REPORT ON RESERVOIR REGULATIONS FOR FLOOD CONTROL

TIBER DAM AND RESERVOIR MONTANA

BUREAU OF RECLAMATION

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

SEPTEMBER 1987

REPORT ON
RESERVOIR REGULATIONS
FOR
FLOOD CONTROL

TIBER DAM AND RESERVOIR
MONTANA
BUREAU OF RECLAMATION

Prepared For
U.S. Army Corps of Engineers
Omaha District
Omaha, Nebraska

Prepared By
RIVER PRO'S
Omaha, Nebraska

OCTOBER 1987

CEMRD-ED-RR (CEMRO-ED-HC/14 Nov 86) (11-2-240a) 3d End
Mr. Murphy/alw/7358
SUBJECT: Reservoir Regulation Manual, Tiber Dam and Reservoir, Montana

DA, Missouri River Division, Corps of Engineers, P.O. Box 103, Downtown Station, Omaha, NE 68101-0103 30 October 1987

FOR: Commander, Omaha District, ATTN: CEMRO-ED

1. The Tiber Dam and Reservoir Regulation Manual is approved. One copy of the subject manual has been forwarded to Office of Chief of Engineers (OCE). This Water Control Manual supersedes the Tiber Dam and Reservoir Manual dated December 1959.

2. According to David Wingerd of OCE, the placement of this project on the list of non-Corps projects contained in Appendix A of ER 1110-2-241 requires only the updating of pertinent data for this project on the table contained in Appendix A of the ER. We have notified OCE that this project should be included in the next publication of this ER.

FOR THE COMMANDER:

[redacted]

Encl wd

Chief, Engineering Division

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TIBER DAM AND RESERVOIR

MONTANA

RESERVOIR REGULATION MANUAL
FOR
TIBER DAM AND RESERVOIR

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PERTINENT DATA

TIBER DAM AND RESERVOIR

GENERAL

Location of Project	-	Liberty and Toole Counties, Montana, on the Marias River, 71 miles upstream from confluence of Marias River with Missouri River and about 15 miles southwest of Chester, Montana.
Purpose	-	Irrigation, flood control, fish and wildlife, municipal and industrial water supply, and recreation.
Authorized By	-	Flood Control Act approved 22 December 1944 (Public Law 534 78 Congress, 2nd Session) in accordance with general plans set forth in Senate Document 191 Seventy-eighth Congress.
Date Completed	-	Construction of Tiber Dam began 15 September 1952 and was completed 6 March 1956. The final river closure was made on 27 October 1954 and the pool initially filled to the top of conservation level on 17 August 1956.
Modifications	-	Auxiliary outlet works - 1967 to 1970. Spillway rehabilitation - 1976 to 1979. Dam embankment and dike raised 5 feet - 1979 to 1981.
Drainage Area	-	Marias River above Tiber Dam - 4923 square miles, of which 518 square miles are considered non-contributing.
Streamflow	-	Average Inflow is 676,994 acre-feet per year.

RESERVOIR DATA

Item	Elevation (ft.,m.s.l.)	Area (acres)	Gross Storage (acre-ft)	Incremental Storage (acre-ft)
Streambed at Dam Axis	2823.5	0	0	
Dead Storage				21,582
Top of Dead Storage Pool	2870.0	1,535	21,582	
Inactive Storage				556,043
Top of Inactive Storage Pool	2966.4	11,708	577,625	
Active Conservation Storage				121,700
Top of Active Cons. Storage Pool	2976.0	13,787	699,325	
Joint-Use Storage				267,994
Top of Joint-Use Storage Pool	2993.0	17,886	967,319	
Replacement and Location F.C. Storage				301,484
Top of Replacement and Local F.C. Storage Pool	3008.1	22,003	1,268,803	
Exclusive Flood Control Storage				99,354
Top of Exclusive Flood Control Storage Pool	3012.5	23,152	1,368,157	
Surcharge Storage				187,741
Top of Surcharge Storage Pool	*3020.2	25,414	1,555,898	
Freeboard Storage				150,867
Top of Dam	3026.0	26,826	1,706,765	

* Maximum Design Water Surface Elevation

Sediment - Average annual deposition of 470 acre-feet estimated by Bureau of Reclamation.

EMBANKMENT

Main Dam

Type	Zoned Earth Fill
Structural Height	211 feet
Hydraulic Height	195 feet
Top Elevation	3026.0 feet, m.s.l.
Crest Length	4300 feet
Crest Width	30 feet
Construction Started	1952
Date of Closure	October 1954

Dike

Type	Zoned Earth Fill
Structural Height	65 feet
Hydraulic Height	51 feet
Top Elevation	3026.0 feet, m.s.l.
Crest Length	16,650 feet
Crest Width	20 feet

SPILLWAY

Location	Landward of Right Abutment.
Type	Gated
Inlet Structure	Varies in width from 76 to 200 feet.
Crest Length	66 feet
Crest Elevation	2975.0 feet, m.s.l.
Gates	3 - 22 x 38 feet, radial
Bays	3 - 22 x 22 feet
Discharge Chute	Varies in width from 76 to 200 feet.
Stilling Basin	200 feet wide
Gate Operation	Hoists and cables from hoist bridge. Auxiliary power system for emergency operation is provided.

RIVER OUTLET STRUCTURE

Location	Right Abutment
Size	72-inch diameter steel pipe
Control	5.0 x 5.0 foot slide gate located in control house on downstream side of dam
Minimum Pool Elevation for Discharge through Outlet.	2870.0 feet, m.s.l.
Capacity	1540 c.f.s. at 3020.2 feet, m.s.l. (max. pool elevation)

CONSTRUCTION OUTLET *

Location	Inside 14-foot diameter outlet tunnel
Size	22-inch diameter steel pipe
Control	24-inch diameter hydraulic operated gate valve
Capacity	65 c.f.s. at elevation 3020.2 feet, m.s.l.

*This pipe has been blocked off and is not currently being used. (See Paragraph 4-05a).

AUXILIARY OUTLET STRUCTURE

Location	Left Abutment
Control	7.25 x 9.25 foot slide gate
Outlet from Control House	10 foot-9 inch diameter tunnel
Limiting Discharge Elev.	2962.0 feet, m.s.l.
Capacity	4250 c.f.s. at 3020.2 feet, m.s.l. (max. pool elevation)

Outlet empties into a chute and stilling basin.

REPORT ON RESERVOIR REGULATIONS

FOR

FLOOD CONTROL

TIBER DAM AND RESERVOIR

SECTION I - INTRODUCTION

1-01. AUTHORITY. This manual has been prepared in compliance with instructions and information specified in ER-1110-2-240 and Chapter 6 of EM-1110-2-3600.

1-02. SCOPE. Tiber Dam and Reservoir was constructed by the Bureau of Reclamation on the Marias River, a tributary of the Missouri River, near Chester, Montana, primarily for flood control and irrigation. Other purposes include municipal water supply, fish and wildlife and recreation. This manual presents information and procedures for flood control regulation of the reservoir. It is subject to future revision and updating as circumstances warrant.

SECTION II - BASIN AND RIVER DESCRIPTION

2-01. LOCATION AND DESCRIPTION. The Marias River basin is located in the high plateau and mountain area of north-central Montana. Total drainage area of the basin is 9,160 square miles of which 4923 square miles lie upstream from Tiber Dam. Included in the 4923 square miles are 518 square miles considered to be non-contributing. The upper portion of the basin consists of forested mountainous terrain lying along the eastern slope of the Rocky Mountains with maximum elevations near 10,000 feet. Elevations in the plateau area vary from 2,500 to 5,000 feet and topography of this area is moderate to steeply rolling. Land use in the plateau portion of the basin is primarily cultivated agricultural and range land. The Marias River originates along the Continental Divide and drains in a general southeasterly direction until it empties into the left bank of the Missouri River near Loma, Montana. Major tributary streams to the Marias River and drainage areas are listed below in Table No. 1.

TABLE NO. 1

MARIAS RIVER BASIN
TRIBUTARY STREAM DRAINAGE AREAS

	Stream	Drainage Area (Sq.Mi.)
Above Tiber:		
	Cut Bank Creek	1232
	Two Medicine Creek	792
	Birch Creek	524
	Dry Fork, Marias River	350
	Willow Creek	987
Below Tiber:		
	Pondera Creek	640
	Cottonwood Creek	460
	Teton Creek	2061

Stream slopes vary from about 50 feet per mile in the mountainous portion of the basin to about four (4) feet per mile in the plateau portion of the area. Basin maps are presented on Plates 1 and 2 with Plate 1 showing the Marias River basin and Plate 2 showing both the Marias basin and the Missouri River basin above Fort Peck Reservoir. A stream profile along the Marias River is shown on Plate 3.

2-02. POPULATION. The major towns in the basin are Browning, Conrad, Cut Bank, and Shelby, with 1980 census populations of 1226, 3074, 3688 and 3142, respectively. Also located in the basin is the southeastern portion of Glacier National Park. The city of Great Falls, Montana, with a population of 56,725 (1980 estimate) is located just outside the basin.

2-03. CLIMATE. Climate of the basin is semiarid with cold winters and hot summers. Average annual precipitation over the plateau portion of the basin varies from 11 to 15 inches and from 20 to 40 inches over the mountain portion of the area. Most of the precipitation in the mountains occurs in the form of snow with an average annual snowfall as high as 90 inches. Average annual snowfall in the plains is about 20 inches. Plains snow cover usually melts in March and April and mountain snow cover in May and June. The average frost-free period in the plateau area is 120 days. Temperatures have ranged from 59 degrees below zero to 110 degrees above zero Fahrenheit. Some of the coldest temperatures in the Continental United States have been recorded at Shelby, Cut Bank, Chester and Browning.

2-04. STREAMFLOW. A typical annual hydrograph on the Marias River shows low flows during the winter months with an increase in March and April resulting from snowmelt runoff over the plateau area. Another increase is generally experienced during May and June as a result of runoff from the mountain snowpack, which is often augmented by rainfall runoff. Low flows are normally the case during the late summer and autumn months. The maximum peak discharge for the year is generally experienced during the May-June period. Ice jams during the March-April runoff period can also create localized flooding in the basin. Average flow and peak discharge data at selected stream gaging stations in the basin are presented in Table No. 2. Data for two Missouri River gaging stations are also shown on the Table. The Fort Benton Station is located on the Missouri River about 12 miles upstream from the mouth of the Marias and the Virgelle station is located about ten (10) miles downstream from the mouth of the Marias.

TABLE NO. 2

PERTINENT STREAM GAGING STATIONS
(RECORD THROUGH 1984)

Stream Gaging Sta. and Loc.	Drainage Area (Sq.Mi.)	Record (Yrs.)	Discharge Average (c.f.s.)	Discharge Peak (c.f.s.)	Date of Peak
Two Medicine River Below South Fork near Browning, MT	250	7	309	4,900(1)	20 May 1980
Badger Creek Below Four Horn Canal near Browning, MT	152	35	224	49,700	8 June 1964
Cut Bank Creek at Cut Bank, MT	1,065	41	190	16,600	9 June 1964
Marias River near Shelby, MT	3,242	76	933	241,000(2)	9 June 1964
Marias River near Chester, MT (3)	4,927	31	(4)867	10,400	16 June 1964
Marias River at Brinkman, MT (3) (Disc. 1956)	6,425	24	885	70,000(5)	June 1908
Teton River near Dutton, MT	1,307	30	157	71,300	9 June 1964
Missouri River at Fort Benton, MT	24,749	94	7,848	140,000	6 June 1908
Missouri River at Virgelle, MT (3)	34,379	49	8,741	122,000	5 June 1953

(1) Maximum discharge of 100,000 c.f.s. on 8 June 1964 estimated on Two Medicine River at location 10 miles downstream from gaging station (caused by dam failure).

(2) Caused by failure of 2 dams (see paragraph 2-10d).

(3) Flow regulated by Tiber Reservoir since 10 November 1955.

(4) Lower average discharge accounted for by reservoir evaporation.

(5) Estimated from high water marks.

2-05. TRAVEL TIMES. Available data along the Marias River indicate travel times for near bankfull discharges as follows:

Cutbank Creek at Cutbank gaging station to Tiber Reservoir	-	10-12 hours
Confluence of Cutbank Creek and Two Medicine River to Tiber Reservoir	-	8-10 hours
Shelby gaging station to Tiber Reservoir	-	4-6 hours
Tiber Dam to Mouth of Marias River	-	12-15 hours
to Fort Peck Reservoir	-	2 days

2-06. CHANNEL CAPACITY. Channel capacity of the Marias River downstream from Tiber Dam to the confluence with the Teton River is 10,000 c.f.s., and from the mouth of the Teton to the mouth of the Marias, 15,000 c.f.s. A flow of 10,000 c.f.s., would give a stage of 10.4 feet on the Chester gage. Channel capacity of the Missouri River at the Virgelle, Montana gaging station is 73,000 c.f.s. at a river stage of 17.0 feet.

2-07. STAGE-DISCHARGE RELATIONSHIP. Open water rating tables are tabulated for selected stream gaging stations on Plate 4. These relationships may shift from time to time and are kept current with discharge measurements made by the Geological Survey. The larger shifts from the open water relationships will occur during ice-affected periods.

2-08. DISCHARGE-DAMAGE RELATIONSHIP. Discharge damage curves for the Marias River from Tiber Dam to the mouth and for the Missouri River from the mouth of the Marias to Fort Peck Reservoir are shown on Plate 5.

2-09. RELATIONSHIP OF TIBER INFLOW TO FORT PECK INFLOW. The average annual inflow of the Missouri River into Fort Peck Reservoir is 6,160,000 acre-feet. The average annual inflow of the Marias River into Tiber Reservoir is about 677,000 acre-feet. There is a good correlation between seasonal inflow into Fort Peck with similar seasonal inflow into Tiber. This relationship is demonstrated on Plate 6 where April-July runoff into Tiber Reservoir is compared to April-July runoff into Fort Peck. The existence of this relationship permits using a portion of Tiber Reservoir storage to assist in flood control along the Missouri River main stem. This is accomplished by holding runoff in Tiber Reservoir during high runoff years, thus keeping it from flowing into Fort Peck. A discussion of operating Tiber storage space in this manner is presented in paragraphs 4-13 to 4-15.

2-10. FLOOD HISTORY. As previously discussed, flooding in the Marias basin can occur during the plains snowmelt and ice-breakup period or during the mountain snowmelt period. The plains snowmelt generally occurs during March and/or April and is frequently accompanied by ice jam conditions that can create severe localized flooding. The mountain snowmelt runoff generally occurs during May and June and floods experienced during this period are generally caused by rainfall runoff augmenting the snowmelt flows. A description of some of the more notable flood events that have occurred on the Marias River is presented in the following paragraphs.

a. Flood of June 1908. Not much information is available concerning this flood. Narrative data indicate, however, that it ranks among the larger floods that have occurred in the basin. The high flows resulted from rainfall runoff augmenting the mountain snowmelt runoff. Information available at the Shelby gaging station indicates that this flood was comparable in magnitude to the June 1948 flood which had a peak discharge of 40,000 c.f.s. At the gaging station located near Brinkman, Montana, the peak discharge estimated from high water marks was about 70,000 c.f.s.

b. Flood of March 1947. The March 1947 flood is an example of floods resulting from a combination of plains snowmelt and ice jam conditions. Snow averaging about 12 inches in depth fell over the Marias basin during the first week of March. High temperatures during the middle of March resulted in rapid melting and high runoff. Ice in the river, which averaged 18 to 24 inches in thickness, broke up and resulted in numerous jams. Two homes were flooded in Loma, fences and irrigation works were damaged, and a bridge south of Chester was destroyed. Total flood damage in the basin was estimated at $122,680, of which $36,000 occurred downstream from Tiber damsite. It was estimated that $69,620 of damage occurred along the Missouri River from the mouth of the Marias to Fort Peck Reservoir. Peak discharge estimates for this event are not available due to the ice-affected conditions.

c. Flood of June 1948. A period of light continuous rainfall occurring over the entire Marias basin during the first fifteen days of June saturated the topsoil and raised water table levels high enough to cause normally dry creeks and springs to flow. The saturated topsoil resulted in unusually high runoff from storms of cloudburst intensity which occurred over the headwater area during the period from 15 to 17 June. Available peak discharge estimates along the Marias River were 40,000 c.f.s. on 18 June at the Shelby gaging station and 50,700 c.f.s. on 19 June at the Brinkman station. Damage to county roads, bridges, Federal highways, irrigation facilities, railroads and farm property was extensive. Minor damage was caused in the towns of Choteau, Conrad, Ledger, Shelby, and Loma. Damages in the Marias

basin totaled $1,446,000, of which $150,000 occurred below Tiber Dam site.

d. Flood of June 1964. The June 1964 flood is the largest in the Marias basin above Tiber Dam. On June 7 a front developed along the Continental Divide and resulted in a rainstorm that produced up to 15 inches of rain in a 24-hour period over some areas. Flooding was extensive on the Marias River upstream from Tiber Reservoir and was compounded by the failure of two private irrigation dams on June 8. Failure of Swift Dam on Birch Creek resulted in a release of over 30,000 acre-feet of stored water and failure of Lower Two Medicine Dam on Two Medicine Creek added over 20,000 acre-feet of stored water to the flood. In addition, two small stock water dams located north of Shelby failed on June 11, releasing approximately 35 acre-feet of water and causing moderate flooding in the city of Shelby. The estimated peak discharge at the Shelby gaging station was 241,000 c.f.s. on 9 June and average inflow into Tiber Dam for a 2.62-hour period was 153,000 c.f.s. During the high inflow period, Tiber releases were held to 1,200 c.f.s. and were gradually increased to a maximum of 10,300 c.f.s. during the reservoir drawdown period. The reservoir reached a maximum level of 3001.9 feet, m.s.l. on 13 June. Damages prevented downstream from Tiber Dam along the Marias River and the main stem of the Missouri River to Fort Peck Reservoir were estimated at $600,000.

e. Flood of June 1975. On 16 June rainfall up to 14 inches near the Continental Divide produced heavy runoff in the Marias River basin upstream from Tiber Dam. The peak discharge recorded at the Shelby gaging station for this flood was 75,700 c.f.s. occurring on 20 June. Peak hourly inflow into Tiber Reservoir was computed at 67,900 c.f.s. and the reservoir reached a maximum level of 2993.9 feet, m.s.l. on 29 June with 984,270 acre-feet of storage. The maximum release with all gates open was 5,777 c.f.s. during the June 25-July 11 reservoir drawdown period. It was estimated that local flood damages along the Mairas River were reduced by $54,000 as a result of the reservoir operation. Total local and replacement storage benefits were estimated to be $20,105,000.

2-11. DESIGN FLOODS. Two design floods were developed for Tiber Dam, a Standard Project Flood and a Spillway Design Flood. The Standard Project Flood has a peak discharge of 65,500 c.f.s. and a 10-day volume of 460,000 acre-feet. The Spillway Design Flood has a peak discharge of 168,500 c.f.s. and a 15-day volume of 770,000 acre-feet. Additional details on these two floods are given in Section X.

SECTION III - WATER RESOURCES DEVELOPMENT

3-01. RESERVOIR DEVELOPMENT. Four reservoirs are located in the Marias River Basin upstream from Tiber Dam, all of which are operated primarily for irrigation. The total usable storage capacity in the four reservoirs is 173,110 acre-feet. Two of the storage sites, Lake Francis and Four Horns, are off-stream reservoirs. Lake Francis has a usable capacity of 112,000 acre-feet and receives its water supply from Birch Creek diversions. Four Horns has a usable capacity of 19,250 acre-feet which is diverted from Badger Creek. The other two reservoirs, Swift and Lower Two Medicine Lake, are on-stream storage sites. Swift Reservoir, with a usable capacity of 29,980 acre-feet, is located on Birch Creek and Lower Two Medicine Lake, with a usable capacity of 11,880 acre-feet, is located on Two Medicine Creek. The operation of all four reservoirs is based on filling the available storage during the spring and early summer runoff periods and releasing the stored water during the summer months to meet irrigation demands. The effect of this operation on Tiber Reservoir is to reduce inflow volume to the reservoir during the spring and to increase inflow volume during the summer as a result of irrigation return flow. The effect of the reservoirs on major floods is minimal since they are generally full during the May-June flood period. However, in the June 1964 flood both Swift and Two Medicine Dams failed, resulting in substantial increases in peak flows along the Marias River above Tiber Dam (see paragraph 2-10d). Both structures have been rebuilt and the storage values presented above are for the rebuilt structures. The major reservoir development in the basin is Tiber Dam.

3-02. IRRIGATION AND WATER SUPPLY FROM TIBER DAM. Tiber Dam was built to serve 127,000 acres in the Lower Marias Irrigation Unit. However, the irrigation distribution works have not been built since they are not considered to be economically feasible. Irrigation water for approximately 3300 acres is provided from Tiber Reservoir to several individual operations under terms of water service contracts with the Bureau of Reclamation. In addition, the Bureau has a contract with the Tiber County Water District to supply 1540 acre-feet of water annually over a 40 year period. Contracts have also been signed to provide 500 acre-feet annually to the City of Chester, Montana, and 70 acre-feet annually to Devon Water, Inc.

3-03. FLOOD CONTROL. Other than Tiber Dam, flood control projects in the basin consist of local government and private improvements. Development in the basin that is vulnerable to damage from flooding include irrigation works, agricultural improvements and transportation facilities.

3-04. POWER. Hydroelectric power has not been one of the major factors in connection with development of the water resources in the Marias basin. Under the Federal Power Act of 1976, three applications have been received by the Federal Energy Regulatory Commission for permission to study the feasibility of a small hydropower project at Tiber Dam. The applicants are; the City of Gillette, Wyoming, the Malta, Montana Irrigation District and the Montana Department of Renewable Resources.

3-05. RECREATION. Fishing, boating, camping and other associated water sports have developed around Tiber Reservoir and several recreation sites are located around the lake. Fishing has improved in the lake since impoundment due to regulation of lake levels during spawning. In addition, release patterns have been varied for the purpose of enhancing fish and wildlife habitat downstream from the dam.

3-06. WATER RIGHTS. On 29 August 1952, the Bureau of Reclamation appropriated 2,200 c.f.s. of Marias River water to fill Lake Elwell to a capacity of 1,337,000 acre-feet, together with all unappropriated natural flow not storable in the reservoir, for use on the irrigated lands of the Lower Marias Unit. Use of this water has not, however, been developed.

SECTION IV - PROJECT HISTORY AND DESCRIPTION

4-01. HISTORY OF TIBER PROJECT.

a. The history of Tiber project is given in "308 Report" on the Marias as follows:

> "The project was first investigated in 1902 by the reclamation branch of the United States Geological Survey. In 1904 investigations were carried on by the United States Bureau of Reclamation to determine storage possibilities on the Marias River. It is said that the work was performed in connection with a proposal to divert St. Mary River water into the Marias drainage, thence into the Milk River, for the Milk River project; and that the investigation disclosed that a separate project was probably feasible, using Marias River water alone, leaving St. Mary's water to be diverted directly into Milk River, as was later done.
>
> The Sixth Annual Report of the Bureau of Reclamation gives considerable information on the proposed development. It has also been the subject of a report in 1914 by D. C. Henny, consulting engineer, to Ralph Budd, assistant to the president of the Great Northern Railway, and in 1919 a report was made by W. B. Saunders, consulting engineer, Helena, Montana, to W. T. Cowan, president of the Marias River Development Association. None of these reports go into the details of the project."

b. Studies for a reservoir located near the present site were made by the Corps of Engineers for the "308 Report" on the Marias, published in 1932 as House Document 191, 72d Congress, 1st Session, but at that time construction of a reservoir did not appear feasible.

c. Construction of the Tiber Dam was recommended in a report prepared by the Bureau of Reclamation and published in April 1944 as Senate Document 191, 78th Congress, 2d Session. The project, as described in the report, had a proposed reservoir capacity of 915,000 acre-feet, of which all except the 340,000 acre-feet designated for irrigation would be inactive storage. The project was authorized by the 1944 Flood Control Act.

d. The comprehensive plan for development of the Missouri River Basin contemplates a system of both main stem and tributary reservoirs to affect the control of floods as well as providing other substantial benefits. In 1948 the Corps of Engineers made planning studies to integrate the flood control functions of Tiber Reservoir with the main stem reservoir system. In view of the large volume of low cost storage available in Tiber Reservoir, it became apparent that

400,000 acre-feet of storage capacity could be used justifiably to supplement the flood control storage space provided in the main stem projects. Therefore, this space was provided in Tiber Reservoir as a portion of the joint plan of the Corps of Engineers and the Bureau of Reclamation for effective integration of the programming of both agencies,having the objectives of overall economy and the maximum practical development of the basin water resources. At the same time this storage will provide a high degree of local flood protection to the lower Marias River.

e. Construction of the Tiber Dam was initiated by the Bureau of Reclamation in 1952 and completed in 1955. Impoundment of water started in 1955 and by 1 November 1956 there were 650,000 acre-feet of water in storage.

4-02. PROJECT MODIFICATIONS. Modifications to the Tiber structure became necessary in 1965 because of excessive settlement of the spillway and the need to meet revised dam safety requirements. During the period from 1967 to 1970 the spillway structure was diked off and the canal outlet structures located in the left abutment of the dam were modified and incorporated into a new auxiliary outlet works structure. During the period from 1976 to 1979 the spillway structure was completely replaced, except for the downstream portion of the chute and the stilling basin. Rehabilitation of the project was completed during the years from 1979 to 1981 when both the dam embankment and the dike were raised five (5) feet.

4-03. PROJECT DESCRIPTION - GENERAL. Tiber Dam is located on the Marias River about 71 miles upstream from its confluence with the Missouri River (see Plate 1). The area intended to be irrigated from the project consisted of a large compact body of land lying north and east of the Marias River plus bottom lands lying along Big Sandy Creek, a tributary of the Milk River. Flood control benefits include those along the Marias River from the dam to its mouth and along the Missouri River between the mouth of the Marias and Fort Peck Reservoir. In addition, flood control benefits are also realized from supplemental-replacement storage to the Missouri River main stem system. The irrigation projects have never been developed so existing storage allocations for the project include more flood control than was originally planned. In addition to these primary functions, there are substantial benefits to recreation and fish and wildlife.

4-04. EMBANKMENT. The embankment for Tiber Dam is divided into two sections. The main dam section is 4,300 feet long, has a structural height of 211 feet and a crest width of 30 feet. The dike section of the embankment begins about one mile from the right abutment of the dam and is 16,650 feet long with a crest width of 20 feet and a maximum height of 65 feet. Location of the dam and dike is shown on Plate 7.

Both embankments consist of an impervious core with upstream and downstream shells of sand, gravel and cobbles. Riprap is provided where required. Crest elevation of the dam and dike, as modified during rehabilitation of the spillway and embankment, is 3026.0 feet, m.s.l. This is five feet higher than the original embankment height. The plan and sections for the dam showing both the original and revised plans is shown on Plate 8. The same information for the dike is shown on Plate 9.

4-05. OUTLET WORKS. Three separate gated structures are provided for releasing water from Tiber Reservoir; the river outlet, the auxiliary outlet and the spillway structure. Location of the outlets is shown on Plate 10 and pertinent features are discussed below.

a. River Outlet. This outlet is located in the right abutment of the dam. It consists of a 72-inch diameter steel pipe approximately 1190 feet long which is used to convey water from the reservoir to the control house at the downstream side of the dam. The pipe is installed in a 14-foot diameter concrete lined outlet tunnel. Two 5'x5' high-pressure hydraulically operated slide gates are provided for the 72-inch pipe, one at the upstream end of the pipe and one in the control house on the downstream side of the dam. The control house gate is used for regulation of discharges from the dam. The upstream gate is fully open when releases from the reservoir are being made and is closed on those occasions when it is desired to shut off the outlet pipe from the reservoir. The minimum pool elevation for discharge through the river outlet is 2870 feet, m.s.l., which is the top of the dead storage pool. Maximum discharge capacity of the river outlet works is 1,540 c.f.s. at elevation 3020.2 feet, m.s.l. (design maximum water surface). The plan and sections for the river outlet works are shown on Plate 11 and rating curves for various gate openings are shown on Plate 12. In addition to the above described outlet, a 22-inch diameter steel pipe and 24-inch gate valve were constructed inside the 14-foot outlet tunnel during construction work on the auxiliary outlet. The pipe was used during the construction period as a bypass tube. After conpletion of construction on the auxiliary outlet works, the 22-inch pipe was blocked and is no longer being used. The design details for the pipe are shown on Plate 11.

b. Auxiliary Outlet Works. Construction of the auxiliary outlet was completed in 1970. This outlet was designed and constructed after the spillway was determined to be unusable in 1965. The outlet provided for higher project releases and the maintenance of a conservation pool while the project was being modified. The general plan and sections of the outlet are shown on Plate 13. It is located in the left abutment of the dam and is a modification of the original canal outlet that was provided for releasing flows from the

reservoir into a proposed irrigation canal. Construction of the irrigation canal was never accomplished. (See paragraph 4-03.) Flows through the auxiliary outlet are regulated by a 7.25'x9.25' slide gate. The limiting elevation for discharge through this outlet is 2962.0 feet, m.s.l., and the maximum capacity is 4,250 c.f.s. at elevation 3020.2 feet, m.s.l. (design maximum water surface). Rating curves for the auxiliary outlet for various gate openings are shown on Plate 14.

c. Spillway. The complete spillway structure, except for the downstream portion of the chute and the entire stilling basin, was replaced during the period from 1976 to 1979. The general plan and sections for the structure are shown on Plate 15. It is located at the right abutment of the dam and consists of an inlet channel, an inlet structure varying in width from 132 to 76 feet and a 66-foot long gated overflow crest at elevation 2975.0 feet, m.s.l. Regulation is provided by three 22'x38' radial gates, a triple conduit section consisting of three 22'x22' bays, a chute varying in width from 76 to 200 feet and a 200-foot wide stilling basin. The radial gates are operated by hoists and cables with access provided by means of a hoist bridge. A control house located on the left side of the spillway gate structure houses an auxiliary power system for emergency operation of the gates during power outages. Rating curves for the spillway at various gate openings are shown on Plate 16. Discharge capacity of the spillway outlet is 67,500 c.f.s. at elevation 3020.2 feet, m.s.l. (design maximum water surface).

4-06 RESERVOIR. The reservoir formed by Tiber Dam is named Lake Elwell. Water surface area of the lake at the top of flood control pool elevation of 3012.5 feet, m.s.l. is 23,152 acres. The lake has a maximum width of three miles and extends upstream for 25 miles along the Marias River and for eight miles along Willow Creek, a tributary entering the lake from the north. Area-capacity tables for Lake Elwell are shown on Plate 17. Allocation of the reservoir storage space is shown in Table No. 3 below.

TABLE NO. 3

LAKE ELWELL STORAGE ALLOCATIONS

Reservoir Use	Elevation Limits (feet, m.s.l.)	Capacity (acre-feet)
Dead Storage	2823.5 - 2870.0	21,582
Inactive Storage	2870.0 - 2966.4	556,043
Active Conservation Storage	2966.4 - 2976.0	121,700
Joint-Use Storage	2976.0 - 2993.0	267,994
Replacement and Local Flood Control Storage	2993.0 - 3008.1	301,484
Exclusive Local Flood Control Storage	3008.1 - 3012.5	99,354
Surcharge Storage	3012.5 - 3020.2	187,741
Total (with surcharge storage)		1,555,898
Total (without surcharge storage)		1,368,157

These allocations are illustrated on page IV-9.

4-07. RELOCATIONS. The Bureau of Reclamation executed a contract with Toole County, Montana, for the relocation of a county road that was inundated by the reservoir. In addition, an easement for a gas pipeline across the reservoir was granted to the Montana Power Company. No other significant relocations were required as a result of the Tiber Dam construction.

4-08. IRRIGATION. As discussed in paragraph 4-01, irrigation was intended to be a major purpose of the Tiber project. The reservoir was originally designed for an irrigation storage allocation of 362,000 acre-feet between elevations 2967.0 and 2992.3. Because the irrigation projects did not develop, the irrigation allocation was reduced for an interim period to 72,000 acre-feet and the remaining 290,000 acre-feet was allocated to flood control. The total flood control allocation during this interim period totaled 690,000 acre feet between elevations 2973.0 and 3012.5 feet, m.s.l. It was composed of the 290,000 acre-feet of reduced irrigation allocation and the original ultimate flood control allocation of 400,000 acre-feet. Currently, the irrigation storage has been reallocated to conservation and flood control uses as shown in Table No. 3. There are only about 3300 acres of land presently being provided with irrigation water. In addition, 2110 acre-feet of water is being provided from this storage zone to the Tiber County Water District and the towns of Chester and Galata, Montana.

4-09. SEDIMENTATION. The Bureau of Reclamation has estimated an average annual sediment deposition in Tiber Reservoir of 470 acre-feet.

4-10. RECREATION. There are no agreements for specific reservoir operations to accommodate recreation use near or on the reservoir. The reservoir lands are managed for recreation by Bureau of Reclamation personnel headquartered at the Tiber Government Camp. Planning for further development of recreation facilities is continuing as funding becomes available.

4-11. FISH AND WILDLIFE. There are no specific requirements for maintenance of reservoir levels for a fishery or for wildlife habitat. The reservoir lands are managed by Bureau of Reclamation personnel for recreation and fish and wildlife purposes according to adaptability, public demand and public use. The fishery in Lake Elwell and in the Marias River below the dam is being developed to enhance recreation opportunities in this area. All hunting and fishing is governed by Montana fish and game laws and regulation.

4-12. POWER. Power was not included as a function in the planning and construction of Tiber Dam. However, under the current non-federal power development program, the construction of a power plant at Tiber seems likely at some future date. Three organizations have applied for a permit to study the feasibility of a small hydropower project at Tiber Dam. The Federal Energy Regulatory Commission is currently considering the advisability of issuing a license to one of these groups.

4-13. REPLACEMENT STORAGE - HISTORY. The Missouri River Main Stem Reservoir System is located downstream from Tiber Dam. This system was designed in the 1940's and construction was essentially completed by the mid-1960's. It is a multi-purpose system that is regulated to provide flood control, hydropower generation, navigation, irrigation, recreation, fish and wildlife needs, water supply and water quality. The flood control storage space provided in the system was developed on the basis that no upstream storage space existed although it was recognized that, as upstream space became operational, a re-evaluation of the main stem system space requirements would be necessary. Continuing analysis of inflows into the main stem system and into tributary reservoirs constructed upstream from the system has indicated that in certain instances, particularly when inflows are distinctly seasonal in nature, storage space provided in upstream reservoirs could effectively replace a portion of the annual flood control and multiple-use space initially provided in the main stem system. Effective operation requires a coordinated regulation of the upstream tributary storage space with the space in the main stem system, which results in the most efficient overall utilization of the basin water resources. Such space provided in upstream reservoirs has been designated as "replacement flood control storage space".

4-14. REPLACEMENT STORAGE-TIBER RESERVOIR. In addition to regulating the flood control storage space provided in Tiber Reservoir for local flood control purposes, it has been determined that replacement type regulation is also feasible. The relatively good relationship between flood season flows into Tiber Reservoir and corresponding inflows into Fort Peck was discussed in paragraph 2-09. With the maintenance of minimum release requirements, there is an opportunity to store a significant amount of water in Tiber Reservoir in those years when above-normal runoff may fully utilize or exceed the flood control capabilities of the main stem system. The flood control storage reservation diagram attached to the Water Control Agreement (Exhibit I) provides for storage drawdown to elevation 2982.0 feet, m.s.l., by 1 December each year with additional drawdown to elevation 2976.0 feet, m.s.l., by the following March 1. The reservoir zone between elevation 2976.0 and 3008.1 feet, m.s.l. (569,478 acre-feet) is therefore available, if needed, for replacement storage. In those years when it is anticipated that the major portion of flood control and multiple-use storage space in Fort Peck Reservoir will be utilized, releases from Tiber will be reduced to a minimum of 300 c.f.s. to insure filling of the replacement storage in Tiber by 15 July. If adequate water supply is available, releases from Tiber Dam will be maintained to provide the desired flows for fish and wildlife as discussed in paragraph 8-02. In addition to replacement storage in Tiber Reservoir, there are 76,674 acre-feet of storage in Clark Canyon Reservoir and 449,335 acre-feet in Canyon Ferry Reservoir that has been allocated for this purpose. Location of these reservoirs is shown on Plate 2.

4-15. JOINT-USE STORAGE-TIBER RESERVOIR. As shown in Table No. 3, the joint-use storage space in Tiber Reservoir extends from elevation 2976.0 to 2993.0 feet, m.s.l. (storage 267,994 acre-feet). In anticipated high runoff years into Fort Peck this space is used for replacement storage as well as for conservation purposes (see paragraph 4-14). In anticipated low runoff years into Fort Peck this space will be filled and used for conservation purposes. Inflow into the reservoir not required for filling this space will be released so that utilization of this water can be made at Fort Peck Reservoir to benefit Fort Peck hydropower production.

4-16. OPERATIONAL HISTORY. Impoundment of water began in Tiber Reservoir in late 1955. Monthly reservoir inflows, outflows and storage from 1956 through 1985 are shown on Plates 18A to 18C.

4-17. WATER CONTROL AGREEMENT. An Interim Water Control Agreement for regulation of Tiber Reservoir flood control space was signed by the Garrison District Engineer, Corps of Engineers and the Regional Director for Region 6 of the Bureau of Reclamation in December 1957. This agreement was

superceded in February 1959 by another interim agreement. In 1960 the flood control storage allocation was revised from 690,000 acre-feet to 400,000 acre-feet. A minor change was made in the agreement in 1964 because of changes in the area-capacity relationships. The 1964 agreement was voided in May 1966 because of the spillway settlement which resulted in storage constraints being imposed on the reservoir. Rehabilitation of the spillway and modifications to the outlet works and dam embankment were accomplished by the Bureau during the period from 1967 to 1981. No agreement was in force during this period. The current Water Control Agreement was signed by the Bureau and the Corps in March 1983. A copy of this agreement is included as Exhibit I of this manual.

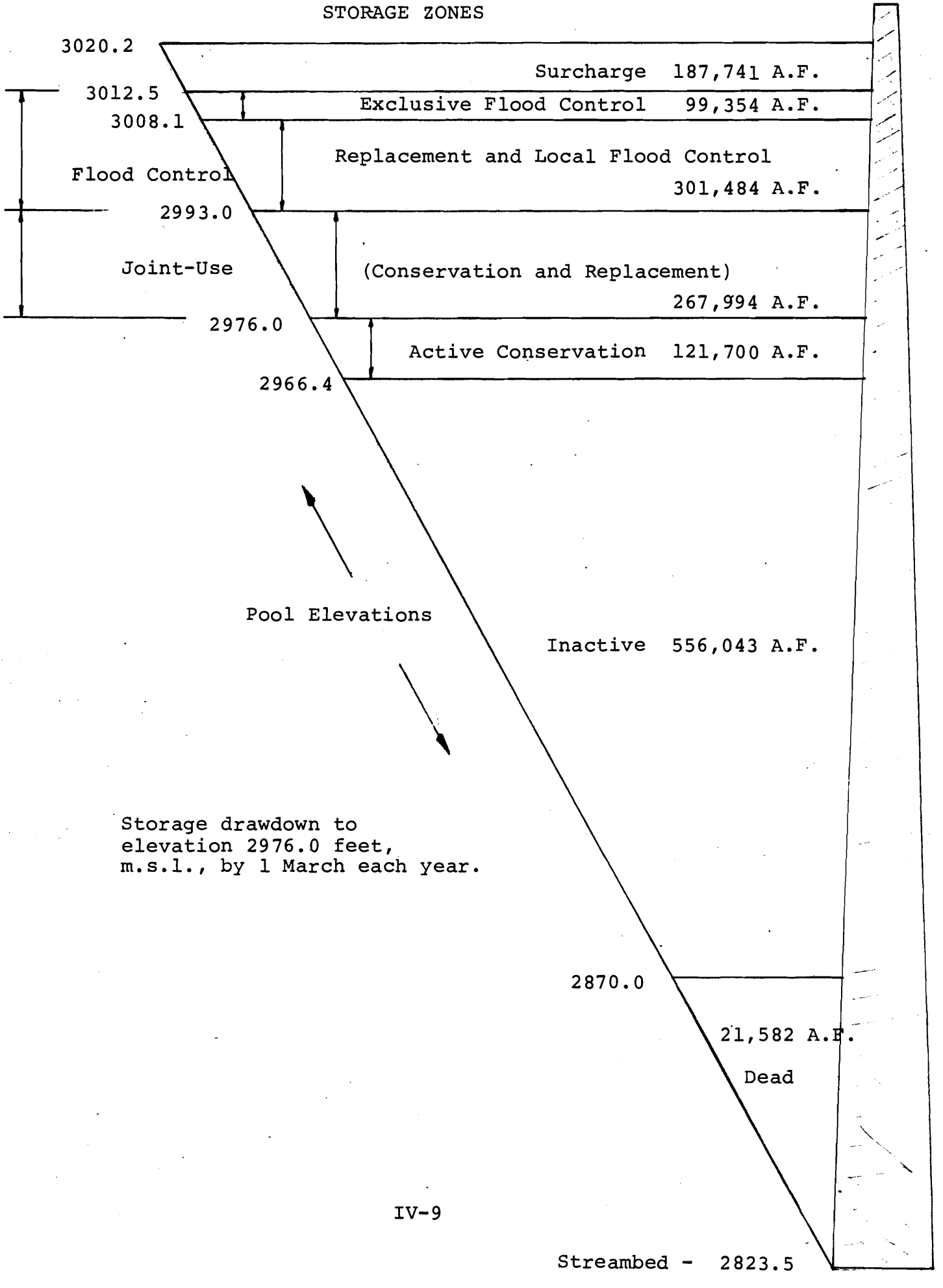
4-18. FLOOD DAMAGE REDUCTION. Operation of Tiber Reservoir through 1986 has prevented $37,238,200 in downstream flood damages. This includes both local damages and those prevented by operation of replacement storage. A tabulation of annual flood control benefits achieved by operation of the reservoir is presented in Table 4.

TABLE 4

TIBER DAM AND RESERVOIR
FLOOD CONTROL BENEFITS

Fiscal Year	Flood Control Benefits	Fiscal Year	Flood Control Benefits
1957	$ 119,000	1974	$ 42,000
1959	$ 142,000	1975	$20,105,000
1962	$ 137,000	1976	$ 234,000
1964	$ 654,000	1978	$ 388,000
1965	$1,188,000	1979	$ 2,000
1966	$ 174,000	1980	$ 68,000
1967	$5,280,000	1981	$ 1,421,000
1968	$ 90,000	1982	$ 307,100
1970	$ 673,000	1983	$ 117,000
1971	$ 5,600	1984	$ 1,756,000
1972	$ 758,600	1985	$ 76,000
1973	$ 67,700	1986	$ 3,433,200
	TOTAL THROUGH FY 1986		$37,238,200

TIBER RESERVOIR
STORAGE ZONES



Storage drawdown to elevation 2976.0 feet, m.s.l., by 1 March each year.

SECTION V - ORGANIZATION FOR RESERVOIR REGULATION

5-01. GENERAL. The organization for regulation of Tiber Dam and Reservoir is based on a division of responsibilities between the Bureau of Reclamation and the Corps of Engineers. In accordance with the Flood Control Act of 1944, the Corps of Engineers is responsible for the regulation of storage allocated to flood control. All other regulating functions for Tiber Dam and Reservoir are the responsibility of the Bureau of Reclamation.

5-02. CORPS OF ENGINEERS ORGANIZATION. Engineering Regulation 1110-2-1400, dated April 1970, assigns Corps of Engineers' reservoir regulation responsibility in the Missouri River Basin to the Missouri River Division Engineer. The regulations permit delegation of certain reservoir regulation functions to the District Engineer in whose area the project is located. The responsiblity for assembly and interpretation of data affecting current reservoir regulation and for carrying out flood control regulation of Tiber Reservoir, according to plans agreed on in advance, has been delegated to the Omaha District Engineer. In those years when replacement storage in Tiber Reservoir is required to assist in flood control regulation of the main stem system, the Division Engineer will provide written authority to the Omaha District regarding the replacement storage needs. In addition, the Division Engineer, through the Missouri River Division Reservoir Control Center, monitors and reviews the overall regulation procedures performed by the Omaha District.

5-03. RESERVOIR REGULATION SECTION. The Reservoir Regulation Section of the Omaha District has been assigned District responsibility for matters pertaining to flood control regulation of tributary reservoirs within the District, including the flood control regulation of Tiber Reservoir. The Section maintains a continuing surveillance of project operations and issues regulation orders to the Bureau for the scheduling of releases from the flood control zone.

5-04. BUREAU OF RECLAMATION ORGANIZATION. The Reservoir Regulation Branch of the Missouri Basin Region Bureau of Reclamation office at Billings, Montana, is responsible for reservoir regulation for all purposes except flood control. A Reservoir Superintendent (Dam Tender) resides at the dam and under normal conditions his instructions are issued from the Regional Director's office. He operates the outlet facilities, collects and reports reservoir and hydrologic data and performs other required operational duties. His instructions for flood control operations are given in Exhibit II.

5-05. COMMUNICATIONS. Telephone facilities are utilized for communication between the Reservoir Superintendent, the USBR Reservoir Regulation Branch of Billings, Montana, and the Omaha District Reservoir Regulation Section. Radio facilities are available between the Reservoir Superintendent and the Bureau offices in Billings.

5-06. REGULATION ORDERS. Except for emergency conditions outlined in Exhibit II, the issuance of regulation orders is the function of the Reservoir Regulation Section of the Omaha District when the pool is in the flood control zone. Regulation orders are normally issued verbally by the Reservoir Regulation Section to the Bureau's Reservoir Regulation Branch of the Missouri Basin Regional office in Billings, Montana. Orders will be confirmed in writing to the Regional Director as soon as possible and a copy furnished to the Reservoir Superintendent and the MRD Reservoir Control Center. The written order will contain a brief statement giving the background and reasons for issuance of the order.

5-07. COORDINATION WITH OTHER AGENCIES. Project operating data and miscellaneous hydrologic information are exchanged as necessary between the Omaha District Reservoir Regulation Section, Bureau of Reclamation Billings office and the Reservoir Superintendent. Cooperation is also maintained with the National Weather Service, U.S. Geological Survey and Soil Conservation Service regarding the collection and reporting of precipitation amounts, snow water content, stream stages and discharges.

SECTION VI - COLLECTION AND DISTRIBUTION OF BASIC HYDROLOGIC DATA

6-01. GENERAL. Various Federal agencies and the State of Montana have established a system of stream and precipitation gages in the State. The U.S. Geological Survey, National Weather Service, Bureau of Reclamation, Soil Conservation Service, Corps of Engineers and the State contribute personnel and/or funds to the support of the system. Meteorological and hydrological data from this system are received by the Reservoir Regulation Section via computer terminals from the National Weather Service and on a National Facsimile Network printer. Additional hydrologic data are obtained by telephone direct from telemetering gages, Satellite Data Collection Platforms (DCP) and local observers.

6-02. STREAM AND PRECIPITATION DATA. Stream and precipitation gaging stations pertinent to the regulation of Tiber Reservoir are listed in Tables 5 and 6. Their locations are shown on Plate 1. The Geological Survey makes periodic streamflow measurements at the river gages and reports them by telephone or mail to the Reservoir Regulation Section. These are used to keep stage-discharge rating curves current. The National Weather Service collects and transmits the precipitation reports and snow depths via computer.

6-03. RESERVOIR DATA. Tiber Reservoir elevations are obtained and recorded by a conventional "Bubbler type" gage and A-35 level recorder. These data are obtained by the Bureau and Corps via satellite using a Data Collection Platform (DCP). The Dam Tender also sends reservoir and rainfall data to Billings on a weekly basis using postcard reports.

6-04. SNOW SURVEYS. Snow survey data are collected in the mountain areas upstream from Tiber on a routine basis during the winter months. The data are published monthly and are utilized in forecasting snowmelt runoff into Tiber Reservoir. The data are also collected on DCP's and made available to the Corps and Bureau offices via a computer terminal. The snow courses measured above Tiber are listed in Table No. 7. Locations of the courses are shown on Plate 1.

TABLE NO. 5

U.S.G.S. STREAM GAGING STATIONS
(Useful to Tiber Reservoir Regulation)

River	Station	Drainage Area - Sq.Mi.	Gage Type
Marias	Near Shelby	3,242	Recorder
Marias	Tiber Reservoir	4,923	*Recorder with DCP
Marias	Near Chester	4,927	Recorder
Teton	Near Dutton	1,307	Recorder
Missouri	At Virgelle	34,379	Recorder

*Recorder gage and DCP (Data Collection Platform) operated by Bureau of Reclamation

TABLE NO. 6

PRECIPITATION STATIONS
NATIONAL WEATHER SERVICE
(Useful to Tiber Reservoir Regulation)

Blackleaf
Brady Aznoc
Browning
Bynum
Chester
Choteau
Conrad
Dupuyer
Dutton
East Glacier
Ethridge
Heart Butte
Joplin
Pendroy
Shelby
Valier

TABLE NO. 7

SNOW SURVEY STATIONS
(Useful to Tiber Reservoir Regulation)

Badger Pass
Blue Lake
Freight Creek
Marias Pass

SECTION VII - FORECASTS AND ANALYSIS PERTINENT TO RESERVOIR REGULATION

7-01. WEATHER FORECASTS. General weather forecasts developed by the National Weather Service consist of daily forecasts of weather conditions for 48 hours ahead furnished every six hours. A 3-day extended outlook (48 to 120 hours) of weather conditions is furnished once daily and a 30-day forecast is furnished on the 1st and 15th day of each month. Weather maps and forecasts, including quantitative precipitation forecasts three times a day, are provided on the National Facsimile Network and are used by the Reservoir Regulation Section in forecasting runoff or flooding conditions.

7-02. RUNOFF FORECASTS - LONG RANGE. The major portion of the annual runoff into Tiber results from mountain snowmelt runoff occurring during the late spring and early summer. Seasonal forecasts of inflow to the reservoir for the April-July period are made each year on January 1 and on a monthly basis thereafter during the January-July period (see Exhibit III). Runoff forecast information for Tiber and other Missouri River tributary reservoirs and for the Missouri River main stem reservoir system is exchanged on a monthly schedule between the Bureau's Reservoir Regulation Branch and the Omaha District Reservoir Regulation Section.

7-03. RUNOFF FORECASTS - SHORT RANGE. Short range streamflow forecasts for the drainage basin above Tiber Dam and for the incremental drainage area between Tiber Dam and the mouth of the Marias River are based on upstream reservoir releases, observed and anticipated precipitation and temperature data, temperature snowmelt relationships, rainfall-runoff relationships and other information that might be available and helpful in estimating runoff distribution and volumes. Unit hydrographs used for short range forecasts are shown on Plate 19.

SECTION VIII - MULTI-PURPOSE REGULATION

8-01. GENERAL. The space in Tiber Reservoir is used for both conservation storage and flood control storage. Regulation of the flood control storage space is discussed in Section IX of this manual. The conservation storage is used to provide municipal water supply, irrigation, recreation and fish and wildlife enhancement.

8-02. CONSERVATION STORAGE REGULATION. Water is currently provided from conservation storage for irrigation of about 3300 acres of land. In addition, municipal water supply is provided to the towns of Chester and Galata. Water is also supplied under terms of a water service contract to Tiber County Water District for municipal, industrial, rural-domestic and livestock use. The lake is also used extensively for fishing, boating and other water-based recreation. The objective of the conservation operation in Lake Elwell is to lower the pool level to 2976.0 feet, m.s.l., by 1 March of each year and then to fill the lake to elevation 2993.0 feet, m.s.l. by the end of June. To enhance the river fishery, the following minimum releases to the Marias River will be maintained whenever adequate water supply is available.

Oct. 16 - Mar. 15	317 c.f.s.
Mar. 16 - May 18	500 c.f.s.
May 19 - July 5	1144 c.f.s.
July 6 - Oct. 15	500 c.f.s.

In many years the water supply is not sufficient to provide these flows. Releases during the fall and winter will often be reduced to 250 c.f.s. and, during critically water short years, releases may be reduced to as low as 100 c.f.s. Releases during the spring and summer may also drop below desired levels. The maximum desired winter release is 600 c.f.s. and, if possible, releases are held steady during the goose nesting season of 1 April to 15 May. In those years when replacement storage has been requested in Tiber Reservoir, a minimum release rate of 300 c.f.s. will be maintained from 1 March to 15 July, as indicated in the Water Control Agreement (Exhibit I).

8-03. ANNUAL OPERATING PLAN. Each year the Bureau of Reclamation publishes a report of reservoir operations during the preceding water year, together with their planned operation of Bureau reservoirs during the coming year. The operation of Tiber Reservoir is included in this report. The report is prepared by the Bureau of Reclamation Upper Missouri Region Reservoir Regulation Branch by 30 September each year. A copy of this report is provided to the Omaha District.

8-04. DROUGHT PERIOD RELEASES. Any request for release of water during drought periods is referred to the Bureau of Reclamation Reservoir Regulation Branch in Billings.

SECTION IX - FLOOD CONTROL REGULATION

9-01. OBJECTIVES. Tiber Dam and Reservoir will be regulated to minimize flood damage along the Marias River and on the Missouri River from the mouth of the Marias to Fort Peck Reservoir. In addition, supplemental flood control storage to the Missouri River main stem system will also be provided. Rules and regulations for operation of flood control storage space as published in the Federal Register, Volume 43, No. 199, dated 13 October 1978, are presented in Exhibit IV.

9-02. METHOD OF FLOOD CONTROL REGULATION. In general, the developed method for flood control regulation of Tiber Reservoir may be classified as Method C defined in EM 1110-2-3600. This represents a combination of the concept of reducing downstream damaging stages as much as possible during each flood with the currently available storage space, giving consideration to control of floods of project design magnitude.

9-03. REGULATION PLAN. The regulation plan for the flood control objectives, as developed in the Water Control Agreement and Flood Control Storage Reservation Diagram shown in Exhibit I, is as follows:

a. Local Flood Control. Project releases will be made in conjunction with incremental reach inflows below the dam to minimize damaging discharges on the Marias and Missouri Rivers from the dam downstream to Fort Peck Lake. Zero damage discharges are given below in paragraph 9-03d. When the Marias River is frozen or partly frozen over below the dam, releases will be limited to no greater than 1,000 c.f.s.

b. Replacement Flood Control. In years when utilization of a major portion of the flood and multiple-use storage zones within the downstream Fort Peck Lake is anticipated, Lake Elwell will assist in flood control along the Missouri River downstream of Fort Peck Lake by storing inflows to withhold flood water from Fort Peck Lake. To achieve this objective, release rates at Tiber Dam will be adjusted beginning 1 March, based on anticipated inflow, in order to assure filling the flood control storage zone to elevation 3008.1 feet, m.s.l. by 15 July, consistent with other operations. Minimum releases of 300 c.f.s. can be made to achieve this fill by 15 July. Evacuation of this zone will be accomplished each year to elevation 2982.0 feet, m.s.l. by 1 December, with total drawdown to elevation 2976.0 feet, m.s.l. by 1 March. In the years when storage in Fort Peck Lake is low, no storage will be filled in Lake Elwell above elevation 2993.0 feet, m.s.l. unless required for local flood control. In the years of low inflow into Fort Peck the storage of water in Lake Elwell will be minimized to augment the level of Fort Peck Lake to benefit Fort Peck hydropower production.

c. Joint-Use Storage. This space (267,994 acre-feet between elevations 2976.0 and 2993.0 feet, m.s.l.) will normally be used for conservation purposes, except when required for flood control and/or replacement purposes as indicated by the Flood Control Storage Reservation Diagram.

d. Exclusive Flood Control - Tiber Reservoir. The reservoir space between elevations 3008.1 and 3012.5 (storage 99,354 acre-feet) has been allocated to exclusive local flood control. This space is to be used for the control of runoff events that may develop suddenly, such as from heavy rainfall over the area above Tiber. Releases will be restricted to a level where, in combination with downstream uncontrolled inflow, damaging discharges will be minimized in the reach from the dam to Fort Peck Reservoir. To achieve this control the damage stages and/or discharges at downstream locations are currently estimated as follows:

Marias River near Chester	10.4 feet -	10,000 c.f.s.
Marias River near Loma		15,000 c.f.s.
Missouri River at Virgelle	17.0 feet -	73,000 c.f.s.

9-04. REGULATION FOR FLOODS EXCEEDING PROJECT SIZE. When it becomes apparent that the reservoir elevation will exceed the top of flood control pool (elevation 3012.5 feet, m.s.l.), the Regional Director of the Bureau of Reclamation will be notified. Operation of the reservoir is the responsibility of the Bureau when the reservoir level is in the surcharge pool. A total of 7.7 feet of surcharge storage with a capacity of 187,700 acre-feet has been provided above the flood control pool. When the pool level is in this zone the District Engineer may make recommendations to the Regional Director for regulation in the interest of flood control, but such recommendations shall not be considered mandatory.

9-05. REGULATION CURVES. The regulation schedule or rule curve on Plate 20 was developed from procedures described in paragraph 4-05 of EM 1110-2-3600, primarily for use as a guide by reservoir regulation personnel during high inflow periods. This regulation schedule is based on a 7-day recession which is representative of a rainfall recession and the Standard Project Flood recession. The curves give the minimum release necessary to assure effective use of the flood control storage by (1) filling the flood control storage space, and (2) maintaining the flood release at a maximum of 10,000 c.f.s. for the longest period possible. Inflows will be computed daily except when inflow is above 40,000 c.f.s. or when the reservoir is above elevation 3008.1 ft., m.s.l., then they will be computed at least twice daily. Inflows will be computed for at least a 12 hour period. Use of the regulation curves are flexible, however, and larger or smaller releases may be prudent based on hydrologic conditions at the time.

9-06. EMERGENCY FLOOD CONTROL REGULATION. Refer to Exhibit II, Section C for emergency flood control regulation.

9-07. RESERVOIR DRAWDOWN GUIDELINES. The objective of evacuating the flood control storage zone under normal operating conditions is to adjust releases to maintain non-damaging flows on the river below Tiber Dam to the maximum extent possible. Normal communication channels between the Omaha District and the Bureau Regional Director's Office are available and operating. Under these conditions, reservoir releases from the exclusive flood control zone (between elevations 3008.1 and 3012.5) will be adjusted to meet the downstream discharge requirements as shown in Paragraph 9-03d. The same guidelines will apply between reservoir elevations 2993.0 and 3008.1, except when replacement storage demands may require a lower release. Under the emergency operating conditions the drawdown regulation of the flood control zone is outlined in Section C of Exhibit II.

SECTION X - EXAMPLES OF FLOOD CONTROL REGULATION

10-01. GENERAL. Design floods developed for the Tiber Project were the Standard Project Flood, derived by the Corps of Engineers, and the Spillway Design Flood, derived by the Bureau of Reclamation. Pertinent data regarding the derivation of these events and the reservoir routing results are discussed below. In addition, the reservoir regulation for the 1964 and 1975 flood events is also presented.

10-02. STANDARD PROJECT FLOOD. A Standard Project Flood was developed in 1957 by the Corps for the Marias River above Tiber Dam using the procedure outlined in the Corps of Engineers Bulletin No. 52-8, dated 1952. Storm rainfall was derived using data developed by the Missouri River Division for Standard Project rainfall in the Sun River basin, a drainage area lying just south of the Marias basin. Average rainfall for the Standard Project storm over the 4923 square mile area lying upstream from Tiber was 3.9 inches in a 48-hour period, 3.0 inches in a 24-hour period and 2.0 inches for the maximum 6-hour period. Computed runoff from the storm was 1.40 inches which produced a flood peak of 65,500 c.f.s. and a 10-day volume of 460,000 acre-feet including 5000 c.f.s. base flow. The capability of the reservoir to control the Standard Project Flood to a maximum release of 10,000 c.f.s. and a maximum pool level of 3012.5 feet, m.s.l. was tested by routing the flood through the reservoir using the regulation curves shown on Plate 20. The routing study indicated that the above constraints could be met by assuming a beginning pool elevation for the routing of 2998.5 feet, m.s.l., at which level the replacement and local flood control zone is about 30 percent full. The maximum pool elevation reached in the routing was 3012.3 feet, m.s.l., with a maximum storage of 1,364,058 acre-feet. Inflow, outflow and pool elevation hydrographs are shown on Plate 21. Regulation of an actual flood event of this magnitude would obviously be more efficient than the regulation curve operation, since additional data would be available on which to base operation decisions.

10-03. SPILLWAY DESIGN FLOOD. The current Spillway Design Flood (Bureau of Reclamation Inflow Design Flood) was developed by the Bureau in July 1966 in order to meet revised dam safety requirements. This flood has a peak discharge of 168,500 c.f.s., a 5-day volume of 630,800 acre-feet and a 15-day volume of 770,000 acre-feet. The design flood was derived by combining the largest recorded 15-day runoff from snowmelt (1925) with runoff from a maximum probable rainstorm over the area above the reservoir. For the rainfall portion of the flood the area above Tiber was divided into three sub-basins. Rainfall intensity over the sub-basins varied from 4.56 to 5.47 inches in 9 hours and from 9.30 to 11.25 inches in 54 hours. A constant retention rate of 0.30 inches per

hour was used. Runoff from the sub-basins varied from 1.88 inches to 2.78 inches. The average weighted runoff was 2.48 inches, of which 2.01 inches occurred in a 3-hour period. The runoff values were applied to sub-basin unit graphs and the resulting hydrographs were routed and combined to develop the Spillway Design inflow hydrograph into Tiber Reservoir. The flood was routed through the reservoir assuming a beginning pool elevation of 3008.1 feet, m.s.l., which is the bottom of the exclusive local flood control zone (reservoir storage - 1,268,803 acre-feet). The reservoir routing resulted in a maximum pool elevation of 3020.2 feet, m.s.l., a maximum reservoir storage of 1,555,898 acre-feet and a maximum outflow of 74,250 c.f.s. consisting of a spillway discharge of 68,470 c.f.s., a river outlet discharge of 1,540 c.f.s. and an auxiliary outlet discharge of 4,240 c.f.s. Inflow, outflow and storage hydrographs for the Spillway Design Flood are shown on Plate 22.

10-04. FLOOD OF JUNE 1964. This flood was caused by runoff from heavy rainfall over the Marias River basin and was augmented by the failure of two private irrigation dams located above Tiber Reservoir. Inflow into Tiber averaged 12,600 c.f.s. between 5:10 P.M. on 8 June and 5:45 A.M. on 9 June. During the next 2.5 hours the inflow averaged 153,000 c.f.s. Reservoir storage continued to increase until early in the morning on 13 June when the pool level peaked at elevation 3001.9 feet, m.s.l. at a maximum storage of 1,137,505 acre-feet. During the 5-day period from June 8-13, the storage in Tiber increased by about 304,000 acre-feet. The pool elevation was 15.5 feet higher and reservoir storage 280,000 acre-feet more than the previous high of June 1959. Releases from the reservoir during the 1964 flood were held to about 1,200 c.f.s. until the morning of 9 June and then increased gradually to 1,500 c.f.s. by about 6:00 P.M. and to 5,000 c.f.s. by midnight. On 10 June the release was increased to 10,000 c.f.s. and this rate was continued until 17 June when it was reduced to 8,000 c.f.s. where it remained until 1 July when gradual release reductions started that reached 1,400 c.f.s. on 5 August. The Bureau of Reclamation reported that none of the releases created any problems along the Marias River except for a short reach immediately below the dam. The reservoir regulation for this event as it actually occurred is shown on Plate 23. The flood was also routed through the reservoir using the regulation rule curves shown on Plate 20 and a beginning pool level of 2998.5 feet, m.s.l. Comparison of the two routings is shown below in Table No. 8.

TABLE NO. 8

JUNE 1964 FLOOD

COMPARISON OF ACTUAL RESERVOIR ROUTING
WITH REGULATION RULE CURVE ROUTING

Condition	Beginning Pool Elev. (ft. m.s.l.)	Beginning Storage (ac.ft.)	Max. Pool Elev. (ft.m.s.l.)	Max. Storage (ac.ft.)	Max. Release (c.f.s.)
Actual Routing	2985.0	832,729	3001.9	1,137,505	10,000
Rule Curve Routing	2998.5(1)	1,070,027	3011.9	1,354,292	10,000

(1) Replacement and Local Flood Control Storage Zone 30 percent full.

10-05. FLOOD OF JUNE 1975. Rainfall of 14 inches above Tiber Dam on 16 June and severe rainstorms on 21 June produced a peak inflow into Tiber of 67,900 c.f.s. on 21 June. The maximum storage reached on 29 June was 983,551 acre-feet at elevation 2993.91 feet, m.s.l. The maximum release from the reservoir with all gates open was 5,777 c.f.s. On 30 July the reservoir water surface dropped below elevation 2,985.0 feet, m.s.l. and on 1 August the lower outlet gates were closed. Releases were gradually reduced until they reached 2,080 c.f.s. on 5 August. The reservoir regulation for this event as it actually occurred is shown on Plate 24. This flood was also routed using the regulation rule curves and a beginning pool level of 2998.5 feet, m.s.l. The routing results are compared in Table No. 9 below.

TABLE NO. 9

JUNE 1975 FLOOD

COMPARISON OF ACTUAL RESERVOIR ROUTING
WITH REGULATION RULE CURVE ROUTING

Condition	Beginning Pool Elev. (ft. m.s.l.)	Beginning Storage (ac.ft.)	Max. Pool Elev. (ft. m.s.l.)	Max. Storage (ac.ft.)	Max. Release (c.f.s.)
Actual Routing	2978.0	727,346	2993.9	983,551	5,777
Rule Curve Routing	2998.5(1)	1,070,027	3008.7	1,282,067	10,000

(1) Replacement and Local Flood Control Storage Zone 30 percent full.

10-06. COMPARISON OF DESIGN AND HISTORICAL FLOODS. For comparison purposes the Standard Project, Spillway Design, and selected historical flood peaks and volumes are shown in Table No. 10 below. These data indicate that the peak discharge of the Standard Project Flood developed in 1957 was exceeded in both the 1964 and 1975 floods.

TABLE NO. 10

DESIGN FLOOD COMPARISONS WITH HISTORICAL EVENTS

Flood	Peak Value	Flood Volumes	Reservoir Routing Max. Pool Elev.
	(c.f.s.)	(ac. ft.)	(ft., m.s.l.)
Standard Project	65,000	5-day - 355,000 10-day - 460,000 15-day - NA	3012.3 (1)
Spillway Design	168,500	5-day - 630,800 10-day - 710,100 15-day - 770,000	*3020.2
June 1948	40,000(2)	5-day - 232,300 10-day - 323,600 15-day - 385,500	NA
June 1964	153,000	5-day - 374,900 10-day - 457,400 15-day - 510,400	3011.9
June 1975	67,900	5-day - 263,200 10-day - 350,800 15-day - 404,300	3008.7

(1) Using regulation rule curve and beginning pool elevation of 2998.5 feet, m.s.l.

(2) Shelby Gaging Station - D.A. = 3242 Square Miles

* Routing from U.S.B.R.

EXHIBIT I

WATER CONTROL AGREEMENT

LAKE ELWELL AND TIBER DAM PROJECT

WATER CONTROL AGREEMENT
LAKE ELWELL AND TIBER DAM PROJECT

Since the storage restrictions placed on Lake Elwell during April of 1966 have been lifted, and until either party to this agreement desires to modify the same, it is agreed that Tiber Dam and Reservoir will be regulated in the interest of flood control in accordance with the regulations set forth in Part 208 - Flood Control Regulations as published in the Federal Register; the Flood Control Storage Reservation Diagram (included as part of this agreement); the Standing Instructions to the Dam Tender; and according to the criteria and procedures established in this water control agreement.

a. Flood Control Storage Capacity Allocation. To achieve the objectives specified in paragraph b below, the storage zone between elevations 2976 and 3012.5 (initially amounting to 668,900 acre-feet) will be utilized for flood control purposes. Of this amount, the zone between elevations 3008.1 and 3012.5 (initially amounting to 99,400 acre-feet) is to be used for exclusive flood control. The zone between elevations 2993 and 3008.1 (initially amounting to 301,500 acre-feet) is to be used for replacement flood control and local flood control. The zone between elevations 2976 and 2993 (initially amounting to 268,000 acre-feet) is joint-use for replacement flood control and conservation purposes. The joint-use zone will be vacated by the Regional Director each year by 1 March.

b. Flood Control Regulation Objectives and Plan. Releases from Lake Elwell will be controlled to achieve the following objectives, insofar as practicable:

(1) Local Flood Control. Project releases will be restricted to the amount which, in conjunction with incremental reach inflows below the dam, will not result in damaging discharges on the Marias and Missouri Rivers from the dam downstream to Fort Peck Lake. To achieve local flood control, the damage stages and/or discharges at downstream locations are currently estimated as follows:

Marias River near Chester	10.4 feet -	10,000 ft^3/s
Marias River near Loma	-	15,000 ft^3/s
Missouri River at Virgelle	17 feet -	73,000 ft^3/s

When the Marias River is frozen or partly frozen over below the dam, releases will be limited to no greater than 1,000 ft^3/s.

(2) Replacement Flood Control. In years when utilization of a major portion of the flood control and multiple-use storage zones within the downstream Fort Peck Lake is anticipated, Lake Elwell will assist in flood control along the Missouri River downstream of Fort Peck by storing inflows to withhold flood water from Fort Peck Lake. To achieve this objective, release rates at Tiber Dam will be adjusted beginning 1 March based on anticipated inflow in order to assure filling the flood control storage zone to elevation 3008.1 by 15 July, insofar as consistent with other operations. Minimum releases of 300 ft^3/s can be made to achieve this fill. Evacuation of this zone will be accomplished each year to elevation 2982 by 1 December with total drawdown to elevation 2976 by 1 March. In the years when the storage in Fort Peck Lake is low, no storage will be made in Lake Elwell flood control zone above elevation 2993 unless required for local

flood control. In those years the storage of water in Lake Elwell will be minimized to augment the level of Fort Peck Lake to benefit Fort Peck hydropower production.

c. Flood Control Regulation Procedures and Criteria. The Regional Director, Upper Missouri Region, Bureau of Reclamation, will regulate the reservoir in the interest of flood control in accordance with the following procedures and criteria:

(1) Regulation of the reservoir when the pool level is in the flood control zone above elevation 2993 shall be construed as flood control and releases or flood control regulation criteria shall be determined by the District Engineer, Omaha District, Corps of Engineers. When the pool level is in the joint-use storage zone (elevation 2976-2993) releases shall be determined by the Regional Director in accordance with the plan given in paragraphs a and b above. At all pool levels below elevation 2993 or above 3012.5, the District Engineer may make recommendations to the Regional Director for operating in the interest of flood control, but such recommendations shall not be considered mandatory, inasmuch as regulation of such storage is the responsibility of the Regional Director.

(2) The flood control regulation plan stated in this agreement is subject to temporary modification by the District Engineer, if necessary during an emergency.

(3) Nothing in this agreement shall prohibit the Regional Director from making the releases required to meet irrigation, or other downstream conservation requirements.

(4) Whenever the reservoir level rises to elevation 2993 or whenever damaging downstream discharge appears imminent, the Regional Director shall report as soon as practicable to the District Engineer and as requested thereafter until the reservoir level falls below elevation 2993 and damaging downstream discharges cease.

(5) The District Engineer shall issue the necessary instructions to the Regional Director for the flood control operation of the reservoir. Oral instructions issued by the District Engineer to the Regional Director shall be confirmed in writing as soon as practicable.

(6) Proposed schedules of conservation releases and storage changes, when available, and current operating data shall be provided to the District Engineer by the Regional Director. Operating data shall be tabulated daily and furnished daily and monthly and shall include such items as reservoir elevation, reservoir storage, inflow, discharge and other pertinent hydrologic data. In turn, any pertinent hydrologic data collected by the District Engineer will be relayed to the Regional Director. This data exchange shall be made according to such detailed arrangements as may be required from time to time.

(7) The discharge characteristics of the river outlet works, auxiliary outlet works, and the spillway (having combined capacity of 74,250 ft^3/s with Tiber Reservoir at elevation 3020.2 ft msl) shall be maintained in accordance with the as-constructed drawings (Bureau of Reclamation Drawing No. 84-D-394 dated 4-26-56, No. 84-D-463 dated 10-4-68 and No. 84-D-609 dated 9-15-80.

(8) Design Limitations. It is recognized that any changes in the discharge characteristics of the spillway structures which are mutually acceptable to the District Engineer and the Regional Director must be approved by the Assistant Commissioner-Engineering and Research of the Bureau of Reclamation.

(9) Nothing in these regulations shall be construed to require that releases shall be made at rates or in a manner inconsistent with requirements for protecting the dam and reservoir from major damage; the safe routing of the spillway design flood; and preventing dangerously rapid changes in releases.

I concur:

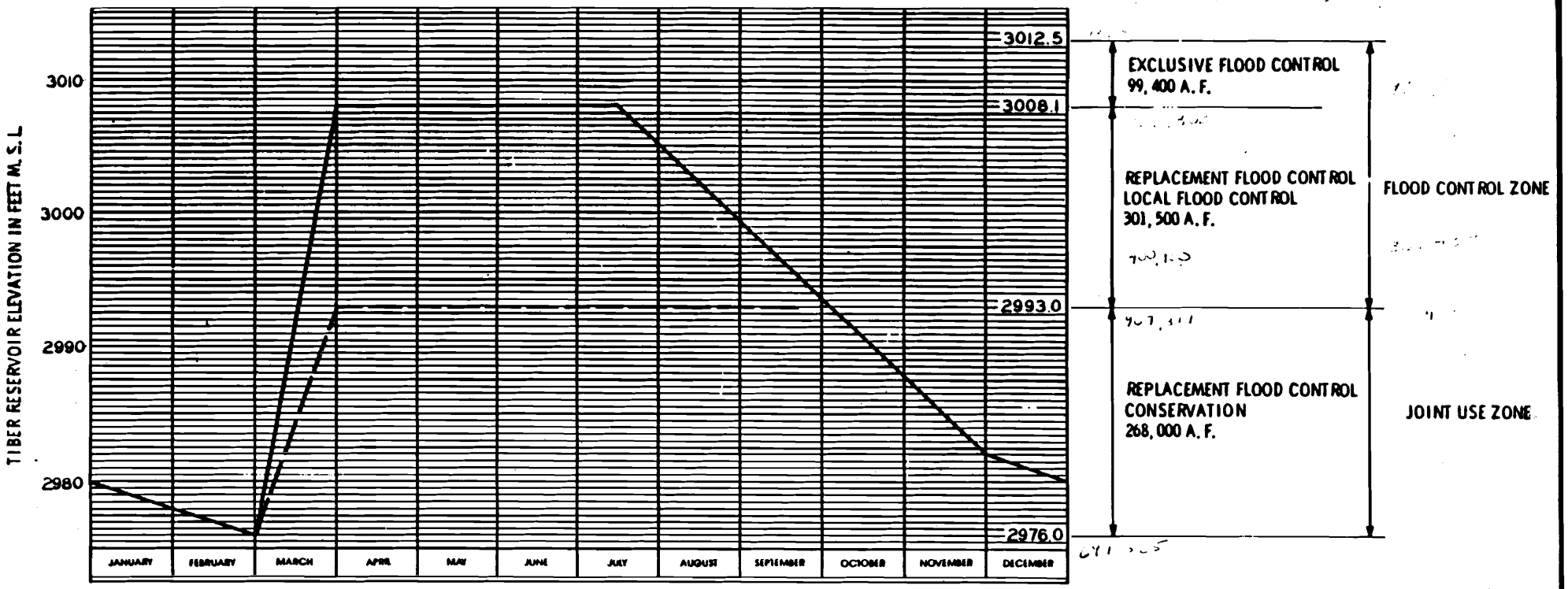
[redacted]

JOSEPH B. MARCOTTE, JR.
Regional Director
Upper Missouri Region
Bureau of Reclamation

[redacted]

[redacted]
Brigadier General, USA
Division Engineer
Missouri River Division

[redacted]
DATE



NOTES:

(1) Releases shall at all times be restricted insofar as possible to limit flows to no greater than the downstream channel capacity which is: 10,000 c.f.s. near Chester and 15,000 c.f.s. at Loma on the Marias River and 73,000 c.f.s. at Virgelle on the Missouri River.

(2) In years when replacement storage is required for the downstream Fort Peck Reservoir, releases from Tiber Dam will be adjusted beginning 1 March 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 c.f.s. Solid line defines the maximum pool levels.

(3) In years when replacement storage is not required for the downstream Fort Peck Reservoir, releases from Tiber Dam will be adjusted to minimize storage in Tiber Reservoir up to a maximum elevation of 2993 feet msl. Dashed line defines the maximum pool level.

(4) The signed original of this diagram is on file in the Office, Chief of Engineers, Washington, D.C. Copies of the diagram currently in force shall be kept on file in and may be obtained from the Office of the Commissioner of Reclamation, Washington, D.C., the District Engineer, Omaha District, Corps of Engineers, and the Regional Director, Upper Missouri Region, Bureau of Reclamation.

TIBER RESERVOIR

MARIAS RIVER, MONTANA

FLOOD CONTROL STORAGE RESERVATION DIAGRAM

Prepared Pursuant to Flood Control Regulations for Tiber Dam and Reservoir (33CFR-208)

APP[redacted]

APPROVED: [signature]

Effective Date: 14 Mar 83

EXHIBIT II

INSTRUCTIONS TO THE DAM TENDER FOR

FLOOD REGULATION OF TIBER DAM AND RESERVOIR

INSTRUCTIONS TO THE DAM TENDER FOR FLOOD REGULATION OF TIBER DAM AND RESERVOIR

SECTION A

GENERAL

A-1. Purpose of Instructions. These instructions are issued for use as a guide for procedures to be used in reservoir regulation by the Dam Tender, both under normal and emergency flood control operation conditions. A copy of these instructions or an acceptable version thereof should be posted by the Dam Tender in such a manner that it is readily accessible at all times. It will be the responsibility of the Dam Tender to make certain that any person temporarily charged with the operation of the reservoir is familiar with these instructions.

A-2. Agency Responsibility. Regulation of the reservoir when the pool level is in the flood control zone (between elevations 2993.0 and 3012.5 feet, m.s.l.) is construed as flood control operation and releases shall be determined by the District Engineer, Omaha District, Corps of Engineers. When the pool level is in the joint-use storage zone (elevation 2976.0 to 2993.0 feet, m.s.l.) releases are determined by the Regional Director, Missouri Basin Region, Bureau of Reclamation in accordance with the mutual Water Control Agreement. At all pool levels below pool elevation 2993.0 or above 3012.5 the Corps may make recommendations to the Bureau for operating in the interest of flood control. However such recommendations shall not be considered mandatory inasmuch as regulation of such storage is the responsibility of the Bureau.

A-3. Routine Observations and Reports. Reports of reservoir data (pool elevations, storage, discharge, precipitation, inflow, etc.) will be forwarded by the Dam Tender daily except on weekends through the Regional Director's office or the National Weather Service to the District Engineer.

SECTION B

NORMAL REGULATION FOR FLOOD CONTROL

B-1. Regulation Objectives. Lake Elwell will be regulated to maintain non-damaging flows on the river below Tiber Dam to the maximum extent possible. In addition, regulation will be based on providing the maximum service to the other purposes for which the project was intended insofar as this regulation is consistent with the primary flood control function.

B-2. Definition of Normal Flood Control Regulation. For the purpose of these instructions, normal flood control regulation is defined to occur at all times when personnel of the District Engineer's office and/or Regional Director's office can be notified within a reasonable time. The Dam Tender should arrange to report the following conditions as required to the Omaha District Engineer and the Bureau Regional Reservoir Regulation Branch:

a. Within 24 hours, whenever the pool rises above elevation 2993.0.

b. Immediately, whenever the pool is above elevation 2993.0 and a sudden increase in the rate of rise occurs equal to or greater than 0.5 foot in 12 hours. (A rise in pool elevation which, in the opinion of the Dam Tender, exceeds the above limit as a result of wind effects will not be used as a basis for notification.)

c. Immediately, whenever rainfall at the dam exceeds 2.0 inches in 24 hours and/or knowledge exists of heavy runoff downstream.

B-3. Personnel. Section D of these instructions lists offices to which reports and questions related to flood control regulation should be directed.

SECTION C

EMERGENCY REGULATIONS FOR FLOOD CONTROL

C-1. Definition of Emergency Flood Control Regulation. For the purpose of these instructions an emergency is defined to begin with a failure in communications between the Dam Tender and personnel of the District Engineer or the Regional Director at the time when a report from the Dam Tender is required by paragraph B-2. Emergency regulation procedures will be initiated only if communications cannot be established within three hours after such time that notification is required by paragraph B-2 and it has been determined that the communication outage may continue for an additional 12 hours. Every possible effort will be made by the Dam Tender, while remaining at or near his post, to establish communication with the District Engineer or Regional Director's office. This includes use of any Federal, commercial or private means of communication, or use of a courier traveling by any available means of transportation to the nearest point where such communication facilities are available.

C-2. Emergency Procedures. Emergency flood control regulation instructions for Lake Elwell are as follows:

a. Follow the last regulation instruction received for the next 12 hours after the conditions in paragraph B-2 occur (unless conditions under "d" below occur) before adjusting releases as provided below.

b. Pool elevations will be observed hourly but releases will not be adjusted more often than at 12 hour intervals.

c. With the pool above elevation 2976.0, with no rain of consequence as defined in "d" below, and after the waiting period as described by "a" above, releases will be adjusted to the level given in the following schedule. However, releases will not be decreased to below the level specified by the latest available regulation order.

Reservoir Elevation	Pool Rise (feet) in 12 Hour Period	Release Schedule
2976.0 - 2993.0	Less than 0.5	Latest Regulation Order
	Greater than 0.5	Latest Regulation Order
2993.0 - 2999.0	Less than 0.5	Latest Regulation Order
	Greater than 0.5	3,000 c.f.s.
2999.0 - 3005.0	Less than 0.5	4,000 c.f.s.
	Greater than 0.5	6,000 c.f.s.
3005.0 - 3012.5	Less than 0.5	8,000 c.f.s.
	Greater than 0.5	10,000 c.f.s.
3012.5 - 3020.2*		10,000 c.f.s. (minimum)

Schedule Continued

Reservoir Elevation	Pool Status in 12 Hour Period	Release Schedule
2993.0 - 2999.0	Stationary or Falling	Latest Regulation Order
2999.0 - 3012.5	Stationary or Falling	Maintain maximum gate opening attained until pool falls to elevation 2999.0.
3012.5 - 3020.2*	Stationary or Falling	Open gates as necessary to pass inflow.
3012.5 - 3020.2*	Falling pool	Maintain maximum gate opening attained during rising pool.

* Operation of the pool as directed by the Bureau of Reclamation.

d. In case of rain in excess of 2.0 inches in 12 hours at Tiber Dam and/or knowledge of heavy runoff downstream, reduce releases to conservation requirements (normally 300 c.f.s.) if above that rate. Maintain this rate for 24 hours, then return to release based on above table.

C-3. Report of Emergency Regulations. The Dam Tender shall report all emergency regulation to the District Engineer and/or Regional Director's office personnel as promptly as practicable when communication facilities permit.

SECTION D

PERSONNEL

D-1. Personnel. Following is a list of offices to which questions and reports relative to flood control regulation should be directed.

Corps of Engineers, Omaha, Nebraska

[redacted]

Bureau of Reclamation, Missouri Basin Region, Billings, Montana

[redacted]

For a listing of current office personnel and home phone numbers, consult the "Telephone Directory of Reservoir Regulation Personnel and Field Offices".

EXHIBIT III

SEASONAL FORECAST PROCEDURES

SEASONAL FORECAST PROCEDURES

1. Development of Forecast Procedures. An April-July volume runoff forecast was developed for Lake Elwell using multiple regression analysis. The analysis was performed relating independent variables of antecedent runoff, snowpack water content and precipitation to the dependent variable of historical April through July runoff. A 17-year period from 1969 through 1985 was analyzed. The correlation used for the final equation provided a correlation coefficient (R) of 0.9711, R squared of 0.9456, and a standard error of 57.27. Following are the independent variables used in the correlation:

1. October + November antecedent runoff in 1,000 AF (ANTON).

2. April 1 snowpack water content in inches (SAPR).

3. April + May + June precipitation in inches (PREAMJ).

Following is the basic equation for May-July runoff in 1,000 AF:

RO = 0.24 (ANTON) + 17.47 (SAPR) + 61.74 (PREAMJ) - 330.69

a. Analysis of the Marias River basin above Tiber Dam indicated accurate up-to-date snowpack water content could be provided by four different snow courses. Table 1 shows a listing of these stations and their average first of the month snow water content. Monthly rainfall data is readily available from the National Weather Service at five reliable reporting stations. Table 2 shows a listing of these stations and their average monthly precipitation.

TABLE 1

Snow Course	Elevation (ft msl)	Average Snow Water Content (inches) February 1	March 1	April 1
Badger Pass	6,900	25.9	34.1	39.0
Blue Lake	5,900	16.3	22.8	26.2
Freight Creek	6,000	NA	13.0	15.6
Marias Pass	5,250	11.5	15.6	18.1
Total Monthly Average (1969-1985)		17.9	21.4	24.7

TABLE 2

Precipitation Station	Average Monthly Precipitation (inches) April	May	June
Cut Bank	0.08	2.25	2.32
East Glacier	1.94	2.55	2.92
Shelby AP	0.65	1.87	1.84
Sweetgrass	0.89	2.66	2.69
Valier	0.82	2.15	2.21
Total Monthly Average (1969-1985)	1.02	2.30	2.40

2. Application of Forecast. The basic forecast equation is used for the entire forecast period with only minor adjustment made for the amount of available data. Forecasts are made monthly beginning February 1 and ending on July 1. Antecedent runoff values for October and November will be known and will remain constant. The basic runoff equation is modified as shown in the following monthly forecast summaries. The resultant runoff is in 1,000 AF. Evaluation of each monthly forecast for the period analyzed is shown in Tables 3 through 8.

February 1 Forecast

ANTON = known October + November antecedent runoff.

SAPR = existing February 1 snowpack water content plus average pickup to April 1. (SFEB + 6.8)

PREAMJ = average total precipitation for April, May and June. (1.02 + 2.30 + 2.40 = 5.72)

Therefore, the modified equation for February 1 is:

$$RO = 0.24(ANTON)+17.47(SFEB+6.8)+61.74(5.72)-330.69$$

which simplifies to:

$$RO = 0.24(ANTON)+17.47(SFEB)+141.26$$

March 1 Forecast

ANTON = known October + November antecedent runoff.

SAPR = existing March 1 snowpack water content plus average pickup to April 1. (SMAR+3.3)

PREAMJ = average total precipitation for April, May and June. (1.02 + 2.30 + 2.40 = 5.72)

Therefore, the modified equation for March 1 is:

RO = 0.24(ANTON)+17.47(SMAR+3.3)+61.74(5.72)-330.69

which simplifies to:

RO = 0.24(ANTON)+17.47(SMAR)+80.11

April 1 Forecast

ANTON = known October + November antecedent runoff.

SAPR = existing April 1 snowpack water content.

PREAMJ = average total precipitation for April, May and June. (1.02 + 2.30 + 2.40 = 5.72)

Therefore, the modified equation for April 1 is:

RO = 0.24(ANTON)+17.47(SAPR)+61.74(5.72)-330.69

which simplifies to:

RO = 0.24(ANTON)+17.47(SAPR)+22.46

May 1 Forecast

ANTON = known October + November antecedent runoff.

SAPR = known April 1 snowpack water content.

PREAMJ = known April plus average May and June precipitation. (PREA + 2.30 + 2.40 = PREA + 4.70)

Therefore, the modified equation for May 1 is:

RO = 0.24(ANTON)+17.47(SAPR)+61.74(PREA+4.70)-330.69

which simplifies to:

RO = 0.24(ANTON)+17.47(SAPR)+61.74(PREA)-40.51

June 1 Forecast

ANTON = known antecedent October + November runoff.

SAPR = known April 1 snowpack water content.

PREAMJ = known April + known May plus average June precipitation. (PREAM + 2.40)

Therefore, the modified equation for June 1 is:

RO = 0.24(ANTON)+17.47(SAPR)+61.74(PREAM+2.40)-330.69

which simplifies to:

RO = 0.24(ANTON)+17.47(SAPR)+61.74(PREAM)-182.51

<u>July 1 Forecast (Basic Equation)</u>

RO = 0.24(ANTON)+17.47(SAPR)+61.74(PREAMJ)-330.69

TABLE 3

Evaluation of February Forecast

Equation: RO=0.24(ANTON)+17.47(SFEB)+141.26

Year	ANTON (1,000 AF)	Snowpack Water Content SFEB (inches)	Avg. Pickup (inches)	PREAMJ (inches)	FORECAST (1,000 AF)	ACTUAL (1,000 AF)	Deviation as Percent of ACTUAL
1969	63.4	25.2	6.8	5.72	596.7	478.4	24.7
1970	25.5	16.2	6.8	5.72	430.4	610.9	-29.5
1971	34.5	26.5	6.8	5.72	612.5	618.0	-0.9
1972	37.7	21.0	6.8	5.72	517.2	623.6	-17.1
1973	54.6	13.2	6.8	5.72	385.0	249.9	54.0
1974	18.0	10.6	6.8	5.72	330.8	481.6	-31.3
1975	24.3	16.9	6.8	5.72	442.3	1048.2	-57.8
1976	85.4	19.6	6.8	5.72	504.2	498.3	1.2
1977	28.9	3.4	6.8	5.72	207.6	95.7	116.9
1978	16.7	22.4	6.8	5.72	536.6	490.5	9.4
1979	36.8	16.2	6.8	5.72	433.1	494.2	-12.4
1980	21.2	15.7	6.8	5.72	420.6	465.1	-9.6
1981	42.7	10.6	6.8	5.72	336.7	432.2	-22.1
1982	20.7	21.3	6.8	5.72	518.3	528.1	-1.8
1983	26.2	15.0	6.8	5.72	409.6	234.2	74.9
1984	22.8	11.6	6.8	5.72	349.4	211.3	65.3
1985	26.9	19.8	6.8	5.72	493.6	290.2	70.1

TABLE 4

Evaluation of March Forecast

Equation: RO=0.24(ANTON)+17.47(SMAR)+80.11

Year	ANTON (1,000 AF)	Snowpack Water Content SMAR (inches)	Avg. Pickup (inches)	PREAMJ (inches)	FORECAST (1,000 AF)	ACTUAL (1,000 AF)	Deviation as Percent of ACTUAL
1969	63.4	24.6	3.3	5.72	525.1	478.4	9.8
1970	25.5	20.4	3.3	5.72	442.6	610.9	-27.5
1971	34.5	30.3	3.3	5.72	617.7	618.0	0.0
1972	37.7	38.9	3.3	5.72	768.7	623.6	23.3
1973	54.6	13.4	3.3	5.72	327.3	249.9	31.0
1974	18.0	29.8	3.3	5.72	605.0	481.6	25.6
1975	24.3	21.7	3.3	5.72	465.0	1048.2	-55.6
1976	85.4	26.0	3.3	5.72	554.8	498.3	11.3
1977	28.9	9.9	3.3	5.72	260.0	95.7	171.7
1978	16.7	22.0	3.3	5.72	468.5	490.5	-4.5
1979	36.8	23.3	3.3	5.72	496.0	494.2	0.4
1980	21.2	15.3	3.3	5.72	352.5	465.1	-24.2
1981	42.7	13.1	3.3	5.72	319.2	432.2	-26.1
1982	20.7	24.5	3.3	5.72	513.1	528.1	-2.8
1983	26.2	16.0	3.3	5.72	365.9	234.2	56.2
1984	22.8	11.2	3.3	5.72	281.2	211.3	33.1
1985	26.9	23.1	3.3	5.72	490.1	290.2	68.9

TABLE 5

Evaluation of April Forecast

Equation: RO=0.24(ANTON)+17.47(SAPR)+22.46

Year	ANTON (1,000 AF)	Snowpack Water Content SAPR (inches)	Avg. Pickup (inches)	PREAMJ (inches)	FORECAST (1,000 AF)	ACTUAL (1,000 AF)	Deviation as Percent of ACTUAL
1969	63.4	24.9	N/A	5.72	472.7	478.4	-1.2
1970	25.5	26.2	N/A	5.72	486.3	610.9	-20.4
1971	34.5	38.1	N/A	5.72	696.3	618.0	12.7
1972	37.7	38.7	N/A	5.72	707.6	623.6	13.5
1973	54.6	15.8	N/A	5.72	311.6	249.9	24.7
1974	18.0	31.3	N/A	5.72	573.6	481.6	19.1
1975	24.3	28.2	N/A	5.72	520.9	1048.2	-50.3
1976	85.4	28.5	N/A	5.72	540.9	498.3	8.5
1977	28.9	16.1	N/A	5.72	310.7	95.7	224.6
1978	16.7	21.7	N/A	5.72	405.6	490.5	-17.3
1979	36.8	26.4	N/A	5.72	492.5	494.2	-0.3
1980	21.2	20.4	N/A	5.72	383.9	465.1	-17.5
1981	42.7	14.8	N/A	5.72	291.3	432.2	-32.6
1982	20.7	31.7	N/A	5.72	581.2	528.1	10.1
1983	26.2	18.8	N/A	5.72	357.2	234.2	52.5
1984	22.8	15.5	N/A	5.72	298.7	211.3	41.4
1985	26.9	23.4	N/A	5.72	437.7	290.2	50.8

TABLE 6

Evaluation of May Forecast

Equation: RO=0.24(ANTON)+17.47(SAPR)+61.74(PREA)-40.51

Year	ANTON (1,000 AF)	SAPR (inches)	PREA (inches)	Precipitation Avg. Pickup (inches)	FORECAST (1,000 AF)	ACTUAL (1,000 AF)	Deviation as Percent of ACTUAL
1969	63.4	24.9	0.16	4.70	419.6	478.4	-12.3
1970	25.5	26.2	1.78	4.70	533.2	610.9	-12.7
1971	34.5	38.1	1.02	4.70	696.4	618.0	12.7
1972	37.7	38.7	0.68	4.70	686.6	623.6	10.1
1973	54.6	15.8	1.08	4.70	315.3	249.9	26.2
1974	18.0	31.3	0.85	4.70	563.1	481.6	16.9
1975	24.3	28.2	1.95	4.70	578.4	1048.2	-44.8
1976	85.4	28.5	1.37	4.70	562.5	498.3	12.9
1977	28.9	16.1	0.07	4.70	252.0	95.7	163.3
1978	16.7	21.7	2.18	4.70	477.2	490.5	-2.7
1979	36.8	26.4	1.72	4.70	535.7	494.2	8.4
1980	21.2	20.4	1.10	4.70	388.9	465.1	-16.4
1981	42.7	14.8	0.33	4.70	248.7	432.2	-42.5
1982	20.7	31.7	0.47	4.70	547.3	528.1	3.6
1983	26.2	18.8	0.41	4.70	319.5	234.2	36.4
1984	22.8	15.5	1.20	4.70	309.8	211.3	46.6
1985	26.9	23.4	0.96	4.70	434.0	290.2	49.6

TABLE 7

Evaluation of June Forecast

Equation: RO=0.24(ANTON)+17.47(SAPR)+61.74(PREAM)-182.51

Year	ANTON (1,000 AF)	SAPR (inches)	PREAM (inches)	Precipitation Avg. Pickup (inches)	FORECAST (1,000 AF)	ACTUAL (1,000 AF)	Deviation as Percent of ACTUAL
1969	63.4	24.9	0.97	2.40	327.6	478.4	-31.5
1970	25.5	26.2	3.33	2.40	486.9	610.9	-20.3
1971	34.5	38.1	3.69	2.40	719.2	618.0	16.4
1972	37.7	38.7	2.31	2.40	645.2	623.6	3.5
1973	54.6	15.8	2.55	2.40	264.1	249.9	5.7
1974	18.0	31.3	2.32	2.40	511.9	481.6	6.3
1975	24.3	28.2	6.41	2.40	711.7	1048.2	-32.1
1976	85.4	28.5	2.36	2.40	481.6	498.3	-3.4
1977	28.9	16.1	1.84	2.40	219.3	95.7	129.1
1978	16.7	21.7	5.06	2.40	513.0	490.5	4.6
1979	36.8	26.4	3.23	2.40	487.0	494.2	-1.5
1980	21.2	20.4	4.91	2.40	482.1	465.1	3.7
1981	42.7	14.8	6.33	2.40	477.1	432.2	10.4
1982	20.7	31.7	3.63	2.40	600.4	528.1	13.7
1983	26.2	18.8	1.23	2.40	228.2	234.2	-2.6
1984	22.8	15.5	2.57	2.40	252.4	211.3	19.5
1985	26.9	23.4	3.61	2.40	455.6	290.2	57.0

TABLE 8

Evaluation of July Forecast

Equation: RO=0.24(ANTON)+17.47(SAPR)+61.74(PREAMJ)-330.69

Year	ANTON (1,000 AF)	SAPR (inches)	PREAMJ (inches)	Precipitation Avg. Pickup (inches)	FORECAST (1,000 AF)	ACTUAL (1,000 AF)	Deviation as Percent of ACTUAL
1969	63.4	24.9	6.24	N/A	504.8	478.4	5.5
1970	25.5	26.2	6.66	N/A	544.3	610.9	-10.9
1971	34.5	38.1	5.70	N/A	695.1	618.0	12.5
1972	37.7	38.7	4.42	N/A	627.3	623.6	0.6
1973	54.6	15.8	3.96	N/A	202.9	249.9	-18.8
1974	18.0	31.3	3.38	N/A	429.1	481.6	-10.9
1975	24.3	28.2	13.26	N/A	986.5	1048.2	-5.9
1976	85.4	28.5	4.65	N/A	474.8	498.3	-4.7
1977	28.9	16.1	2.95	N/A	139.6	95.7	45.9
1978	16.7	21.7	6.33	N/A	443.2	490.5	-9.6
1979	36.8	26.4	5.07	N/A	452.4	494.2	-8.5
1980	21.2	20.4	8.20	N/A	537.1	465.1	15.5
1981	42.7	14.8	8.99	N/A	493.2	432.2	14.1
1982	20.7	31.7	5.61	N/A	574.4	528.1	8.8
1983	26.2	18.8	2.96	N/A	186.8	234.2	-20.2
1984	22.8	15.5	4.42	N/A	218.5	211.3	3.4
1985	26.9	23.4	4.21	N/A	344.5	290.2	18.7

EXHIBIT IV

FLOOD CONTROL REGULATIONS

absence of any indication that further public comment would shed any new light on the matter, OSHA concludes that no change in the standard is warranted. Accordingly, the ground-fault protection standard at 29 CFR 1910.309(c) and 29 CFR 1926.400(h), as promulgated on December 21, 1976, is hereby reaffirmed.

(Secs. 6(b) and 8(c), Pub. L. 91-596, 84 Stat. 1593, 1599 (29 U.S.C. 655, 657); sec. 107, Pub. L. 91-54, 83 Stat. 96 (40 U.S.C. 333); Secretary of Labor's Order No. 8-76 (41 FR 25059); 29 CFR Part 1911.)

Signed at Washington, D.C., this 3d day of October 1978.

EULA BINGHAM,
Assistant Secretary of Labor.

[FR Doc. 78-28687 Filed 10-12-78; 8:45 am]

[3710-92-M]

Title 33—Navigation and Navigable Waters

CHAPTER II—CORPS OF ENGINEERS, DEPARTMENT OF THE ARMY

[ER 1110-2-241]

PART 208—FLOOD CONTROL REGULATIONS

Use of Storage Allocated for Flood Control and Navigation Purposes

AGENCY: U.S. Army Corps of Engineers, DOD.

ACTION: Final rule.

SUMMARY: This revision of 33 CFR 208.11 regulations prescribes the policy and procedure for regulating reservoir projects capable of regulation for flood control or navigation and the use of storage allocated for such purposes and provided on the basis of flood control and navigation. The revised regulations are applicable to dam and reservoir projects licensed, maintained, and operated under provisions of the Federal Power Act (41 Stat. 1063 (16 U.S.C. 791(A))), Pub. L. 83-436, and other similar authorizing legislation; as well as to reservoir projects constructed wholly or in part with Federal funds as directed by section 7 of the Flood Control Act of 1944. These regulations are intended to establish an understanding between project owners, operating agencies and the Corps of Engineers with regard to certain activities and responsibilities concerning water control management throughout the Nation in the interest of flood control and navigation. Interested persons were given until November 2, 1977 (42 FR 57141) to submit comments. No written comments were received.

DATES: This regulation is effective on October 15, 1978.

ADDRESSES: HQDA (DAEN-CWE-HY) Washington, D.C. 20314.

FOR FURTHER INFORMATION CONTACT:

Mr. Edgar P. Story, Engineering Division, Civil Works Directorate, Office of the Chief of Engineers, Washington, D.C. 20314 202-693-7330.

SUPPLEMENTARY INFORMATION: This final regulation is essentially the same as the proposed rule (42 FR 53637), however, certain reordering has been done of the reference material presented in § 208.11(b). Specifically, excerpts from sections 4(e), 10(a), and 10(c) of the Federal Power Act have been added for improved clarity. Also Federal Power Commission order No. 540 issued October 31, 1975, and published November 7, 1975 (40 FR 51998), amending § 2.9 of the Commission's general policy and interpretations which prescribed standardized conditions (Forms) for inclusion in preliminary permits and licenses issued under part I of the Federal Power Act has been cited and appropriately excerpted. Reference to and citation from article 33 of Federal Power Commission license No. 2009 have been deleted in lieu thereof.

In addition to the proposed action, certain project names and pertinent data are added to and deleted from the list of projects shown in § 208.11(e), list of projects (42 FR 53637). The following projects are added to the list of projects:

(a) U.S. Army Corps of Engineers, Missouri River Division area: Webster Dam and Lake.

(b) U.S. Army Corps of Engineers, New England Division area:

(i) Bear Swamp Pumped Storage Project.

(ii) Turners Falls Reservoir.

(c) U.S. Army Corps of Engineers, North Pacific Division area:

(i) American Falls Dam and Reservoir.

(ii) Anderson Ranch Dam and Reservoir.

(iii) Arrowrock Dam and Reservoir.

(iv) Brownlee Dam and Reservoir.

(v) Grand Coulee Dam and Franklin D. Roosevelt Lake.

(vi) Hells Canyon Dam and Reservoir.

(vii) Kerr Dam and Flathead Lake.

(viii) Mayfield Dam and Reservoir.

(ix) Mossyrock Dam and Davisson Lake.

(x) Oxbow Dam and Reservoir.

(xi) Priest Rapids Dam and Reservoir.

(xii) Ririe Dam and Reservoir.

(xiii) Rocky Reach Dam and Lake Entiat.

(xiv) Ross Dam and Reservoir.

(xv) Upper Baker Dam and Baker Lake.

(xvi) Wanapum Dam and Reservoir.

(xvii) Wells Dam and Lake Pateros.

(d) U.S. Army Corps of Engineers, South Atlantic Division area: Lewis M. Smith Dam and Reservoir.

(e) U.S. Army Corps of Engineers, South Pacific Division area:

(i) Indian Valley Dam and Reservoir.

(ii) Lemon Dam and Reservoir.

(iii) Navajo Dam and Reservoir.

(iv) Paolina Dam and Reservoir.

(v) Vallecito Dam and Reservoir.

The following projects are deleted from the list of projects:

(a) U.S. Army Corps of Engineers, South Atlantic Division area: H. Neely Henry Dam and Reservoir.

(b) U.S. Army Corps of Engineers, South Pacific Division area:

(i) Causey Dam and Reservoir.

(ii) Devil Creek Dam and Reservoir.

NOTE.—The Chief of Engineers has determined that this rule does not contain a major proposal requiring preparation of an inflation impact statement under Executive Order 11821 and OMB Circular A-107 (Statutory Authority Pub. L. 90-483).

Dated: October 10, 1978.

CHARLES I. MCGINNIS,
Major General, USA,
Director of Civil Works.

Section 208.11 is revised to read as follows:

§ 208.11 Regulations for use of storage allocated for flood control or navigation and/or project operation at reservoirs subject to prescription of rules and regulations by the Secretary of the Army in the interest of flood control and navigation.

(a) *Purpose.* This regulation prescribes the responsibilities and general procedures for regulating reservoir projects capable of regulation for flood control or navigation and the use of storage allocated for such purposes and provided on the basis of flood control and navigation, except projects owned and operated by the Corps of Engineers; the International Boundary and Water Commission, United States and Mexico; and those under the jurisdiction of the International Joint Commission, United States, and Canada, and the Columbia River Treaty. The intent of this regulation is to establish an understanding between project owners, operating agencies, and the Corps of Engineers.

(b) *Responsibilities.* The basic responsibilities of the Corps of Engineers regarding project operation are set out in the cited authority and described in the following paragraphs:

(1) Section 7 of the Flood Control Act of 1944 (58 Stat. 890, 33 U.S.C. 709) directs the Secretary of the Army to prescribe regulations for flood control and navigation in the following manner:

Hereafter, it shall be the duty of the Secretary of War to prescribe regulations for the use of storage allocated for flood control or navigation at all reservoirs constructed wholly or in part with Federal funds provided on the basis of such purposes, and the operation of any such project shall be in accordance with such regulations: *Provided*, That this section shall not apply to the Tennessee Valley Authority, except that in case of danger from floods on the lower Ohio and Mississippi Rivers the Tennessee Valley Authority is directed to regulate the release of water from the Tennessee River into the Ohio River in accordance with such instructions as may be issued by the War Department.

(2) Federal Energy Regulatory Commission (formerly Federal Power Commission (FPC)) licenses.

(i) Responsibilities of the Secretary of the Army and/or the Chief of Engineers in Federal Energy Regulatory Commission (FERC) licensing actions are set out in the Federal Power Act. Pertinent sections of that Act are cited herein. The Commission may also stipulate, as part of license conditions, that the licensee enter into an agreement with the Department of the Army providing for operation of the project during flood times, in accordance with rules and regulations prescribed by the Secretary of the Army.

(A) Section 4(e) of the Federal Power Act requires approval by the Chief of Engineers and the Secretary of the Army of plans of dams or other structures affecting the navigable capacity of any navigable waters of the United States, prior to issuance of a license by the Commission as follows:

The Commission is hereby authorized and empowered to issue licenses to citizens * * * for the purpose of constructing, operating, and maintaining dams, water conduits, reservoirs, powerhouses, transmission lines, or other project works necessary or convenient for the development and improvement of navigation and for the development, transmission, and utilization of power across, along, from or in any of the streams or other bodies of water over which Congress has jurisdiction * * * *Provided further*, That no license affecting the navigable capacity of any navigable waters of the United States shall be issued until the plans of the dam or other structures affecting navigation have been approved by the Chief of Engineers and the Secretary of the Army.

(B) Sections 10(a) and 10(c) of the Federal Power Act specify conditions of project licenses including the following:

(1) Section 10(a). That the project adopted * * * shall be such as in the judgment of the Commission will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for the use of benefit of interstate or foreign commerce, for the improvement and utilization of waterpower development, and for other beneficial public use * * *.

(2) Section 10(c). That the licensee shall * * * so maintain and operate said works as not to impair navigation, and shall conform . . to such rules and regulations as the Commission may from time to time prescribe for the protection of life, health, and property.* * *

(C) Section 18 of the Federal Power Act directs the operation of any navigation facilities built under the provision of that act, be controlled by rules and regulations prescribed by the Secretary of the Army as follows:

The operation of any navigation facilities which may be constructed as part of or in connection with any dam or diversion structure built under the provisions of this Act, whether at the expense of a licensee hereunder or of the United States, shall at all times be controlled by such reasonable rules and regulations in the interest of navigation; including the control of the pool caused by such dam or diversion structure as may be made from time to time by the Secretary of the Army, * * *

(ii) Federal Power Commission order No. 540 issued October 31, 1975, and published November 7,1975 (40 FR 51998), amending section 2.9 of the Commission's general policy and interpretations prescribed standardized conditions (forms) for inclusion in preliminary permits and licenses issued under part I of the Federal Power Act. As an example, article 12 of standard form L-3, titled: "Terms and Conditions of License for Constructed Major Projects Affecting Navigable Waters of the United States," sets out the Commission's interpretation of appropriate sections of the Act, which deal with navigation aspects, and attendant responsibilities of the Secretary of the Army in licensing actions as follows:

The United States specifically retains and safeguards the right to use water in such amount, to be determined by the Secretary of the Army, as may be necessary for the purposes of navigation on the navigable waterway affected; and the operation of the Licensee, so far as they affect the use, storage and discharge from storage of waters affected by the license, shall at all times be controlled by such reasonable rules and regulations as the Secretary of the Army may prescribe in the interest of navigation, and as the Commission may prescribe for the protection of life, health, and property, * * *, and the Licensee shall release water from the project reservoir at such rate * * *, as the Secretary of the Army may prescribe in the interest of navigation, or as the Commission may prescribe for the other purposes hereinbefore mentioned.

(3) Section 9 of Public Law 436, 83d Congress (68 Stat. 303) provides for the development of the Coosa River, Ala. and Ga., and directs the Secretary of the Army to prescribe rules and regulations for project operation in the interest of flood control and navigation as follows:

The operation and maintenance of the dams shall be subject to reasonable rules and regulations of the Secretary of the Army in the interest of flood control and navigation.

NOTE.—This Regulation will also be applicable to dam and reservoir projects operated under provisions of future legislative acts wherein the Secretary of the Army is directed to prescribe rules and regulations in the interest of flood control and navigation. The Chief of Engineers, U.S. Army Corps of Engineers, is designated the duly authorized representative of the Secretary of the Army to exercise the authority set out in the congressional acts. This regulation will normally be implemented by letters of understanding between the Corps of Engineers and project owner and will incorporate the provisions of such letters of understanding prior to the time construction renders the project capable of significant impoundment of water. A water control agreement signed by both parties will follow when deliberate impoundment first begins or at such time as the responsibilities of any corps-owned projects may be transferred to another entity. Promulgation of this regulation for a given project will occur at such time as the name of the project appears in the FEDERAL REGISTER in accordance with the requirements of § 208.11(d)(11). When agreement on a water control plan cannot be reached between the corps and the project owner after coordination with all interested parties, the project name will be entered in the FEDERAL REGISTER and the Corps of Engineers plan will be the officials water control plan until such time as differences can be resolved.

(c) *Scope and terminology.* This regulation applies to Federal authorized flood control and/or navigation storage projects, and to non-Federal projects which require the Secretary of the Army to prescribe regulations as a condition of the license, permit or legislation, during the planning, design and construction phases, and throughout the life of the project. In compliance with the authority cited above, this regulation defines certain activities and responsibilities concerning water control management throughout the Nation in the interest of flood control and navigation. In carrying out the conditions of this regulation, the owner and/or operating agency will comply with applicable provisions of Pub. L. 85-624, the Fish and Wildlife Coordination Act of 1958, and Pub. L. 92-500, the Federal Water Pollution Control Act Amendments of 1972. This regulation does not apply to local flood protection works governed by § 208.10, or to navigation facilities and associated structures which are otherwise covered by part 207 (Navigation Regulations) of title 33 of the code. Small reservoirs, containing less than 12,500 acre-feet of flood control or navigation storage, may be excluded from this regulation and covered under § 208.10, unless specifically required by law or conditions of the license or permit.

(1) The terms "reservoir" and "project" as used herein include all water resource impoundment projects constructed or modified, including natural lakes, that are subject to this regulation.

(2) The term "project owner" refers to the entity responsible for maintenance, physical operation, and safety of the project, and for carrying out the water control plan in the interest of flood control and/or navigation as prescribed by the Corps of Engineers. Special arrangements may be made by the project owner for "operating agencies" to perform these tasks.

(3) The term "letter of understanding" as used herein includes statements which consummate this regulation for any given project and define the general provisions or conditions of the local sponsor, or owner, cooperation agreed to in the authorizing legislative document, and the requirements for compliance with section 7 of the 1944 Flood Control Act, the Federal Power Act or other special congressional act. This information will be specified in the water control plan and manual. The letter of understanding will be signed by a duly authorized representative of the Chief of Engineers and the project owner. A "field working agreement" may be substituted for a letter of understanding, provided that the specified minimum requirements of the latter, as stated above, are met.

(4) The term "water control agreement" refers to a compilation of water control criteria, guidelines, diagrams, release schedules, rule curves and specifications that basically govern the use of reservoir storage space allocated for flood control or navigation and/or release functions of a water control project for these purposes. In general, they indicate controlling or limiting rates of discharge and storage space required for flood control and/or navigation, based on the runoff potential during various seasons of the year.

(5) For the purpose of this regulation, the term "water control plan" is limited to the plan of regulation for a water resources project in the interest of flood control and/or navigation. The water control plan must conform with proposed allocations of storage capacity and downstream conditions or other requirements to meet all functional objectives of the particular project, acting separately or in combination with other projects in a system.

(6) The term "real-time" denotes the processing of current information or data in a sufficiently timely manner to influence a physicial response in the system being monitored and controlled. As used herein the term connotes * * * the analyses for and execution of water control decisions for both minor and major flood events and for navigation, based on prevailing hydrometeorological and other conditions and constraints, to achieve efficient management of water resource systems.

(d) *Procedures.* (1) *Conditions during project formulation.* During the planning and design phases, the project owner should consult with the Corps of Engineers regarding the quantity and value of space to reserve in the reservoir for flood control and/or navigation purposes, and for utilization of the space, and other requirements of the license, permit or conditions of the law. Relevant matters that bear upon flood control and navigation accomplishment include: runoff potential, reservoir discharge capability, downstream channel characteristics, hydrometeorological data collection, flood hazard, flood damage charateristics, real estate acquisition for flowage requirements (fee and easement), and resources required to carry out the water control plan. Advice may also be sought on determination of and regulation for the probable maximum or other design flood under consideration by the project owner to establish the quantity of surcharge storage space, and freeboard elevation of top of dam or embankment for safety of the project.

(2) *Corps of Engineers involvement.* If the project owner is responsible for real-time implemenetation of the water control plan, consultation and assistance will be provided by the Corps of Engineers when appropriate and to the extent possible. During any emergency that affects flood control and/or navigation, the Corps of Engineers may temporarily prescribe regulation of flood control or navigation storage space on a day-to-day (real-time) basis without request of the project owner. Appropriate consideration will be given for other authorized project functions. Upon refusal of the project owner to comply with regulations prescribed by the Corps of Engineers, a letter will be sent to the project owner by the Chief of Engineers or his duly authorized representative describing the reason for the regulations prescribed, events that have transpired, and notification that the project owner is in violation of the Code of Federal Regulations. Should an impasse arise, in that the project owner or the designated operating entity persists in noncompliance with regulations prescribed by the Corps of Engineers, measures may be taken to assure compliance.

(3) *Corps of Engineers implementation of real-time water control decisions.* The Corps of Engineers may prescribe the continuing regulation of flood control storage space for any project subject to this regulation on a day-to-day (real-time) basis. When this is the case, consultation and assistance from the project owner to the extent possible will be expected. Special requests by the project owner, or appropriate operating entity, are preferred before the Corps of Engineers offer advice on real-time regulation during surcharge storage utilization.

(4) *Water control plan and manual.* Prior to project completion, water control managers from the Corps of Engineers will visit the project and the area served by the project to become familiar with the water control facilities, and to insure sound formulation of the water control plan. The formal plan of regulation for flood control and/or navigation, referred to herein as the water control plan, will be developed and documented in a water control manual prepared by the Corps of Engineers. Development of the manual will be coordinated with the project owner to obtain the necessary pertinent information, and to insure compatibility with other project purposes and with surcharge regulation. Major topics in the manual will include: Authorization and description of the project, hydrometeorology, data collection and communication networks, hydrologic forecasting, the water control plan, and water resource management functions, including responsibilities and coordination for water control decisionmaking. Special instructions to the dam tender or reservoir manager on data collection, reporting to higher Federal authority, and on procedures to be followed in the event of a communication outage under emergency conditions, will be prepared as an exhibit in the manual. Other exhibits will include copies of this regulation, letters of understanding consummating this regulation, and the water control agreements. After approval by the Chief of Engineers or his duly authorized representative, the manual will be furnished the project owner.

(5) *Water control agreement.* (i) A water control diagram (graphical) will be prepared by the Corps of Engineers for each project having variable space reservation for flood control and/or navigation during the year; e.g., variable seasonal storage, joint-use space, or other rule curve designation. Reservoir inflow parameters will be included on the diagrams when appropriate. Concise notes will be included on the diagrams prescribing the use of storage space in terms of release schedules, runoff, nondamaging or other controlling flow rates downstream of the damsite, and other major factors as appropriate. A water control release schedule will be prepared in tabular form for projects that do not have variable space reservation for flood control and/or navigation. The water control diagram or release schedule will be signed by a duly authorized representative of the Chief of Engineers, the project owner, and the designated operating agency, and will be used as the basis for carrying out this

regulation. Each diagram or schedule will contain a reference to this regulation.

(ii) When deemed necessary by the Corps of Engineers, information given on the water control diagram or release schedule will be supplemented by appropriate text to assure mutual understanding on certain details or other important aspects of the water control plan not covered in this regulation, on the water control diagram or in the release schedule. This material will include clarification of any aspects that might otherwise result in unsatisfactory project performance in the interest of flood contol and/or navigation. Supplementation of the agreement will be necessary for each project where the Corps of Engineers exercises the discretionary authority to prescribe the flood control regulation on a day-to-day (real-time) basis. The agreement will include delegation of the responsibility. The document should also cite, as appropriate, section 7 of the 1944 Flood Control Act, the Federal Power Act and/or other congressional legislation authorizing construction an/or directing operation of the project.

(iii) All flood control regulations published in the FEDERAL REGISTER under this section (part 208) of the code prior to the date of this publication which are listed in paragraph 208.11(e) are hereby superseded.

(iv) Nothing in this regulation prohibits the promulgation of specific regulations for a project in compliance with the authorizing acts, when agreement on acceptable regulations cannot be reached between the Corps of Engineers and the owner.

(6) *Hydrometeorological instrumentation.* The project owner will provide instrumentation in the vicinity of the damsite and will provide communication equipment necessary to record and transmit hydrometeorological and reservoir data to all appropriate Federal authorities on a real-time basis unless there are extenuating circumstances or are otherwise provided for as a condition of the license or permit. For those projects where the owner retains responsibility for real-time implementation of the water control plan, the owner will also provide or arrange for the measurement and reporting of hydrometeorological parameters required within and adjacent to the watershed and downstream of the damsite, sufficient to regulate the project for flood control and/or navigation in an efficient manner. When data collection stations outside the immediate vicinity of the damsite are required, and funds for installation, observation, and maintenance are not available from other sources, the Corps of Engineers may agree to share the costs for such stations with the project owner. Availability of funds and urgency of data needs are factors which will be considered in reaching decisions on cost sharing.

(7) *Project safety.* The project owner is responsible for the safety of the dam and appurtenant facilities and for regulation of the project during surcharge storage utilization. Emphasis upon the safety of the dam is especially important in the event surcharge storage is utilized, which results when the total storage space reserved for flood control is exceeded. Any assistance provided by the Corps of Engineers concerning surcharge regulation is to be utilized at the discretion of the project owner, and does not relieve the owner of the responsibility for safety of the project.

(8) *Notification of the general public.* The Corps of Engineers and other interested Federal and State agencies, and the project owner will jointly sponsor public involvement activities, as appropriate, to fully apprise the general public of the water control plan. Public meetings or other effective means of notification and involvement will be held, with the initial meeting being conducted as early as practicable but not later than the time the project first becomes operational. Notice of the initial public meeting shall be published once a week for 3 consecutive weeks in one or more newspapers of general circulation published in each county covered by the water control plan. Such notice shall also be used when appropriate to inform the public of modifications in the water control plan. If no newspaper is published in a county, the notice shall be published in one or more newspapers of general circulation within that county. For the purposes of this section a newspaper is one qualified to publish public notices under applicable State law. Notice shall be given in the event significant problems are anticipated or experienced that will prevent carrying out the approved water control plan or in the event that an extreme water condition is expected that could produce severe damage to property or loss of life. The means for conveying this information shall be commensurate with the urgency of the situation. The water control manual will be made available for examination by the general public upon request at the appropriate office of the Corps of Engineers, project owner or designated operating agency.

(9) *Other generalized requirements for flood control and navigation.* (i) Storage space in the reservoirs allocated for flood control and navigation purposes shall be kept available for those purposes in accordance with the water control agreement, and the plan of regulation in the water control manual.

(ii) Any water impounded in the flood control space defined by the water control agreement shall be evacuated as rapidly as can be safely accomplished without causing downstream flows to exceed the controlling rates; i.e., releases from reservoirs shall be restricted insofar as practicable to quantities which, in conjunction with uncontrolled runoff downstream of the dam, will not cause water levels to exceed the controlling stages currently in force. Although conflicts may arise with other purposes, such as hydropower, the plan or regulation may require releases to be completely curtailed in the interest of flood control or safety of the project.

(iii) Nothing in the plan of regulation for flood control shall be construed to require or allow dangerously rapid changes in magnitudes of releases. Releases will be made in a manner consistent with requirements for protecting the dam and reservoir from major damage during passage of the maximum design flood for the project.

(iv) The project owner shall monitor current reservoir and hydro- meteorological conditions in and adjacent to the watershed and downstream of the damsite, as necessary. This and any other pertinent information shall be reported to the Corps of Engineers on a timely basis, in accordance with standing instructions to the damtender or other means requested by the Corps of Engineers.

(v) In all cases where the project owner retains responsibility for real-time implementation of the water control plan, he shall make current determinations of: Reservoir inflow, flood control storage utilized, and scheduled releases. He shall also determine storage space and releases required to comply with the water control plan prescribed by the Corps of Engineers. The owner shall report this information on a timely basis as requested by the Corps of Engineers.

(vi) The water control plan is subject to temporary modification by the Corps of Engineers if found necessary in time of emergency. Requests for and action on such modifications may be made by the fastest means of communication available. The action taken shall be confirmed in writing the same day to the project owner and shall include justification for the action.

(vii) The project owner may temporarily deviate from the water control plan in the event an immediate short-term departure is deemed necessary for emergency reasons to protect the safety of the dam, or to avoid other serious hazards. Such actions shall be immediately reported by the fastest

means of communication available. Actions shall be confirmed in writing the same day to the Corps of Engineers and shall include justification for the action. Continuation of the deviation will require the express approval of the Chief of Engineers, or his duly authorized representative.

(viii) Advance approval of the Chief of Engineers, or his duly authorized representative, is required prior to any deviation from the plan of regulation prescribed or approved by the Corps of Engineers in the interest of flood control and/or navigation, except in emergency situations provided for in paragraph (d)(9)(vii) of this section. When conditions appear to warrant a prolonged deviation from the approved plan, the project owner and the Corps of Engineers will jointly investigate and evaluate the proposed deviation to insure that the overall integrity of the plan would not be unduly compromised. Approval of prolonged deviations will not be granted unless such investigations and evaluations have been conducted to the extent deemed necessary by the Chief of Engineers, or his designated representatives, to fully substantiate the deviation.

(10) *Revisions.* The water control plan and all associated documents will be revised by the Corps of Engineers, as necessary, to reflect changed conditions that come to bear upon flood control and navigation, e.g., reallocation of reservoir storage space due to sedimentation or transfer of storage space to a neighboring project. Revision of the water control plan, water control agreement, water control diagram, or release schedule requires approval of the Chief of Engineers or his duly authorized representative. Each such revision shall be effective upon the date specified in the approval. The original (signed document) water control agreement shall be kept on file in the Office, Chief of Engineers, Department of the Army, Washington, D.C. Copies of the agreement shall be kept on file and may be obtained from the office of the project owner, or from the office of the appropriate Division Engineer, Corps of Engineers.

(11) *Federal Register.* The following information for each project subject to section 7 of the 1944 Flood Control Act and other applicable congressional acts shall be published in the FEDERAL REGISTER prior to the time the projects becomes operational and prior to any significant impoundment before project completion or * * * at such time as the responsibility for physical operation and maintenance of the Corps of Engineers owned projects is transferred to another entity: (i) Reservoir, dam, and lake names, (ii) stream, county, and State corresponding to the damsite location, (iii) the maximum current storage space in acre-feet to be reserved exclusively for flood control and/or navigation purposes, or any multiple-use space (intermingled) when flood control or navigation is one of the purposes, with corresponding elevations in feet above mean sea level, and area in acres, at the upper and lower limits of said space, (iv) the name of the project owner, and (v) congressional legislation authorizing the project for Federal participation.

(e) *List of projects.* The following tables, "Pertinent Project Data—Section 208.11 Regulation," show the pertinent data for projects which are subject to this regulation.

(Sec. 7, Pub. L. 78-534, 58 Stat. 890 (33 U.S.C. 709); the Federal Power Act, 41 Stat. 1063 (16 U.S.C. 791(A)); and Sec. 9, Pub. L. 83-436, 68 Stat. 303.)

[FR Doc. 78-29100 Filed 10-12-78; 8:45 am]

PERTINENT PROJECT DATA - SECTION 208.11 REGULATIONS

[redacted]

PERTINENT PROJECT DATA - SECTION 208.11 REGULATIONS

PROJECT NAME	STREAM	COUNTY & STATE	EXCLUSIVE					MULTIPLE-USE					PROJECT OWNER	AUTH. LEGIS.
			FLOOD CONTROL/NAVIGATION					FLOOD CONTROL/NAVIGATION						
			STORAGE	ELEV. LIMITS		AREA		STORAGE	ELEV. LIMITS		AREA			
			1000 ac-ft	feet m.s.l. UPPER	LOWER	acres UPPER	LOWER	1000 ac-ft	feet m.s.l. UPPER	LOWER	acres UPPER	LOWER		
Hells Canyon Dam & Reservoir	Snake River	Wallowa, OR; Adams, ID	-	-	-	-	-	11.7	1698.0	1683.0	2,380	2,280	Idaho Power Company	FPC No. 1971-A
Hoover Dam & Lake Mead	Colorado River	Clark NV & Mohave, AZ	1500.0	1229.0	1219.6	162,700	156,500	15,853	1219.6	1083.0	156,500	83,500	Bureau of Reclamation	PL 70-642
Hungry Horse Dam & Reservoir	S. Fork Flathead Riv.	Flathead, MT	2982.0	3560.0	3330.0	23,800	5,400	-	-	-	-	-	Bureau of Reclamation	PL 78-329
Indian Valley Dam&Reservoir	N.Fork Cache Creek	Lake, CA	-	-	-	-	-	40.0	1485.0	1474.7	1,975	3,749	Yolo Cty Fl. Cont&WtrCons	PL 84-984 Dist.
Jamestown Dam & Reservoir	James River	Stutsman, ND	185.4	1454.0	1432.67	13,206	2,555	6.6	1432.67	1429.8	2,555	2,085	Bureau of Reclamation	PL 78-534
Kerr Dam Flathead Lake	Flathead River	Lake, MT	-	-	-	-	-	1219.0	2893.0	2883.0	125,560	120,000	Montana Power Co.	FPC No. 5
Keyhole Dam & Reservoir	Belle Fourche	Crook, WY	140.2	4111.5	4099.3	13,686	9,394	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Kirwin Dam & Reservoir	N. Fork Solomon River	Phillips, KS	215.1	1757.3	1729.25	10,640	5,073	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Lemon Dam & Reservoir	Florida River	La Plata, Colorado	-	-	-	-	-	39.0	8148	8023	622	62	Bureau of Reclamation	PL 84-485
Lewis M. Smith Dam & Reservoir	Sipsey Fork Black Warrior Riv.	Cullman & Walker, AL	280.6	522.0	510.0	25,700	21,200	-	-	-	-	-	Alabama Power Co.	Fed.Power Act
Little Wood River Dam & Reservoir	Little Wood River	Blain, ID	30.0	5237.3	5127.8	574	0	-	-	-	-	-	Bureau of Reclamation	PL 84-993
Logan Martin Dam & Reservoir	Coosa River	Talladega, AL	245.3	477.0	465.0	26,310	15,260	-	-	-	-	-	Alabama Power Co.	PL 83-436
Los Banos Dam & Detention Res.	Los Banos Creek	Merced, CA	-	-	-	-	-	14.0	353.5	327.8	619	467	Bureau of Reclamation	PL 86-488
Lost Creek Dam & Res.	Lost Creek	Morgan, UT	-	-	-	-	-	20.0	6005.0	5912.0	365	93	Bureau of Reclamation	PL 81-273
Lovewell Dam & Reservoir	White Rock Creek	Jewell, KS	50.5	1595.3	1562.6	5,025	2,986	-	-	-	-	-	Bureau of Reclamation	PL 78-534

PERTINENT PROJECT DATA - SECTION 208.11 REGULATIONS

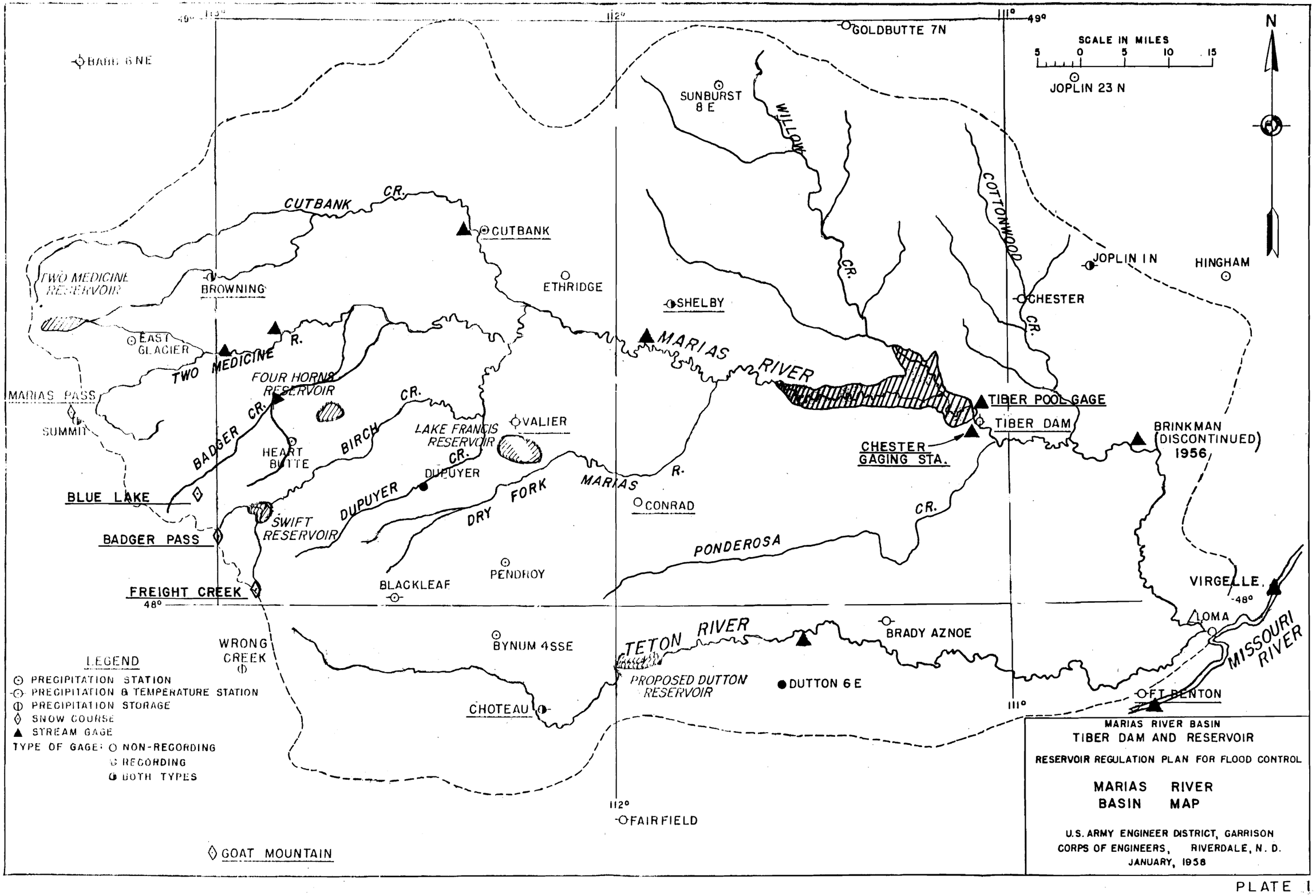
PROJECT NAME	STREAM	COUNTY & STATE	EXCLUSIVE FLOOD CONTROL/NAVIGATION STORAGE 1000 ac-ft	ELEV. LIMITS feet m.s.l. UPPER	ELEV. LIMITS feet m.s.l. LOWER	AREA acres UPPER	AREA acres LOWER	MULTIPLE-USE FLOOD CONTROL/NAVIGATION STORAGE 1000 ac-ft	ELEV. LIMITS feet m.s.l. UPPER	ELEV. LIMITS feet m.s.l. LOWER	AREA acres UPPER	AREA acres LOWER	PROJECT OWNER	AUTH. LEGIS.
Markham Ferry Dam & Lake Wash E. Hudson	Grand (Neosho) River	Mayes, OK	244.2	636.0	619.0	18,000	10,900	-	-	-	-	-	Grand River Dam Authority	PL 76-476
Mayfield Dam & Reservoir	Cowlitz River	Lewis, WA	-	-	-	-	-	21.4	425.0	415.0	2,070	1,825	City of Tacoma	FPC No. 2016-A
Medicine Creek Dam & Harry Strunk Lake	Medicine Creek	Frontier, NB	52.2	2386.2	2366.1	3,465	1,850	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Mossyrock Dam Davisson Lake	Cowlitz River	Lewis, WA	-	-	-	-	-	1397.0	778.5	621.5	11,800	5,000	City of Tacoma	FPC No. 2016-B
Navajo Dam Reservoir	San Juan River	Rio Arriba & San Juan, NM	-	-	-	-	-	1036.1	6085	5990	15,610	7,400	Bureau of Reclamation	PL 84-485
New Exchequer Dam & Lake McClure	Merced River	Tuolomne, CA	-	-	-	-	-	400.0	867.0	799.7	7,110	4,849	Merced Irrig. District	PL 86-645
Norton Dam & Reservoir	Prairie Dog Creek	Norton, KS	98.8	2331.4	2304.3	5,316	2,181	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Ochoco Dam & Reservoir	Ochoco Creek	Crook, OR	51.4	3136.2	3048.1	1,150	120	-	-	-	-	-	Bureau of Reclamation	PL 84-992
Oroville Dam & Lake	Feather River	Butte, CA	-	-	-	-	-	750.0	900.0	848.5	15,800	13,346	CA Dept of Wtr Resources	PL 85-500
Oxbow Dam & Reservoir	Snake River	Baker, OR; Adams, ID	-	-	-	-	-	5.0	1805.0	1800.0	1,165	1,115	Idaho Power Company	FPC No. 1971-B
Pactola Dam & Reservoir	Rapid Creek	Pennington, SD	43.0	4621.5	4580.2	1,232	860	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Palisades Dam & Reservoir	Snake River	Bonneville, ID	202.0	5620.0	5452.43	16,100	2,170	-	-	-	-	-	Bureau of Reclamation	PL 81-864
Paonia Dam & Reservoir	Muddy Creek	Gunnison, Colorado	-	-	-	-	-	17.0	6447.5	6373.0	334	120	Bureau of Reclamation	PL 80-117 PL 84-485
Pineview Dam & Reservoir	Odgen River	Weber, UT	-	-	-	-	-	110.0	4900.0	4818.0	2,874	0	Bureau of Reclamation	PL 81-273
Platoro Dam & Reservoir	Conejos River	Conejos, CO	6.0	10034.0	10027.5	747	920	540.0	10027.5	994.5	920	0	Bureau of Reclamation	PL 76-640
Priest Rapids Dam & Reservoir	Columbia River	Grant, WA	-	-	-	-	-	44.0	488.0	481.5	7,100	6,500	Grant County PUD No. 2	FPC No. 2114-A
Prineville Dam & Reservoir	Crooked Creek	Crook, OR	153.0	3234.8	3112.0	2,990	120	-	-	-	-	-	Bureau of Reclamation	PL 84-992

PERTINENT PROJECT DATA - SECTION 208.11 REGULATIONS

PROJECT NAME	STREAM	COUNTY & STATE	EXCLUSIVE FLOOD CONTROL/NAVIGATION STORAGE 1000 ac-ft	ELEV. LIMITS feet m.s.l. UPPER	ELEV. LIMITS feet m.s.l. LOWER	AREA acres UPPER	AREA acres LOWER	MULTIPLE-USE FLOOD CONTROL/NAVIGATION STORAGE 1000 ac-ft	ELEV. LIMITS feet m.s.l. UPPER	ELEV. LIMITS feet m.s.l. LOWER	AREA acres UPPER	AREA acres LOWER	PROJECT OWNER	AUTH. LEGIS.
Prosser Creek & Reservoir	Prosser Creek	Nevada, CA	-	-	-	-	-	20.0	5741.2	5703.7	745	334	Bureau of Reclamation	PL 84-858
Red Willow Dam & Hugh Butler Lake	Red Willow Creek	Frontier, NB	48.9	2604.9	2581.8	2,682	1,629	-	-	-	-	-	Bureau of Reclamation	PL 78-534 & PL 85-783
Ririe Dam & Reservoir	Willow Creek Snake River	Bonneville, ID	-	-	-	-	-	90.0	5119.0	5023.0	1,560	360	Bureau of Reclamation	PL 87-874
Rocky Reach Dam Lake Entiat	Columbia River	Chelan, WA	-	-	-	-	-	37.0	707.0	703.0	9,600	0	Chelan Caty PUD No. 1	FPC No. 2145
Ross Dam & Reservoir	Skagit River	Whatcom, WA	-	-	-	-	-	530.5	1602.5	1475.0	6,000	2,168	City of Seattle	FPC No. 553-C
Savage River Dam & Res.	Savage River	Garrett, MD	-	-	-	-	-	16.028	1468.5	1400.0	366	127	Upper Potomac Riv Commission	PL 79-526
Shadehill Dam & Reservoir	Grand River	Perkins, SD	217.7	2302.0	2272.0	9,900	4,800	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Shasta Dam & Lake	Sacramento River	Shasta, CA	-	-	-	-	-	1300.0	1067.0	1018.6	29,570	23,894	Bureau of Reclamation	PL 75-392 & PL 76-868
Smith Mtn & Leesville Dam & Res.	Roanoke River	Bedford, Campbell & Pittsylvania, VA	-	-	-	-	-	(No Specific FC/Nav. Storage Allocation)					Appalacian Power Co.	Fed. Power Act
Trenton Dam & Reservoir	Republican River	Hitchcock, NB	133.8	2773.0	2752.0	7,975	4,974	-	-	-	-	-	Bureau of Reclamation	PL 78-534
Turner Falls Res (Includes Northfield Mtn Pumped Storage Project)	Connecticut River (Briggs Brook)	Franklin, MA	-	-	-	-	-	(No Specific FC/Nav. Storage Allocation)					Northeast Utilities Service Co. Hartford, CT	Fed. Power Act
Twitchell Dam & Reservoir	Cuyama River	Santa Barbara, CA	89.0	651.5	623.0	3,690	2,650	-	-	-	-	-	Bureau of Reclamation	PL 83-774
Upper Baker Dam Baker Lake	Baker River	Whatcom, WA	-	-	-	-	-	220.63	724.0	655.0	4,890	0	Puget Sound Power & Light Co.	Sec. 201 PL 89-298 FPC No. - 2150-8

PERTINENT PROJECT DATA - SECTION 208.11 REGULATIONS

PROJECT NAME	STREAM	COUNTY & STATE	EXCLUSIVE FLOOD CONTROL/NAVIGATION STORAGE 1000 ac-ft	EXCLUSIVE FLOOD CONTROL/NAVIGATION ELEV. LIMITS feet m.s.l. UPPER	EXCLUSIVE FLOOD CONTROL/NAVIGATION ELEV. LIMITS feet m.s.l. LOWER	EXCLUSIVE FLOOD CONTROL/NAVIGATION AREA acres UPPER	EXCLUSIVE FLOOD CONTROL/NAVIGATION AREA acres LOWER	MULTIPLE-USE FLOOD CONTROL/NAVIGATION STORAGE 1000 ac-ft	MULTIPLE-USE FLOOD CONTROL/NAVIGATION ELEV. LIMITS feet m.s.l. UPPER	MULTIPLE-USE FLOOD CONTROL/NAVIGATION ELEV. LIMITS feet m.s.l. LOWER	MULTIPLE-USE FLOOD CONTROL/NAVIGATION AREA acres UPPER	MULTIPLE-USE FLOOD CONTROL/NAVIGATION AREA acres LOWER	PROJECT OWNER	AUTH. LEGIS.
Vallecito Dam Reservoir	Los Pinos River	La Plata, Colorado	-	-	-	-	-	115.4	7665	7600	2,723	693	Bureau of Reclamation	PL 61-288 PL 68-292
Wanapum Dam & Reservoir	Columbia River	Grant, WA	-	-	-	-	-	151.6	571.5	560.0	14,400	9,600	Grant County PUD No. 2	FPC No. 2114-B
Wanship Dam & Rockport	Weber River	Summit, UT	-	-	-	-	-	61.0	6037.0	5930.0	1,077	121	Bureau of Reclamation	PL 81-273
Warm Springs Dam & Res.	Middle Fork Malheur Riv.	Malheur, OR	-	-	-	-	-	191.0	3406.0	3327.0	4,600	90	50%Vale Irr. Dist & 50% Bu. of Rec.	-
Waterbury Dam & Reservoir	Little River	Washington, VT	27.7	617.5	592.0	1,330	890	-	-	-	-	-	State of Vermont	PL 78-534
Weiss Dam & Reservoir	Coosa River	Cherokee, AL	397.0	574.0	564.0	50,000	30,200	-	-	-	-	-	Alabama Power Co.	PL 83-436
Wells Dam & Lake Pateros	Columbia River	Douglas, WA	-	-	-	-	-	74.0	779.0	771.0	10,700	7,700	Douglas Cnty PUD No. 1	FPC No. 2149
Webster Dam & Reservoir	S. Fork Solomon Riv.	Rooks, KS	183.4	1923.7	1892.45	8,480	3,766	-	-	-	-	-	Bureau of Reclamation	PL 534-78-2
Yellowtail Dam & Bighorn Lake	Bighorn River	Big Horn, MT	259.0	3657.0	3640.0	17,298	12,685	250.0	3640.0	3614.0	12,685	7,410	Bureau of Reclamation	PL 78-534



MARIAS RIVER BASIN

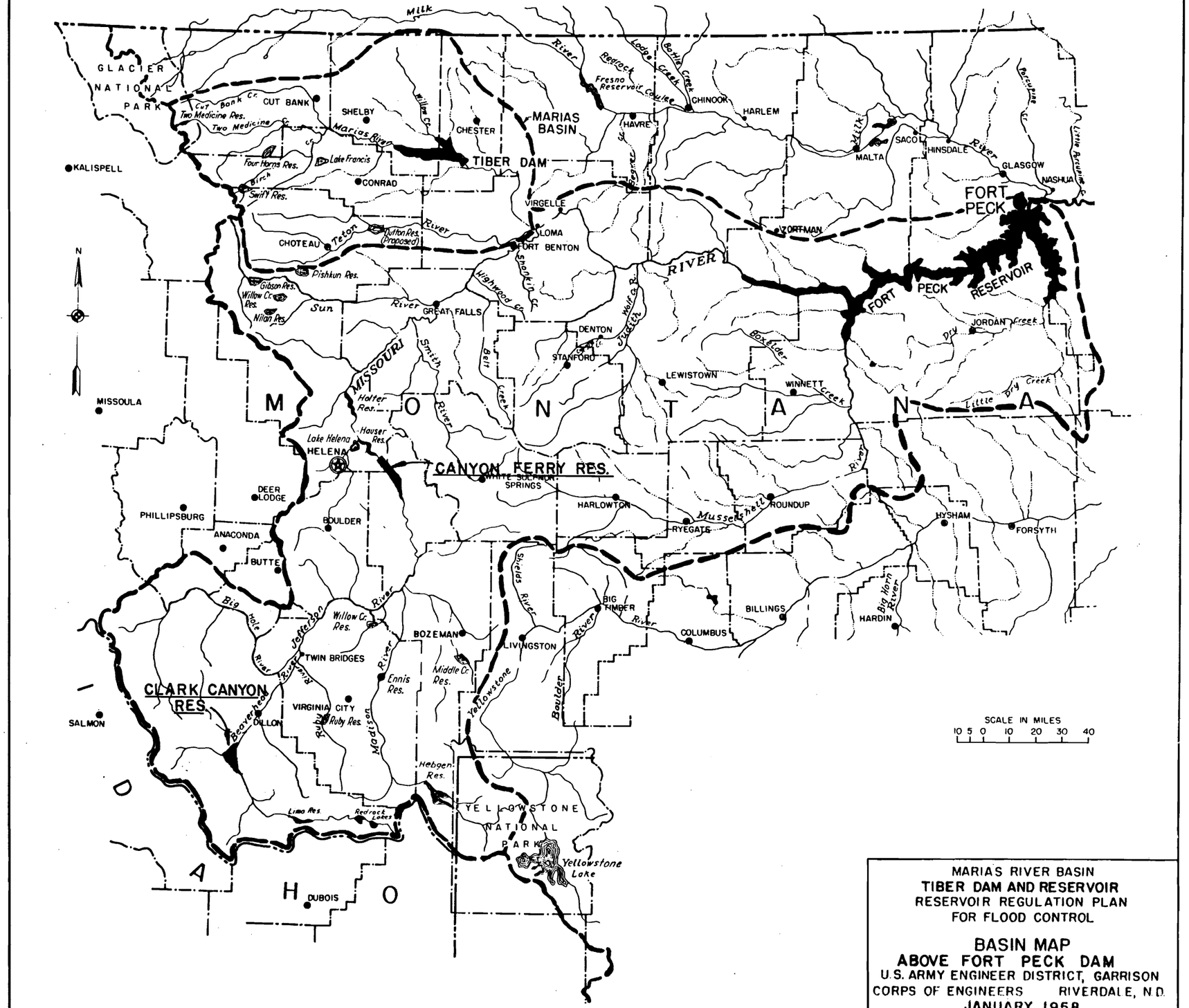
TIBER DAM AND RESERVOIR

RESERVOIR REGULATION PLAN FOR FLOOD CONTROL

MARIAS RIVER BASIN MAP

U.S. ARMY ENGINEER DISTRICT, GARRISON
CORPS OF ENGINEERS, RIVERDALE, N. D.
JANUARY, 1958

PLATE 1



MARIAS RIVER BASIN
TIBER DAM AND RESERVOIR
RESERVOIR REGULATION PLAN
FOR FLOOD CONTROL

BASIN MAP
ABOVE FORT PECK DAM
U.S. ARMY ENGINEER DISTRICT, GARRISON
CORPS OF ENGINEERS RIVERDALE, N.D.
JANUARY 1958

PLATE 2

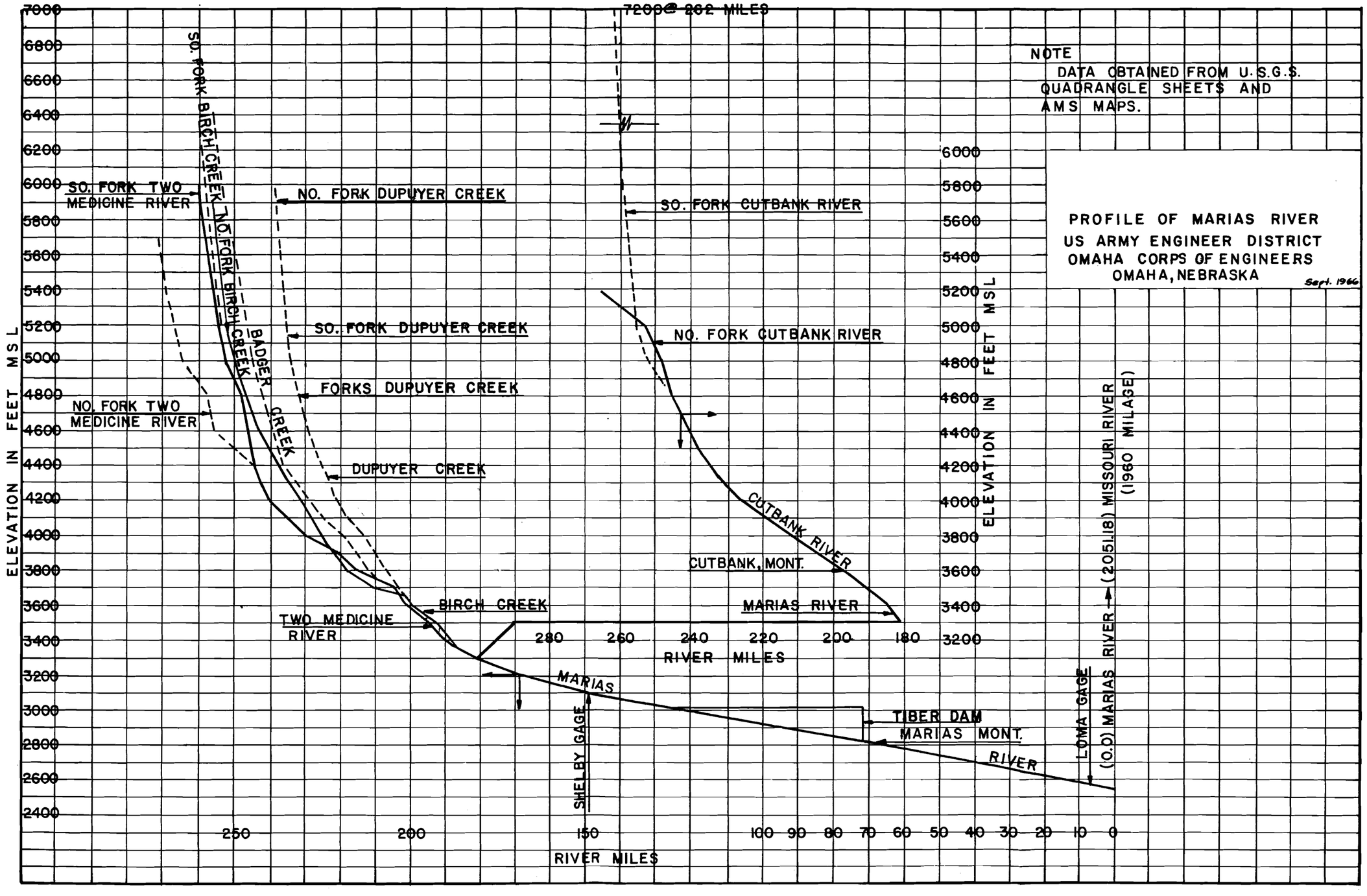

NOTE
DATA OBTAINED FROM U.S.G.S. QUADRANGLE SHEETS AND AMS MAPS.
PROFILE OF MARIAS RIVER
US ARMY ENGINEER DISTRICT
OMAHA CORPS OF ENGINEERS
OMAHA, NEBRASKA
Sept. 1966
ELEVATION IN FEET MSL
7000
6800
6600
6400
6200
6000
5800
5600
5400
5200
5000
4800
4600
4400
4200
4000
3800
3600
3400
3200
3000
2800
2600
2400
SO. FORK TWO MEDICINE RIVER
NO. FORK TWO MEDICINE RIVER
SO. FORK BIRCH CREEK
NO. FORK BIRCH CREEK
BADGER CREEK
NO. FORK DUPUYER CREEK
SO. FORK DUPUYER CREEK
FORKS DUPUYER CREEK
DUPUYER CREEK
TWO MEDICINE RIVER
BIRCH CREEK
SHELBY GAGE
MARIAS
250
200
150
RIVER MILES
7200@ 282 MILES
SO. FORK CUTBANK RIVER
NO. FORK CUTBANK RIVER
CUTBANK RIVER
CUTBANK, MONT.
MARIAS RIVER
280
260
240
220
200
180
RIVER MILES
TIBER DAM
MARIAS MONT.
RIVER
LOMA GAGE
(0.0) MARIAS RIVER → (2051.18) MISSOURI RIVER (1960 MILAGE)
100 90 80 70 60 50 40 30 20 10 0

PLATE 3

DISCHARGE RATING TABLES

FOR SELECTED STREAM GAGING STATIONS

GAGE HT. IN FEET	DISCHARGE IN CUBIC FEET PER SECOND			
	Marias River Near Shelby, Montana	Marias River near Chester, Montana	Teton River near Dutton, Montana	Missouri River at Virgelle, Montana
2.0			136	
2.5			254	
3.0	140	340	400	4520
3.5	260	600	590	5770
4.0	290	970	800	7150
4.5	1400	1300	1060	8620
5.0	2035	1760	1360	10200
5.5	3310	2280	1700	11810
6.0	3940	2870	2100	13570
6.5	4000	3480	2500	15460
7.0	5500	4250	3000	17470
7.5	7000	5000	3450	19540
8.0	8400	5800	4000	21670
8.5	10000	6400	4600	23880
9.0	11900	7500	5200	26170
9.5	12500	8300	5760	28540
10.0	14300	9250	6500	30960
10.5	15000	10200		33410
11.0	20000	11000		35920
11.5	24000			38500
12.0	26500			41230
12.5	30000			44070
13.0	33000			47060
13.5	39400			50110
14.0	48000			53220
15.0				59670
16.0				66400
17.0				73270
18.0				80400
19.0				87670
20.0				95170

FLOOD STAGES (feet)

Shelby	-	13.0
Chester	-	10.4
Dutton	-	7.0
Virgelle	-	17.0

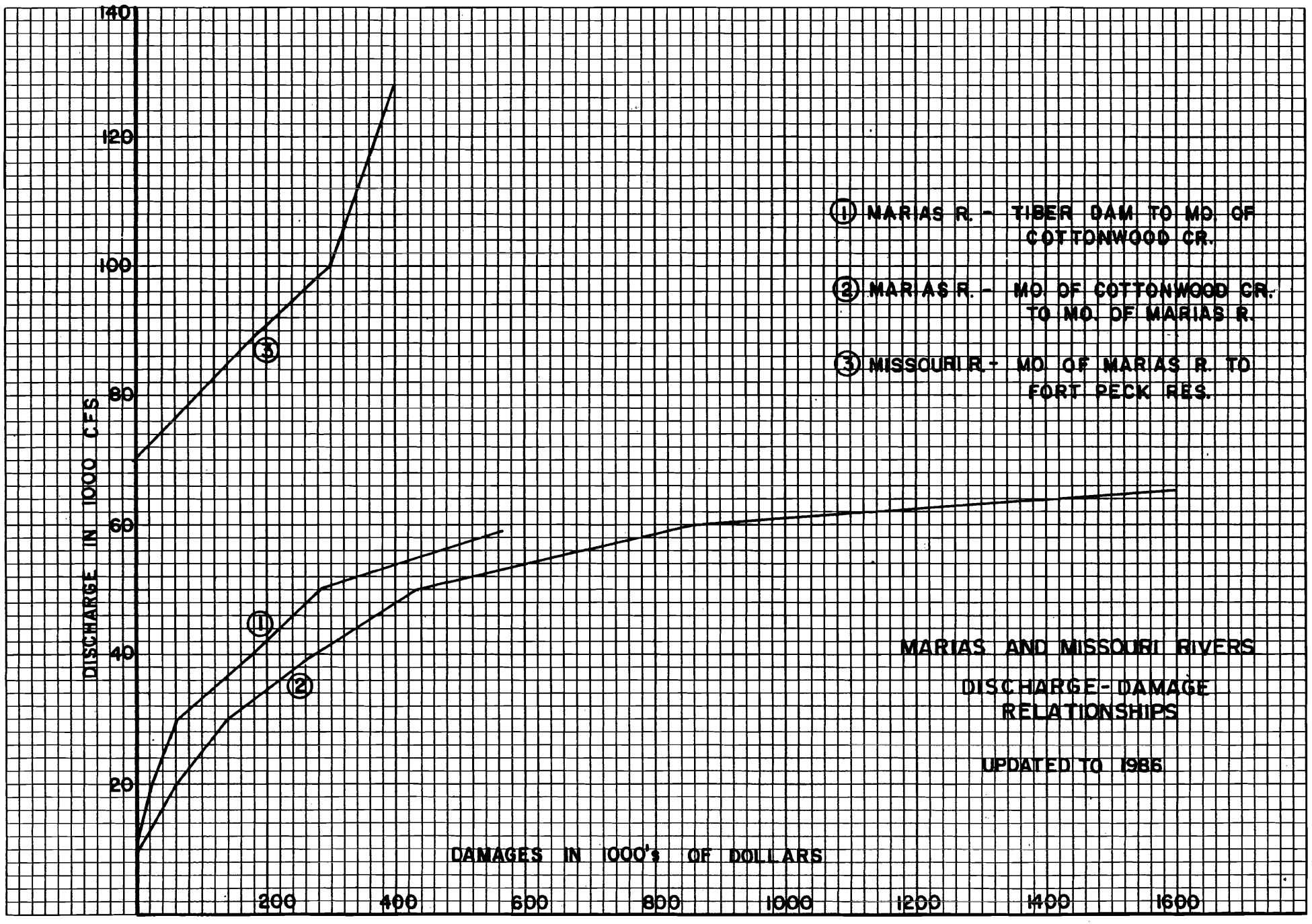


PLATE 5

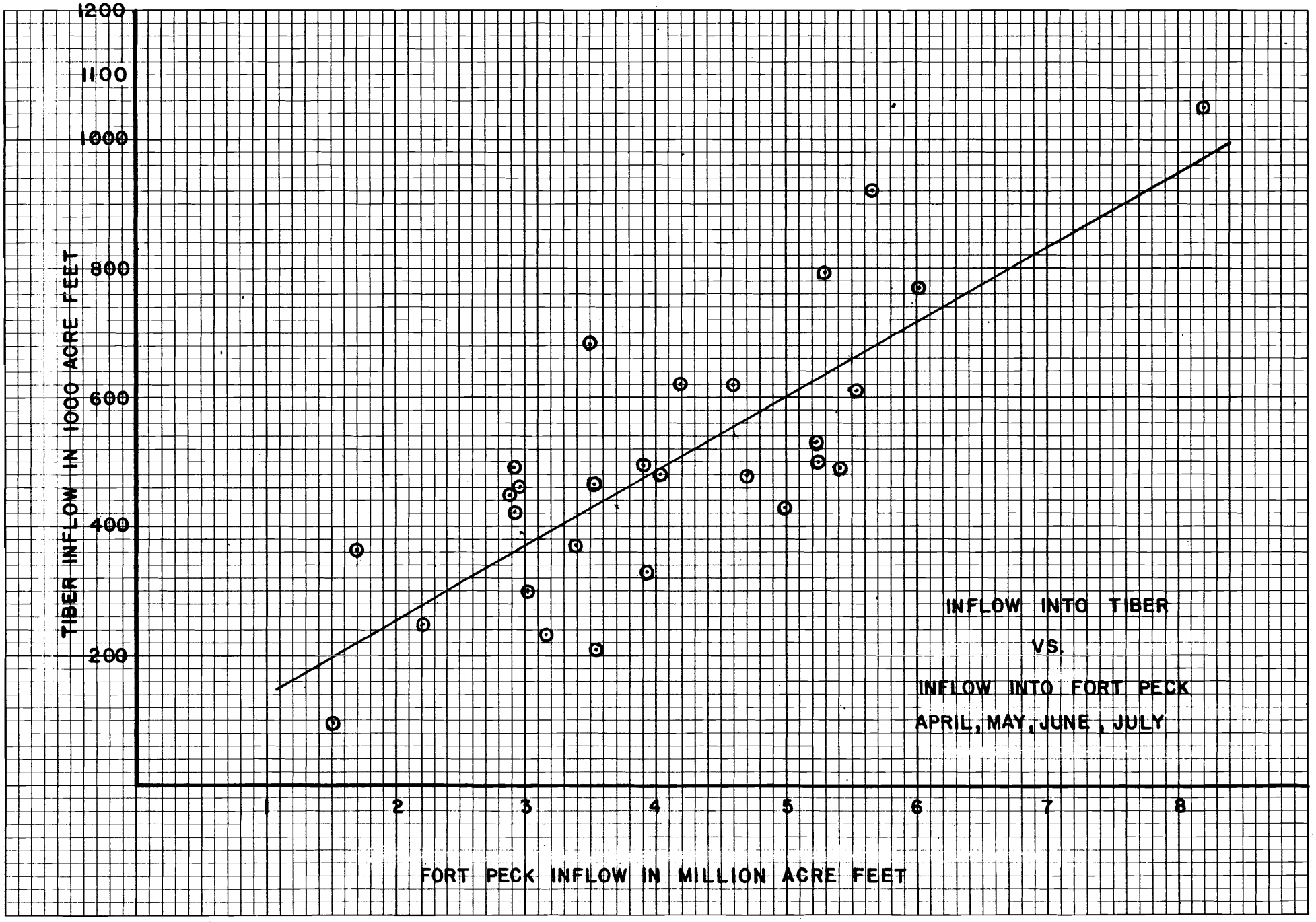
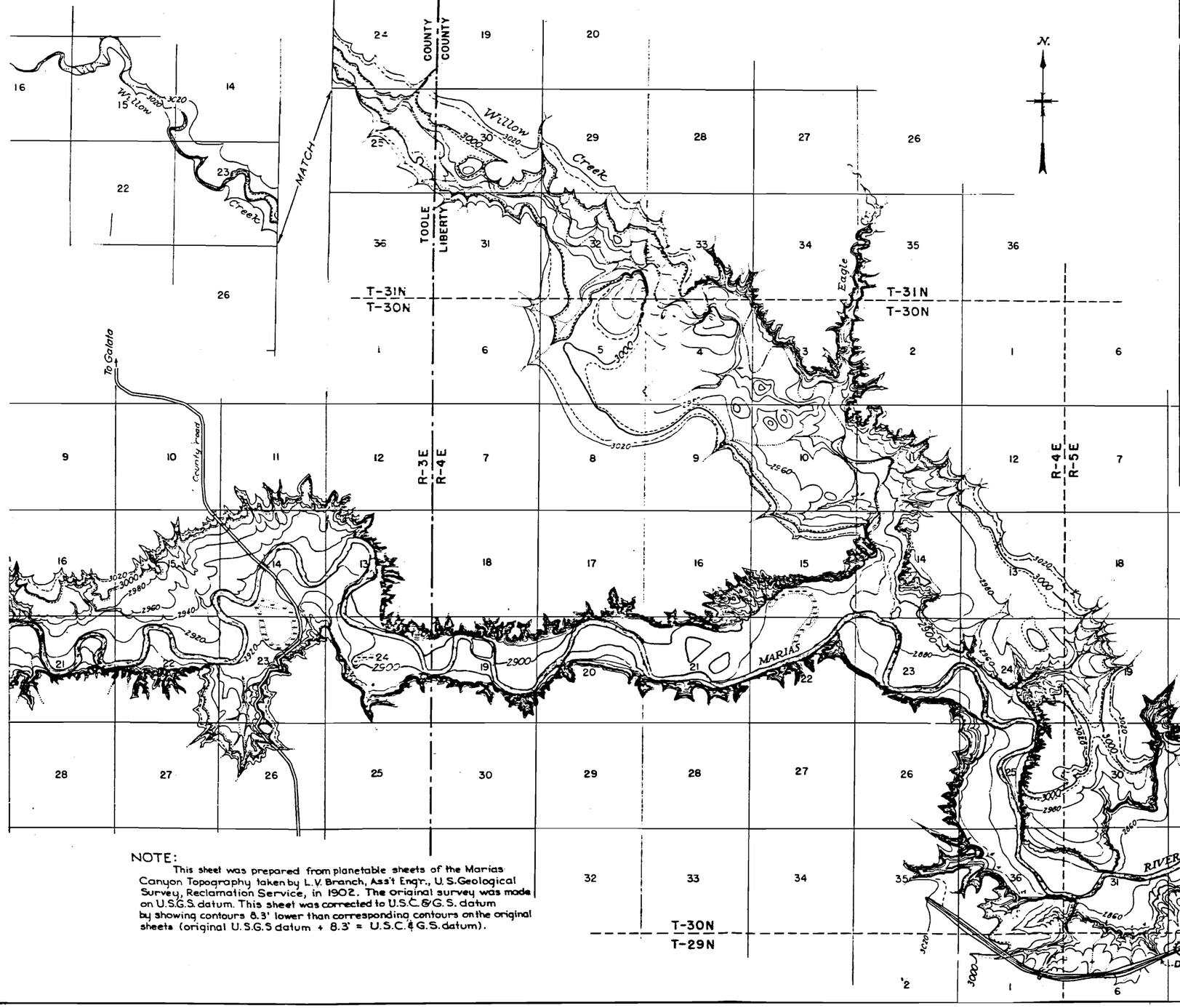
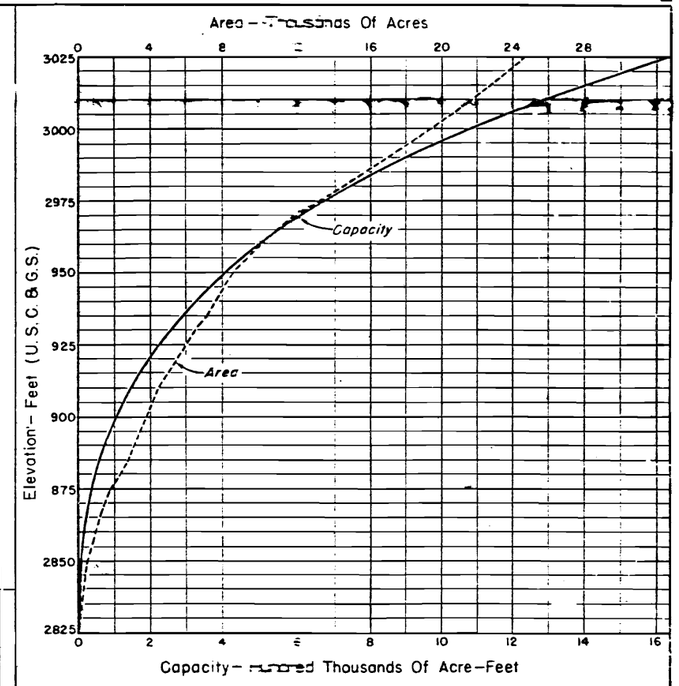


PLATE 6





AREA AND CAPACITY CURVES

* See latest form 7-1686, Reservoir Capacity Allocations and Area-Capacity Curves and table.

Scale Of Miles

Contour Interval – 20 Feet

NOTE:
This sheet was prepared from planetable sheets of the Marias Canyon Topography taken by L. V. Branch, Ass't Engr., U. S. Geological Survey, Reclamation Service, in 1902. The original survey was made on U.S.G.S. datum. This sheet was corrected to U.S.C.&G.S. datum by showing contours 8.3' lower than corresponding contours on the original sheets (original U.S.G.S datum + 8.3' = U.S.C.&G.S. datum).

3-26-73	ADDED NOTE.

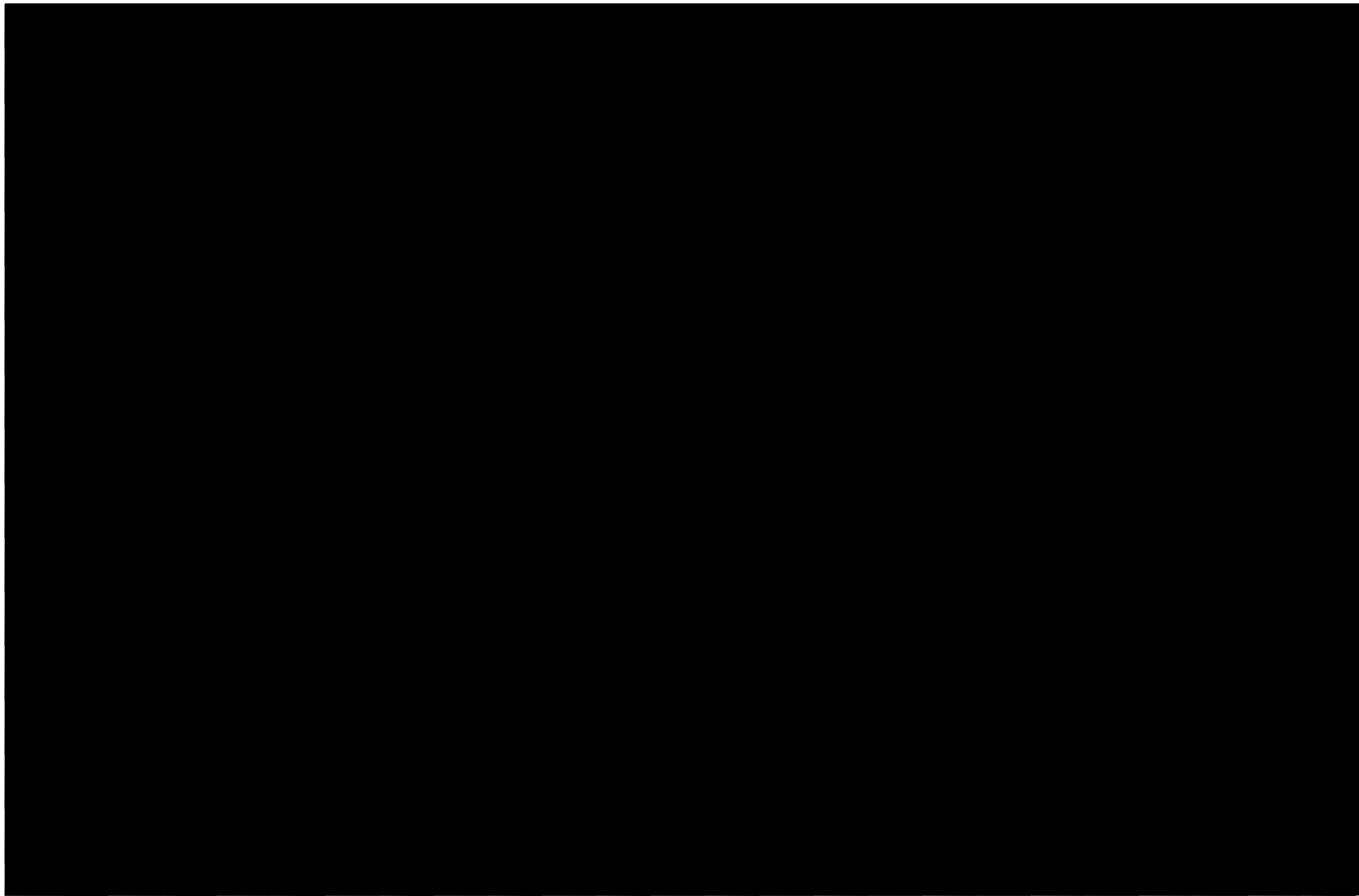
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
MISSOURI RIVER BASIN PROJECT
LOWER MARIAS UNIT – MONTANA

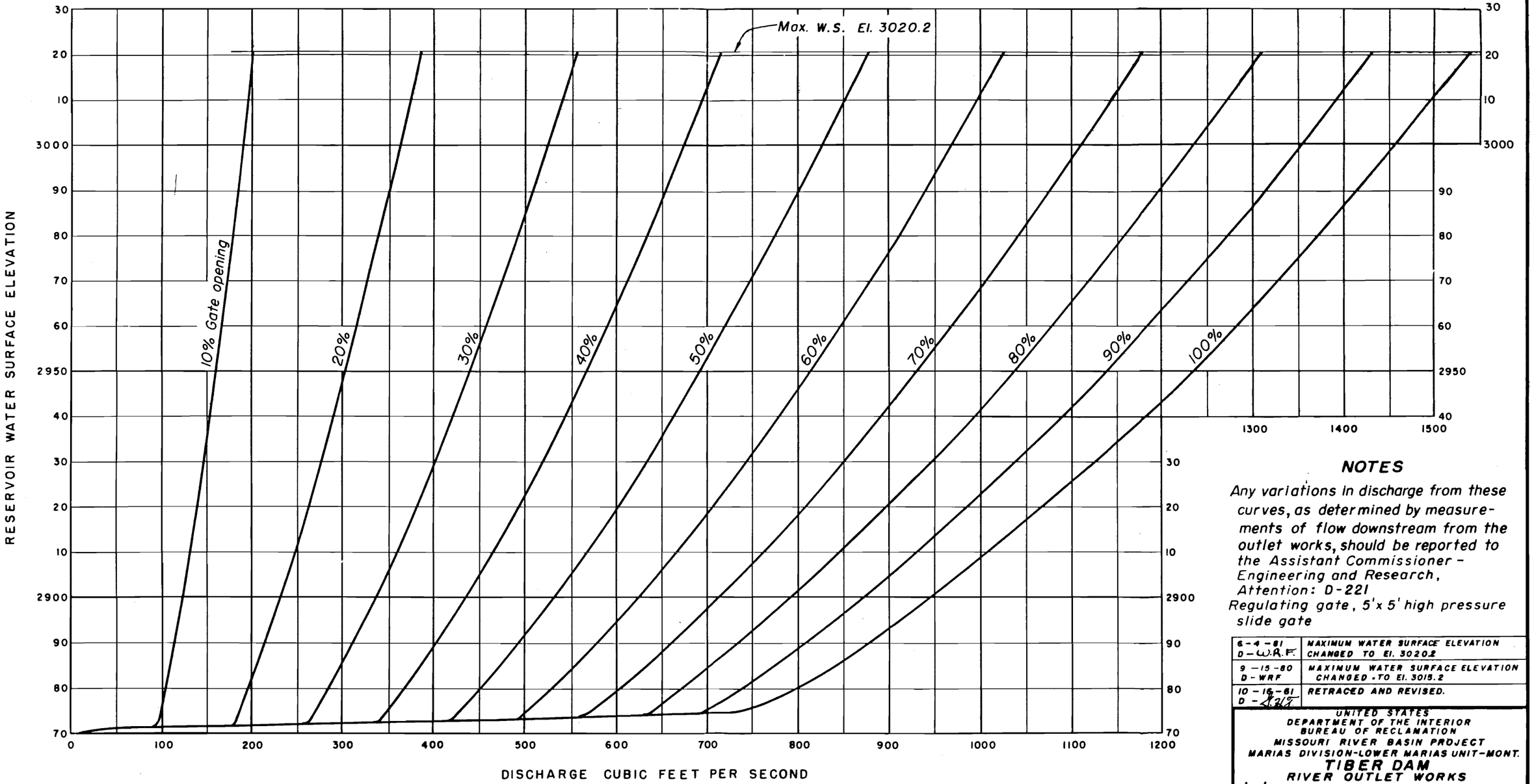
TIBER DAM AND DIKE LOCATION

DRAWN (SEE NOTE)	SUBMITTED	Roland C. Knight	
TRACED P.R.B.	RECOMMENDED	O. L. Rice	
CHECKED E.A. Ugd.	APPROVED	L. N. McClellan, Chief Engineer	
14-1-6	BILLINGS, MONTANA, FEB., 1944		84-D-77

PLATE 7

[redacted]





NOTES

Any variations in discharge from these curves, as determined by measurements of flow downstream from the outlet works, should be reported to the Assistant Commissioner - Engineering and Research, Attention: D-221

Regulating gate, 5'x 5' high pressure slide gate

6-4-81 D-W.R.F.	MAXIMUM WATER SURFACE ELEVATION CHANGED TO El. 3020.2
9-15-80 D-WRF	MAXIMUM WATER SURFACE ELEVATION CHANGED TO El. 3015.2
10-16-61 D-[illegible]	RETRACED AND REVISED.

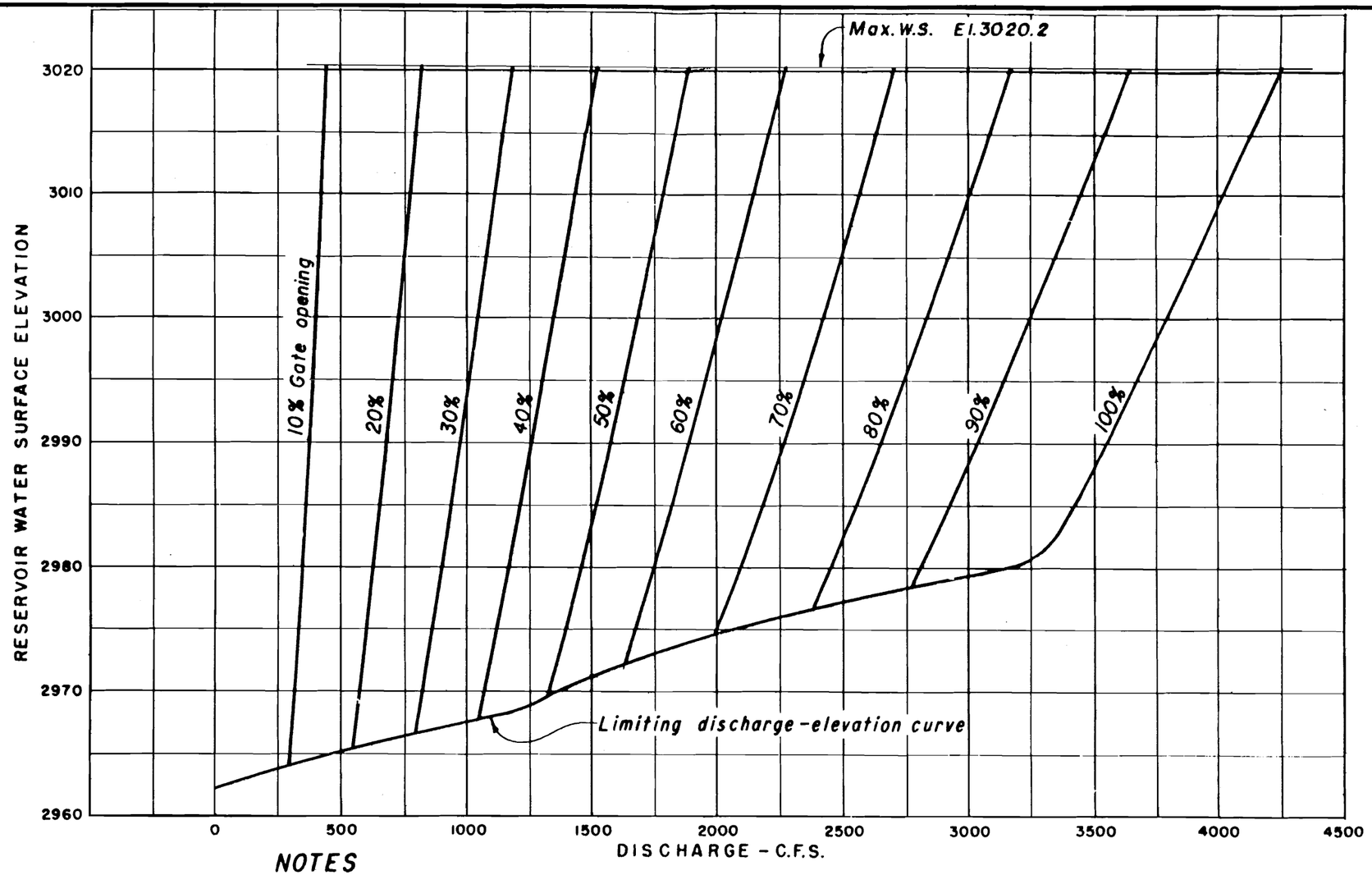
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
MISSOURI RIVER BASIN PROJECT
MARIAS DIVISION-LOWER MARIAS UNIT-MONT.

TIBER DAM
RIVER OUTLET WORKS
5'x5' H.P. REG. GATE DISCHARGE CURVES

DRAWN M.C.G. SUBMITTED R.W. Whinnergh
TRACED P.W.T. RECOMMENDED O.L. Rice
CHECKED G.H.T. APPROVED K.B. Keener
CHIEF DESIGN ENGR

DENVER, COLORADO 4-26-56 | 84-D-394

PLATE 12



NOTES

Regulating gate, 7.25' x 9.25' outlet gate.
Outlet gate must not be operated below "Limiting discharge - elevation curve".
Any variations in discharge from percent gate opening curves, as determined by measurements of flow downstream from the auxiliary outlet works, should be reported to the Assistant Commissioner—Engineering and Research, Attention: D-221

6-4-81 D-W.R.F.	MAXIMUM WATER SURFACE ELEVATION CHANGED TO El. 3020.2.
9-18-80 D-WRF	MAXIMUM WATER SURFACE ELEVATION CHANGED TO El. 3015.2.

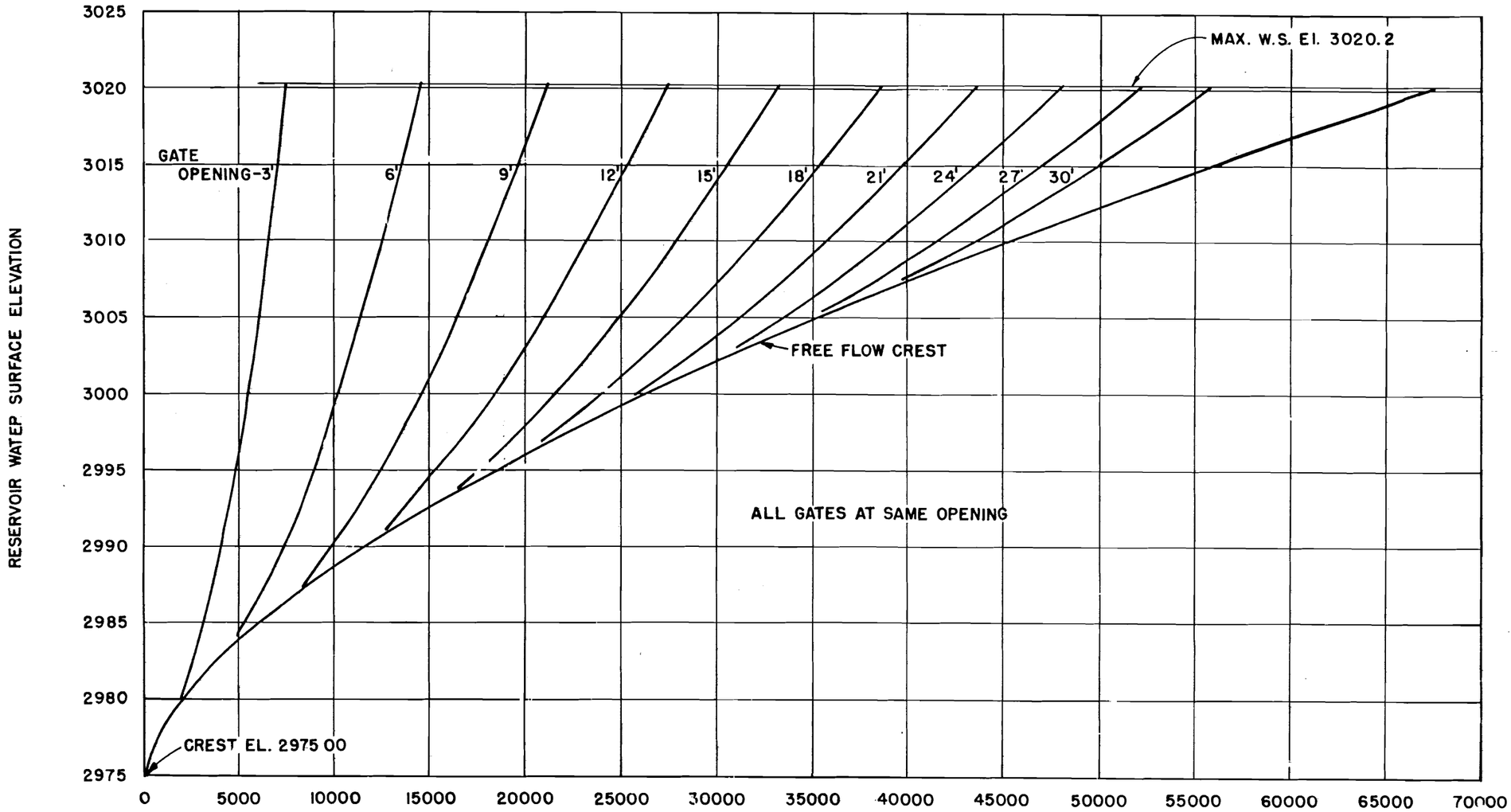
GIVE THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
MISSOURI RIVER BASIN PROJECT
MARIAS DIVISION - LOWER MARIAS UNIT - MONTANA

[redacted]

DENVER, COLO. OCT. 4, 1968 | 84-D-463

PLATE 14



NOTES

Three 22'x38' Radial Gates.

Any variation in discharge from this curve, as determined by flow measurements downstream of the spillway should be reported to the Assistant Commissioner - Engineering and Research, Attention: D-221

Gate openings are measured from spillway crest to bottom of gate.

6-4-81 D-W.R.F.	MAXIMUM WATER SURFACE ELEVATION CHANGED TO EI. 3020.2

ALWAYS THINK **SAFETY**

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
MISSOURI RIVER BASIN PROJECT
MARIAS DIVISION-LOWER MARIAS UNIT-MONTANA

TIBER DAM
SPILLWAY DISCHARGE CURVES

DESIGNED B.W.M. TECHNICAL APPROVAL
DRAWN
CHECKED W.R.F. APPROVED
CHIEF, DAMS BRANCH

DENVER, COLORADO SEPT. 15, 1980 | 84-D-609

PLATE 16

TIBER RESERVOIR

AREA IN ACRES

SEPTEMBER 1963

ELEVATION FEET	0	1	2	3	4	5	6	7	8	9
2820							6	8	13	17
2830	21	27	35	44	55	68	84	102	122	144
2840	168	197	227	257	287	316	330	344	358	373
2850	390	410	434	463	497	537	593	654	720	789
2860	861	931	1002	1072	1143	1213	1278	1343	1407	1471
2870	1535	1597	1661	1726	1793	1863	1942	2024	2107	2191
2880	2275	2352	2429	2505	2582	2660	2745	2830	2915	2998
2890	3079	3151	3220	3287	3351	3414	3475	3536	3598	3661
2900	3726	3797	3871	3949	4030	4116	4210	4307	4405	4505
2910	4605	4699	4792	4884	4975	5066	5156	5245	5332	5413
2920	5508	5625	5746	5869	5992	6113	6214	6313	6409	6505
2930	6601	6703	6807	6913	7020	7130	7241	7354	7468	7583
2940	7699	7811	7924	8039	8158	8280	8410	8544	8683	8825
2950	8972	9122	9275	9432	9593	9757	9929	10102	10278	10454
2960	10630	10800	10968	11136	11305	11475	11640	11809	11983	12166
2970	12359	12587	12825	13069	13315	13562	13787	14010	14233	14456
2980	14683	14925	15171	15417	15661	15904	16120	16336	16555	16780
2990	17016	17297	17589	17886	18186	18483	18749	19011	19270	19530
3000	19790	20069	20349	20630	20911	21189	21494	21717	21977	22237
3010	22497	22757	23019	23285	23555	23833	24137	24445	24754	25059
3020	25357	25644	25917	26172	26405	26613				

TIBER RESERVOIR

CAPACITY IN ACRE FEET

SEPTEMBER 1963

ELEVATION FEET	0	1	2	3	4	5	6	7	8	9
2820							2	8	19	34
2830	53	77	108	148	198	260	336	429	541	674
2840	830	1013	1225	1467	1739	2040	2368	2699	3050	3416
2850	3798	4198	4620	5069	5549	6066	6631	7255	7942	8697
2860	9522	10418	11385	12422	13530	14708	15954	17265	18640	20079
2870	21582	23148	24777	26471	28231	30059	31962	33945	36011	38160
2880	40393	42707	45098	47565	50109	52730	55433	58221	61094	64051
2890	67090	70205	73391	76645	79964	83347	86792	90298	93865	97495
2900	101189	104951	108785	112695	116685	120758	124921	129180	133536	137991
2910	142546	147198	151944	156782	161712	166733	171841	177034	182313	187681
2920	193142	198709	204395	210203	216134	222187	228351	234615	240976	247433
2930	253986	260638	267393	274253	281220	288295	295481	302779	310190	317716
2940	325357	333112	340980	348962	357061	365280	373625	382102	390716	399470
2950	408369	417416	426615	435969	445482	455157	465000	475016	485206	495572
2960	506114	516829	527713	538765	549986	561376	572934	584659	596555	608630
2970	620893	633366	646072	659019	672211	685650	699325	713224	727346	741691
2980	756261	771065	786113	801407	816946	832729	848741	864969	881415	898083
2990	914981	932138	949581	967319	985355	1003690	1022306	1041186	1060327	1079727
3000	1099387	1119317	1139526	1160016	1180787	1201837	1223159	1244745	1266592	1288699
3010	1311066	1333693	1356581	1379733	1403153	1426847	1450832	1475123	1499723	1524630
3020	1549838	1575339	1601120	1627165	1653454					

REVISED JULY 1966

PLATE 17

(1) 23 May 6030 15 June 4500 7 June 6660 15 May 4400 31 May 5500 20 May 3200 7 June 3000 9 June 95000 18 June 10700
(2) June* 2820 June* 3110 5 June 3750 9 June 2260 8 June 3070 23 Aug 2050 June* 1218 June* 10300 Sept-Oct* 3100

(1) MAXIMUM ANNUAL DAILY INFLOW IN C.F.S.
(2) MAXIMUM ANNUAL DAILY OUTFLOW IN C.F.S.
*Occurred on more than one day.

POOL ELEVATION IN FEET, M.S.L.

110
3000
2990
2980
2970
2960
2950
2940
2930
2920
2910
2900

MONTHLY INFLOW - OUTFLOW IN AC.FT.

110
100
90
80
70
600,000
500,000
400,000
300,000
200,000
100,000
0

Jan. Feb. Mar. Apr. May June July Aug. Sept Oct. Nov. Dec.

1956 1957 1958 1959 1060 1961 1962 1963 1964 1965

PLATE 18a

(1) 5 June 4800 -3 June 10500- 10 June 3310-28 June 5870- 16 June 7750- 29 May 6400- 13 March 11520- 21 May 4140- 18 June 5240-
(2) 8 June 3140 - June* 5308-June-July* 1302-20 May 2077- 8 June 3312- June* 3283 June* 3075 June-July* 656 May* 2170

(1) MAXIMUM ANNUAL DAILY INFLOW IN C.F.S.
(2) MAXIMUM ANNUAL DAILY OUTFLOW IN C.F.S.
*Occurred on more than one day

21 June 53100
June-July* 5777

POOL ELEVATION IN FEET, M.S.L.

MONTHLY INFLOW - OUTFLOW IN AC.FT.

3000 2990 2980 2970 2960 2950 2940 2930 2920 2910 2900

110 100 90 80 70 600,000 500,000 400,000 300,000 200,000 100,000 0

Jan. Feb. Mar. Apr. May June July Aug. Sept Oct. Nov. Dec.

1966 1967 1968 1969 1970 1971 1972 1973 1974 1975

47 3733

K+E 10 YEARS BY MONTHS X 110 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

PLATE 18b

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
(1)	12 June 5733	13 June 1406	21 March 11207	10 March 8855	27 May 10370	24 May 8895	13 April 6271	29 May 4300	2 June 2820	31 May 4860
(2)	May* 3049	Jan* 378	Mar-Apr* 2850	May* 2098	Aug* 2258	June* 3289	June* 3684	2 June 658	July-Aug* 628	Nov* 2131

(1) MAXIMUM ANNUAL DAILY INFLOW IN C.F.S.
(2) MAXIMUM ANNUAL DAILY OUTFLOW IN C.F.S.
*Occurred on more than one day.

POOL ELEVATION IN FEET, M.S.L.

MONTHLY INFLOW - OUTFLOW IN AC.FT.

3000, 2990, 2980, 2970, 2960, 2950, 2940, 2930, 2920, 2910, 2900

110, 100, 90, 80, 70, 600,000, 500,000, 400,000, 300,000, 200,000, 100,000, 0

Jan. Feb. Mar. Apr. May June July Aug. Sept Oct. Nov. Dec.

1976 _ | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985

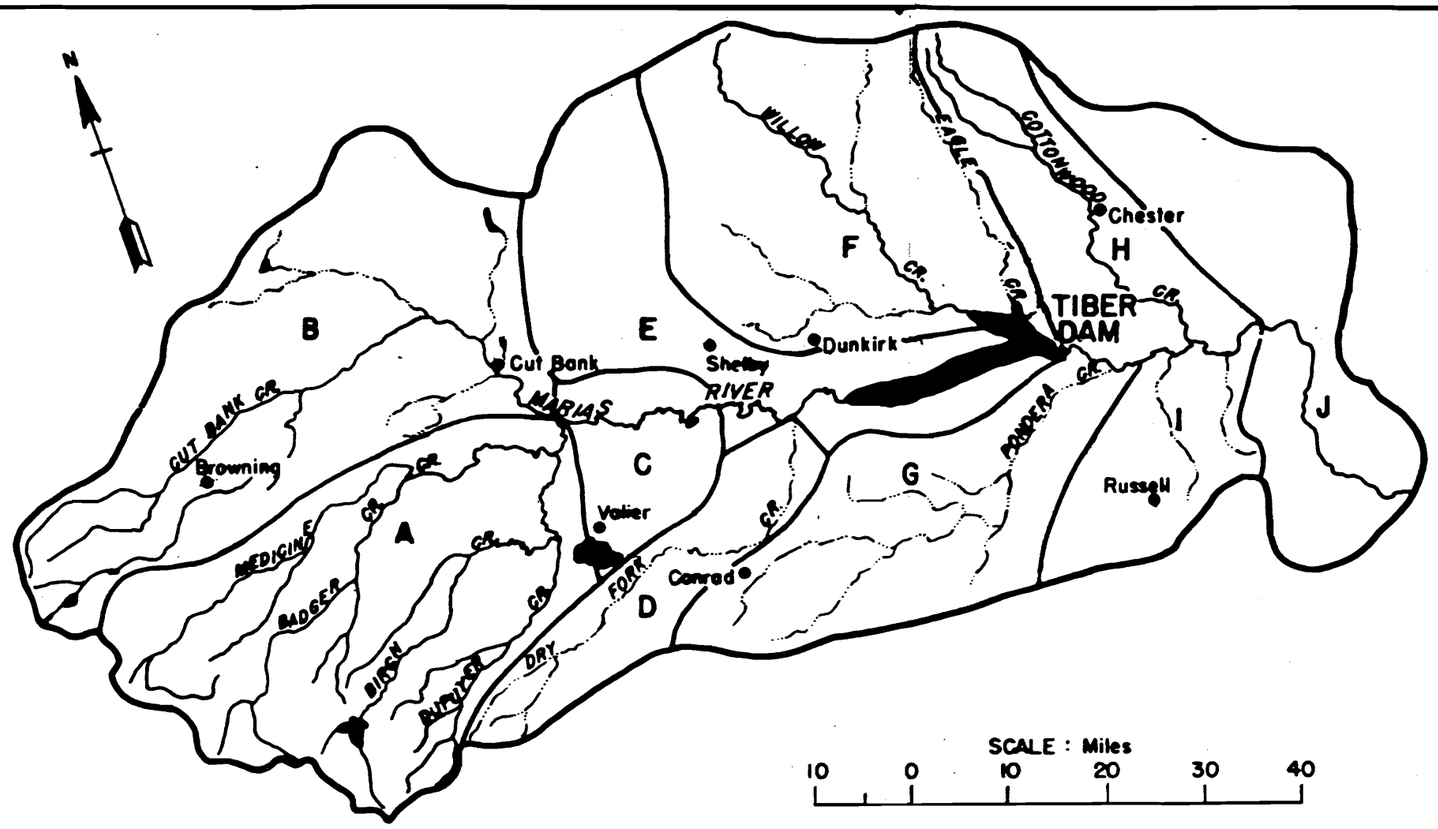
47 3733

K+E 10 YEARS BY MONTHS X 110 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

PLATE 18c

6-Hour Unit Hydrographs in Hundred C.F.S.

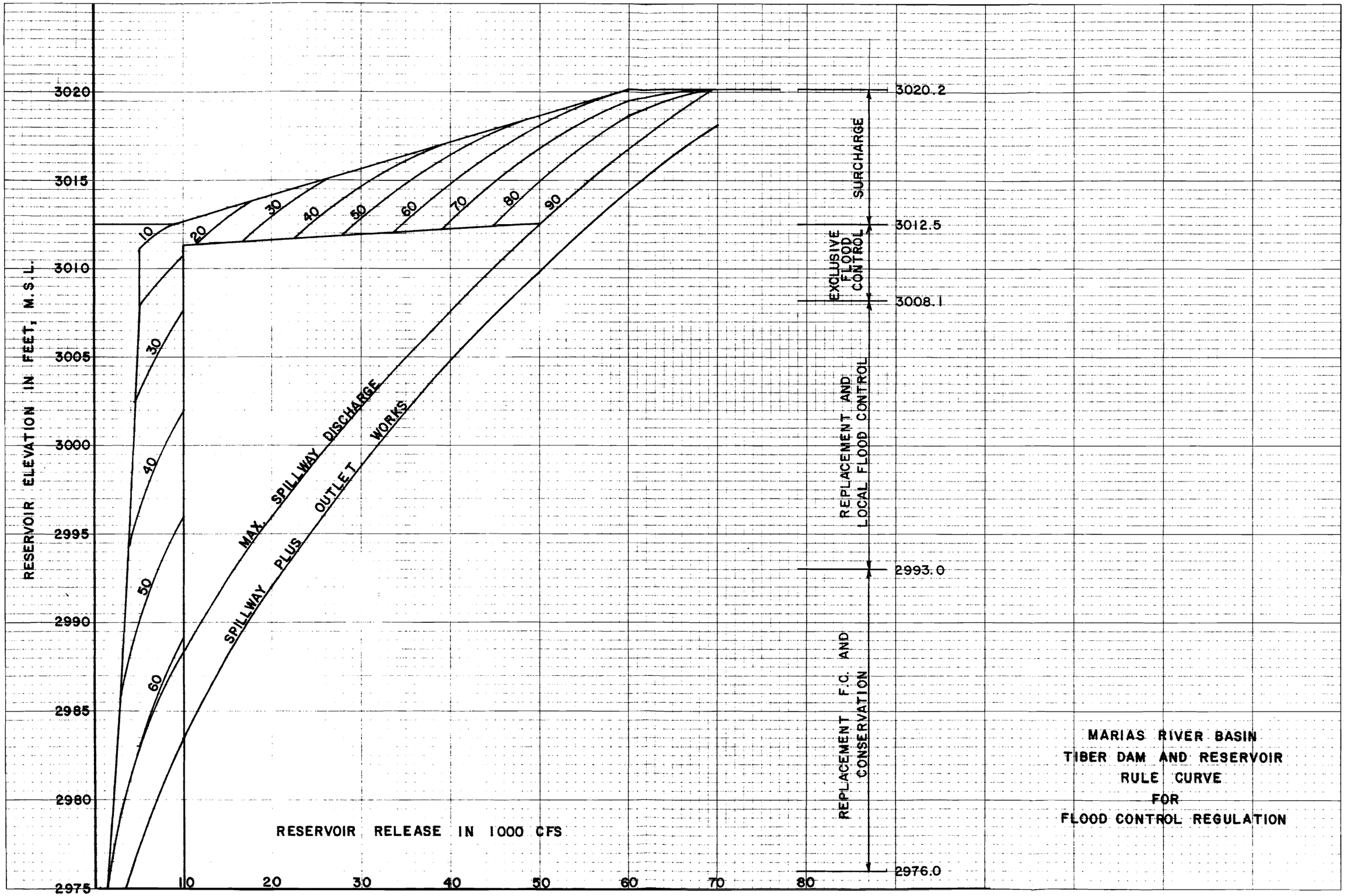
6-Hour Period	To Shelby			To Tiber Reservoir			To Mouth of Marias			
	A	B	C	D	E	F	G	H	I	J
1	4	3	17	3	8	17	2	3	2	13
2	14	16	41	10	23	49	5	11	9	44
3	37	44	41	23	42	91	14	25	21	71
4	64	78	30	36	58	110	26	45	33	89
5	90	106	24	41	66	100	38	57	38	84
6	102	114	20	40	68	87	47	62	38	73
7	101	109	16	35	65	73	54	54	33	64
8	93	97	13	30	61	63	54	45	29	57
9	86	86	11	25	55	56	51	39	25	51
10	79	78	10	22	49	50	46	34	22	45
11	73	70	8	19	44	45	41	30	19	41
12	67	64	7	17	40	40	37	26	17	36
13	61	58	6	16	37	36	34	23	15	32
14	56	52	4	14	34	32	31	20	13	28
15	51	47	3	13	31	27	28	18	11	25
16	46	42	2	12	28	24	25	15	9	22
17	42	37	1	10	26	21	23	13	8	19
18	38	33		9	23	18	20	12	7	16
19	34	29		8	21	15	18	11	6	14
20	30	25		6	19	12	16	9	5	12
21	27	22		5	17	10	14	8	4	9
22	24	19		4	14	8	13	7	3	8
23	21	16		3	12	6	11	6	2	6
24	18	13		2	10	4	10	4	1	4
25	15	10		1	9	3	8	3		3
26	13	8			7	2	7	2		2
27	11	6			6	1	6	1		1
28	9	4			5		5			
29	7	3			4		4			
30	5	2			3		3			
31	4	1			2		2			
32	3				1		1			
33	2									
34	1									
35										



MARIAS RIVER BASIN
TIBER DAM AND RESERVOIR
RESERVOIR REGULATION PLAN FOR FLOOD CONTROL

UNIT HYDROGRAPHS

U.S. ARMY ENGINEER DISTRICT, GARRISON
CORPS OF ENGINEERS, RIVERDALE, N. D.
JANUARY, 1959



MARIAS RIVER BASIN
TIBER DAM AND RESERVOIR
RULE CURVE
FOR
FLOOD CONTROL REGULATION

PLATE 20

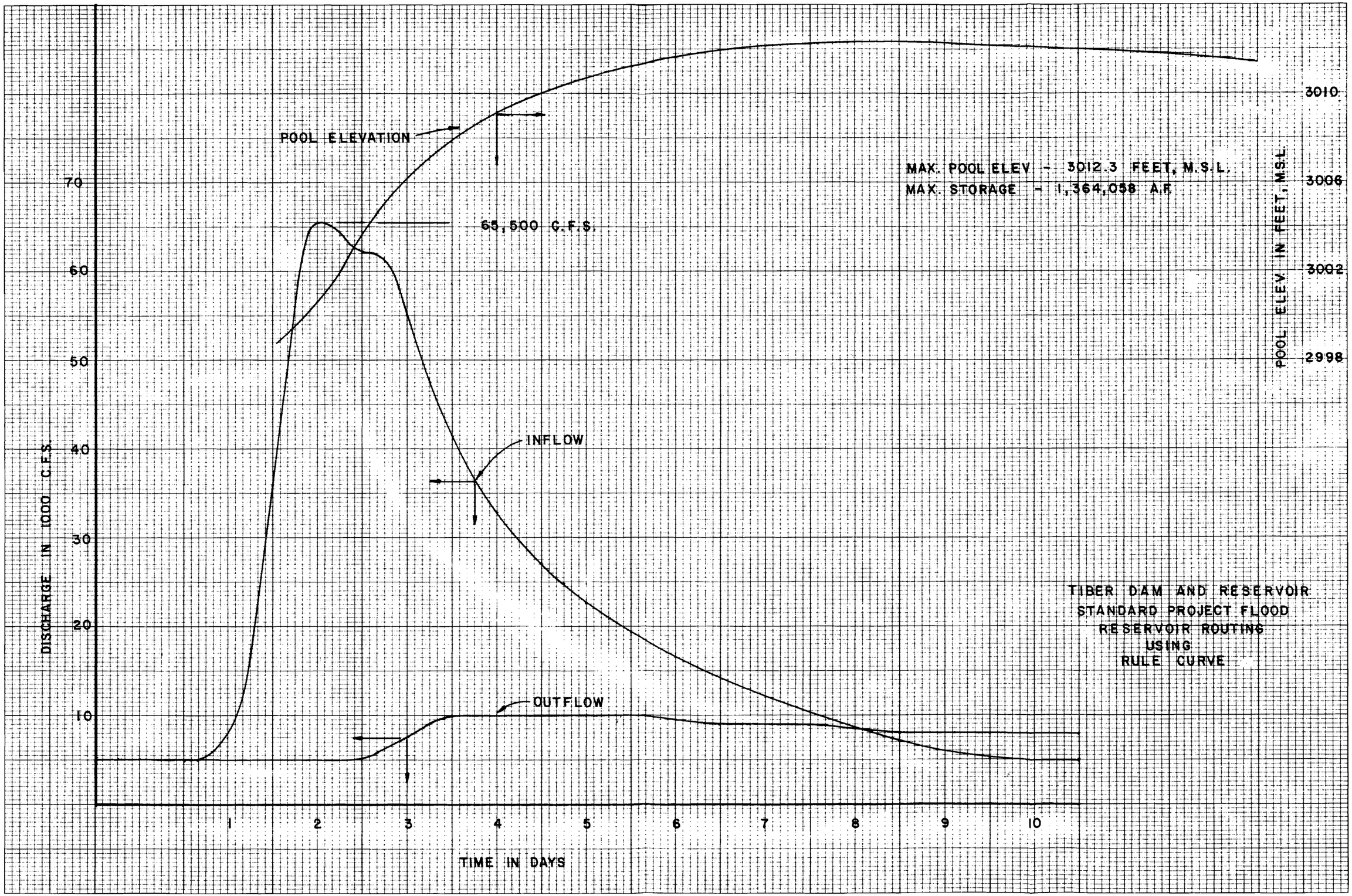


PLATE 21

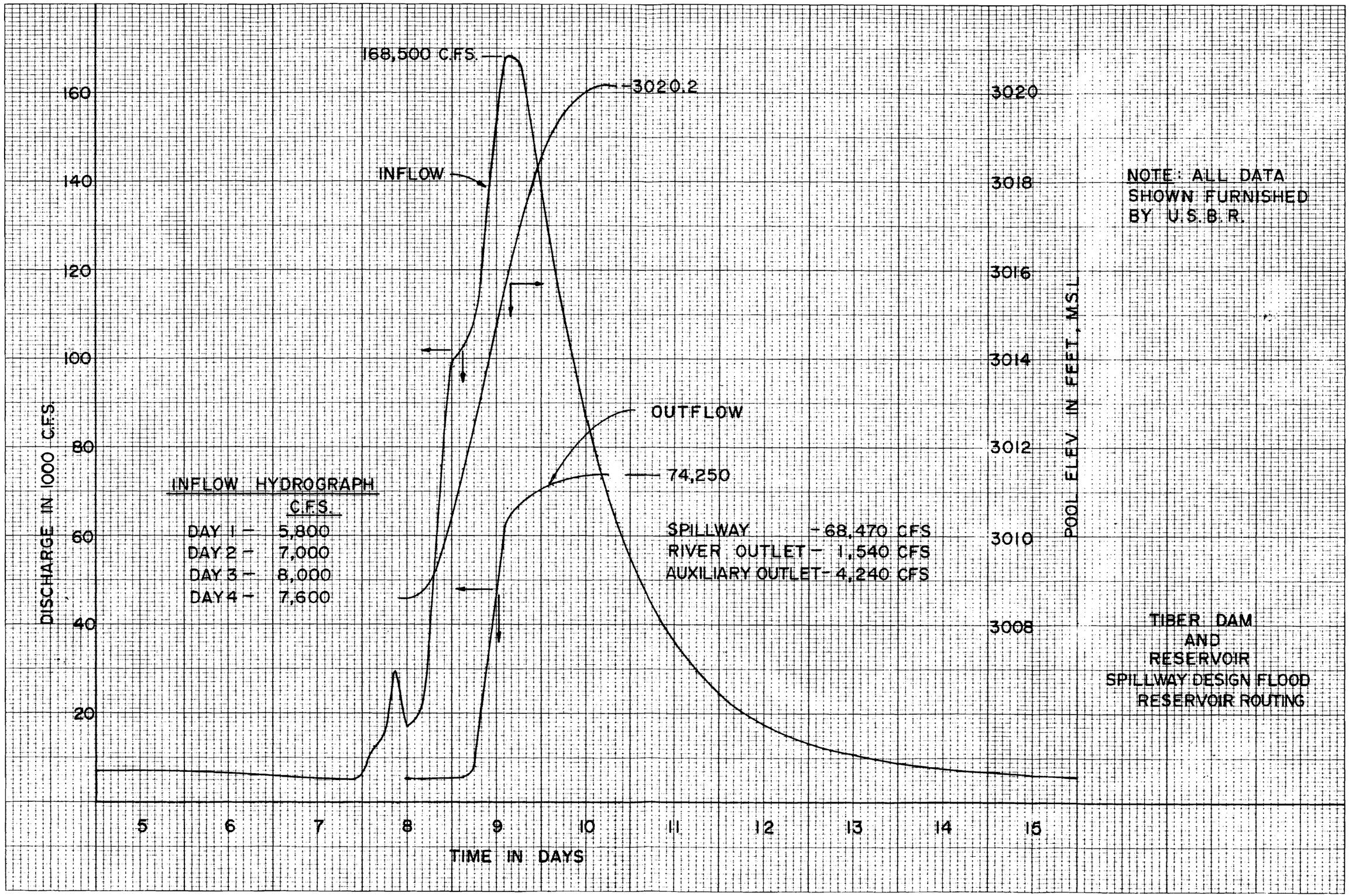
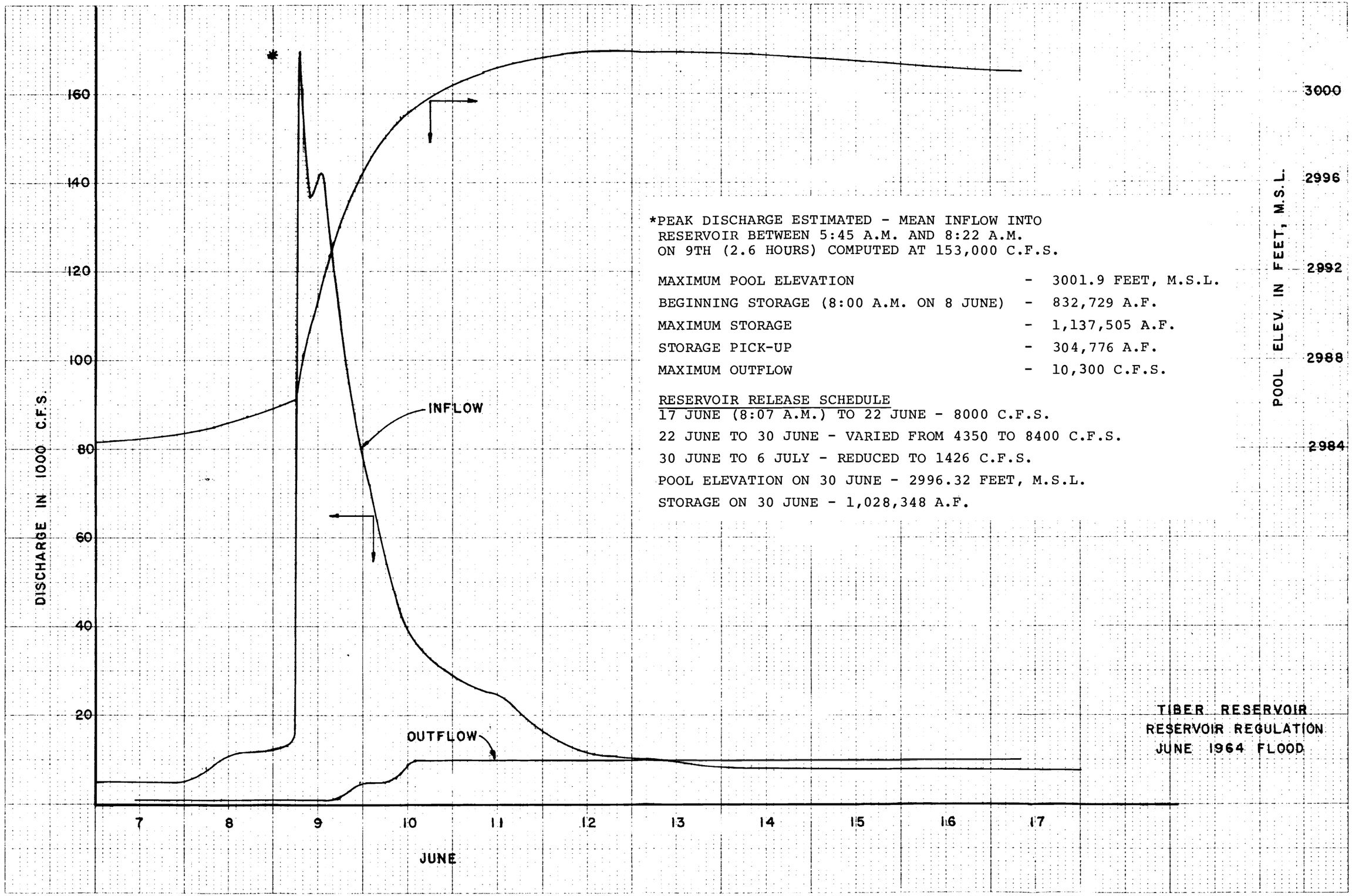


PLATE 22



*PEAK DISCHARGE ESTIMATED - MEAN INFLOW INTO RESERVOIR BETWEEN 5:45 A.M. AND 8:22 A.M. ON 9TH (2.6 HOURS) COMPUTED AT 153,000 C.F.S.

MAXIMUM POOL ELEVATION	-	3001.9 FEET, M.S.L.
BEGINNING STORAGE (8:00 A.M. ON 8 JUNE)	-	832,729 A.F.
MAXIMUM STORAGE	-	1,137,505 A.F.
STORAGE PICK-UP	-	304,776 A.F.
MAXIMUM OUTFLOW	-	10,300 C.F.S.

RESERVOIR RELEASE SCHEDULE

17 JUNE (8:07 A.M.) TO 22 JUNE - 8000 C.F.S.

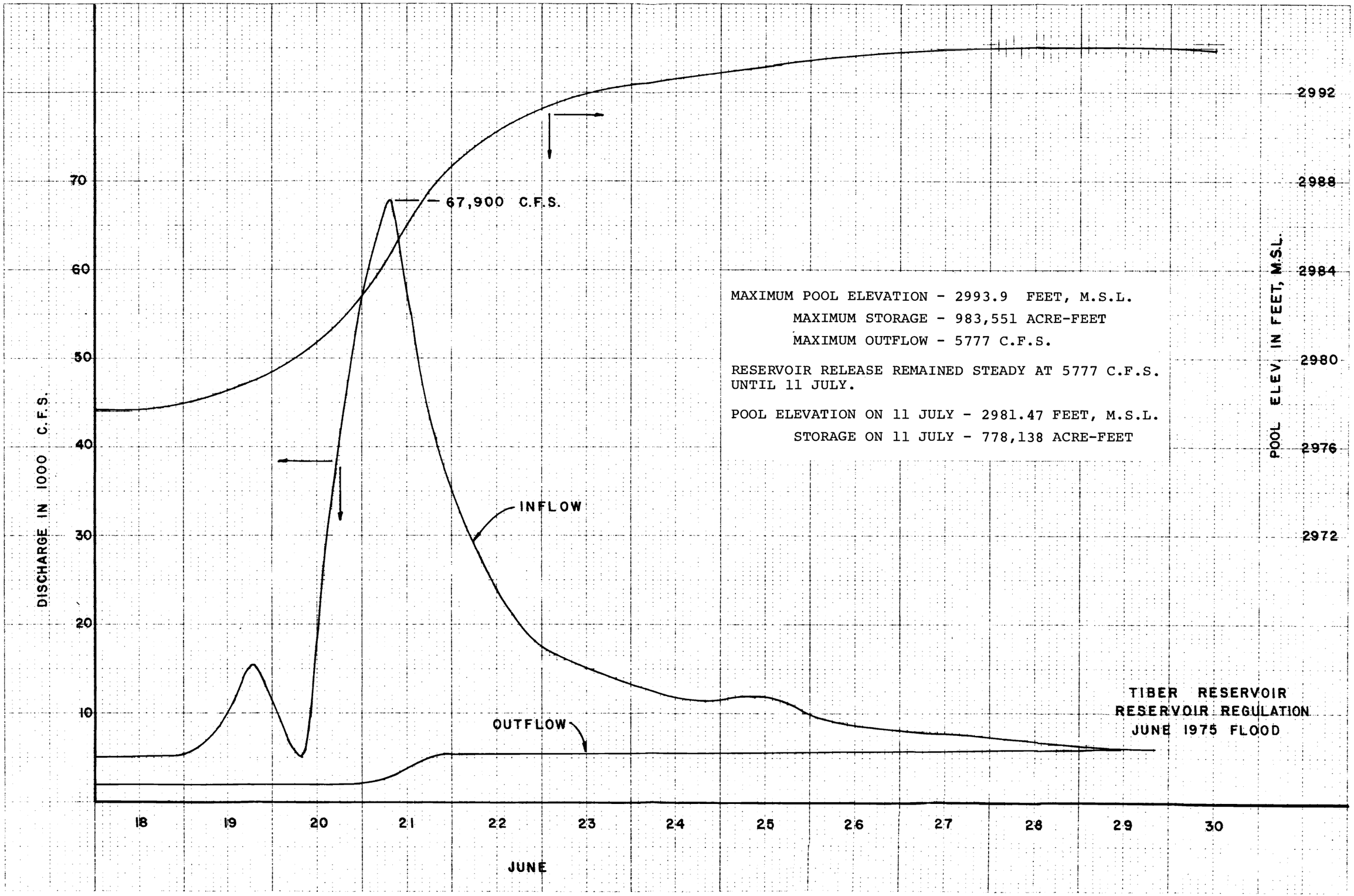
22 JUNE TO 30 JUNE - VARIED FROM 4350 TO 8400 C.F.S.

30 JUNE TO 6 JULY - REDUCED TO 1426 C.F.S.

POOL ELEVATION ON 30 JUNE - 2996.32 FEET, M.S.L.

STORAGE ON 30 JUNE - 1,028,348 A.F.

TIBER RESERVOIR
RESERVOIR REGULATION
JUNE 1964 FLOOD



MAXIMUM POOL ELEVATION - 2993.9 FEET, M.S.L.
MAXIMUM STORAGE - 983,551 ACRE-FEET
MAXIMUM OUTFLOW - 5777 C.F.S.

RESERVOIR RELEASE REMAINED STEADY AT 5777 C.F.S. UNTIL 11 JULY.

POOL ELEVATION ON 11 JULY - 2981.47 FEET, M.S.L.
STORAGE ON 11 JULY - 778,138 ACRE-FEET

TIBER RESERVOIR
RESERVOIR REGULATION
JUNE 1975 FLOOD