ANNUAL

OPERATING

PLAN

Kansas River Projects

1957 Operations

1958 Outlook

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION 7
DENVER, COLORADO

February 1958

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BUREAU OF RECLAMATION
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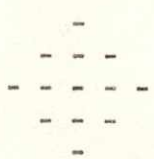
ANNUAL OPERATING PLAN

KANSAS RIVER PROJECTS

1957 OPERATIONS
1958 OUTLOOK



February 1958

SYNOPSIS

Annual Operating Plan - Kansas River Projects
1957 Operations
1958 Outlook

INTRODUCTION

This is the fifth Annual Operating Plan for irrigation units in the Kansas River Projects area. Its primary purpose is to describe the irrigation operations and responsibilities of the Bureau of Reclamation. It does not include operations for flood control which are the responsibility of the Corps of Engineers.

The report is concerned primarily with the Federally constructed irrigation facilities in the Republican, Solomon, and Smoky Hill River drainage areas which were in operation during 1957 or are expected to be in operation during 1958. Chapter 1 (or the Introduction) of the report is a brief description of the irrigation units in the Kansas River Projects Area. Chapter 11 gives a summary of actual operations during 1957. Chapter 111 presents operational estimates for 1958. The operational data regarding Harlan County Reservoir, which was constructed and is operated by the Corps of Engineers, has been prepared with the cooperation of the Corps.

1957 OPERATIONS

The water supply for 1957 was more than adequate to satisfy the irrigation requirements for the year. Irrigation water was delivered to 49,200 acres under Bureau-constructed systems. Above average precipitation during the irrigation season resulted in only approximately 4,200 acres of land served by privately owned pumps and canals contracting for supplemental storage water. Inflow at all reservoirs was above average and in most cases was among the wettest years of record. Reservoirs in operation were Bonny, Swanson Lake, Enders, Harry Strunk Lake, Harlan County (operated by the Corps of Engineers), Lovewell, Kirwin, Webster and Cedar Bluff. Lovewell Reservoir was placed in operation during October 1957. Controlled spills occurred at all reservoirs except Lovewell.

1958 OUTLOOK

The carryover storage in reservoirs of the Kansas River Projects area is more than adequate to meet all expected irrigation demands in 1958, even if extremely dry conditions develop. Approximately 66,500 acres of Bureau-constructed or operated systems will receive irrigation water in 1958. Under dry conditions as many as 17,000 acres under privately constructed irrigation systems may obtain supplemental water. This 17,000 acres includes 9,600 acres under the Culbertson canal which was privately constructed, although in 1957 the Bureau of Reclamation initiated rehabilitation work on the canal.

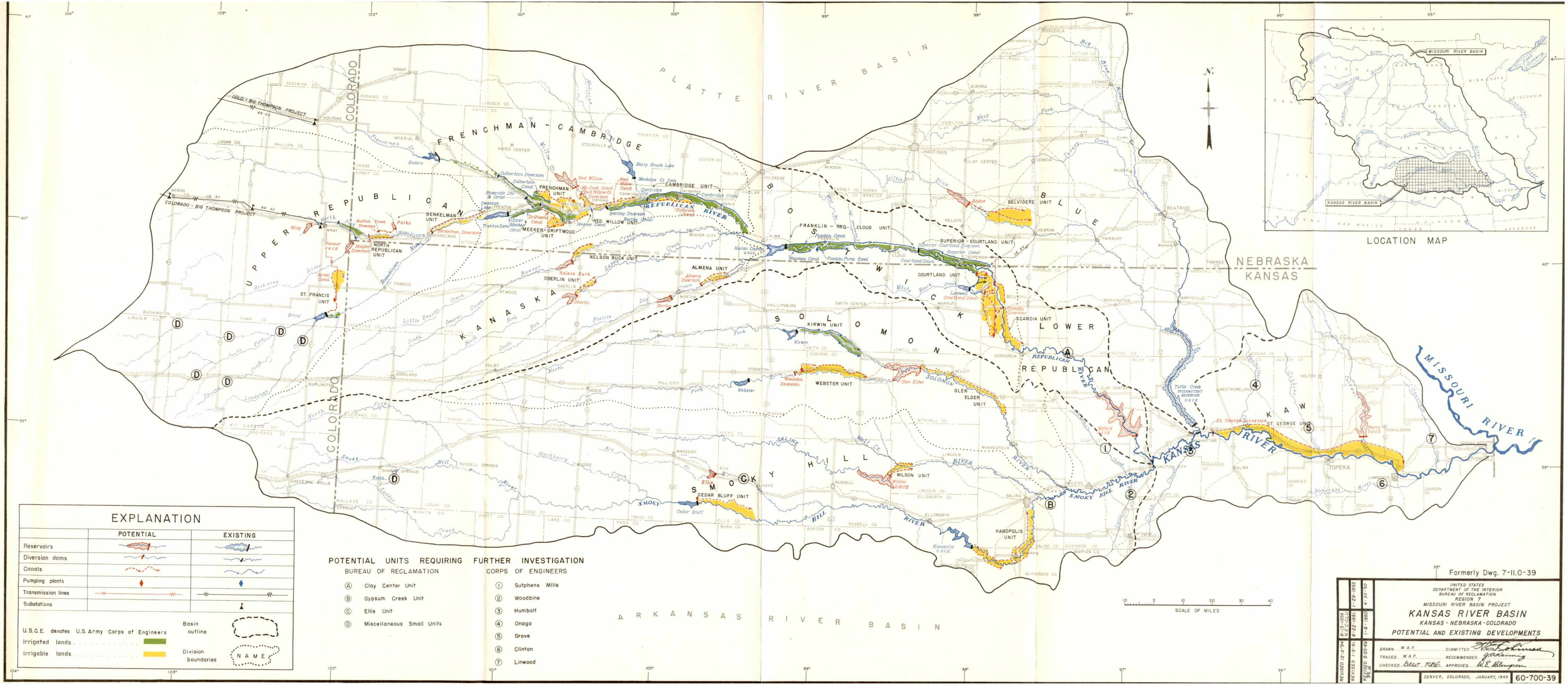
KANSAS RIVER PROJECTS
1957 OPERATIONS
1958 OUTLOOK

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF EXHIBITS



EXPLANATION
POTENTIAL
EXISTING
Reservoirs
Diversion dams
Canals
Pumping plants
Transmission lines
Substations
U.S.C.E. denotes U.S. Army Corps of Engineers
Irrigated lands
Irrigable lands
Basin outline
Division boundaries
NAME
POTENTIAL UNITS REQUIRING FURTHER INVESTIGATION
BUREAU OF RECLAMATION
Ⓐ Clay Center Unit
Ⓑ Gypsum Creek Unit
Ⓒ Ellis Unit
Ⓓ Miscellaneous Small Units
CORPS OF ENGINEERS
① Sutphens Mills
② Woodbine
③ Humbolt
④ Onaga
⑤ Grove
⑥ Clinton
⑦ Linwood
LOCATION MAP
MISSOURI RIVER BASIN
KANSAS RIVER BASIN
PLATTE RIVER BASIN
ARKANSAS RIVER BASIN
NEBRASKA
KANSAS
COLORADO
MISSOURI RIVER
UPPER REPUBLICAN
FRENCHMAN - CAMBRIDGE
KANASKA
BOSTWICK
SOLOMON
LOWER REPUBLICAN
SMOKY HILL
KAW
BLUE
REPUBLICAN RIVER
SMOKY HILL RIVER
KANSAS RIVER
SCALE OF MILES
Formerly Dwg. 7-11.0-39
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION 7
MISSOURI RIVER BASIN PROJECT
KANSAS RIVER BASIN
KANSAS - NEBRASKA - COLORADO
POTENTIAL AND EXISTING DEVELOPMENTS
DRAWN W.A.F.
TRACED W.A.F.
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
DENVER, COLORADO, JANUARY, 1949
60-700-39

ANNUAL OPERATING PLAN - KANSAS RIVER PROJECTS

1957 OPERATIONS - 1958 OUTLOOK

CHAPTER I - INTRODUCTION

Purpose of Report

The purpose of this Annual Operating Plan is to advise water users, cooperating agencies, and other interests of the results of irrigation operations during 1957 and the plan of irrigation operations during 1958. The report also includes a brief description of the irrigation units, including Federally-constructed canals and reservoirs.

Location and Major Features

The Kansas River Projects refers to irrigation units of the Kansas River Basin that are a part of the Missouri River Basin Project. This includes multiple-purpose reservoirs which provide storage for irrigation, flood control, municipal water supply, recreational purposes, stream pollution abatement, and other uses. The irrigation systems for these units are served by dams and reservoirs that have been constructed (and are operated) by the Bureau of Reclamation or the Corps of Engineers. The canals and diversion dams have been constructed (or rehabilitated) by the Bureau of Reclamation. The location map of the various units is shown in the general map of the Kansas River Basin (Frontispiece).

Ten reservoirs are now in operation. Eight of these (Bonny, Swanson Lake, Enders, Harry Strunk Lake, Lovewell, Kirwin, Webster, and Cedar Bluff) are operated by the Bureau of Reclamation. Two reservoirs (Harlan County and Kanopolis) are operated by the Corps of Engineers. Kanopolis Reservoir is not being used at present to serve an irrigation unit, therefore, it is not listed with other irrigation facilities referred to in this report. Storage allocations for the various reservoirs are shown in Table 1 on page 13. A schematic layout of these reservoirs and the main irrigation canals is shown in Exhibit 1, page 18. Insofar as it will be practical to do so, a plan of system operation will be followed that will permit the water supply of the various reservoirs to be shared equally during periods of shortages.

Irrigation Districts

Seven irrigation districts in the Kansas River Projects area have contracted with the Bureau of Reclamation for construction of irrigation facilities. These are the Frenchman Valley, H. & R. W., Frenchman-Cambridge, and Nebraska-Bostwick in the State of Nebraska; and the Kansas-Bostwick, Kirwin, and Webster Irrigation Districts in the State of Kansas. Also the Almena Irrigation District, in Kansas, is negotiating with the Bureau for such facilities. In addition to these districts, there are possibilities that irrigation districts below Cedar Bluff and Kanopolis Reservoirs (in Kansas) will be organized during 1958.

Frenchman Valley

Enders Reservoir and Culbertson Canal will be used to serve the Frenchman Valley Irrigation District. The Bureau of Reclamation initiated rehabilitation work on the Culbertson Canal during 1957; however, additional construction work is being delayed pending the outcome of litigation regarding the validity of the district's repayment contract with the government. If storage water, to supplement the natural flow rights of the canal, cannot be made available in 1958 under the repayment contract, it can be delivered under a temporary Warren Act contract to the approximately 9,600 acres under the canal.

H. & RW

The H & RW (initials for Hitchcock and Red Willow Counties) Irrigation District will be served after enlarging and extending the Culbertson Canal now used to serve the Frenchman Valley District. Work on this is being delayed because this is affected by the same legal question affecting the Frenchman Valley District. Present schedules of construction (assuming no extended litigation) provide for deliveries of water to part of the 11,500 acres of project lands under the Culbertson Canal Extension by July 1961.

Frenchman-Cambridge

Eventually the Frenchman-Cambridge Irrigation District will receive storage water primarily from three reservoirs. Two of these, Swanson Lake and Harry Strunk Reservoir, are in operation. Construction of the third, Red Willow Reservoir, is being delayed until construction funds become available for it.

Canals now in use for the District are Cambridge, Bartley, Meeker-Driftwood (part of which is still under construction), and the old Meeker Canal (which becomes a part of the new Meeker-Driftwood system after June 1959 when that canal is expected to be completed). Two additional canals, McCook and Red Willow, are planned for construction when a storage water supply becomes available from Red Willow Reservoir. After full development of the project a total of about 42,400 acres will be irrigated in the District.

Nebraska - Bostwick

Harlan County Reservoir is the primary source of storage water for the Nebraska-Bostwick Irrigation District. After full development by water users of the project area about 24,200 acres will be irrigated in the District. The Franklin, Naponee, Franklin Pump, Superior, and Courtland Canals have been completed to serve the district.

Storage water for the Kansas-Bostwick Irrigation District is provided primarily by Harlan County and Lovewell Reservoirs. The Courtland Canal above and below Lovewell Reservoir will be used to serve approximately 49,000 acres in the District. Most of the system above Lovewell Reservoir is complete except for small areas to be served by pumps. The system below Lovewell Reservoir is expected to be completed by May 1961.

Kirwin

The Kirwin Irrigation District is comprised of a project area of about 11,500 acres. Most of the Kirwin canal system will be completed before the 1958 irrigation season. Kirwin Reservoir is used to supply storage water to the District.

Webster

The Webster Canal, now under construction, will serve 8,500 acres in the Webster Irrigation District. Some of the area may be irrigated in 1960. However, the completion of the canal system is not expected before May 1961. Storage water for the District will be supplied from Webster Reservoir.

Municipal Water

The city of Russell, Kansas, contracted for storage water from Cedar Bluff Reservoir to supplement their natural flow rights in 1954 through 1957. The contracts for this have been of a temporary nature because negotiations have not been completed for a long term contract.

A long term contract for supplying municipal water to the city of Norton, Kansas, appears to be in the final stages of negotiation. Actual deliveries of storage water under this contract must wait until funds become available for construction of Norton Dam and Reservoir.

There is a possibility that additional cities, such as Beloit, Kansas, may in future years consider contracting for municipal water.

CHAPTER II - SUMMARY OF 1957 OPERATIONS

Precipitation

Precipitation over most of the Kansas River Projects area was above average during 1957. This resulted in less demands on reservoir storage for irrigation. The total annual precipitation at the weather stations of the various dams ranged from 99 percent of normal at Trenton and Lovewell Dams to 156 percent of normal at Webster Dam. See Table 2 on Page 14.

Streamflow

At most reservoirs the total annual inflow was one of the highest on record. At Bonny Reservoir and Swanson Lake the 1957 inflow was exceeded only in 1935. Inflows at Kirwin, Webster, and Cedar Bluff Reservoirs were second only to those of 1951. The inflows to the other reservoirs were well above normal. The total annual reservoir inflows of calendar year 1957 are compared graphically with other years of record in Exhibits 23 through 31 (Page 40 to 48). Table 3 on Page 15 shows that the inflows varied from 104 percent of normal at Enders Reservoir to over 348 percent of normal at Cedar Bluff Reservoir.

Reservoir Operations - 1957

There were no irrigation shortages and controlled spills occurred at all Kansas River Projects reservoirs except Lovewell. Operation hydrographs on which are plotted reservoir content, mean monthly inflow, and mean monthly outflow are shown in Exhibits 2 through 10 (pages 19 to 27). Table 4 on Page 16 gives the monthly figures in acre feet for these values at each reservoir during 1957.

At reservoirs where the irrigation pools were filled there were no instances where the flood control pool was even half filled. In most instances less than 25 percent of the flood control pool was ever filled. The highest was 44 percent at Cedar Bluff Reservoir. This information is given so as not to give the erroneous impression that flood protection was not provided when the irrigation pools were filled and the reservoirs spilled.

Bonny Reservoir

Controlled spills occurred at Bonny Reservoir during all, or parts of, the months of May through September. During September the reservoir level was lowered about three feet below the top of the irrigation pool to reduce the amount of spill releases that may be required during winter months. Releases to the Hale Ditch, a privately constructed and operated canal system, were made to satisfy natural flow rights. There was no demand for supplemental storage water.

Swanson Lake

The irrigation pool in Swanson Lake was filled for the first time in May 1957. Controlled spills occurred throughout parts of May, June, July, and August. Releases for irrigation were made for Meeker-Driftwood Canal, Bartley Canal, and supplemental requirements (under Warren Act Contracts) to the Meeker Canal.

Enders Reservoir

There was little demand for storage water in Enders Reservoir except for some under Warren Act Contracts for pumps along Frenchman Creek and Stinking Water Creek. During most of the summer months the natural inflow was released for senior water rights downstream. Controlled spills occurred in April, May and June.

Harry Strunk Lake

The water supply from Harry Strunk Lake was more than adequate to meet the irrigation demands of the Courtland Canal and of a few pump irrigators obtaining storage water under Warren Act Contracts. Controlled spills occurred during most of the period May through September.

Harlan County Reservoir

The irrigation pool in Harlan County Reservoir was filled for the first time in June 1957. Controlled spills occurred during parts of June, July, August and December. Irrigation releases were made for the Franklin, Naponee, Franklin Pump, Superior, and Courtland Canals. During October approximately 27,000 acre-feet of water was released from Harlan County Reservoir for storage in Lovewell Reservoir. This resulted in a drawdown of almost 1½ feet of the water surface elevation at Harlan County; however, this drawdown was replaced by inflow by the end of December. The transfer was not made before October because Lovewell Dam was not completed.

Lovewell Reservoir

Closure in Lovewell Dam was made May 29, 1957, but planned storage did not start until October 2, 1957. Over half of the total annual inflow of 43,100 acre-feet occurred during June. Most of this inflow was stored temporarily, but was released as soon as possible so that construction of the dam could be completed. No releases were made for irrigation purposes. During October approximately 28,000 acre-feet of water from the Republican River and Harlan County Reservoir were diverted into Lovewell Dam through the Upper Courtland Canal.

Kirwin Reservoir

The irrigation pool in Kirwin Reservoir was filled for the first time in July 1957 and controlled spills occurred during that month. This was the first year of releases to the Kirwin Canal.

Webster Reservoir

Webster Reservoir had the irrigation pool filled for the first time during June 1957. Controlled spills occurred during parts of July, September, and October. No releases were made for irrigation.

Cedar Bluff Reservoir

Exceptionally high inflows into Cedar Bluff Reservoir kept the reservoir level in the flood control pool during the last half of 1957. Controlled spills also occurred during this period. These spills were more than adequate to satisfy any downstream demands by pump irrigators for irrigation water. No special releases were made for the municipal water pumps of the City of Russell, Kansas because any requirements were met by the reservoir spills.

Canal Operations

During 1957 the total diversions by Bureau constructed and operated canals (including the existing Meeker Canal) amounted to 96,470 acre-feet to serve 49,203 acres. This acreage included 11,468 acres in Kansas and 37,735 acres in Nebraska.

In addition, 388 acre-feet of surplus storage was made available under Warren Act Contracts to 4,187 acres under pump irrigation in Nebraska. Total releases of natural flow to the Hale Ditch amounted to 2,677 acre-feet for 880 acres.

Monthly diversions for each canal are shown in Table 5 on Page 17. Total annual diversions for the past few years of record and acres irrigated are shown graphically in Exhibits 11 through 21 (Pages 28 to 39).

CHAPTER III - ANNUAL OPERATING PLAN FOR 1958

Water Supply - 1958

The water supply outlook for 1958 is excellent for all Kansas River Projects. No shortages for the Projects are expected, even under the most dry weather conditions because of carryover storage in the various reservoirs.

The total water supply at each reservoir which will be available to meet demands on the reservoir amounts to the carryover storage from previous years plus the 1958 inflow. The carryover figure is easily determined; however, it is practically impossible to predict future inflows in areas where the major part of the reservoir inflow results from rain flood runoff. For this reason, estimates of future inflows are based on a probability analysis of recorded runoff. The "most probable" inflow was assumed to be that point on the curve where the annual historical inflow was equaled or exceeded 50 percent of the time. Ten percent of all the historical annual flows have been less than the selected "reasonable minimum" and 10 percent have been greater than the selected "reasonable maximum." The probability curves were shown in last year's Annual Operating Plan and are not reproduced in this report. The "most probable", "reasonable minimum", and "reasonable maximum" values used at each reservoir are shown in Table 3 on page 15. These values are shown graphically on Exhibits 23 through 31 (pages 40 to 48) for ready comparison with historical values.

Reservoir Operations - 1958

Storage limitations at all of the reservoirs for irrigation purposes will be limited to storage below the top of the irrigation pool at each reservoir as indicated in Table 1 on page 13. State laws regulating the use of water will also affect the amount and time of storing streamflows.

During winter months, when it is apparent that a reservoir will spill before the start of the next irrigation season, only that portion of the inflow will be stored continuously as will be required to fill most of the irrigation pool by the first of May. This will avoid extremes in reservoir releases. Also the reservoir level will be kept lower during winter months when high winds can cause damage to riprap by high wave action. Continuous releases through the river outlet at Bonny Dam during winter months is not desirable because of possible damage to the Hale Ditch outlet pipe by freezing water.

Estimates for the calendar year 1958 showing the probable effects on each reservoir under "most probable", "reasonable minimum", and "reasonable maximum" inflow conditions are shown in Exhibits 2 through 10 (pages 19 to 27). Seepage losses, which vary from 1 cfs at Swanson Lake to 8 cfs and Enders Reservoir, will be adequate to meet minimum flow requirements at Bureau operated reservoirs.

Bonny Reservoir

Carryover storage in Bonny Reservoir will be more than adequate to meet any 1958 irrigation requirements of supplemental storage water by the Hale Ditch. Controlled spills will occur during 1958 even under very low inflow conditions. This can occur as overflow through the gated spillway or by releases through the river outlet. Drawdowns by making releases to the river in advance of anticipated inflow conditions which will cause the irrigation pool to more than fill are also considered controlled spills. During freezing weather conditions, it is not desirable to make releases through the outlet works or over the spillway.

In the future, some reduction in fluctuation of reservoir levels may be obtained by not trying to keep the level at the top of the irrigation pool during the summer months. Since it is desirable to enter the winter months with a reservoir level three to four feet below the top of the irrigation pool, holding the reservoir level at about 3670 feet (2 feet below the top of the irrigation pool) during the summer months would make it necessary to make a drawdown of only one or two feet (instead of 3 or 4 feet) prior to winter operation. Of course, this plan of operation would be subject to revision during flood inflow or very dry weather conditions. The preferable time for fall drawdown will be the month of September.

Swanson Lake

Irrigation releases from Swanson Lake will be used primarily to serve lands under the Meeker, new Meeker-Driftwood, and Bartley Canals. If necessary, releases may be made to assist in serving canal systems down-stream. No shortages are anticipated during 1958. Surplus storage may be sold under temporary contracts to non-project systems. Swanson Lake will spill under all inflow conditions.

Enders Reservoir

Controlled spills will occur at Enders Reservoir during 1958. Some releases can be made to assist in satisfying irrigation requirements of the Meeker and the Bartley Canals, although this probably will not be necessary. Surplus storage may be supplied under temporary "Warren Act" contracts to non-project systems and to the Culbertson Canal system.

Harry Strunk Lake

Harry Strunk Lake will spill by the start of the 1958 irrigation season. The main irrigation releases will be to the Cambridge Canal. Storage releases of surplus water may be made under temporary contracts to supplement natural flow rights of pump irrigators in the Medicine Creek watershed.

Harlan County

Early spills will occur at Harlan County Reservoir, even under most dry inflow conditions. Irrigation releases will be made to the Franklin, Naponee, Franklin Pump, Superior and Courtland Canal in Nebraska. Also releases will be made to the Courtland Canal and to Lovewell Reservoir in Kansas.

The plan of irrigation development for the Bostwick Division in Nebraska and Kansas calls for irrigation use of Republican River flows by diverting them through the upper Courtland Canal. 1957 was the first year that releases from Harlan County Reservoir were made for Lovewell Reservoir but in the future some releases for this purpose may be expected each year. The timing and the amount of such transfers of storage will vary according to the weather conditions and the storage in both reservoirs. During the irrigation season, Harlan County Reservoir will be used to satisfy part of the irrigation requirements under all of the Courtland Canal in Nebraska and Kansas.

If conditions permit, transfers of the larger amounts of storage water usually will not be made except during the first and last months of the irrigation season. In most years, this will be May and September. However, unusual conditions may result in transfers a month before or a month after the irrigation season. Transfers of storage during winter months will be kept to a minimum because the canal needs to be dry during that period for maintenance work. Also diversion during extremely cold weather adds to maintenance costs of canal structures.

Minimum flow releases will be made in accordance with the statement of operational objectives for Harlan County Reservoir.

Lovewell Reservoir

Lovewell Reservoir was planned for regulation of Courtland Canal flows as well as for storage of the natural flows of White Rock Creek. The irrigation demands of lands under the lower Courtland Canal will be met by water from both sources. During periods of low water supply in Harlan County Reservoir and Lovewell Reservoir as much as possible of all the flow of the Republican River at the Superior-Courtland Diversion Dam that is not needed by the Superior Canal, Courtland Canal, or by downstream rights will be diverted into Lovewell Reservoir through the Courtland Canal. During extremely dry periods, such diversion may be continued through the non-irrigation season except for the months of January and February.

During peri ds of adequate carryover storage, such as now exists, diversions through the Courtland Canal during the non-irrigation season will be kept to a minimum. This will reduce operating and maintenance costs of the upper Courtland Canal. It is desirable that the reservoir

level at Lovewell be at an elevation of approximately 1578 feet or above to reduce the possibilities of erosion of the upstream face of the dam. If conditions permit, any drawdown of Harlan County Reservoir required to put the Lovewell elevation at 1578 feet at the end of the irrigation season will be done in September. If surplus water is available in Harlan County Reservoir and in the pickup below the Reservoir, the irrigation pool in Lovewell Reservoir will be filled (elevation 1582.6 feet) during the first month of the irrigation season. This probably will be during May.

Some releases will be made to the lower Courtland Canal during 1958 although part of the system is still under construction. Spills are very likely during the early part of the irrigation season. Some supplemental water may be sold under Warren Act Contracts.

Kirwin Reservoir

Kirwin Reservoir will be spilling under all but dry conditions. Releases will be made to the Kirwin Canal. The project area under the Kirwin Canal is extra large for the expected available water supply and successful operation of the project will be dependent at times upon several years of carryover reservoir storage. For this reason, it is very doubtful if supplemental storage water will be made available to non-project lands.

Webster Reservoir

Construction work on the Woodston Diversion Dam, about 26 miles below Webster Dam, will restrict reservoir releases to practically zero second-feet until about May 1, 1958 unless emergency flood conditions develop before then. Small inflows will be stored in the flood control pool during this construction period, provided that the Corps of Engineers determine that minor storage amounts in the flood control pool will not limit overall flood protection provided by the reservoir. During the 1958 irrigation season, most of the releases will be those necessary to keep the reservoir level from rising above the top of the irrigation pool, except for storage in the flood control pool during flood emergencies. Some releases may be made to supplement natural flow rights under Warren Act Contracts. No irrigation requirements for project lands are expected before 1960.

Cedar Bluff Reservoir

Carryover storage in Cedar Bluff Reservoir is much more than adequate to satisfy all expected demands on the reservoir during 1958. Water will be available to make storage releases to supplement natural flow rights of pump irrigators downstream and of the City of Russell, Kansas for municipal water.

Construction of a fish hatchery below Cedar Bluff Reservoir was authorized by Congress during 1957. We do not expect construction of the hatchery to be completed in time to place demands on the reservoir during 1958. The total annual use of water by the hatchery after completion is estimated to be 4,000 acre-feet.

Canal Operations - 1958 Estimates

A total of approximately 66,500 acres under irrigation units in the Kansas River Projects area may receive irrigation water in 1958. Of this total, 45,500 acres will be in Nebraska and 21,000 acres will be in Kansas. Expected acreages and probable canal diversion requirements under "most probable". "reasonable driest year" and "reasonable wettest year" are shown graphically in Exhibits 11 through 22 (pages 28 to 39). The canal requirements for the values used in each of the three types of years are based on probability curves from data taken from water supply studies. Estimated acreages to be irrigated in 1958 are also listed on Table 5 (page 17).

In addition to the above acreages, it may be possible to deliver surplus storage water under temporary contracts to non-project irrigation systems.

Some of the irrigation Districts in the Kansas River Projects area will operate all or parts of the canal systems in their districts during 1958. Some canal operation and maintenance will be performed by the Bureau of Reclamation. Since the canal operations may vary according to the irrigation district under which they will be operated, the canal operations for 1958 are discussed under the various district headings.

Frenchman Valley Irrigation District

The Culbertson Canal and diversion dam will be operated by the Frenchman Valley Irrigation District. Rehabilitation of the canal has been started by the Bureau of Reclamation, and the Bureau will maintain the diversion dam and main canal during 1958.

H. & R. W. Irrigation District

The Bureau of Reclamation has contracted with the H. & R. W. Irrigation District to enlarge and extend the Culbertson Canal, operated by the Frenchman Valley Irrigation District, to serve a new irrigation unit. Construction on this system has been delayed and there will be no canal to operate in the H. & R. W. District in 1958.

Frenchman-Cambridge Irrigation District

In 1958 the Frenchman-Cambridge Irrigation District will operate and maintain the Bartley and Cambridge Canals (including the Bartley and Cambridge Diversion Dams) which are described as Block I of their system. The Bureau of Reclamation will operate and maintain the Meeker Canal (including the diversion dam) and the new Upper Meeker Canal. These will not

be turned over to the District until more of the canal system in the Meeker-Driftwood Unit is completed. See location map.

Nebraska-Bostwick Irrigation District

The Nebraska-Bostwick Irrigation District will operate and maintain their canal systems. These will include the Franklin, Naponee, Franklin Pump, Superior Canals, and the Courtland Canal laterals (including farm deliveries from the main canal).

The only parts of the Nebraska-Bostwick Canal system that will not be operated by the district in 1958 are the Superior-Courtland Diversion Dam and the main Courtland Canal between the diversion dam and the Nebraska-Kansas state line. These features will be operated and maintained by theBureau of Reclamation in 1958 because they are also integral parts of the Kansas-Bostwick irrigation system now under construction.

Kansas-Bostwick Irrigation District

The Kansas-Bostwick Irrigation District will operate and maintain the laterals and farm turnouts served by the Courtland Canal between the Nebraska-Kansas state line and Lovewell Reservoir. For the next year or two, the Bureau will make deliveries to and maintain the main Courtland Canal.

Work on the Courtland Canal below Lovewell Reservoir will be completed enough to serve about 6,460 acres in 1958. The operation and maintenance will be performed by the Bureau of Reclamation because the canal system is still under construction.

Kirwin Irrigation District

The Kirwin Canal system will be completed in 1958, but operation and maintenance performed will be done by the Bureau of Reclamation in 1958.

Webster Irrigation District

The Osborne Canal system for the Webster Irrigation District is under construction. No operation and maintenance for irrigation is expected before 1960.

TABLE 1

RESERVOIR DATA - KANSAS RIVER PROJECTS

RESERVOIR	STORAGE ALLOCATIONS DEAD 1/	IRRIGATION 1/	FLOOD CONTROL	CONDITIONS EXPECTED AT START OF IRRIGATION SEASON (APPROX. MAY 1, 1958)
Bonny				
Elevation (Ft.)	3635.5	3672.0	3710.0	3672.0
Total Acre Feet	1,420	41,340	170,160	41,340
Net Acre Feet	1,420	39,920	128,820	39,920
Swanson Lake				
Elevation (Ft.)	2710.0	2752.0	2773.0	2752.0
Total Acre Feet	4,100	120,160	253,950	120,160
Net Acre Feet	4,100	116,060	133,790	116,060
Enders				
Elevation (Ft.)	3080.0	3112.3	3127.0	3112.3
Total Acre Feet	8,470	44,480	74,520	44,480
Net Acre Feet	8,470	36,010	30,040	36,010
Harry Strunk				
Elevation (Ft.)	2335.0	2366.1	2386.2	2366.1
Total Acre Feet	5,370	39,230	90,920	39,230
Net Acre Feet	5,370	33,860	51,690	33,860
Harlan County				
Elevation (Ft.)	1920.0 2/	1946.0	1973.5	1946.0
Total Acre Feet	97,200	350,120	850,000	350,120
Net Acre Feet	97,200	252,920	499,880	252,920
Lovewell				
Elevation (Ft.)	1562.07 3/	1582.6	1595.3	1582.6
Total Acre Feet	5,050	41,690	92,150	41,690
Net Acre Feet	5,050	36,640	50,460	36,640
Kirwin				
Elevation (Ft.)	1693.0	1728.4	1757.3	1728.4
Total Acre Feet	6,380	95,180	314,550	95,180
Net Acre Feet	6,380	88,800	219,370	88,800
Webster				
Elevation (Ft.)	1855.5	1889.6	1923.7	1889.6
Total Acre Feet	2,180	67,100	260,740	67,100
Net Acre Feet	2,180	64,920	193,640	64,920
Cedar Bluff				
Elevation (Ft.)	2090.0	2144.0	2166.0	2144.0
Total Acre Feet	8,260	185,090	376,950	185,090
Net Acre Feet	8,260	176,830	191,860	176,830

1/ Includes space for sediment storage.
2/ Elevation at outlet to Franklin Canal.
3/ Elevation of floor in stilling basin outlet to lower Courtland Canal. Need Elev. 1571.7 (16,760 A.F.) to supply full canal capacity.

TABLE 2

PRECIPITATION AT DAMS DURING 1957

(Inches and Percent of Normal)

	Bonny		Trenton (Swanson L.)		Enders		Medicine Cr. (H. Strunk L.)		Harlan County	
	In.	% of Normal	In.	% of Normal	In.	% of Normal	In.	% of Normal	In.	% of Normal
Jan.	.07	20%	.08	18%	.08	19%	.21	52%	.10	24%
Feb.	T	0%	.15	29%	.26	56%	.19	30%	.15	26%
Mar.	1.37	150%	.64	53%	.88	83%	1.05	106%	1.30	137%
Apr.	2.82	177%	1.72	89%	2.80	144%	2.08	90%	3.22	142%
May	5.07	211%	5.40	169%	6.29	186%	7.23	224%	5.78	180%
June	3.69	144%	3.67	115%	3.66	109%	4.32	123%	7.91	216%
July	2.64	114%	2.71	104%	3.93	179%	2.27	81%	.77	27%
Aug.	2.66	117%	2.28	91%	1.39	62%	1.22	47%	2.92	118%
Sept.	.23	18%	.49	29%	.49	27%	3.07	152%	1.68	77%
Oct.	1.35	182%	1.23	141%	2.04	255%	3.32	296%	1.63	158%
Nov.	.26	63%	.52	76%	.49	91%	.31	37%	.40	52%
Dec.	.24	62%	.10	22%	.42	93%	.14	24%	.22	45%
Jan.-Dec. 1/	20.40	130%	18.99	99%	22.73	122%	25.10	119%	26.08	125%
May-Oct. 1/	15.64	135%	15.78	112%	17.80	129%	21.43	140%	20.69	134%

	Lovewell		Kirwin		Webster		Cedar Bluff	
	In.	% of Normal	In.	% of Normal	In.	% of Normal	In.	% of Normal
Jan.	.20	33%	.18	38%	.16	40%	.04	8%
Feb.	.24	28%	.13	18%	.16	20%	.04	6%
Mar.	3.12	248%	2.21	188%	2.43	243%	2.82	224%
Apr.	2.93	132%	3.57	149%	2.80	127%	2.23	116%
May	4.65	129%	6.26	216%	5.47	189%	4.25	117%
June	5.51	114%	6.41	171%	11.74	317%	7.11	181%
July	.77	27%	2.76	96%	4.90	181%	2.16	93%
Aug.	3.56	133%	2.23	78%	2.65	96%	2.18	90%
Sept.	1.40	52%	1.38	61%	1.81	72%	5.07	246%
Oct.	1.50	103%	3.10	246%	1.33	95%	1.41	122%
Nov.	.33	32%	.67	80%	.81	81%	1.08	126%
Dec.	.40	52%	.07	12%	.10	14%	T	0%
Jan.-Dec. 1/	24.61	99%	28.97	131%	34.36	156%	28.39	133%
May-Oct.1/	17.39	96%	22.14	139%	27.90	175%	22.18	143%

1/ Inclusive

TABLE 3

INFLOW INTO RESERVOIRS - 1957 RECORDS, 1958 ESTIMATES

1	2	3	4	5	6	7	8
	1,000 Acre-Feet (Except Col. 4)						
	1957 Records		Average		1958 Estimates 2/		
Reservoir	Actual	Adjusted 1/	Percent of Average	for Period of Record	Reasonable Minimum	Most Probable	Reasonable Maximum
Bonny	63.8		193.3%	33.0	18.5	26.2	42.0
Swanson Lake	191.3	196.3	143.2%	137.1 1/	68.0	119.0	205.0
Enders	51.8		104.0%	49.8	42.8	49.3	57.2
Harry Strunk Lake	67.9		123.5%	55.0	33.0	51.7	82.0
Harlan County	506.4	642.7	130.5%	492.4 1/	260.0	455.6	780.0
Lovewell 3/	30.0		106.0%	28.3	3.4	17.9	64.0
Kirwin	121.4		218.0%	55.7	17.0	38.1	115.0
Webster	131.0		251.9%	52.0	12.5	33.9	98.0
Cedar Bluff	226.1		348.9%	64.8	12.4	36.9	138.0

1/ Actual records plus upstream depletions caused by reservoirs and canals in Missouri Basin Projects.

2/ Values determined from inflow frequency curve. A value of 90% on curve = reasonable minimum conditions, 50% = most probable conditions, and 10% = reasonable maximum conditions.

3/ Natural inflow. Does not include inflow from Courtland Canal.

TABLE 4
RESERVOIR OPERATIONS - 1957
(1000 Acre-Feet)

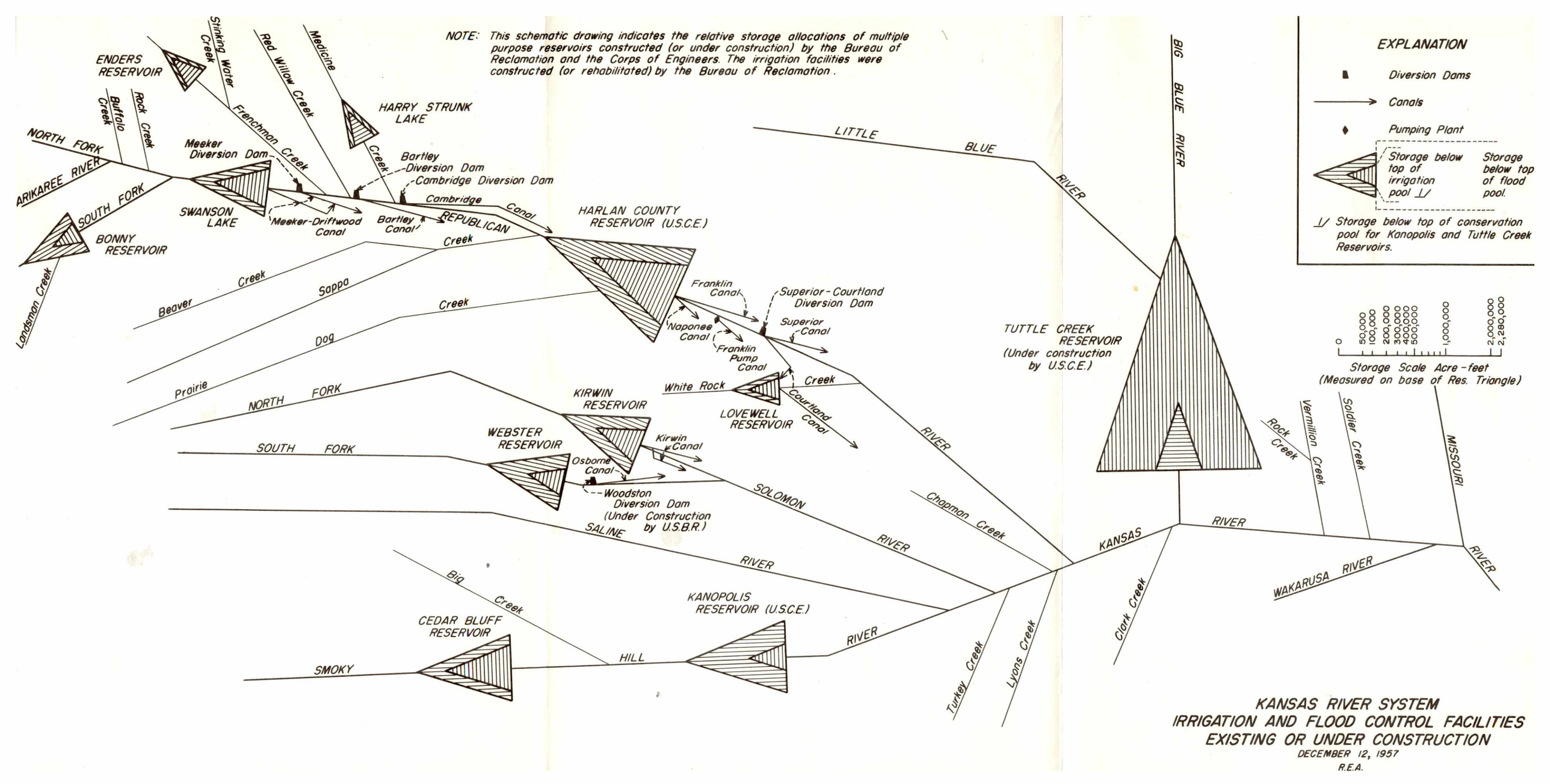
Reservoir	Dec.'56	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Bonny-Inflow	-	1.9	2.1	2.6	3.0	23.4	6.6	13.4	3.2	0.9	2.7	1.9	2.1	63.8
Outflow	-	0.4	0.4	0.5	2.8	16.6	15.4	5.5	8.2	7.0	1.8	0.4	0.4	59.4
Content End of Mo.	35.1	36.2	37.8	39.8	40.6	45.4	42.2	48.0	41.8	35.3	35.7	37.2	38.8	-
Swanson-Inflow	-	4.8	7.6	10.6	17.3	47.1	33.4	33.8	9.8	6.6	5.4	6.9	8.0	191.3
Outflow	-	0.1	0	0	0	38.8	36.7	13.6	25.9	6.8	1.9	1.5	0.5	125.8
Content End of Mo.	73.5	76.6	84.4	92.8	108.1	118.8	123.7	135.4	115.7	111.9	113.4	117.3	122.8	-
Enders-Inflow	-	4.8	4.4	4.4	4.8	5.3	4.1	4.0	3.3	3.6	3.7	4.5	4.9	51.8
Outflow	-	2.3	2.1	2.3	3.5	5.3	5.2	4.2	5.5	4.7	3.2	2.3	0.6	41.2
Content End of Mo.	37.4	39.2	41.1	42.5	43.8	44.1	43.0	42.0	38.9	37.3	38.0	39.4	43.1	-
Harry Strunk-Inflow	-	2.6	3.1	3.9	6.2	19.4	6.2	9.0	3.1	4.2	3.2	3.5	3.5	67.9
Outflow	-	0.3	0.3	0.3	0.3	17.2	10.1	8.6	4.5	3.6	4.6	4.2	1.6	55.6
Content End of Mo.	25.3	27.5	30.2	33.1	38.4	42.9	42.9	41.7	39.5	39.8	38.4	37.2	38.4	-
Harlan County-Inflow	-	4.5	9.5	11.6	21.4	118.3	207.7	55.9	12.7	18.8	14.0	18.5	13.5	506.4
Outflow	-	0.5	0.7	0.5	0.5	1.6	23.8	173.5	29.5	8.7	27.1	2.3	10.7	279.4
Content End of Mo.	139.7	143.3	152.0	163.3	185.4	288.7	485.9	369.9	345.0	350.3	334.4	348.1	349.8	-
Lovewell-Natural Inflow 1/							28.2	0	1.1	0.7	0	0	0	30.0
Canal Inflow 2/		Closure in dam made					0	0.2	0.4	0.2	27.9	0.2	0	28.9
Total Inflow		May 29, 1957.					28.2	0.2	1.5	0.9	27.9	0.2	0	58.9
Outflow		Planned storage commenced					17.5	6.7	1.3	0.9	0	0	0	26.4
Content End of Mo.		October 2, 1957					13.6	6.2	6.4	6.4	29.0	28.1	28.1	-
Kirwin-Inflow	-	0	0	0.1	4.9	19.0	73.8	18.6	1.9	1.2	0.4	0.7	0.8	121.4
Outflow	-	0	0	0	0	0	0	10.0	2.7	0.3	0.6	0	0.1	13.7
Content End of Mo.	7.9	7.8	7.8	8.0	10.3	28.3	88.9	89.8	86.7	85.2	83.9	83.8	83.5	-
Webster-Inflow	-	0	0	0.2	4.4	19.8	58.7	20.0	13.2	9.9	1.5	1.9	1.4	131.0
Outflow	-	0	0	0	0	0	0	43.5	0.8	10.7	0.8	0	0	55.8
Content End of Mo.	2.2	2.2	2.0	2.2	5.7	27.7	92.7	66.6	72.4	69.7	68.7	69.5	70.2	-
Cedar Bluff-Inflow	-	0	0	0.2	2.0	57.5	80.4	55.6	6.1	21.0	1.5	1.1	0.7	226.1
Outflow	-	0	0	0	0	0	46.2	91.0	25.5	37.2	12.0	3.5	2.0	217.4
Content End of Mo.	121.1	120.3	120.6	121.1	123.6	180.7	257.4	231.4	206.4	208.6	194.8	192.7	189.9	-

1/ Inflow from White Rock Creek.
2/ Diversions by Courtland Canal from Republican River into Lovewell Reservoir.
Note: Inflow and outflow data are tentative records at inflow and outflow gaging stations. These monthly flow records do not take into account evaporation losses, bank storage losses of reservoir, reservoir gain from bank storage recovery, and pickup below inflow gages. These losses and gains are reflected in reservoir storage values.

TABLE 5
ACRES IRRIGATED AND CANAL DIVERSIONS

Irrigation Facilities	Acres Irrigated Planned 1/	Acres Irrigated 1958 Est.	Acres Irrigated 1957 2/	Acre-feet Diverted (1957) June	July	August	Sept.	October	Total
Frenchman-Cambridge Irrig. Dist									
Bartley Canal	7,000	6,600	6,246	0	3,005	4,530	547	475	8,557
Cambridge Canal	15,600	15,600	13,029	0	8,005	11,220	1,109	1,097	21,431
Total District Operated	22,600	22,200	19,275	0	11,010	15,750	1,656	1,572	29,988
Meeker-Driftwood Canal	16,440	2,300	739	83	728	1,817	849	0	3,477
Meeker Canal	-	3,010	3,003	268	2,281	3,191	2,134	1,032	8,906
Total Bureau Operated	16,440	5,310	3,742	351	3,009	5,008	2,983	1,032	12,383
Total Frenchman-Cambridge	39,040	27,510	23,017	351	14,019	20,758	4,639	2,604	42,371
Nebraska-Bostwick Irrig. Dist									
Franklin Canal	11,750	7,560	6,511	274	5,516	6,018	1,341	0	13,149
Naponee Canal	1,670	1,420	1,077	0	780	1,158	0	0	1,938
Franklin Pump Canal	2,200	1,700	1,418	0	1,166	637	0	0	1,803
Superior Canal	6,130	5,790	4,689	200	5,040	4,578	510	165	10,493
Courtland Canal, (Nebr.) 3/	2,400	1,530	1,023	312	1,139	1,004	289	- 6/	2,744
Total Nebraska-Bostwick	24,150	18,000	14,718	786	13,641	13,395	2,140	165	30,127
Kansas-Bostwick Irrig. Dist.									
Courtland Can. (Kan.ab.Res.) 4/	15,270	10,030	10,028	787	9,011	7,862	782	- 6/	18,442
Courtland Can. (Kan.bel.Rel.)		6,460	0						
Total Kansas-Bostwick		16,490	10,028						
Kirwin Irrigation District									
Kirwin Canal	11,500	4,500	1,440	0	1,981	2,664	242	643	5,530
Total for Bureau Constructed	89,960	66,500	49,203	1,924	38,652	44,679	7,803	3,412	96,470
Warren Act (Nebraska)	-	-	4,187	0	0	322	66	0	388
Hale Ditch 5/	-	-	880	77	563	674	1,063	300	2,677

1/ Planned acreage as of January 1, 1958
2/ Acres for which water was purchased.
3/ Total diversion less flow past Nebr.-Kan.State Line
4/ Flow past Nebr.-Kan.State line, less canal deliveries to Lovewell Reservoir.
5/ Canal not constructed or operated by Bureau but diverts flows directly from Bonny Reservoir.
6/ Outflow exceeded inflow because of lowering canal checks.



KANSAS RIVER SYSTEM
IRRIGATION AND FLOOD CONTROL FACILITIES
EXISTING OR UNDER CONSTRUCTION

DECEMBER 12, 1957

R.E.A.

BONNY RESERVOIR
OPERATION HYDROGRAPHS

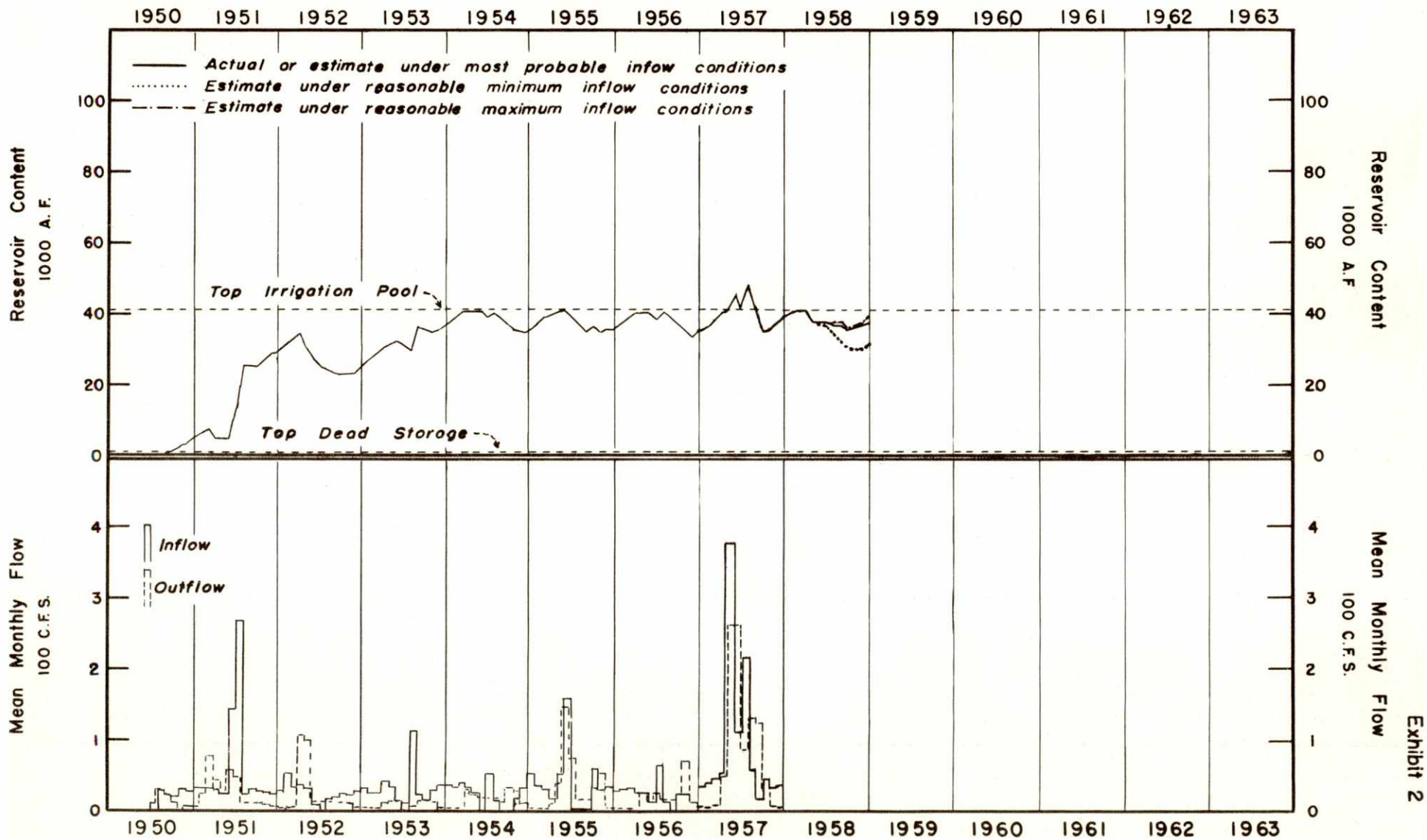
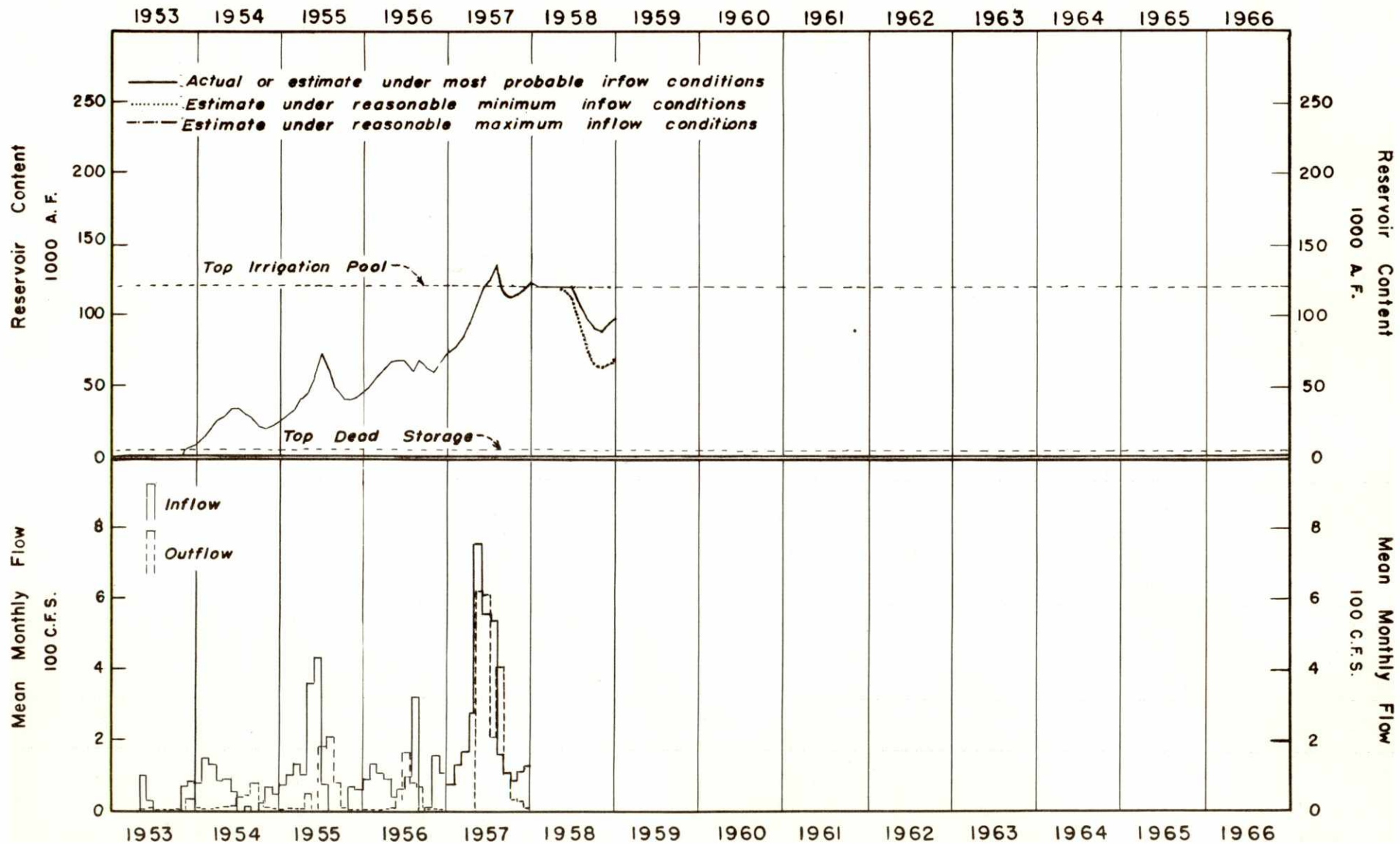


Exhibit 2

SWANSON LAKE
OPERATION HYDROGRAPHS



ENDERS RESERVOIR
OPERATION HYDROGRAPHS

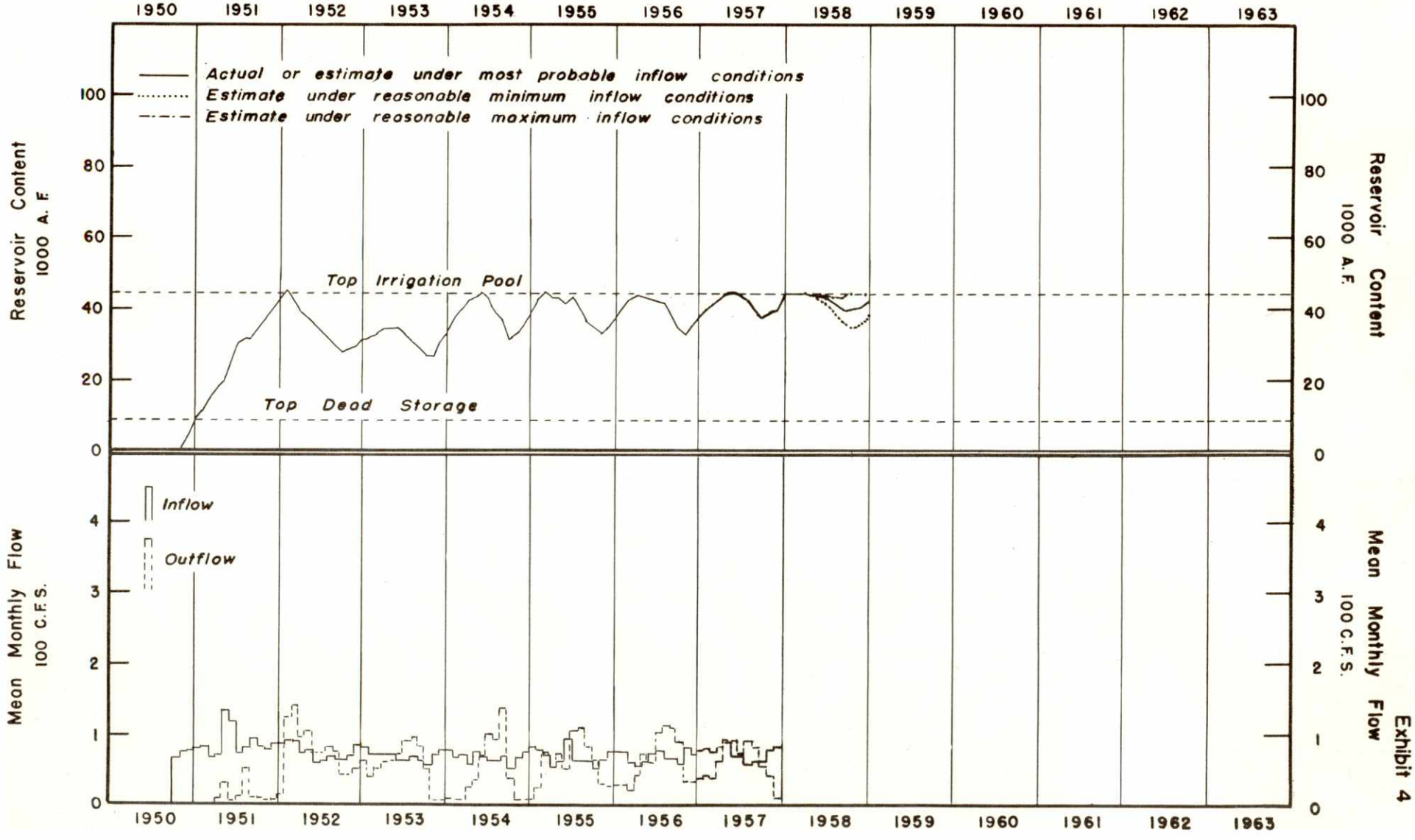


Exhibit 4

HARRY STRUNK LAKE
OPERATION HYDROGRAPHS

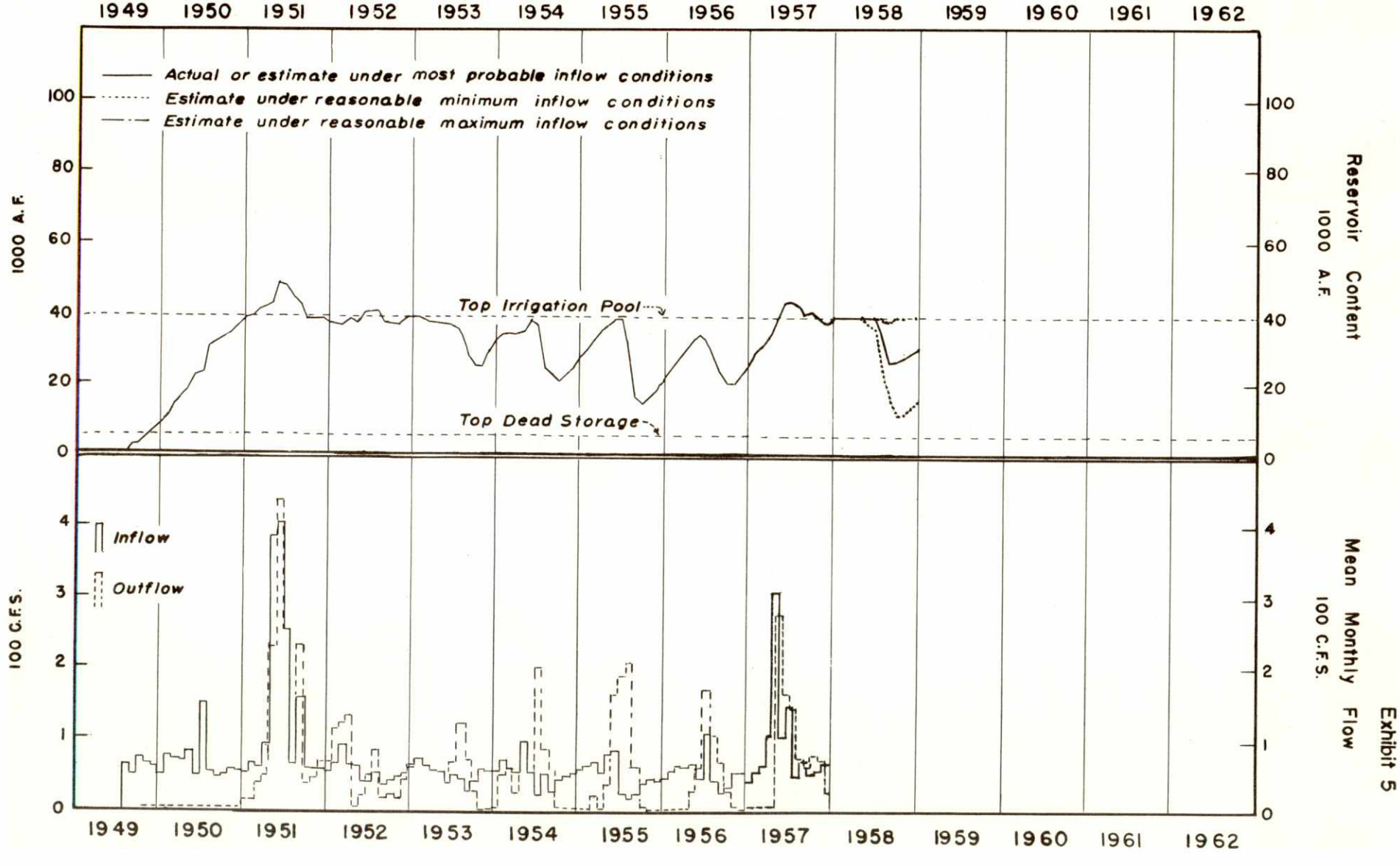
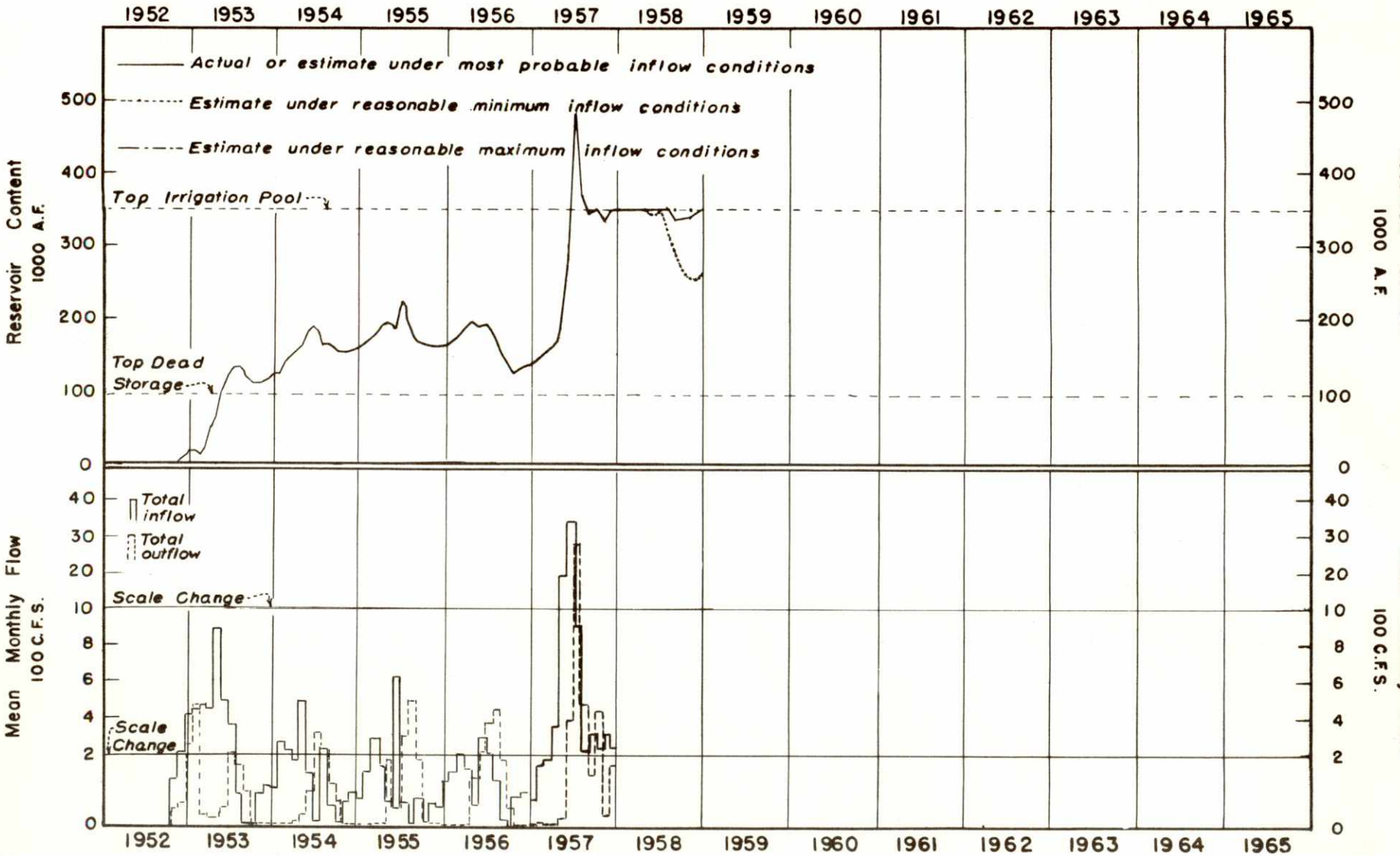


Exhibit 5

HARLAN COUNTY RESERVOIR
OPERATION HYDROGRAPHS



LOVEWELL RESERVOIR
OPERATION HYDROGRAPHS

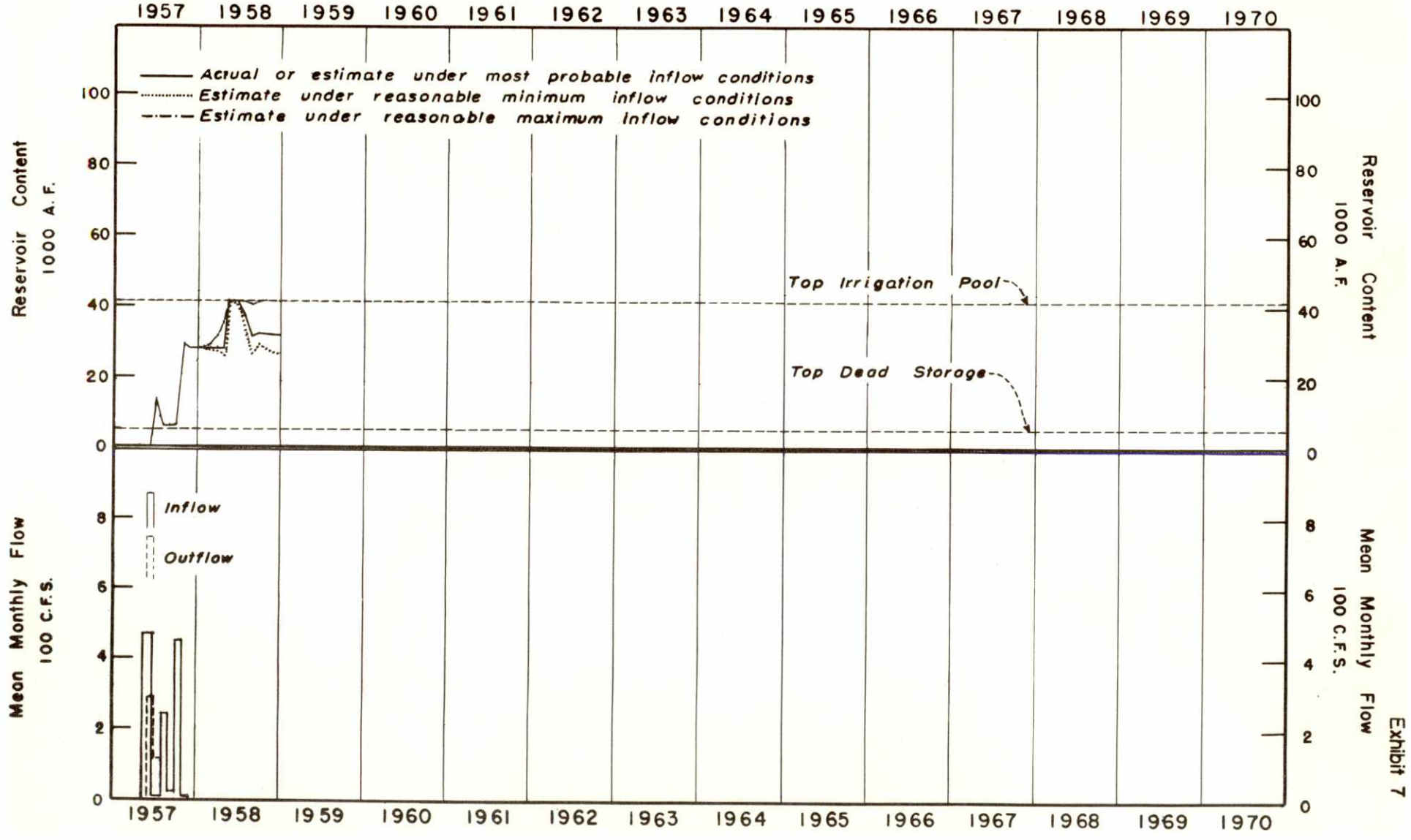


Exhibit 7

KIRWIN RESERVOIR
OPERATION HYDROGRAPHS

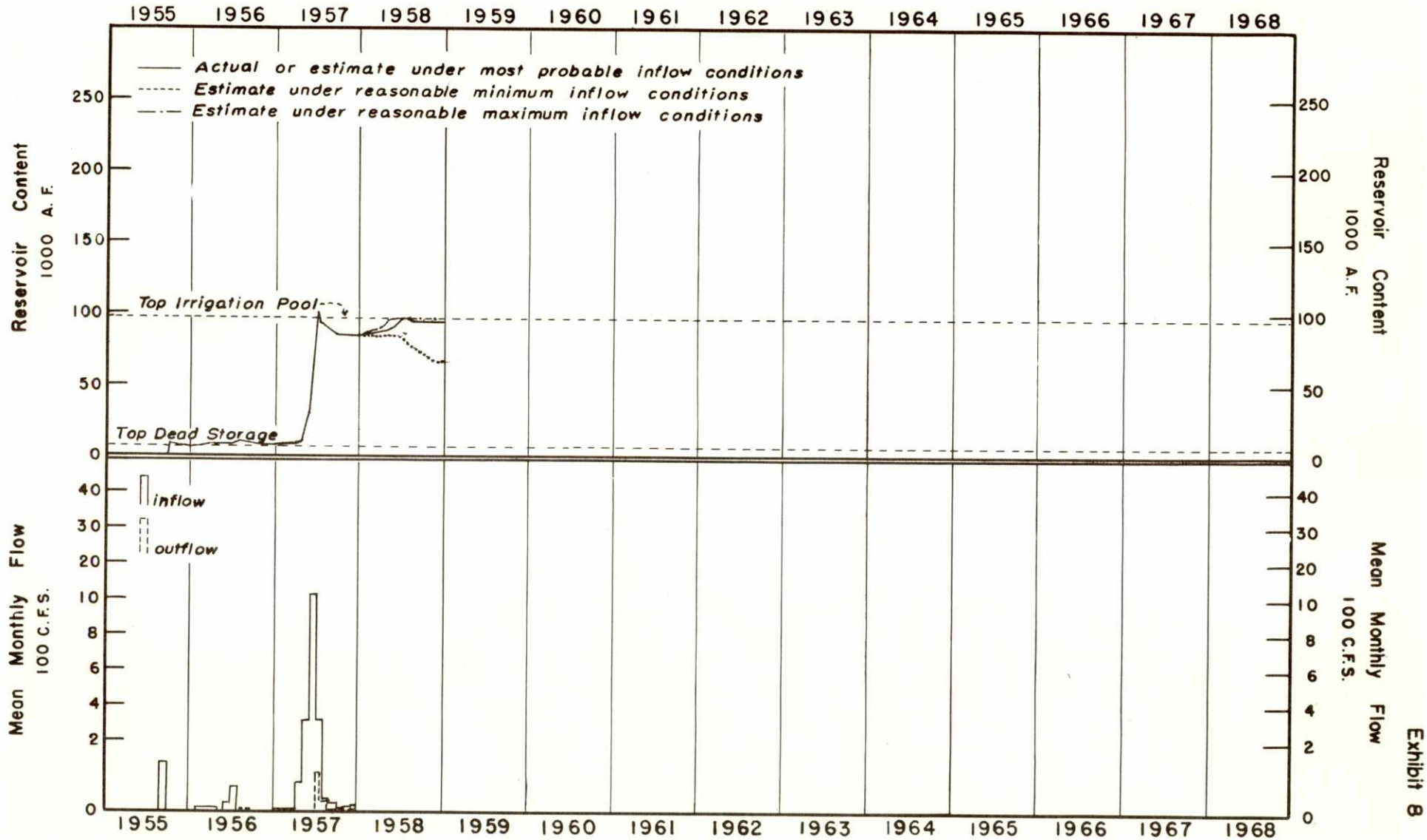


Exhibit B

WEBSTER RESERVOIR
OPERATION HYDROGRAPHS

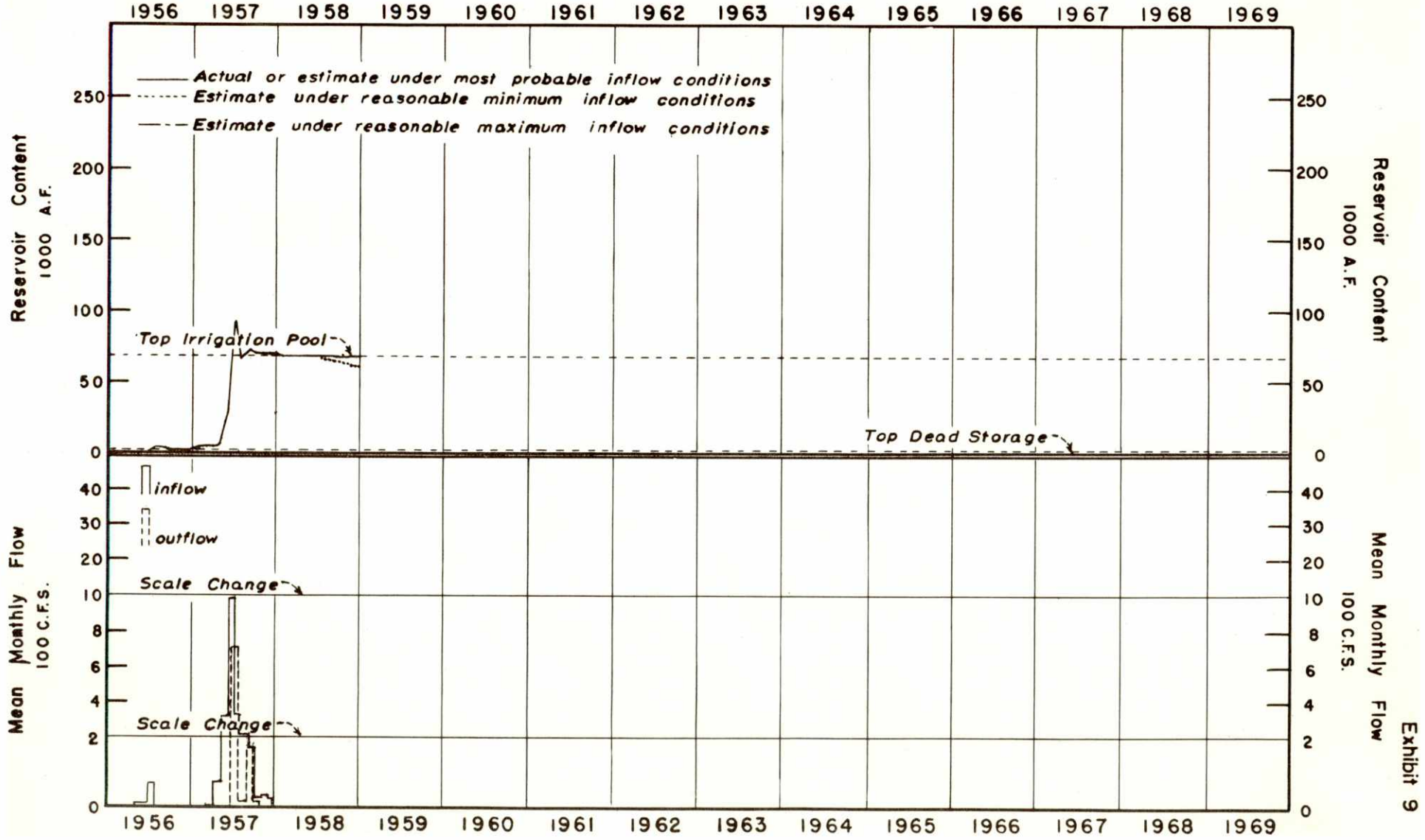
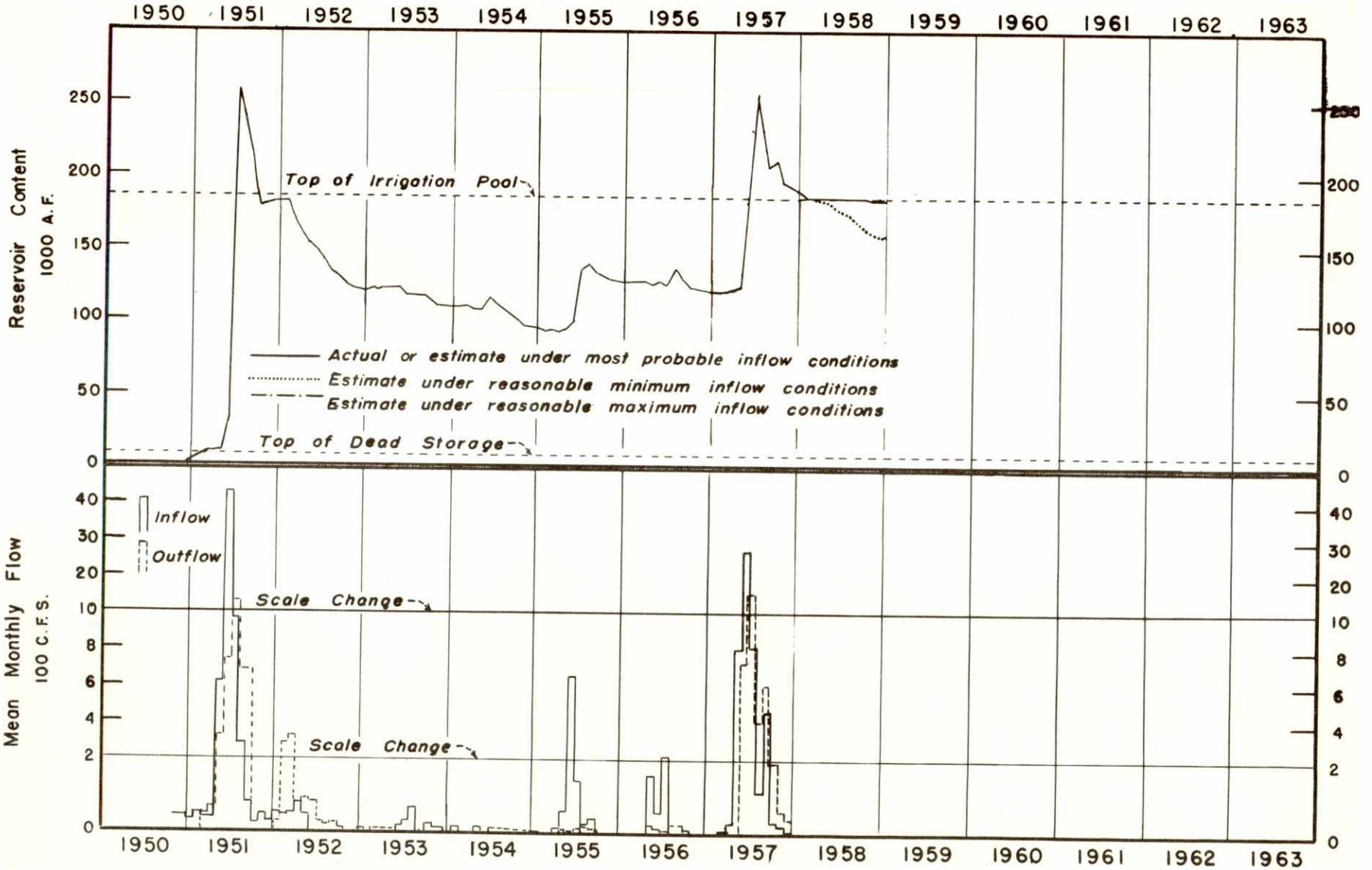
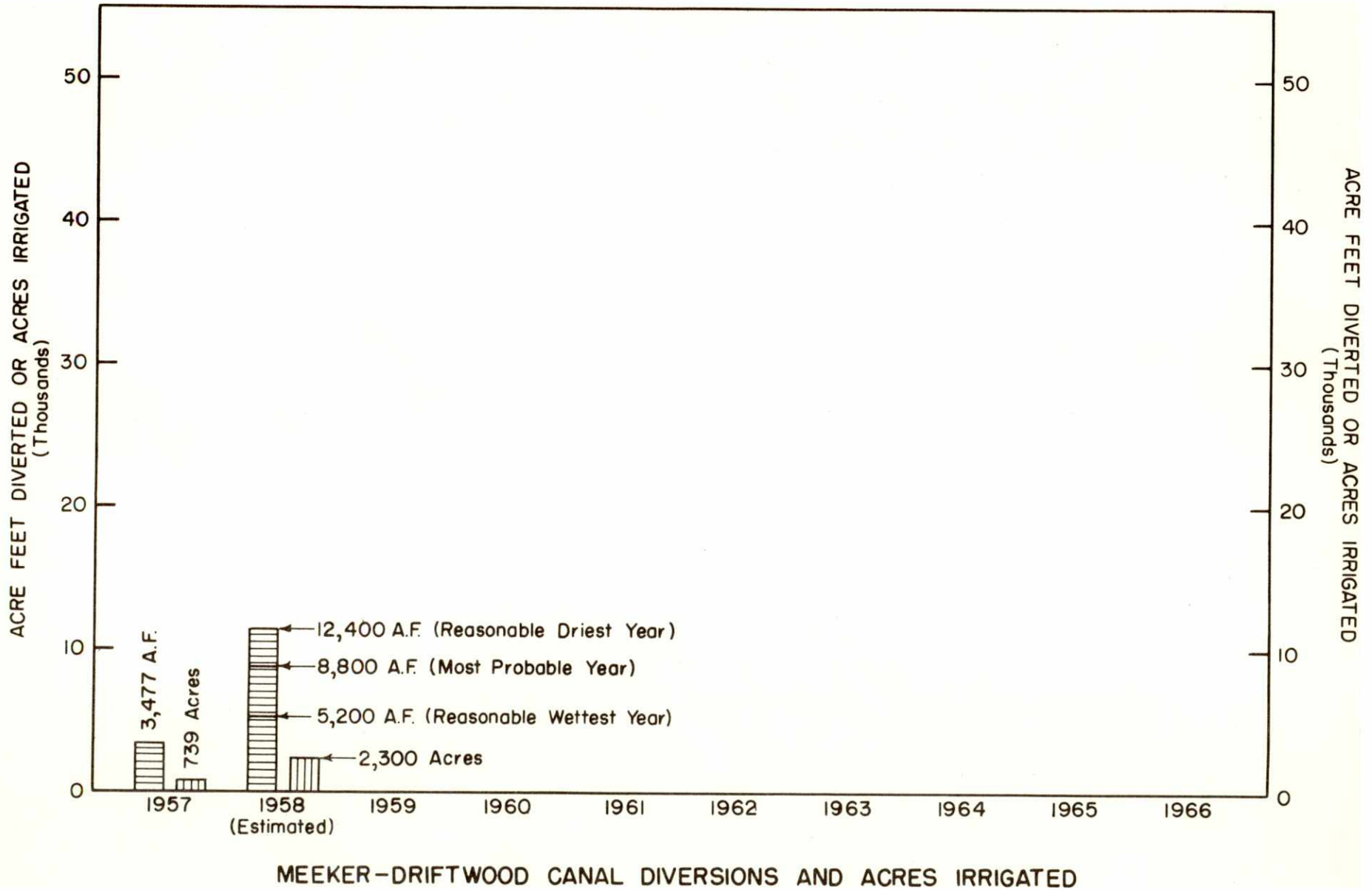


Exhibit 9

CEDAR BLUFF RESERVOIR
OPERATION HYDROGRAPHS

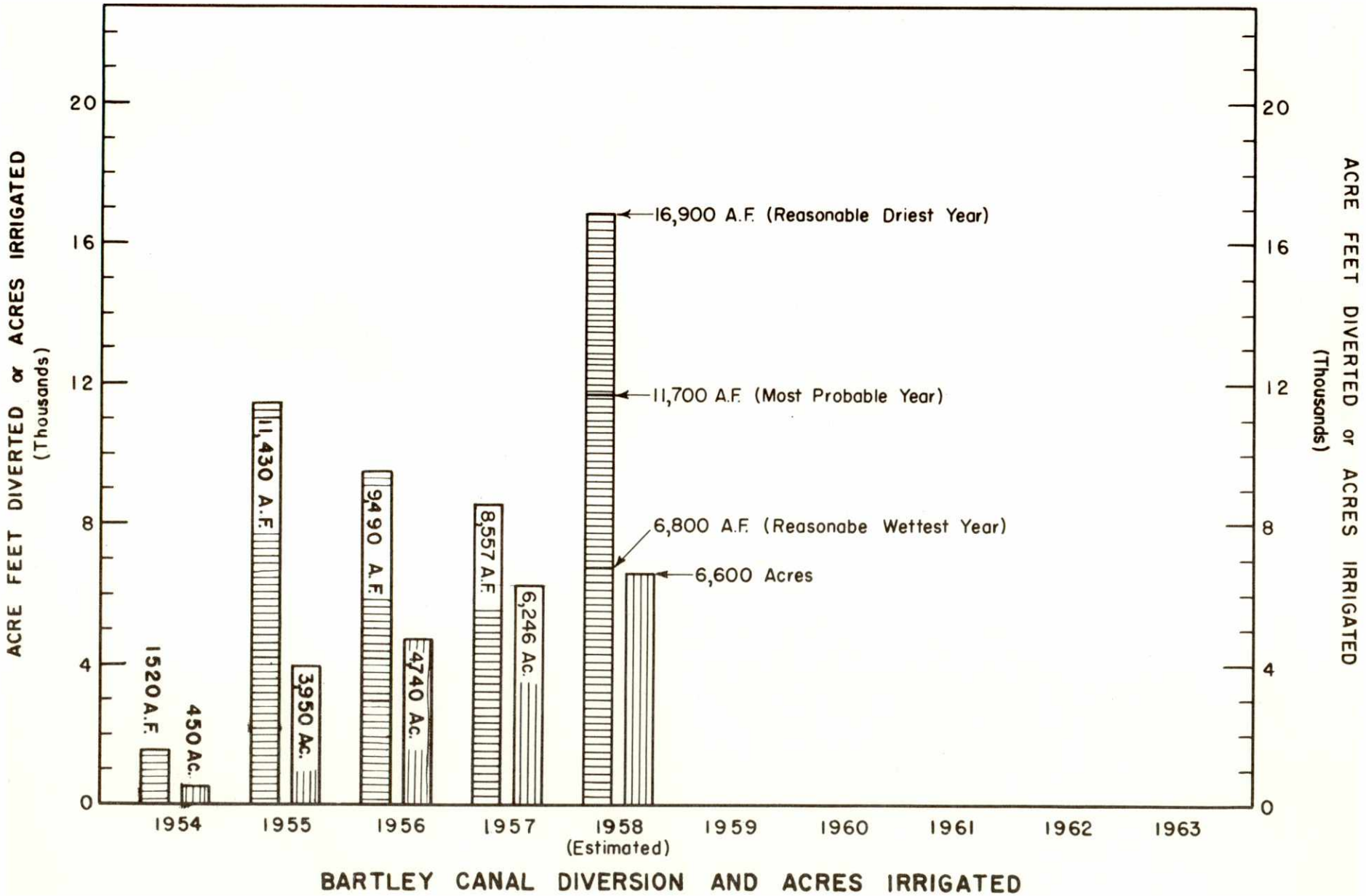




MEEKER-DRIFTWOOD CANAL DIVERSIONS AND ACRES IRRIGATED

MEEKER CANAL DIVERSIONS AND ACRES IRRIGATED

Exhibit 12



BARTLEY CANAL DIVERSION AND ACRES IRRIGATED

CAMBRIDGE CANAL DIVERSIONS AND ACRES IRRIGATED

Exhibit 14

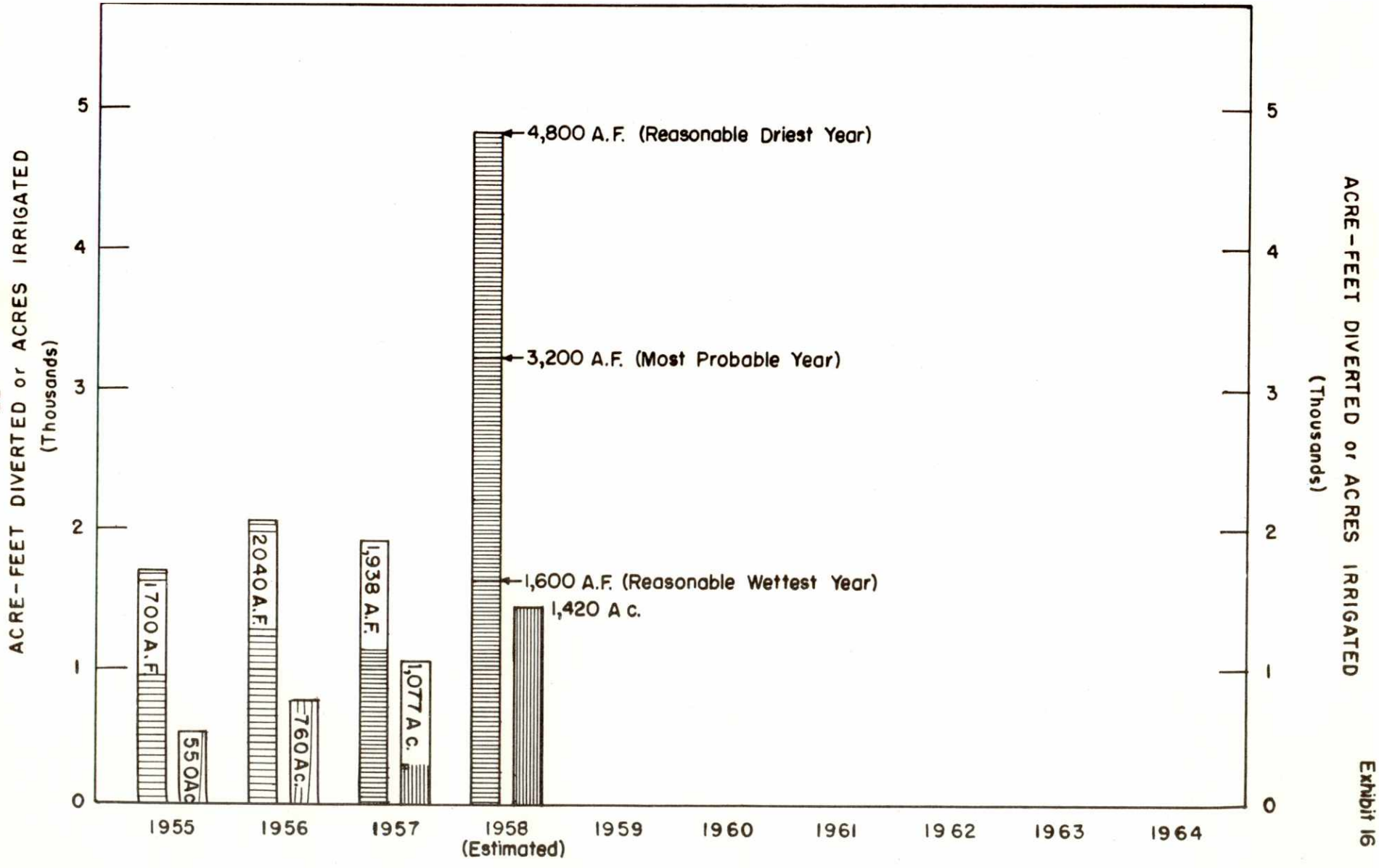
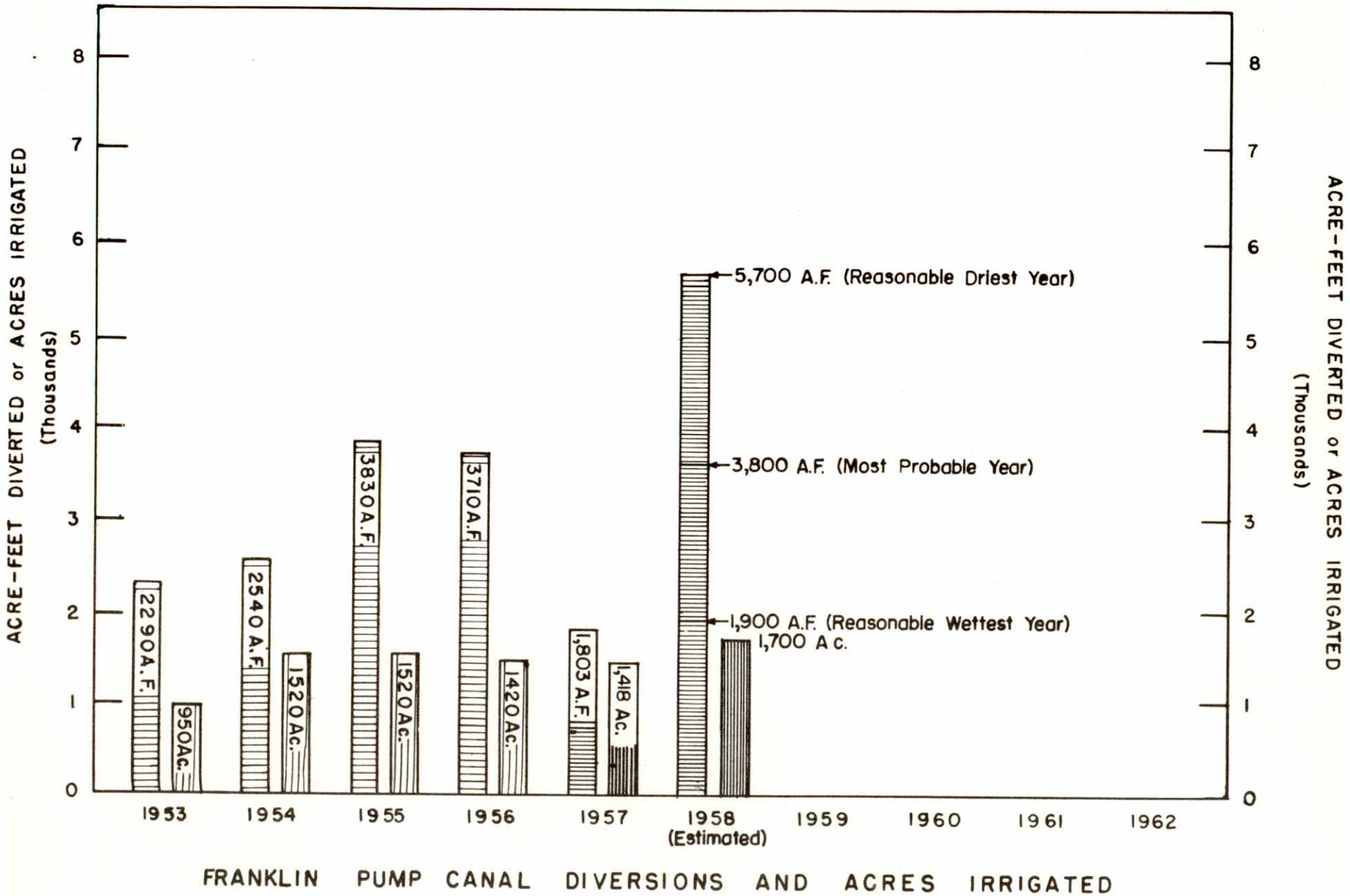


Exhibit 16

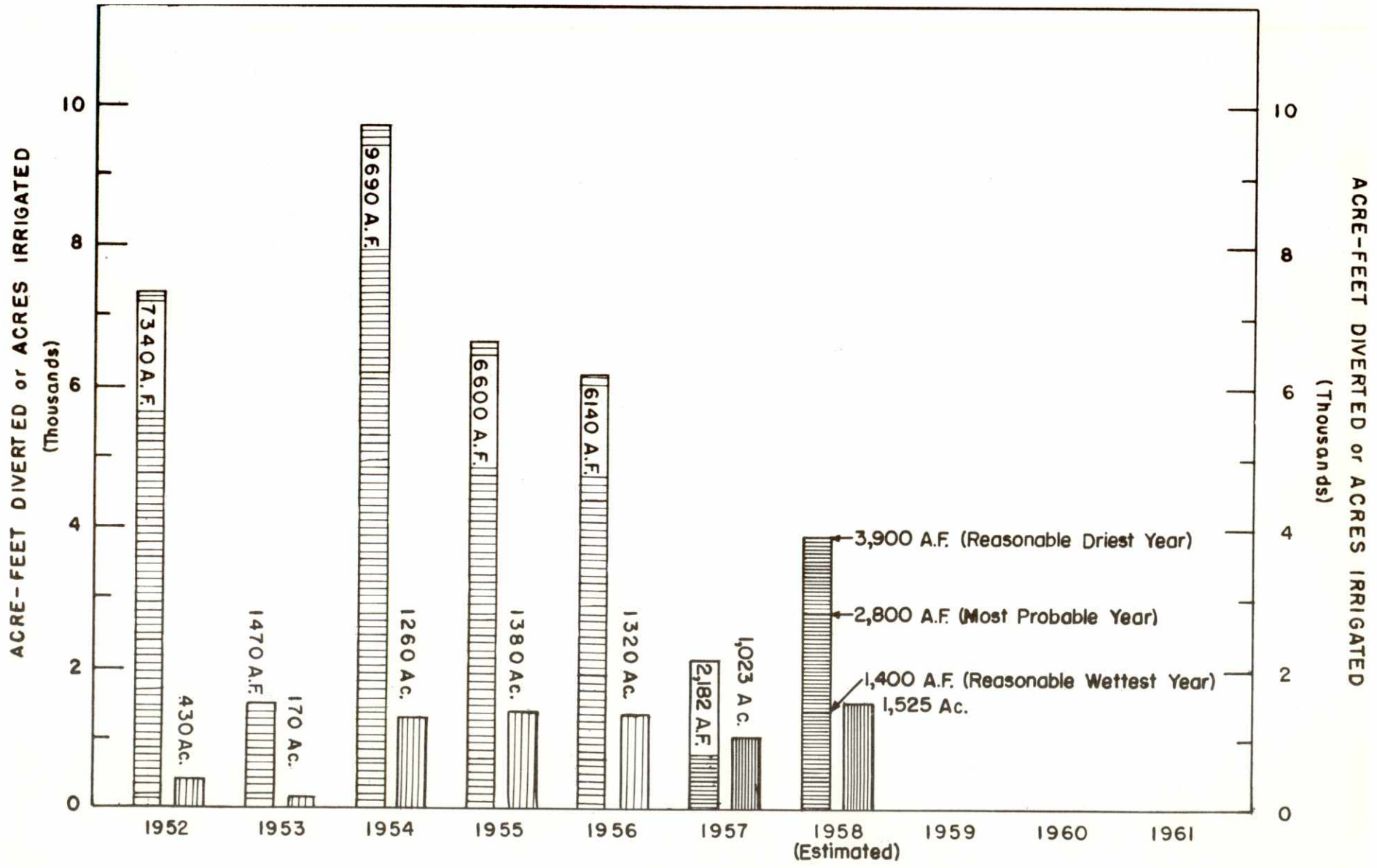
NAPONEE CANAL DIVERSIONS AND ACRES IRRIGATED



FRANKLIN PUMP CANAL DIVERSIONS AND ACRES IRRIGATED

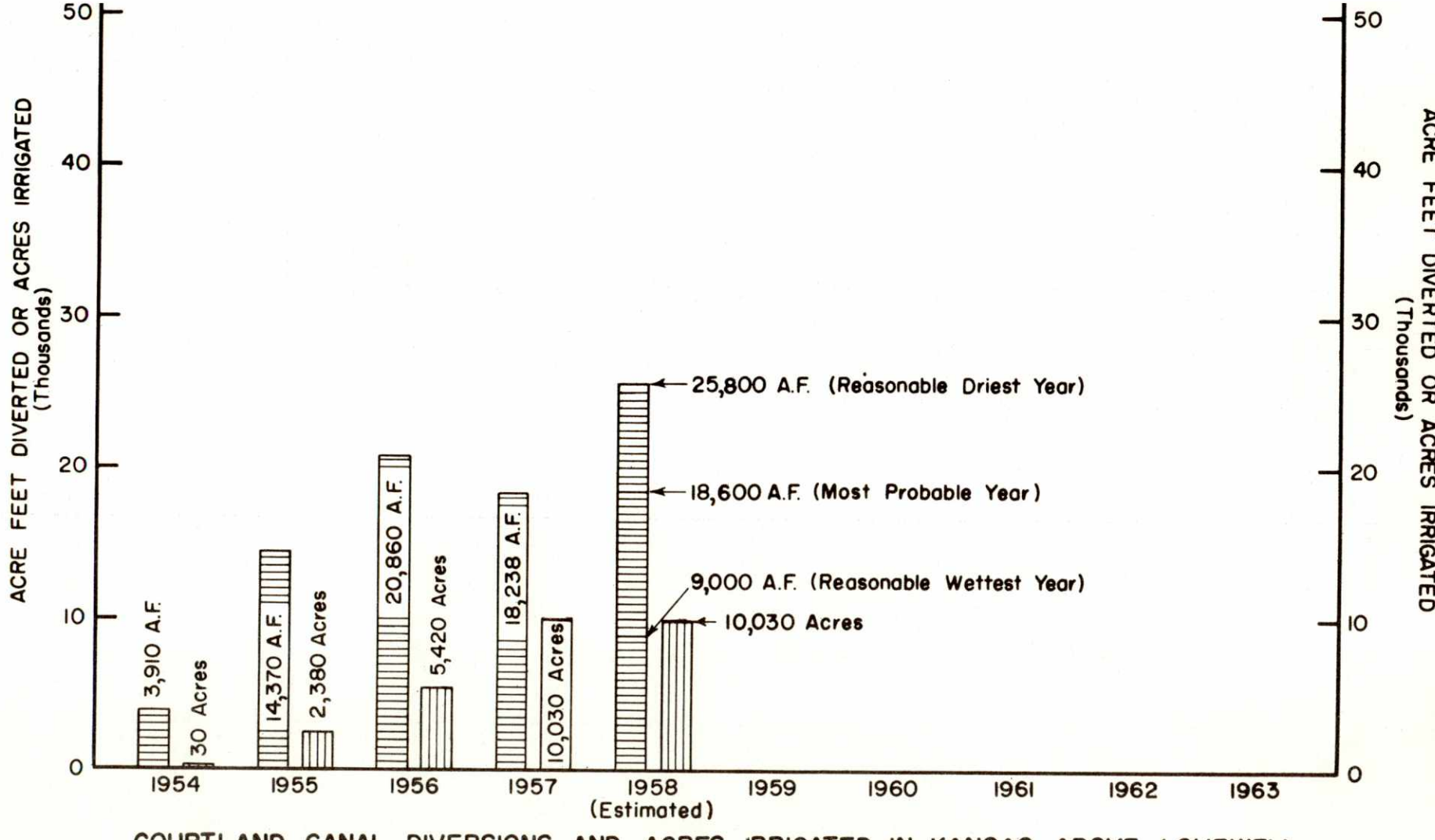
ACRE FEET DIVERTED or ACRES IRRIGATED
(Thousands)
0
3
6
9
12
15
1,940 A.F.
300 Ac.
6,280 A.F.
1,490 Ac.
10,170 A.F.
2,840 Ac.
9,610 A.F.
3,860 Ac.
15,100 A.F.
4,316 Ac.
13,190 A.F.
4,610 Ac.
10,493 A.F.
4,689 Ac.
17,200 A.F. (Reasonable Driest Year)
12,400 A.F. (Most Probable Year)
6,000 A.F. (Reasonable Wettest Year)
5,790 A.c.
1951
1952
1953
1954
1955
1956
1957
1958 (Estimated)
1959
1960
ACRE FEET DIVERTED or ACRES IRRIGATED
(Thousands)
SUPERIOR CANAL DIVERSIONS AND ACRES IRRIGATED

Exhibit 18



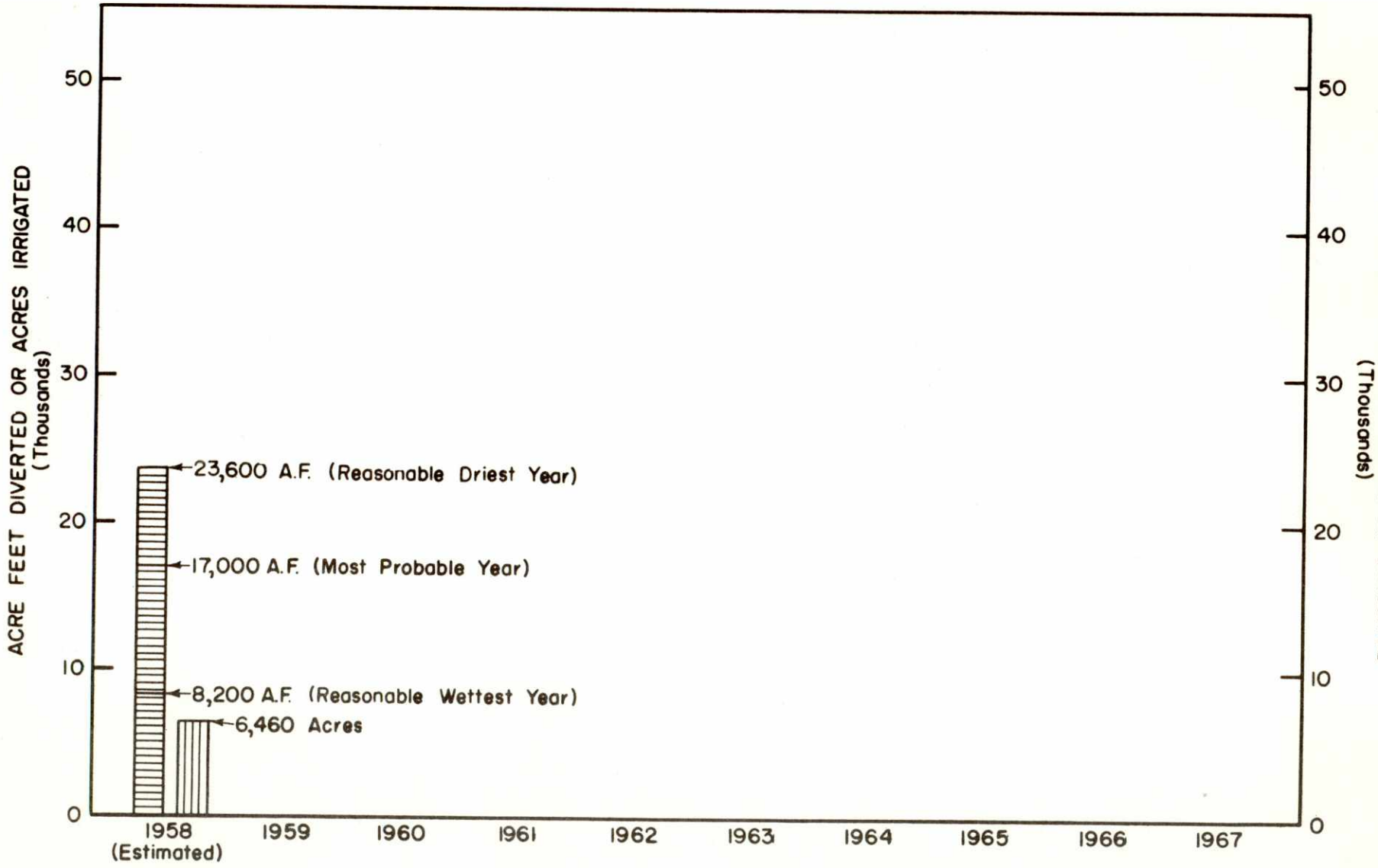
COURTLAND CANAL DIVERSIONS AND ACRES IRRIGATED IN NEBRASKA

TOTAL DIVERSIONS LESS FLOW AT NEBR.-KAN. STATE LINE



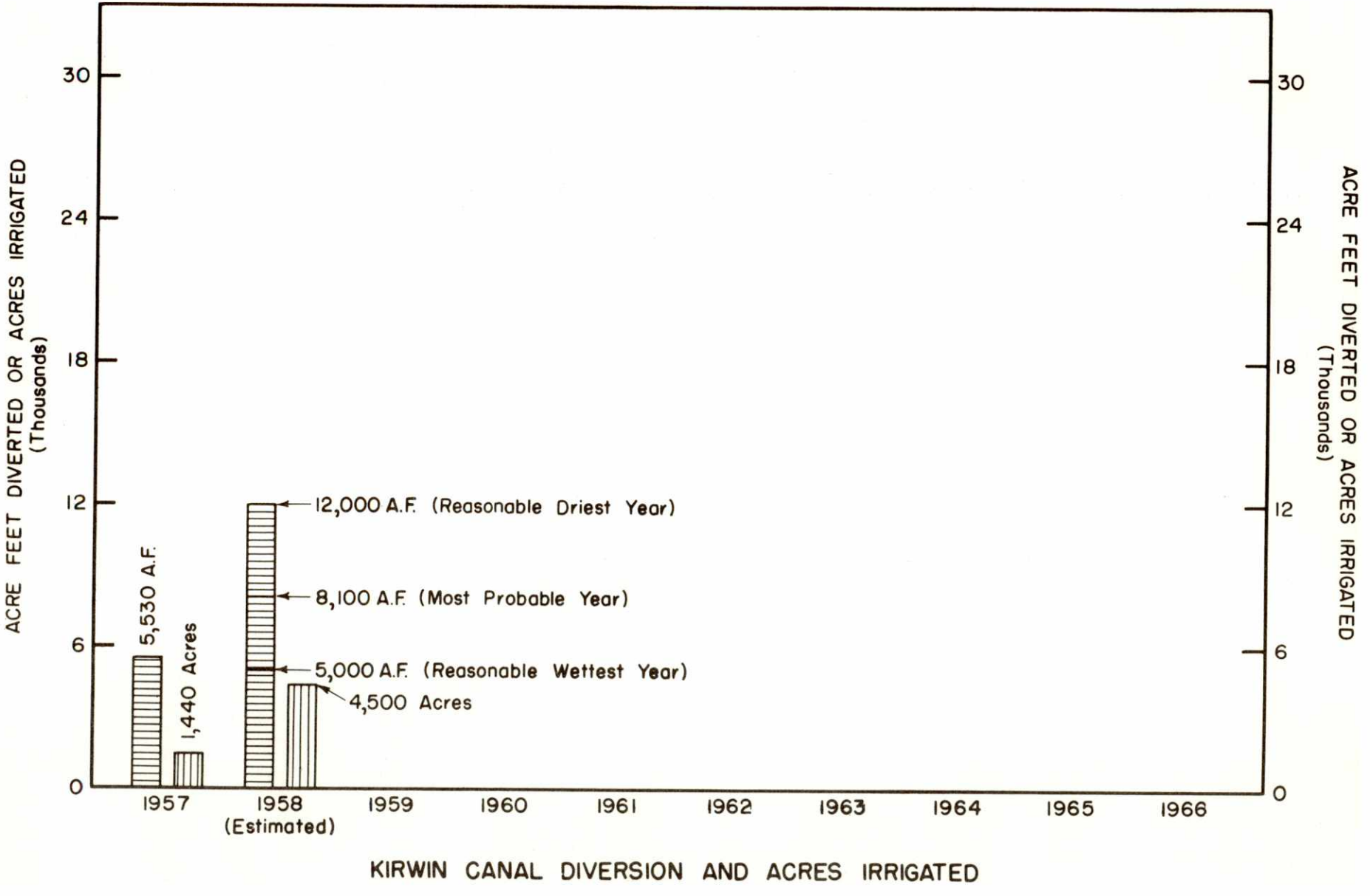
COURTLAND CANAL DIVERSIONS AND ACRES IRRIGATED IN KANSAS ABOVE LOVEWELL
ACRE-FEET DIRECTED IS STATE LINE RECORDS LESS THE CANAL DELIVERIES TO LOVEWELL RESERVOIR

Exhibit 20



COURTLAND CANAL DIVERSIONS AND ACRES IRRIGATED IN KANSAS BELOW LOVEWELL

Exhibit 21



KIRWIN CANAL DIVERSION AND ACRES IRRIGATED

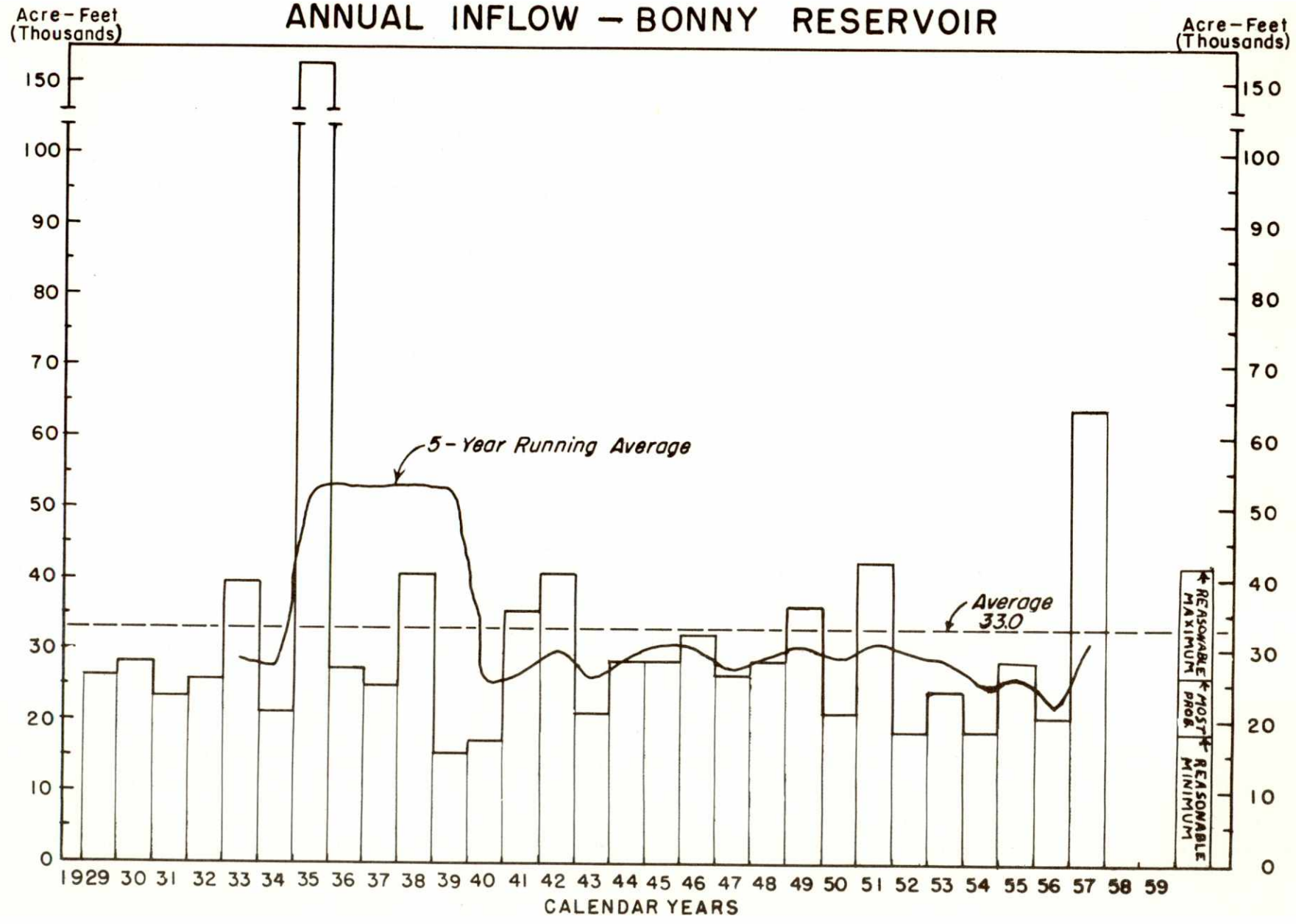
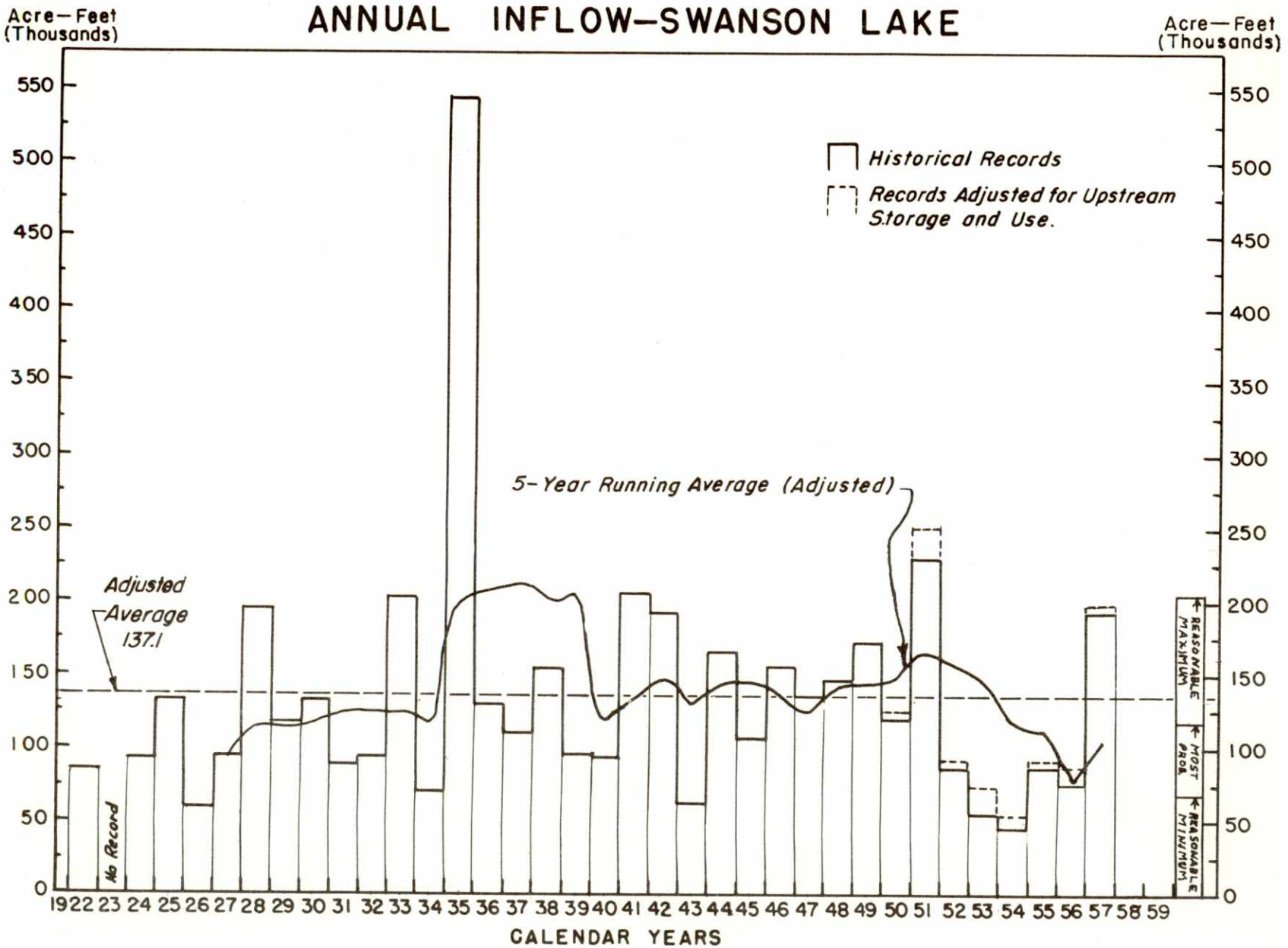
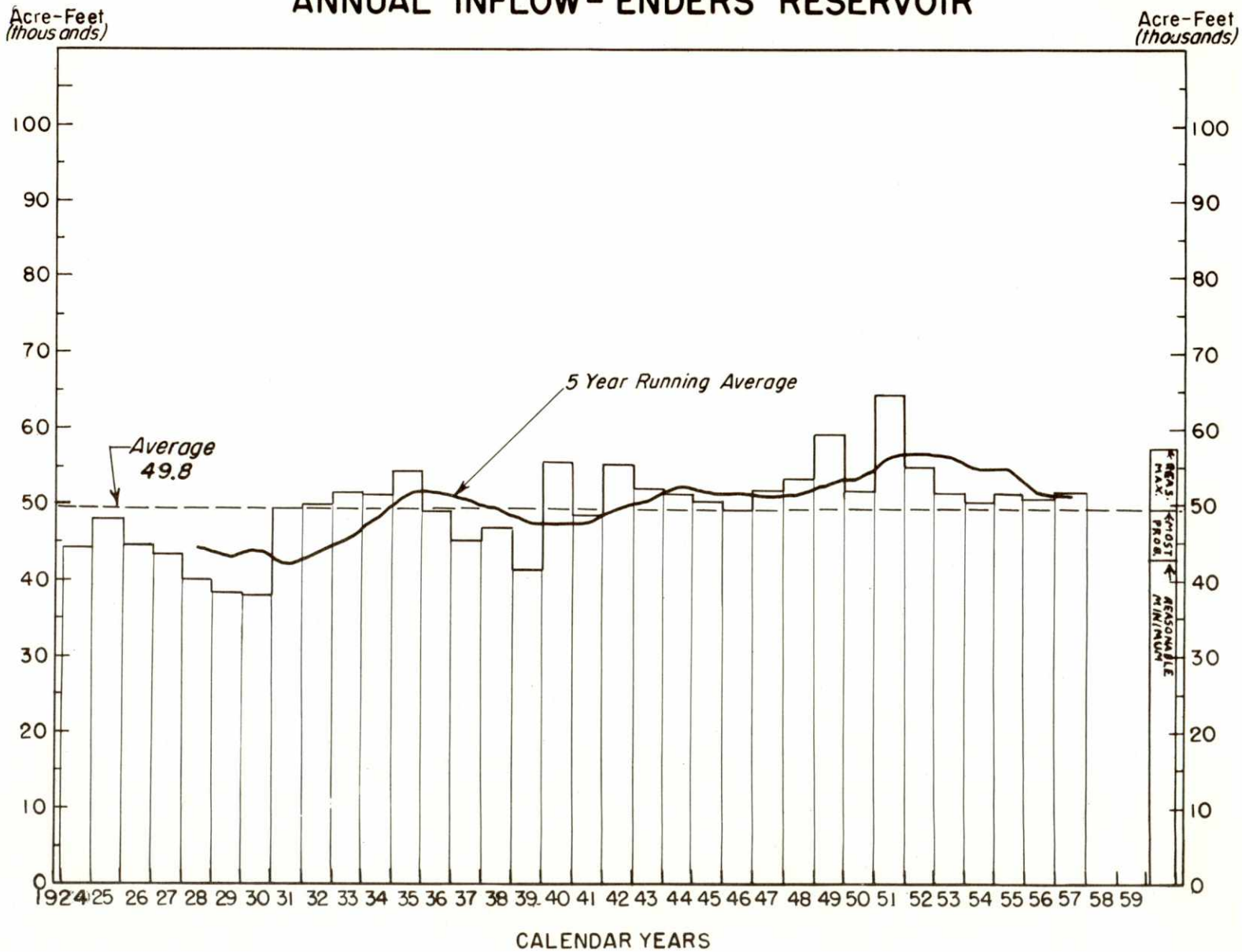

ANNUAL INFLOW — BONNY RESERVOIR
Acre-Feet (Thousands)
Acre-Feet (Thousands)
150
100
90
80
70
60
50
40
30
20
10
0
5-Year Running Average
Average 33.0
REASONABLE MAXIMUM
MOST PROB
REASONABLE MINIMUM
1929 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59
CALENDAR YEARS

Exhibit 23


ANNUAL INFLOW—SWANSON LAKE
Acre—Feet (Thousands)
Acre—Feet (Thousands)
Historical Records
Records Adjusted for Upstream Storage and Use.
5-Year Running Average (Adjusted)
Adjusted Average 137.1
No Record
REASONABLE MAXIMUM
MOST PROB.
REASONABLE MINIMUM
550
500
450
400
350
300
250
200
150
100
50
0
1922 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59
CALENDAR YEARS

ANNUAL INFLOW - ENDERS RESERVOIR



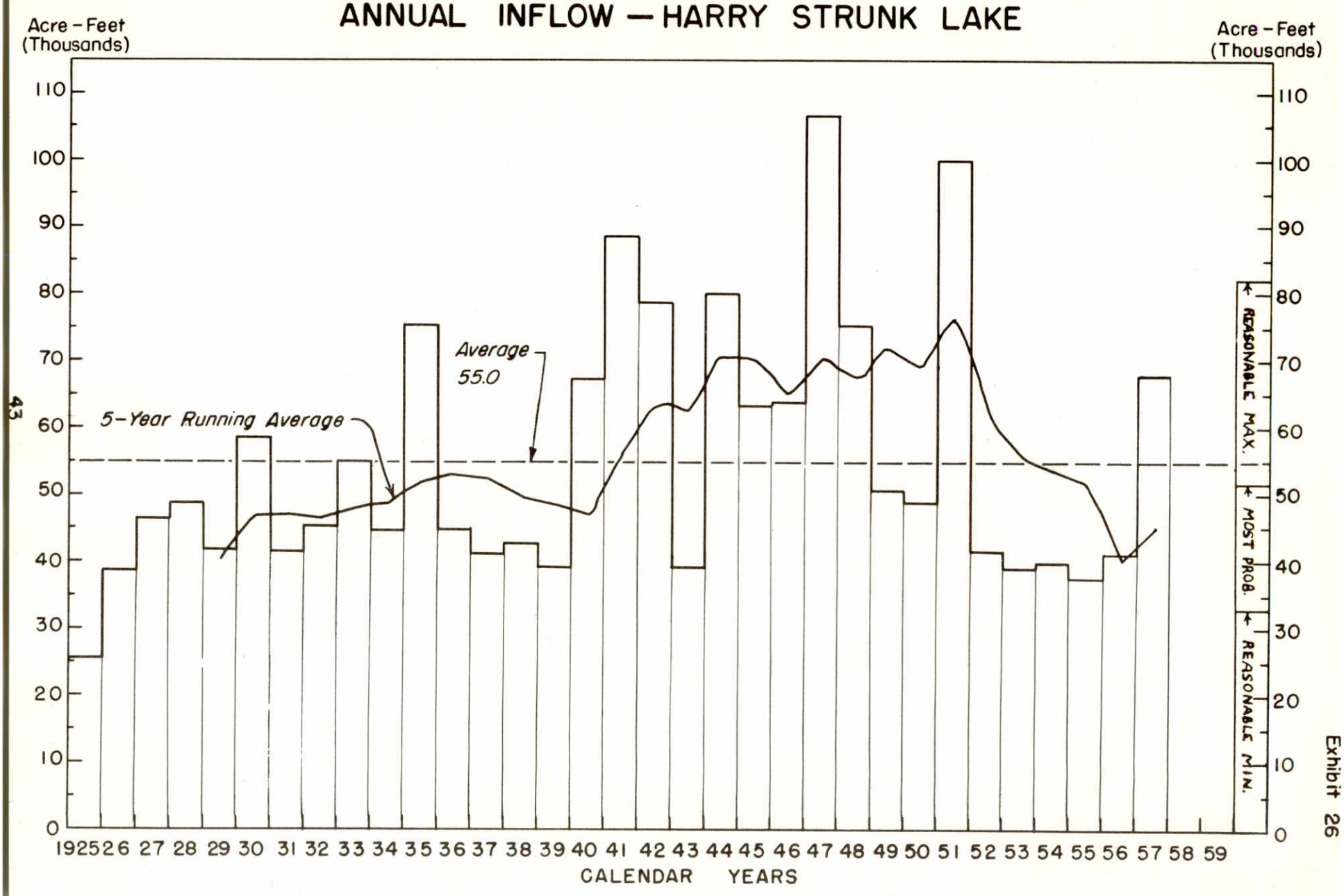
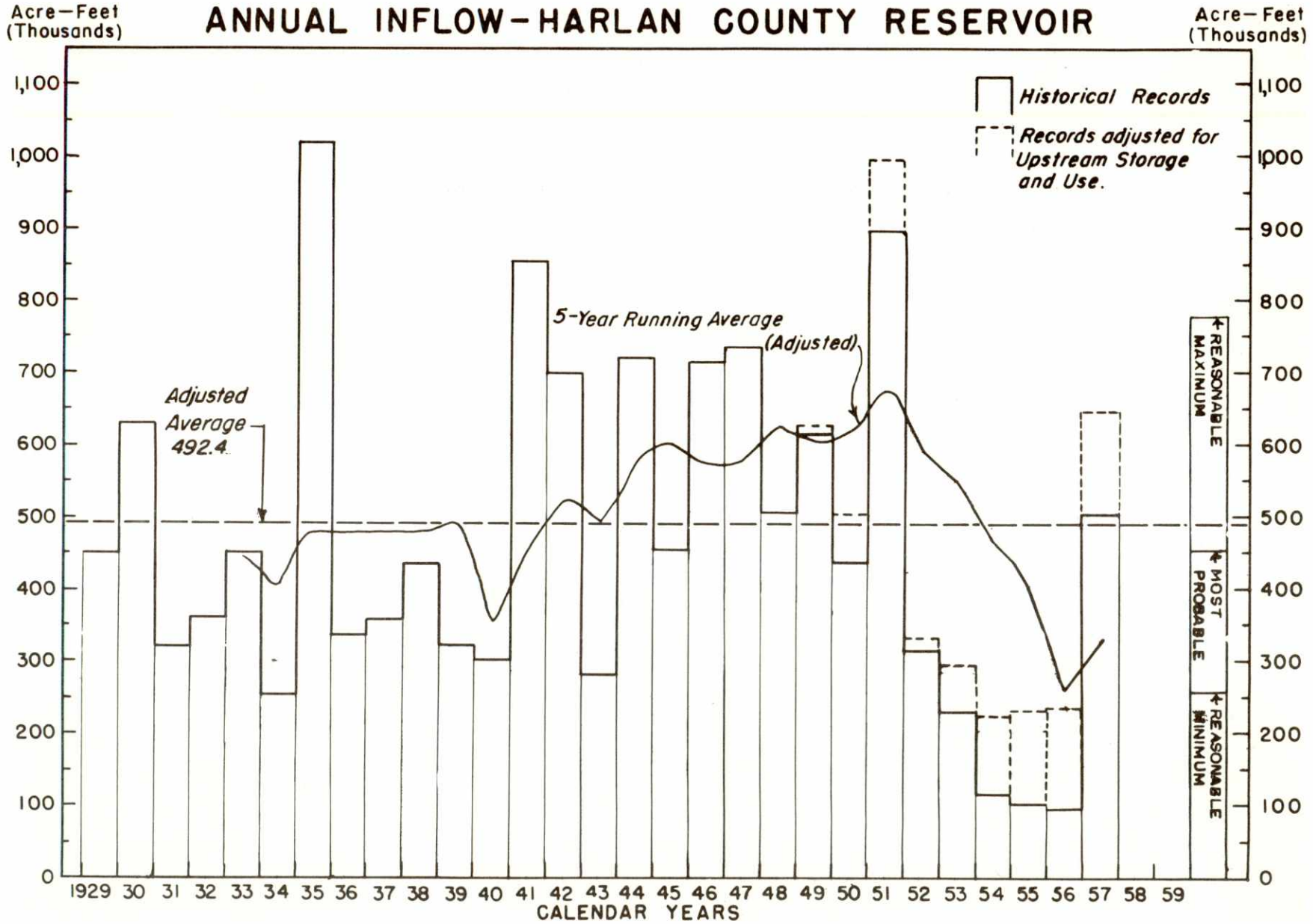
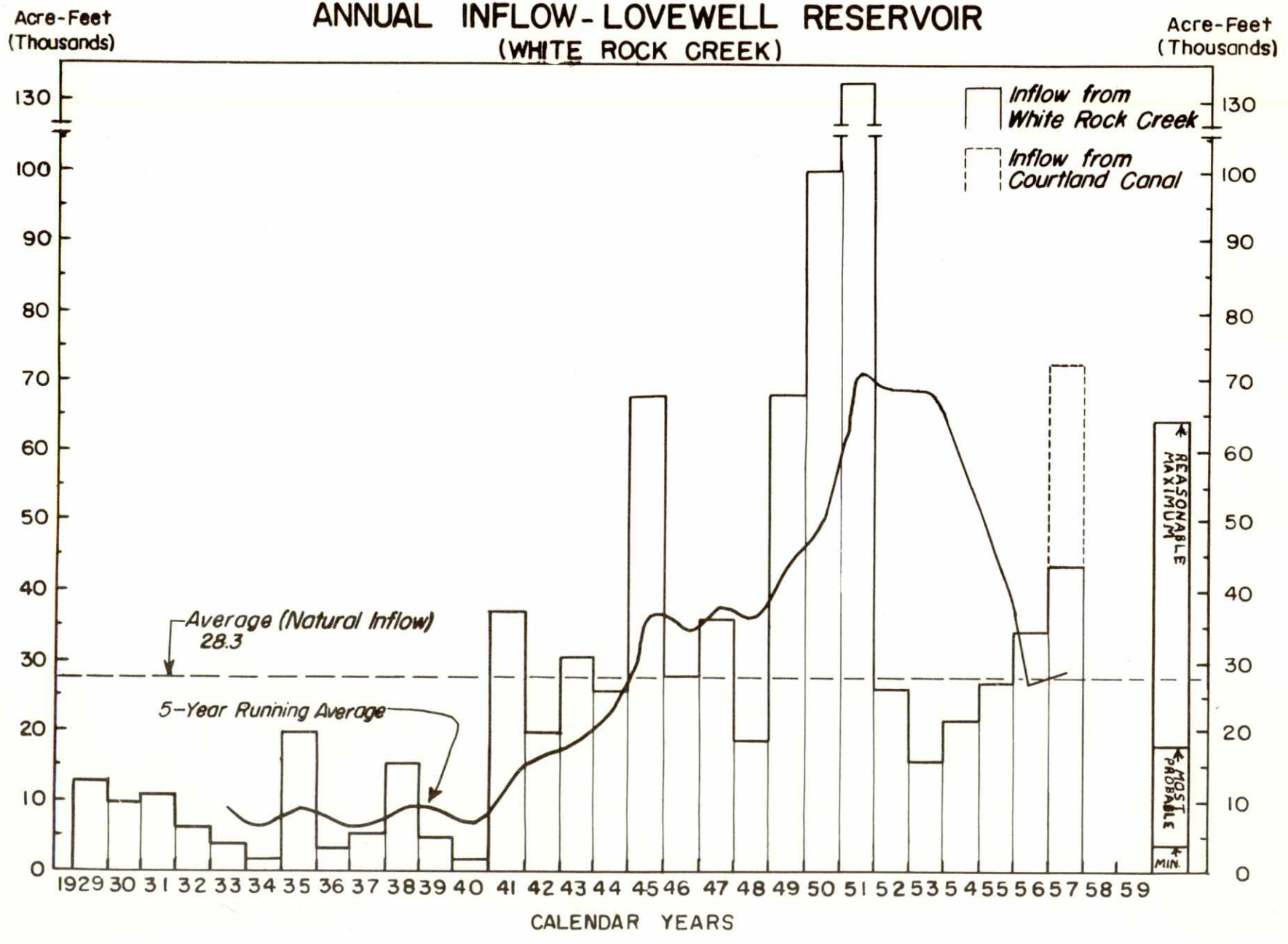
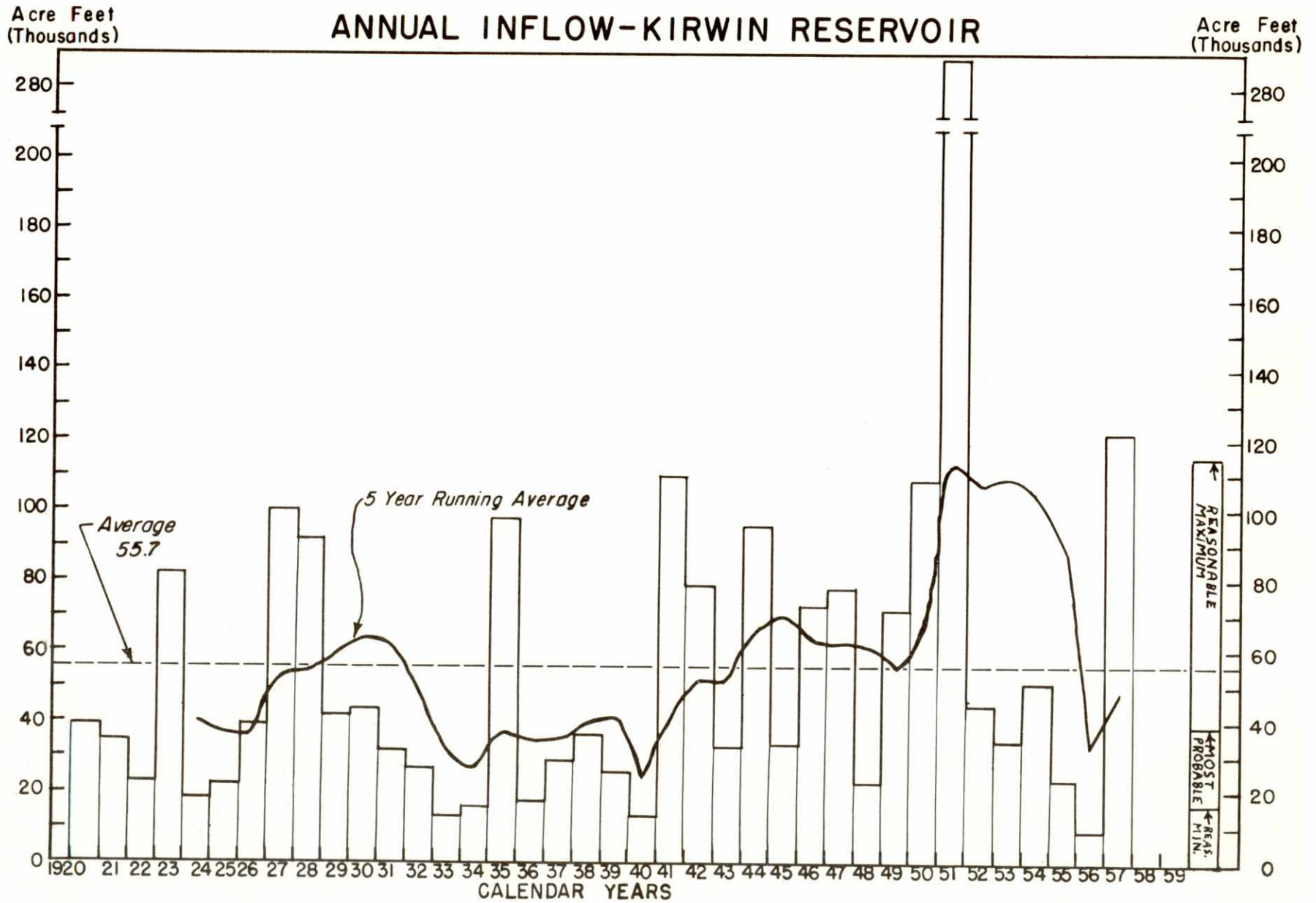

ANNUAL INFLOW — HARRY STRUNK LAKE
Acre - Feet (Thousands)
Acre - Feet (Thousands)
110
100
90
80
70
60
50
40
30
20
10
0
Average 55.0
5-Year Running Average
REASONABLE MAX.
MOST PROB.
REASONABLE MIN.
1925 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59
CALENDAR YEARS

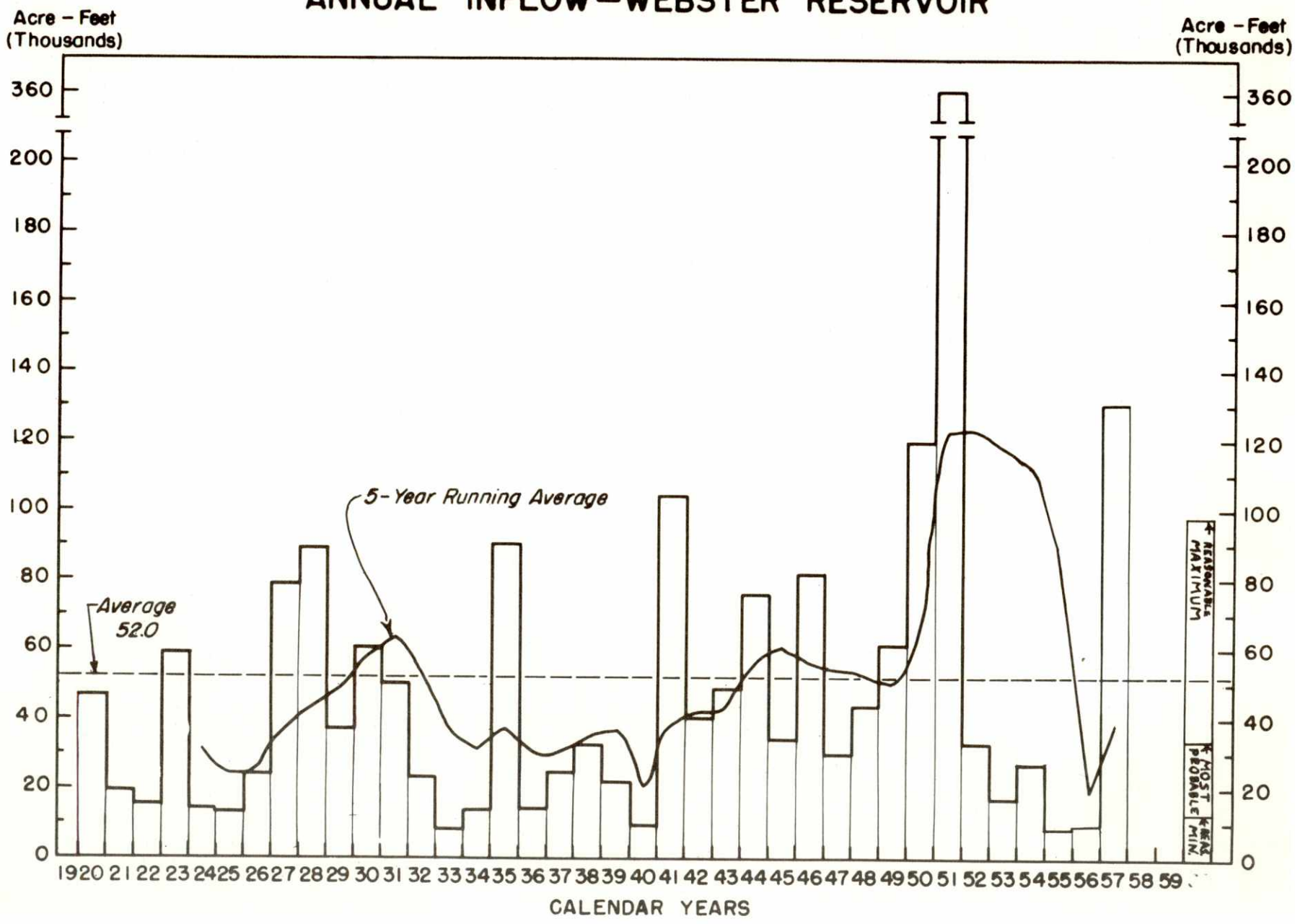
Exhibit 26


ANNUAL INFLOW - HARLAN COUNTY RESERVOIR
Acre-Feet (Thousands)
Acre-Feet (Thousands)
1,100
1,000
900
800
700
600
500
400
300
200
100
0
Historical Records
Records adjusted for Upstream Storage and Use.
5-Year Running Average (Adjusted)
Adjusted Average 492.4
REASONABLE MAXIMUM
MOST PROBABLE
REASONABLE MINIMUM
1929 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59
CALENDAR YEARS

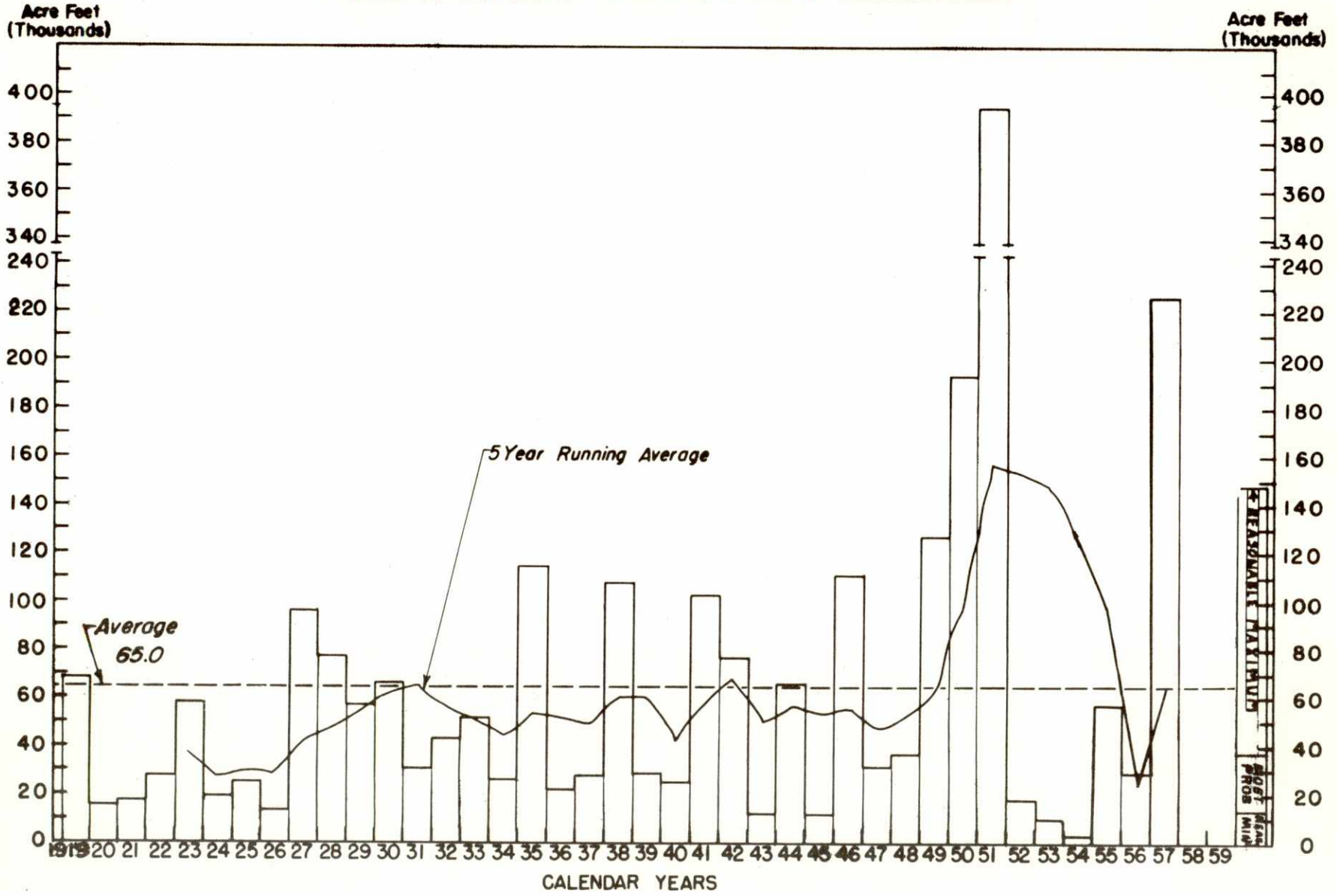

ANNUAL INFLOW - LOVEWELL RESERVOIR
(WHITE ROCK CREEK)
Acre-Feet
(Thousands)
Acre-Feet
(Thousands)
Inflow from
White Rock Creek
Inflow from
Courtland Canal
Average (Natural Inflow)
28.3
5-Year Running Average
REASONABLE
MAXIMUM
MOST
PROBABLE
MIN.
130
100
90
80
70
60
50
40
30
20
10
0
1929 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59
CALENDAR YEARS


ANNUAL INFLOW-KIRWIN RESERVOIR
Acre Feet (Thousands)
Acre Feet (Thousands)
280
200
180
160
140
120
100
80
60
40
20
0
Average 55.7
5 Year Running Average
REASONABLE MAXIMUM
MOST PROBABLE
REAS. MIN.
1920 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59
CALENDAR YEARS

ANNUAL INFLOW—WEBSTER RESERVOIR



ANNUAL INFLOW–CEDAR BLUFF RESERVOIR



GPO 852206

Exhibit 31