for releases to meet downstream water rights when pool elevations are below the outlet weir crest.

Precipitation reported at Lakewood, Colorado ranged from a minimum of 0.15" in January to a maximum of 2.59" in April. The only Reservoir Regulation Order was issued on 3 July 1986. This action was taken to lower the pool level below the ungated weir to allow dry inspection of the outlet conduit.

The maximum pool achieved during the period was 5559.58 feet MSL on 11 June 1986. The peak daily inflow was 175 cfs on 11 April 1986. The peak outflow of 180 cfs also occurred on this date. The minimum pool elevation of 5557.08 ft MSL occurred on 9 July 1986. This is the second lowest pool elevation since initial fill. No flood control was achieved during this period.

BEAR CREEK DAM AND LAKE (CONT'D)

Maximums of Record:

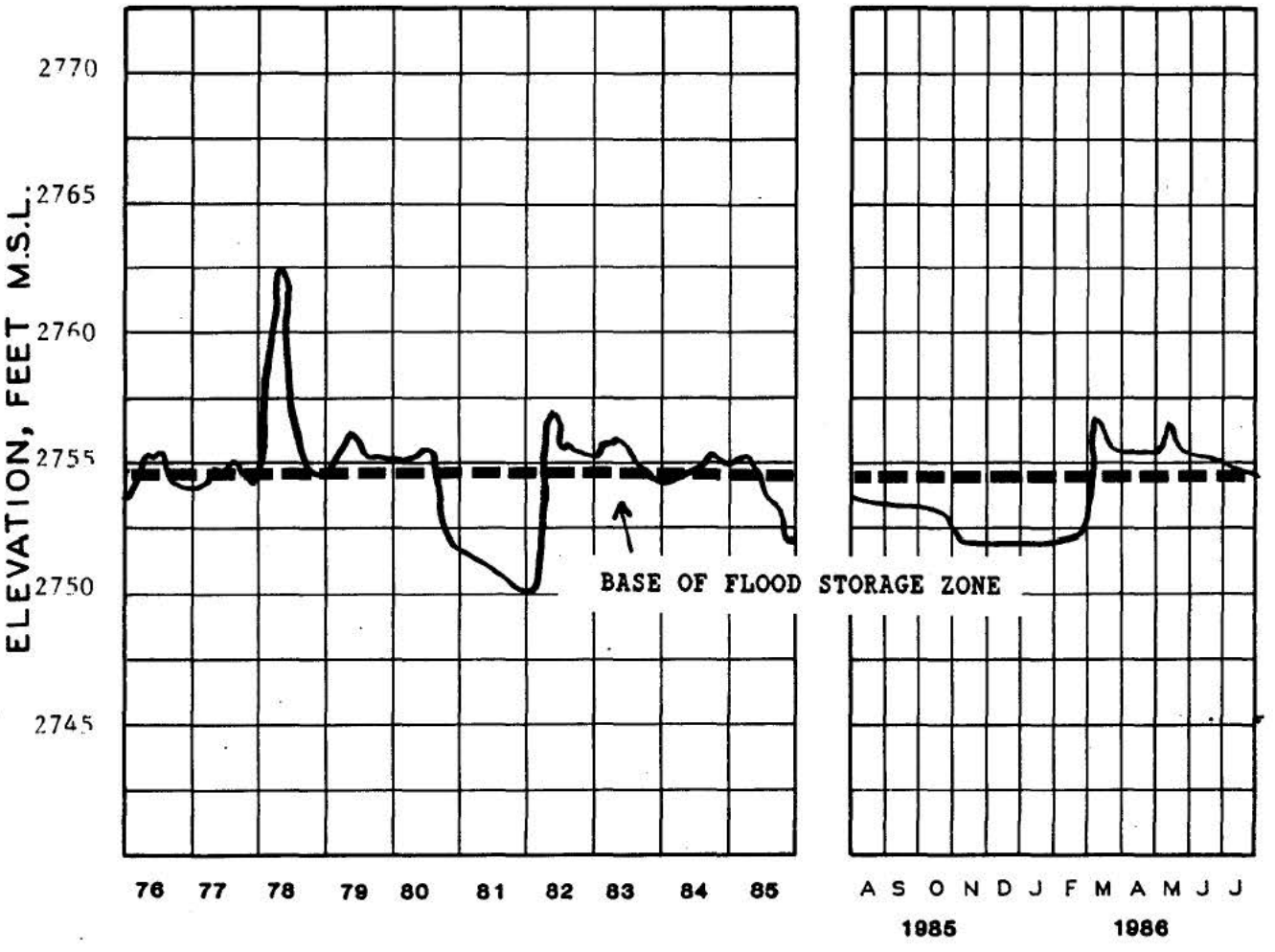
	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	5581.0 Jun 23 83	910 cfs May 1 80	800 cfs May 5-12 80
2nd	5576.3 May 19 80	690 cfs Jun 10 79	800 cfs Jun 12 79
3rd	5567.9 Jun 10 79	625 cfs May 23 83	605 cfs Jun 29-Jul 2 83

Minimums of Record (since initial fill):

	Pool-Date
Lowest	5556.98 Feb 9 82
2nd	5557.08 Jul 9 86

BOWMAN-HALEY DAM AND LAKE
GRAND RIVER BASIN, NORTH DAKOTA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



From 22 October to 8 November the Lake was lowered one foot from elevation 2753 to 2752 in response to a request by the local sponsor. A gated low or mid level release of 40 cfs was made. This operation lowered the volume of the full conservation pool to 73 percent and was made in an attempt to improve the lake water quality, hoping it would refill with better quality water. Following consultation with the Corps, the local sponsor had then planned to pump poor quality from the lake bottom into the outlet during mid-February while the surface was still frozen. However, the pumps and pipeline were not obtained in time to safety permit this operation. Instead, following a request by the local sponsor, the low or mid-level gate was opened on 28 February to discharge 20 cfs and increased to discharge 60 cfs. The release was maintained by the Corps. The gate was closed on 26 March. The low or mid-level gated release during October-November was 1,350 AF and March 2,800 AF. Any water improvement effect of these releases has not been determined. The local sponsor plans to pump in February 1987 as they now have equipment for this operation. Based on this year's early release, a release of 10-15 cfs starting in late January or early February could be made without causing any siginficant downstream problems. The melt and runoff of the winter snow pack began on 26 February. Water began to

spill over the morning-glory spillway on 4 March. The maximum pool elevation during the period occurred on 7 March at elevation 2757.1 feet msl. A total of 4,275 AF or about 6 percent of the 72,700 AF flood control zone was utilized. The peak daily inflow was 1,400 cfs occurring on 6 March

The maximum daily outflow was 517 cfs occurring on 8 March. The minimum pool level was 2751.99 occurring on 10 November. The low level gate was again opened for 3 days in July to a release rate of 60 cfs in order to lower the pool below the morning-glory crest to permit day inspection of the outlet conduit. No significant flood control was achieved during the period.

Maximums of Record:

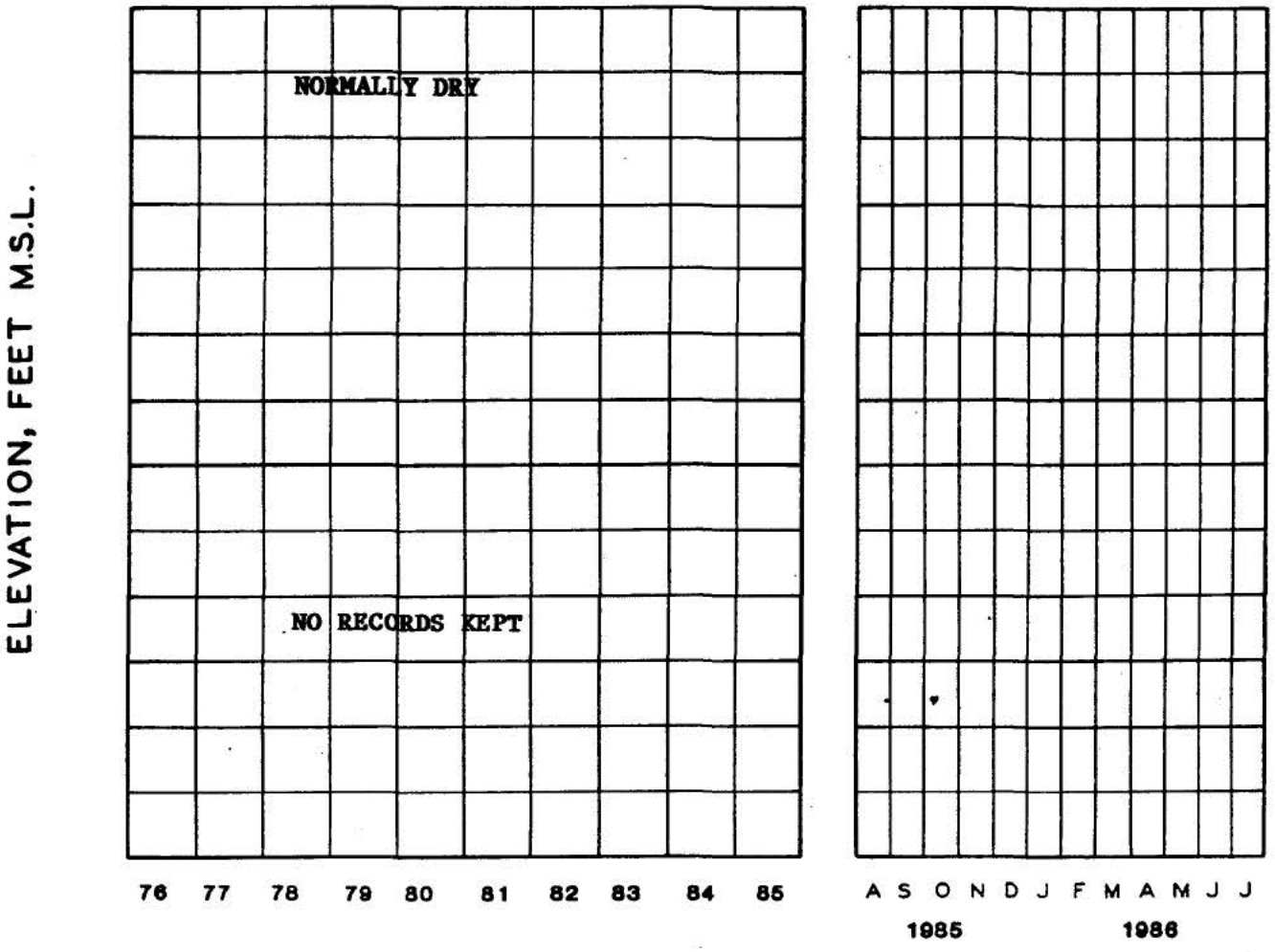
	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	2762.66 Mar 28 78	5,310 cfs Mar 27 78	2,390 cfs Mar 28 78
2nd	2758.50 Mar 13 72	1,770 cfs Mar 11 72	1,125 cfs Mar 14 72
3rd	2758.08 Mar 30 71	1,755 cfs Mar 21 69	930 cfs Mar 30 71

Minimums of Record (since initial fill):

	Pool-Date
Lowest	2749.96 Jan 9 82
2nd	2752.78 Mar 8, 9, 10 75

BULL HOOK-SCOTT COULEE DAMS
MILK RIVER BASIN, MONTANA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



Bull Hook and Scott Coulee Dams are both part of the Bull Hook Unit providing flood control for the city of Havre, Montana. Bull Hook and Scott Coulee dams are both located south of Havre on Bull Hook and Scott Coulee Creeks, respectively.

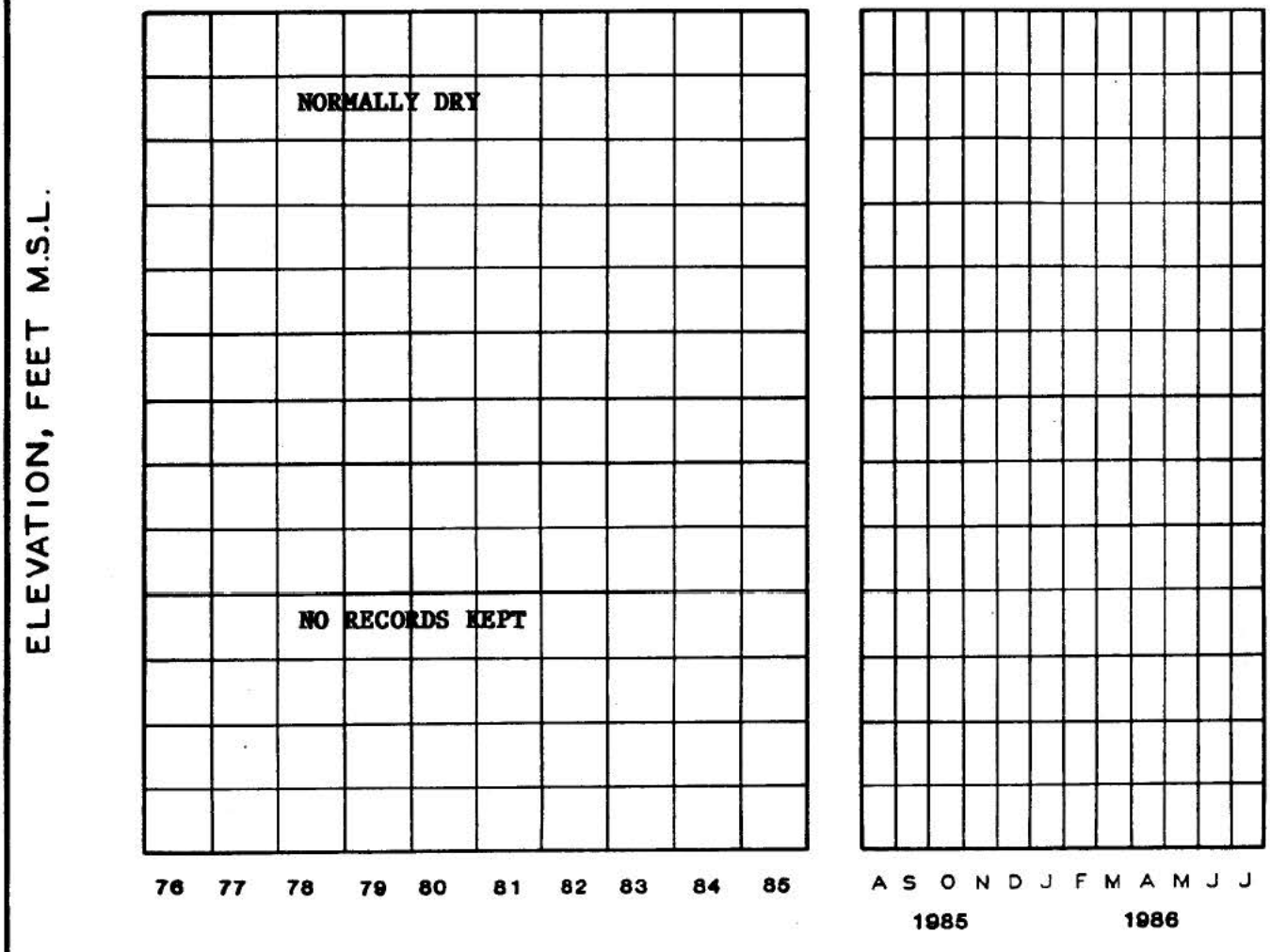
Under normal circumstances the conduit valves of both dams will be kept partially open to evacuate accumulated storage as expeditiously as possible to allow the dams to function as flood protection facilities if excess runoff occurs upstream. Valve openings are to be maintained that will allow only the minimal damages to occur in the city of Havre.

At times of high flows on the Milk River it may be necessary to shut off releases in both dams to prevent flooding behind the Milk River levees.

A small amount of storage accumulated due to snowmelt in late February (approximately 2 feet in Bull Hook and 1 foot in Scott Coulee). No flood control was achieved during the report period.

CEDAR CANYON DAM (RED DALE GULCH)
RAPID CREEK BASIN, SOUTH DAKOTA
1985-1986 REGULATIONS

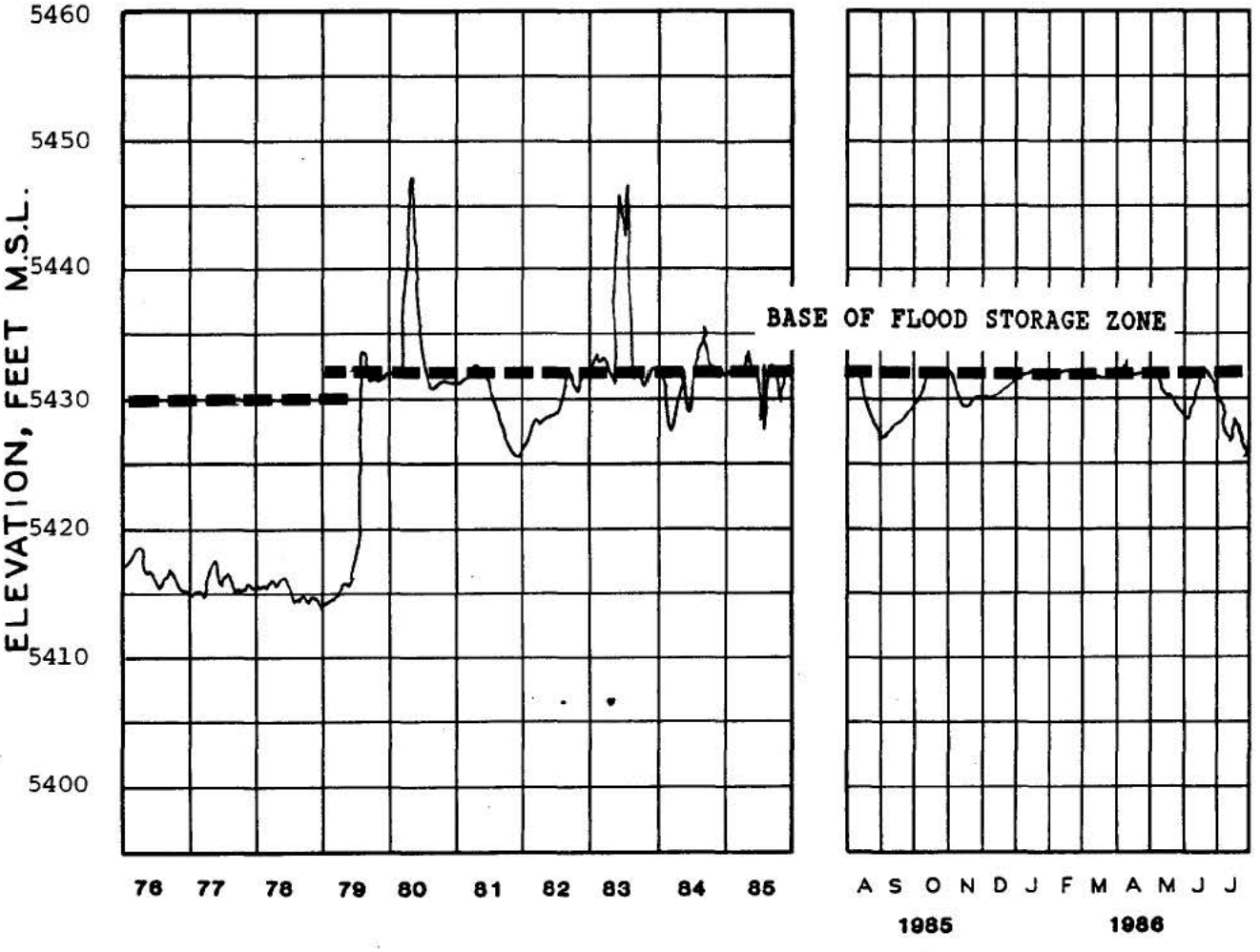
A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



Cedar Canyon Dam is located on the western outskirts of Rapid City, South Dakota. The dam is designed as a detention structure with no permanent storage, however, a small pool may sometimes exist in the dead storage below the invert of the outlet pipe. The dam collects runoff from approximately 261 acres. The outlet and spillway are uncontrolled. No water accumulated during the report period, other than small amounts of runoff from a few heavy rains that fell in the Rapid City area although not centered over the drainage area of this project. Inflow was negligible and outflow was zero for the period. No flood control was achieved.

CHATFIELD DAM AND LAKE
SOUTH PLATTE RIVER BASIN, COLORADO
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



Before the dam became operational, the Corps (MROED-HC) requested that the Colorado State Engineer's Office, acting through the District 8 Water Commissioner, assume responsibility for determining releases from the multipurpose pool in an effort to keep the Corps free of water right conflicts. This relationship was put into a formal document dated March 30, 1973 and revised March 1, 1979, when the multipurpose pool was increased and contained water storage commitments by the State. By contract the State is committed to keeping the pool above elevation 5423.0 for recreation and fish and wildlife purposes. Since 1979, the City of Denver through the State of Colorado has been permitted to regulate storage in the conservation pool in return for the City's commitment to provide sufficient water in the pool for recreation. The City is committed to keeping 20,000 AF (Elev. 5426.94 feet MSL) of water in the pool from May 1 to August 31, and permitted to use storage space (10,000 AF) in the reservoir between elevations 5423.8 and 5432.0 feet MSL. The original top of multipurpose pool level was at elevation 5426 feet MSL.

CHATFIELD DAM AND LAKE (CONT'D)

The April through September streamflow on the South Platte River at South Platte was 109% of average. The pool was maintained near elevation 5432.0 ft. MSL from January through April. Releases from the flood storage zone were directed by the Corps from April 4 through 15 following high runoff from a widespread snowstorm. The drawdown which occurred during the summer months was ordered by the State of Colorado in response to the Denver Water Board reutilization of water from the Moffit Tunnel to meet downstream water rights. The Colorado courts are currently considering the issue of water reuse in the accounting system. This drawdown action was not in violation of any contracts that exist between the Corps and the State, however, breech of contract did occur between the State Game and Parks Department and the concessioner at Chatfield. The July 31, 1986 pool elevation of 5426.17 feet MSL is the second lowest pool of record since initial fill.

The maximum pool achieved during the period was 5432.69 feet MSL on April 10, 1986 (989 AF of 204,737 AF of flood space was utilized). The peak daily inflow was 870 cfs on June 11. Outflow on this date was 42.1 cfs. The peak daily outflow was 892 cfs on August 4, 1985. Downstream flooding was prevented by the project.

Maximums of Record:

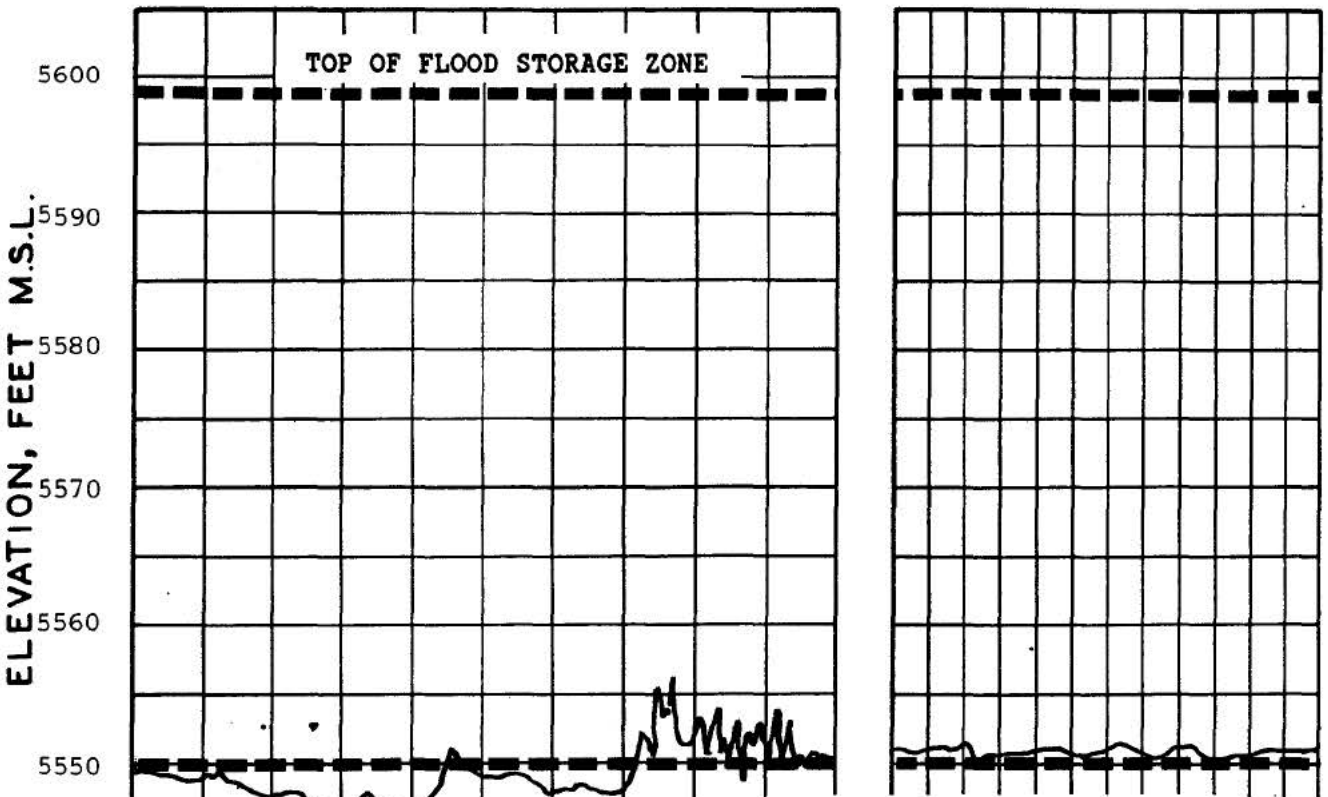
	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	5447.58 May 26 80	3,370 cfs May 30 83	3,034 cfs May 15 84
2nd	5447.08 Jun 30 83	3,155 cfs May 9 80	2,858 cfs Jul 8 83
3rd	5445.97 Jun 16 83	3,030 cfs May 15 84	2,415 cfs May 12 83

Minimums of Record (since initial fill):

	Pool-Date
Lowest	5425.20 Dec 6 81
2nd	5426.17 Jul 31 86

CHERRY CREEK DAM AND LAKE
CHERRY CREEK, SOUTH PLATTE RIVER BASIN, COLORADO
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



The Cherry Creek basin experienced the fourth consecutive year of above normal runoff with a water year total of 11,980 AF (166% of average). Runoff from the September 1985 through February 1986 averaged 499% of normal. A total of 10,695 AF of water was released from the project during the reporting period.

A gate flushing operation was performed April 16, to evaluate the effectiveness of various gated releases on the sediment which has accumulated in front of the outlet conduit. The final recommendation based on this flushing operation is to conduct a semi-annual flushing using all four gates in the intake structure using a release rate of between 200 and 300 cfs for about 1-2 hours for each gate. In conjunction with any operational release or a semi-annual flushing operation it is recommended that the service gate be raised to release 600-800 cfs for a period of 5-15 minutes since the higher release was demonstrated to remove more sediment than the lower releases.

CHERRY CREEK DAM AND LAKE (CONT'D)

The maximum pool achieved during the period was 5552.32 feet MSL on April 9. A total of 2,052 AF or about 3 percent of the 79,960 AF exclusive flood control zone was utilized. The maximum daily inflow was 120 cfs on April 11. The maximum daily outflow was 200 cfs on April 10-11. The maximum instantaneous release was 800 cfs on April 16. No downstream flooding was prevented by this project.

Maximums of Record:

	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	5565.82 Jun 3 73	6,150 cfs Jun 16 65	560 cfs Aug 7-8 65
2nd	5562.52 Aug 1 65	3,195 cfs May 6 73	375 cfs Jun 8 75
3rd	5557.89 Jul 25 83	2,480 cfs May 7 73	330 cfs Apr 23-May 1 May 28-Jun 2 63

Minimums of Record (since initial fill):

	Pool-Date
Lowest	5543.51 Jan 29 65
2nd	5545.90 Nov 23-24 78

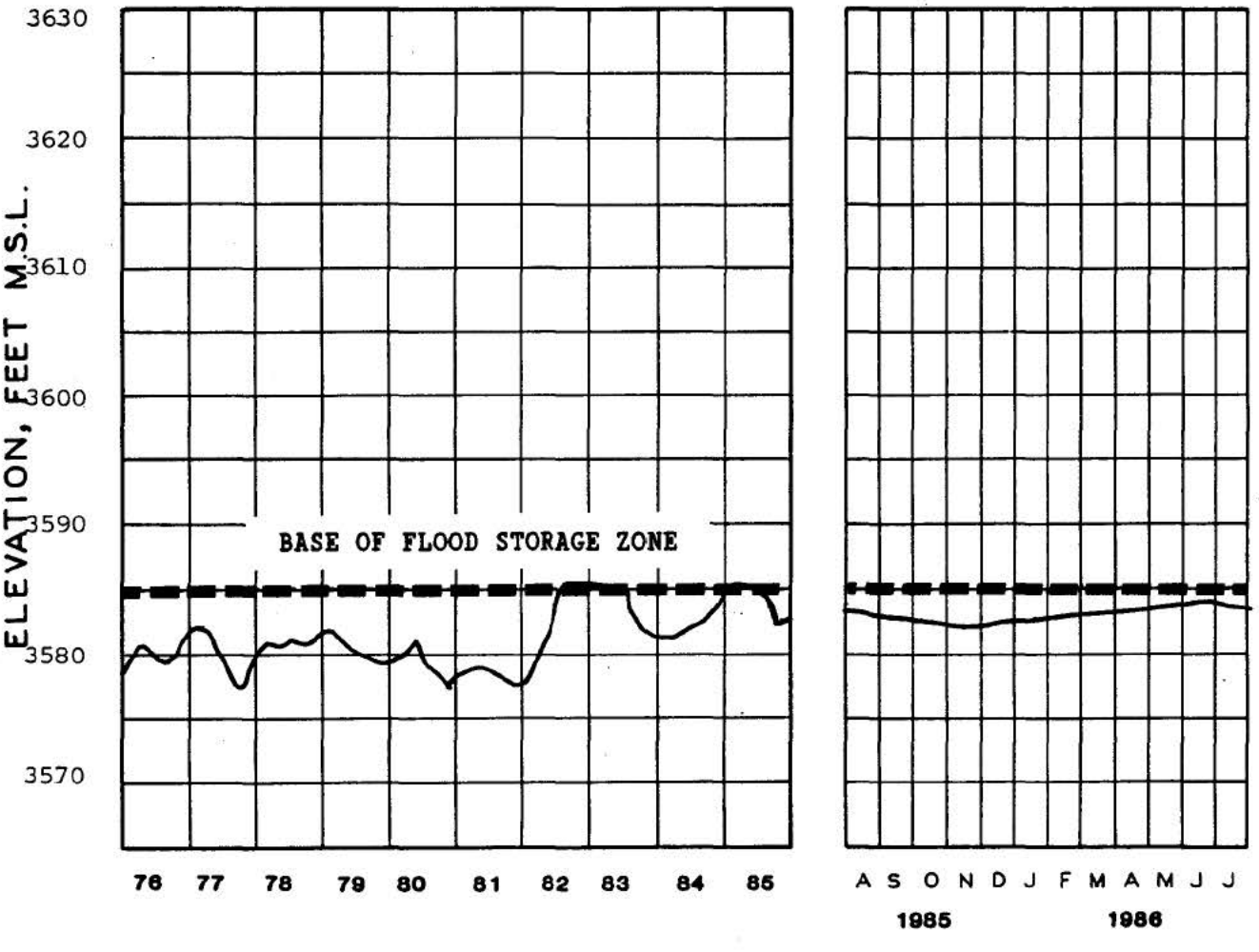
CHERRY CREEK RESERVOIR
RELEASE SUMMARY
(As of October 31, 1986)

YEAR	RELEASE (A.F.)	RELEASE MONTHS{1}	MAXIMUM DAILY AVG RELEASE (c.f.s.)	PEAK DISCHARGE{3} (c.f.s.-date)
1948	Embankment closed October 1948 (Gates remained open)			
1949		ALL YEAR		
1950		ALL YEAR		
1951	2,560	ALL YEAR	69	635 AUG 23
1952	2,370	ALL YEAR	51	321 AUG 29
1953	2,010	ALL YEAR	55	465 AUG 27
1954	1,570	ALL YEAR	104	480 JUL 21
1955	2,630	ALL YEAR	315	1,270 AUG 05
1956	2,790	ALL YEAR	727	1,440 JUL 31{4}
1957	940	JAN thru MAY{2}	190	315 MAY 09
1958	540	JUN,JUL,AUG	138	502 JUL 19
1959	170	JUN	62	106 JUN 03
1960	6,690	MAR,APR,MAY	450	532 MAR 26
1961	880	AUG	330	508 AUG 07
1962	2,640	FEB,MAR	135	139 FEB 12
1963	2,010	AUG	250	260 AUG 07
1964	1,700	APR	124	130 APR 04
1965	16,620	AUG,SEPT	560	574 AUG 06
1966	1,160	APR	270	275 APR 25
1967	NONE			
1968	NONE			
1969	NONE			
1970	920	MAR	125	144 MAR 25
1971	NONE			
1972	NONE			
1973	19,580	APR thru JUL	375	394 JUN 12
1974	12,300	FEB thru MAY	260	275 MAR 19
1975	1,820	APR,MAY	57	85 APR 23
1976	NONE			
1977	NONE			
1978	NONE			
1979	NONE			
1980	20	MAY,JUL	5	75 JUL 13
1981	NONE			
1982	NONE			
1983	23,840	APR thru AUG	330	344 APR 22
1984	35,540	FEB thru DEC	250	271 AUG 31
1985	17,045	JAN,MAR-JUN,OCT,DEC	300	302 JUN 03
1986	7,620	JAN THRU APRIL	200 {5}	625 APR 16

{1} Prior to May 15, 1957 gates on occassion were temporarily lowered for flood control.
{2} Gates closed on May 15 initiating permanent storage in the reservoir.
{3} Determined by USGS gaging station 2000 ft. below the dam.
{4} Maximum of record since 1950.
{5} Reservoir flushing operation, maximum release was 800 cfs for five minutes

COLD BROOK DAM AND LAKE
FALL RIVER BASIN, SOUTH DAKOTA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



Clarification by the State of South Dakota of the water right held by Larive Lake limits the appropriation to the inflow to Cold Brook Reservoir up to 1.1 c.f.s. During this reporting period, approximately 243 AF of water was delivered to Larive Lake. Cold Brook pool elevations fluctuated approximately one foot below the top of the conservation zone throughout the period.

The maximum reported pool elevation reached during this period was 3583.74 feet MSL on June 10. The maximum daily inflow was 3.50 cfs on June 9. Outflow on this date was 0.40 cfs. The peak daily outflow of 1.00 cfs occurred on October 13. No flood control was achieved during this period.

Maximums of Record:

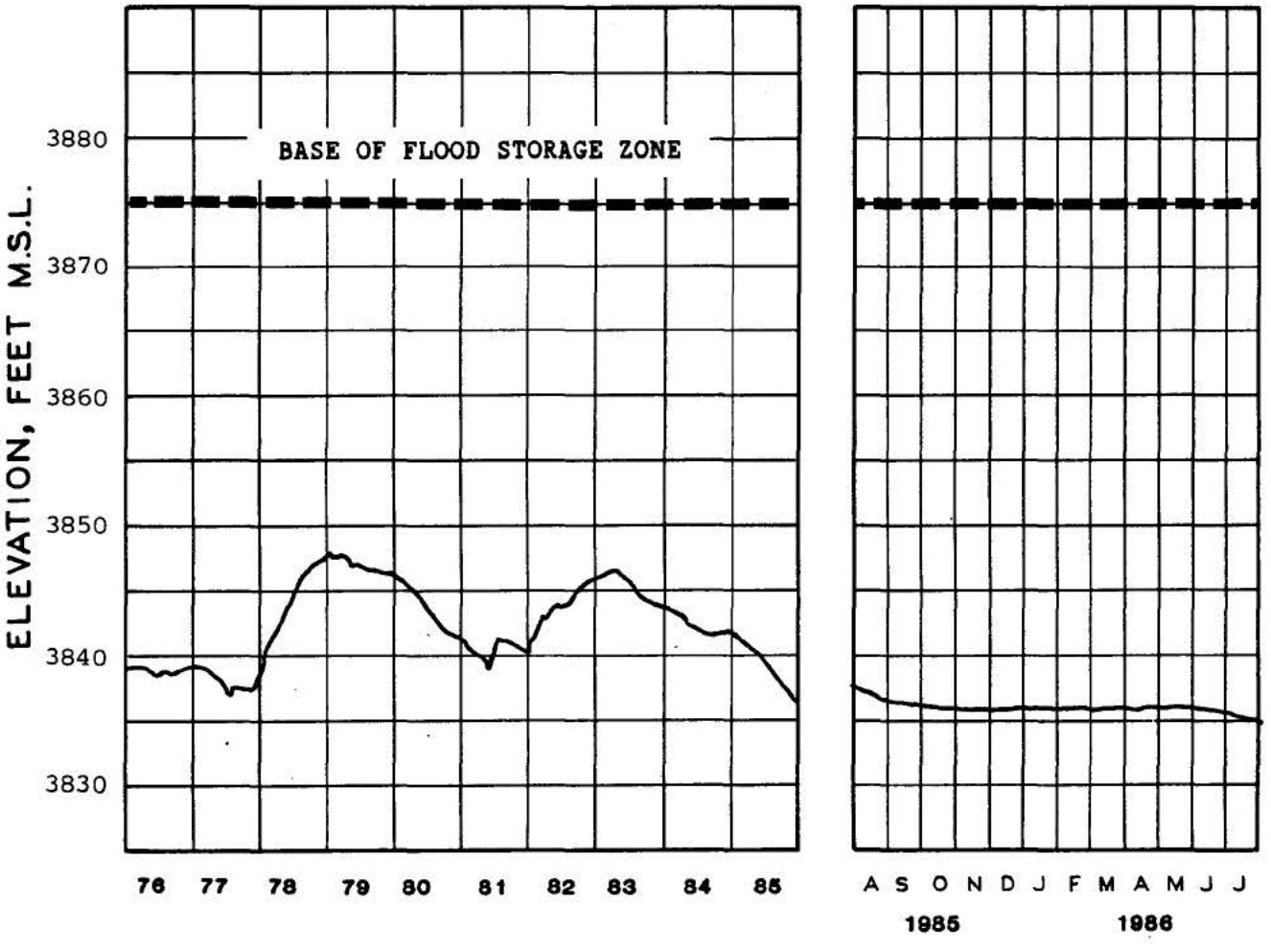
	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	3585.38 Aug 17	74 cfs Jul 14 62	2.0 cfs May 16-20 72
2nd	3585.26 Jul 22 82	65 cfs Jul 8 61	1.9 cfs Oct 1 72-Jan
3rd	3585.25 Jan 12 85	40 cfs May 19 82	1.9 cfs Jun 9-11 75
	3585.25 Feb 22-24 85		1.9 cfs May 2-7 76

Minimums of Record (since initial fill):

	Pool	Date
Lowest	3576.6	Oct 22 77
2nd	3576.8	Sep 14-Oct 2 81 Sep 21, 22, 29 77

COTTONWOOD SPRINGS DAM AND LAKE
FALL RIVER BASIN, SOUTH DAKOTA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



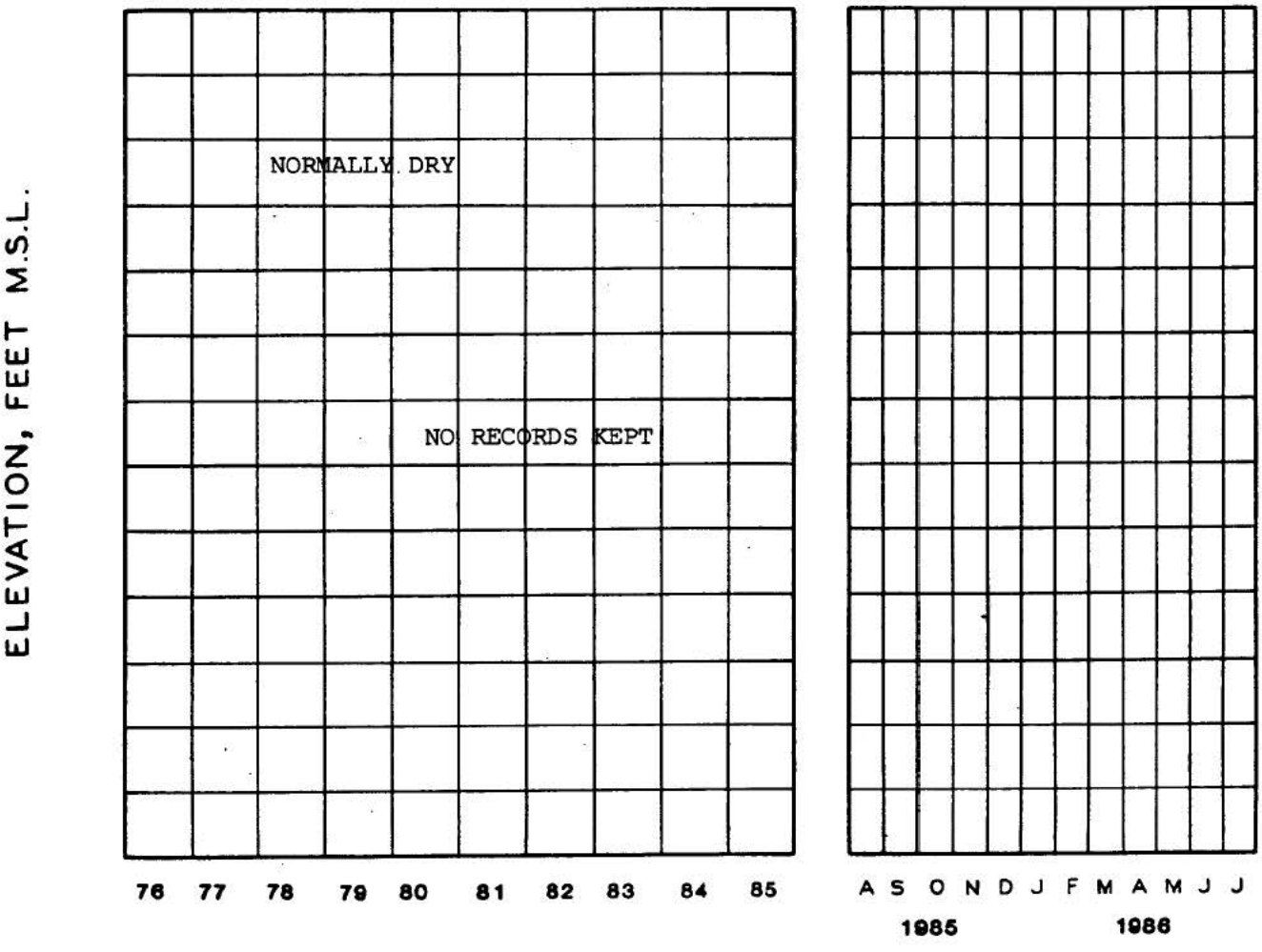
The maximum pool elevation during the report period was 3838.0 feet MSL and occurred at the beginning of the report period. The pool gradually dropped during the report period and the minimum pool elevation was 3835.0 feet MSL at the end of July. No releases were made from the reservoir and no flood control was achieved.

Maximums of Record:

	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	3847.9 Jun 9 79	-	-
2nd	3845.70 Mar-Apr 83	-	-

KELLEY ROAD DAM
SAND CREEK BASIN, COLORADO
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.

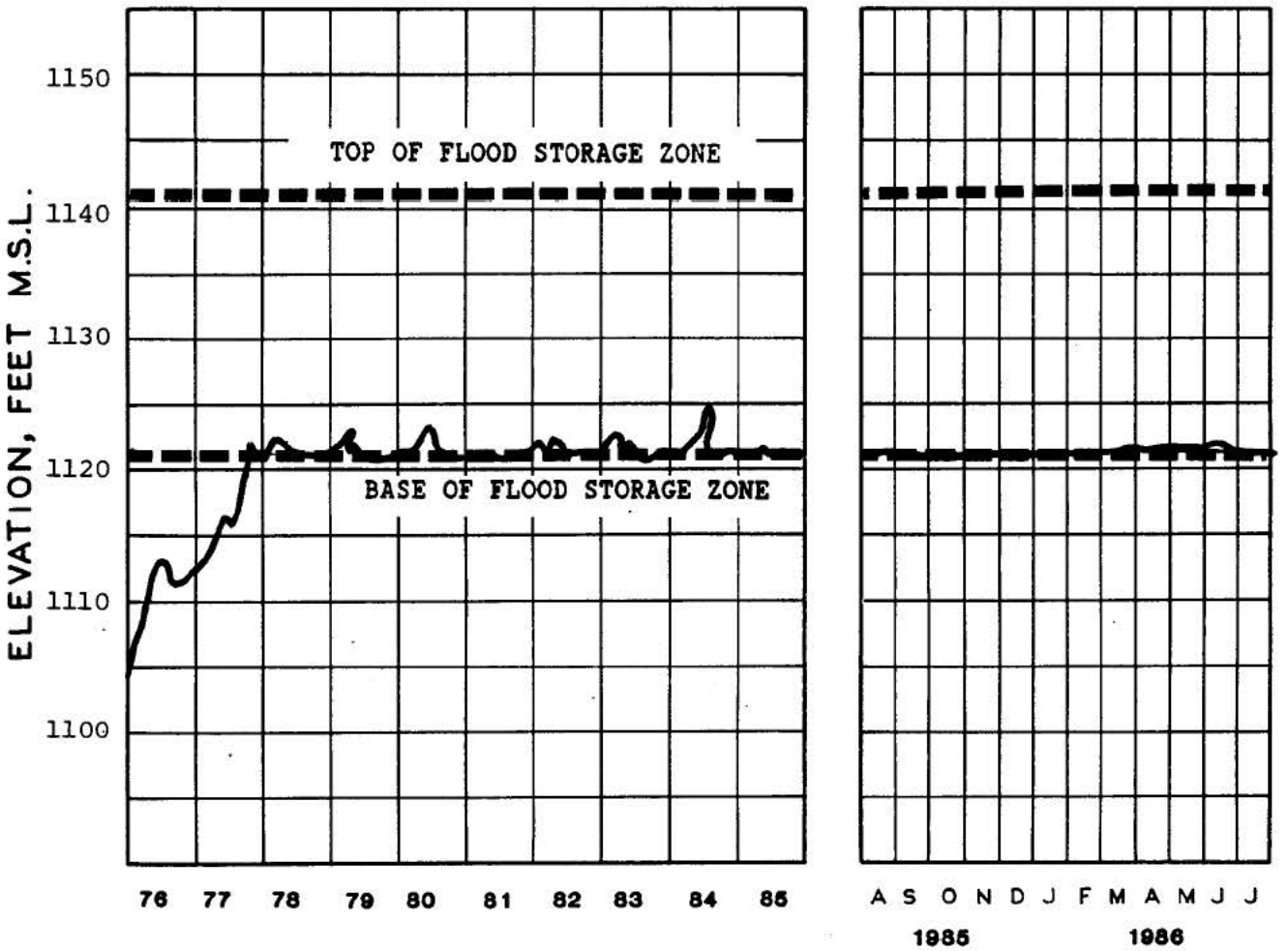


Kelley Road Detention Dam is located on Westerly Creek, a tributary of the South Platte River and provides flood control for the City of Aurora, Colorado. It is located entirely within the boundaries of Lowry Air Force Base. The projects sole purpose is that of flood control and was not designed to permanently store water. Water is automatically impounded by the project and released through a ground level 24-inch CMP conduit or high overflow drop inlet that has never required regulation orders. The City of Aurora is responsible for obtaining pool gage readings during flood periods and general observation of project operation. The local cooperation agreement with the city also requires the city to monitor weather and provide project maintenance and downstream channel improvements.

Localized heavy rains caused Kelley Road Dam to temporarily store approximately 10 AF of water on July 21 (Elev. 5347.00 feet MSL). It evacuated the storage through the low level box inlet at an average rate of approximately 20 cfs. No flood control was achieved.

GLENN CUNNINGHAM DAM AND LAKE
PAPILLION CREEK BASIN - NO. 11, NEBRASKA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



CALENDAR YEARS REPORT PERIOD

Rainfall and runoff kept the pool level above the base of the flood control zone, except for a brief period in September where the pool level fell below this level. Heavy rainfall during April, May and June (7.26 inches during April, 4.58 inches during May and 3.63 inches during June at the damsite) caused higher rises within the pool level. Inflows during April, May and June were 128 percent, 109 percent and 70 percent of average, respectively. The maximum midnight pool level achieved was 1122.0 MSL on June 11. The maximum daily average inflow was 111 cfs on June 11. The outflow on this date was 30 cfs. The maximum daily average outflow was 37 cfs on June 12. No flood control was achieved by the Papio Creek Dams during the period.

Maximums of Record:

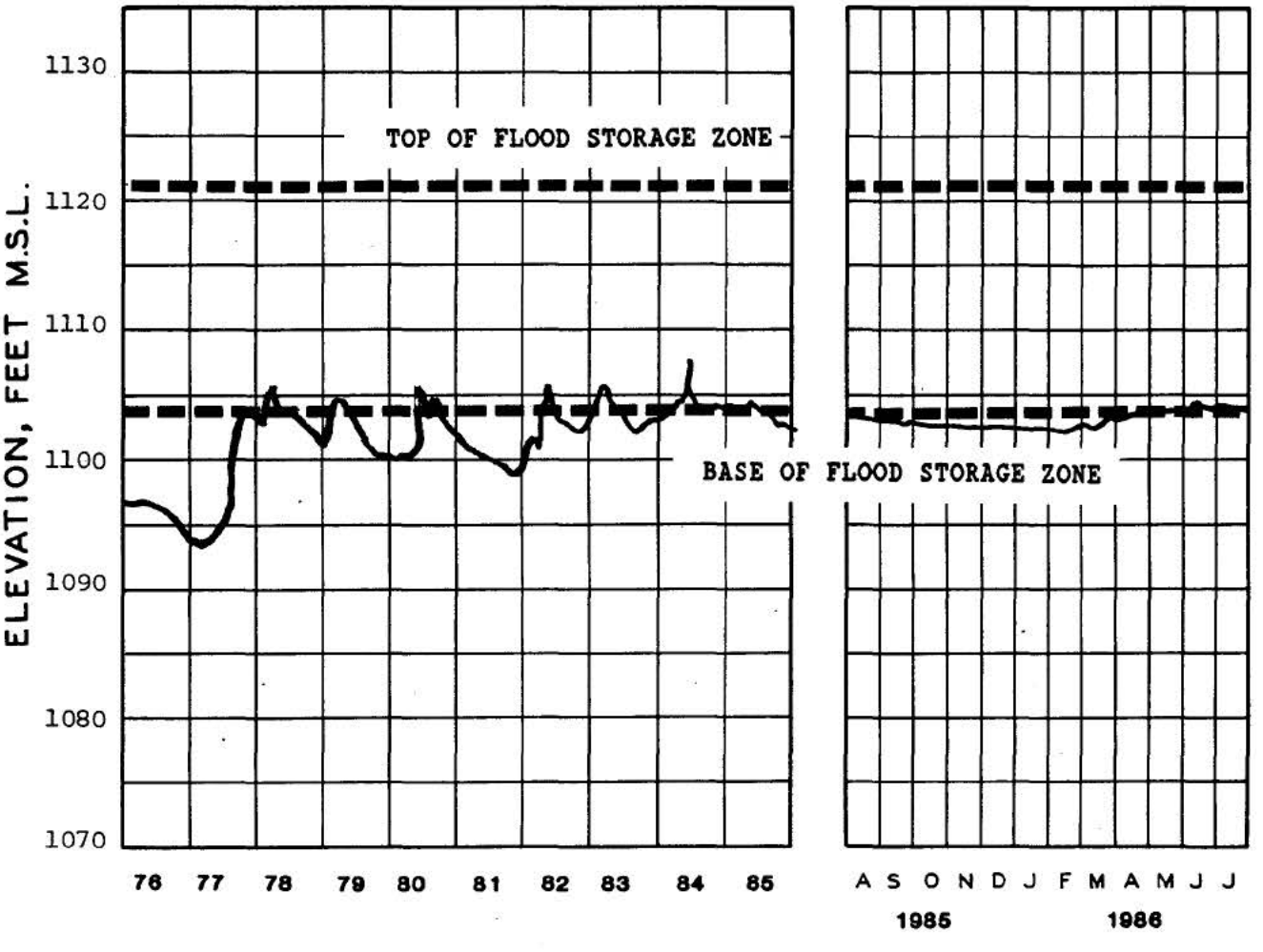
	Pool - Date	Daily Inflow - Date	Daily Outflow - Date
Highest	1124.4 Jun 17 84	345 cfs Jun 15 80	152 cfs Jun 18 84
2nd	1123.7 Jun 15 80	344 cfs Mar 02 79	145 cfs Jun 19 84
3rd	1123.2 Mar 03 79	301 cfs Jun 16 84	144 cfs Jun 17 84

Minimums of Record (since initial fill):

	Pool - Date
Lowest	1120.5 Jul 17 81
2nd	1120.7 Sep 11 78

STANDING BEAR DAM AND LAKE
PAPILLION CREEK BASIN - NO. 16, NEBRASKA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



The pool level at Standing Bear Lake remained below the base of the flood control zone through most of the period. Rainfall during the April-July period caused the pool level to slowly rise above the base of the flood control zone for a brief period. The maximum midnight pool level achieved was 1104.5 feet MSL on June 11. The maximum daily average in flow was 32 cfs on June 11. The outflow on this date was 5 cfs. The maximum daily outflow was 8 cfs on June 12. No flood control was achieved by the Papio Dams during the period.

Maximums of Record:

	Pool - Date	Daily Inflow - Date	Daily Outflow - Date
Highest	1107.8 Jan 16 84	266 cfs Jun 14 84	65 cfs Jun 16-17 84
2nd	1106.8 May 21 82	180 cfs Jun 17 83	64 cfs Jun 15 84
3rd	1106.5 Jun 15 80	176 cfs Jun 12 80	52 cfs May 22 82

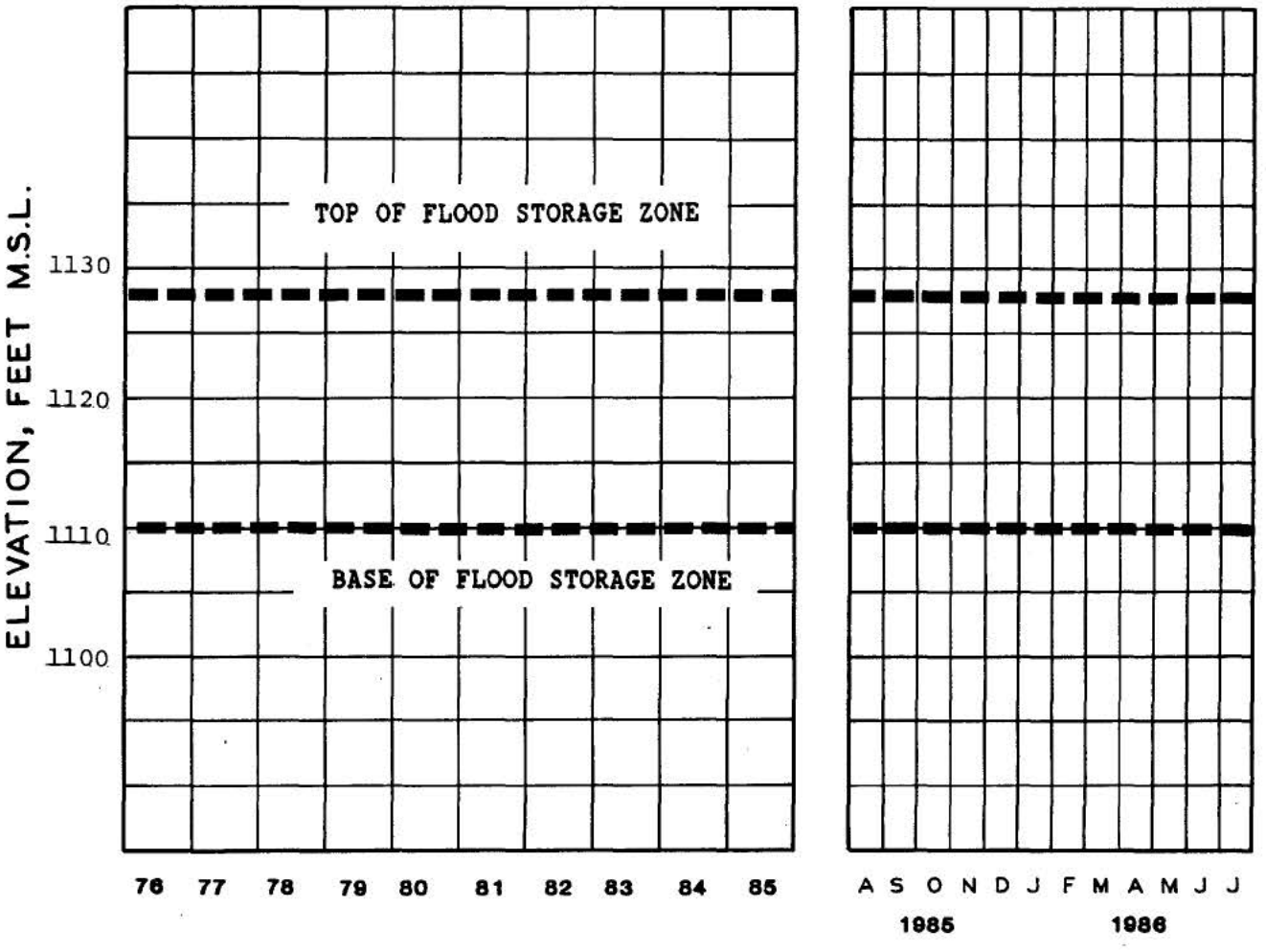
STANDING BEAR DAM AND LAKE (CONT'D)

Minimums of Record (since initial fill):

	Pool - Date
Lowest	1098.3 Feb 11 82
2nd	1099.4 May 31 80

PAPILLION CREEK BASIN - NO. 18, NEBRAKSA
1985-1986 REGULATION

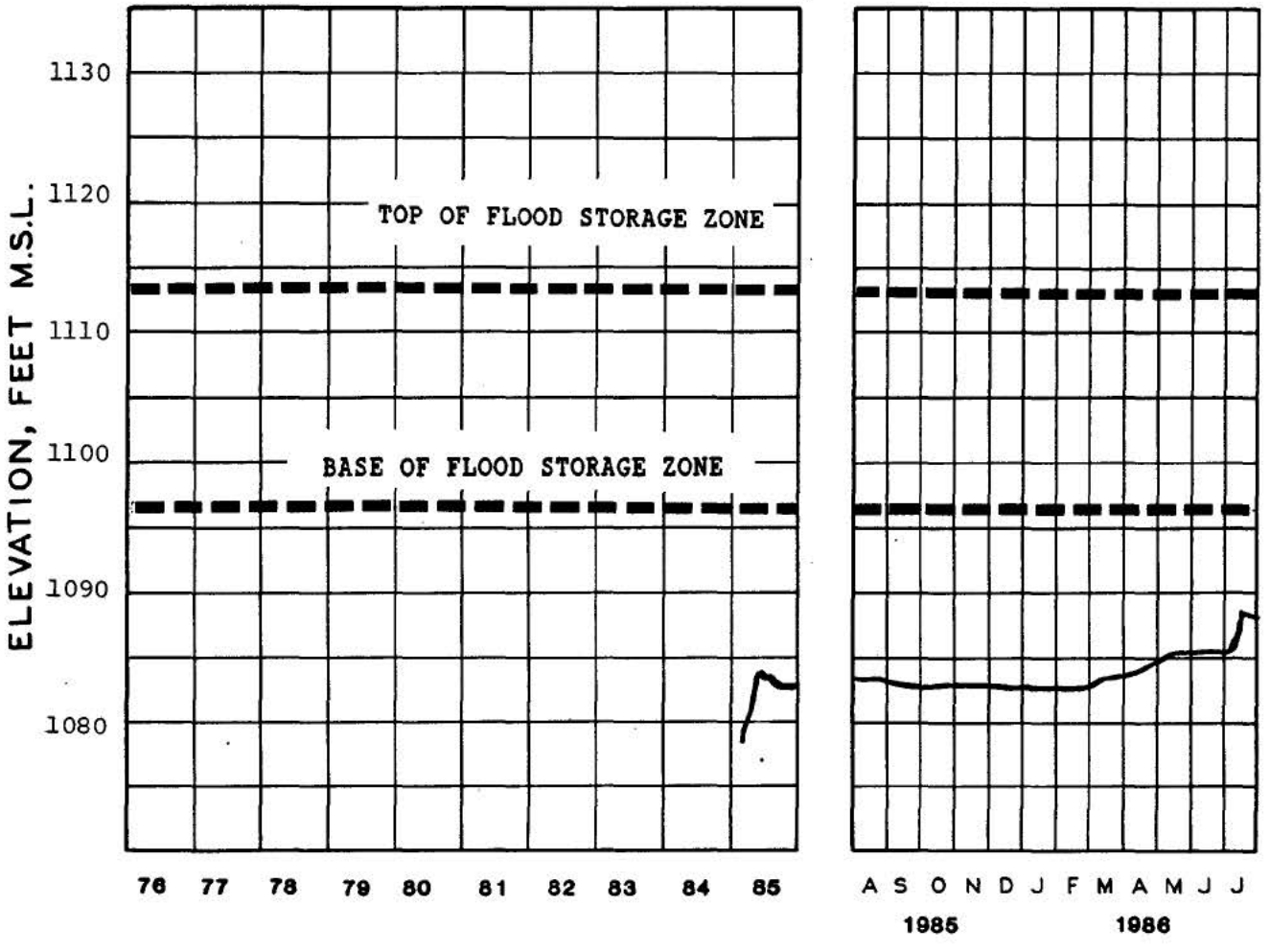
A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



Although closure of the embankment occurred on July 15, 1984, no water has been impounded dued to a water quality problem. The gates will remain open until the pollution problem is resolved.

WEHRSPANN DAM AND LAKE
PAPILLION CREEK BASIN - 20, NEBRASKA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



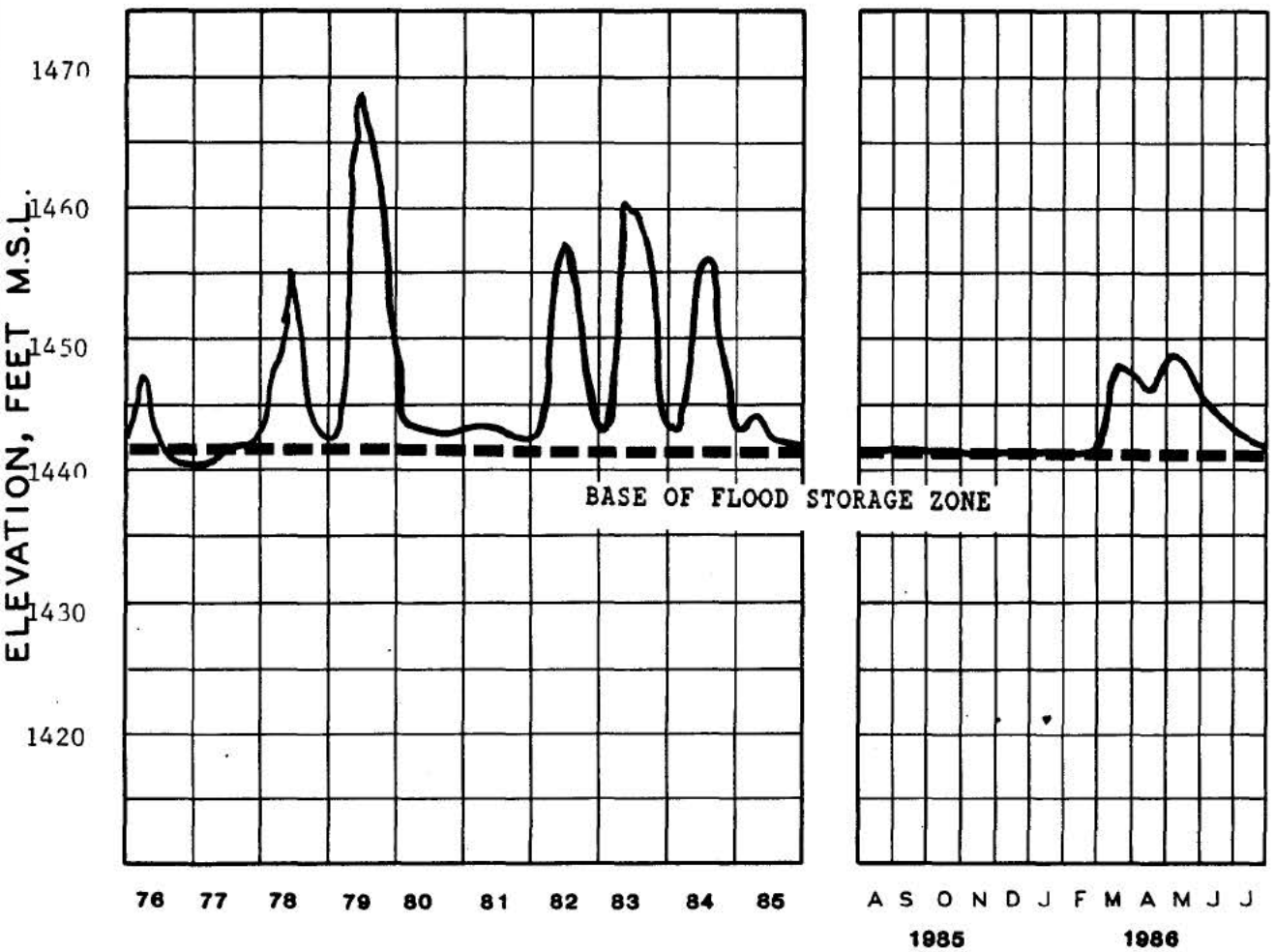
The multipurpose pool has not filled since the low level gate was closed in March 1985. The maximum midnight pool level achieved was 1088.9 feet MSL on July 12. The peak daily average inflow was 171 cfs on July 12. The outflow was zero throughout the period. No flood control was achieved by the Papio Dams during the period.

Maximums of Record:

	Pool - Date	Daily Inflow - Date
Highest	1088.9 Jul 12 86	171 cfs Jul 12 86
2nd	1083.7 Jun 5-17 85	46 cfs May 15 85

PIPESTEM DAM AND LAKE
PIPESTEM CREEK JAMES RIVER BASIN, NORTH DAKOTA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



From the beginning of the report period, August 1, 1985 to March 2, no releases were made from Pipestem Dam. The pool level remained below the flood control zone averaging 1441.40 feet MSL for the first seven months of the period. (Base of the flood control is 1442.40 feet MSL). Inflow was also minimal for the first seven months with a maximum inflow of 15 cfs and averaging 2 cfs.

The pool level rose rapidly on March 4th and 5th due to a warming trend with a 1 to 3 inch snow water equivalent in the area. The pool rose to 1443.64 feet MSL during the 4-day period from March 2 to March 6 before the temperatures cooled down and freezing occurred. Another warming trend occurred on March 12 which pushed the pool even higher to a level of 1447.04 feet MSL by the end of March. On March 4 the pool rose into the flood control zone for the first time in the report period. The releases were limited to discharges up to 100 cfs at this time. On March 21, the 36 inch low level gate was opened to one foot for water quality purposes.

During April the pool continued to fall to 1445.84 feet MSL on April 18 when inflows increased pushing the pool upward once more to a report period peak of 1447.90 feet MSL on May 5. On May 30 the service gates were lowered restricting outflow to 50 cfs while maintaining the 1 foot low level setting. This measure was taken in order to conserve water for live streamflow through the Jamestown area during storage evacuation. On July 14 the low level gate was closed which brought releases from 50 cfs on July 13 to zero cfs on July 18 as the pool dropped below the drop inlet crest. Discharges remained zero for the balance of the report period.

The maximum pool achieved during the period was 1447.90 feet MSL on May 5. Four percent of the flood control zone was utilized or 5,879 AF of 137,010 AF of flood control allocated storage. The peak daily inflow was 485 cfs on March 4. Outflow on this date was 18 cfs. The peak daily outflow was 100 cfs from March 6 to May 29. The maximum combined Pipestem/Jamestown release was 308 cfs from April 28 to May 2. Downstream flooding in South Dakota was reduced by this project during the runoff season.

Maximums of Record:

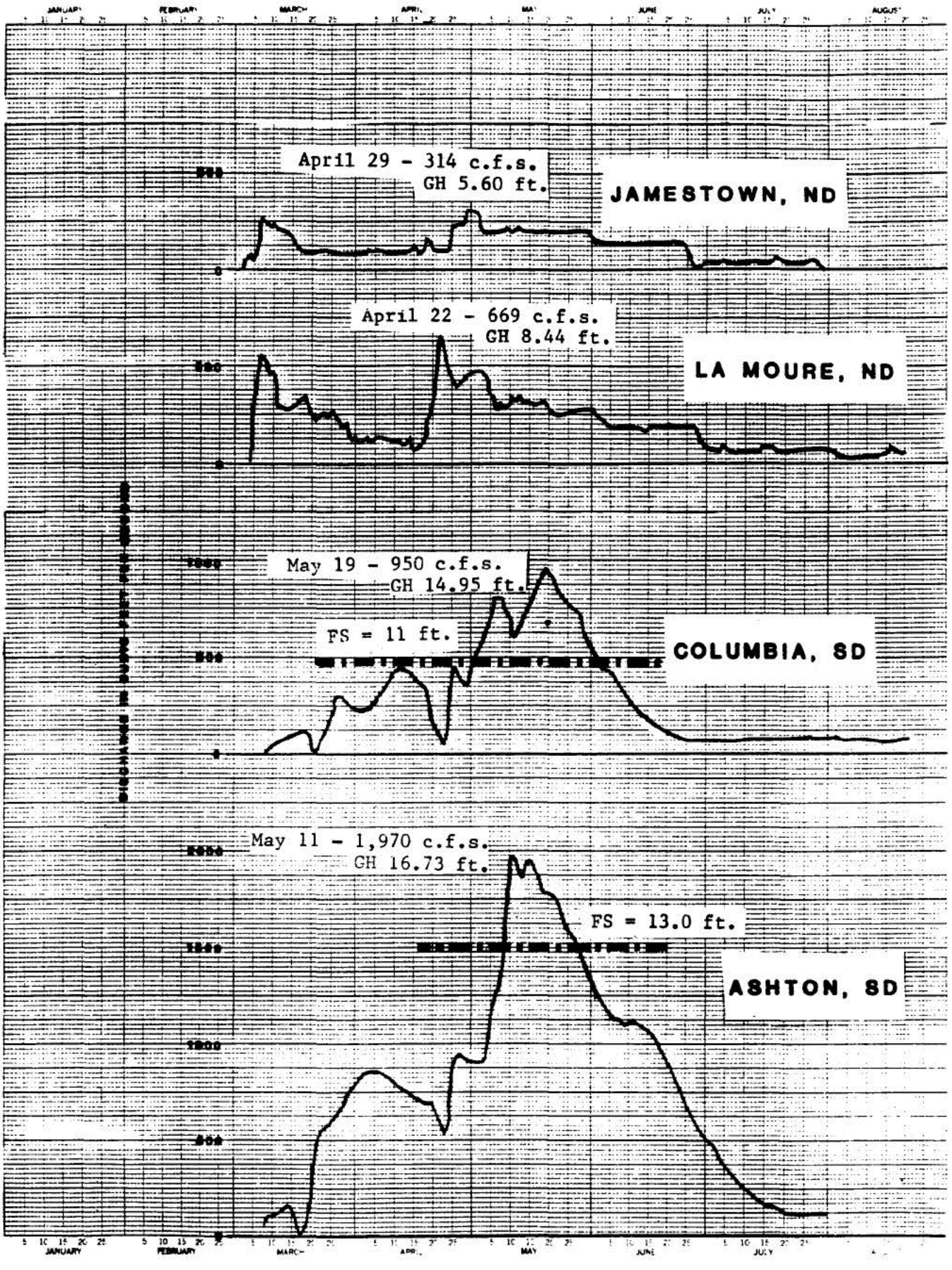
	Pool - Date	Daily Inflow - Date	Daily Outflow - Date
Highest	1468.35 May 10 79	3,380 cfs Apr 20 75	310 cfs Oct 22-26,31 Nov 01 75
2nd	1466.06 Jul 17 75	3,000 cfs Apr 18 79	250 cfs Apr 10-12 76
3rd	1459.94 Apr 19-22 83	1,945 cfs Mar 05 83	200 cfs Apr 26-29 & Aug 30 thru Nov 12 79
			200 cfs Apr 06-09 84

Minimums of Record (since initial fill in May 1974):

	Pool - Date
Lowest	1439.97 Jan 01 77
2nd	1449.59 Feb 09-10 75

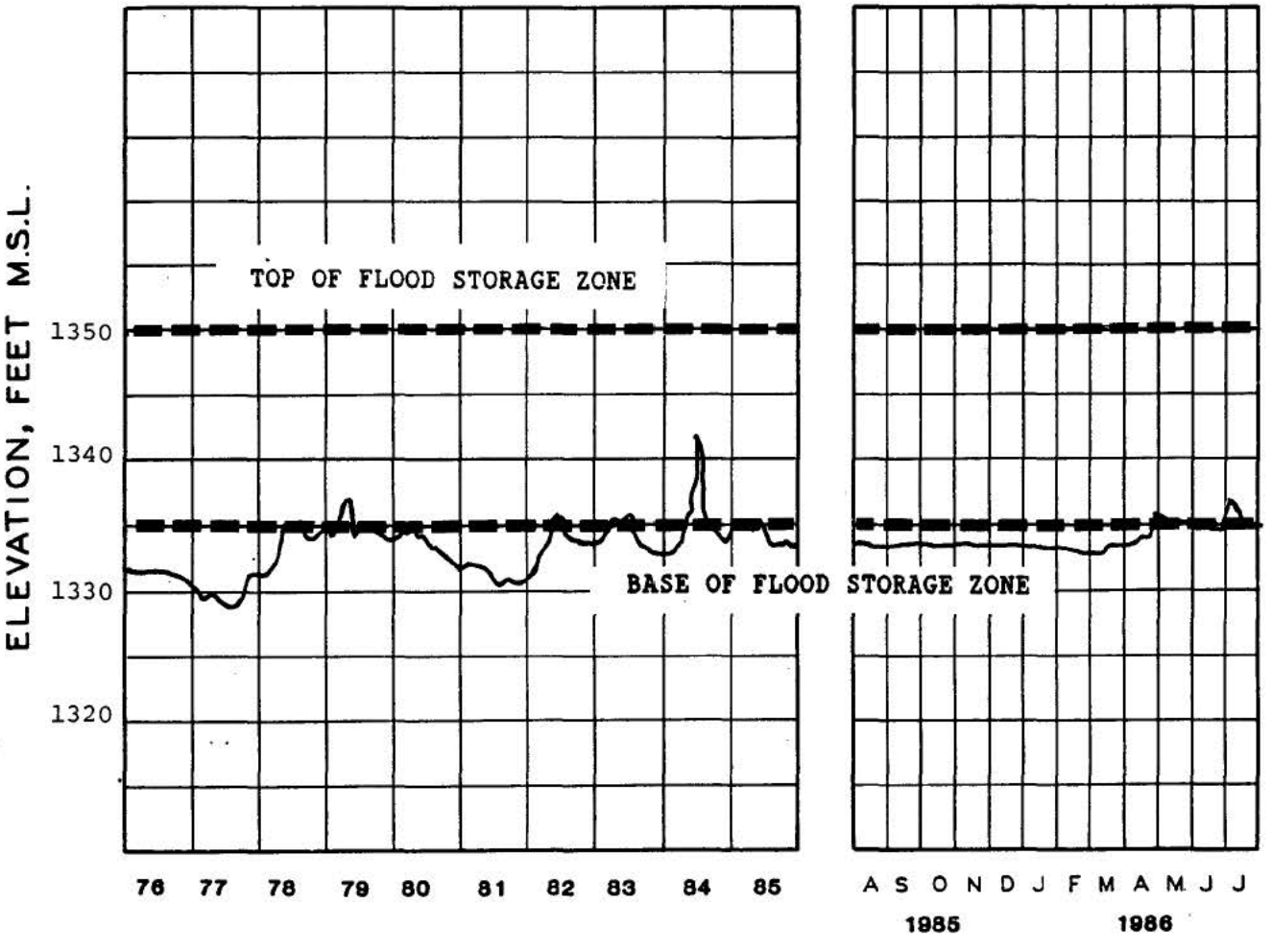
JAMES RIVER HYDROGRAPHS

1986



OLIVE CREEK DAM AND LAKE
SALT CREEK BASIN - NO. 2, NEBRASKA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



Heavy rainfall during April and June (6.14 inches during April and 4.88 inches during June at the damsite) caused the pool level to rise above the base of the flood control zone. The inflow for April and June were 259 percent and 93 percent of average, respectively. The maximum midnight pool level achieved was 1337.2 feet MSL on July 1. The maximum daily average inflow was 185 cfs on July 1. The outflow on this date was 77 cfs, the highest average outflow reported for the period. Downstream flooding was reduced by the Salt Creek dams.

Maximums of Record:

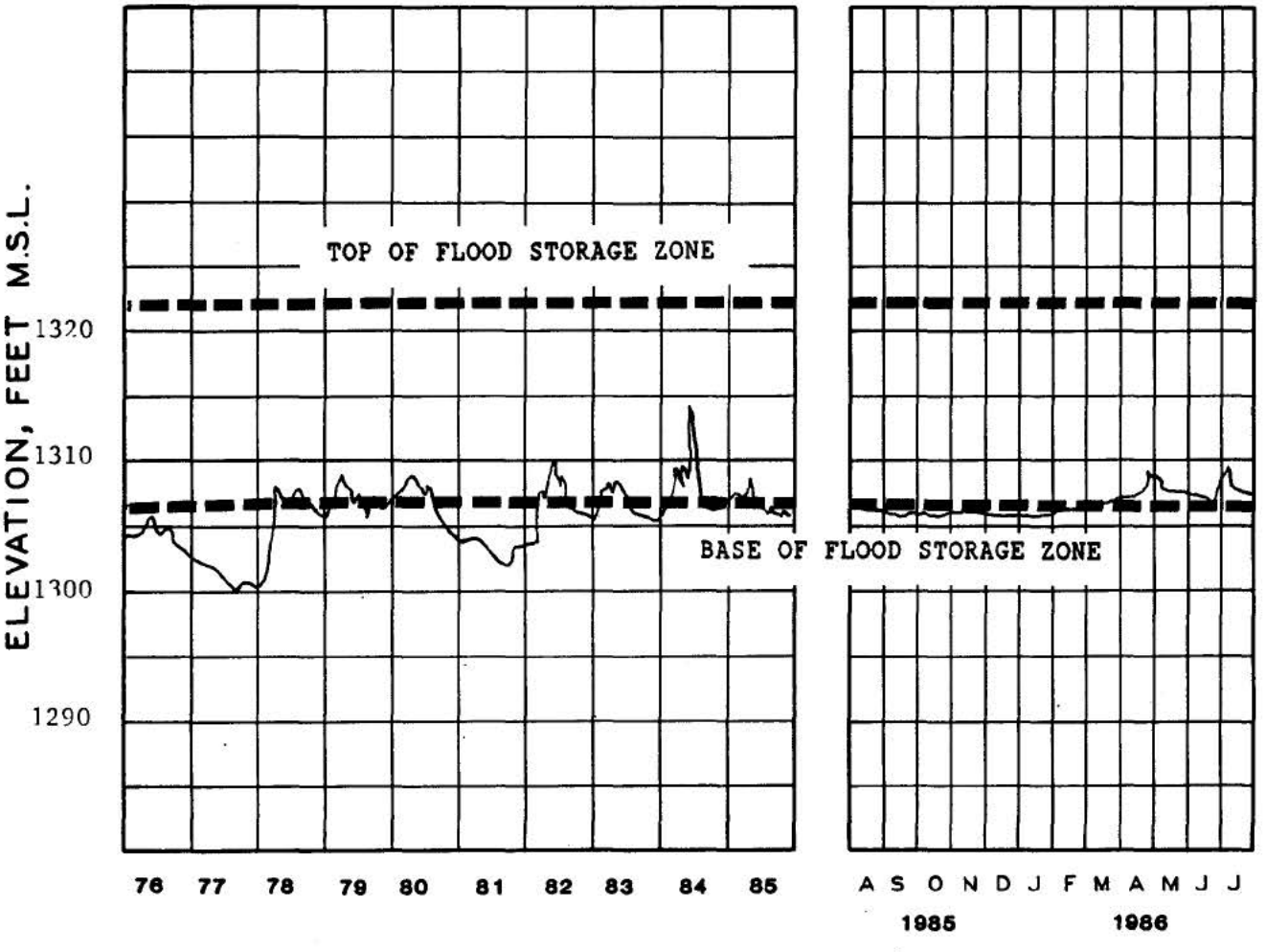
	Pool - Date	Daily Inflow - Date	Daily Outflow - Date
Highest	1342.6 Oct 11 73	764 cfs Jun 12 84	176 cfs Oct 12 73
2nd	1342.6 Jun 12 84	749 cfs Oct 10 73	171 cfs Jun 13 84
3rd	1337.8 Mar 02 79	275 cfs Mar 02 79	77 cfs Mar 03 79

Minimums of Record (since initial fill):

	Pool - Date
Lowest	1328.1 Aug 01 71
2nd	1330.5 Jul 11 81

BLUE STEM DAM AND LAKE
SALT CREEK BASIN - NO. 4, NEBRASKA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



Heavy rainfall during April and July (4.74 inches during April and 5.34 inches in July) caused the pool level to rise above the base of the flood control zone. The inflows for April and July were 233 percent and 520 percent of average, respectively. The maximum midnight pool level achieved was 1309.4 feet MSL on July 3. The maximum daily average inflow was 263 cfs on April 27. The outflow on this date was 60 cfs. The maximum average daily inflow was 263 cfs on April 27. The outflow on this date was 60 cfs. The maximum daily average outflow was 74 cfs on July 7. Downstream flooding was reduced by the Salt Creek dams.

Maximums of Record:

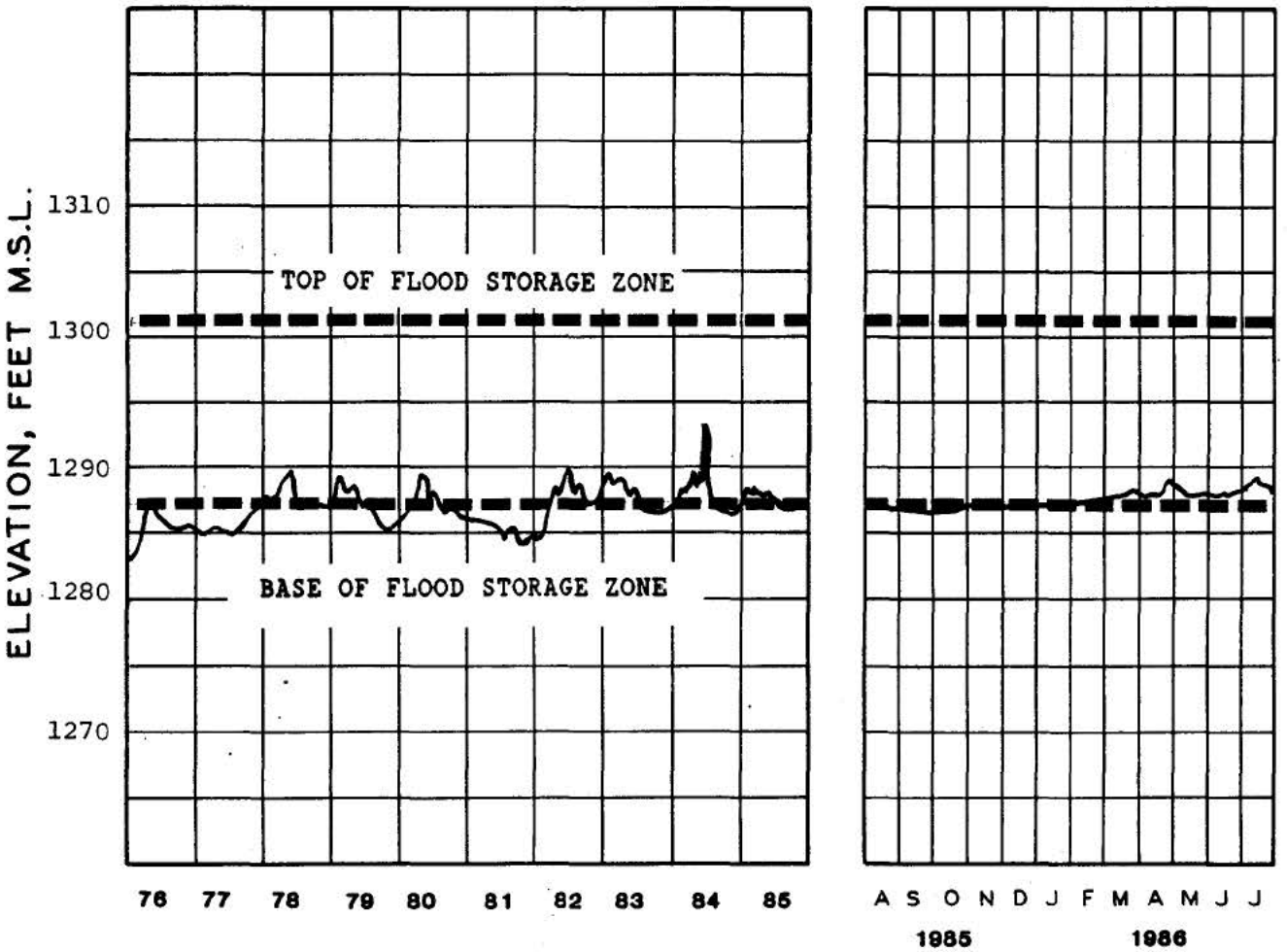
	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	1316.5 Oct 11 73	1,447 cfs Oct 10 73	342 cfs Oct 12 73
2nd	1314.5 Jun 13 84	908 cfs Jun 13 84	198 cfs Jun 13 84
3rd	1310.3 May 25 82	438 cfs May 25 82	97 cfs May 26 82

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1299.9 Sep 1 77
2nd	1301.8 Sep 21 81

WAGON TRAIN DAM AND LAKE
SALT CREEK BASIN - NO. 8, NEBRASKA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



Rainfall and runoff during March caused the pool level to rise above the base of the flood control zone. Heavy rainfall during April through July (5.94 inches in April and 4.17 inches during July) caused further rises in the pool level. The pool level receded below the flood control zone near the end of July. Inflows for April and July were 127 percent and 291 percent of average, respectively. The maximum midnight pool level achieved was 1289.3 feet MSL on July 6. The maximum daily average inflow was 147 cfs on July 6. The outflow on this date was 37 cfs. The maximum daily average outflow was 50 cfs on July 7. Downstream flooding was reduced by the Salt Creek dams.

Maximums of Record:

	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	1295.4 Oct 11 73	1,199 cfs Oct 10 73	329 cfs Oct 12 73
2nd	1293.2 Jun 13 84	643 cfs Jun 13 84	170 cfs Jun 14 84
3rd	1291.2 Jul 22 78	632 cfs Jul 22 78	107 cfs Jul 23 78

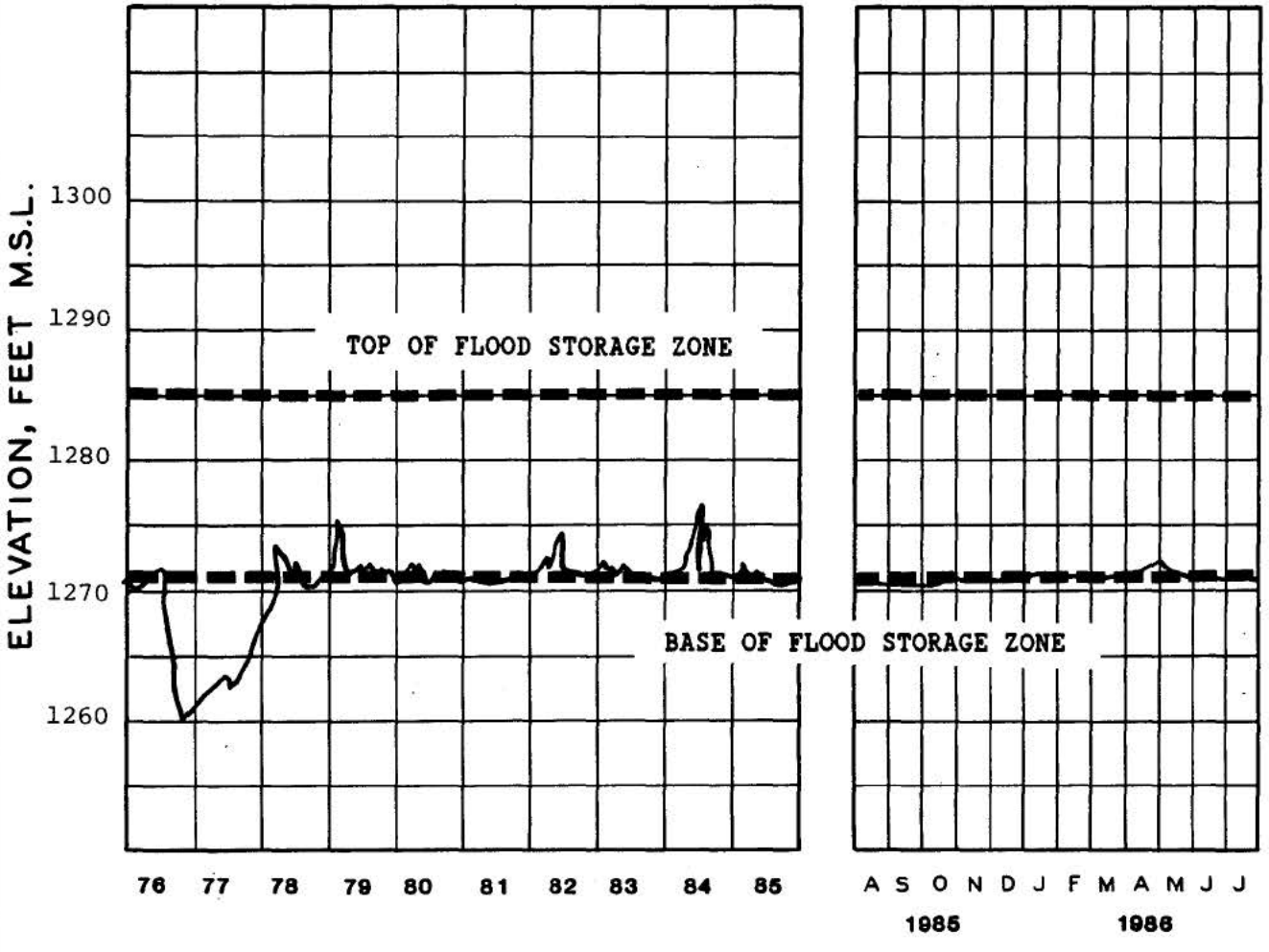
WAGON TRAIN DAM AND LAKE (CONT'D)

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1282.2 Nov 28 75
2nd	1284.6 Oct 21 81

STAGECOACH DAM AND LAKE
SALT CREEK BASIN - NO. 9, NEBRASKA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



Runoff from snowmelt caused the pool level to rise above the base of the flood control zone in January. It receded below that level near the early part of February and reentered the flood control zone in March where it remained until the last part of July, mostly due to rainfall. Heavy rainfall in April (4.02 inches at the damsite) caused high rises in the pool level around the end of the month. However, inflows during April were only 57 percent of average. The maximum midnight pool level achieved was 1272.7 feet MSL on April 26. The maximum daily average inflow was 136 cfs on April 26. The outflow on this date was 29 cfs. The maximum daily average outflow was 46 cfs on April 27. Downstream flooding was reduced by the Salt Creek dams.

Maximums of Record:

	Pool - Date	Daily Inflow - Date	Daily Outflow - Date
Highest	1279.0 Oct 11 73	958 cfs Oct 10 73	190 cfs Oct 12 73
2nd	1277.1 Jun 13 84	482 cfs Jun 12 84	109 cfs Jun 14 84
3rd	1275.2 Mar 03 79	278 cfs Mar 02 79	87 cfs Mar 04 79

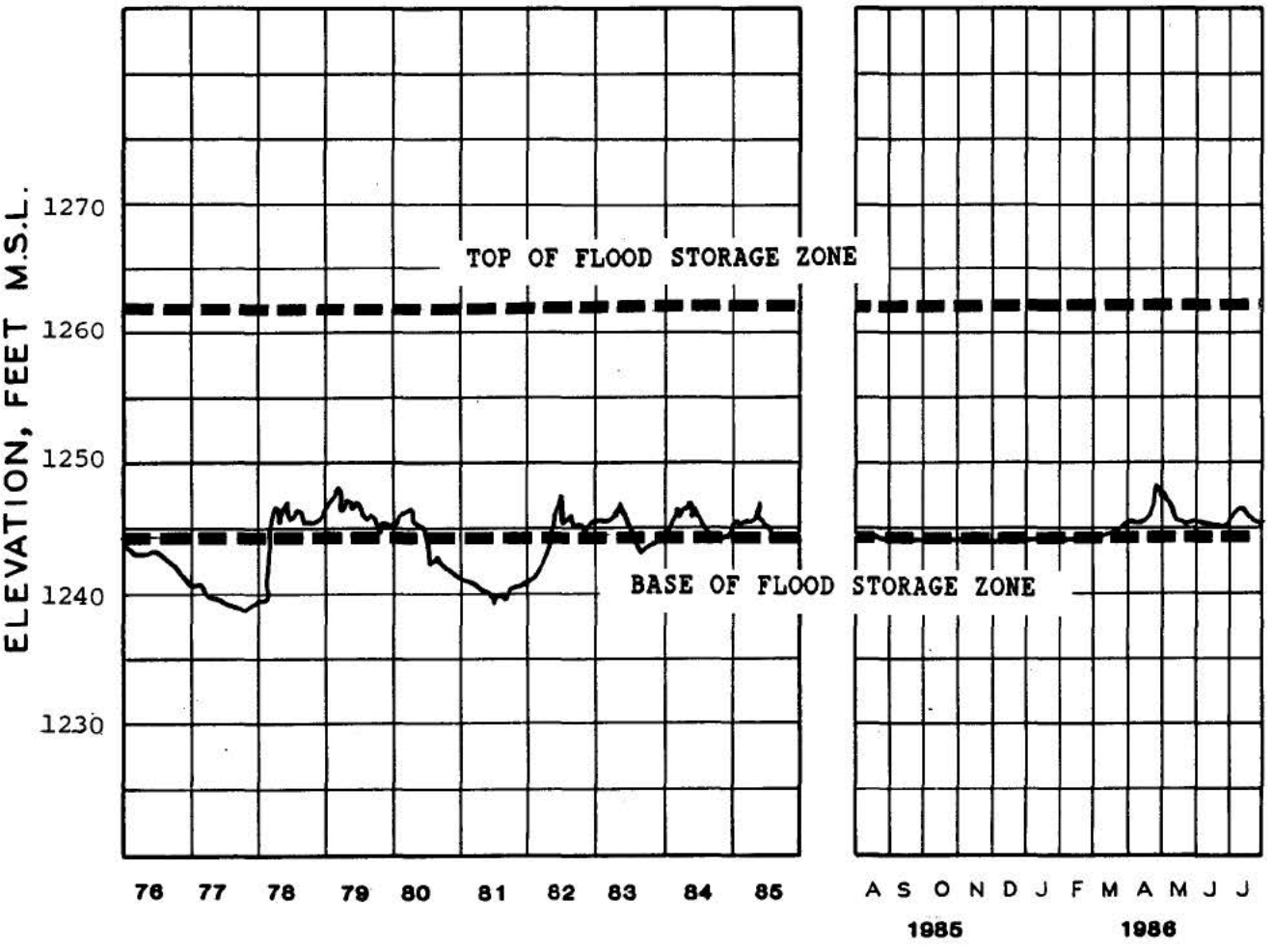
STAGECOACH DAM AND LAKE (CONT'D)

Minimums of Record (since initial fill):

	Pool - Date
Lowest	1260.5 Aug 09 76
2nd	1262.8 Jul 10 77

YANKEE HILL DAM AND LAKE
SALT CREEK BASIN - NO. 10, NEBRASKA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



Rainfall runoff during March caused the pool level to rise above the base of the flood control zone. It remained there throughout the period. Heavy rainfall during April through July (7.14 inches in April, 3.85 inches during July) caused further rises in the pool level. Inflows in April and July were 231 percent and 610 percent of average, respectively. The maximum midnight pool level achieved was 1248.5 feet MSL on April 28 establishing a new third highest pool level. The maximum average daily inflow was 254 cfs on April 27. The outflow on this date was 47 cfs. The maximum daily average outflow was 79 cfs on April 29. Downstream flooding was reduced by the Salt Creek dams.

Maximums of Record:

	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	1252.3 Oct 11 73	690 cfs Oct 10 73	145 cfs Oct 12 73
2nd	1250.7 Jun 13 84	513 cfs Jun 12 84	114 cfs Jun 14 84
3rd	1248.5 Apr 28 86	254 cfs Apr 27 86	79 cfs Apr 29 86

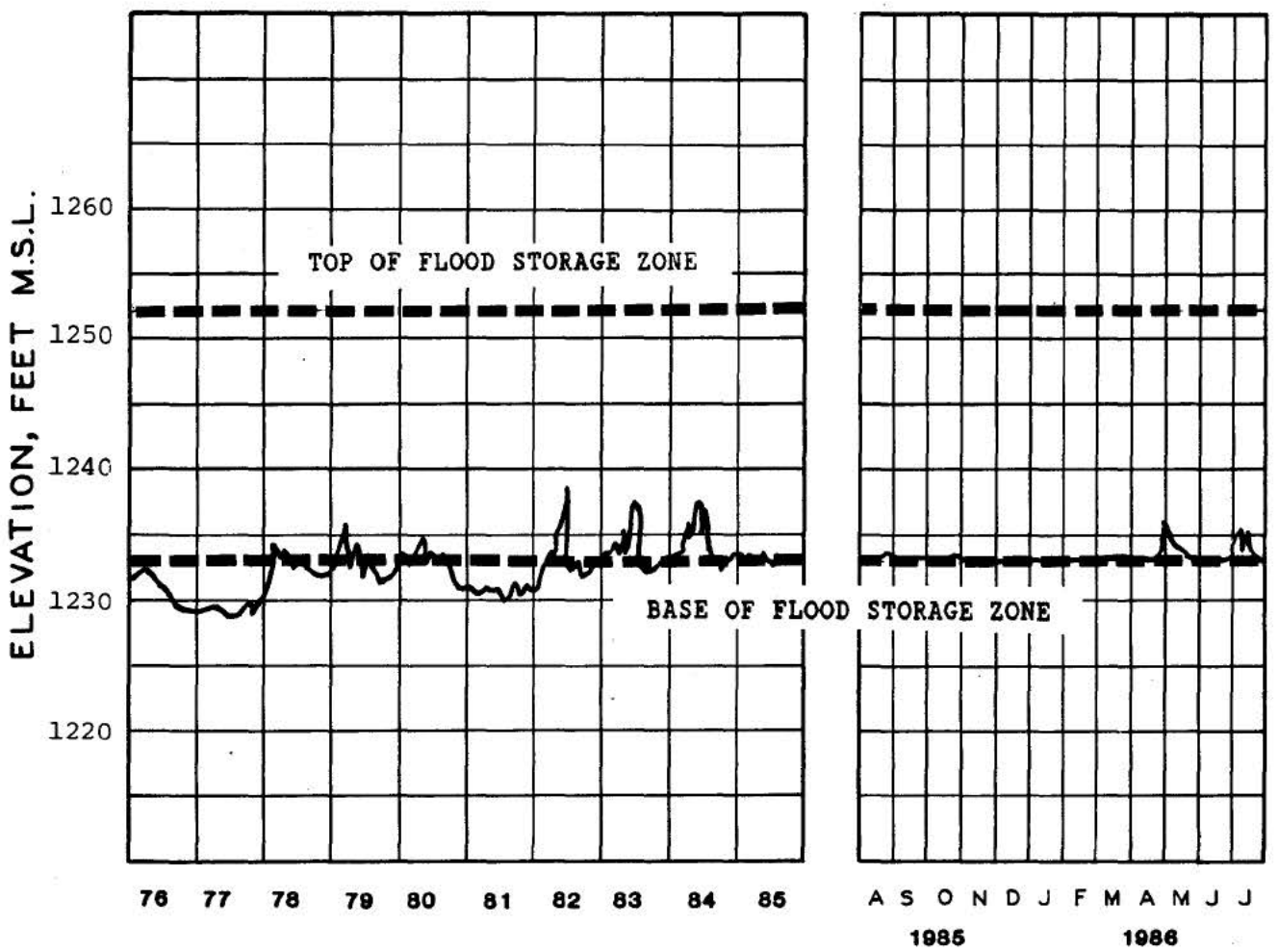
YANKEE HILL DAM AND LAKE (CONT'D)

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1238.9 Aug 8 77
2nd	1239.1 Sep 19 81

CONESTOGA DAM AND LAKE
SALT CREEK BASIN - NO. 12, NEBRASKA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



Rainfall and runoff during the period kept the pool level above the base of the flood control zone. Heavy rainfall during April and July (7.85 inches during April and 6.54 inches in July at the damsite) caused high rises in the pool levels for brief periods. Inflows in April and July were 302 percent and 499 percent of average, respectively. The maximum midnight pool level achieved was 1236.0 feet MSL on April 28. The maximum daily average inflow was 277 cfs on April 27. The outflow on this date was 75 cfs. The maximum average daily outflow was 109 cfs on April 29. Downstream flooding was reduced by the Salt Creek dams.

Maximums of Record:

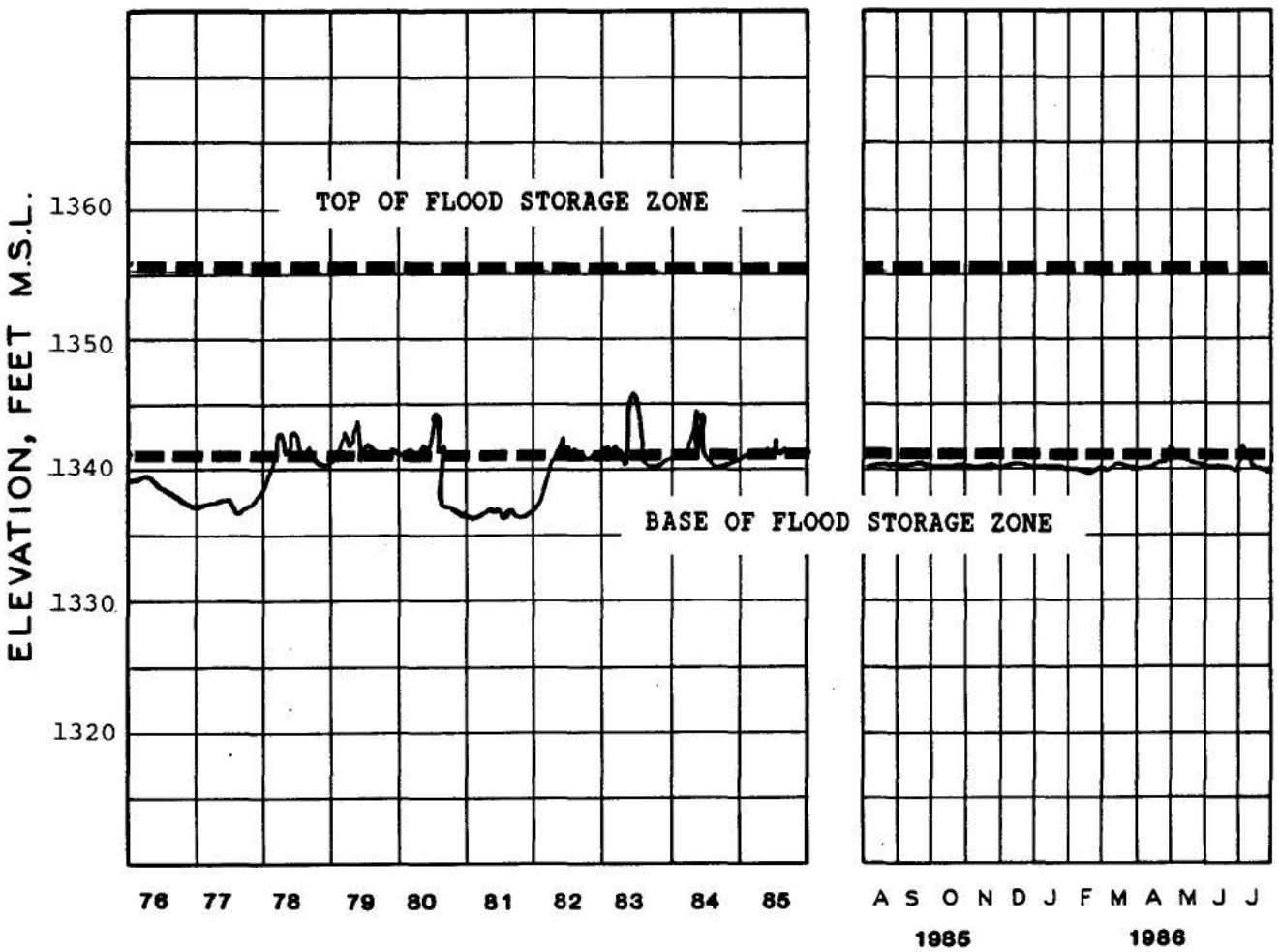
	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	1239.6 Oct 11 73	661 cfs Jun 27 83	152 cfs Jun 16 82
2nd	1238.3 Jun 15 82	620 cfs Jun 15 82	151 cfs Oct 12 73
3rd	1237.8 Jun 27 83	619 cfs Oct 10 73	147 cfs Jun 28 83

Minimums of Record (since initial fill):

	Pool	Date
Lowest	1228.4	Aug 28 77
2nd	1230.0	Jul 30 81

TWIN LAKES DAM AND LAKE
SALT CREEK BASIN - NO. 13, NEBRASKA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



The pool level fluctuated near or below the base of the flood control zone throughout the period. Heavy rainfall during April and July (5.66 inches during April and 1.62 inches in July at the damsite) caused higher rises in the pool level. Inflows during April and July were 350 percent and 411 percent of average, respectively. Maximum midnight pool level achieved was 1342.9 feet MSL on April 29 and July 1. The maximum daily average inflow was 382 cfs on July 1. Outflow on this date was 134 cfs. The maximum daily average outflow was 134 cfs on July 1. Downstream flooding was reduced by the Salt Creek dams.

Maximums of Record:

	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	1346.9 Jun 29 83	452 cfs May 19 84	168 cfs Jun 30 83
2nd	1344.6 May 19 84	408 cfs Jun 29 83	162 cfs May 20 84
3rd	1344.1 Oct 11 73	333 cfs Oct 11 73	148 cfs Oct 12 73

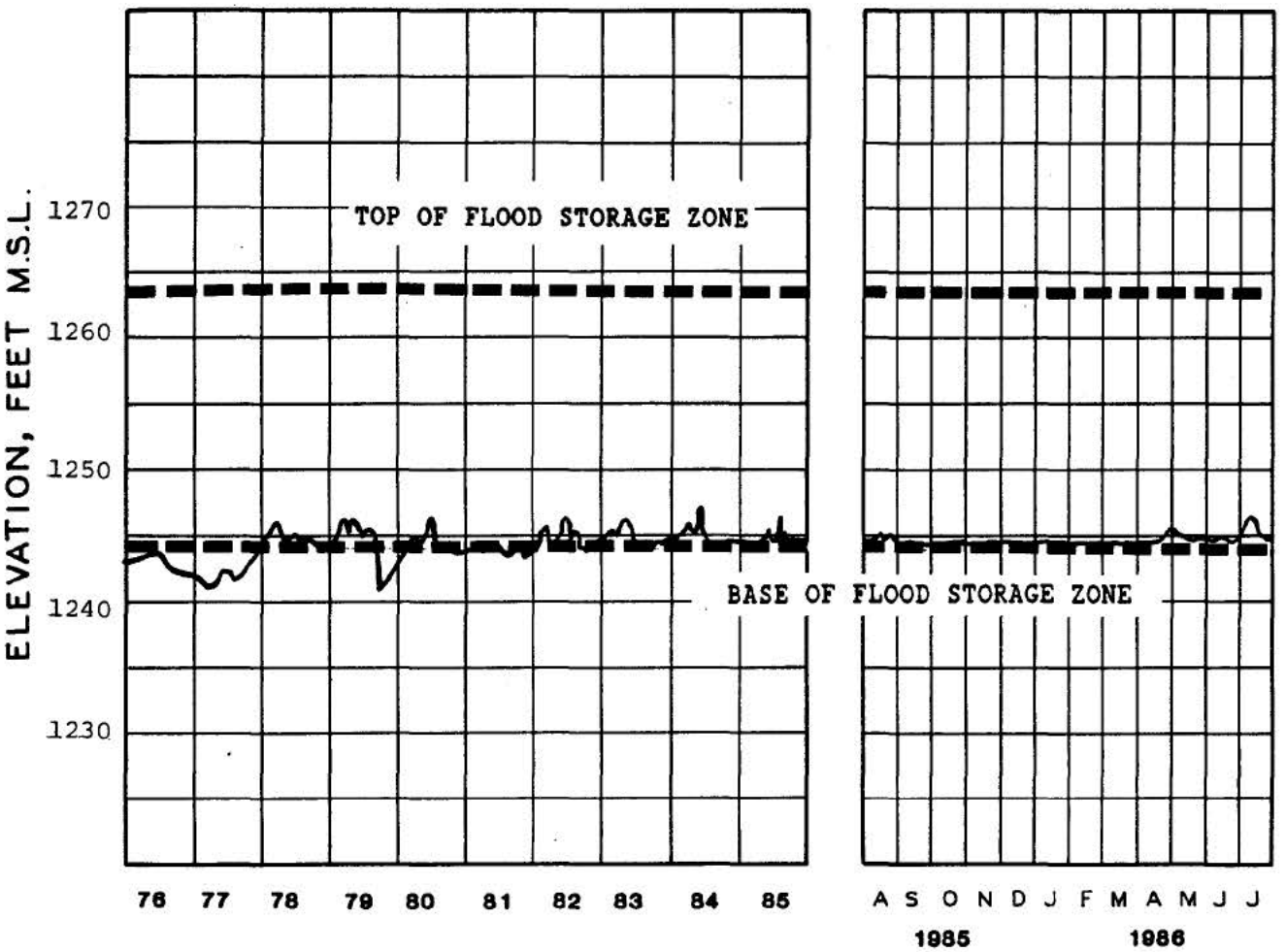
TWIN LAKES DAM AND LAKE (CONT'D)

Minimums of Record (since initial fill):

	Pool-Date
Lowest	1336.3 Aug 29 77
2nd	1336.3 Jul 29 81

PAWNEE DAM AND LAKE
SALT CREEK BASIN - NO. 14, NEBRASKA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



Rainfall and snowmelt kept the pool level above the base of the flood control zone throughout the reporting period. Heavy rainfall during April, June, and July (5.12 inches during April, 5.06 inches during June, and 4.17 inches in July at the damsite) caused significant rises in the pool level. Inflows during April, June and July were 194 percent, 127 percent and 544 percent of average, respectively. The maximum midnight pool level achieved was 1246.8 feet MSL on July 1. The maximum daily average inflow was 901 cfs on July 1. The outflow on this date was 294 cfs. The maximum daily average outflow was 294 cfs on July 1. Downstream flooding was reduced by the Salt Creek dams.

Maximums of Record:

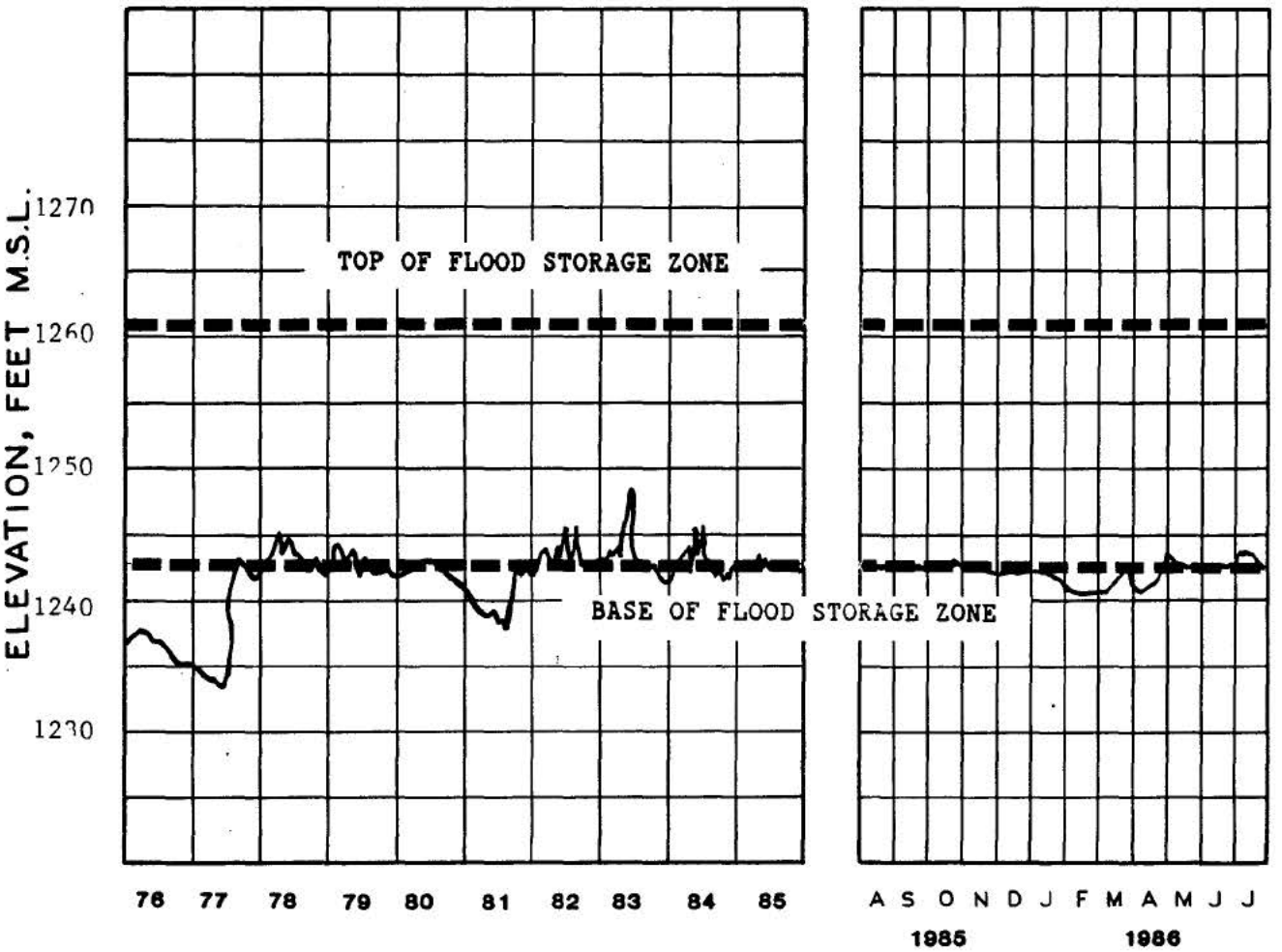
	Pool - Date	Daily Inflow - Date	Daily Outflow -Date
Highest	1247.1 Jun 12 84	1,074 cfs Jul 19 85	311 cfs Jun 13 84
2nd	1246.8 Jul 1 86	901 cfs Jul 1 86	294 cfs Jul 1 86
3rd	1246.7 Oct 11 73	701 cfs Jun 15 82	251 cfs Jul 20 85

Minimums of Record (since initial fill):

	Pool - Date	
Lowest	1240.2	Oct 14 79
2nd	1241.2	Jan 01 77

ANTELOPE CREEK DAM AND HOLMES PARK LAKE
SALT CREEK BASIN - NO. 17, NEBRASKA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



The pool level was near or below the base of the flood control zone until April. Gated releases were made on January 21-23 and March 21-24 to lower the pool level to permit construction on 70th Street. Heavy rainfall during April, June, and July (5.98 inches during April, 4.48 inches during June and 5.99 inches in July at the damsite) caused the pool level to rise above the base of the flood control zone until the end of July when it receded below the base of this zone. Inflows during July were 231 percent of average. The maximum midnight pool level achieved was 1243.8 feet MSL on July 6. The maximum daily average inflow was 78 cfs on July 1. The outflow on this date was 41 cfs. The maximum daily average outflow was 57 cfs on July 7. Downstream flooding was reduced by the Salt Creek dams.

Maximums of Record:

	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	1249.9 Jun 12 84	433 cfs Jun 12 84	187 cfs Jun 29 83
2nd	1248.1 Jun 27 83	381 cfs Jun 27 83	178 cfs Jun 28 83
3rd	1247.1 Oct 10 73	340 cfs Oct 10 73	134 cfs May 25 84

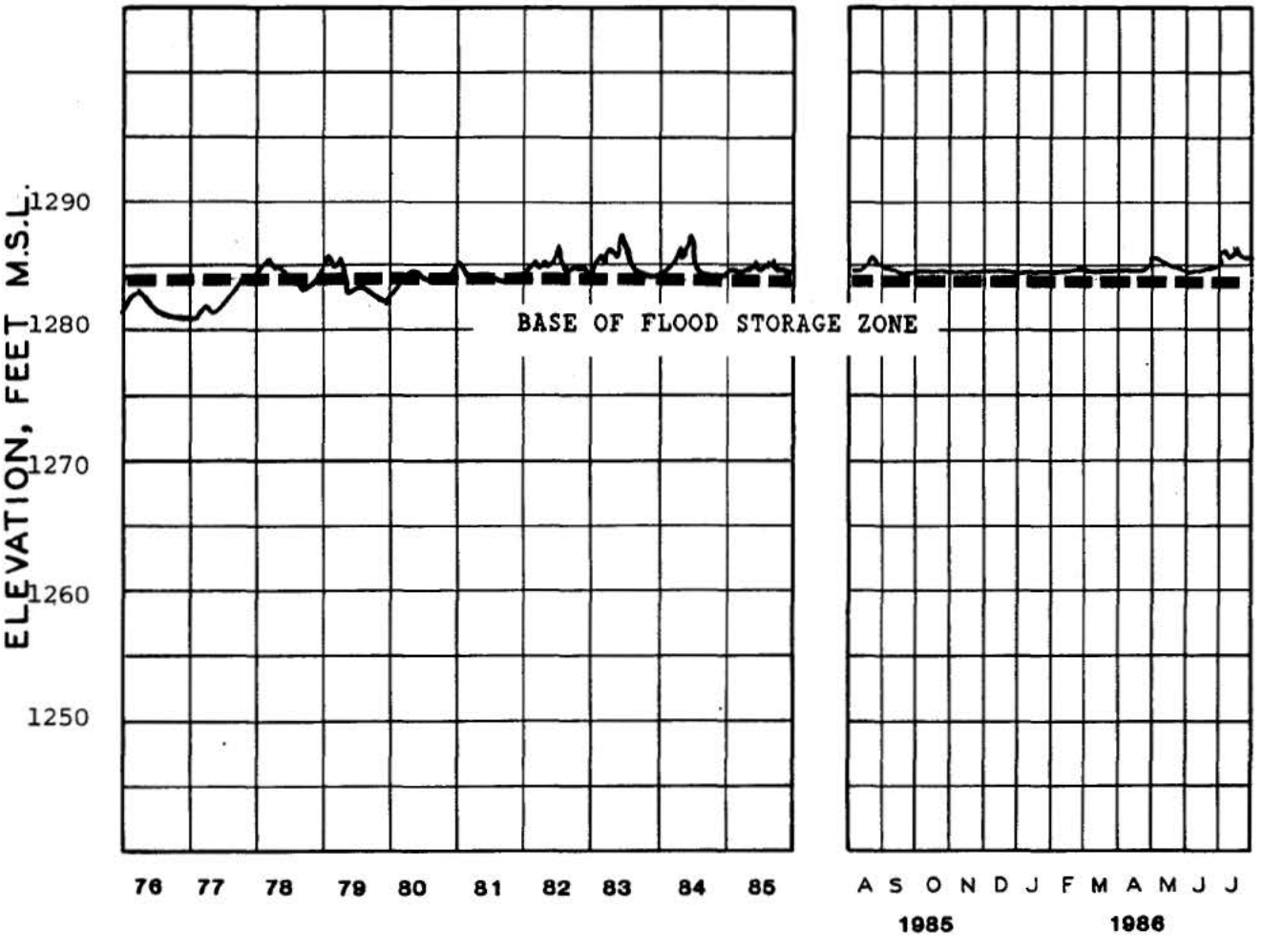
ANTELOPE CREEK DAM AND HOLMES PARK LAKE (CONT'D)

Minimums of Record (since initial fill):

	Pool	Date
Lowest	1232.9	Aug 3 77
2nd	1236.8	Feb 26 76

BRANCHED OAK DAM AND LAKE
SALT CREEK BASIN - NO. 18, NEBRASKA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



CALENDAR YEARS REPORT PERIOD

Rainfall and runoff caused the pool level to remain above the base of the flood control zone throughout the period. Heavy rainfall during April, June, and July (5.95 inches during April, 6.98 inches during June and 4.22 inches in July at the damsite) causes higher rises of the pool level. Inflow during April, June and July were 146 percent, 171 percent and 413 percent of average, respectively. The maximum midnight pool level achieved was 1286.3 feet MSL on July 1. The maximum daily average inflow was 1,417 cfs on June 30. The outflow on this date was 150 cfs. The daily maximum average outflow was 331 cfs on July 2. Downstream flooding was reduced by the Salt Creek dams.

Maximums of Record:

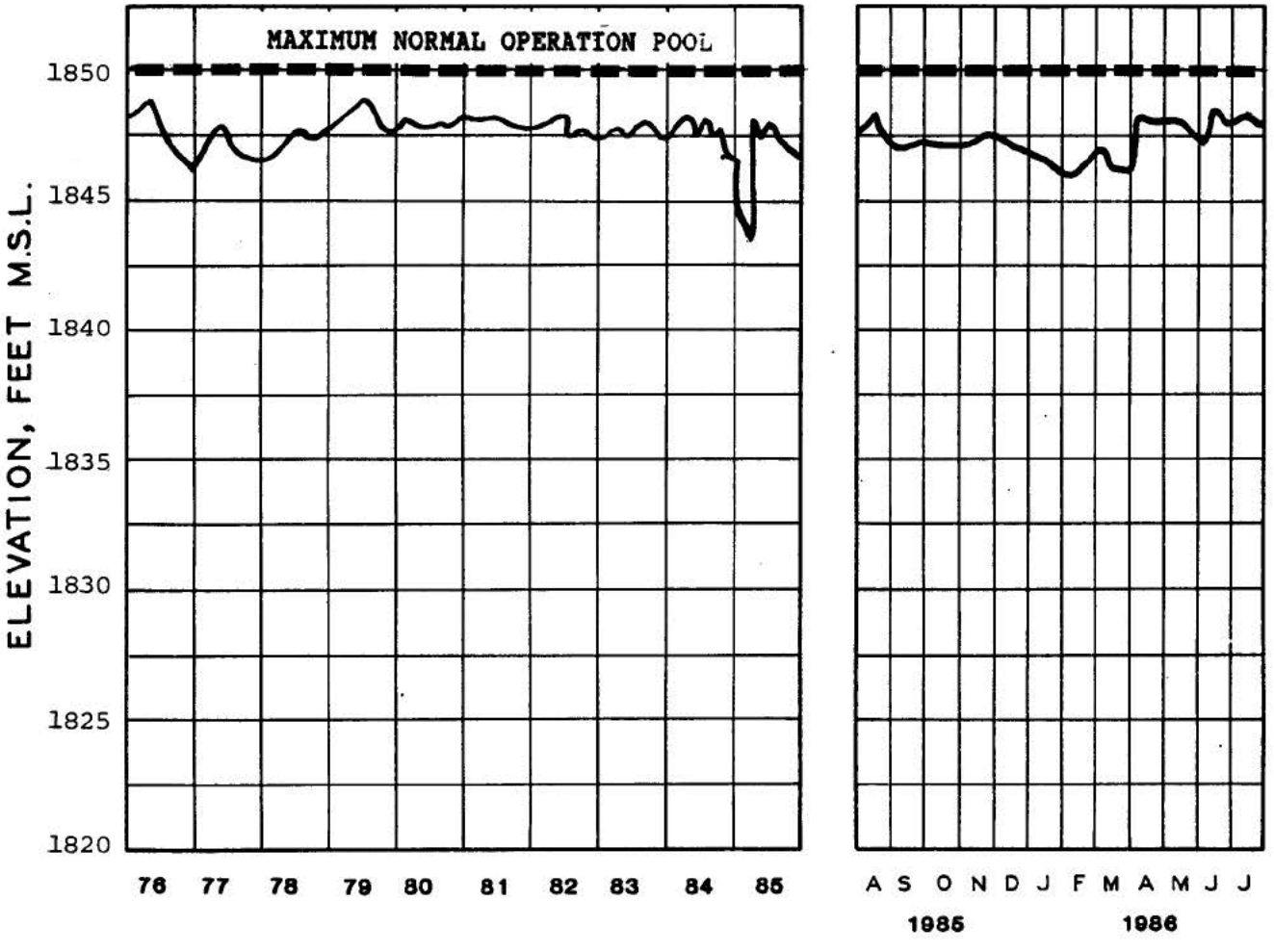
	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	1287.7 Jun 18 83	1,780 cfs Jun 18 83	670 cfs Jun 19 83
2nd	1286.7 Jun 13 84	1,569 cfs Jun 12 84	482 cfs Jun 14 84
3rd	1286.7 Oct 12 73	1,487 cfs Oct 11 73	397 cfs Oct 12 73

Minimums of Record (since initial fill):

	Pool	Date
Lowest	1280.9	Jan 1 77
2nd	1281.9	Nov 11 75

SNAKE CREEK DAM AND LAKE AUDUBON
LAKE SAKAKAWEA SUBIMPOUNDMENT
MISSOURI RIVER BASIN, NORTH DAKOTA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



The freshening program that was started in mid-1984 to lower salinity levels in Lake Audubon was continued during this period. On November 21, 1985 the gate in the Snake Creek embankment structure was closed. This was at the request of the Bureau of Reclamation, Missouri-Sauris Project Office to discontinue the refreshening program during the winter season. The gate had been open to approximately 9.5 feet (1,200 cfs) since 1 May 1985. In early April the lake was refilled and the pool elevation was maintained near 1,848 feet MSL for the rest of the period. During the reporting period, pool elevations ranged from 1846.21 feet MSL on March 24, 1986 to 1848.00 feet MSL on June 9, 1986. No flood control was achieved during this period.

SNAKE CREEK DAM AND LAKE AUDUBON (CONT'D)

Maximums of Record:

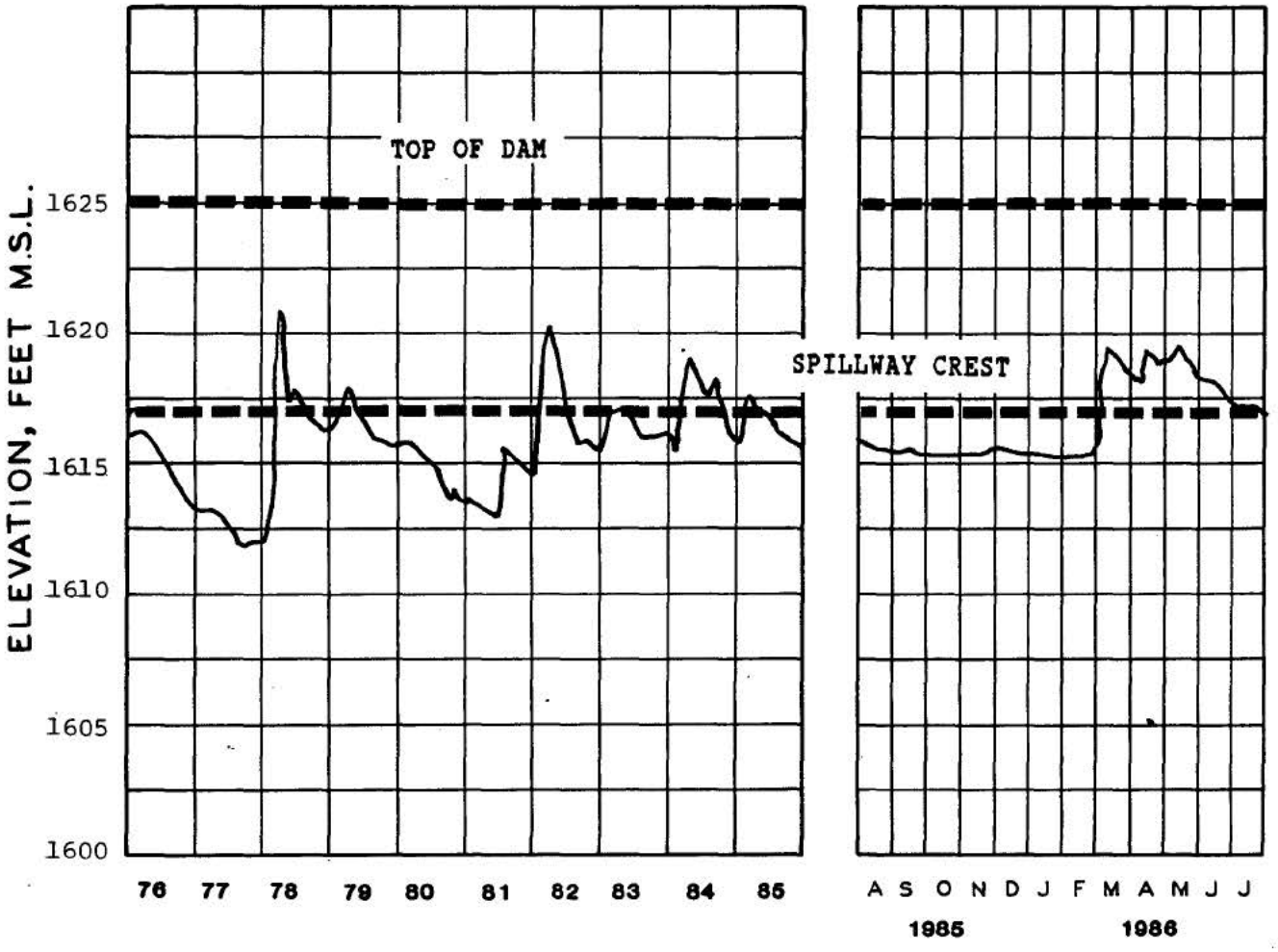
	Pool - Date
Highest	1848.61 May 26 76
2nd	1848.57 May 21 79

Minimums of Record (since initial fill):

	Pool - Date
Lowest	1843.39 Mar 15 85
2nd	1846.21 on March 24, 1986

SPRING CREEK DAM AND LAKE POCASSE
(LAKE OAHE SUBIMPOUNDMENT)
MISSOURI RIVER BASIN, SOUTH DAKOTA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



Lake Pocasse is operated and administered as the Pocasse Natural Wildlife Refuge by the Department of Interior's Fish and Wildlife Service under an agreement with the Corps of Engineers. The pool levels of Oahe Reservoir and Lake Pocasse are contiguous at or above elevation 1617 feet m.s.l., the top of joint-use storage for Lake Oahe. The long-term plan of regulation is to maintain the lake level as high as possible. Every 4 or 5 years, an early summer drawdown to Elevation 1614 feet MSL will assist in the re-establishment of shoreline vegetation and improved water quality.

As a result of spring runoff the reservoir began releasing water over the crest of the spillway (Elevation 1617.0 feet MSL) on March 4 and continued to spill through the end of the reporting period. The maximum pool elevation achieved during the report period was 1619.25 feet MSL on March 14. The minimum pool elevation was 1615.15 feet MSL on February 19-22. Downstream flooding was reduced by the project.

SPRING CREEK DAM AND LAKE POCASSE (CONT'D)

Maximums of Record:

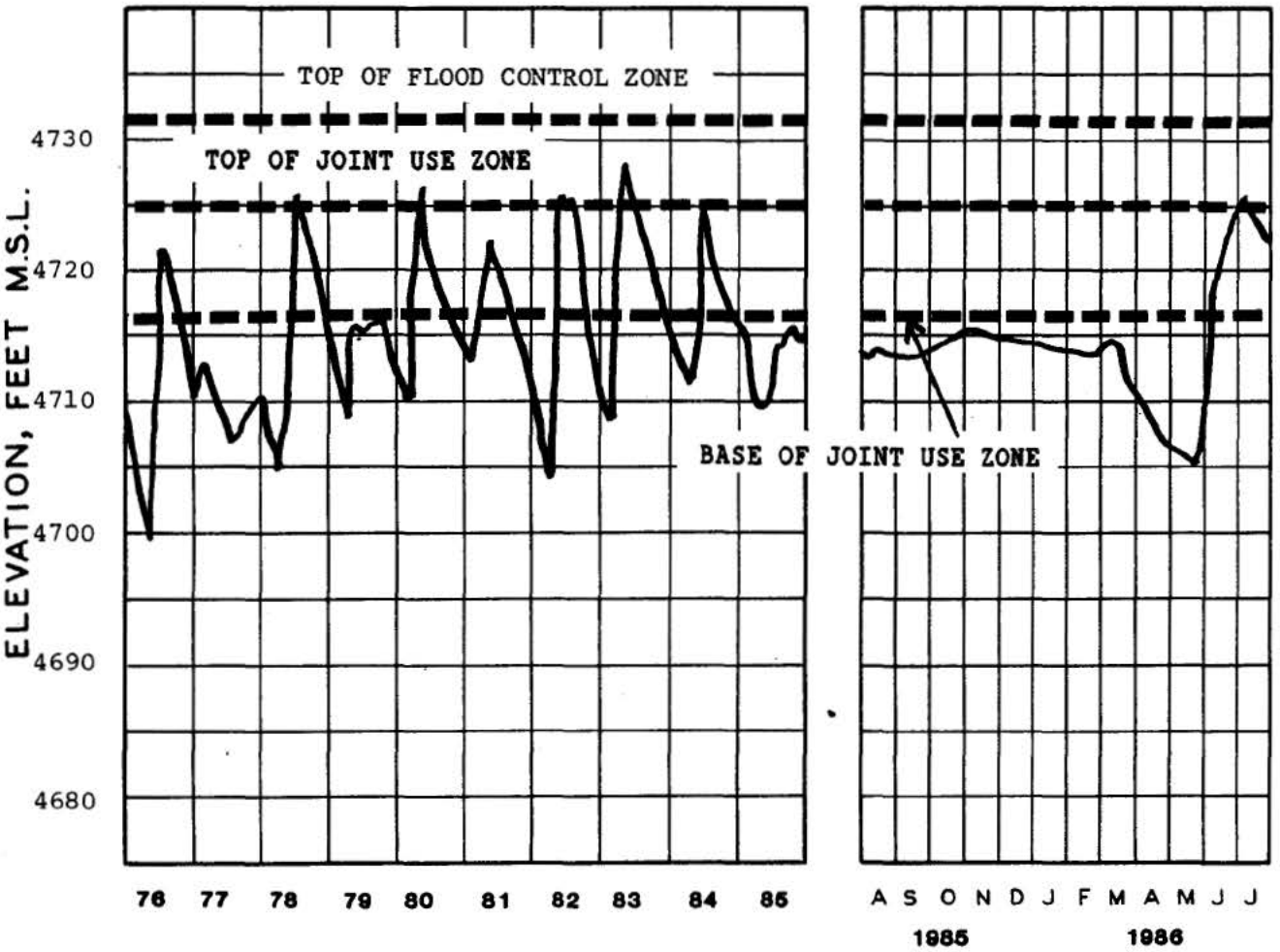
	Pool - Date
Highest	1621.20 Mar 31 78
2nd	1620.52 Mar 19 72
3rd	1620.10 Apr 02 82

Minimums of Record (since initial fill):

	Pool - Date
Lowest	1611.75 Sep 17 77
2nd	1612.45 Jul 11 81

BOYSEN DAM AND LAKE
BIGHORN RIVER BASIN, WYOMING
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



CALENDAR YEARS REPORT PERIOD

Pool elevations remained constant through the winter months until mid-March when the Bureau began drafting storage in anticipation of the predicted above average runoff. A warmer than normal spring combined with above average precipitation values produced an April-July runoff of 1,098,100 AF, approximately 156 percent of normal. Boysen Reservoir entered the exclusive flood storage zone on July 1 and remained there for thirteen days. The maximum pool reached during this period was 4725.64 feet MSL. A total of 12,667 AF or 8 percent of the 150,400 AF exclusive flood storage zone was utilized. The maximum daily inflow was 14,106 cfs on June 8. Outflow on this date was 4,440 cfs. The maximum daily outflow of 7,230 cfs occurred on June 13, 1986. Downstream flooding was prevented by this project.

Maximums of Record:

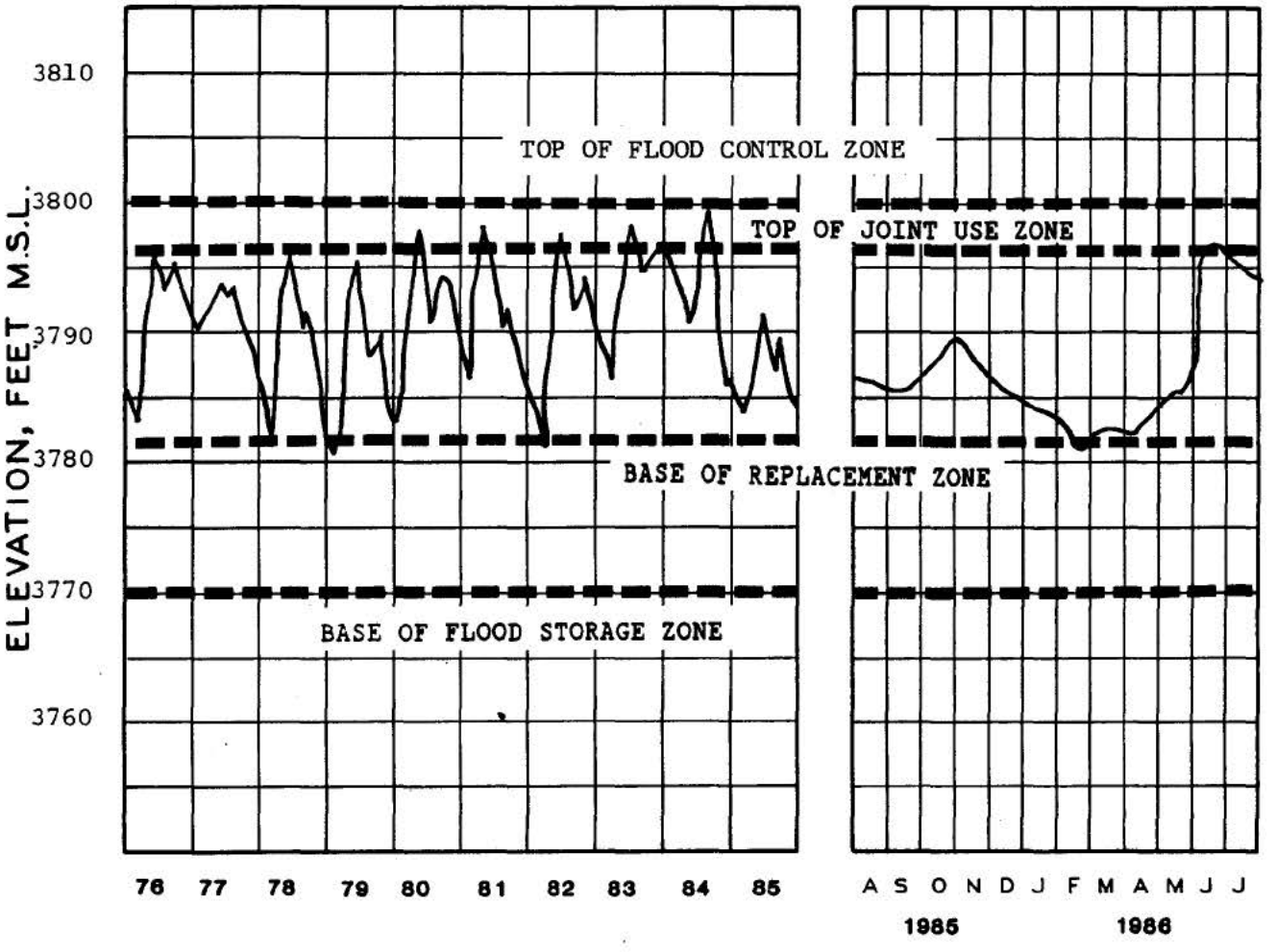
	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	4730.83 Jul 6 67	19,253 cfs Jun 23 67	14,204 cfs Jul 7 67
2nd	4729.85 Jul 5 57	17,975 cfs Jun 17 63	8,518 cfs Jun 24 63
3rd	4727.89 Jul 4 83	15,780 cfs Jun 8 57	8,146 cfs Jun 30 71

Minimums of Record (since initial fill):

	Pool-Date
Lowest	4684.18 Mar 18-19 56
2nd	4686.42 Sep 21 60

CANYON FERRY DAM AND RESERVOIR
MISSOURI RIVER BASIN, MONTANA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



At the beginning of the reporting period, storage in Canyon Ferry Lake was 1,638,031 AF at elevation 3787.18 feet MSL. Because of the warm weather and above normal fall precipitation, inflows to the lake were well above normal during October. Storage steadily rose and to prevent causing any problems to the ongoing construction work on the environmental enhancement dikes, releases were gradually increased to about 5,000 cfs by late October. Storage steadily declined to the low of the year of 1,460,051 AF at elevation 3781.35 feet MSL on February 21.

Unseasonably mild, warm weather and strong winds were experienced during the last 2 weeks of February. Inflows increased significantly to over 8,000 cfs, signaling the beginning of the spring snowmelt season. The April 1 water supply forecast, based on mountain snowpack, indicated the April-July runoff into Canyon Ferry Lake would be about 85 percent of normal. Above normal precipitation during April continued to improve this forecast to about 90 percent of normal. By late May, warm temperatures caused the high mountain snowpack to melt rapidly. Inflows rose to a peak for the year of 22,980 cfs on June 6 and by the end of June had declined to about 5,000 cfs. The heavy runoff caused

storage to rise dramatically to the peak for the year of 1,960,286 AF at elevation 3797.25 feet MSL on June 24, 8,227 AF and 0.25 feet above the top of the joint use pool. To control the rapid rate of fill, spills of 1,000 cfs in excess of powerplant capacity were started on June 4 and gradually increased to 7,000 cfs on June 11. As the inflows to Canyon Ferry Lake declined the spills were gradually reduced until being discontinued on June 20. About 134,400 AF of water was spilled during the June 4-20 period. Storage entered the exclusive flood pool on June 21 and remained there for only a brief period until June 27. Actual April-July runoff into Canyon Ferry Lake was 1,907,240 AF or 95 percent of normal. Downstream flooding was prevented.

Maximums of Record:

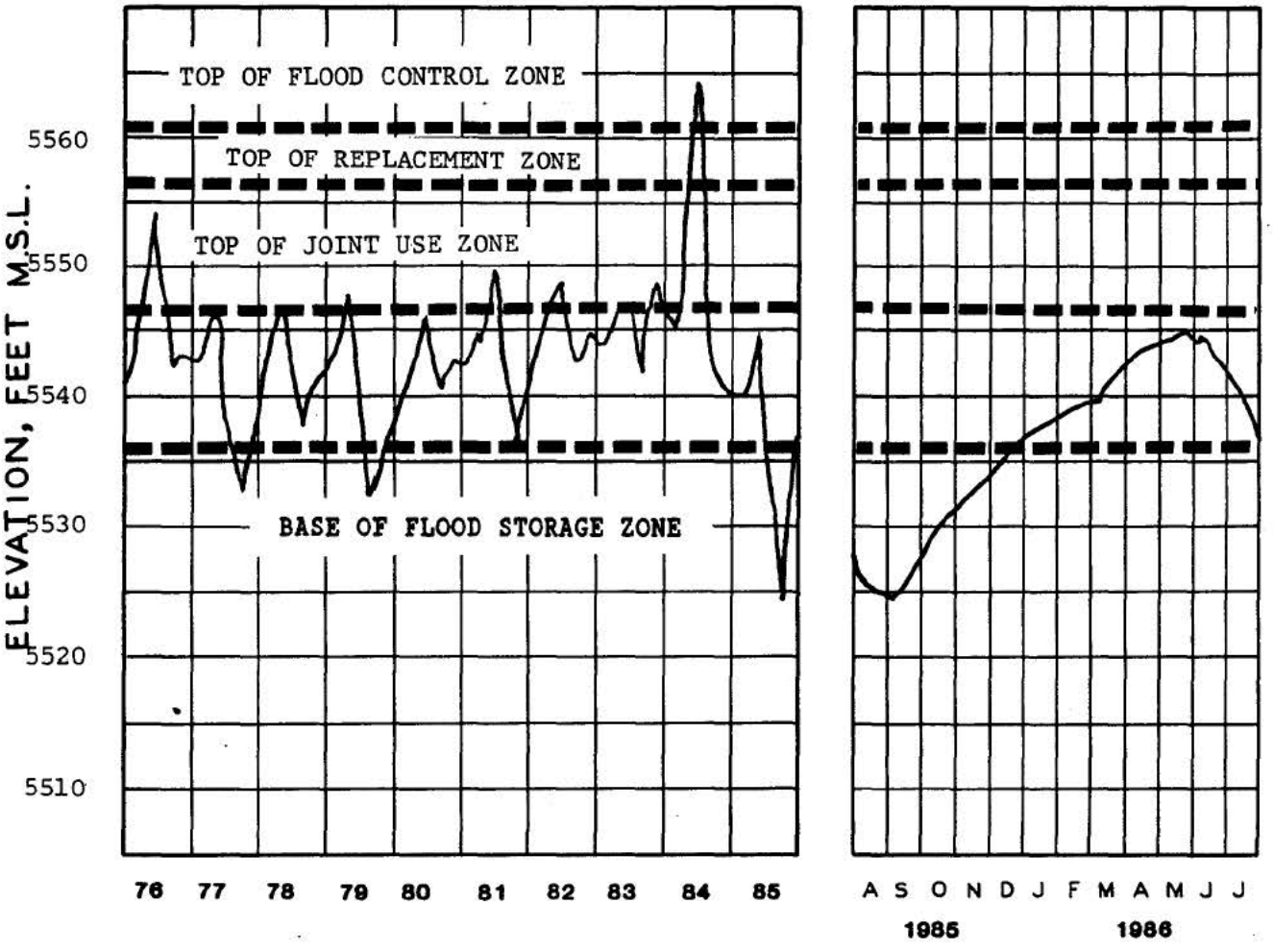
	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	3800.00 1955, 1956, 1962	29,050 cfs May 24 81	25,720 cfs Jun 13 81
2nd	3799.93 Jul 7-12 75	27,570 cfs Jun 19 74	24,370 cfs Jun 19 64
3rd	3799.66 Jun 4-5 62	27,110 cfs May 30 56	24,030 cfs May 31 56

Minimums of Record (since initial fill):

	Pool-Date
Lowest	3764.70 Apr 11 67
2nd	3772.75 Mar 25 62

CLARK CANYON DAM AND RESERVOIR
BEAVERHEAD RIVER BASIN, MONTANA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



CALENDAR YEARS REPORT PERIOD

Clark Canyon Reservoir (Hap Hawkins Lake) started the period in the conservation storage zone and continued to occupy this space through mid-December when the pool entered the joint-use zone (El. 5535.7 to 5546.1). The low pool was reported on September 8, as 5524.35 feet MSL. This reporting period marks the first time since 1974 that Clark Canyon Reservoir has not filled the joint use zone. The maximum pool during this period was 5544.83 feet MSL on September 8, 1985. The maximum daily inflow (less evaporation) was 1,176 cfs on June 5, 1986. Outflow on this date was 871 cfs. The peak daily outflow of 1,050 cfs occurred on June 21. No flood control was achieved during this period.

Maximums of Record:

	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	5564.70 Jun 25 84	3,416 cfs Jun 22 84	2,561 cfs Jun 25 84
2nd	5556.88 Jul 22 75	2,800 cfs Jun 20 75	1,289 cfs Jul 31 75
3rd	5554.54 Jun 25 76	2,208 cfs Mar 31 69	1,275 cfs Aug 12-24 75

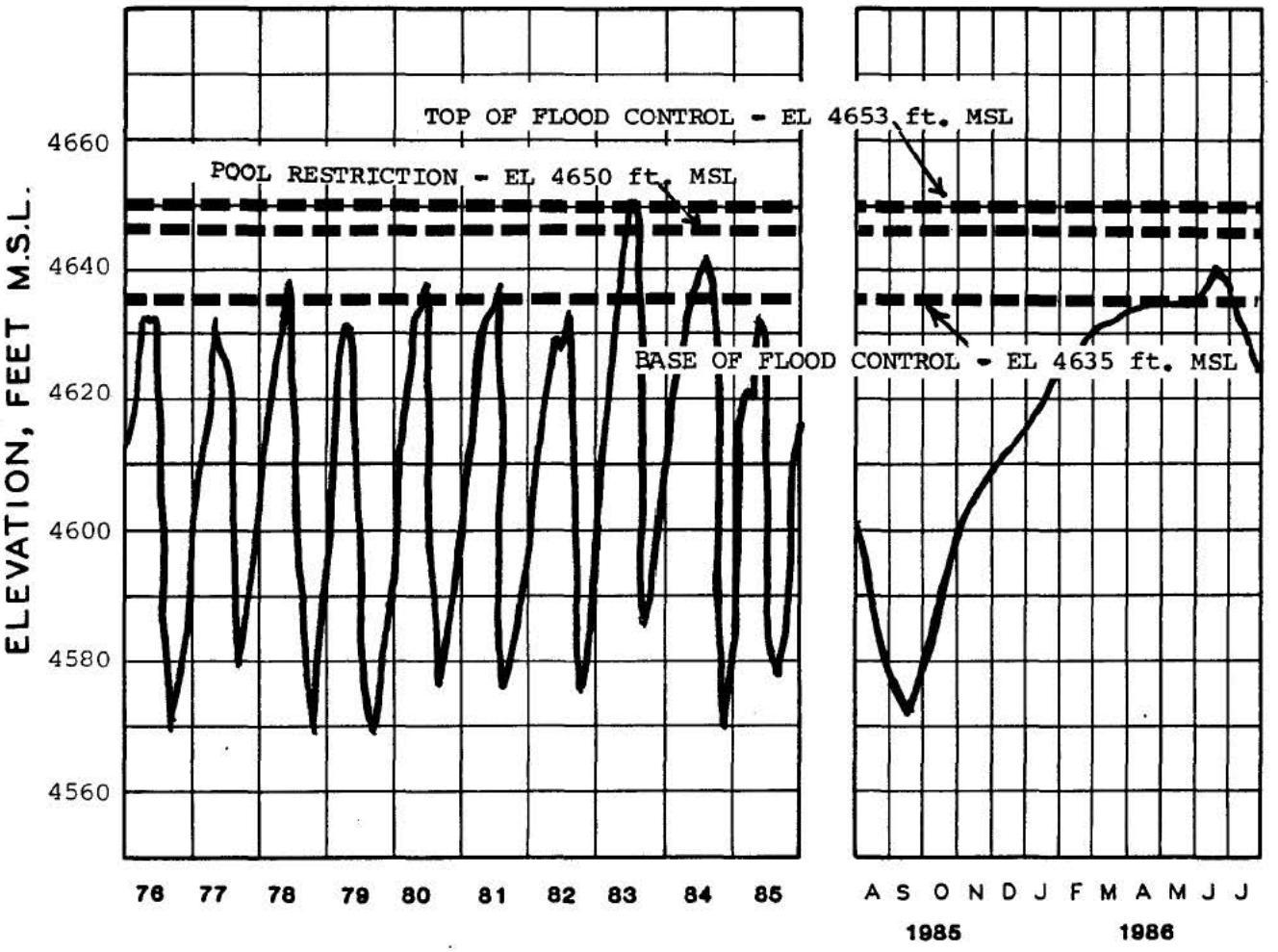
CLARK CANYON DAM AND RESERVOIR (CONT'D)

Minimums of Record (since initial fill):

	Pool	Date
Lowest	5516.80	Oct 11 74
2nd	5521.24	Sep 29-30 66

GLENDO DAM AND RESERVOIR
NORTH PLATTE RIVER BASIN, WYOMING
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



The 1971 Field Working Agreement stipulates that releases from Glendo Reservoir will be determined by the District Engineer while the water surface is between Elevations 4635.00 feet MSL and 4653.00 feet MSL. The Bureau of Reclamation imposed an elevation restriction of 4,650 feet MSL in December of 1983 due to increased dike seepage. This restriction reduces the available flood storage space to 80 percent and precludes the use of the spillway and surcharge storage zone.

Water stored in the North Platte River Basin was 123 percent of normal at the beginning of August 1985 with below average precipitation (34% of average; 4th lowest in 27 years of record) reported during the first month at Glendo. September 1985 thru January 1986 showed average to above average precipitation at Glendo. Glendo entered the flood storage zone on June 9 reflecting the heavy precipitation and runoff in the basin. Releases at this time were maintained at 2,100 cfs. On June 12 releases were cut from 2,100 cfs to 500 cfs in response to a Bureau of Reclamation request to lower the Guernsey Reservoir pool. The pool rose steady until June 17 (Elev. 4639.62 feet MSL) when releases were

increased to 2,200 cfs. The pool continued to rise to a peak of 4610.55 feet MSL occurring on June 22. The reservoir then declined to the end of the report period. The pool at the end of the report period was at Elev. 4626.40 ft. MSL. Inflows early in the report period were above normal throughout the system with Glendo receiving 186 percent of average in April. Inflows fell to 48 percent of average in May, but averaged above normal for the remaining two months of the period.

The maximum pool achieved was 4640.15 feet MSL on June 22 (5.15 feet into the flood control zone). This level utilized 25 percent of the allocated flood storage or 30 percent of the restricted zone. The peak daily inflow was 9,544 cfs on June 11. Outflow on this date was 2,200 cfs. The peak daily outflow was 8,651 on July 1. Flood control was achieved by this project.

Maximums of Record:

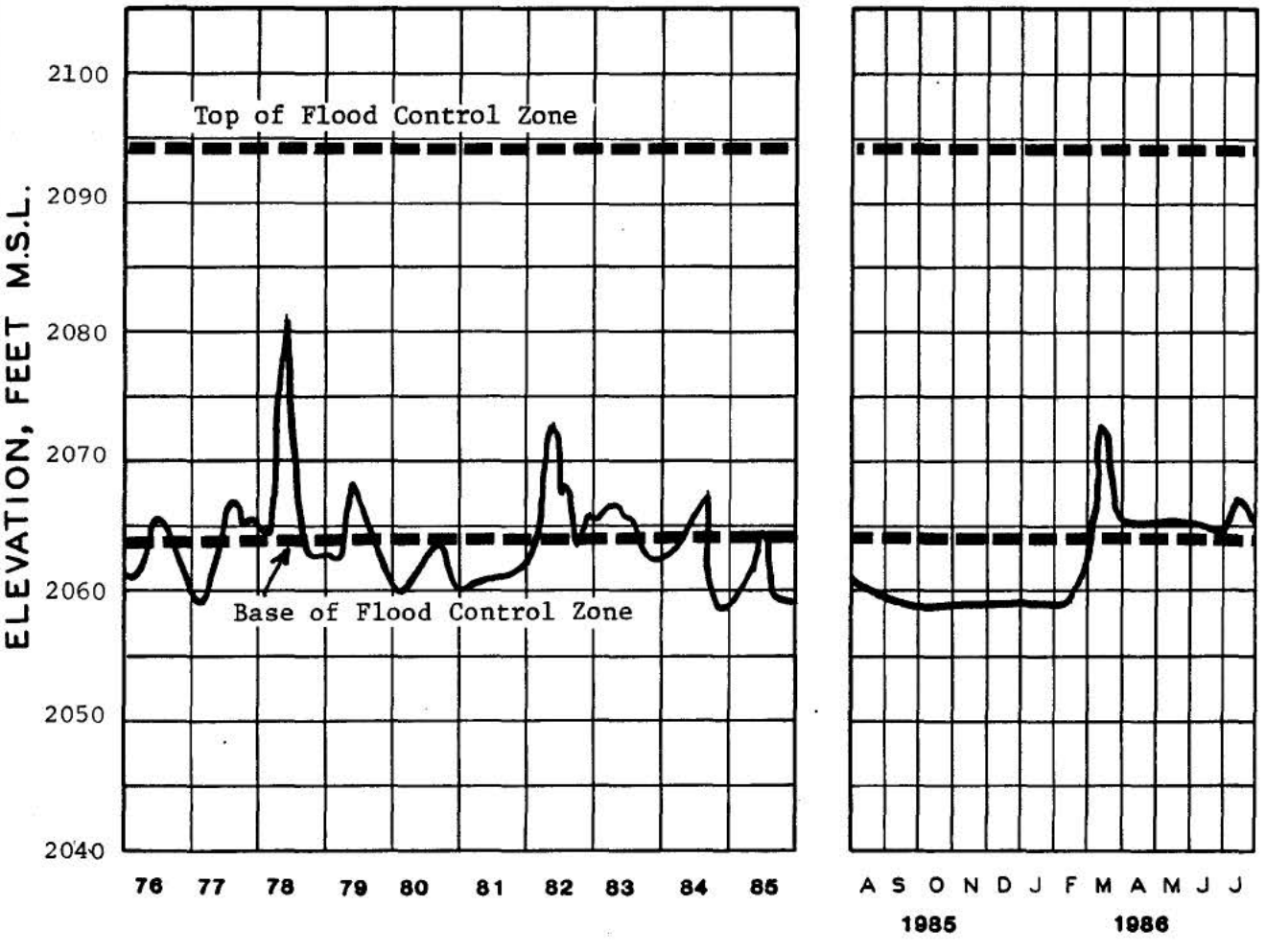
	Pool - Date	Daily Inflow - Date	Daily Outflow - Date
Highest	4650.90 May 27 73	18,840 cfs May 15 65	10,292 cfs Jun 30 84
2nd	4650.27 Jun 14 83	17,560 cfs Jun 13 70	10,266 cfs Jul 01 84
3rd	4648.45 May 31 71	14,661 cfs May 21 73	10,060 cfs Aug 26 83

Maximums of Record (since initial fill):

	Pool - Date
Lowest	4548.10 Sep 28 66
2nd	4560.42 Sep 26 72

HEART BUTTE DAM AND RESERVOIR (LAKE TSCHIDA)
HEART RIVER BASIN, NORTH DAKOTA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



Lake Tschida was below the base of the flood control zone (2064.5 feet MSL) at 2061.29 feet MSL at the beginning of the report period and fell slowly to a low of 2059.17 feet MSL for the report period on October 29 and 30. The pool rose less than one foot over the next four months until a large rise occurred near the end of February due to above average temperatures that melted much of the plains snowpack. The warming trend lasted for approximately one week. Inflows rose to 7,200 cfs. The pool remained in the flood control zone for the remainder of the period except for a brief time at the end of June and beginning of July. The pool however rose back into the flood control zone by July 4 and ended the period at 2065.32 feet MSL.

The maximum pool achieved was on March 6 at 2073.19 feet MSL (8.7 feet into the flood pool). Flood storage utilized was approximately 22 percent or 32,750 AF of 147,900 AF of available flood storage. Maximum daily inflow occurred on March 4 at 7,200 cfs. Outflow on this date was 3,100 cfs. The peak daily outflow was on March 7 at 3,310 cfs. Downstream flooding was reduced by this project.

HEART BUTTE DAM AND RESERVOIR (LAKE TSCHIDA) (CONT'D)

Maximums of Record:

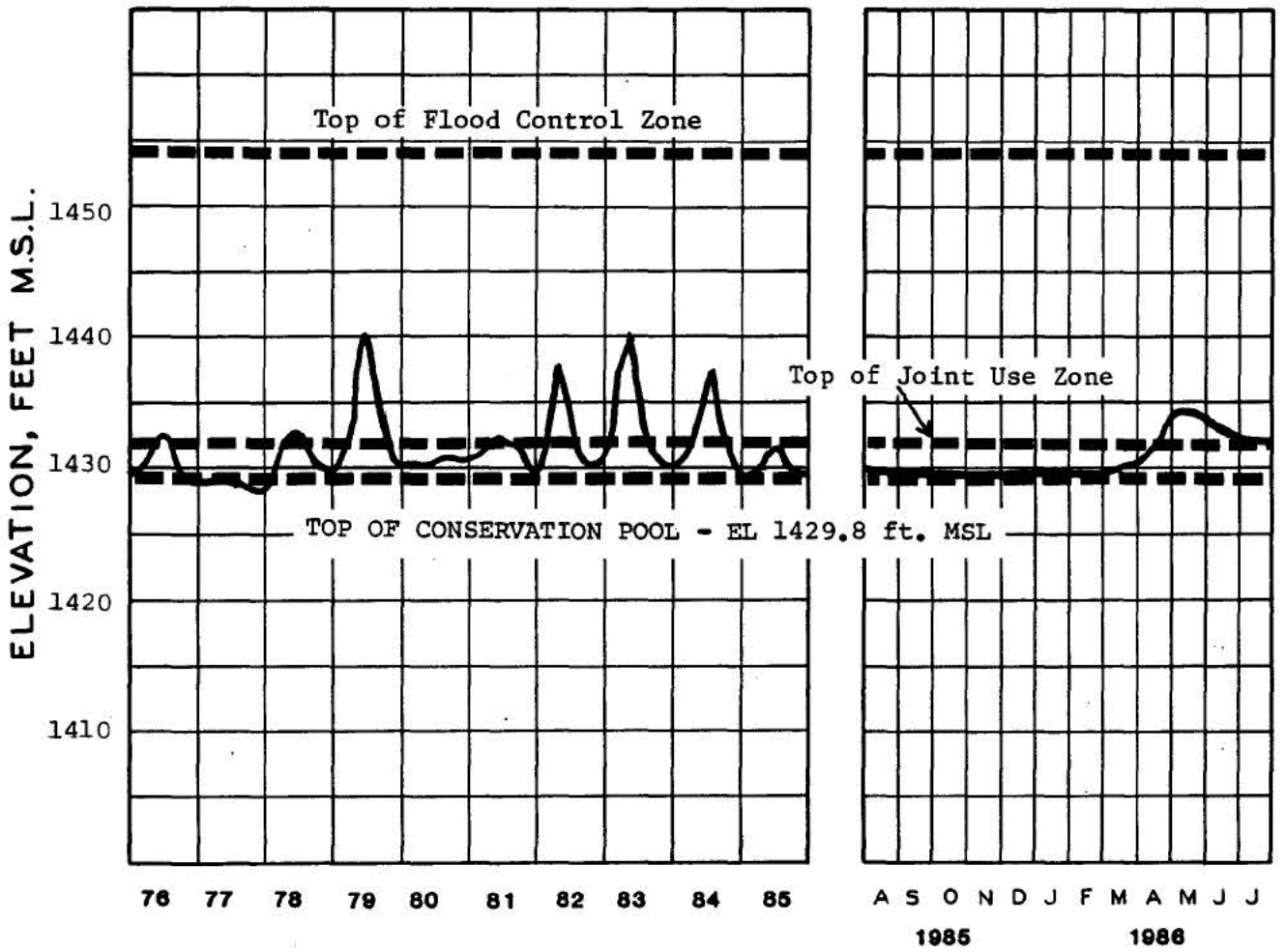
	Pool - Date	Daily Inflow - Date	Daily Outflow - Date
Highest	2086.23 Apr 09 52	22,450 cfs May 09 70	4,050 cfs Apr 09 52
2nd	2083.77 Mar 31 78	22,000 cfs Apr 17 50	3,931 cfs May 31 78
3rd	2082.70 May 12 70	12,960 cfs Apr 06 52	3,864 cfs May 13 70

Minimums of Record (since initial fill):

	Pool - Date
Lowest	2052.80 Dec 31 61
2nd	2054.70 Apr 01 62

JAMESTOWN DAM AND LAKE
JAMES RIVER BASIN, NORTH DAKOTA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



The pool level at Jamestown Dam at the beginning of the report period (August 1, 1985) was 1430.67 feet MSL with discharges ranging from 53 cfs on August 1, 1985 to zero cfs on August 17, 1985. The zero releases were maintained until April 24 when a 101 cfs release rate was initiated and held until April 28. On this date releases were increased to 208 cfs to slow the rate of pool rise. This release rate was maintained through May 2 (pool elevation 1433.93 feet MSL) when releases were then reduced to 108 cfs. The pool rose slightly with the lower releases to 1434.53 feet MSL before dropping to 1432.57 feet MSL by July's end.

The maximum pool achieved during the period was 1434.53 feet MSL on May 16. Outflow on this date was 108 cfs (11,757 AF of 192,000 AF of flood space or 6 percent was utilized). The peak daily inflow was 500 cfs on April 14. Outflow on this date was zero. The peak daily outflow was 208 cfs from April 28 to May 2. The combined maximum Jamestown/Pipestem release was 308 cfs from April 28 to May 2. Downstream flooding in South Dakota was reduced by this project.

JAMESTOWN DAM AND LAKE (CONT'D)

Maximums of Record:

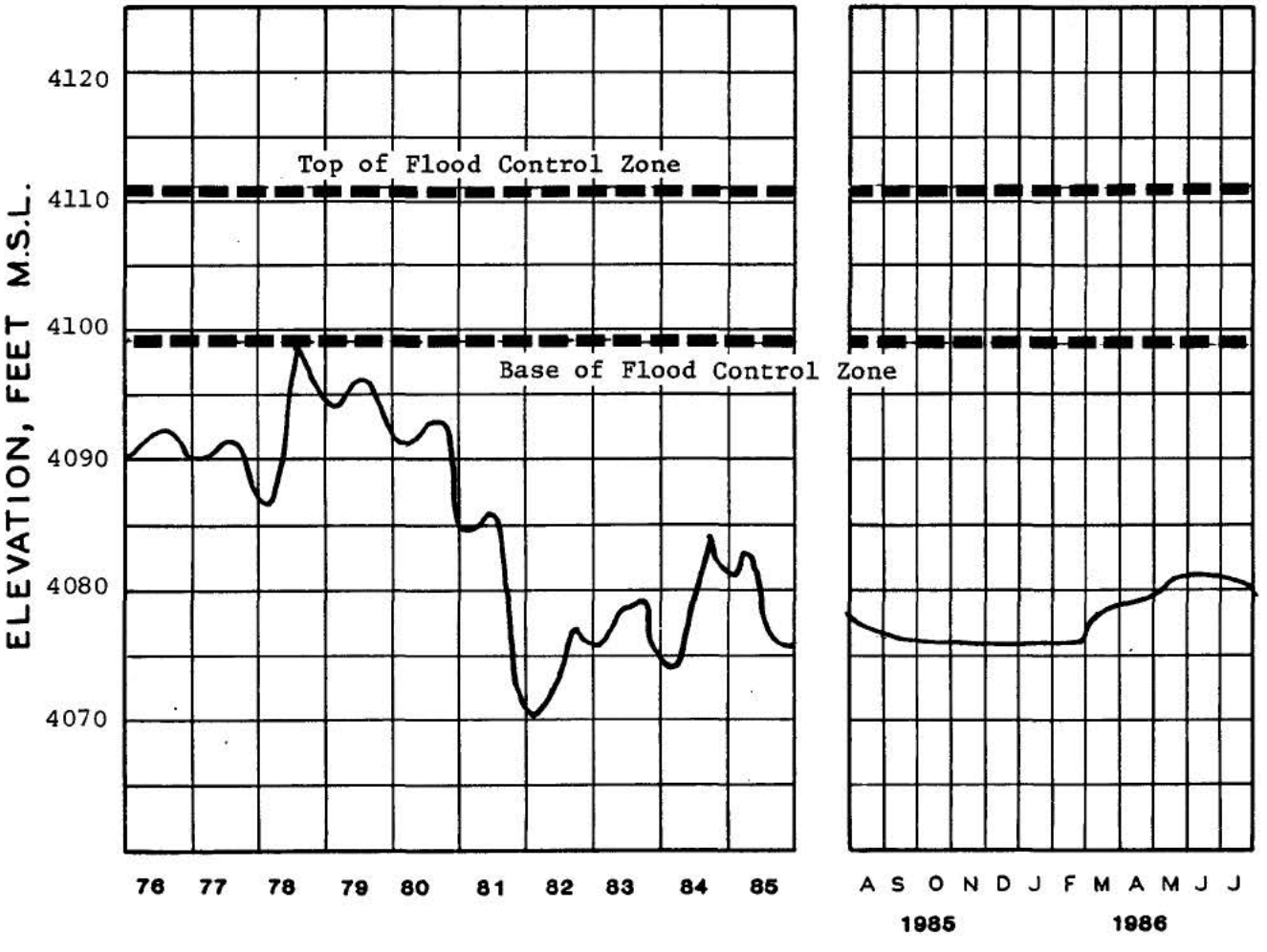
	Pool - Date	Daily Inflow - Date	Daily Outflow - Date
Highest	1440.10 Apr 27 69	7,220 cfs Apr 18 69	489 cfs Apr 16 83
2nd	1440.90 Apr 01 83	2,900 cfs May 03 79	400 cfs Mar,Apr,May 66 400 cfs May,Jun,Jul 69
3rd	1440.16 May 13/14 79	2,845 cfs Mar 28 66	350 cfs May,Jun 74 350 cfs Apr,May,Jun 75 350 cfs May,Jun 79

Minimums of Record (since initial fill):

	Pool - Date
Lowest	1427.46 Sep 21 73
2nd	1428.48 Mar 9-10 78

KEYHOLE DAM AND RESERVOIR
BELLE FOURCHE RIVER BASIN, WYOMING
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



The maximum pool reached at Keyhole Dam was 4081.27 feet MSL on June 11, well below the flood control base of 4099.3 feet MSL. The minimum pool was 4076.03 feet MSL on November 11-14. Irrigation releases for the period were terminated on September 3, and resumed on July 11. The peak daily inflow was 1,200 cfs on May 11, 1986. No release was made on this date. The peak daily outflow was 125 cfs on August 1, 1985. No flood control was achieved during the period.

Maximums of Record:

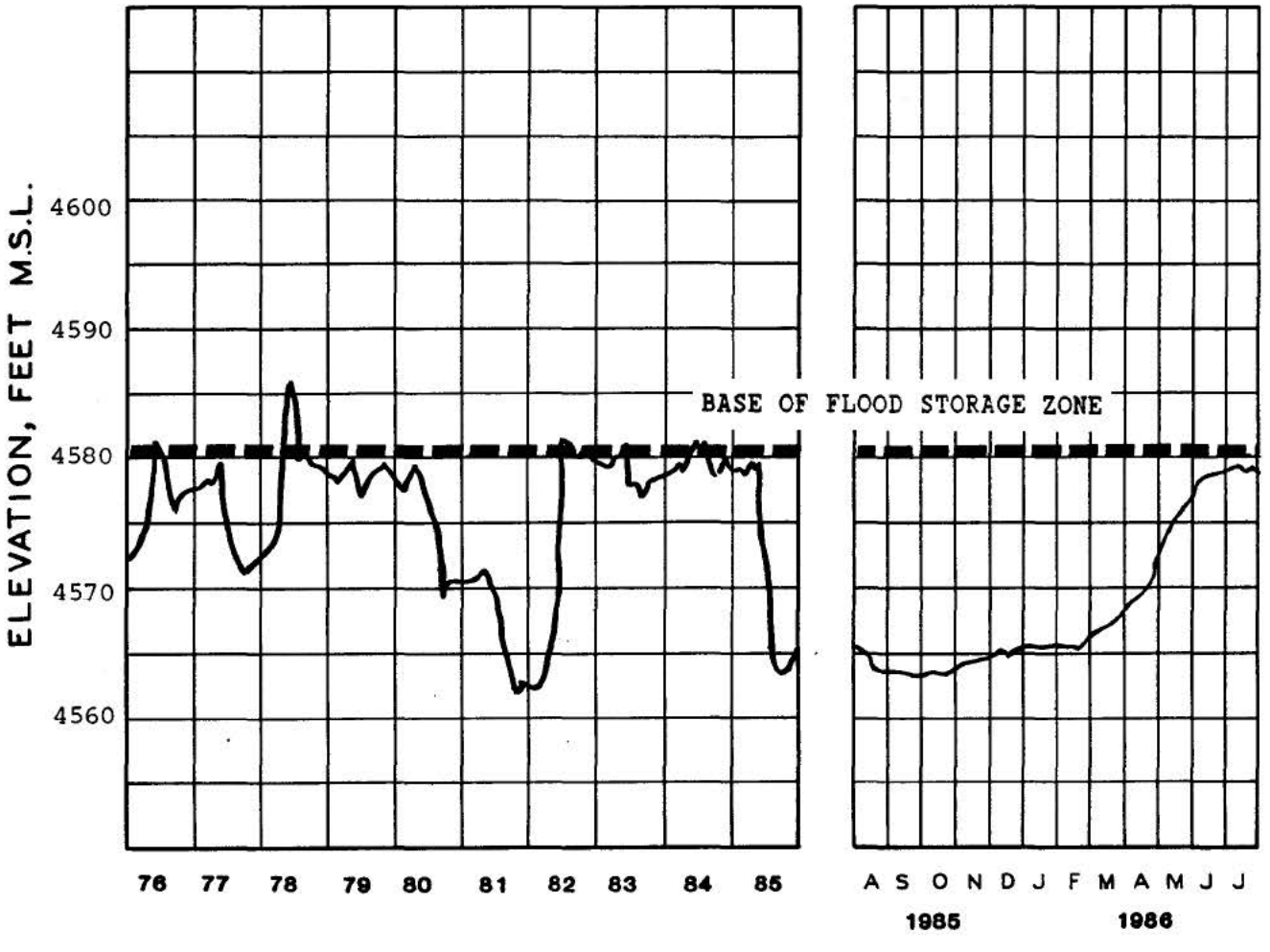
	Pool - Date	Daily Inflow - Date	Daily Outflow - Date
Highest	4100.38 May 21 78	10,720 cfs May 19 78	1,347 cfs May 24 78
2nd	4098.78 Mar 07 72	4,780 cfs Feb 29 72	820 cfs May 23-24 62
3rd	4096.41 May 06 73	3,530 cfs Jun 18 62	801 cfs Mar 11-15 72

Minimums of Record (since initial fill):

	Pool - Date
Lowest	4071.51 Dec 12-25 81
2nd	4074.61 Oct 07-08 83

PACTOLA DAM AND RESERVOIR
RAPID CREEK BASIN, SOUTH DAKOTA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



Excess rainfall and runoff caused the pool level to gradually rise during April and May even with irrigation demands. The maximum pool level achieved during the period was 4579.29 feet MSL on July 23. The maximum daily average inflow was 220 cfs on May 9. The outflow on this date was 20 cfs. The maximum daily outflow was 82 cfs on August 3. No flood control was achieved during the period.

Maximums of Record:

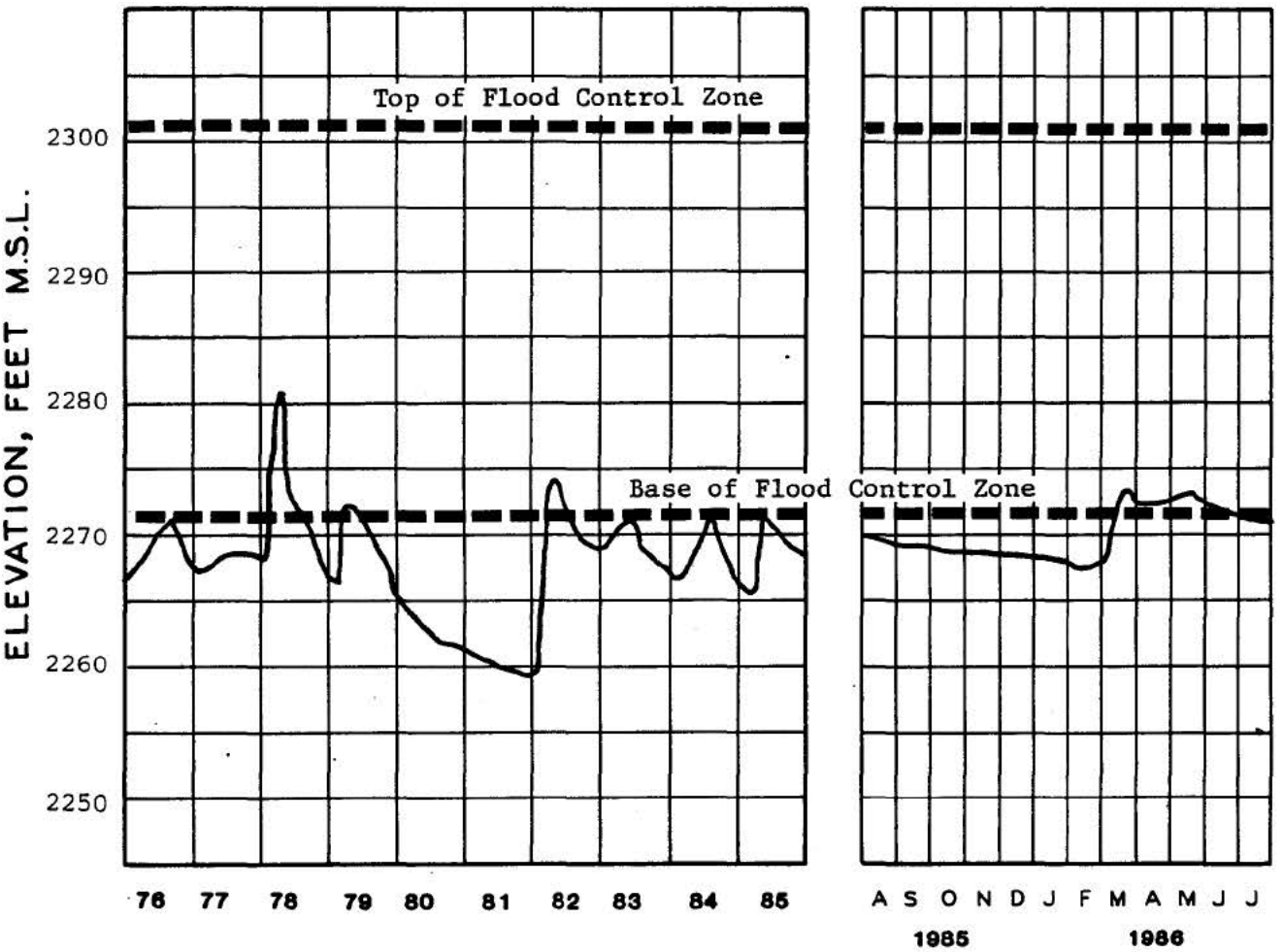
	Pool - Date	Daily Inflow - Date	Daily Outflow - Date
Highest	4485.87 May 19 65	1,110 cfs May 16 65	500 cfs May 20 65
2nd	4485.44 May 21 78	485 cfs May 11 78	350 cfs May 22 78
3rd	4585.06 Jan 22 72	445 cfs Jun 10 72	255 cfs May 11 83

Minimums of Record (since initial fill):

	Pool - Date
Lowest	4561.50 Oct 2 81
2nd	4563.70 Oct 1 74

SHADEHILL DAM AND RESERVOIR
GRAND RIVER BASIN, SOUTH DAKOTA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



The maximum pool occurred on May 11 at 2273.78 feet MSL. The minimum pool occurred on February 26-28 at 2267.80 feet MSL. The peak daily inflow of 2,300 cfs occurred on May 10. Outflow on that date was 471 cfs. The maximum daily outflow was 953 cfs on May 12. Downstream flooding was prevented.

Maximums of Record:

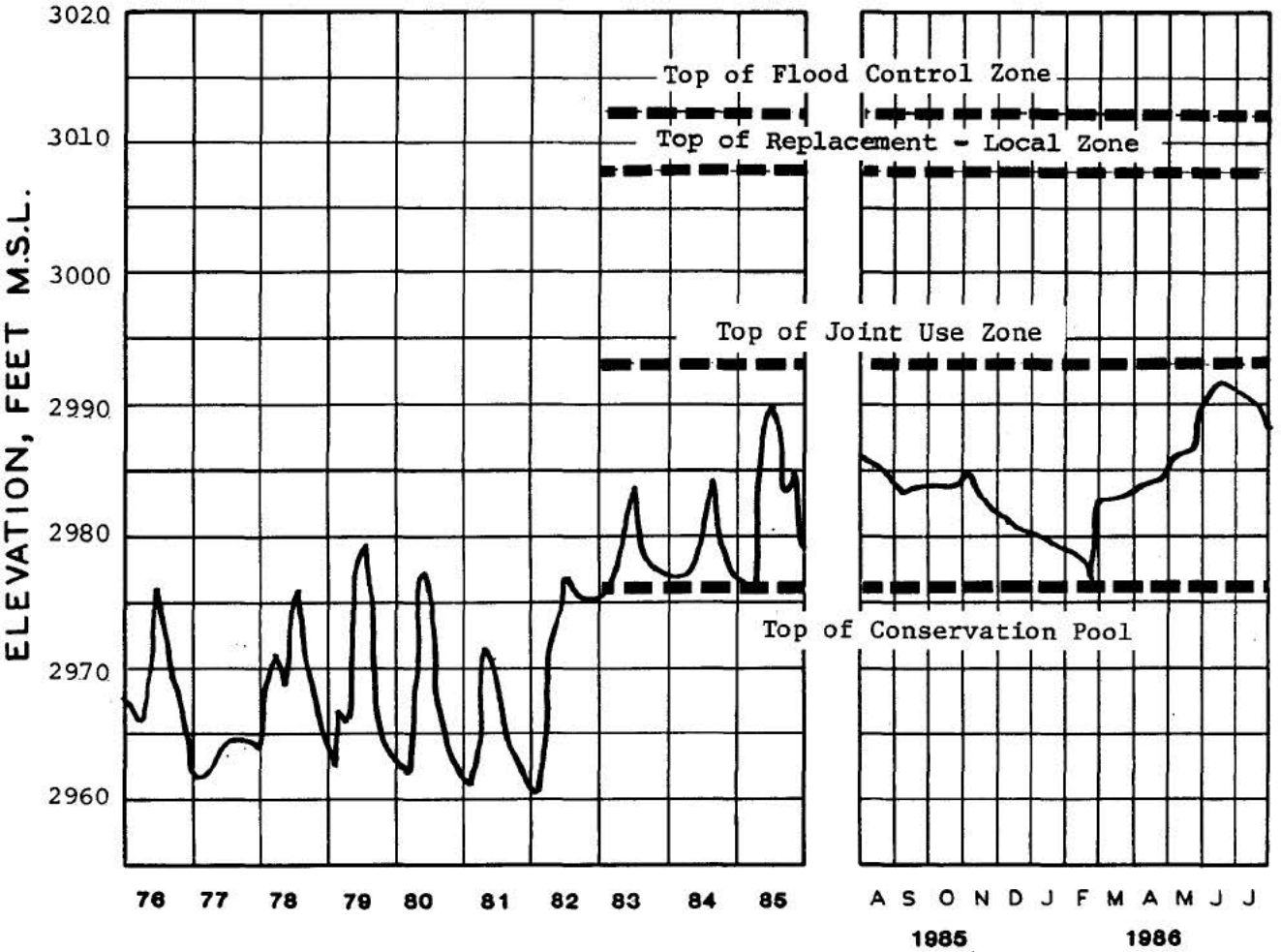
	Pool - Date	Daily Inflow - Date	Daily Outflow - Date
Highest	2297.90 Apr 10 52	32,152 cfs Apr 08 52	5,078 cfs Apr 10 52
2nd	2282.42 Apr 01 78	9,900 cfs Mar 29 78	4,190 cfs Apr 01 78
3rd	2276.37 Mar 15 72	6,730 cfs Mar 13 72	3,020 cfs Mar 16 72

Minimums of Record (since initial fill)

	Pool - Date
Lowest	2258.62 Nov 17 81
2nd	2259.11 Feb 28 62

TIBER DAM AND RESERVOIR (LAKE ELWELL)
MARIAS RIVER BASIN, MONTANA
1985–1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



The Bureau of Reclamation and the Corps of Engineers signed a new Water Control Agreement and Flood Control Storage Reservation Diagram for Lake Elwell and Tiber Dam on March 14, 1983. The previous agreement, made October 30, 1964, was voided on March 29, 1966, when the Bureau gave notice that structural problems with the spillway and its foundation required that the spillway gates remain fully open until repairs could be made. Repairs were completed in October 1981.

The Agreement stipulates that "regulation of the reservoir when the pool level is in the flood control zone," Elevation 2993.0 - 3012.5, "shall be construed as flood control and releases or flood control regulation criteria shall be determined by the District Engineer." In years when replacement storage is required for the downstream Fort Peck Reservoir, releases from Tiber Dam will be adjusted beginning March 1 and based on anticipated inflow to fill the reservoir to Elevation 3008.1 feet MSL prior to mid-July. Minimum releases to achieve this fill are 300 cfs.

TIBER DAM AND RESERVOIR (LAKE ELWELL) (CONT'D)

The maximum pool elevation during the report period was 2991.53 feet MSL on June 18. This is the maximum pool achieved since the signing of the new Water Control Agreement and is the highest the pool has risen since 1975. The minimum pool elevation during the report period was 2977.22 feet MSL on February 24.

A warm front accompanied by high winds moved through Montana and northern Wyoming in late February. The warm temperatures caused the snow to melt almost instantly, resulting in near record high runoff and flooding. On February 26 the peak daily inflow to the reservoir was 25,200 cfs, the third highest peak inflow of record. Outflow on this date was 913 cfs.

The peak daily outflow for the period was 2,131 cfs on November 19-20. Downstream flooding was prevented and reduced.

Maximums of Record:

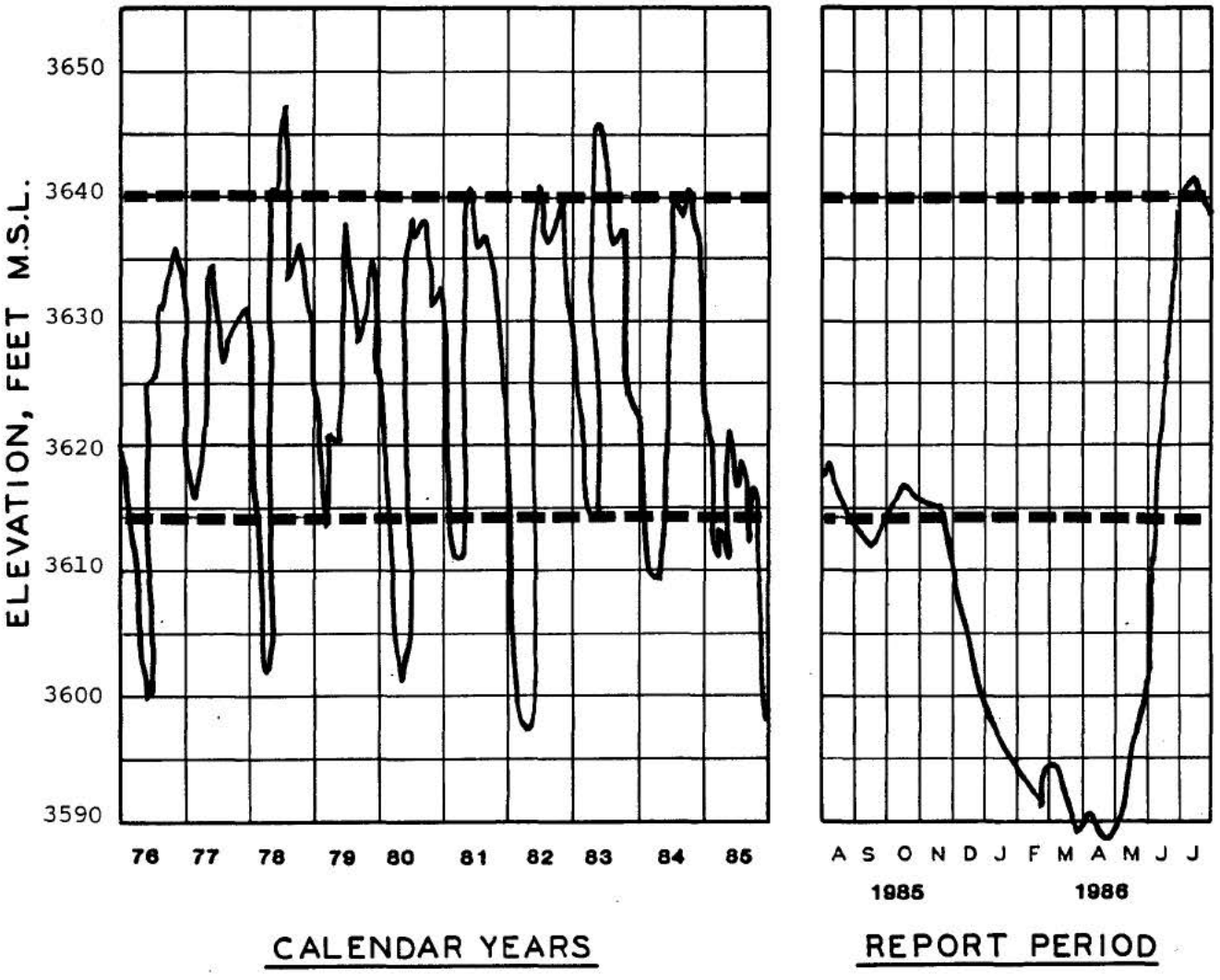
	Pool - Date	Daily Inflow - Date	Daily Outflow - Date
Highest	3005.59 Jul 12 65	102,888 cfs Jun 10 64	10,300 cfs Jun 13-14 64
2nd	3001.91 Jun 13 64	53,053 cfs Jun 21 75	5,777 cfs Jun 25 & Jul 11 75
3rd	2993.94 Jun 29 75	25,200 cfs Feb 26 86	5,308 cfs Jun 22-24 67

Minimums of Record (since initial fill in August 1956):

	Pool - Date
Lowest	2953.81 Mar 31 68
2nd	2955.31 Apr 27 67

YELLOWTAIL DAM AND LAKE (BIG HORN LAKE)
BIG HORN RIVER BASIN, MONTANA
1985-1986 REGULATION

A 10-year pool elevation hydrograph is shown below, with the current reporting period expanded for ease of reading.



At the beginning of the period, the pool elevation was at 3617.42 feet MSL. This was 3.42 feet above the base of the joint use zone. The pool elevation fluctuated within a few feet of the base of the joint use zone until late November. During the winter and early spring months the pool declined until it reached 3588.90 feet MSL on April 25. This was 25.1 feet below the base of the joint use zone. The maximum pool achieved during the period was 3640.60 feet MSL on July 16. This was 0.6 of a foot above the top of the joint use zone. The peak daily inflow was 15,359 cfs on June 19. The peak daily outflow of 7,847 cfs occurred on June 22. The highest monthly total precipitation was 9.71 inches in June. A monthly total precipitation of 7.70 inches also occurred in July. No flood control was achieved during this period.

YELLOWTAIL DAM AND LAKE (BIG HORN LAKE) (CONT'D)

Maximums of Record:

	Pool-Date	Daily Inflow-Date	Daily Outflow-Date
Highest	3656.36 Jul 6 67	29,775 cfs Jul 1 67	24,721 cfs Jul 8 67
2nd	3648.55 Jul 13-14 78	29,705 cfs Jul 2 67	24,700 cfs Jul 9 67
3rd	3646.99 Jul 16 83	28,435 cfs Jun 30 67	24,641 cfs Jul 7 67

Minimums of Record (since initial fill):

	Pool-Date
Lowest	3574.45 Mar 11 70
2nd	3585.68 May 22 68

OMAHA DISTRICT
RESERVOIR REGULATION MANUAL AND REPORTS

PROJECT	DATE APPROVED	ESTIMATED NEXT SUB. DATE TO MRD
CORPS OF ENGINEERS MISSOURI RIVER DAMS-I		
FORT PECK	Oct 1976 (F)	2/
GARRISON	Aug 1978 (F)	2/
OAHE	Sep 1978 (F)	2/
BIG BEND	Dec 1978 (F)	2/
FORT RANDALL	Feb 1979 (F)	2/
GAVINS POINT	Mar 1979 (F)	2/
CORPS OF ENGINEERS TRIBUTARY DAMS-I		
CHATFIELD	Jan 1973 (P)	Dec 87 (F)
CHERRY CREEK	Oct 1971 (F)	2/ Jul 86 (UD)
PIPESTEM	Aug 1986 (F)	2/
BEAR CREEK	Jan 1978 (P)	May 88 Jan 86 (F)
BUREAU OF RECLAMATION DAMS-I		
BOYSEN	Dec 1966 (F)	2/
CANYON FERRY	Mar 1972 (P)	Aug 87 (F)
CLARK CANYON	Aug 1976 (F)	2/
GLENDO	Apr 1970 (P)	Aug 87 Dec 85 (F)
JAMESTOWN	Nov 1957 (F)	2/
PACTOLA	Feb 1977 (F)	2/
TIBER	Dec 1959 (F) 1/	Nov 86 (UD)
YELLOWTAIL	Jan 1974 (F)	2/
CORPS OF ENGINEERS TRIBUTARY DAMS-II		
BOWMAN-HALEY	Jan 1968 (P)	Nov 86 (F)
CEDAR CANYON	Jan 1971 (F)	2/
COLD BROOK	Aug 1954 (F)	Mar 88 Apr 86 (UD)
COTTONWOOD SPRINGS	Sep 1973 (F)	2/
KELLY ROAD	Jan 1971 (F)	Apr 87 Jan 86 (UD)
PAPILLION CREEK	-	Dec 86 (F)
SALT CREEK	Dec 1978 (F)	2/
BUREAU OF RECLAMATION DAMS-II		
HEART BUTTE	Feb 1951 (F)	2/
KEYHOLE	Jun 1969 (F)	2/
SHADEHILL	Nov 1951 (F)	Jul 88 (UD)

NOTES

I - DAMS REQUIRING REGULATION
II - DAMS HAVING PRIMARILY F.C. REGULATION
(P) PRELIMINARY MANUAL OR REPORT
(F) FINAL MANUAL OR REPORT
(UD) UPDATE

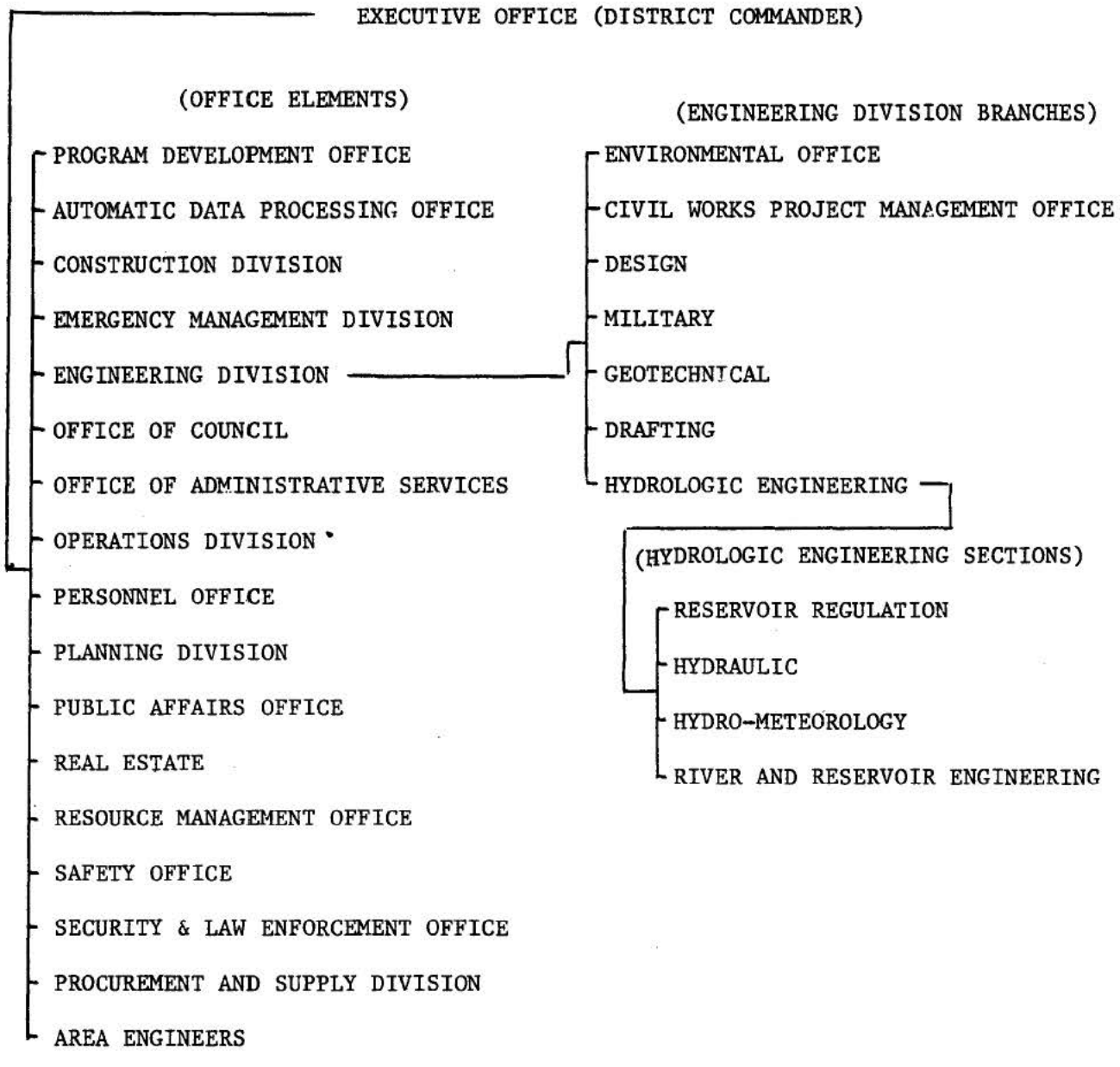
1/ PROJECT WAS REHABILITATED. A WATER CONTROL AGREEMENT FOR FLOOD CONTROL REGULATION WAS EXECUTED ON MARCH 14, 1983 BETWEEN THE BUREAU AND CORPS.

2/ TO BE REVISED WHEN NECESSARY TO CONFORM WITH CHANGING REQUIREMENTS RESULTING FROM DEVELOPMENTS IN THE PROJECT AREA AND DOWNSTREAM, IMPROVEMENTS IN TECHNOLOGY, NEW LEGISLATION, AND OTHER RELEVANT FACTORS, PROVIDED SUCH REVISIONS COMPLY WITH EXISTING FEDERAL REGULATIONS AND ESTABLISHED CORPS OF ENGINEERS POLICY (REF. PARAGRAPH 6C, ER 1110-2-240, DATED OCTOBER 8, 1982).

ORGANIZATION CHART

OMAHA DISTRICT

31 JULY 1986



ENCLOSURE 6