





**DEPARTMENT OF THE ARMY**  
**NORTHWESTERN DIVISION, CORPS OF ENGINEERS**  
**12565 WEST CENTER ROAD**  
**OMAHA, NEBRASKA 68144-3869**

**REPLY TO**  
**ATTENTION OF:**

December 2004

This Annual Operating Plan (AOP) presents information regarding the Corps of Engineers' regulation of the Missouri River Mainstem Reservoir System (System) through December 2005. The information provided in this AOP is based on water management guidelines designed to meet the regulation objectives of the Missouri River Master Water Control Manual dated March 19, 2004. These guidelines are applied to computer simulations of System regulation assuming inflow scenarios based on water supply records from 1898 to 1997. This approach provides a wide range of water management simulations for dry, average, and wet conditions.

The AOP provides a framework for the development of detailed monthly, weekly, and daily regulation schedules for the System's six individual dams during the upcoming year to serve its Congressionally authorized project purposes. In addition, 5-year extensions to the AOP water management simulations, through March 2011, are presented to serve as guides for longer range planning. System water management is provided by my staff at the Missouri River Basin Water Management Division, Northwestern Division, U.S. Army Corps of Engineers located in Omaha, Nebraska.

On December 16, 2003, and in response to the Corps's request for the reinitiation of consultation, the U.S. Fish and Wildlife Service (USFWS) issued an amendment to its 2000 Biological Opinion (2003 Amended BiOp). The 2003 Amended BiOp includes a "reasonable and prudent alternative" (RPA) that calls for a "spring pulse" and a low summer release from the Mainstem Reservoir System. The 2003 Amended BiOp allows a two-year period of study prior to implementing the spring pulse to establish an acceptable flow management plan, which will likely avoid jeopardy to the continued existence of the pallid sturgeon and will not result in the destruction or adverse modification of critical habitat in the Missouri River. While a spring pulse is planned for 2006, the USFWS confirmed in their November 30, 2004 letter, that a spring pulse is not planned for 2005. The 2003 Amended BiOp includes a provision that the low summer release may be modified, in consultation with the USFWS, if 1200 acres of shallow water habitat (SWH) for the endangered pallid sturgeon is constructed. In their letter, the USFWS also affirmed the Corps' plan to provide minimum service flow support in the summer of 2005 based on the construction of over 1200 acres of shallow water habitat during 2004.

A "steady release - flow-to-target" schedule is planned during the 2005 nesting season of the interior least tern and piping plover, which are listed for protection under the Endangered Species Act. The initial steady release (SR) will be based on hydrologic conditions and the availability of habitat at that time. Once the majority of the birds have nested on the newly constructed, high elevation habitat, releases will be made to meet downstream targets (FTT). The purpose of this regulation is to continue to meet the project purposes while minimizing the loss of nesting threatened and endangered species and conserving water in the upper three reservoirs. It also provided certainty for downstream users that releases could be increased if needed to meet flow targets.

The ability to provide steady to rising pool levels in the upper three reservoirs during the spring fish spawn period is very dependent on the volume, timing, and distribution of runoff. The reservoir regulation simulations presented in this AOP for the Upper Decile, Upper Quartile, and Median runoff scenarios show that steady to rising pool levels would occur for the upper three System reservoirs. For Lower Quartile and Lower Decile runoff scenarios, the Corps will, to the extent reasonably possible, set releases to result in steady to rising pools at Oahe during April and May, and steady to rising pools at Fort Peck during May and June. In 2004, we initiated a strategy to

rotate emphasis among the upper three System reservoirs on a yearly basis during their forage fish spawns. Even though this strategy has been modified for the 2005 AOP, we intend to continue to use this strategy during drought, in an attempt to maximize the benefit to fish species in those reservoirs.

A draft of this AOP was made available to the public in September 2004. Seven fall public meetings on the Draft 2004-2005 AOP were held as follows: October 12, 2004 in Williston, North Dakota; October 13, 2004 in Glasgow, Montana and Pierre, South Dakota; October 14, 2004 in Kansas City, Missouri; October 26, 2004 in Omaha, Nebraska; October 27, 2004 in New Orleans, Louisiana; and October 28, 2004 in St. Louis, Missouri. The primary purposes of these meetings were to present a synopsis of the Draft AOP and to allow those in attendance to make comments in person to Corps of Engineers' staff. Attendees included representatives from the Tribes, Missouri River basin states, public and industry interest groups and private citizens. Copies of the comment letters received on the Draft AOP and a report on the comments received at the seven meetings are available upon request, as outlined below.

In addition to the AOP, two separate documents are also available entitled: "System Description and Operation" and "Summary of Actual Calendar Year 2004 Operations." To receive copies of those documents you may contact the Water Management Division at 12565 West Center Road, Omaha, Nebraska 68144-3869, phone (402) 697-2676. The System Description and Operation document is now available at the "Reports and Publications" link on our web site at: [www.nwd.usace.army.mil/rcc](http://www.nwd.usace.army.mil/rcc) while the Summary of Actual Calendar Year 2004 Operations will be available in April 2005 at the same site.

We thank you for your interest in the regulation of the System. During this extended drought, the Corps is attempting to balance the needs of the entire basin. We believe our recently revised Master Manual and this AOP provide an appropriate balance of benefits to the various Congressionally authorized System project purposes. The basin must work together as a team - Federal, State and local agencies, as well as, the diverse stakeholders - and remain committed to preserving the Missouri River as a National treasure, allowing everyone to enjoy its beauty and many resources.



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# MISSOURI RIVER MAINSTEM RESERVOIR SYSTEM

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13	Tentative Five-Year Extension of 2004-2005 AOP
14	Tentative Five-Year Extension of 2004-2005 AOP

## ABBREVIATIONS

AOP	- annual operating plan
ac.ft.	- acre-feet
AF	- acre-feet
B	- Billion
cfs	- cubic feet per second
COE	- Corps of Engineers
CY	- calendar year (January 1 to December 31)
elev	- elevation
ft	- feet
FY	- fiscal year (October 1 to September 30)
GIS	- Geographic Information System
GWh	- gigawatt hour
KAF	- 1,000 acre-feet
Kcfs	- 1,000 cubic feet per second
kW	- kilowatt
kWh	- kilowatt hour
M	- million
MAF	- million acre-feet
MRBA	- Missouri River Basin Association
MRNRC	- Missouri River Natural Resources Committee
msl	- mean sea level
MW	- megawatt
MWh	- megawatt hour
plover	- piping plover
pp	- powerplant
RCC	- Reservoir Control Center
RM	- river mile
tern	- interior least tern
tw	- tailwater
USFWS	- United States Fish and Wildlife Service
USGS	- United States Geological Survey
yr	- year

## DEFINITION OF TERMS

Acre-foot (AF, ac-ft) is the quantity of water required to cover 1 acre to a depth of 1 foot and is equivalent to 43,560 cubic feet or 325,850 gallons.

Cubic foot per second (cfs) is the rate of discharge representing a volume of 1 cubic foot passing a given point during 1 second and is equivalent to approximately 7.48 gallons per second or 448.8 gallons per minute. The volume of water represented by a flow of 1 cubic foot per second for 24 hours is equivalent to 86,400 cubic feet, approximately 1.983 acre-feet, or 646,272 gallons.

Discharge is the volume of water (or more broadly, volume of fluid plus suspended sediment) that passes a given point within a given period of time.

Drainage area of a stream at a specific location is that area, measured in a horizontal plane, enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into the river above the specified point. Figures of drainage area given herein include all closed basins, or noncontributing areas, within the area unless otherwise noted.

Drainage basin is a part of the surface of the earth that is occupied by drainage system, which consists of a surface stream or body of impounded surface water together with all tributary surface streams and bodies of impounded water.

Gaging station is a particular site on a stream, canal, lake, or reservoir where systematic observations of hydrologic data are obtained.

Runoff in inches shows the depth to which the drainage area would be covered if all the runoff for a given time period were uniformly distributed on it.

Streamflow is the discharge that occurs in a natural channel. Although the term "discharge" can be applied to the flow of a canal, the word "streamflow" uniquely describes the discharge in a surface stream course. The term "streamflow" is more general than "runoff" as streamflow may be applied to discharge whether or not it is affected by diversion or regulation.

# MISSOURI RIVER MAINSTEM RESERVOIR SYSTEM

## Annual Operating Plan 2004 - 2005

### I. FOREWORD

This Annual Operating Plan (AOP) presents pertinent information and plans for regulating the Missouri River Mainstem Reservoir System (System) through December 2005 under widely varying water supply conditions. It provides a framework for the development of detailed monthly, weekly, and daily regulation schedules for the System's six individual dams during the coming year to serve the Congressionally authorized project purposes. Regulation is directed by the Reservoir Control Center in the Missouri River Basin Water Management Division, Northwestern Division, U. S. Army Corps of Engineers (Corps). A map of the Missouri River basin is shown on *Plate 1* and the summary of engineering data for the six System projects is shown on *Plate 2*.

This plan may require adjustments when substantial departures from expected runoff occur, to meet emergencies, or to meet the provisions of applicable laws, including the Endangered Species Act (ESA).

Prior to the 1998-1999 AOP, a System description and discussion of the typical System regulation, a historic summary of the previous year's regulation, and the plan for future System regulation was included in one document. Since the 1998-1999 AOP, this information has been published in separate reports available upon request. This document provides the plan for future regulation of the System. To receive a copy of either the updated version of the "System Description and Operation," dated Spring 2002, or the "Summary of Actual Calendar Year 2003 Operations," dated April 2004, contact the Missouri River Basin Water Management Division at 12565 West Center Road, Omaha, Nebraska 68144-3869, phone (402) 697-2676. Both reports are currently available at the "Reports and Publications" link on our web site at: **[www.nwd-mr.usace.army.mil/rcc](http://www.nwd-mr.usace.army.mil/rcc)**. The "Summary of Actual Calendar Year 2004 Regulation" will be available at the same site in the spring of 2005.



## **II. PURPOSE AND SCOPE**

Beginning in 1953, projected System reservoir regulation for the year ahead was developed annually as a basis for advance coordination with the various interested Federal, State, and local agencies and private citizens. Also beginning in 1953, a coordinating committee was organized to make recommendations on each upcoming year's System regulation. The Coordinating Committee on Missouri River Mainstem Reservoir Operations held meetings semiannually until 1981 and provided recommendations to the Corps. In 1982, the Committee was dissolved because it did not conform to the provisions of the Federal Advisory Committee Act. Since 1982, to continue providing a forum for public participation, one or more open public meetings are held semiannually in the spring and fall. The fall public meeting is conducted to take public input on a draft of the AOP, which typically is published in early October each year. The spring meetings are conducted to update the public on the current hydrologic conditions and projected System regulation for the remainder of the year as it relates to implementing the Final AOP.

Last spring's public meetings were held at the following locations and dates: April 5, 2004 at Omaha, Nebraska; April 6, 2004 at Lewistown, Montana; April 7, 2004 at Bismarck, North Dakota; and April 8, 2004 at Kansas City, Missouri. The attendees were given an update regarding the outlook for 2004 runoff and projected Mainstem reservoir regulation for the remainder of 2004. Preliminary Draft 2004-2005 AOP data was presented to the Missouri River Basin Association (MRBA) and to the Missouri River Natural Resources Committee (MRNRC) on August 12, 2004. Seven fall public meetings on the Draft 2004-2005 AOP were held as follows: October 12, 2004 in Williston, North Dakota; October 13, 2004 in Glasgow, Montana and Pierre, South Dakota; October 14, 2004 in Kansas City, Missouri; October 26, 2004 in Omaha, Nebraska; October 27, 2004 in New Orleans, Louisiana; and October 28, 2004 in St. Louis, Missouri. In the spring of 2005, public meetings will be held to discuss the basin's hydrologic conditions and the effects those conditions are expected to have on the implementation of the 2004-2004 Final AOP.

### **III. MAINSTEM MASTER MANUAL REVIEW AND UPDATE AND ESA CONSULTATIONS**

The Missouri River Master Water Control Manual (Master Manual) presents the water control plan and operational objectives for the integrated regulation of the Mainstem Reservoir System. First published in 1960 and subsequently revised during the 1970's, the Master Manual was revised again in March 2004 following the release of the U.S. Fish and Wildlife Service (USFWS) 2003 Amendment to the 2000 Biological Opinion (2003 Amended BiOp).

The "reasonable and prudent alternative" (RPA) presented in the 2003 Amended BiOp calls for a low summer release from the Mainstem Reservoir System of 25,000 cubic feet per second (cfs) each year beginning no later than July 1 and lasting for a minimum of 30 days. The 2003 Amended BiOp includes a provision that this low summer release may be modified, in consultation with the USFWS, if 1200 acres of shallow water habitat (SWH) for the endangered pallid sturgeon is constructed. During the summer of 2004 the Corps, in cooperation with the USFWS, other Federal agencies, and the states of Nebraska, Iowa, Kansas and Missouri, constructed more than 1200 acres of new SWH from Ponca State Park on the Nebraska-South Dakota border to the mouth of the Osage River in central Missouri to comply with the ESA. Therefore, this AOP and future AOPs will not include provisions for a low summer release.

The 2003 Amended BiOp also calls for a "spring pulse" from the System, but allows a two-year period of study to establish an acceptable flow management plan, which will likely avoid jeopardy to the continued existence of the pallid sturgeon and will not result in the destruction or adverse modification of critical habitat in the Missouri River. Although a spring rise is not planned in 2005, the Corps will be working closely with basin stakeholders over the coming year to develop a spring rise for inclusion in the 2005-2006 AOP.

#### IV. FUTURE WATER SUPPLY - AUGUST 2004 - DECEMBER 2005

Water supply (runoff) into the six System reservoirs is typically low and relatively stable during the August-to-February period. The August 1 calendar year runoff forecast is used as input to the Basic reservoir regulation simulation (Simulation) in the AOP studies for the period August 2004 to February 2005. Two other runoff scenarios based on the August 1 runoff forecast were developed for the same period. These are the 80 percent and 120 percent of the August 1 runoff forecast scenarios, which are input to the 80 percent and 120 percent of Basic Simulations for the August 2004 to February 2005 period.

Simulations for the March 1, 2005 to February 28, 2006 time period use five statistically derived inflow scenarios based on an analysis of water supply records from 1898 to 1997. This approach provides a good range of simulation for dry, average, and wet conditions, and eliminates the need to forecast future precipitation, which is very difficult.

The five statistically derived inflows are identified as the Upper Decile, Upper Quartile, Median, Lower Quartile and Lower Decile runoff conditions. Upper Decile runoff (34.5 million acre-feet (MAF)) has a 1 in 10 chance of being exceeded, Upper Quartile (30.6 MAF) has a 1 in 4 chance of being exceeded, and Median (24.6 MAF) has a 1 in 2 chance of being exceeded. Lower Quartile runoff (19.5 MAF) has a 1 in 4 chance of the occurrence of less runoff, and Lower Decile (15.5 MAF) has a 1 in 10 chance of the occurrence of less runoff. There is still a 20 percent chance that a runoff condition may occur that has not been simulated; i.e., a 10 percent chance runoff could be lower than Lower Decile, and a 10 percent chance runoff could be greater than Upper Decile.

The Upper Decile and Upper Quartile simulations extend from the end of the 120 percent of Basic simulation through February 2006. Likewise, the Median simulation extends from the end of the Basic simulation, and the Lower Quartile and Lower Decile simulations extend from the end of the 80 percent of Basin simulation through February 2006.

The estimated natural flow at Sioux City, the corresponding post-1949 water use effects, and the net flow available above Sioux City are shown in *Table I*, where water supply conditions are quantified for the period August 2004 through February 2006. The natural water supply for calendar year (CY) 2003 totaled 17.6 MAF.

**TABLE I**  
**NATURAL AND GROSS WATER SUPPLY AT SIOUX CITY**  
**(Volumes in 1,000 Acre-Feet)**

	<u>Natural</u> <sup>1/</sup>	<u>Post-1949 Depletions</u>	<u>Net</u> <sup>2/</sup>
	(Volumes in 1,000 Acre-Feet)		
August 2004 through February 2005 (Basic Runoff Scenario)			
Basic	5,800	-300	5,500
120% Basic	6,900	-100	6,800
80% Basic	4,600	-100	4,500
Runoff Year March 2005 through February 2006 (Statistical Analysis of Past Records)			
Upper Decile	34,500	-2,500	32,000
Upper Quartile	30,600	-2,600	28,000
Median	24,600	-2,600	22,000
Lower Quartile	19,500	-2,700	16,800
Lower Decile	15,500	-2,500	13,000

<sup>1/</sup> The word “Natural” is used to designate flows adjusted to the 1949 level of basin development, except that regulation and evaporation effects of the Fort Peck reservoir have also been eliminated during its period of regulation prior to 1949.

<sup>2/</sup> The word “Net” represents the total streamflow after deduction of the post-1949 irrigation, upstream storage, and other use effects.

## **V. ANNUAL OPERATING PLAN FOR 2004-2005**

**A. General.** The anticipated regulation described in this AOP is designed to meet the regulation objectives presented in the March 2004 Master Manual. Consideration has been given to all of the authorized project purposes, and to the needs of threatened and endangered (T&E) species. The plan relies on a wealth of regulation experience. Reservoir regulation experience available for preparation of the 2004-2005 AOP includes 13 years of regulation at Fort Peck (1940) by itself, plus 51 years of System experience as Fort Randall (1953), Garrison (1955), Gavins Point (1955), Oahe (1962), and Big Bend (1964) have been brought progressively into System regulation. This regulation experience includes lessons learned during the six consecutive years of drought from 1987 through 1992, the high runoff period that followed, and the current five-year drought that began in 2000. Runoff during the period 1993 to 1999 was greater than the Upper Quartile level in five of those seven years, including the record 49.0 MAF of runoff in 1997. In addition to the long period of actual System reservoir

regulation experience, many background regulation studies for the completed System are available for reference.

As described in the Master Manual, flow support for navigation and other downstream purposes is defined based on service level. A “full-service” level of 35,000 cfs results in target flows of 31,000 cfs at Sioux City and Omaha, 37,000 cfs at Nebraska City and 41,000 cfs at Kansas City. Similarly, a “minimum service” level of 29,000 cfs results in target values of 6,000 cfs less than the full service levels. Selection of the appropriate service level is based on the actual volume of water-in-storage (storage) in the System on March 15 and July 1.

The relation of System storage to navigation service level is presented in *Table II*. The volumes presented in *Table II* were derived from long-range model simulations that helped identify how the System should be regulated to meet authorized purposes during significant multi-year droughts. Straight-line interpolation defines intermediate service levels between full and minimum service. These service level determinations are for conservation and normal System regulation. During years when flood evacuation is required, the service level is calculated monthly to facilitate a smooth transition in System release.

As shown in *Table II*, the water control plan calls for suspension of navigation service if System storage is at or below 31 MAF on March 15 of any year. It should be noted that the occurrence of System storage at or below 31 MAF would likely coincide with a national drought emergency. If any of the reservoir regulation studies performed for the development of an AOP indicate that System storage will be at or below 31 MAF by the upcoming March 15, the Corps will notify the Secretary of the Army. Per the revised Master Manual, the Corps will obtain approval from the Secretary of the Army prior to implementation of back-to-back non-navigation years.

**TABLE II**  
**RELATION OF SYSTEM STORAGE TO NAVIGATION SERVICE LEVEL**

<u>Date</u>	<u>System Storage (MAF)</u>	<u>Navigation Service Level</u>
March 15	54.5 or more	35,000 cfs (full-service)
March 15	49.0 to 31	29,000 cfs (minimum-service)
March 15	31.0 or less	No navigation service
July 1	57.0 or more	35,000 cfs (full-service)
July 1	50.5 or less	29,000 cfs (minimum-service)

The System storage check for navigation season length is made on July 1 of each year. Assuming the System storage is above 31 MAF on March 15, a navigation season will be supported. A full 8-month navigation season will be provided if System storage is 51.5 MAF or above on July 1, unless the navigation season is extended to evacuate flood control storage. However, if System storage falls below 51.5 MAF on July 1, a shortened navigation season will be provided to conserve water. The specific technical criteria for season length are shown in *Table III*. Straight-line interpolation between 51.5 and 46.8 MAF of storage on July 1 provides the closure date for a season length between 8 and 7 months. If System storage on July 1 is between 46.8 and 41.0 MAF, a 7-month navigation season is provided. A straight-line interpolation is again used between 41.0 and 36.5 MAF, providing season lengths between 7 and 6 months. For System storage on July 1 below 36.5 MAF, a 6-month season is provided.

**TABLE III**  
**RELATION OF SYSTEM STORAGE TO NAVIGATION SEASON LENGTH**

<u>Date</u>	<u>System Storage (MAF)</u>	<u>Season Closure Date at Mouth of the Missouri River</u>
July 1	51.5 or more	December 1 (8-month season)
July 1	46.8 through 41.0	November 1 (7-month season)
July 1	36.5 or less	October 1 (6-month season)

The System release required to meet minimum and full service target flows varies by month in response to downstream tributary flows. An analysis of the average monthly Gavins Point release needed to meet flow targets was completed in 1999. As part of that study, the relationship between annual runoff upstream of Sioux City and the average Gavins Point release required for the navigation season was analyzed. The study showed that generally more water was needed downstream to meet flow targets during years with below normal upper basin runoff than during years with higher upper basin runoff. Therefore, regulation studies performed since 1999 use two levels of System release requirements; one for Median, Upper Quartile, and Upper Decile runoff scenarios, and another for Lower Quartile and Lower Decile scenarios. The updated release requirements for full and minimum service flow support are given in *Table IV*. Releases required for minimum service flow support are 6,000 cfs less than full service support. A final report detailing the procedures used in this study is available on our web site.

An examination of the data presented in *Table IV* reflects that, early in the season, the target location is generally at Sioux City with adequate tributary flows to meet the other downstream flow targets. As the runoff season progresses, tributary

flows normally recede during the summer, and the target location moves from Sioux City to Nebraska City and then to Kansas City. This requires higher flow support from the System as the season progresses through summer. Often the target moves upstream during the fall when higher downstream tributary flows return. This seasonal tributary flow pattern is reflected in the Gavins Point release data presented below.

The releases presented in *Table IV* are average monthly values during the period studied for various runoff conditions and do not reflect the range of daily releases that may be required during any given month to meet flow targets. Actual regulation, therefore, requires daily adjustments to fully serve the Congressionally authorized project purpose of navigation. An additional analysis was conducted in the spring of 2003 that concluded a 30,000 cfs release would be needed to provide a 90 percent assurance of meeting minimum service flow targets in July and August. That study was based on runoff data from the period of record 1898 through 1997.

**TABLE IV**  
**GAVINS POINT RELEASES NEEDED TO MEET TARGET FLOWS**  
**FOR INDICATED SERVICE LEVEL**  
**1950 to 1996 Data**  
**(Discharges in 1,000 cfs)**

	<b><u>Median, Upper Quartile, Upper Decile Runoff</u></b>								
	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	
Full Service	26.7	28.0	27.9	31.6	33.2	32.6	32.0	31.1	
Minimum Service	20.7	22.0	21.9	25.6	27.2	26.6	26.0	25.1	
	<b><u>Lower Quartile, Lower Decile Runoff</u></b>								
	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	
Full Service	29.8	31.3	31.2	34.3	34.0	33.5	33.1	31.2	
Minimum Service	23.8	25.3	25.2	28.3	28.0	27.5	27.1	25.2	

In general, releases from Gavins Point are adjusted as needed to meet target flow levels on the lower Missouri River. However, during the nesting season of the endangered interior least tern (tern) and the threatened piping plover (plover), care must be taken to avoid impacts to nesting areas. These two bird species are listed as threatened and endangered under the ESA and are protected under that Act. Several scenarios have been used in past years to regulate the System during the nesting season. Under the Steady-Release (SR) scenario, when the birds begin to initiate nesting activities in early to mid-May, the release from Gavins Point is set to the level expected to be required to meet downstream flow targets through August and maintained at that level until the end of the nesting season. This regulation results in releases that exceed the amount necessary to meet downstream flow targets during the early portion of the nesting season, and may result in targets being missed if basin conditions are drier than

expected during the summer. The SR scenario prevents the birds from nesting at low elevations that would subsequently be inundated if higher releases were required later in the nesting season. One tradeoff of the SR scenario is availability of habitat. Although the full habitat potential of the reach is not made available during the current nesting season, the SR scenario conserves habitat over the long run by preventing seed germination and by reducing erosion.

Gavins Point releases, under the Flow-to-Target (FTT) scenario, are adjusted as needed throughout the nesting season to meet downstream flow targets and would typically result in increasing releases as the nesting season progresses. This is due to reduced tributary inflows downstream as the summer heat builds, evaporation increases, and precipitation wanes. Increasing releases as the nesting season progresses can inundate nests and chicks on low-lying emergent sandbar habitat. Compared to the SR scenario, this scenario conserves more water in the System, which keeps the pool levels at the upper three System projects at relatively higher levels. However, this scenario also increases the risk of inundating nests. The FTT scenario also ensures that targets on the lower river are met throughout the nesting season.

A third scenario for Gavins Point releases, which combines features of the other two options, was used during the 2003 nesting season. This scenario, called the Steady Release - Flow-to-Target (SR-FTT) scenario, sets Gavins Point releases at an initial steady rate, and then allows releases to be adjusted upward or downward during the nesting season to meet downstream flow targets, if necessary. Compared to the SR scenario, this regulation may make a larger amount of habitat available early in the nesting season and save additional water in the upper three reservoirs depending on where the initial steady release is set. As with the SR scenario, the full habitat potential of the reach is not made available during the current nesting season, however, the SR-FTT scenario conserves habitat over the long run by preventing seed germination and by reducing erosion. The SR-FTT scenario also reduces the potential for flooding nests when compared to the FTT scenario. The SR-FTT regulation also provides certainty for downstream users that releases could be increased if needed to meet Missouri River flow targets.

**B. 2004-2005 AOP Simulations.** AOP simulations for the five runoff scenarios are shown in the final section of this AOP as studies 4 through 8. Results of the simulations are shown in *Plates 3 and 4* for the System storage and the Fort Peck, Garrison and Oahe pool elevations. The March 15 and July 1 System storage checks from *Tables II and III* were used to determine the level of flow support and the navigation season length. For modeling purposes in this AOP, the SR regulation scenario is shown during the 2005 nesting season. The August minimum service release shown in *Table IV* was used for June through August. The May minimum service release shown in *Table IV* was used for two-thirds of the days in May and the August minimum service release was used for the other third to reflect every third day peaking



from Gavins Point. However, the planned regulation for the 2005 nesting season will be SR-FTT. This regulation is expected to use slightly less water than indicated in the AOP model runs depending on actual hydrologic conditions in the summer of 2005. The initial steady release (SR) will be based on hydrologic conditions and the availability of habitat at that time. Once the majority of the birds have nested on the newly constructed, high elevation habitat, releases will be made to meet downstream targets (FTT). It is anticipated that sufficient habitat will be available above the planned release rates to provide for successful nesting. The purpose of this regulation is to continue to meet the project purposes while minimizing the loss of nesting T&E species and conserving water in the upper three reservoirs.

*Table IV* values were used in all the AOP studies for navigation support during the spring and fall months. Winter 2004-2005 and winter 2005-2006 releases of 12,500 cfs are shown in the simulations. This is lower than recent actual winter releases required for downstream powerplants and water supply intakes, but on-going modification of intakes will permit lower winter releases as a conservation measure when System storage is low. Non-winter, non-navigation releases were modeled at 11,000 cfs as a further water conservation measure, although the goal is to reduce Gavins Point releases to as low as 9,000 cfs, as described in the 2004 Mainstem Master Manual, provided downstream tributary flows are adequate to serve water supply requirements. Adequate tributary flows in the Missouri River reach below the System allowed this goal to be achieved in the fall of 2004.

The Gavins Point releases shown in this and previous AOPs are not absolute. Adjustments are made as necessary based on hydrologic conditions to meet the Missouri River target flows whose values are determined by the March 15 and July 1 storage checks.

Application of the July 1 storage check shown on *Table III* indicates the navigation season will be shortened 27 days for Upper Decile, 31 days for Upper Quartile and Median, 56 days for Lower Quartile, and the maximum 61 days for Lower Decile runoff. Minimum service navigation flows are provided for all runoff conditions due to low System storage. None of the simulations reach the desired 57.1 MAF System storage level on March 1, 2006.

Intrasystem releases are adjusted to best serve the multiple purposes of the projects with special emphasis placed on regulation for non-listed fisheries starting in early April and for T&E bird species beginning in early May and continuing through August. During the late 1980 to early 1990 drought years, a two-day-down, one-day-up peaking cycle from Gavins Point was utilized during the nesting season. This regulation provided for lower flows for two out of three days to conserve water in the System while ensuring that T&E bird species did not nest on low-lying habitat. This cycling was successfully utilized in May 2004 during nest initiation as a water

conservation measure. Depending on hydrologic conditions, a peaking cycle may be used to conserve water at the beginning of the nesting season in 2005. It may also be necessary to cycle releases for flood control regulation during the T&E species' nesting season.

The Median, Upper Quartile, and Upper Decile simulations include releases that provide a steady to rising pool level in the three large upper reservoirs during the spring fish spawn period. Similar regulation in the past has resulted in a higher fish reproduction success.

Actual System regulation from January 1 through July 31, 2004 and the regulating plans for each project for CY 2005 using the five runoff scenarios described on page 5 are presented on *Plates 5 through 10*, inclusive. An exception is the omission of Big Bend, since storage at that project is relatively constant and average monthly releases are essentially the same as those at Oahe. These plates also show, on a condensed scale, actual regulation since 1953.

*Plate 11* illustrates for Fort Peck, Garrison, Oahe, and Gavins Point the actual releases (Regulated Flow) as well as the Missouri River flows (Unregulated Flow) that would have resulted if the reservoirs were not in place during the period January 2003 through July 2004. *Plate 12* presents past and simulated gross average monthly power generation, and gross peaking capability for the System.

### **C. Regulation for the Balance of the 2004 Navigation Season and Fall of 2004.**

The regulation of the System for the period of August through November 2004 is presented in the following paragraphs.

Fort Peck Dam. Releases averaged near 7,000 cfs during August and the first half of September. In mid-September they were gradually reduced to the minimum of 4,000 cfs. The 4,000 cfs release rate will be held until late November. The Fort Peck pool fell to a new record low level of 2199.7 feet mean sea level (msl) in October. The record low elevation during the previous drought was 2208.7 feet msl set in April 1991.

Garrison Dam. Releases continued at 17,000 cfs until mid-September when irrigation ceased, then they were reduced to 12,000 cfs. In early October releases were further reduced to 11,500 cfs and held at that rate until late November as a water conservation measure. The Garrison pool level declined to a record low elevation of 1812.6 feet msl in November. The record low during the previous drought was 1815.0 in May 1991.

Oahe Dam. Releases averaged 23,900 cfs in August, and only 12,900 cfs in September to initiate an early fall drawdown of the Fort Randall pool as the navigation season closed early in 2004. The average daily release in October was a record low

7,000 cfs. Low release will continue in November to maintain Fort Randall at a low pool elevation until they are increased in the winter for power generation.

Big Bend Dam. Releases will parallel those from Oahe. Big Bend will generally fluctuate between 1420.0 and 1421.0 feet msl for weekly cycling during high power load periods.

Fort Randall Dam. Releases averaged 24,300 cfs in August and 22,900 cfs in September to back up the releases from Gavins Point Dam. When the navigation season ended in early October, releases were gradually lowered to as low as 7,000 cfs in November. The majority of the Fort Randall fall pool drawdown was accomplished by mid-October this year due to the shortening of the navigation season.

Gavins Point Dam. Releases from Gavins Point Dam averaged 25,000 cfs in August, and 24,400 cfs in September. They continued to support downstream minimum service flows until the first week of October when they were reduced by 3,000 cfs per day, reaching 12,000 cfs on October 10. From there, releases were reduced at a rate of 500 cfs every 5 to 7 days which allowed sufficient travel time for the release changes to reach the critical downstream intake locations prior to the next reduction. The minimum release of 9,000 cfs was reached on November 15. Intakes were closely monitored during this period to ensure their operability. Releases will be increased to the winter System release rate prior to significant river ice formation. It was understood that 9,000 cfs might be less than is required for downstream water supply intakes without sufficient incremental tributary inflow below the System. Tributary inflow was adequate in 2004 to allow a reduction to the 9,000 cfs level. We believe that this 9,000 cfs minimum spring-fall flow represents a reasonable long-term goal for water intake owners to strive for as they make improvements to their facilities. The navigation season was shortened 47 days in 2004 in accordance with the July 1 System storage check given in the Master Manual. The Gavins Point pool level was raised 1.5 feet to elevation 1207.5 feet msl in July when it was determined that T&E species were not nesting along the reservoir. The pool level will remain near that elevation during the fall and winter months.

**D. Regulation Plan for Winter 2004-2005.** The September 1 System storage check is used to determine the amount of the winter System release. During the winter of 2004-2005, we will strive to average 12,000 cfs System release. If mild weather conditions prevail, System releases may be set lower than 12,000 cfs, but only if downstream water supply intakes can remain operable. Conversely, 12,000 cfs may be less than is required for downstream water supply intakes without sufficient incremental tributary inflow below the System, and therefore, releases may need to be set at levels higher than 12,000 cfs at times to ensure downstream water supply intakes are operable. However, we believe that this minimum winter flow represents a reasonable long-term goal for water intake owners to strive for as they make

improvements to their facilities. It may be necessary at times to increase Gavins Point releases to provide adequate downstream flows if ice jams or blockages form which temporarily restrict flows, therefore the model results indicate an average winter System release of 12,500 cfs to allow for these increases. Based on past experiences, these events are expected to occur infrequently and be of short duration. It is anticipated that this year's winter release will be adequate to serve all downstream water intakes except for very short periods during significant river ice formation or ice jamming.

Fort Peck Dam. Releases are expected to average 6,500 cfs December through January, 3,500 to 5,000 cfs below the 1967-2003 average. The Basic simulation shows that the Fort Peck pool level will fall 2.2 feet by the end of the winter period. Carryover multiple purpose storage in the three large upper reservoirs will be near a balanced condition on March 1, 2005. The pool level is expected to rise nearly 1 foot to elevation 2198.1 feet msl by March 31, 33.7 feet below normal.

Garrison Dam. Releases will be adjusted to serve winter power loads and balance System storage. Releases will be scheduled at 16,000 to 17,000 cfs at the time of normal freeze-in and may have to be reduced for a short period during the freeze-in in the Bismarck area to prevent exceeding a targeted 13-foot stage at the Bismarck gage. Flood stage is 16 feet. Garrison releases are expected to average 16,000 cfs at the beginning of the winter period and increase very slightly to 17,000 cfs in January and February, 6,700 to 8,000 cfs less than normal. The Garrison pool level is expected to fall from near elevation 1812.1 feet msl to elevation 1807.1 feet msl by March 1, 27.4 feet below the base of the annual flood control storage zone. The Median simulation indicates the pool level will rise to elevation 1808.8 feet msl by March 31, which would be 26.3 feet below normal.

Oahe Dam. Releases for the winter season will provide backup for the Fort Randall and Gavins Point releases plus fill the recapture space available in the Fort Randall reservoir consistent with anticipated winter power loads. Monthly average releases may vary substantially with fluctuations in power loads occasioned by weather conditions but, in general, are expected to average 15,000 cfs. Daily releases will vary widely to best meet power loads. Peak hourly releases, as well as daily energy generation, will be constrained to prevent urban flooding in the Pierre and Fort Pierre areas if severe ice problems develop downstream of Oahe Dam. This potential reduction has been coordinated with the Western Area Power Administration.

The Oahe pool level is expected to gradually rise from elevation 1574.0 feet msl at the end of the 2004 navigation season to elevation 1575.7 feet msl by March 1, then rise to elevation 1578.7 feet msl by the end of March, 27.1 feet below normal.

Big Bend Dam. The Big Bend pool level will be maintained in the normal 1420.0 to 1421.0 feet msl range during the winter.

Fort Randall Dam. Releases will average near 11,000 cfs. The Fort Randall pool level is expected to rise from a low elevation of 1337.5 feet msl to near elevation 1350.0 feet msl, the seasonal base of flood control, by March 1. However, if the plains snowpack flood potential downstream of Oahe Dam is quite low at that time, measures will be taken to raise the Fort Randall pool level to near elevation 1353.0 feet msl by March 1. It is likely that a pool level above elevation 1353.0 feet msl, to as high as 1355.2, will be reached by the end of the winter period on March 31, if runoff conditions permit. The Fort Randall pool level above the White River delta near Chamberlain, South Dakota will likely remain at a higher elevation than the pool level below the delta from early October through December, due to the damming effect of this delta area.

Gavins Point Dam. Releases are discussed in the first paragraph of this section. The Gavins Point pool level will be near elevation 1207.5 feet msl until late February when it will be lowered to elevation 1206.0 feet msl to create additional capacity to store spring runoff, primarily from the Niobrara River and Ponca Creek along the Fort Randall to Gavins Point reach.

System storage for all five runoff conditions will be substantially below the base of the annual flood control zone by March 1, 2005, the beginning of next year's runoff season.

**E. Regulation Plan During the 2005 Navigation Season.** The Upper Decile, Upper Quartile, Median, Lower Quartile, and Lower Decile runoff scenarios modeled for this year's AOP follow the specific technical criteria presented in the March 2004 Master Manual for navigation service flow support. The normal 8-month navigation season is shortened as a water conservation measure for all runoff scenarios as shown in *Table V*. Releases from Fort Peck, Garrison, and Fort Randall will follow repetitive daily patterns from early May, at the beginning of the T&E species' nesting season, to the end of the nesting in late August. As previously stated, the model runs included in this AOP have Gavins Point releases cycling two days down and one day up during May to keep birds from nesting at low elevations, then increasing on June 1 to the release required to meet downstream minimum service support to navigation flows through August. The planned regulation for the 2005 nesting season will be SR-FTT. The initial steady release (SR) will be based on hydrologic conditions and the availability of habitat at that time. Once the majority of the birds have nested on the newly constructed, high elevation habitat, releases will be made to meet downstream targets (FTT). The purpose of this regulation is to continue to meet the project purposes while minimizing the loss of nesting T&E species and conserving water in the upper three reservoirs.

TABLE V  
**NAVIGATION SERVICE SUPPORT  
 FOR THE 2005 SEASON**

	<b>Runoff Scenario (MAF)</b>	<b>System Storage</b>		<b>Flow Level Above or Below Full Service (cfs)</b>		<b>Season Shortening (Days)</b>
		<b>March 15 (MAF)</b>	<b>July 1 (MAF)</b>			
				<u>Spring</u>	<u>Summer/Fall</u>	
U.D.	34.5	37.9	47.5	-6,000	-6,000	27
U.Q	30.6	37.7	45.4	-6,000	-6,000	31
Med	24.6	35.7	41.3	-6,000	-6,000	31
L.Q.	19.5	34.4	37.2	-6,000	-6,000	56
L.D.	15.5	34.2	35.1	-6,000	-6,000	61

The reservoir regulation simulations presented in this AOP for the Upper Decile, Upper Quartile, and Median runoff scenarios show that steady to rising pool levels would occur during the spring fish spawn period for the upper three System reservoirs. The studies show that inflows are sufficient to maintain steady to rising pools at Fort Peck and Garrison in April and May for Lower Quartile and Lower Decile runoff scenarios, however Oahe would fall during this period. The ability to provide steady to rising pool levels in the upper three reservoirs in low runoff years is very dependent on the volume, timing, and distribution of that runoff. If runoff is not sufficient to keep all the pool levels rising during the fish spawn in 2005, the Corps will, to the extent reasonably possible, set releases to result in steady to rising pools at Oahe during April and May, and steady to rising pools at Fort Peck during May and June. This will be accomplished by setting Fort Peck releases at a level that would maintain the rising pool, but no less than the minimum required to supply downstream irrigation. Oahe pool levels will be maintained by local runoff and releases from Garrison Dam. Adjustments to Garrison's releases, however, may be limited when the terns and plovers begin nesting. If the drought continues, emphasis during the fish spawn will be rotated between Garrison and Oahe. In years when Oahe is favored, Fort Peck releases will be set at a level that would maintain the rising pool, but no less than the minimum required to supply downstream irrigation. Management of the reservoirs during the fish spawn will continue with consideration of other Congressionally authorized project purposes, be opportunistic with regard to runoff potential, and will continue to evolve as additional information becomes available.

All five runoff scenarios studied for this year's AOP provide gradually increasing Gavins Point releases to meet navigation season flow rates at the mouth of the Missouri near St. Louis by April 1, 2005, the normal navigation season opening date. The corresponding dates at upstream locations are Sioux City, March 23; Omaha, March 25; Nebraska City, March 26; and Kansas City, March 28. However, if there is no

commercial navigation scheduled to use the upper reaches of the navigation channel, outside the tern and plover nesting season, we will consider eliminating flow support for targets in those reaches to conserve water in the System, as was done in 2004. The studies illustrated on *Plates 5 through 10* and summarized in *Table V* are based on providing minimum service flows (except May through July when flows may exceed minimum service) and a shortened navigation season for all runoff scenarios. Navigation season shortening is shown as 27 days from the normal 8-month season for Upper Decile, 31 days for Upper Quartile and Median, 56 days for Lower Quartile, and 61 days for Lower Decile.

Navigation flow support for the 2005 season will be determined by actual System storage on March 15 and July 1. Although all runoff scenarios modeled indicate minimum service flow support throughout the navigation season, if the July 1 System storage check indicates an increase in service level, any increase greater than 2,000 cfs will be delayed until the end of the T&E bird species' nesting season. Gavins Point releases may be quite variable during the 2005 navigation season but are expected to range from 22,000 to 28,000 cfs. Release reductions necessary to minimize downstream flooding are not reflected in these monthly averages but will be instituted as conditions warrant. Simulated storages and releases for the System and individual reservoirs within the System are shown on *Plates 5 through 10*. Ample storage space exists in the System to control flood inflows under all conditions studied.

Two modified reservoir regulation plans shown in previous AOPs, the Fort Peck "mini-test" and unbalancing the upper three reservoirs, will not be implemented in 2005 due to low System storage. When System storage recovers sufficiently, the Corps anticipates that both these plans will be implemented.

The first of these two modified plans is a test of flow modifications for the endangered pallid sturgeon. When Fort Peck has adequate water above the spillway crest by mid to late May of any year, a flow modification "mini-test" will be conducted in early June to monitor effects of higher spring releases and warmer water released from the spillway. The purposes of the "mini-test" are to allow for an evaluation of the integrity of the spillway structure, to test data collection methodology, and to gather information on river water temperatures with various combinations of flow from the spillway and powerhouse. Streambank erosion and fishing impacts will also be monitored. Stop protocol for the "mini-test" is identified in the Fort Peck Flow Modification Mini-Test Environmental Assessment, dated March 2004. Before either test is run, the Corps will fully coordinate with the Tribes of the Fort Peck Reservation, the State of Montana, and any other potentially affected stakeholders.

During the Fort Peck "mini-test," which will last about four weeks, flows will vary from 8,000 to 15,000 cfs as various combinations of spillway and powerplant releases are monitored. The maximum spillway release of 11,000 cfs will combine with a

minimum powerplant release of 4,000 cfs for six days. This test will be timed to avoid lowering the pool level during the forage fish spawn. The “mini-test” will not be conducted if sufficient flows will not pass over the spillway crest (elevation 2225 feet msl). A minimum pool level of about 2229 feet msl is needed during the test to avoid unstable flows over the spillway. Results of the AOP simulations show that this elevation will not be achieved in 2005 for any of the five runoff scenarios. A more extensive test with a combined 23,000 cfs release from Fort Peck is scheduled to be conducted beginning in early June in the year following the “mini-test” to allow further tests of the integrity of the spillway and to determine if warm water releases will benefit the native river fishery. Peak outflows during the full test would be maintained for two weeks within the four-week test period.

The second modified regulation plan involves unbalancing the three large upper reservoirs as shown on *Table VI* to benefit reservoir fishery and the three protected species. Reservoir unbalancing is computed based on the percentage of the carryover multiple purpose pool that remains in Fort Peck, Garrison and Oahe Reservoirs. The unbalancing would alternate at each project; high one year, float (normal regulation) the next year, and low the third year, as shown on *Table VI*. *Table VII* shows the pool levels proposed by the MRNRC at which the unbalancing would be terminated. *Table VII* indicates that no reservoir unbalancing should occur for any of the five runoff scenarios in 2005.

**TABLE VI  
RESERVOIR UNBALANCING SCHEDULE**

	Fort Peck		Garrison		Oahe	
<i>Year</i>	<i>March 1</i>	<i>Rest of Year</i>	<i>March 1</i>	<i>Rest of Year</i>	<i>March 1</i>	<i>Rest of year</i>
<b>1</b>	High	Float	Low	Hold Peak	Raise & hold during spawn	Float
<b>2</b>	Raise & hold during spawn	Float	High	Float	Low	Hold peak
<b>3</b>	Low	Hold peak	Raise & hold during spawn	Float	High	Float

**Notes:** **Float year:** Normal regulation, then unbalance 1 foot during low pool years or 3 feet when System storage is near 57.1 MAF on March 1.

**Low year:** Begin low, then hold peak the remainder of the year.

**High year:** Begin high, raise and hold pool during spawn, then float.



**TABLE VII  
MRNRC RECOMMENDED  
RESERVOIR ELEVATION GUIDELINES  
FOR UNBALANCING**

	<b>Fort Peck</b>	<b>Garrison</b>	<b>Oahe</b>
Implement unbalancing if March 1 pool is above this level.	2234 feet msl	1837.5 feet msl	1607.5 feet msl
Implement unbalancing if March 1 pool level is in this range <b>and</b> the pool is expected to raise more than 3 feet after March 1.	2227-2234 feet msl	1827-1837.5 feet msl	1600-1607.5 feet msl
Scheduling Criteria	Avoid pool level decline during spawn period which ranges from April 15 - May 30	Schedule after spawn period of April 20 - May 20	Schedule after spawn period of April 8 - May 15

Summary of Reservoir Regulation Activities for T&E Species  
and Fish Propagation Enhancement

As discussed in the previous section, the 2004-2005 AOP includes no provisions for unbalancing the Fort Peck, Garrison, and Oahe reservoirs for any of the runoff scenarios. The criteria for unbalancing are based on recommendations provided by the MRNRC and the USFWS. Under all simulations, System storage will be below the minimum levels under which unbalancing is recommended by either the MRNRC or the USFWS.

Fort Peck Dam. Releases during the tern and plover nesting season will follow a repetitive daily pattern from early May to the end of the nesting season in late August. This regulation should result in habitat conditions for nesting terns and plovers similar to what was available in 2004. The State of Montana has requested that releases be restricted to 8,000 cfs or less. The 2004-2005 AOP studies show that releases from Fort Peck would not exceed 9,000 cfs. While it is possible to restrict releases to 8,000 cfs, this would not affect the annual volume of water released because intrasystem regulation is designed to balance the upper three reservoirs by the beginning of March of each year. Limiting releases to 8,000 cfs or less during the summer would result in relatively higher releases during the spring and fall when power demands are generally low, which would contribute to the upward pressure on hydropower rates paid by WAPA customers.

If flood flows enter the Missouri River below the project during the nesting season, hourly releases will be lowered to no less than 3,000 cfs in order to keep traditional riverine fish rearing areas continuously inundated while helping to lower river stages at downstream nesting sites. April releases should be adequate for trout spawning below the project. If runoff is not sufficient to keep all the pool levels rising during the fish spawn in 2005, the Corps will, to the extent reasonably possible, set releases to result in a steady to rising pool at Fort Peck during May and June. This will be accomplished by setting releases at a level that would maintain the rising pool, but no less than the minimum required to supply downstream irrigation. A rising pool in May and June will be dependent upon the daily inflow pattern to the reservoir but appears possible with all runoff simulations. The T&E flow modification “mini-test” will not be run under any runoff scenario. The Fort Peck pool level must be at elevation 2229 msl to allow releases required for the “mini-test” through the spillway.

Garrison Dam. Daily average releases from Garrison will be much less than full powerplant capacity during the tern and plover nesting season under all runoff scenarios. Monthly average releases will decline 500 to 1,000 cfs during the summer nesting season. Hourly peaking will be limited to no more than 30,000 cfs for six hours if the daily average release is lower than 28,000 cfs. This will limit peak stages below the project for nesting birds.

Garrison elevations will not reach levels considered necessary for optimum fish spawning during the month of May for any of the runoff scenarios. The pool level may again approach a level that jeopardizes the volume of cold-water habitat in 2005. Given Median or higher runoff, the pool level should rise during the fish spawn season, however, the actual timing of the rise in pool level will be dependent upon the pattern of inflow at that time and the Garrison releases needed to support a steady or rising Oahe pool during its fish spawn.

Oahe Dam. Releases in the spring and summer will back up those from Gavins Point Dam. Given Median or higher runoff, the pool level should be steady to rising in the spring. If runoff is not sufficient to keep all the pool levels rising during the fish spawn in 2005, the Corps will, to the extent reasonably possible, set releases to result in a steady to rising pool at Oahe during April and May. Oahe pool levels will be maintained by local runoff and releases from Garrison Dam. Adjustments to Garrison's releases, however, may be limited when the terns and plovers begin nesting. Under all AOP simulations, the Oahe pool will fall during the summer.

Fort Randall Dam. Fort Randall will be regulated to provide for a pool elevation near 1355 feet msl during the fish spawn period, provided water can be supplied from other reservoirs for downstream uses, and the pool will not be drawn down below elevation 1337.5 feet msl in the fall to ensure adequate supply for water intakes. Hourly releases from Fort Randall during the 2005 nesting season will be limited to 37,000 cfs for six hours. Daily average flows may be increased every third day to preserve the capability of increasing releases later in the summer if conditions turn dry.

Gavins Point Dam. Based on 2003 and 2004 nesting season results with the SR-FTT regulation and planned habitat development activities, it is anticipated that sufficient habitat will be available above the planned release rates to provide for successful nesting. All reasonable measures to minimize the loss of nesting T&E bird species will be used. These measures include, but are not limited to, such things as a relatively high initial SR during the peak of nest initiation, the use of the Kansas River basin reservoirs, moving nests to higher ground when possible, and monitoring nest fledge dates to determine if delaying an increase a few days might allow threatened chicks to fledge. The location of tows and river conditions at intakes would also be monitored to determine if an increase could be temporarily delayed with little or no impact. Cycling releases every third day may be used to conserve water during the month of May if extremely dry conditions develop. In addition, cycling may be used for downstream flood control regulation.

The Gavins Point pool will be regulated near 1206.0 feet msl in the spring and early summer with day-to-day variations due to rainfall runoff. Greater fluctuations occur in the river, increasing the risk of nest inundation in the upper end of the Gavins Point pool. Several factors contribute to the increased risk of nest inundation in the upper end of the Gavins Point pool. First, because there are greater numbers of T&E bird species nesting below the Gavins Point project, Gavins Point releases are restricted during the nesting season, to minimize loss of nests or chicks. Second, rainfall runoff between Fort Randall Dam and Gavins Point Dam can result in sudden pool rises because the Gavins Point project has a smaller storage capacity than the other System reservoirs. Third, the regulation of Gavins Point for downstream flood control may necessitate sudden release reductions to prevent downstream T&E bird species losses. And finally, high releases required in wet years make nest inundation more likely.

When combined, all these factors make it difficult and sometimes impossible to prevent inundation of nests in the upper end of the Gavins Point reservoir. The pool will be increased to elevation 1207.5 feet msl if it is determined that there are no terns or plovers nesting along the reservoir.

## **VI. SUMMARY OF RESULTS EXPECTED IN 2005**

With regulation of the System in accordance with the 2004-2005 AOP outlined in the preceding pages, the following results can be expected.

**A. Flood Control.** All runoff scenarios studied will begin the March 1, 2005 runoff season substantially below the desired 57.1 MAF base of annual flood control and multiple use zone. Therefore, the entire System flood control zone, plus an additional 7.8 to 26.0 MAF of the carryover multiple use zone, will be available to store runoff. The System will be available to significantly reduce peak discharges and store a significant volume of water for all floods that may originate above the System.

Remaining storage in the carryover multiple use zone will be adequate to provide support for all of the other multiple purposes of the System, though at reduced levels.

**B. Water Supply and Water Quality Control.** Although below normal winter releases are being provided for all five runoff scenarios, all water supply and water quality requirements on the Missouri River both below Gavins Point Dam and between System reservoirs should be met for all flow conditions studied. It is possible with the low winter releases that ice formation or ice jams may temporarily reduce river stages to levels below which some intakes can draw water. Therefore, during severe cold spells, experience has shown that for brief periods it may be necessary to increase Gavins Point releases to help alleviate water supply problems along the lower river.

If the drought continues, reservoir pool levels and releases may continue to fall below their previous historic lows creating the potential for water supply problems at intakes, particularly those located on the upper three reservoirs. These intakes are primarily for the purposes of municipal and rural water supplies, nuclear and thermal powerplant cooling, and irrigation supplies. During the non-navigation periods in the spring and fall, System releases as low as 9,000 cfs are possible with adequate downstream tributary flow as occurred in the fall of 2004, to conserve water in the System for future use by all authorized purposes. If a non-navigation year would occur, summer releases as low as 18,000 cfs from the System are possible during the summer months. These lower release rates will result in reduced river levels that may impact some downstream intakes that have marginal access to the Missouri River. Historically, water access problems have been associated with an intakes' ability to access the river or reservoir rather than insufficient water supply. The lower flows

associated with a non-navigation summer may also result in negative impacts to thermal powerplants given the restrictions of their water quality and safety permits. As with water supply in river reaches, the Corps will strive to provide, to the extent reasonably possible, releases that allow thermal powerplants to meet their water quality and safety permit requirements. The Corps continues to encourage intake operators throughout the System and along the lower river to make necessary modifications to their intakes to allow efficient operation over the widest possible range of hydrologic conditions.

**C. Irrigation.** Scheduled releases from the System reservoirs will be sufficient to meet the volumes of flow required for irrigation diversions from the Missouri River. Some access problems may be experienced, however, if drought conditions persist. Tributary irrigation water usage is fully accounted for in the estimates of water supply.

**D. Navigation.** Service to navigation in 2005 will be scheduled at minimum service flow support for all runoff scenarios. Although the AOP simulations provide a comparison of typical flow support under varying runoff conditions, the actual rate of flow support for the 2005 navigation season will be based on actual System storage on March 15 and July 1, 2005.

All simulations have a shortened navigation season. The anticipated service level and season length for all runoff conditions simulated are shown in *Table V*.

**E. Power.** *Tables VIII and IX* give the estimated monthly System load requirements and hydropower supply of the Eastern Division, Pick-Sloan Missouri Basin Program (P-S MBP), from August 2004 through December 2005. Estimates of monthly peak demands and energy include customer requirements for firm, short-term firm, summer firm, peaking, and various other types of power sales, System losses, and the effects of diversity. Also included in the estimated requirements are deliveries of power to the Western Division, P-S MBP, to help meet its firm power commitments.

**F. Recreation, Fish and Wildlife.** The regulation of the System will continue to provide recreation and fish and wildlife opportunities in the project areas and along the Missouri River as well as other benefits of a managed system. As a result of the drought, reservoir levels will remain well below normal and recreation access will be limited at several locations. Special regulation adjustments incorporating specific objectives for these purposes will be accomplished whenever possible. Conditions in the lower three reservoirs should be favorable for the many visitors who enjoy the camping, boating, fishing, hunting, swimming, picnicking, and other recreational activities associated with the System reservoirs and for increasing usage of the regulated reaches of the Missouri River downstream of the reservoirs.

TABLE VIII  
PEAKING CAPABILITY AND SALES  
(1,000 kW at plant)

2004	Estimated Committed Sales*	Expected C of E Capability					Expected Bureau Capability					Expected Total System Capability				
		120%	Basic	80%			120%	Basic	80%			120%	Basic	80%		
Aug	2182	1994	1991	1987			181	178	178			2175	2169	2165		
Sep	1862	1976	1969	1955			183	181	178			2159	2150	2133		
Oct	1658	1958	1948	1938			187	184	181			2145	2132	2119		
Nov	1767	1965	1949	1936			187	186	180			2152	2135	2116		
Dec	1929	1942	1918	1909			183	186	178			2125	2104	2087		
<b>2005</b>																
Jan	2036	1958	1933	1924			181	186	176			2139	2119	2100		
Feb	1877	1971	1943	1918			178	185	174			2149	2128	2092		
		<u>U.D.</u>	<u>U.Q.</u>	<u>Med</u>	<u>L.Q.</u>	<u>L.D.</u>	<u>U.D.</u>	<u>U.Q.</u>	<u>Med</u>	<u>L.Q.</u>	<u>L.D.</u>	<u>U.D.</u>	<u>U.Q.</u>	<u>Med</u>	<u>L.Q.</u>	<u>L.D.</u>
Mar	1778	2048	2039	2000	1970	1965	193	193	188	176	176	2241	2232	2188	2146	2141
Apr	1668	2077	2062	2012	1968	1961	197	198	189	177	177	2274	2260	2201	2145	2138
May	1647	2105	2085	2027	1969	1953	196	201	197	184	184	2301	2286	2224	2153	2137
Jun	1912	2154	2128	2066	1997	1960	208	211	206	192	192	2362	2339	2272	2189	2152
Jul	2187	2169	2139	2066	1987	1941	213	213	209	195	194	2382	2352	2275	2182	2135
Aug	2182	2162	2137	2056	1969	1918	209	209	207	195	193	2371	2346	2263	2164	2111
Sep	1862	2165	2128	2045	1932	1883	209	208	205	197	195	2374	2336	2250	2129	2078
Oct	1658	2132	2100	2011	1932	1881	207	207	204	200	198	2339	2307	2215	2132	2079
Nov	1767	2144	2109	2015	1932	1880	206	204	203	199	197	2350	2313	2218	2131	2077
Dec	1929	2131	2095	1992	1913	1849	199	197	198	196	194	2330	2292	2190	2109	2043

\* Estimated sales, including system reserves. Power in addition to hydro production needed for these load requirements will be obtained from other power systems by interchange or purchase.

\*\* Total output of Canyon Ferry and 1/2 of the output of Yellowtail powerplant.

TABLE IX  
ENERGY GENERATION AND SALES  
(Million kWh at plant)

2004	Estimated Committed Sales*	Expected C of E Generation					Expected Bureau Generation **					Expected Total System Generation				
		120%	Basic	80%			120%	Basic	80%			120%	Basic	80%		
Aug	836	662	671	680			38	31	31			701	702	711		
Sep	714	519	528	505			37	29	30			557	557	535		
Oct	720	353	352	385			38	30	30			391	382	415		
Nov	776	328	329	334			48	29	29			375	357	362		
Dec	886	478	453	485			49	30	29			527	483	514		
<b>2005</b>																
Jan	898	457	452	478			49	30	30			506	482	507		
Feb	857	411	408	432			44	27	26			454	435	458		
		<u>U.D.</u>	<u>U.Q.</u>	<u>Med</u>	<u>L.Q.</u>	<u>L.D.</u>	<u>U.D.</u>	<u>U.Q.</u>	<u>Med</u>	<u>L.Q.</u>	<u>L.D.</u>	<u>U.D.</u>	<u>U.Q.</u>	<u>Med</u>	<u>L.Q.</u>	<u>L.D.</u>
Mar	791	404	435	426	428	424	48	48	29	29	29	452	483	456	457	452
Apr	740	461	496	511	597	583	66	61	44	26	26	527	556	554	624	610
May	684	585	629	646	699	689	85	78	54	30	30	670	707	700	729	719
Jun	748	664	695	706	709	702	101	88	55	32	32	765	783	761	741	733
Jul	835	741	766	783	780	768	130	115	74	48	38	871	881	856	828	806
Aug	842	758	743	738	738	720	99	93	73	48	38	857	836	811	787	758
Sep	713	629	571	582	494	442	95	89	77	47	37	724	660	659	541	479
Oct	721	448	510	504	319	310	98	90	77	48	44	546	600	581	367	354
Nov	779	363	376	364	354	337	92	85	73	52	47	455	461	438	406	384
Dec	<u>887</u>	<u>552</u>	<u>564</u>	<u>518</u>	<u>525</u>	<u>479</u>	<u>93</u>	<u>88</u>	<u>76</u>	<u>56</u>	<u>48</u>	<u>645</u>	<u>651</u>	<u>594</u>	<u>581</u>	<u>527</u>
CY TOT	9495	6473	6651	6637	6504	6362	999	927	688	472	424	7472	7578	7325	7025	6786

\* Estimated sales including system reserves and losses. Power in addition to hydro production needed for these load requirements will be obtained from other systems by interchange or purchase.

\*\* Total output Canyon Ferry and 1/2 output of Yellowtail powerplant.

Boat ramps that were lowered and low water ramps that were constructed during the drought of the late 1980's to early 1990's and the further improvements made in 2003 and 2004 should provide adequate reservoir access this year even under the Lower Decile runoff scenario. However, boat ramps in some areas where the ramps cannot be extended may become unusable. This will affect the normal use patterns, as visitors will have to seek out areas with usable boat ramps. Boat ramp elevations for Fort Peck, Garrison, Oahe and Fort Randall reservoirs are available on the Missouri River Basin Water Management Division web site at [www.nwd-mr.usace.army.mil/rcc](http://www.nwd-mr.usace.army.mil/rcc).

The effects of the simulated System regulation during 2005 on fish and wildlife are included in the section entitled, "Summary of Reservoir Regulation Activities for T&E Species and Fish Propagation Enhancement."

**G. System Storage.** If presently anticipated runoff estimates based upon the August 1, 2004 Basic runoff forecast materialize, System storage will total about 34.8 MAF by the close of CY 2004, breaking the 2003 previous record low end-of-year storage of 38.7 MAF. This end-of-year storage is 19.7 MAF less than the 1967 to 2003 average. The previous record low storage was 40.8 MAF in January 1991 during the 1988-1992 drought. The end-of-year System storages have ranged from a maximum of 60.9 MAF, which occurred in 1975, to the 2003 minimum of 38.7 MAF. Forecasted System storage on December 31, 2005 is presented in *Table X* for the runoff scenarios simulated.

**H. Summary of Water Use by Functions.** Anticipated water use in CY 2004, under the regulation plan with the Basic Forecast of water supply is shown in *Table XI*. Actual water use data for CY 2003 are included for information and comparison. Under the simulated reservoir regulation scenarios, estimated water use in CY 2005 also is shown in *Table XI*.

**TABLE X  
ANTICIPATED DECEMBER 31, 2005 SYSTEM STORAGE**

Water Supply Condition	Total (12/31/05)	Carryover Storage Remaining 1/	Unfilled Carryover Storage 2/	Total Change CY 2005
(Volumes in 1,000 Acre-Feet)				
Upper Decile	49,300	31,200	7,800	13,400
Upper Quartile	46,200	28,100	10,900	10,300
Median	39,600	21,500	17,500	4,800
Lower Quartile	34,300	16,200	22,800	300
Lower Decile	31,100	13,000	26,000	-2,800

- 1/ Net usable storage above 18.1 MAF System minimum pool level established for power, recreation, irrigation diversions, and other purposes.
- 2/ System base of annual flood control zone containing 57.1 MAF.



**TABLE XI**  
**MISSOURI RIVER MAINSTEM SYSTEM**  
**WATER USE FOR CALENDAR YEARS 2003, 2004, AND 2005 ABOVE SIOUX CITY, IOWA**  
**in Million Acre-Feet (MAF)**

	CY 2003 Actual	CY 2004 Basic Simulation	Simulations for Calendar Year 2005					
			Upper Decile	Upper Quartile	Median	Lower Quartile	Lower Decile	
Upstream Depletions (1)								
Irrigation, Tributary Reservoir Evaporation & Other Uses	2.0	2.3						
Tributary Reservoir Storage Change	<u>0.0</u>	<u>0.0</u>						
Total Upstream Depletions	2.0	2.3	2.5	2.6	2.7	2.8	2.7	
System Reservoir Evaporation (2)	2.6	2.6	1.0	1.1	1.5	1.8	1.7	
Sioux City Flows								
Navigation Season								
Unregulated Flood Inflows Between Gavins Point & Sioux City (3)	0.0	0.0						
Navigation Service Requirement Supplementary Releases	12.5	10.2	13.6	12.9	11.6	10.7	10.4	
T&E Species (4)	0.5	1.0	0.5	0.5	0.5	0.2	0.2	
Flood Evacuation (5)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Non-navigation Season								
Flows	3.8	4.1	3.3	3.2	3.4	3.5	3.2	
Flood Evacuation Releases (6)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
System Storage Change	<u>-4.0</u>	<u>-4.0</u>	<u>13.6</u>	<u>10.3</u>	<u>4.9</u>	<u>0.5</u>	<u>-2.7</u>	
Total	17.4	16.2	34.5	30.6	24.6	19.5	15.5	
Project Releases								
Fort Peck	5.4	5.0	4.3	5.1	5.1	5.0	5.0	
Garrison	12.9	12.2	12.8	12.8	12.5	12.3	11.7	
Oahe	14.9	13.0	11.2	11.7	12.4	13.1	13.0	
Big Bend	13.8	12.3	11.1	11.6	12.3	12.9	12.8	
Fort Randall	14.9	13.1	12.4	12.6	13.1	13.2	13.1	
Gavins Point	16.0	14.3	14.5	14.4	14.4	14.3	14.1	

- (1) Tributary uses above the 1949 level of development including agricultural depletions and tributary storage effects.
- (2) Net evaporation is shown for 2005.
- (3) Incremental inflows to reach which exceed those usable in support of navigation at the target level, even if Gavins Point releases were held to as low as 6,000 cfs.
- (4) Increased releases required to maintain navigation release flexibility during the T&E species' nesting season.
- (5) Includes flood control releases for flood control storage evacuation and releases used to extend the navigation season beyond the normal December 1 closing date at the mouth of the Missouri River.
- (6) Releases for flood control storage evacuation in excess of a 15,000 cfs Fort Randall release.

## **VII. TENTATIVE PROJECTION OF REGULATION THROUGH MARCH 2011**

The five-year extensions to the AOP (March 2006 to March 2011) have been prepared to serve as a guide for the Western Area Power Administration's marketing activities and to provide data to allow basin interests to conduct long term planning. Due to the severity of the ongoing drought and record low System storage, all five statistically derived inflows are used in the extensions. Previous AOPs have not included Upper Decile and Upper Quartile extensions because System storage normally recovers rapidly with these high inflows. The record low System storage associated with the current drought results in a longer recovery period. These extensions provide additional information for planning purposes on the recovery of the reservoir levels in the large upper three reservoirs and total System storage. The five inflows are identified as Upper Decile, Upper Quartile, Median, Lower Quartile and Lower Decile runoff conditions. Upper Decile (34.5 MAF) has a 1 in 10 chance of being exceeded, Upper Quartile (30.6 MAF) has a 1 in 4 chance of being exceeded, Median (24.6 MAF) has a 1 in 2 chance of being exceeded. Lower Quartile runoff (19.5 MAF) has a 1 in 4 chance of the occurrence of less runoff, and Lower Decile (15.5 MAF) has a 1 in 10 chance of the occurrence of less runoff.

The navigation service level and season length criteria described in Section V, Chapter A were applied to the extensions. The March 15 and July 1 System storage checks shown in *Tables II and III* were used to determine the flow support for navigation and other downstream uses, and the navigation season length. *Table IV* releases, as computed by the March 15 and July 1 System storage checks, were used in the extension studies. It is expected that releases closer to those shown in *Table IV* will be provided in future years during the tern and plover nesting season as additional emergent sandbar habitat becomes available. The September 1 System storage check was used to determine the winter System release.

The extensions show a cycled release from Gavins Point in May and a steady release from June 1 through August 31 during the T&E species' nesting season. Navigation service support and season length, end of year System storage, and the winter release rate for the extensions are shown on *Table XII*.

**TABLE XII  
NAVIGATION SERVICE SUPPORT, AOP EXTENSIONS**

	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>
<b>UPPER DECILE</b>					
Flow Level Below Full Service					
Spring (kcfs)	-3.6	-0.7	**	**	**
Summer/Fall (kcfs)	0	**	**	**	**
Season Length (Months)	8	8+10 days	8+10 days	8+10 days	8+10 days
Dec 31 Storage (MAF)	55.1	57.5	57.8	57.9	57.9
Winter Release (kcfs)	16.2	20.0	23.0	22.5	22.0
<b>UPPER QUARTILE</b>					
Flow Level Below Full Service					
Spring (kcfs)	-6.0	-1.1	0	**	**
Summer/Fall (kcfs)	-2.7	0	0	**	**
Season Length (Months)	8	8	8+10 days	8+10 days	8+10 days
Dec 31 Storage (MAF)	52.1	55.4	57.2	57.6	57.6
Winter Release (kcfs)	12.5	17.0	17.0	20.0	20.0
<b>MEDIAN</b>					
Flow Level Below Full Service					
Spring (kcfs)	-6.0	-5.5	-2.3	-0.6	0
Summer/Fall (kcfs)	-6.0	-5.5	-2.3	-0.6	0
Season Length (Months)	7	8-3 days	8	8	8
Dec 31 Storage (MAF)	44.6	48.5	50.9	52.1	52.8
Winter Release (kcfs)	12.5	12.5	12.5	12.7	14.0
<b>LOWER QUARTILE</b>					
Flow Level Below Full Service					
Spring (kcfs)	-6.0	-6.0	-6.0	-6.0	-6.0
Summer/Fall (kcfs)	-6.0	-6.0	-6.0	-6.0	-6.0
Season Length (Months)	8-51 days	8-36 days	7	7	7
Dec 31 Storage (MAF)	35.8	37.5	39.4	41.2	43.7
Winter Release (kcfs)	12.5	12.5	12.5	12.5	12.5
<b>LOWER DECILE</b>					
Flow Level Below Full Service					
Spring (kcfs)	-6.0	*	-6.0	-6.0	-6.0
Summer/Fall (kcfs)	-6.0	*	-6.0	-6.0	-6.0
Season Length (Months)	6	0	6	6	6
Dec 31 Storage (MAF)	29.2	32.0	31.6	31.9	32.4
Winter Release (kcfs)	12.5	12.5	12.5	12.5	12.5

No navigation service support in 2007 under Lower Decile runoff conditions.

\*\* Releases exceed full service flow to evacuate excess flood control storage.

**A. Upper Decile Runoff.** Studies 9 through 13 present the computer simulation results for Upper Decile runoff (34.5 MAF) from 2006 through 2010. System storage on March 1, 2006 is 50.1 MAF, rising to the desired base of the annual flood control and multiple use storage of 57.1 MAF by March 1, 2008. Releases from the summer of 2007 through the 2010 navigation season exceed full service navigation flow requirements to evacuate excess flood control storage. A 10-day extension to the navigation season from 2007 through 2010 is also shown to evacuate excess flood control storage. Winter releases increase from 16,200 cfs during the winter of 2006-2007 to 23,000 cfs during the winter of 2008-2009. Releases during the last two winters of the simulations are slightly less due to decreasing runoff. Under Upper Decile runoff scenarios, the Fort Peck “mini-test” could be conducted in June of 2006 with releases averaging 12,800 cfs. The full test is shown in June of 2007 with releases averaging 18,200 cfs. The test includes a 19,000 cfs spillway release for five days. Unbalancing of reservoir storage at Fort Peck, Garrison, and Oahe would occur as shown in *Table XIII*. The pattern of “high”, “float”, “low” as described in *Table VI* would be followed. The amount of unbalancing was generally 4 feet at Fort Peck and 3 feet at Garrison and Oahe.

**B. Upper Quartile Runoff.** Simulations for Upper Quartile runoff (30.6 MAF) are shown as studies 14 through 18. March 1 System storage does not fully recover to 57.1 MAF until 2009. Full service support to navigation flows resumes in the summer of 2007. Releases during the 2009 and 2010 navigation season are in excess of full service to evacuate flood control storage. A 10-day extension to the navigation season is shown from 2008 through 2010. Winter releases are 12,500 cfs during winter of 2006-2007, 17,000 cfs in the winter of 2007-2008 and the winter of 2008-2009 and 20,000 cfs for the remaining two winter periods. The Fort Peck “mini-test” is shown in June of 2007 and the full test is shown in June of 2008. Reservoir unbalancing is shown each March 1 for all extension years.

**C. Median Runoff.** Studies 19 through 23 present the results of simulations for Median runoff (24.6 MAF) from 2006 through 2010. The March 1, 2006 System storage would be 39.8 MAF and would rise to 52.8 MAF by March 1, 2011, 4.3 MAF below the desired March 1 storage of 57.1 MAF, the base of the annual flood control and multiple use pool. Winter System releases would increase slightly from an average of the minimum 12,500 cfs to 12,700 cfs beginning the winter of 2009-2010. The winter releases of 2010-2011 would be 14,000 cfs. Fort Peck, Garrison, and Oahe pools rise to the elevation criteria described in *Table VII* for initiation of unbalancing by March 1, 2009. The Fort Peck “mini-test” could be conducted in 2009 by unbalancing the upper three reservoirs as shown in *Table XIII*. The Fort Peck release would average 12,800 cfs in June of 2009. Fort Peck would be favored again in 2010 to accommodate the full test.

**TABLE XIII**  
**MARCH 1 RESERVOIR UNBALANCING, AOP EXTENSIONS**  
**(Feet)**

Upper Decile Runoff

Year	Fort Peck	Garrison	Oahe
2007	0.0	+3.0	-3.0
2008	-4.7	0.0	+3.0
2009	+4.2	-3.0	0.0
2010	0.0	+3.0	-3.0
2011	-4.6	0.0	+3.0

Upper Quartile Runoff

Year	Fort Peck	Garrison	Oahe
2007	+4.3	-3.0	0.0
2008	0.0	+3.0	-3.0
2009	-4.8	0.0	+3.0
2010	+4.2	-3.0	0.0
2011	0.0	+3.0	-3.0

Median Runoff

Year	Fort Peck	Garrison	Oahe
2009	+4.3	-3.0	0.0
2010	+4.2	-3.0	0.0
2011	0.0	+3.0	-3.0

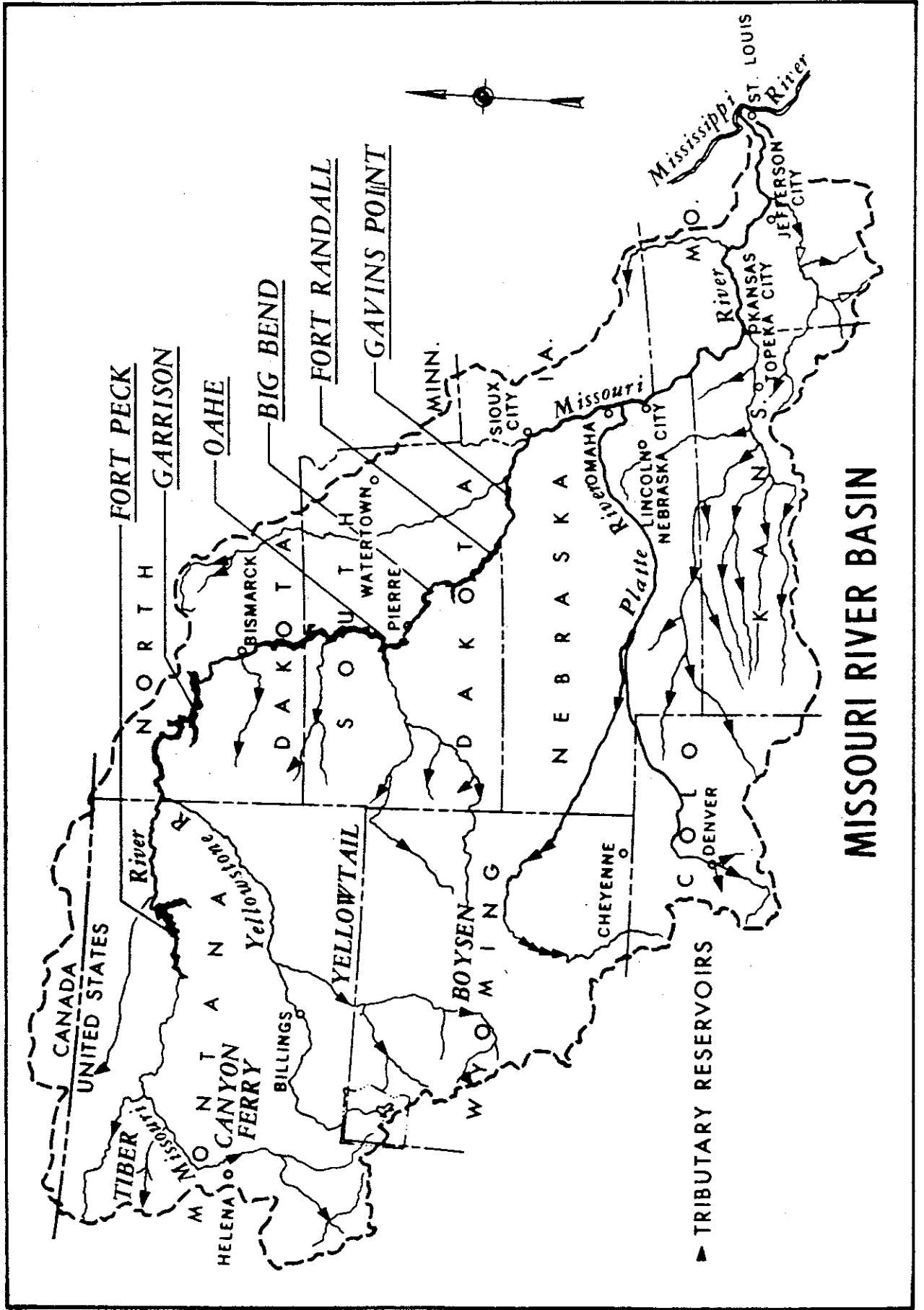
**D. Lower Quartile Runoff.** Studies 24 through 28 show the results of Lower Quartile runoff extensions. System storage on March 1, 2006 is 34.1 MAF and rises to 43.8 MAF by March of 2011 with navigation service levels remaining at minimum service during the simulation period. The navigation season is shortened 51 days in 2006, 36 days in 2007 and 31 days from 2008 through 2010 as System storage increases. A 12,500 cfs average winter release is shown for the entire study period. Since the upper three reservoirs do not refill under Lower Quartile runoff, their percent of remaining carryover multiple use storage is balanced each March 1.

**E. Lower Decile Runoff.** Studies 29 through 33 show the results of Lower Decile runoff extensions. System storage is 30.8 MAF on March 1, 2006, reaching a low of 29.0 MAF on February 1, 2007, then rising to 32.5 MAF by March of 2011. The navigation season is shortened two months in 2006. March 15, 2007 Lower Decile System storage is 29.8 MAF, less than the 31 MAF March 15 navigation preclude and there would be no support to navigation flows in 2007. June through September releases from Gavins Point are shown at 18,000 cfs from June through September, but would be adjusted as needed to meet downstream water supply requirements. March 15 System storage is above 31 MAF in succeeding years and navigation service levels are minimum service with a minimum 6-month season length. A 12,500 cfs average winter release is shown for the entire study period.

*Plate 13* presents System storage, Gavins Point, and System peaking capability for Upper Decile, Upper Quartile, Median, Lower Quartile, and Lower Decile runoff for the period 2006 through March of 2011. Peak power, or peaking capability, is the amount of power available when all powerplants are operating at maximum.

*Plate 14* presents reservoir pool elevations for Fort Peck, Garrison, Oahe, and Fort Randall for Upper Decile, Upper Quartile, Median, Lower Quartile, and Lower Decile runoff for the period 2006 through March of 2011.





# MISSOURI RIVER BASIN



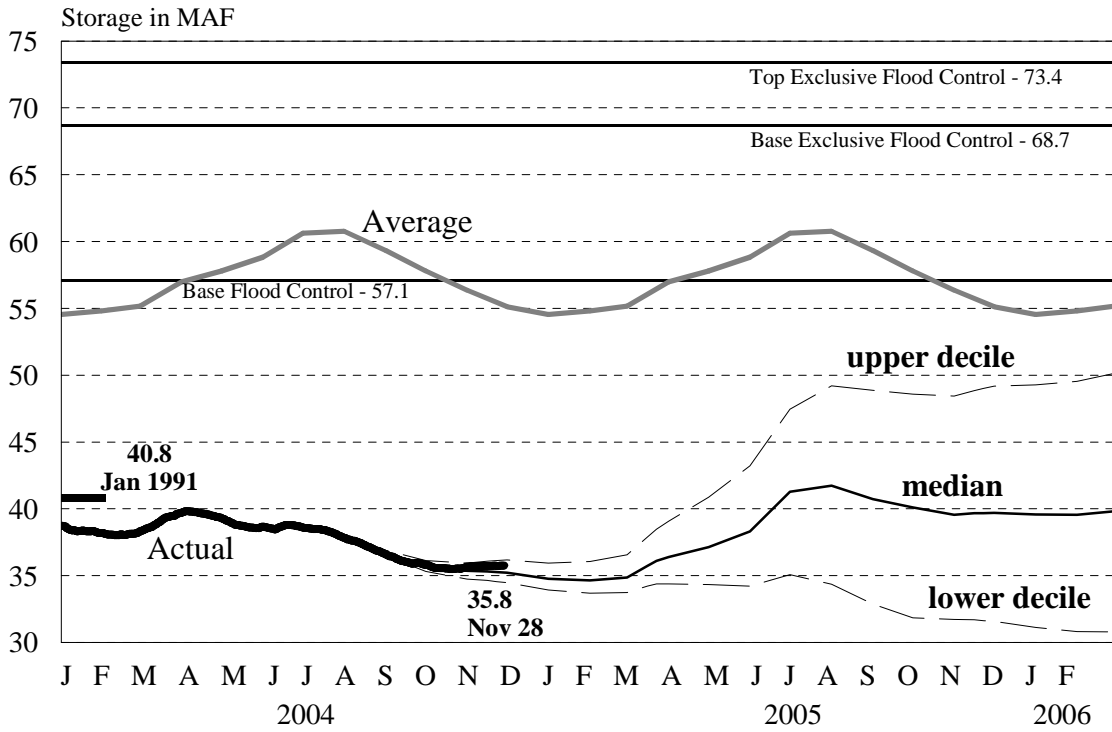
**Summary of Engineering Data -- Missouri River Mainstem System**

Item No.	Subject	Fort Peck Dam - Fort Peck Lake	Garrison Dam - Lake Sakakawea	Oahe Dam - Lake Oahe
1	Location of Dam	Near Glasgow, Montana	Near Garrison, ND	Near Pierre, SD
2	River Mile - 1960 Mileage	Mile 1771.5	Mile 1389.9	Mile 1072.3
3	Total & incremental drainage areas in square miles	57,500	181,400 (2) 123,900	243,490 (1) 62,090
4	Approximate length of full reservoir (in valley miles)	134, ending near Zortman, MT	178, ending near Trenton, ND	231, ending near Bismarck, ND
5	Shoreline in miles (3)	1520 (elevation 2234)	1340 (elevation 1837.5)	2250 (elevation 1607.5)
6	Average total & incremental inflow in cfs	10,200	25,600 15,400	28,900 3,300
7	Max. discharge of record near damsite in cfs	137,000 (June 1953)	348,000 (April 1952)	440,000 (April 1952)
8	Construction started - calendar yr.	1933	1946	1948
9	In operation (4) calendar yr.	1940	1955	1962
<b>Dam and Embankment</b>				
10	Top of dam, elevation in feet msl	2280.5	1875	1660
11	Length of dam in feet	21,026 (excluding spillway)	11,300 (including spillway)	9,300 (excluding spillway)
12	Damming height in feet (5)	220	180	200
13	Maximum height in feet (5)	250.5	210	245
14	Max. base width, total & w/o berms in feet	3500, 2700	3400, 2050	3500, 1500
15	Abutment formations ( under dam & embankment)	Bearpaw shale and glacial fill	Fort Union clay shale	Pierre shale
16	Type of fill	Hydraulic & rolled earth fill	Rolled earth filled	Rolled earth fill & shale berms
17	Fill quantity, cubic yards	125,628,000	66,500,000	55,000,000 & 37,000,000
18	Volume of concrete, cubic yards	1,200,000	1,500,000	1,045,000
19	Date of closure	24 June 1937	15 April 1953	3 August 1958
<b>Spillway Data</b>				
20	Location	Right bank - remote	Left bank - adjacent	Right bank - remote
21	Crest elevation in feet msl	2225	1825	1596.5
22	Width (including piers) in feet	820 gated	1336 gated	456 gated
23	No., size and type of gates	16 - 40' x 25' vertical lift gates	28 - 40' x 29' Tainter	8 - 50' x 23.5' Tainter
24	Design discharge capacity, cfs	275,000 at elev 2253.3	827,000 at elev 1858.5	304,000 at elev 1644.4
25	Discharge capacity at maximum operating pool in cfs	230,000	660,000	80,000
<b>Reservoir Data (6)</b>				
26	Max. operating pool elev. & area	2250 msl 246,000 acres	1854 msl 380,000 acres	1620 msl 374,000 acres
27	Max. normal op. pool elev. & area	2246 msl 240,000 acres	1850 msl 364,000 acres	1617 msl 360,000 acres
28	Base flood control elev & area	2234 msl 212,000 acres	1837.5 msl 307,000 acres	1607.5 msl 312,000 acres
29	Min. operating pool elev. & area	2160 msl 90,000 acres	1775 msl 128,000 acres	1540 msl 117,000 acres
<b>Storage allocation &amp; capacity</b>				
30	Exclusive flood control	2250-2246 975,000 a.f.	1854-1850 1,489,000 a.f.	1620-1617 1,102,000 a.f.
31	Flood control & multiple use	2246-2234 2,717,000 a.f.	1850-1837.5 4,222,000 a.f.	1617-1607.5 3,201,000 a.f.
32	Carryover multiple use	2234-2160 10,785,000 a.f.	1837.5-1775 13,130,000 a.f.	1607.5-1540 13,461,000 a.f.
33	Permanent	2160-2030 4,211,000 a.f.	1775-1673 4,980,000 a.f.	1540-1415 5,373,000 a.f.
34	Gross	2250-2030 18,688,000 a.f.	1854-1673 23,821,000 a.f.	1620-1415 23,137,000 a.f.
35	Reservoir filling initiated	November 1937	December 1953	August 1958
36	Initially reached min. operating pool	27 May 1942	7 August 1955	3 April 1962
37	Estimated annual sediment inflow	18,100 a.f. 1030 yrs.	25,900 a.f. 920 yrs.	19,800 a.f. 1170 yrs.
<b>Outlet Works Data</b>				
38	Location	Right bank	Right Bank	Right Bank
39	Number and size of conduits	2 - 24' 8" diameter (nos. 3 & 4)	1 - 26' dia. and 2 - 22' dia.	6 - 19.75' dia. upstream, 18.25' dia. downstream
40	Length of conduits in feet (8)	No. 3 - 6,615, No. 4 - 7,240	1529	3496 to 3659
41	No., size, and type of service gates	1 - 28' dia. cylindrical gate 6 ports, 7.6' x 8.5' high (net opening) in each control shaft	1 - 18' x 24.5' Tainter gate per conduit for fine regulation	1 - 13' x 22' per conduit, vertical lift, 4 cable suspension and 2 hydraulic suspension (fine regulation)
42	Entrance invert elevation (msl)	2095	1672	1425
43	Avg. discharge capacity per conduit & total	Elev. 2250 22,500 cfs - 45,000 cfs	Elev. 1854 30,400 cfs - 98,000 cfs	Elev. 1620 18,500 cfs - 111,000 cfs
44	Present tailwater elevation (ft msl)	2032-2036 5,000 - 35,000 cfs	1670-1680 15,000- 60,000 cfs	1423-1428 20,000-55,000 cfs
<b>Power Facilities and Data</b>				
45	Avg. gross head available in feet (14)	194	161	174
46	Number and size of conduits	No. 1-24'8" dia., No. 2-22'4" dia.	5 - 29' dia., 25' penstocks	7 - 24' dia., imbedded penstocks
47	Length of conduits in feet (8)	No. 1 - 5,653, No. 2 - 6,355	1829	From 3,280 to 4,005
48	Surge tanks	PH#1: 3-40' dia., PH#2: 2-65' dia.	65' dia. - 2 per penstock	70' dia., 2 per penstock
49	No., type and speed of turbines	5 Francis, PH#1-2: 128.5 rpm, 1-164 rpm , PH#2-2: 128.6 rpm	5 Francis, 90 rpm	7 Francis, 100 rpm
50	Discharge cap. at rated head in cfs	PH#1, units 1&3 170', 2-140' 8,800 cfs, PH#2-4&5 170'-7,200 cfs	150' 41,000 cfs	185' 54,000 cfs
51	Generator nameplate rating in kW	1&3: 43,500; 2: 18,250; 4&5: 40,000	3 - 109,250, 2 - 95,000	112,290
52	Plant capacity in kW	185,250	517,750	786,030
53	Dependable capacity in kW (9)	181,000	388,000	534,000
54	Avg. annual energy, million kWh (12)	1,122	2,387	2,820
55	Initial generation, first and last unit	July 1943 - June 1961	January 1956 - October 1960	April 1962 - June 1963
56	Estimated cost September 1999 completed project (13)	\$158,428,000	\$305,274,000	\$346,521,000

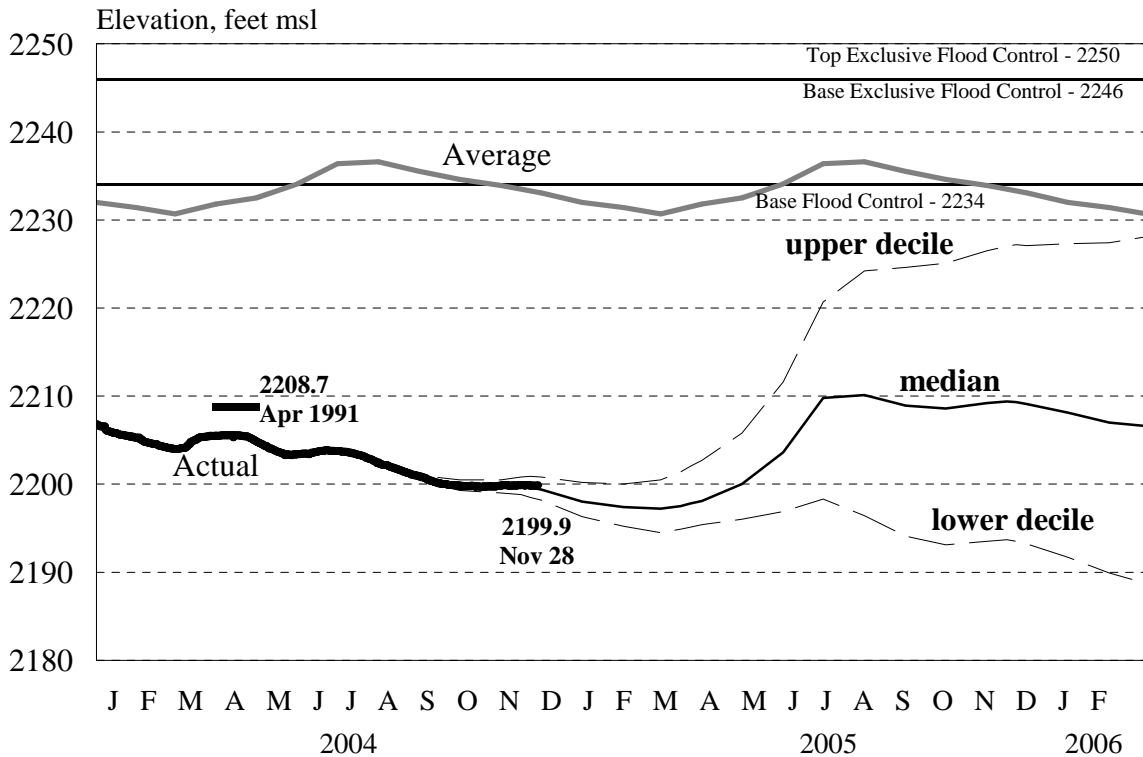
**Summary of Engineering Data -- Missouri River Mainstem System**

Big Bend Dam - Lake Sharpe		Fort Randall Dam - Lake Francis Case		Gavins Point Dam - Lewis & Clark Lake		Total	Item No.	Remarks
21 miles upstream Chamberlain, SD		Near Lake Andes, SD		Near Yankton, SD			1	(1) Includes 4,280 square miles of non-contributing areas. (2) Includes 1,350 square miles of non-contributing areas. (3) With pool at base of flood control. (4) Storage first available for regulation of flows. (5) Damming height is height from low water to maximum operating pool. Maximum height is from average streambed to top of dam. (6) Based on latest available storage data. (7) River regulation is attained by flows over low-crested spillway and through turbines. (8) Length from upstream face of outlet or to spiral case. (9) Based on 8th year (1961) of drought drawdown (From study 8-83-1985). (10) Affected by level of Lake Francis case. Applicable to pool at elevation 1350. (11) Spillway crest. (12) 1967-2003 Average (13) Source: Annual Report on Civil Works Activities of the Corps of Engineers. Extract Report Fiscal Year 1999. (14) Based on Study 8-83-1985
Mile 887.4		Mile 880.0		Mile 811.1			2	
249,330 (1)	5,840	263,480 (1)	14,150	279,480 (1)	16,000		3	
80, ending near Pierre, SD		107, ending at Big Bend Dam		25, ending near Niobrara, NE		755 miles	4	
200 (elevation 1420)		540 (elevation 1350)		90 (elevation 1204.5)		5,940 miles	5	
28,900		30,000	1,100	32,000	2,000		6	
440,000 (April 1952)		447,000 (April 1952)		480,000 (April 1952)			7	
1959		1946		1952			8	
1964		1953		1955			9	
1440		1395		1234			10	
10,570 (including spillway)		10,700 (including spillway)		8,700 (including spillway)		71,596	11	
78		140		45		863 feet	12	
95		165		74			13	
1200, 700		4300, 1250		850, 450			14	
Pierre shale & Niobrara chalk		Niobrara chalk		Niobrara chalk & Carlile shale			15	
Rolled earth, shale, chalk fill		Rolled earth fill & chalk berms		Rolled earth & chalk fill			16	
17,000,000		28,000,000 & 22,000,000		7,000,000		358,128,000 cu. yds	17	
540,000		961,000		308,000		5,554,000 cu. yds.	18	
24 July 1963		20 July 1952		31 July 1955			19	
Left bank - adjacent		Left bank - adjacent		Right bank - adjacent			20	
1385		1346		1180			21	
376 gated		1000 gated		664 gated			22	
8 - 40' x 38' Tainter		21 - 40' x 29' Tainter		14 - 40' x 30' Tainter			23	
390,000 at elev 1433.6		620,000 at elev 1379.3		584,000 at elev 1221.4			24	
270,000		508,000		345,000			25	
1423 msl	61,000 acres	1375 msl	102,000 acres	1210 msl	31,000 acres	1,194,000 acres	26	
1422 msl	60,000 acres	1365 msl	95,000 acres	1208 msl	28,000 acres	1,147,000 acres	27	
1420 msl	57,000 acres	1350 msl	77,000 acres	1204.5 msl	24,000 acres	989,000 acres	28	
1415 msl	51,000 acres	1320 msl	38,000 acres	1204.5 msl	24,000 acres	450,000 acres	29	
1423-1422	60,000 a.f.	1375-1365	985,000 a.f.	1210-1208	59,000 a.f.	4,670,000 a.f.	30	
1422-1420	117,000 a.f.	1365-1350	1,309,000 a.f.	1208-1204.5	90,000 a.f.	11,656,000 a.f.	31	
		1350-1320	1,607,000 a.f.			38,983,000 a.f.	32	
1420-1345	1,682,000 a.f.	1320-1240	1,517,000 a.f.	1204.5-1160	321,000 a.f.	18,084,000 a.f.	33	
1423-1345	1,859,000 a.f.	1375-1240	5,418,000 a.f.	1210-1160	470,000 a.f.	73,393,000 a.f.	34	
November 1963		January 1953		August 1955			35	
25 March 1964		24 November 1953		22 December 1955			36	
4,300 a.f.	430 yrs.	18,300 a.f.	250 yrs.	2,600 a.f.	180 yrs.	92,500 a.f.	37	
None (7)		Left Bank		None (7)			38	
		4 - 22' diameter					39	
		1013					40	
		2 - 11' x 23' per conduit, vertical lift, cable suspension					41	
1385 (11)		1229		1180 (11)			42	
		Elev 1375					43	
		32,000 cfs - 128,000 cfs						
1351-1355(10)	25,000-100,000 cfs	1228-1239	5,000-60,000 cfs	1155-1163	15,000-60,000 cfs		44	
70		117		48		764 feet	45	
None: direct intake		8 - 28' dia., 22' penstocks		None: direct intake			46	
		1,074				55,083	47	
None		59' dia, 2 per alternate penstock		None			48	
8 Fixed blade, 81.8 rpm		8 Francis, 85.7 rpm		3 Kaplan, 75 rpm		36 units	49	
67'	103,000 cfs	112'	44,500 cfs	48'	36,000 cfs		50	
3 - 67,276, 5 - 58,500		40,000		44,100			51	
494,320		320,000		132,300		2,435,650 kw	52	
497,000		293,000		74,000		1,967,000 kw	53	
1,030		1,824		752		9,935 million kWh	54	
October 1964 - July 1966		March 1954 - January 1956		September 1956 - January 1957		July 1943 - July 1966	55	
	\$107,498,000		\$199,066,000		\$49,617,000		\$1,166,404,000	56

# System Storage 2004-2005 Final AOP

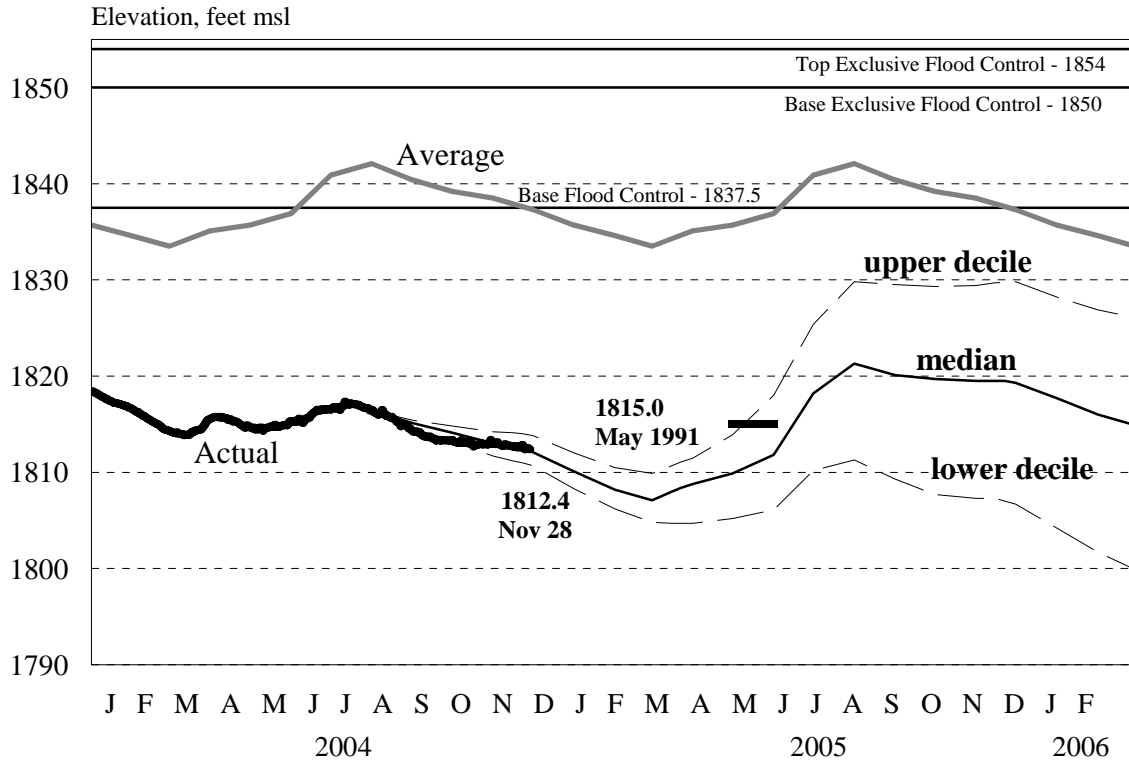


# Fort Peck 2004-2005 Final AOP



# Garrison

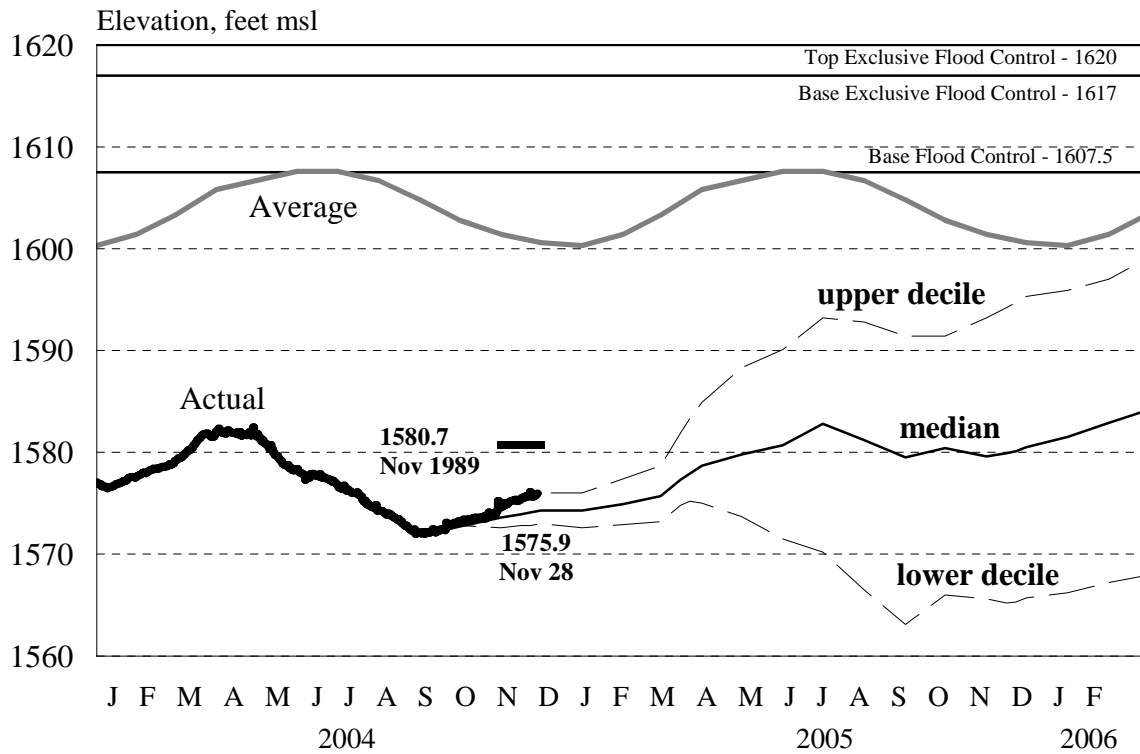
## 2004-2005 Final AOP



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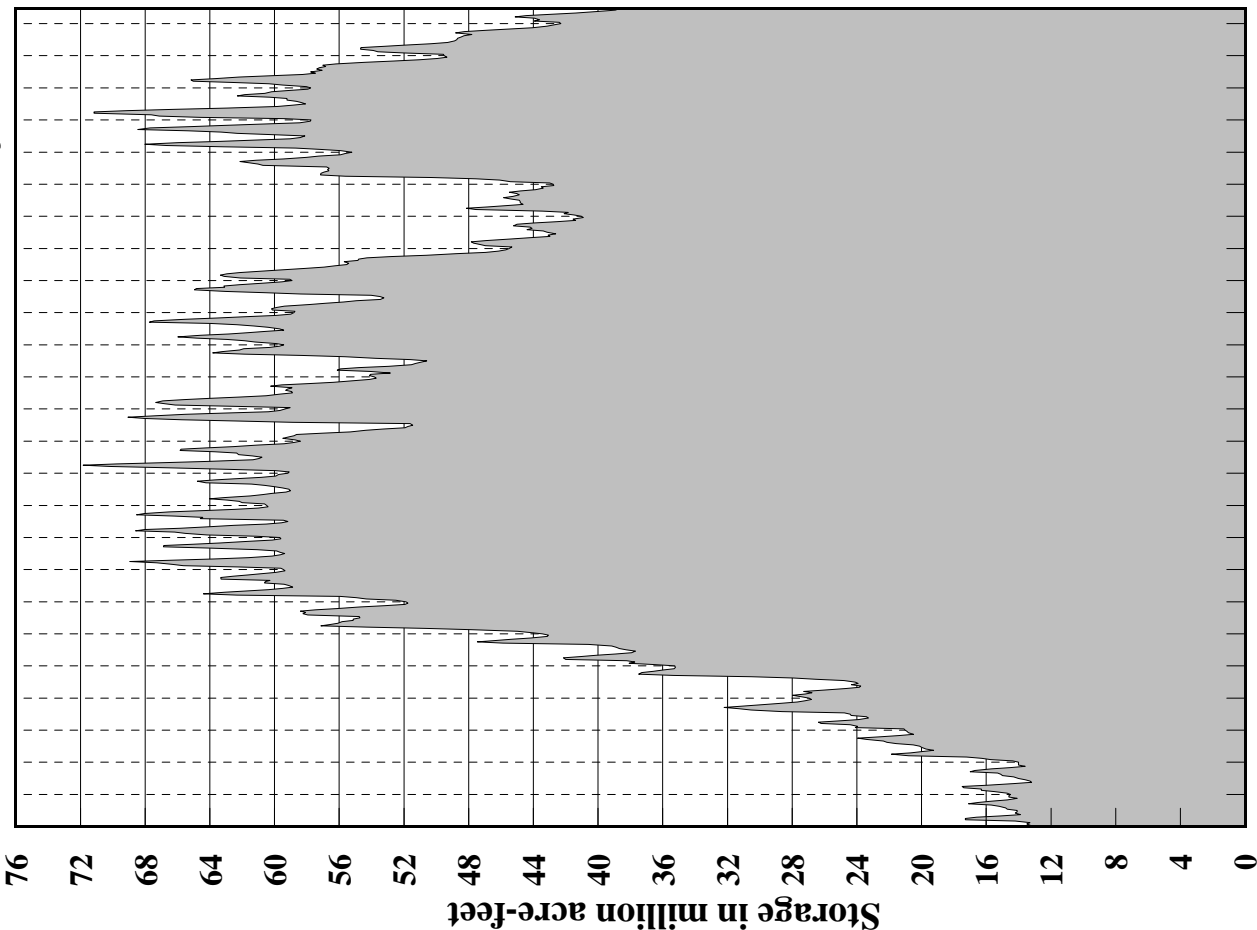
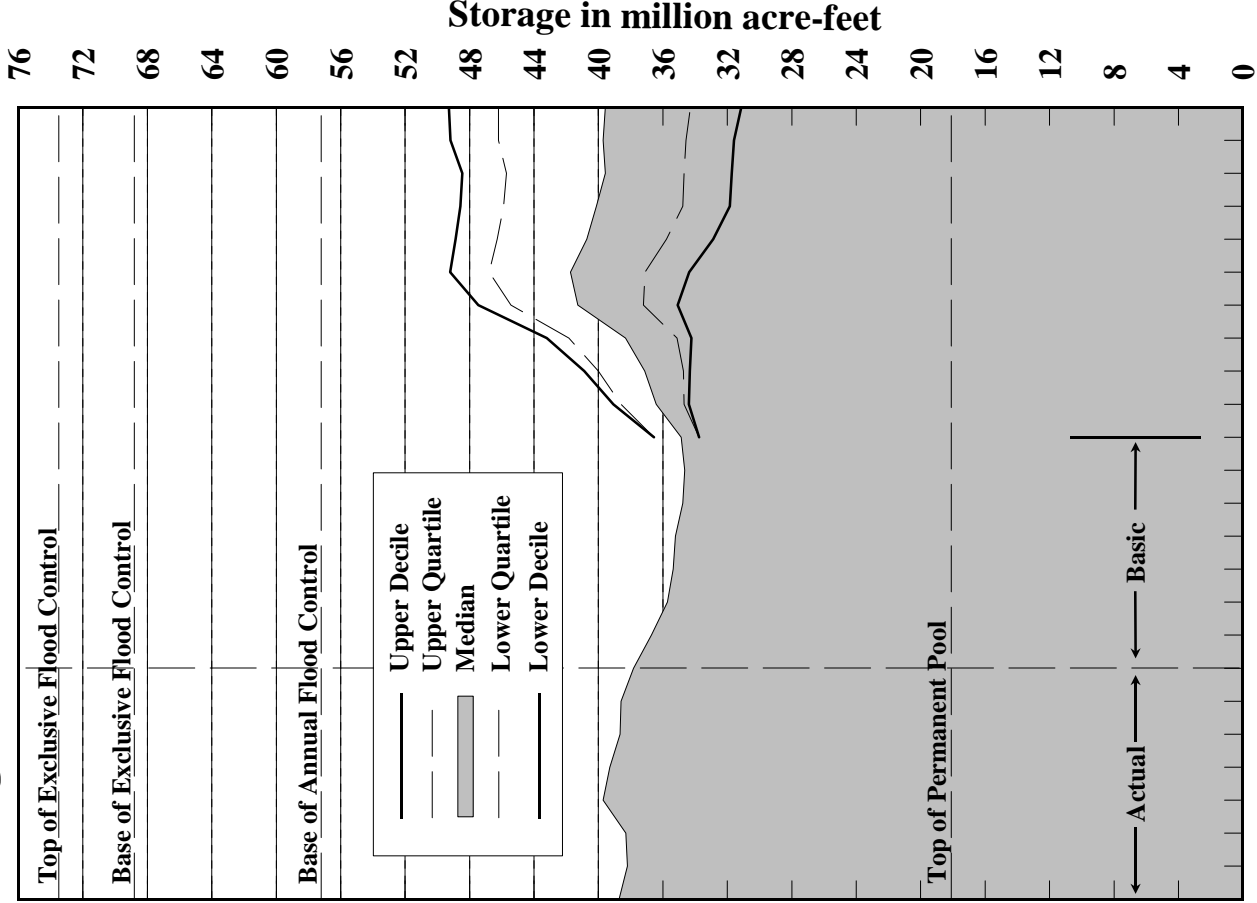
# Oahe

## 2004-2005 Final AOP

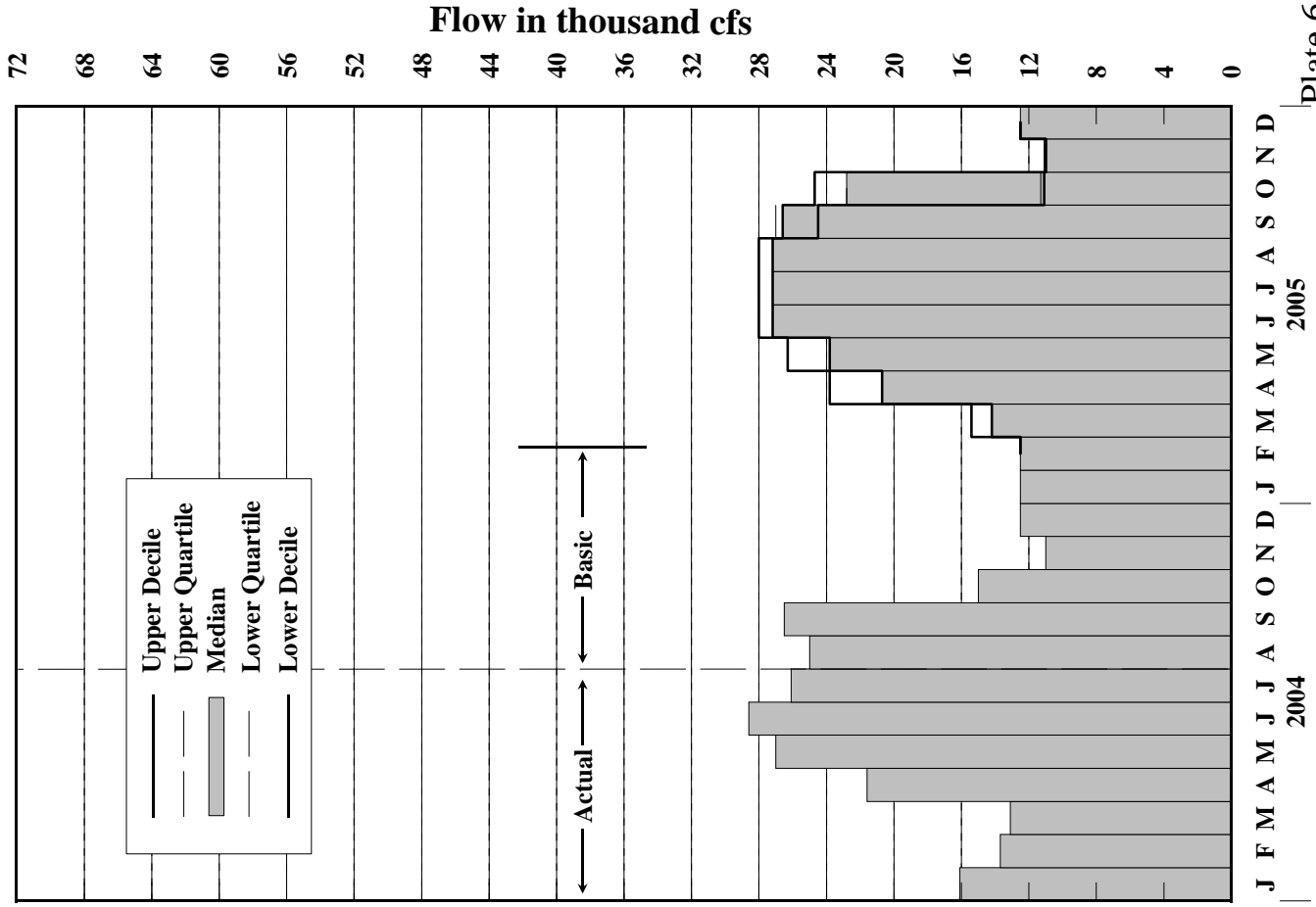
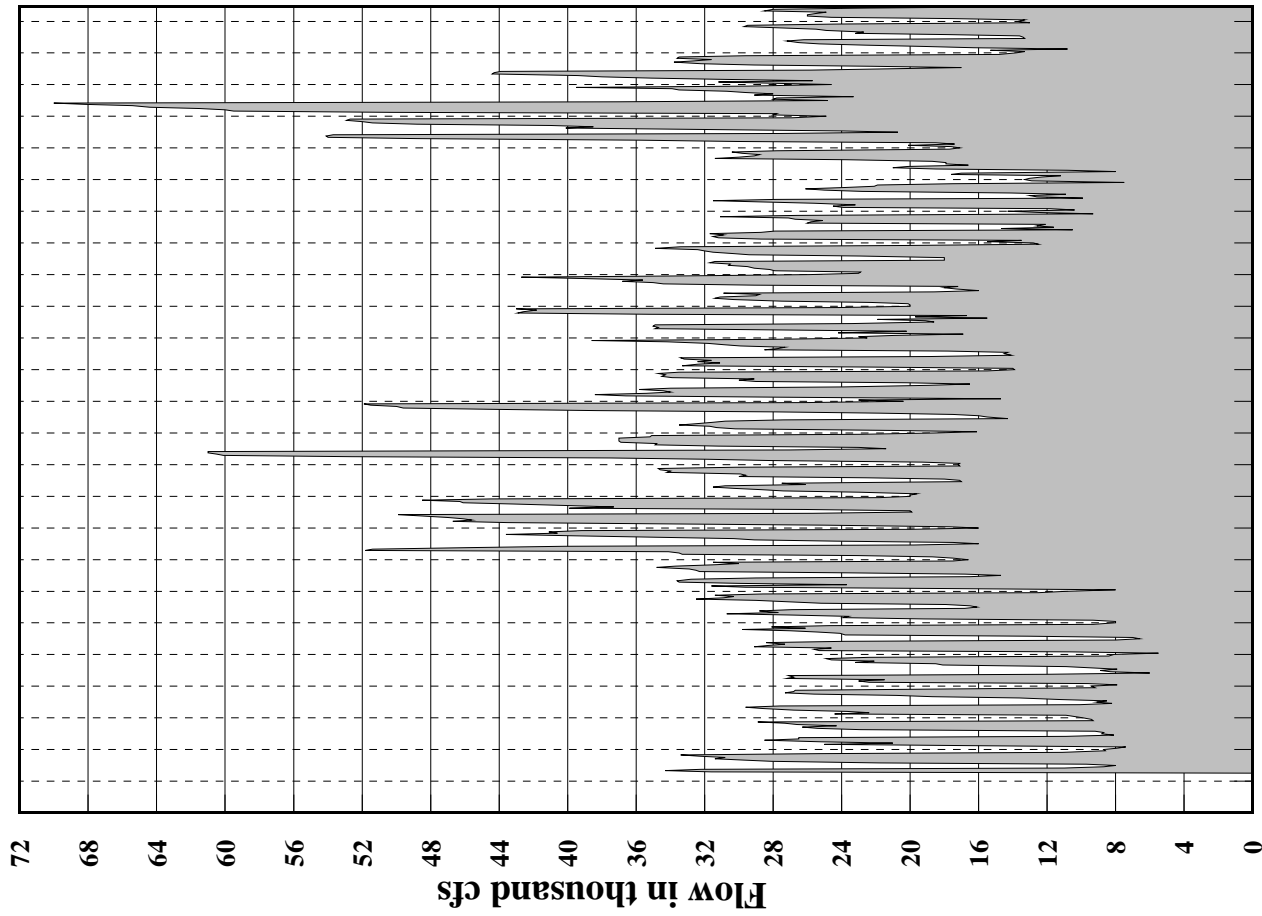


Average: 1967-2003

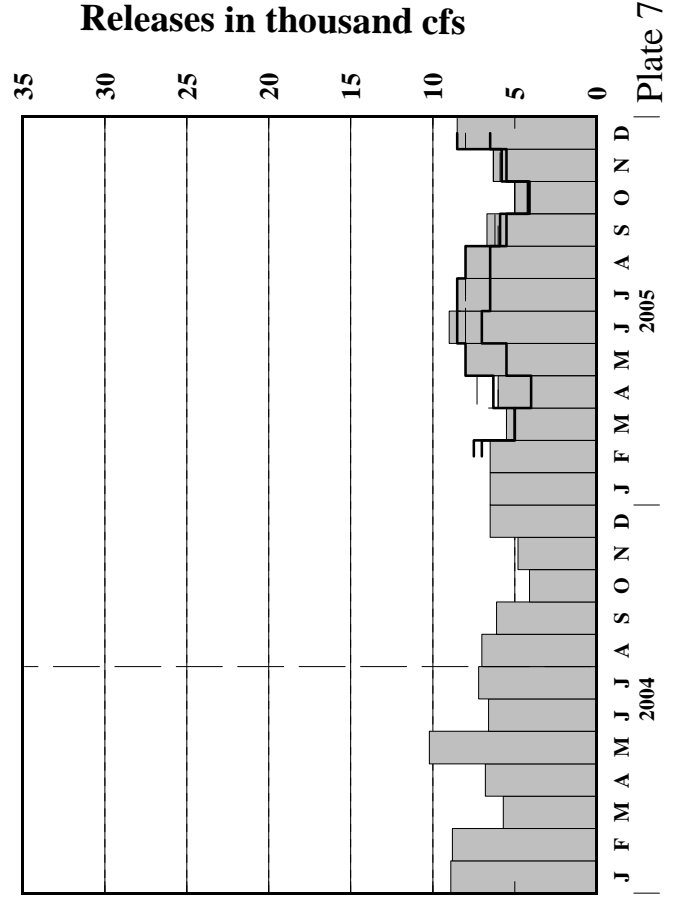
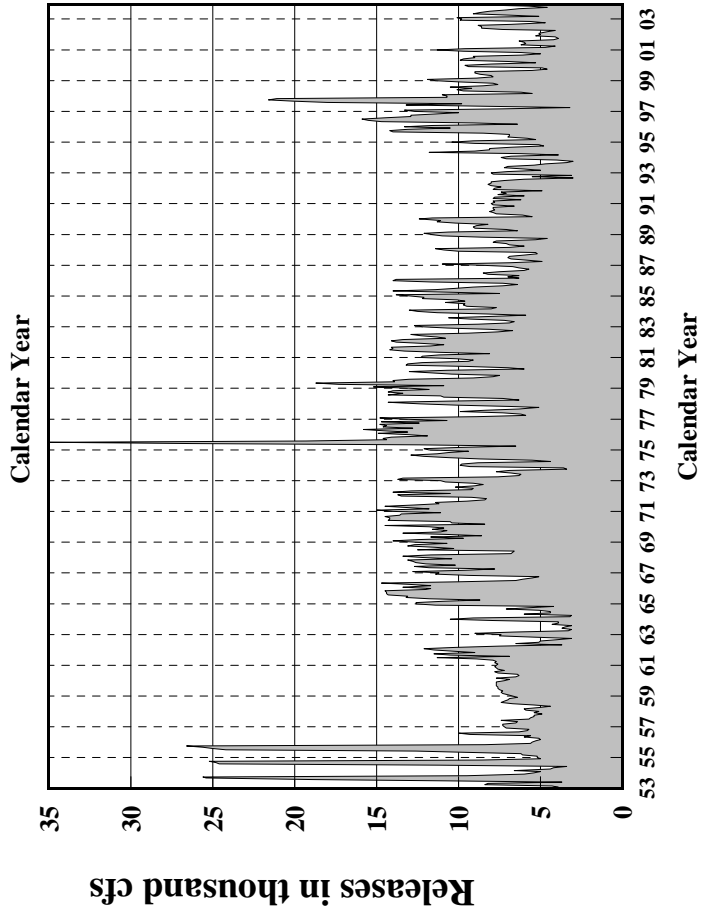
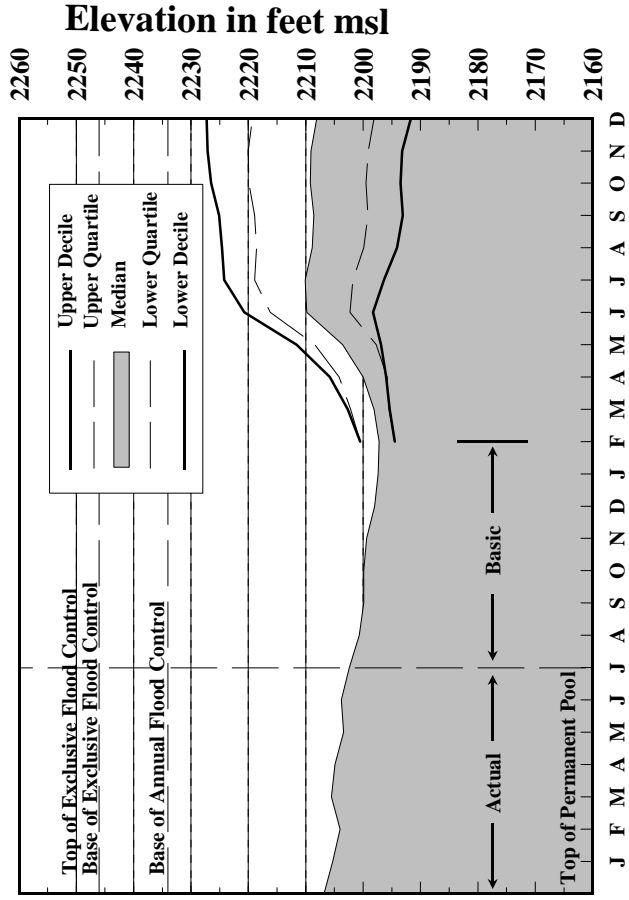
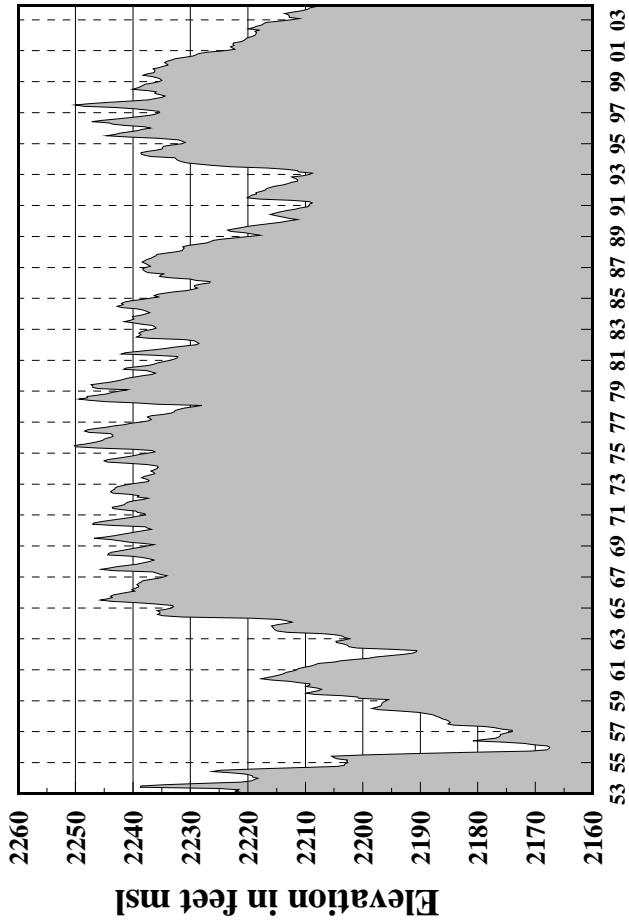
# System Storage



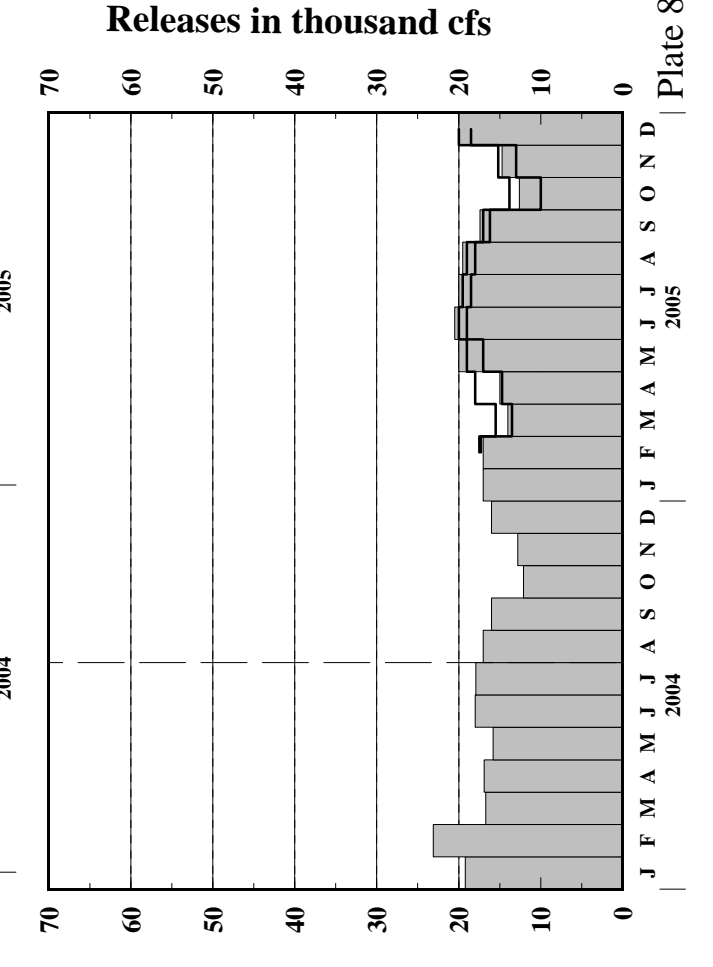
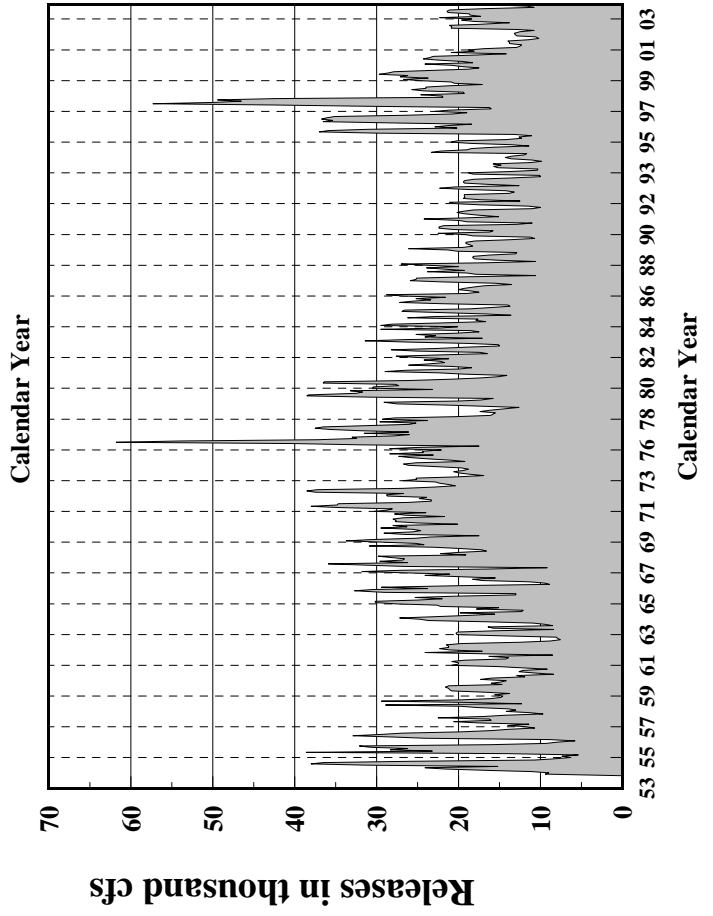
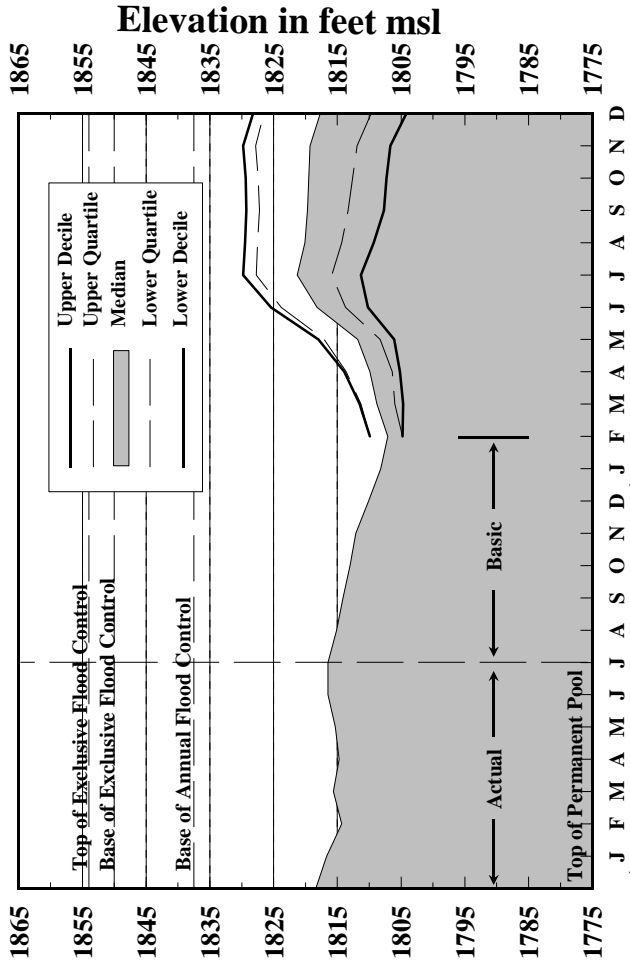
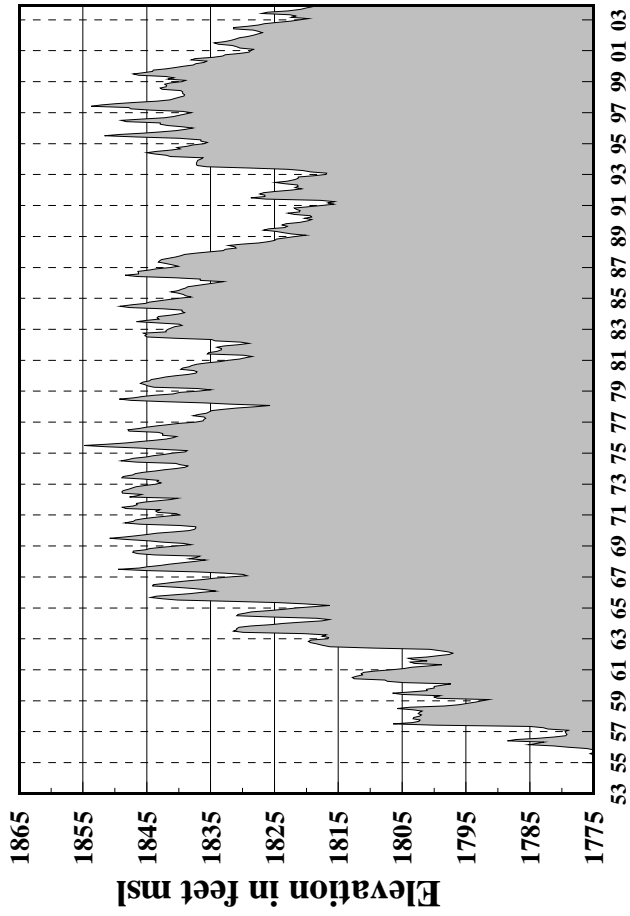
# Gavins Point Releases



# Fort Peck Elevations and Releases

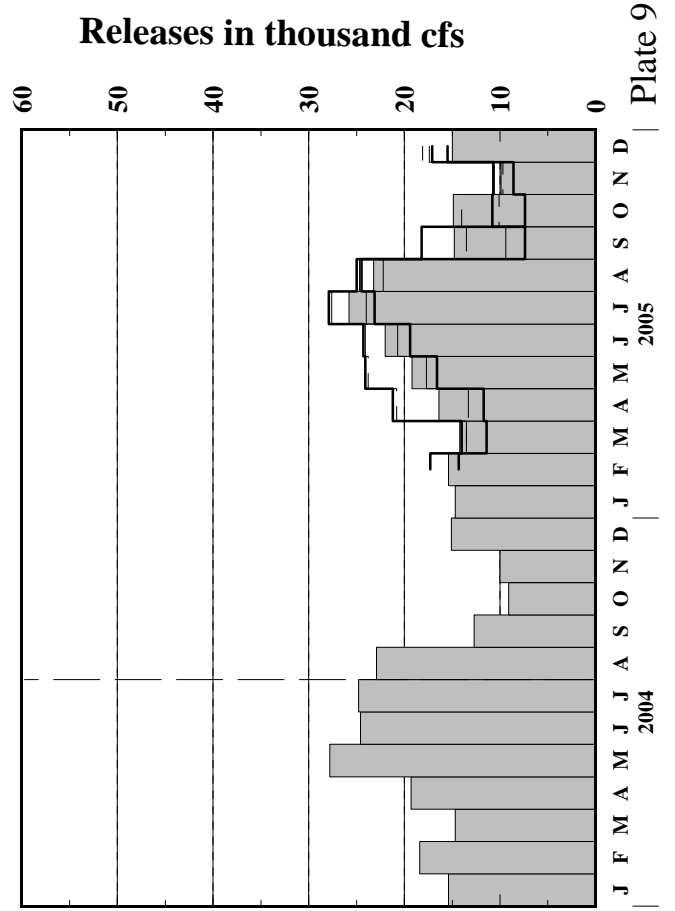
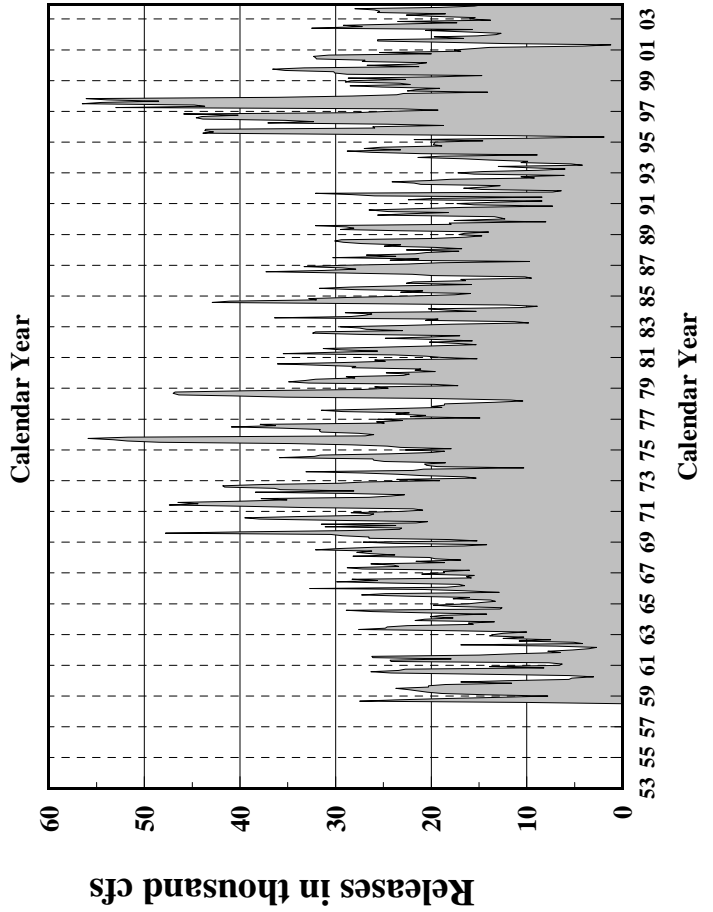
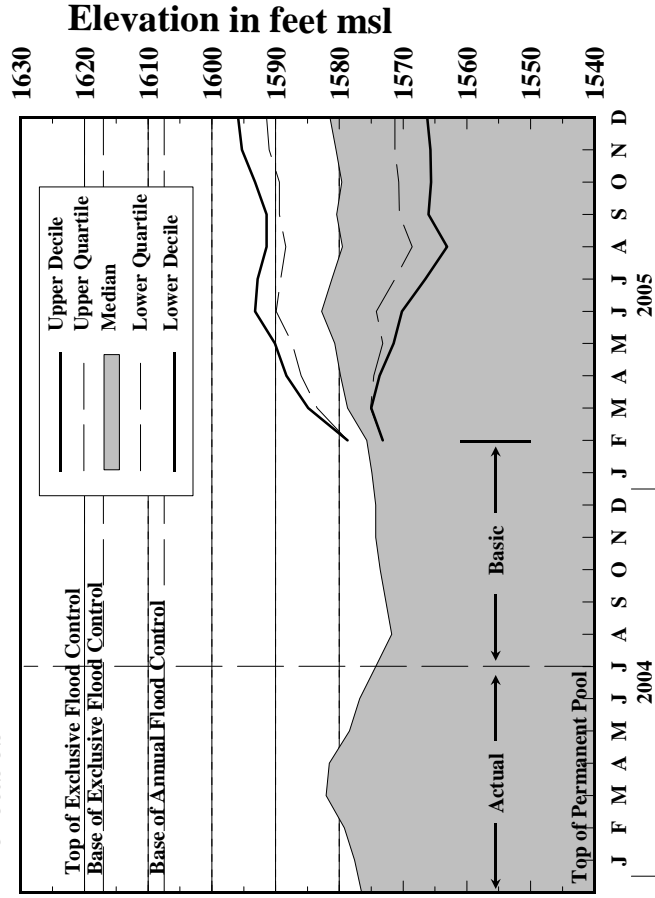
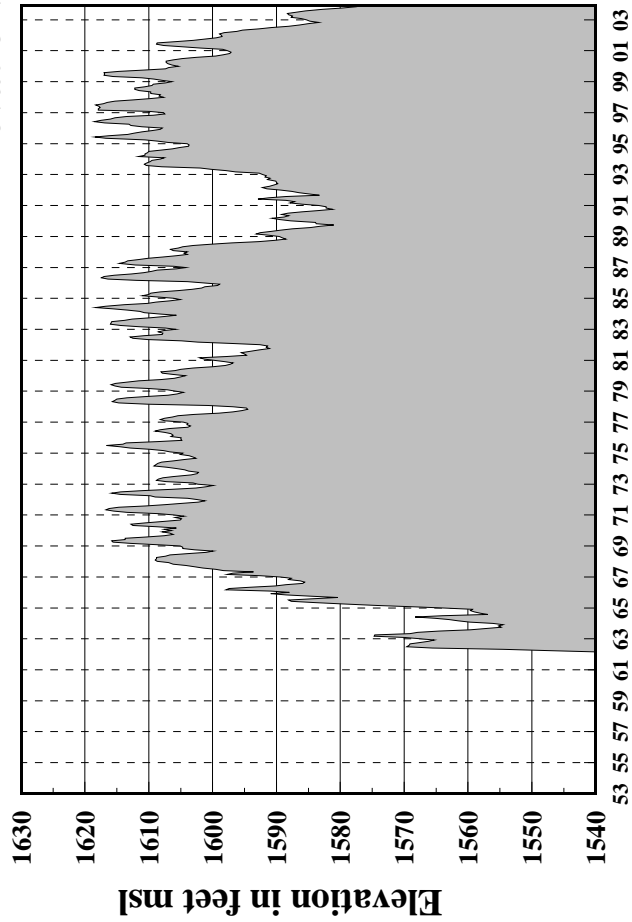


# Garrison Elevations and Releases

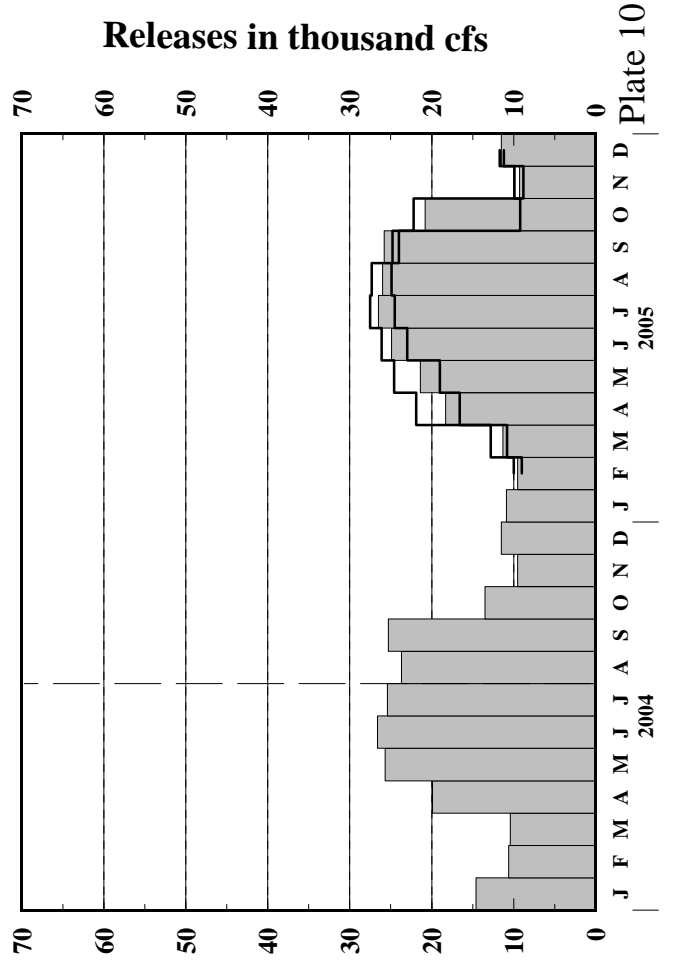
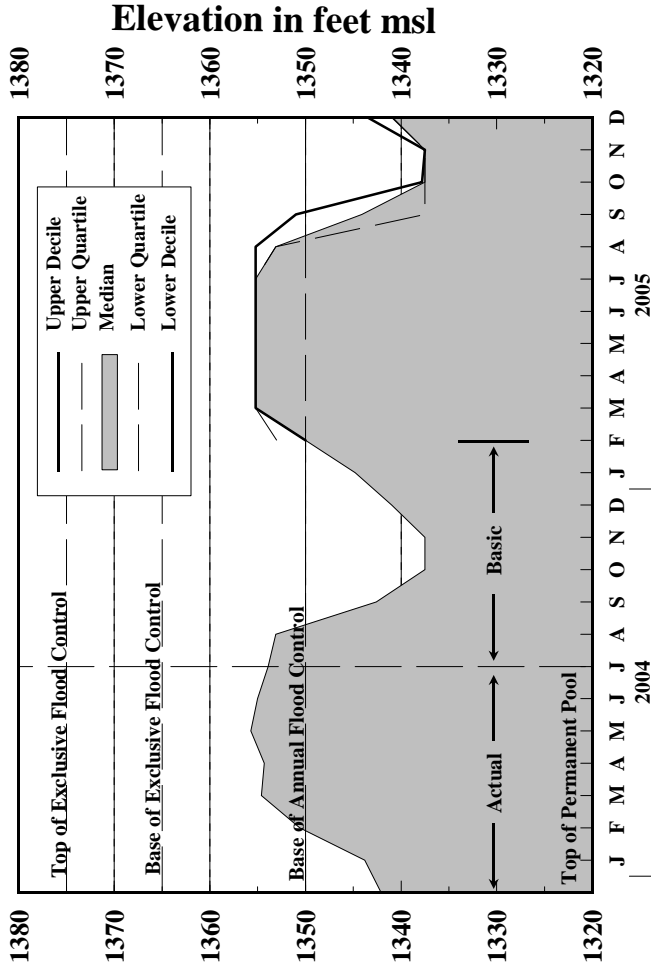
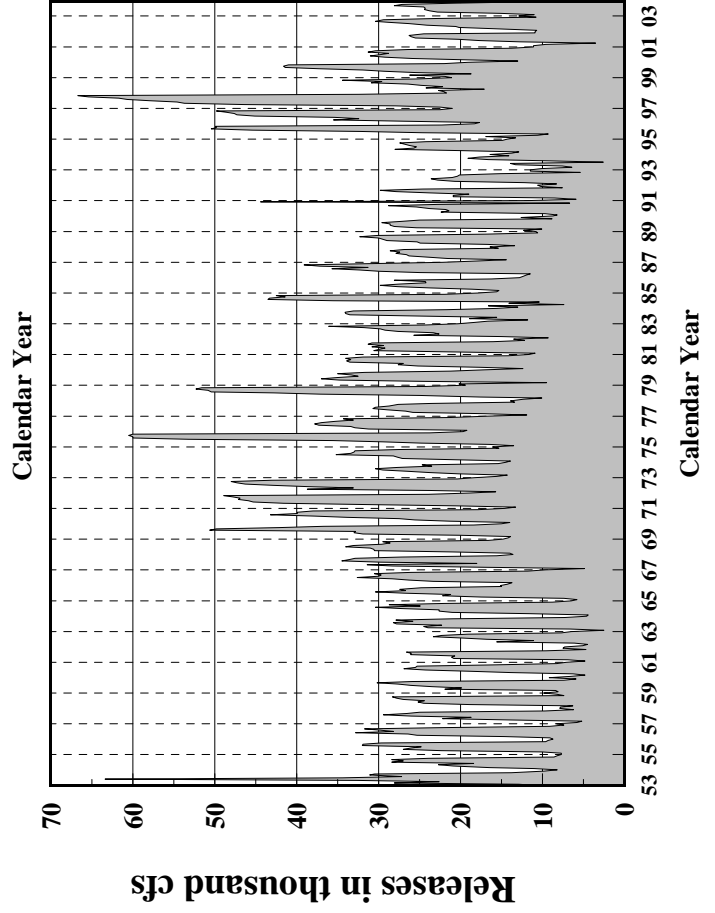
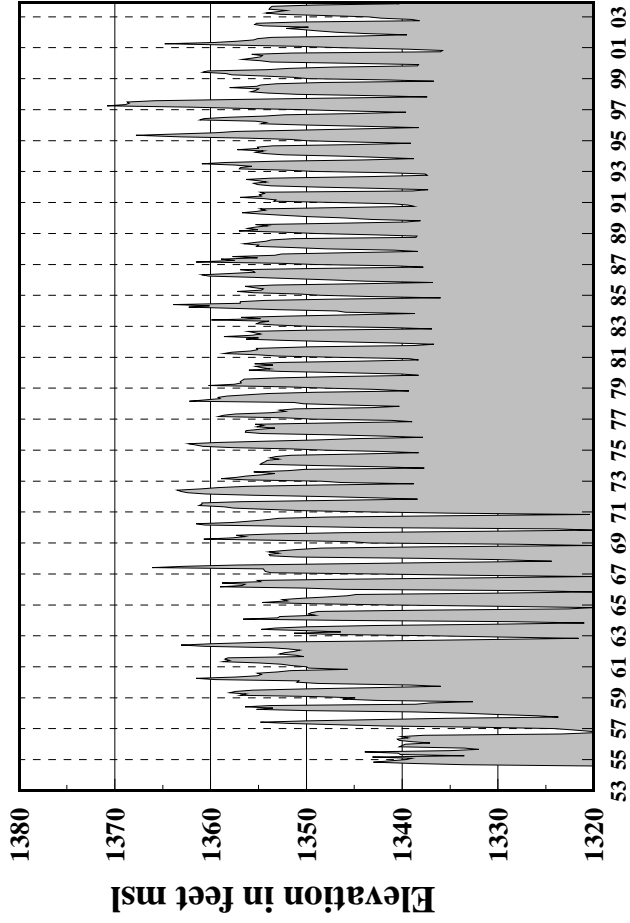




# Oahe Elevations and Releases

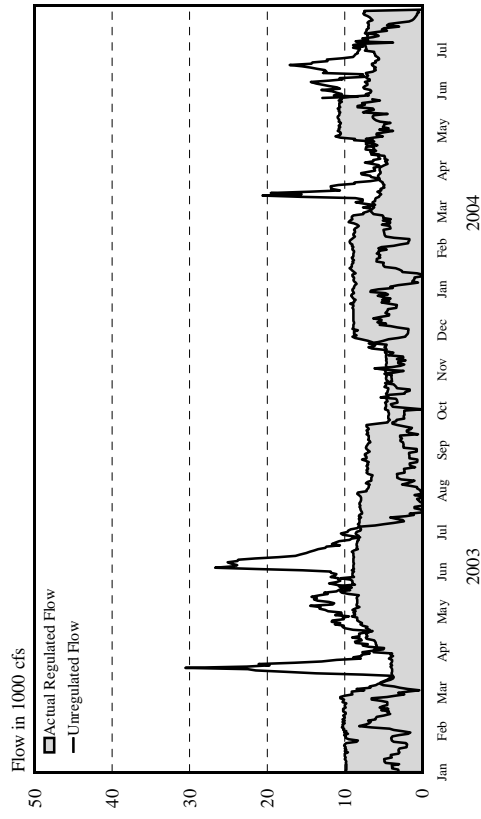


# Fort Randall Elevations and Releases

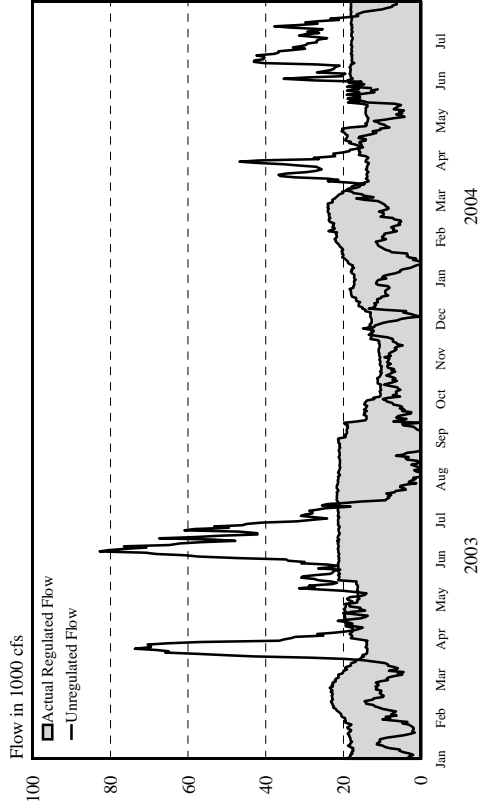


# Reservoir Release and Unregulated Flow

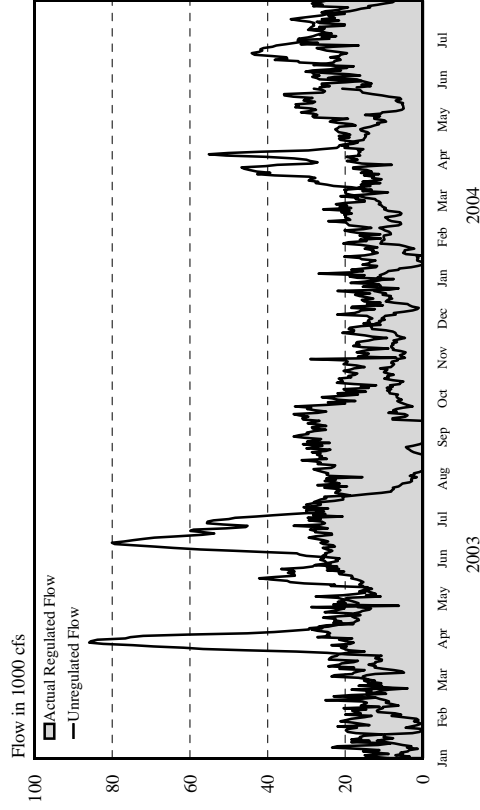
## Fort Peck



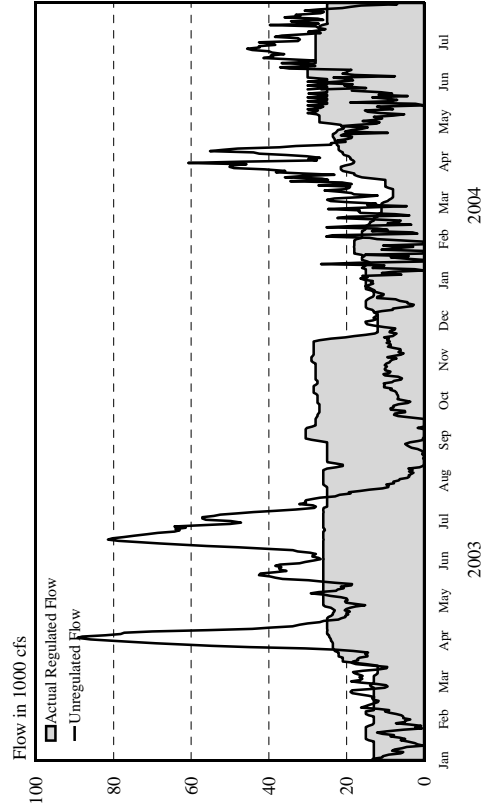
## Garrison



## Oahe



## Gavins Point



# System Gross Capability and Average Monthly Generation

