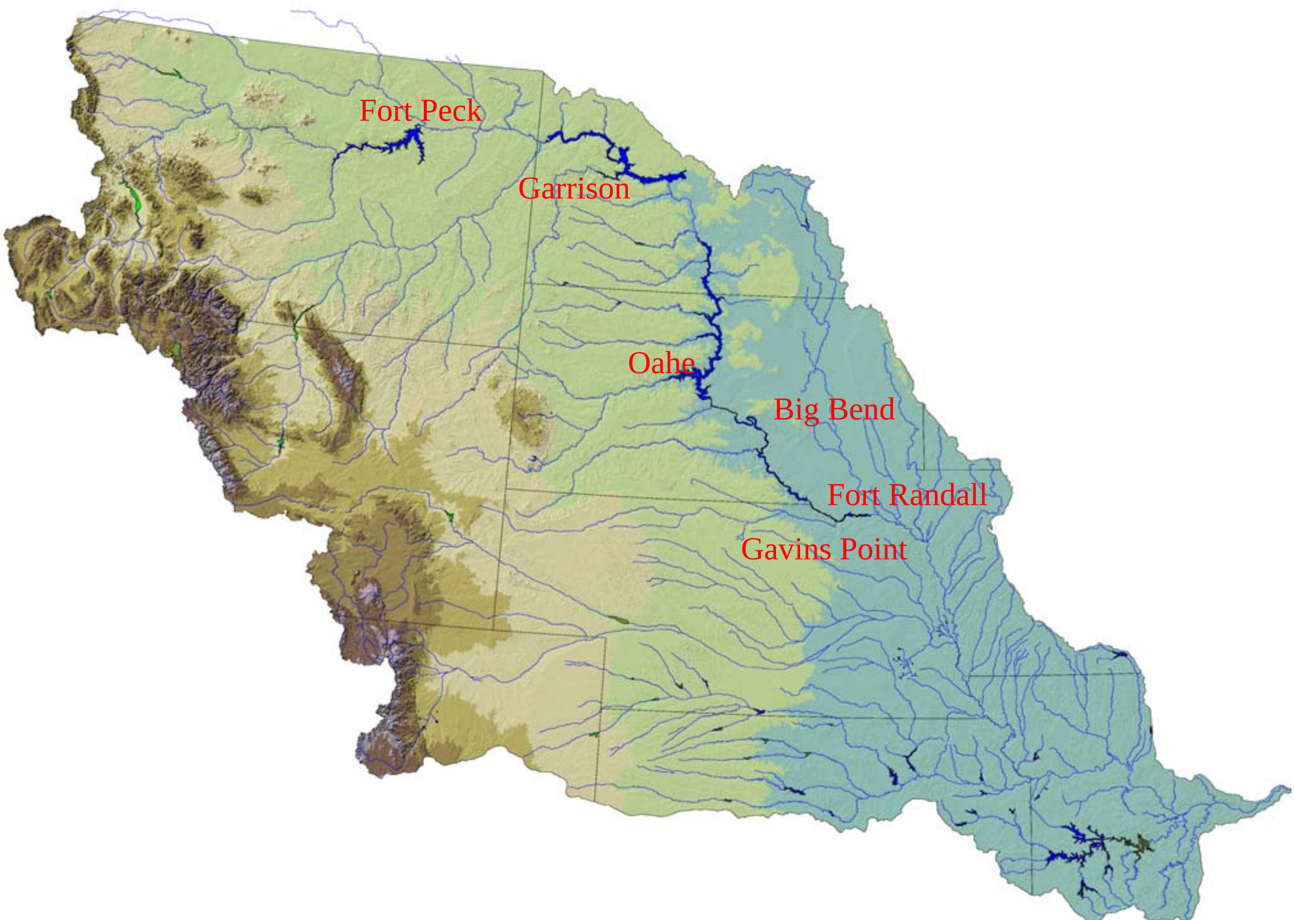
US Army Corps
of Engineers

Northwestern Division

Missouri River Mainstem Reservoir System

Summary of Actual 2017 Regulation

Missouri River Basin



U.S. Army Corps of Engineers
Northwestern Division
Missouri River Basin Water Management Division
Omaha, Nebraska

May 2018

Missouri River Mainstem Reservoir System

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LIST OF ABBREVIATIONS AND ACRONYMS

AOP	annual operating plan
AF	acre-feet
cfs	cubic feet per second
BIA	Bureau of Indian Affairs
consultation	government-to-government consultation
CPFLP	coldwater permanent fish life propagation
CY	calendar year (January 1 to December 31)
DMS	Data Management System
deg C	degrees Celsius
deg F	degrees Fahrenheit
EA	Environmental Assessment
ENSO	El Niño Southern Oscillation
EOM	End of Month
Five Year Plan	Cultural Resources Program Five Year Plan
FTT	Flow to Target
HPRCC	High Plains Regional Climate Center
kAF	thousand acre-feet
kW	kilowatt
kWh	kilowatt hour
M	million
MAF	million acre-feet
Master Manual	Master Water Control Manual
MGD	million gallons per day
µg/l	micrograms per liter
mg/l	milligrams per liter
MRNRC	Missouri River Natural Resources Committee
MRBWM	Missouri River Basin Water Management
MV	motor vessel
MVD	Corps' Mississippi Valley Division
MW	megawatt
MWh	megawatt hour
M&I	municipal and industrial
NDEQ	Nebraska Department of Environmental Quality
NHPA	National Historic Preservation Act
NOAA-CPC	National Oceanic and Atmospheric Administration - Climate Prediction Center
NOAA-NCDC	National Oceanic and Atmospheric Administration - National Climatic Data Center
NOAA-NWS	National Oceanic and Atmospheric Administration - National Weather Service
NOHRSC	National Operational and Hydrologic Remote Sensing Center

LIST OF ABBREVIATIONS AND ACRONYMS (cont'd)

NRCS-SNOTEL	Natural Resources Conservation Service SNOwpack TELemetry
NWD	Corps' Northwestern Division
NWK	Corps' Kansas City District
NWO	Corps' Omaha District
OPPD	Omaha Public Power District
PA	2004 Programmatic Agreement
plover	piping plover
P-S MBP	Pick-Sloan Missouri Basin Program
RM	river mile
SD GFP	South Dakota Game Fish and Parks
SHPO	State Historic Preservation Officer
SR	Steady Release
SWE	snow water equivalent
System	Missouri River Mainstem Reservoir System
tern	interior least tern
THPO	Tribal Historic Preservation Officer
TMDL	Total Maximum Daily Load
T&E	Threatened and Endangered
USBR	U.S. Bureau of Reclamation
USDA	epartment of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
WCSC	Waterborne Commerce Statistics Center
Western	Western Area Power Administration
WPFLP	warmwater permanent fish life propagation

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. Conversely, 1.5 cfs for 24 hours is approximately 1 million gallons; therefore, 1.5 cfs is approximately 1 million gallons per day (MGD).

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.

Drought is three or more consecutive years of below-average calendar year runoff into the Missouri River above Sioux City, IA.

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

Summary of Actual 2017 Regulation

I. FOREWORD

This document contains a summary of the actual regulation of the Missouri River Mainstem Reservoir System (System) for the 2017 Calendar Year (CY). Two other reports related to System regulation are also available, the ***System Description and Regulation*** and ***Final 2016-2017 Annual Operating Plan.*** All three reports can be obtained by contacting the Missouri River Basin Water Management Division (MRBWM), Northwestern Division, U.S. Army Corps of Engineers at 1616 Capitol Avenue, Suite 365, Omaha, Nebraska 68102-4909, phone (402) 996-3841. The reports are also available on the MRBWM website at www.nwd-mr.usace.army.mil/rcc.

A Missouri River Basin (Basin) map is presented on ***Plate 1*** and the pertinent data for the System are shown on ***Plate 2.***

II. REVIEW OF REGULATION – JANUARY-DECEMBER 2017

A. General

This report summarizes the System regulation as it pertains to all eight congressionally-authorized purposes. During 2017 the System was regulated in accordance with the Master Water Control Manual (Master Manual) and the applicable provisions of the Final 2016-17 Annual Operating Plan (AOP), which was made available for review and comment by representatives of State and Federal agencies, Tribes, the general public, and specific interest groups. For the purposes of this report, the upper Missouri River Basin (upper Basin) is the Missouri River Basin above Sioux City, IA and the lower Missouri River Basin (lower Basin) is the Missouri River Basin from Sioux City, IA to the mouth.

B. Precipitation and Water Supply Available in 2017

Plains snowpack, mountain snowpack and general weather conditions in the Missouri River Basin during the 2017 calendar year are discussed in the following sections. The 1981-2010 average reference period is used for plains and mountain snowpack, precipitation and temperature conditions.

1. Plains Snowpack

Plains snowpack during the 2016-2017 winter was generally light to moderate in eastern Montana, and moderate to heavy in North Dakota and northern South Dakota; plains snowpack was light in the remainder of the upper Basin. The moderate snowpack developed in North Dakota and South Dakota during several large winter storms in December. Winter season temperatures and precipitation were influenced by a mild La Niña climate pattern. From December 2016 to February 2017, the climatological winter, temperature departures were well-below normal (***Figure 1***) in Montana, northern Wyoming, western North Dakota and western South Dakota. Temperature departures were above normal in the eastern Dakotas and the lower Basin. Well-above normal winter precipitation throughout the upper Basin (***Figure 2***) also contributed to the development of the moderate plains snowpack.

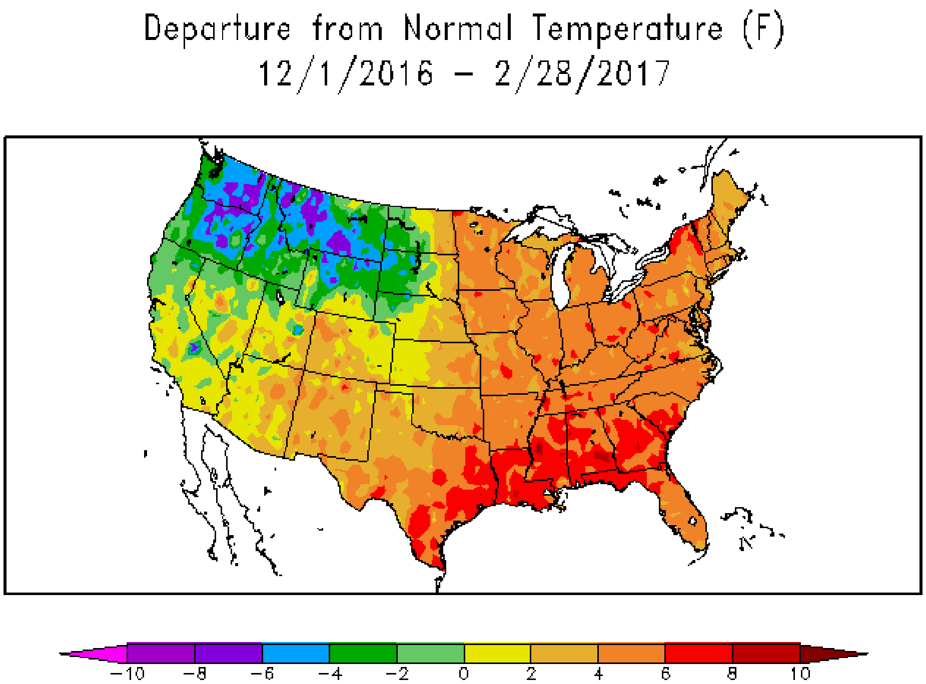


Figure 1. December 2016 – February 2017 departure from normal temperature (deg F).

Source: High Plains Regional Climate Center (HPRCC).

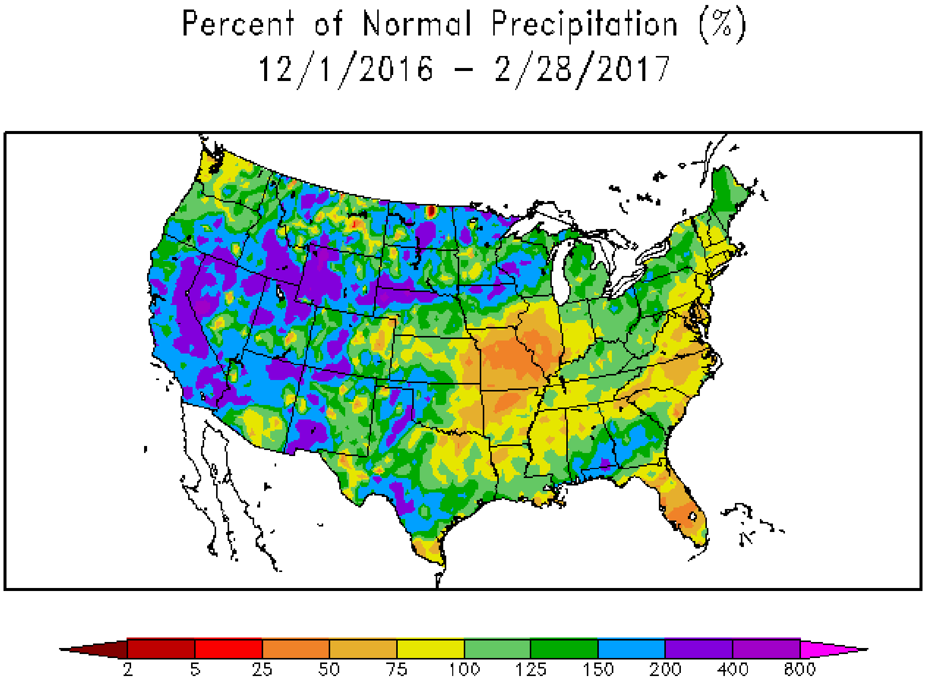


Figure 2. December 2016 – February 2017 percent of normal precipitation. Source: HPRCC.

Prior to the first accumulations of the 2016-2017 winter plains snowpack, soil moisture conditions (***Figure 3***) were greater than the 70^{th} percentile ranking (wetter than normal) in Montana, northwestern Wyoming, North Dakota, eastern South Dakota, eastern Nebraska and northwestern Iowa. Soil moisture was very wet in northern Montana due to heavy rainfall in the fall of 2016. Soil moisture was below the 30^{th} percentile ranking (drier than normal) in western South Dakota and eastern Wyoming. Fall soil moisture is significant in its relation to spring runoff. During the onset of the winter, much of this moisture is frozen in the soil and is later released during the spring thaw. Soil moisture typically does not change during the winter; therefore, high or low fall soil moisture typically establishes wet or dry spring soil moisture conditions, respectively.

The snowpack across the Northern Plains began accumulating in earnest in central North Dakota during the last three days of November. Snowfall totals in North Dakota during the last three days of November ranged from 15 to 25 inches. Heavy accumulations included 18.7 inches at the Bismarck, ND airport; 20 inches in Mandan, ND; and 24.5 inches in northeastern Bismarck, ND. Northern South Dakota received about 10 inches of snowfall during this time period. As of December 5, much of the heavy snow remained on the plains (see ***Figure 4***), and shallow accumulations of snow were also present in Montana, Wyoming, South Dakota, eastern North Dakota and northwest Iowa.

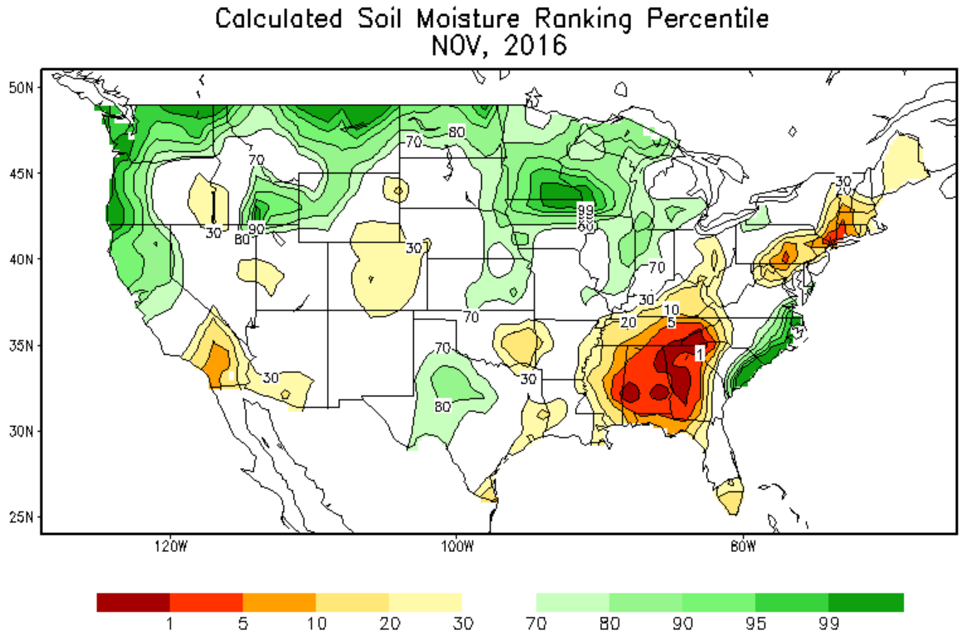


Figure 3. Soil moisture percentile ranking, November 2016. Source: NOAA CPC

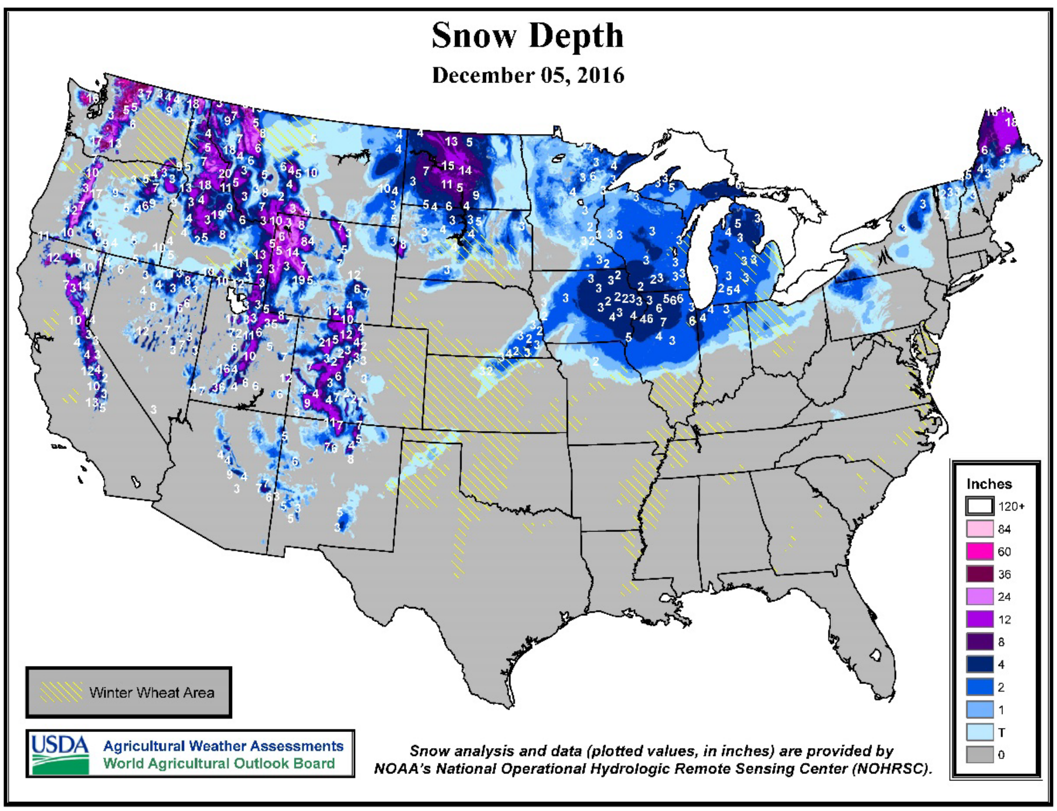


Figure 4. Snow depth in inches on December 5, 2016.

In December heavy plains snowfall occurred over southern Montana, northern Wyoming, North Dakota and northern South Dakota due to heavy precipitation accumulations and well-below-normal temperatures. Significant monthly snowfall amounts during December were 30.4 inches at Billings, MT; 15.9 inches at Great Falls, MT; 24.5 inches at Bismarck, ND; and 13.6 inches at Watertown, SD. Snowpack depths as of December 31, 2016 were greater than 12 inches over much of North Dakota and north-central South Dakota (see ***Figure 5)***. The greatest depth of snow in central North Dakota for the Basin was 24 inches near Bismarck.

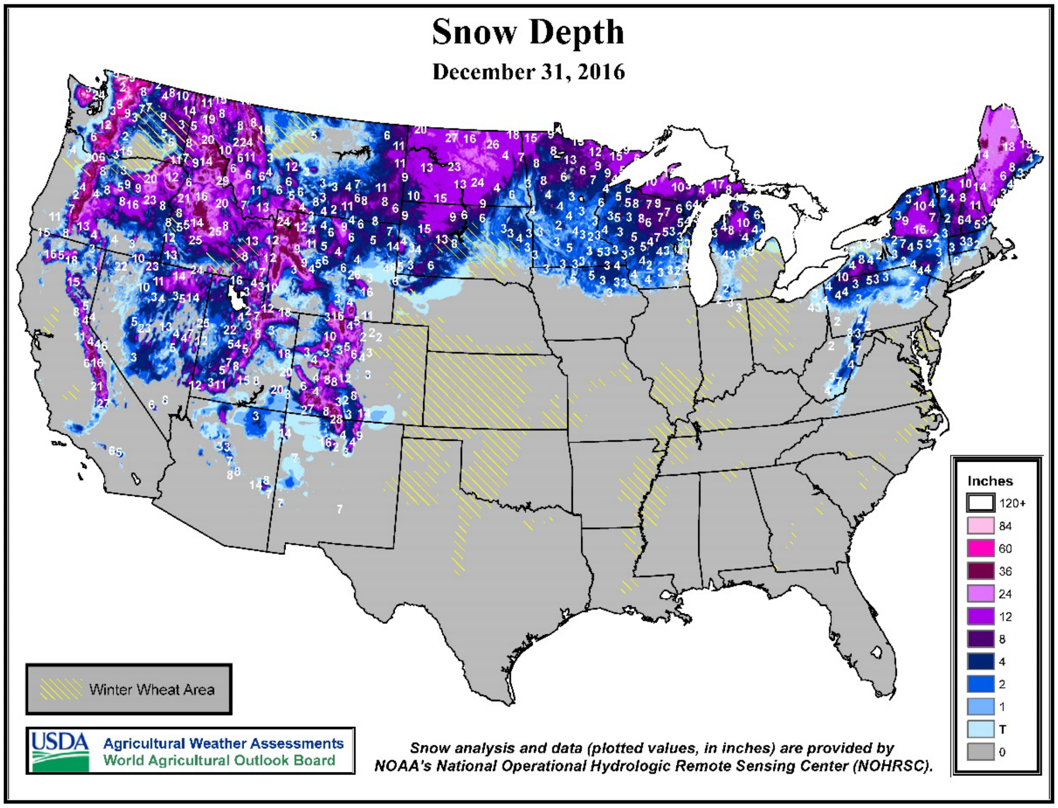


Figure 5. Snow depth in inches on December 31, 2016.

Moderate precipitation and snowfall accumulations occurred during January. While the Rocky Mountains received well-above-normal precipitation as snowfall, the plains snowfall was more moderate and limited in extent. Temperature departures were well-below normal in Montana, Wyoming, the western Dakotas and western Nebraska, but normal to above normal in the eastern Dakotas and eastern Nebraska. January snowfall amounts ranged from 10 to 15 inches in southern Montana, North Dakota, and northern South Dakota. Very little snow fell in the lower Basin in January. By February 4, moderate to heavy snowpack still covered eastern and southern Montana, Wyoming, North Dakota and north central South Dakota (see ***Figure 6***). Very little plains snowpack was present in north central Montana, eastern South Dakota, Wyoming, and most of the lower Basin.

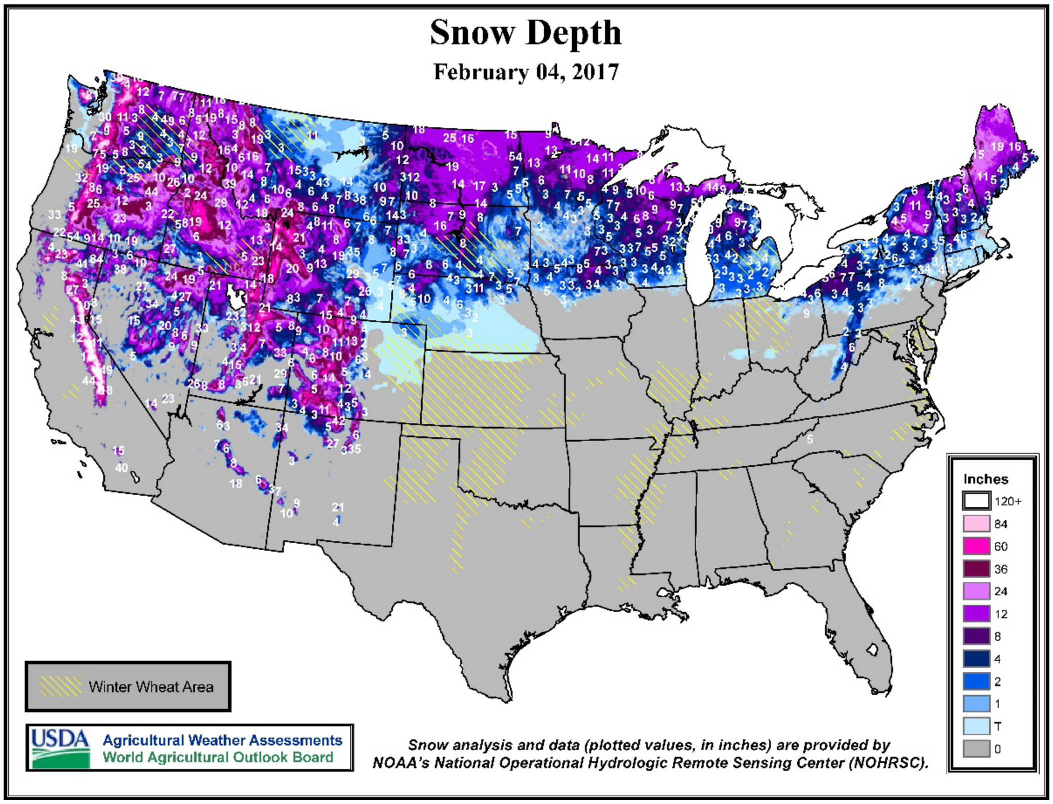


Figure 6. Snow depth in inches on February 4, 2017.

The peak plains snowpack coverage and snow water equivalent (SWE) occurred around February 4. The deepest SWE amounts were present in central North Dakota and north central South Dakota. Amounts in these areas generally ranged from 3 to 6 inches based on the NOAA's National Operational Hydrologic Remote Sensing Center (NOHRSC) modeled snow assessment shown in ***Figure 7***. In surrounding areas within the upper Basin, plains SWE ranged from 1 to 3 inches. MRBWM cooperative snow observers measured season high SWE amounts of 3.6 inches in Bismarck, ND; 7.3 inches in Beulah, ND; 4.1 inches near Jamestown, ND; 5 inches south of Carrington, ND; and 7.3 inches near McIntosh, SD.

During February, precipitation as snowfall was below normal in the Dakotas and much of the lower Basin, while above-normal precipitation as snowfall continued to occur in Montana and Wyoming. February temperature departures were above normal throughout the plains (see ***Figure 8***). Above-normal February temperatures caused much of the plains snowpack to melt. By March 4, light seasonal plains snowpack remained in central North Dakota with some light amounts also present in central and western Montana (see ***Figure 9***). During March, additional light amounts of SWE less than 1 inch in depth accumulated in the upper Basin.

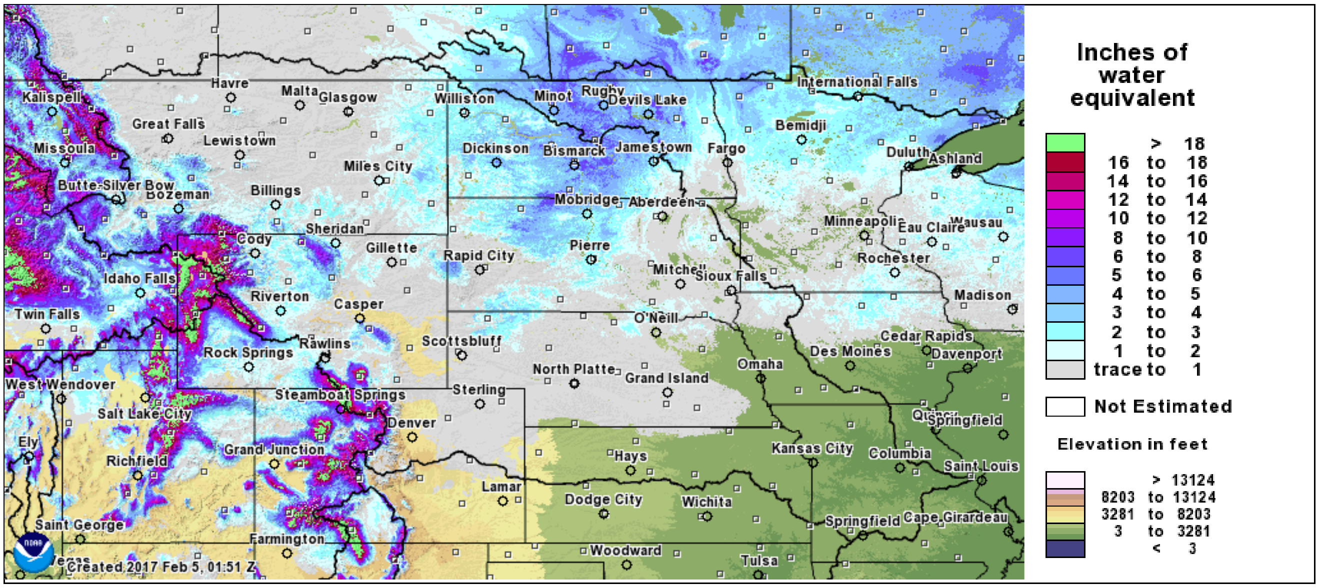


Figure 7. Missouri River Basin snowpack and SWE on February 4, 2017. Source: NOAA NOHRSC.

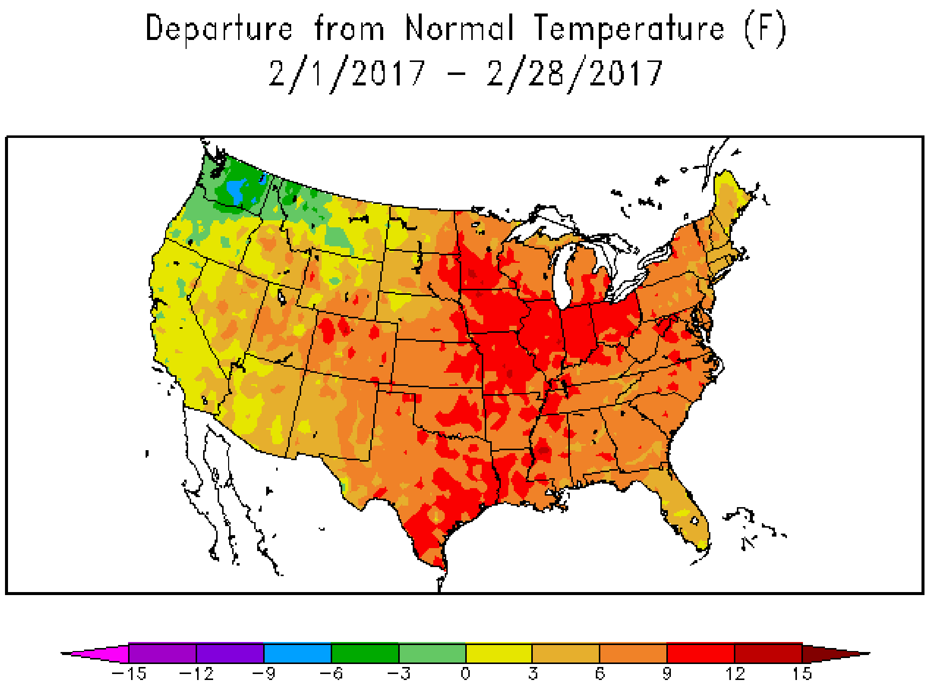


Figure 8. February 2017 departure from normal temperature (deg F). Source: HPRCC.

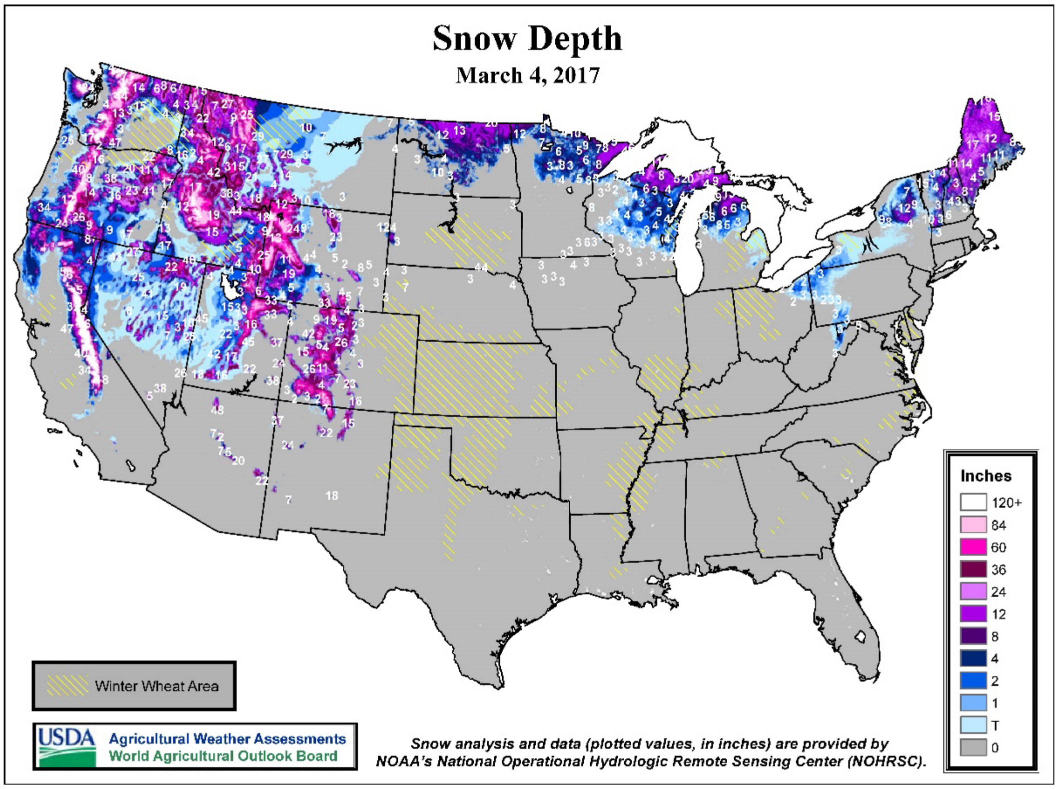


Figure 9. Snow depth in inches on March 4, 2017.

Plains snowfall totals from July 2016 to June 2017 and the previous three seasons for locations in the plains are listed in ***Table 1***. During the 2016-17 winter, Billings, MT and Bismarck, ND snowfall totals were above average. Compared to the 1981-2010 average snowfall, Billings, MT received 19.0 inches above average and Bismarck, ND received 20.4 inches above average. Great Falls, MT received 14.8 inches below the average, while other locations in the upper Basin were near average. Snowfall totals in Sioux City, IA, Omaha, NE, and Kansas City, MO were all below average.

Table 1
Missouri River Basin - Plains Snowfall Totals (inches)

Location	2013-14 Total	2014-15 Total	2015-16 Total	2016-17 Total	Annual Average (1981-2010)
Billings, MT	103.5*	55.4	28.1	74.1	55.1
Glasgow, MT	30.4	43.2	27.6	37.7	34.6
Great Falls, MT	74.6	57.9	46.9	48.4	63.2
Bismarck, ND	40.5	24.1	24.1	71.6	51.2
Aberdeen, SD	32.7	20.2	26.5	39.9	38.1
Watertown, SD	28.2	25.3	28.7	40.7	35.9
Sioux Falls, SD	45.3	31.9	68.5	42.9	44.5
Sioux City, IA	23.8	21.5	57.6	28.6	34.8
Omaha, NE	17.8	13.8	27.4	11.4	26.4
Kansas City, MO	26.1	14.2	5.9	4.9	18.8

*Maximum of record
Source: NOAA Online Weather Data (NOWData). Totals represent total snowfall from July to June of the following year.

2. Mountain Snowpack

Mountain snowpack is monitored by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service's (NRCS) network of SNOwpack TELemetry (SNOTEL) stations. For purposes of monitoring the mountain snowpack and forecasting spring and summer runoff from the Rocky Mountains, average mountain snowpack expressed as inches of SWE is computed from the SNOTEL stations within the reservoir reaches above Fort Peck and from Fort Peck to Garrison. The 2016-17 mountain snowpack accumulation and melt pattern for each of the two reaches is illustrated in ***Figure 10***. Mountain SWE is discussed in the following paragraphs as a percent of the 1981-2010 average SWE occurring on the first day of each month. SWE accumulation for the two reaches is summarized in ***Table 2***, which contains the mountain snowpack as a percent of the seasonal average and as a percent of the normal April 15 snowpack.

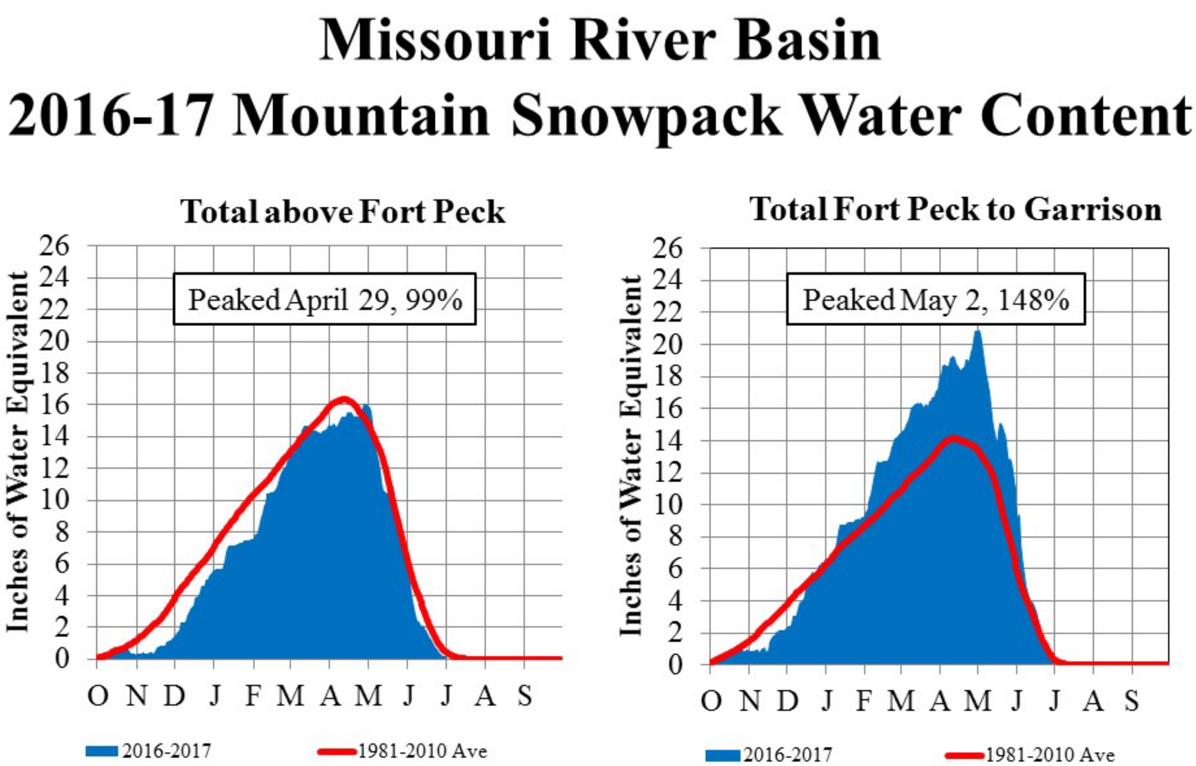


Figure 10. Missouri River Basin 2016-17 mountain SWE. Data Source: USDA-NRCS National Water and Climate Center.

In the Total above Fort Peck reach, the mountain snowpack was generally below average from October through July. Snowpack was below average until early March when above-normal precipitation began to increase the snow accumulation to average in the reach. Snowpack in the Total above Fort Peck reach was below average during the majority of the accumulation period and peaked at 99 percent of the 1981-2010 average peak on April 29 (see ***Figure 10****)*. Normally the mountain snowpack peaks in this reach around April 15. Colder-than-normal temperatures and above-normal precipitation during May briefly delayed the mountain snowmelt, but warmer-than-normal temperatures near the end of May and in June caused the snowpack in this reach to melt rapidly. By July 4, all mountain snowpack in this reach as monitored by the SNOTEL network had melted (***Table 2***).

In the Total Fort Peck to Garrison reach (see ***Figure 10)*** snowpack accumulation began slowly. Above-normal precipitation and colder-than-normal temperatures from October to December caused increased accumulation rates beginning in mid-November, particularly in the upper Yellowstone, Wind and Bighorn River basins. The average mountain snowpack in this reach was below average until the middle of December. Mountain snowpack was near normal on January 1 and February 1. By March 1 the snowpack increased to 133 percent of average (***Table 2***). Continued above-normal precipitation and colder-than-normal temperatures through the end of April resulted in the mountain snowpack in this reach peaking later than normal on May 2 at 148 percent of average. Cold and wet conditions in the reach maintained above-average SWE through early June, when warmer-than-normal temperatures began to cause rapid snowmelt. All mountain snowpack in this reach as monitored by the SNOTEL network had melted by July 2.

Table 2
Mountain SWE Accumulation, 2016-17

Month	Above Fort Peck (Percent of Normal)	Fort Peck to Garrison (Percent of Normal)	Average Percent of Actual Peak Accumulation
November 1	28	54	9
December 1	38	60	26
January 1	77	104	44
February 1	75	109	47
March 1	97	132	74
April 1	93	133	89
Peak	April 29, 99	May 2, 148	100
May 1*	107 / 98	155 / 147	92
June 1*	104/ 40	164 / 72	45
July 1*	37 / 1	36 / 1	1
Melt-out	July 4	July 2	

*Percent of May 1, June 1 or July 1 normal / Percent of normal April 15 peak

3. Weather Conditions

The upper Basin experienced contrasting precipitation conditions and much warmer-than-normal temperatures during 2017. January-December precipitation and temperature statewide rankings for the past 123 years are shown in ***Figure 11*** and ***Figure 12***, respectively. With regard to precipitation rankings, Montana ranked 36th driest (Below Average) and North Dakota ranked 8th driest (Much Below Average). South Dakota was ranked in the Near Average category while Wyoming was ranked in the Above Average category. With regard to temperature rankings, all upper Basin state temperatures were ranked Above Average and Much Above Average (112th coldest or higher). In the lower Basin, precipitation was Above or Near Average, and temperatures were Above Average.

Figure 13 includes the National Drought Mitigation Center's drought maps of three-month periods during 2017. ***Figure 14*** shows percent of normal precipitation maps for each month of 2017. ***Figure 15*** shows departure from normal temperature maps for three-month periods in 2017.

In 2017, the six Mainstem reservoirs on the Missouri River stored excess runoff in their respective Annual Flood Control and Multiple Use Zones and released those stored waters during the drier portions of the year. Plots of the actual or regulated flow versus the unregulated flow are shown in ***Figure 16A*** at Wolf Point, MT and Bismarck, ND; in ***Figure 16B*** at Sioux City, IA and St. Joseph, MO; and in ***Figure 16C*** at Boonville, MO and Hermann, MO. As it relates to actual and unregulated flows on the Missouri River, the following paragraphs describe precipitation and temperature conditions during three-month periods in 2017.

a. January – March

In early January, Moderate Drought (D1) conditions (***Figure 13***) were present in northeastern Wyoming and western South Dakota. Severe Drought conditions (D2) extended from southwestern South Dakota into Wyoming. Abnormally Dry (D0) conditions were also present in the western Dakotas and Montana, with an area of D1 conditions in western Montana.

During January, precipitation was above normal in much of Wyoming, southern South Dakota, Nebraska and Iowa (see ***Figure 14***). Much of the January precipitation in the eastern Dakotas, Nebraska and Iowa occurred as freezing rain followed by snow; therefore, snowfall was below normal in these regions. January precipitation was above normal in localized areas in Montana and North Dakota, but departures were mixed. In February, above-normal precipitation continued in Wyoming, northern and western Montana and northern Nebraska. Below-normal precipitation occurred from southeastern Montana through South Dakota. In March, western and central Wyoming, and southern and southwestern Montana received above-normal precipitation, while the remaining upper Basin received below-normal precipitation. The eastern Dakotas were particularly dry in March, receiving less than 50 percent of normal precipitation.

The year began with colder-than-normal January temperatures in Montana, Wyoming, western North Dakota and western South Dakota. In the eastern Dakotas, Nebraska and Iowa, January temperatures were normal to slightly warmer than normal. Temperatures in February and March were near normal to warmer than normal in the upper Basin. As a result, January to

March temperature departures (see ***Figure 15***) were above normal in the lower Basin, normal to above normal in the upper Basin plains, and normal to below normal in the Rocky Mountains and adjacent plains of Montana and Wyoming.

Winter season precipitation in the plains occurred primarily as snow or freezing rain, and mountain snowpack continued to build from January to March; therefore, high flow events that occurred in February and March in the upper Basin at Wolf Point, MT; Bismarck, ND; and Sioux City, IA (see ***Figure 16A*** and ***Figure 16B***) were due primarily to runoff from plains snowpack, which melted in February and March.

b. April – June

By early April, spring snowmelt and precipitation reduced the D2 conditions to D1 conditions in southwestern South Dakota and western Montana (***Figure 13***). Furthermore, D0 conditions had diminished throughout Montana.

The weather during the April-June period was predominantly dry in the upper Basin with the exception of above-normal precipitation in western Montana and central Wyoming. During the most critical precipitation period for the plains region, precipitation was less than 50 percent of normal in a large portion of northeastern Montana, central and western North Dakota and northern South Dakota. April precipitation ranged from 150 percent of normal to 400 percent of normal in western and southern Montana and Wyoming (***Figure 14***), leading to above-average mountain snowpack accumulation rates in April. April precipitation totals included 3.3 inches (1.7 inches above normal) in Billings, MT and 4.6 inches (3.0 inches above normal) in Sheridan, WY. In contrast, precipitation was less than 75 percent of normal in much of the upper Basin plains. In the lower Basin, precipitation ranged from 125 to 200 percent of normal in Kansas and Missouri. Lower Basin precipitation totals included 6.0 inches (2.5 inches above normal) in Topeka, KS; 6.9 inches (3.1 inches above normal) in Lawrence, KS; 6.6 inches (2.9 inches above normal) in Kansas City, MO; 7.5 inches (3.2 inches above normal) in Sedalia, MO; 8.8 inches (4.3 inches above normal) in Columbia, MO; and 8.0 inches (3.7 inches above normal) in Jefferson City, MO. Runoff from significant rainfall events in the lower Basin resulted in high inflows into tributary reservoirs as well as high Missouri River flows in early May 2017 (see ***Figure 16C***).

In May and June, below-normal precipitation occurred over most of the upper Basin. Most notably, less than 50 percent of normal precipitation fell over much of Montana, northwestern Wyoming and the Dakotas (***Figure 14***). In contrast, above-normal precipitation, ranging from 110 to 200 percent of normal, occurred over Nebraska, southeastern South Dakota, western Iowa and north-central Kansas. May monthly totals included 8.0 inches (3.8 inches above normal) in Concordia, KS; 6.3 inches (2.0 inches above normal) in Lincoln, NE; and 7.3 inches (2.7 inches above normal) near Valley, NE. In June, less than 70 percent of normal precipitation occurred over most of the upper Basin, and less than 50 percent of normal precipitation occurred over central and eastern Montana, western North Dakota, much of Wyoming, southern South Dakota and Nebraska.

May and June unregulated peak hydrographs at Wolf Point, MT; Bismarck, ND; and Sioux City, IA (see ***Figure 16A*** and ***Figure 16B***) were primarily influenced by mountain snowmelt and above-normal rainfall that occurred over Wyoming and southern Montana in April. Due to the dominance of mountain snowpack runoff on the unregulated peak flows at these locations, the influence of rainfall runoff is indistinguishable from snowmelt runoff. ***Figures 16A*** through ***16C*** indicate how regulation of the System greatly reduced peak unregulated flows from Wolf Point to Sioux City, IA; however, the precipitation and runoff downstream of Sioux City reduces the effect of reservoir regulation. The heavy precipitation that occurred downstream of the System over southeastern South Dakota, Nebraska, and western Iowa, was the main cause of the late May actual and unregulated peak flow observed at St. Joseph, MO (see ***Figure 16B***).

April–June temperatures (***Figure 15***) were generally 0 to 2 deg F above normal over most of the upper Basin with temperature departures ranging from 2 to 4 deg F above normal in Montana, western North Dakota and western South Dakota. Temperatures were also slightly above normal in the lower Basin.

c. July – September

Due to dry conditions in the upper Basin, drought conditions rapidly intensified from April through June (***Figure 13***). In early July, D2 conditions covered the eastern half of Montana, much of North Dakota, and northern South Dakota, while D1 and D0 conditions covered a larger area encompassing the D2 conditions. Extreme Drought (D3) conditions developed in northeastern Montana, western North Dakota and northern South Dakota.

Precipitation as a percent of normal varied greatly from month-to-month during the July – September period. Precipitation was well below normal in most of the Basin during July. Large areas of less than 50 percent of normal precipitation covered Montana, central Wyoming, North Dakota, South Dakota, Iowa and Kansas (see ***Figure 14***). Dry conditions continued into August in Montana and Wyoming, where precipitation was less than 50 percent of normal in Montana, but mixed in Wyoming. In contrast, August precipitation was well above normal in North Dakota and South Dakota. In North Dakota, Williston received 3.7 inches of precipitation (2.3 inches above normal), and Bismarck received 5.1 inches of precipitation (2.8 inches above normal). Sioux Falls, SD received 5.4 inches of precipitation (2.4 inches above normal), and Sioux City, IA received 8.2 inches of precipitation (4.9 inches above normal). As a result, August runoff in the Oahe and Fort Randall reaches was more than three times the average monthly runoff, and runoff in the Gavins Point and Sioux City reaches was well above average (see ***Table 4***). In Missouri, August precipitation totals included 10.2 inches (6.3 inches above normal) in Kansas City, MO; 11.3 inches (6.8 inches above normal) in Lee’s Summit, MO; and 5.7 inches (1.4 inches above normal) in Jefferson, City, MO.

During July and August, areas of localized heavy precipitation in Missouri resulted in high Missouri River flow events at Boonville, MO and Hermann, MO (see ***Figure 16C***). Travel time of Gavins Point releases to Boonville and Hermann are 8 and 9 days, respectively. The slight difference between unregulated and actual (regulated) flows during these events demonstrates how the System may not be able to provide much flood reduction benefit when suddenly-developing rainfall events downstream of the System occur.

In September, above-normal precipitation continued in the Dakotas and Nebraska, and it extended westward into Montana and Wyoming. Some notable September totals were 2.7 inches (1.4 inches above normal) at Billings, MT; 3.3 inches (2.0 inches above normal) at Lake Yellowstone, WY; and 5.4 inches (2.8 inches above normal) at Watertown, SD. Although the recent heavy precipitation in the upper Basin did not have any influence on the unregulated flows from Wolf Point, MT to Sioux City, IA (see ***Figure 16A*** and ***Figure 16B***), it did help to alleviate drought conditions in the upper Basin.

July – September temperatures (***Figure 15***) were generally near normal in the lower Basin and the Dakotas. Temperatures in Montana ranged from 1 to 4 deg F above normal, while temperatures in Wyoming ranged from 0 to 2 deg F below normal in the interior of the state, to slightly above normal in the outer regions of Wyoming.

d. October – December

Dry summer conditions in Montana led to further expansion of the D2 and D3 drought conditions, shown in early October in ***Figure 13***, across northern and central Montana. Exceptional Drought (D4) conditions developed in north-central Montana. Areas of above-normal precipitation in central North Dakota led to some drought condition improvement; however, the dry conditions in western South Dakota led to the development of D3 drought conditions. Wetter-than-normal conditions reduced drought impacts in central Nebraska; however, the dry conditions in July–September in Kansas led to new drought development.

In October, the dry pattern returned to the upper Basin resulting in much of the upper Basin plains receiving less than 25 percent of normal precipitation (***Figure 14***). In contrast, precipitation in the southeastern portion of the upper Basin and the entire lower Basin was well above normal. Some notable October precipitation totals included 5.3 inches (3.1 inches above normal) at Sioux Falls, SD; 6.8 inches (4.7 inches above normal) at Sioux City, IA; 4.1 inches (1.9 inches above normal) at Omaha, NE; 4.1 inches (1.3 inches above normal) at St. Joseph, MO; 4.9 inches (1.7 inches above normal) at Kansas City, MO; and 6.6 inches (3.3 inches above normal) at Kirksville, MO. The occurrence of this precipitation caused a similar rise in both actual and unregulated flow in the Missouri River from St. Joseph, MO (***Figure 16B***) to Hermann, MO (***Figure 16C***) in October.

In November, the dry pattern moved eastward into the plains resulting in less than 25 percent of normal precipitation in the Dakotas, Nebraska, Kansas, Iowa and Missouri (***Figure 14***). With the development of weak La Niña climate conditions, the weather pattern favored above-normal precipitation in the Rocky Mountains and plains in Montana and Wyoming in November and December. Southwestern Montana and northwestern Wyoming were particularly wet, receiving greater than 200 percent of normal precipitation in both November and December.

Temperatures during the October–December period ranged from normal to 2 deg F above normal throughout a majority of the Missouri Basin (***Figure 15***). Three-month temperatures were normal to below normal in central and western Montana, and 2 to 4 deg F above normal in southern Wyoming and Colorado.

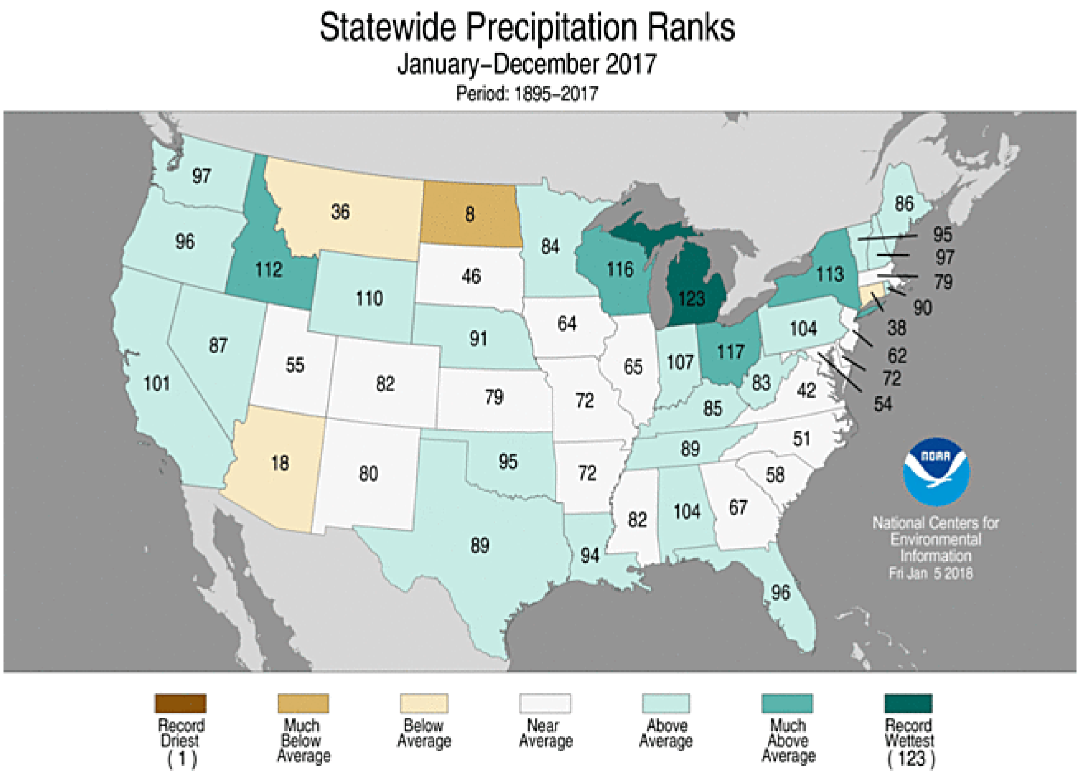


Figure 11A. January-December 2017 Statewide Precipitation Ranks (Source: NOAA/NCDC).

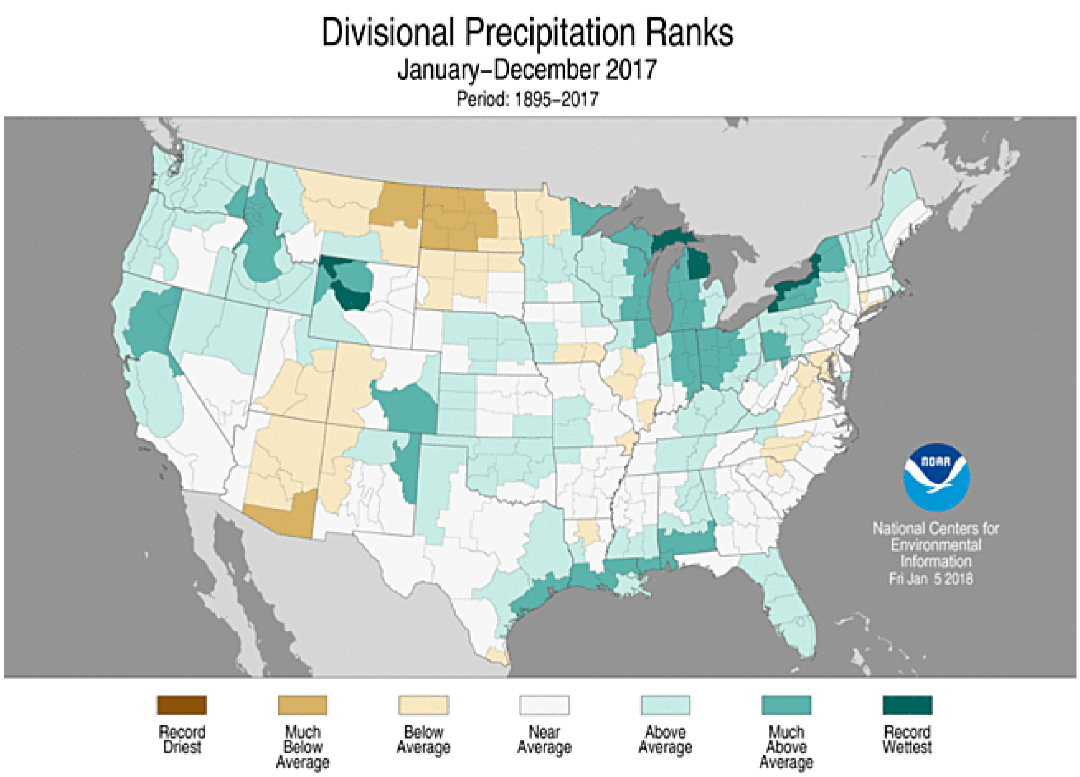


Figure 11B. January-December 2017 Divisional Precipitation Ranks (Source: NOAA/NCDC).

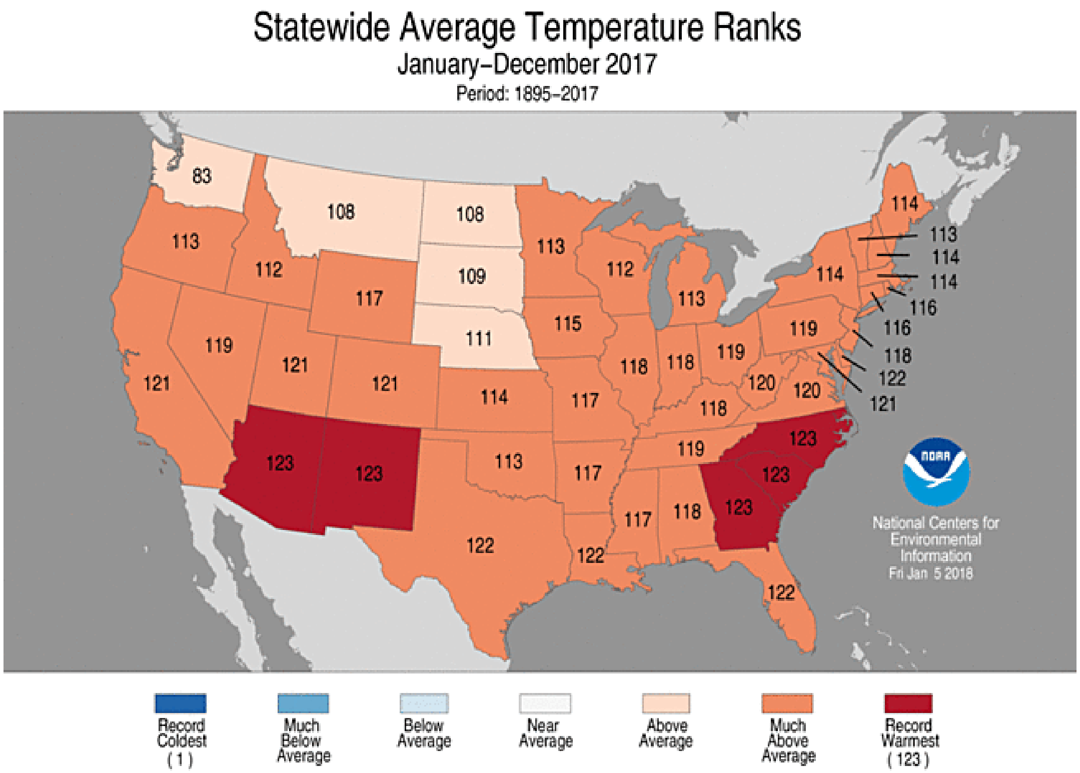


Figure 12A. January-December 2017 Statewide Temperature Ranks (Source: NOAA/NCDC).

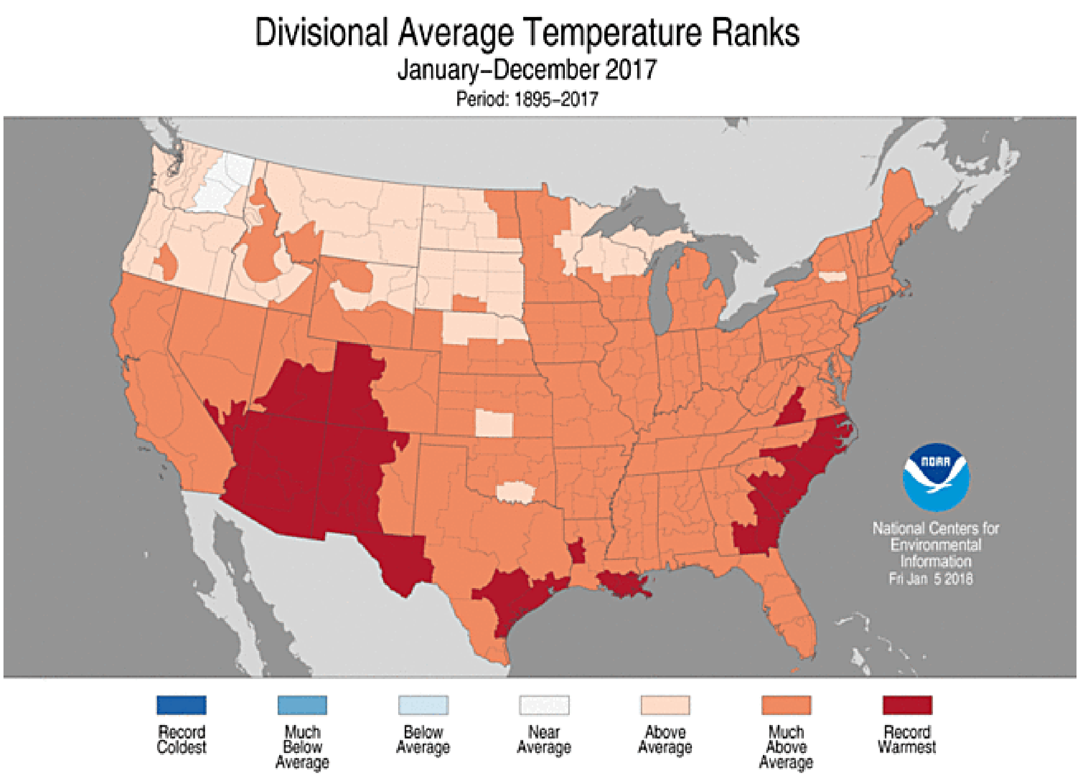


Figure 12B. January-December 2017 Divisional Temperature Ranks (Source: NOAA/NCDC).

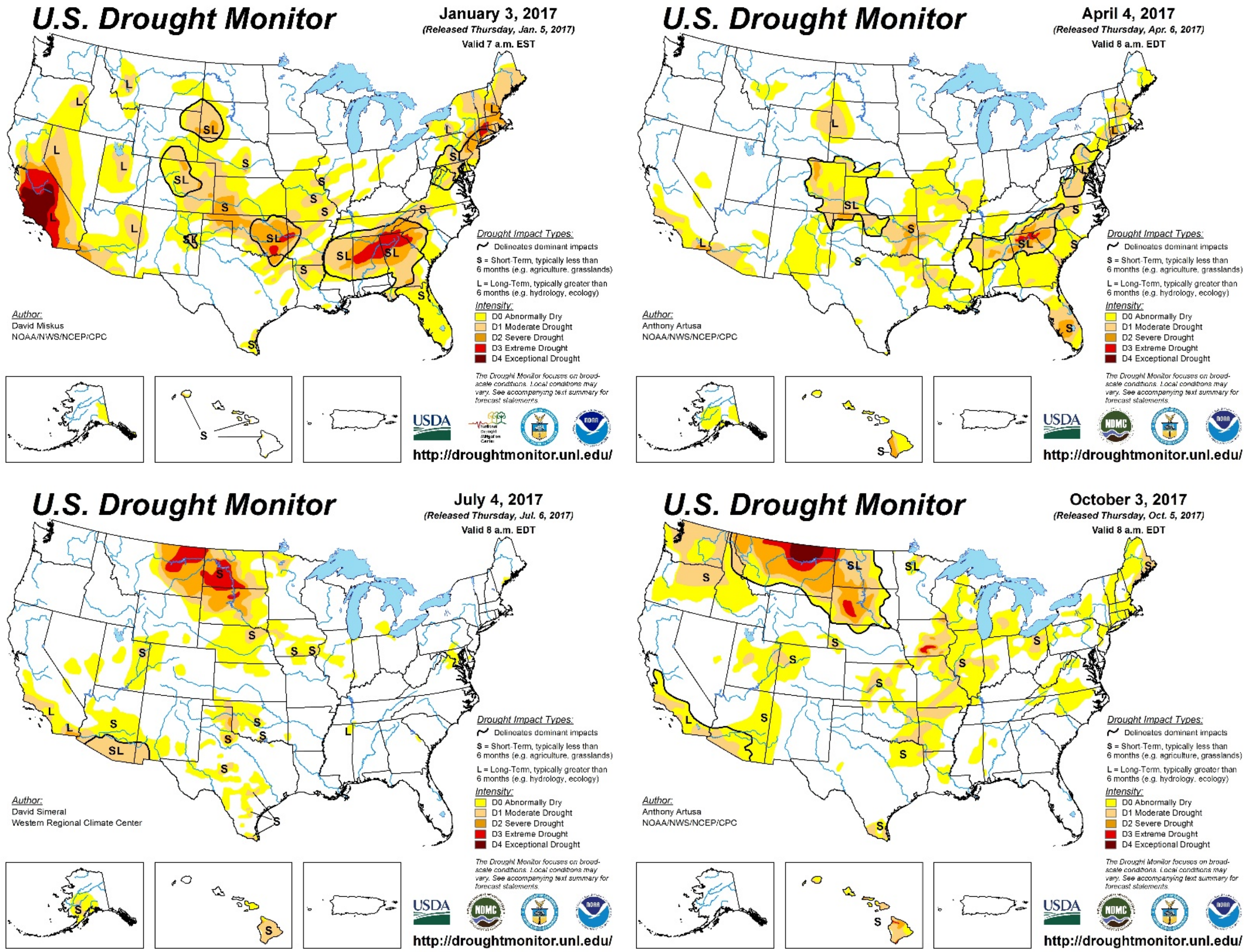


Figure 13. The National Drought Mitigation Center’s drought maps for early January, April, July and October 2017.

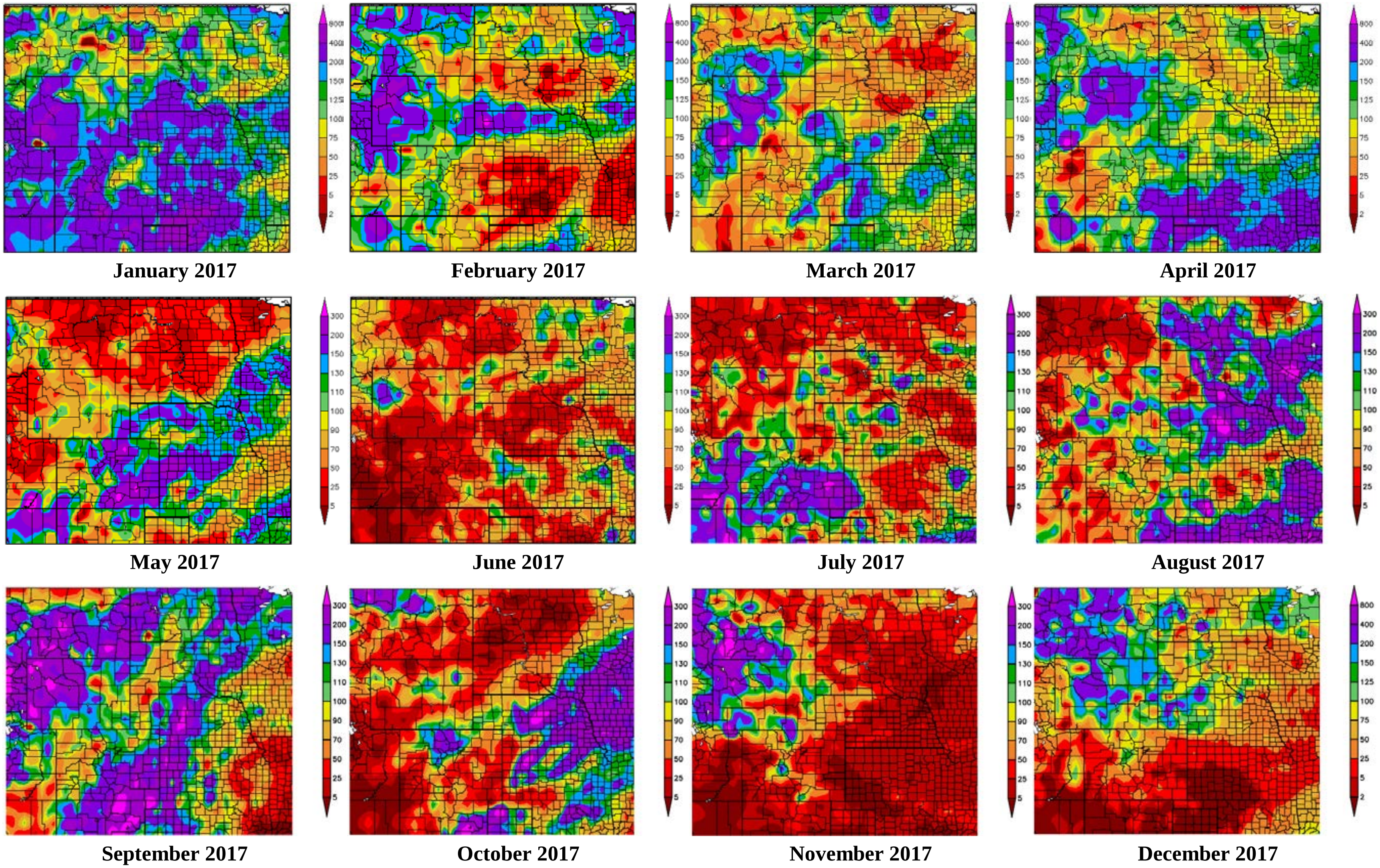


Figure 14. Percent of normal precipitation maps for 2017, by month. Reformatted from the High Plains Regional Climate Center Climate Summary Maps.

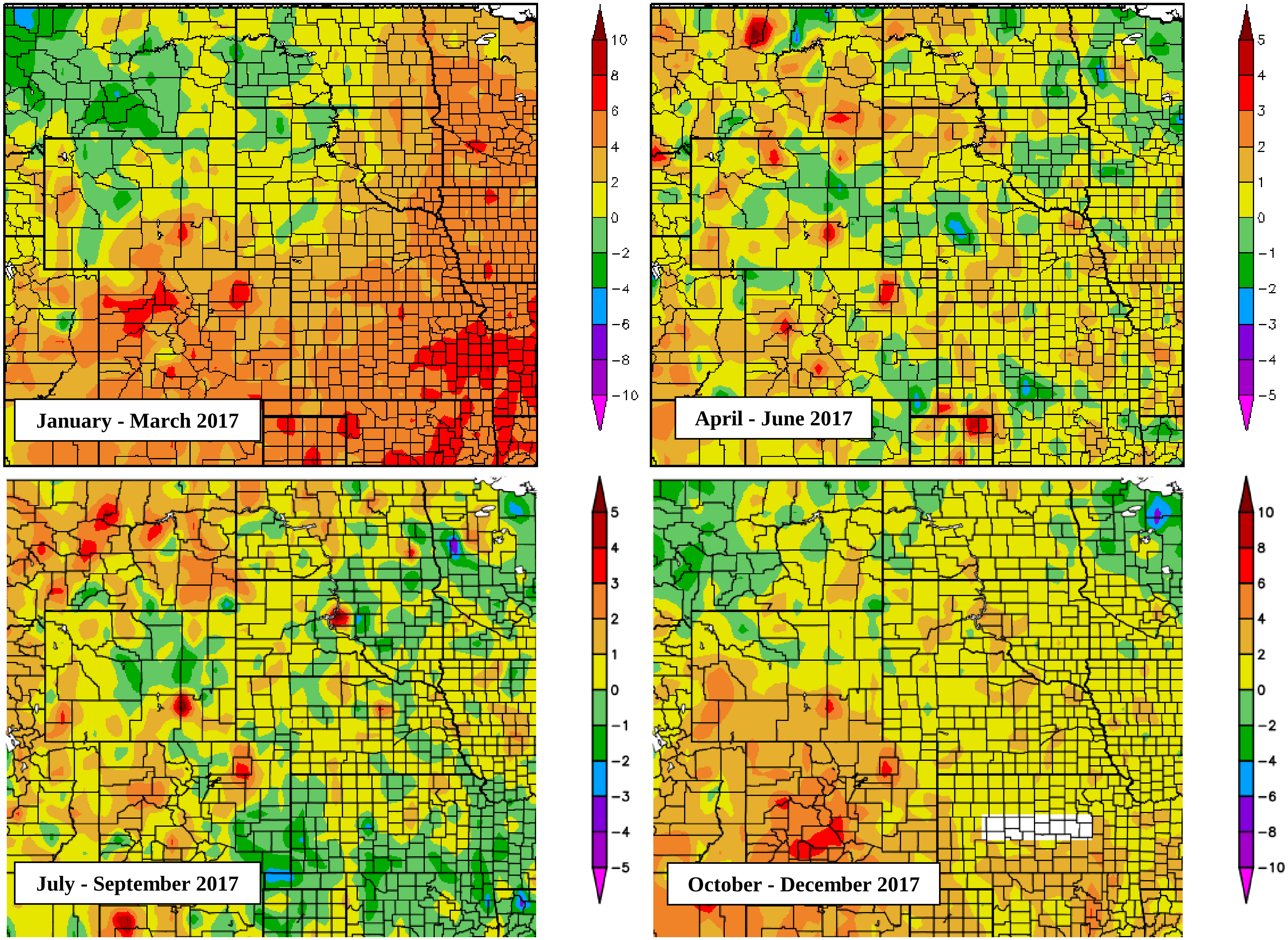
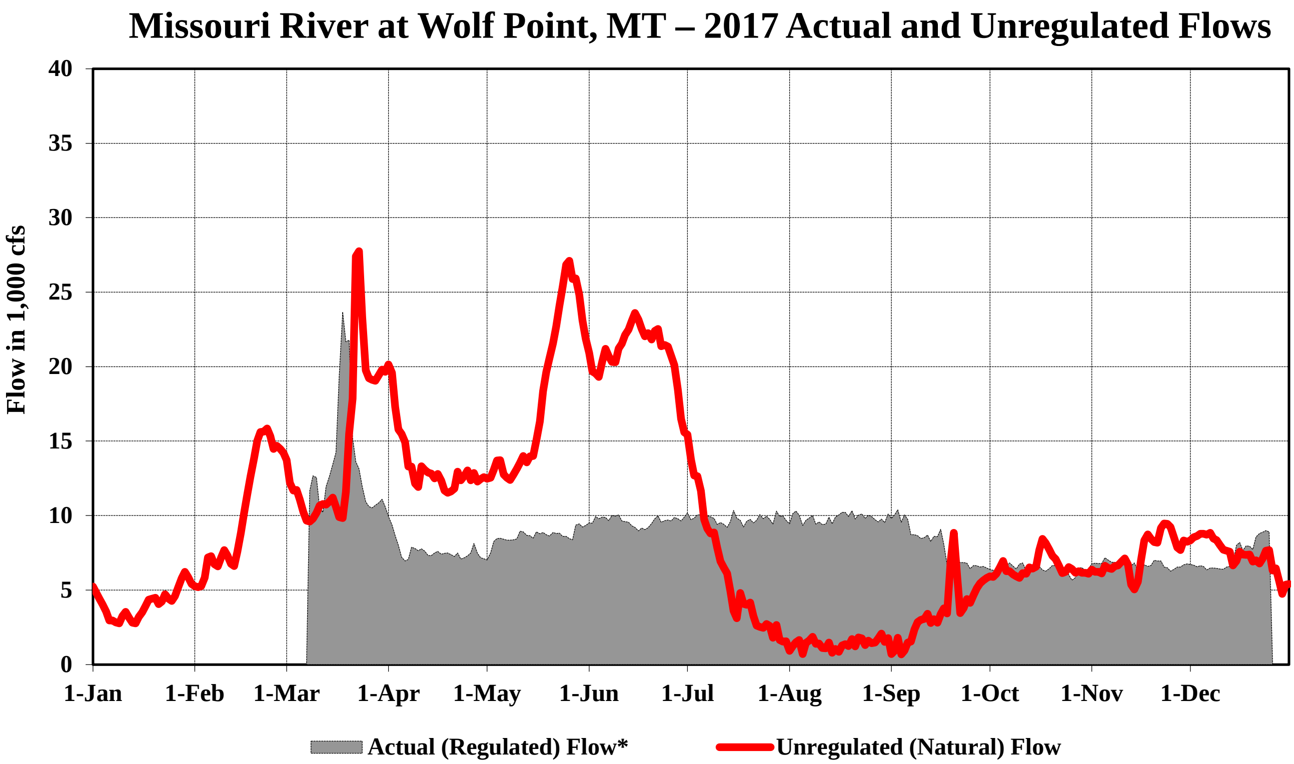
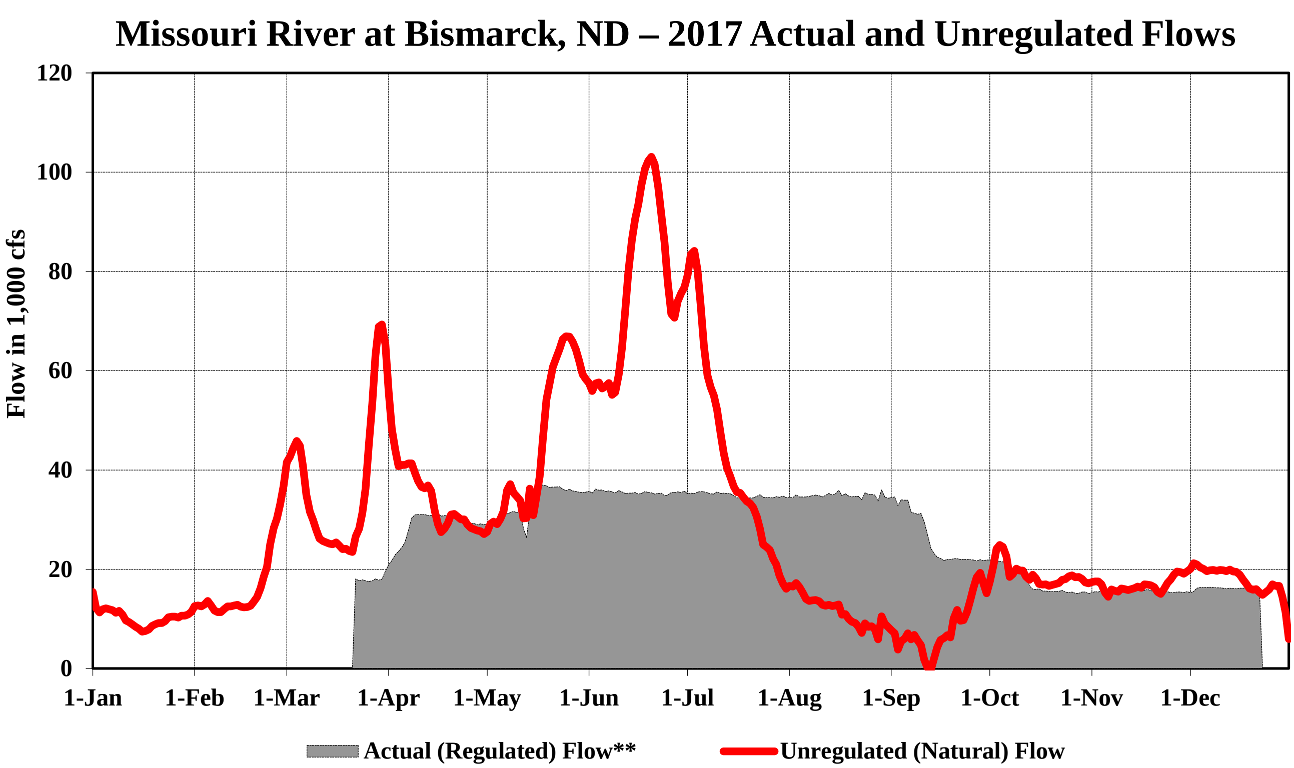


Figure 15. Departure from normal temperature (deg F) for the 2017 three-month periods: January-March, April-June, July-September and October-December. Reformatted from the High Plains Regional Climate Center Climate Summary Maps.

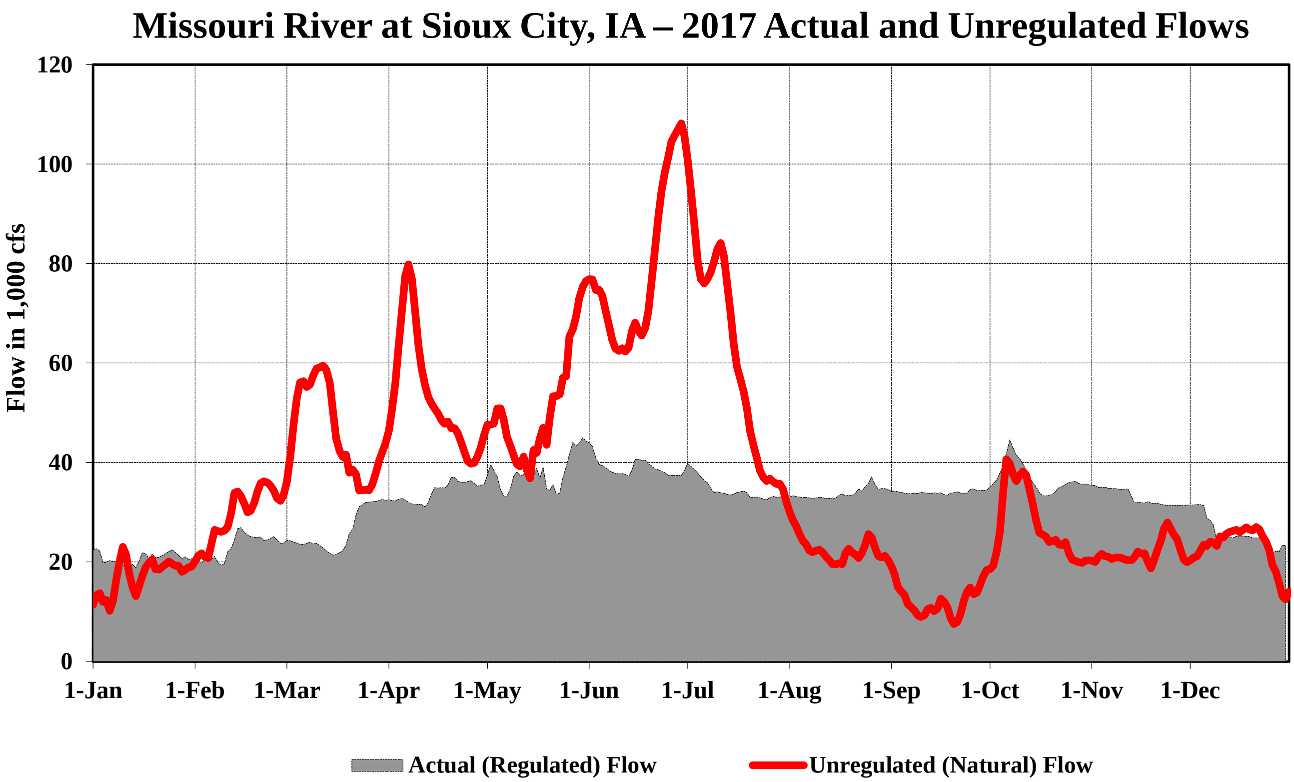


*Actual flow prior to March 8, 2017 and after December 25, 2017 is ice affected.



**Actual flow prior to March 22, 2017 and after December 22, 2017 is ice affected.

Figure 16A. 2017 actual and unregulated flows – Wolf Point, MT and Bismarck, ND.



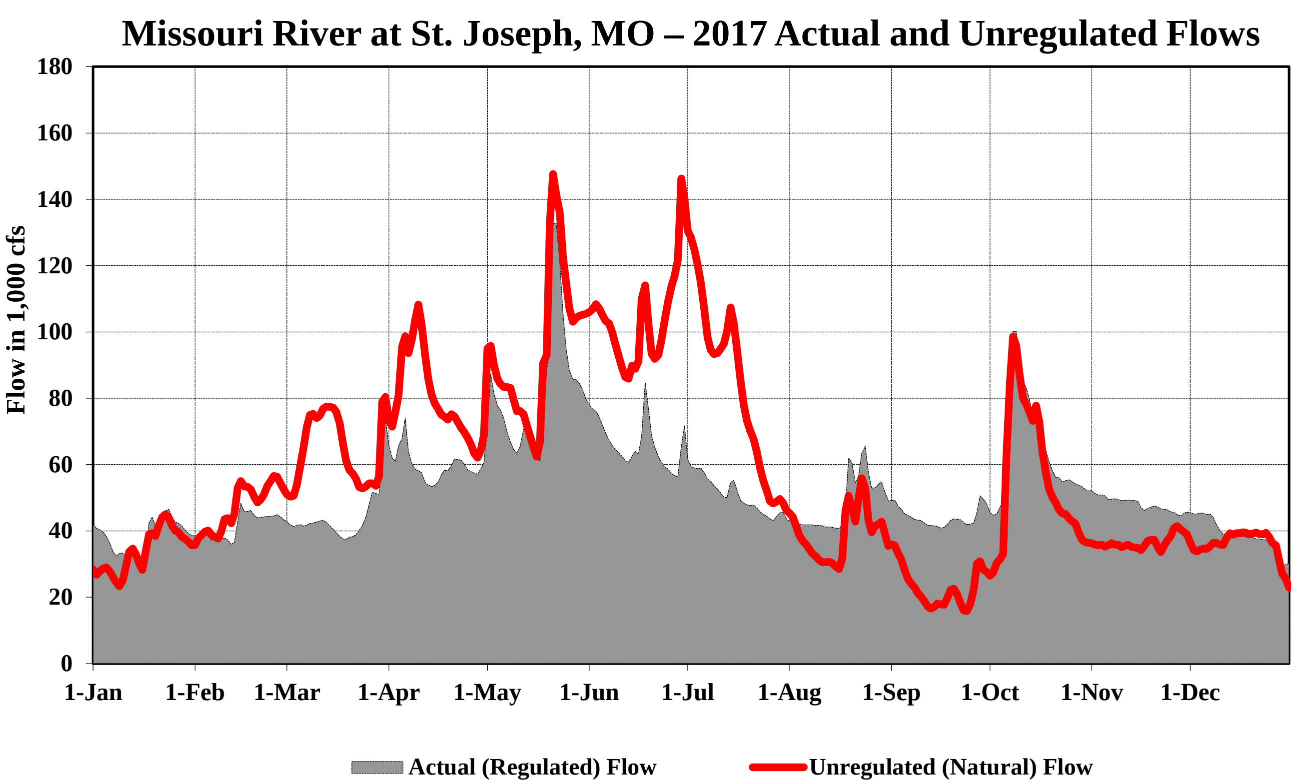
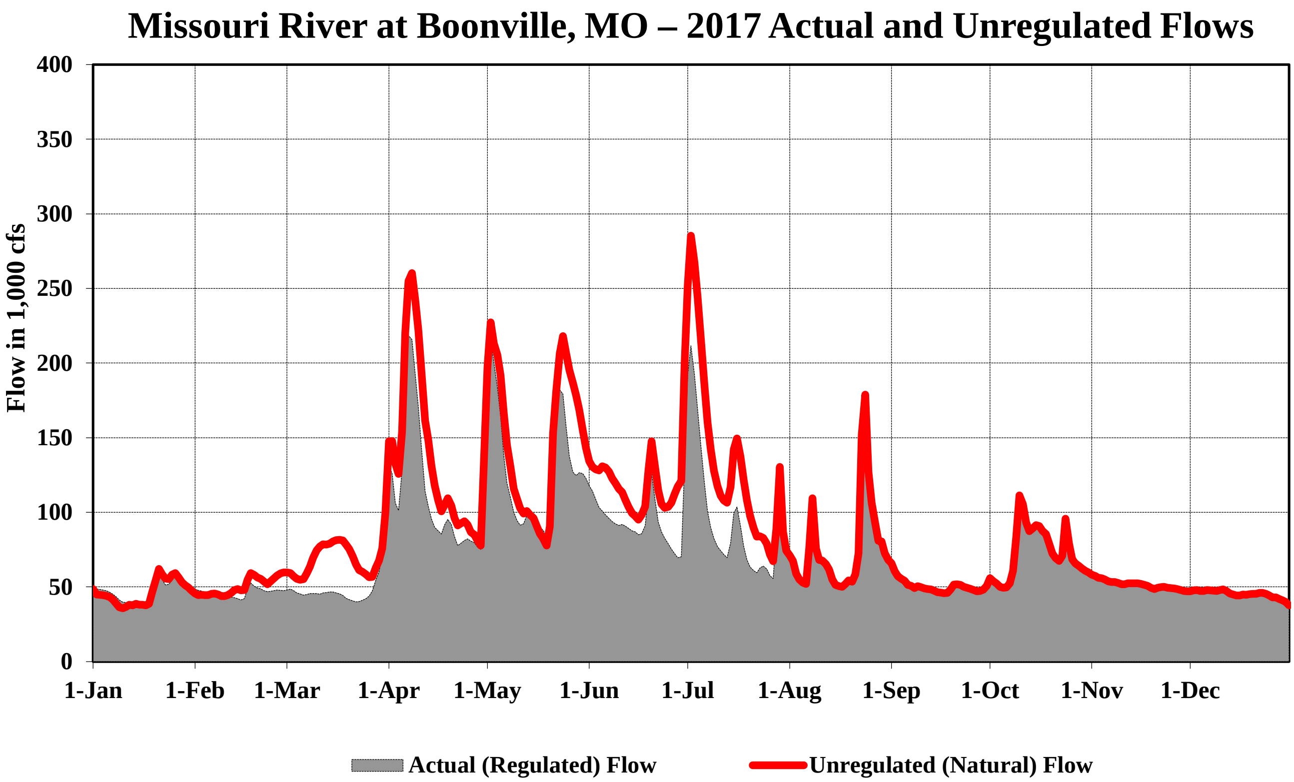


Figure 16B. 2017 actual and unregulated flows – Sioux City, IA and St. Joseph, MO.



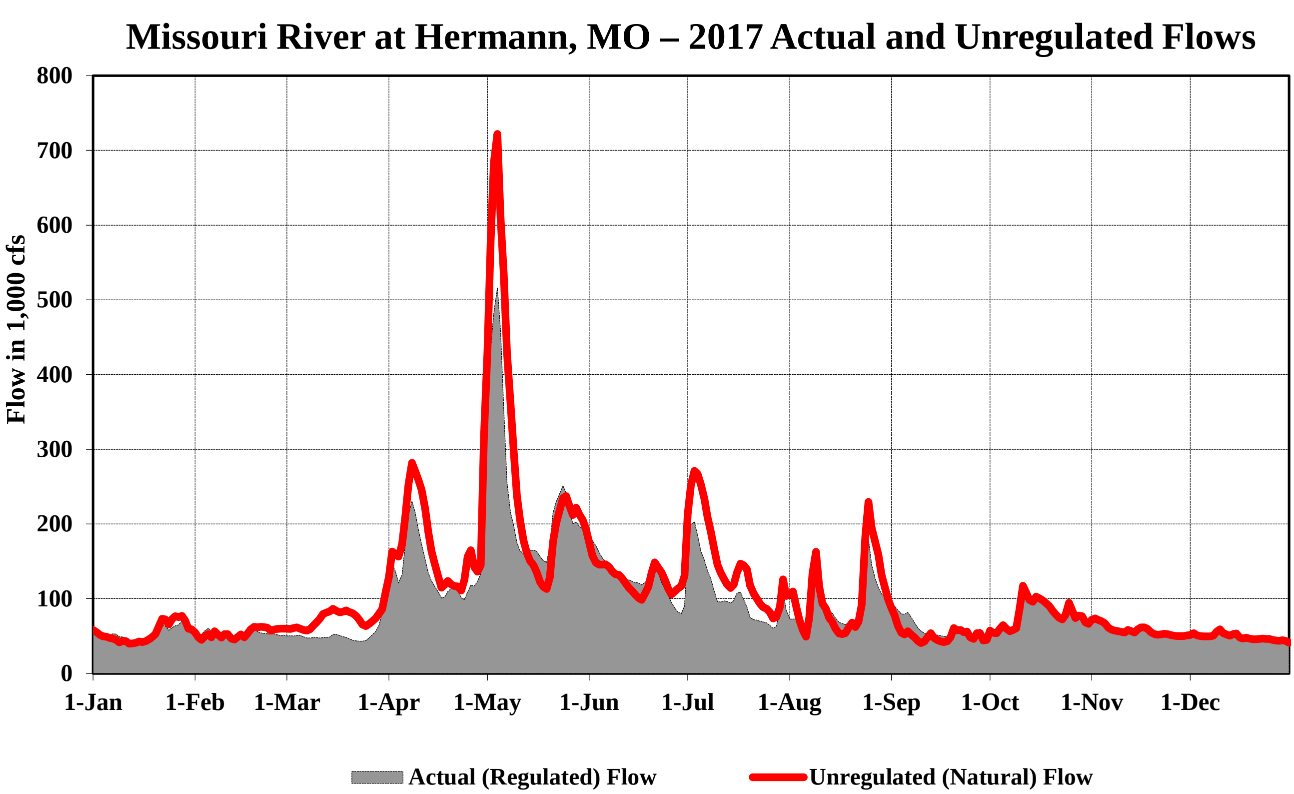


Figure 16C. 2017 actual and unregulated flows – Boonville, MO and Hermann, MO.

4. 2017 Calendar Year Runoff

The 2017 unregulated runoff volume for the upper Basin above Sioux City, IA totaled 29.6 million acre-feet (MAF), 117 percent of average, based on the historical period of 1898-2016, as shown in ***Table 3*** and ***Figure 17***. ***Table 4*** lists the runoff for the upper Basin by month and reach and is the adjusted compilation of the runoff into the System. As the year progresses, this table is filled in with observed monthly runoff data for those months that have occurred and with forecasted runoff data for the remaining months in the year. This forecast forms a basis for intra-system balancing of storage accumulated in the System and is updated by MRBWM on the first of each month to forecast the runoff for the remainder of the year. The monthly accumulation of actual runoff is shown under the "Accumulated Summation above Sioux City" column. As the season progresses, more of the actual runoff is accumulated, and the estimate of annual runoff volume becomes more reliable. The majority of the annual runoff has usually occurred by the end of July, and the remainder of the year can be estimated with a greater degree of accuracy. ***Table 3*** compares 2017 monthly and calendar year totals to the 1898-2016 historic period of record.

Total runoff in the lower Basin, from Sioux City, IA to Hermann, MO totaled 44.0 MAF, 101 percent of average (see ***Table 3***). Of the six reaches in the upper Basin (above Sioux City) outlined in ***Table 3***, runoff was above average in Fort Peck to Garrison and the Gavins Point to Sioux City reaches. Runoff was below average in the other four reaches in the upper Basin. Of the three reaches in the lower Basin, the runoff in the reach between Sioux City, IA and Nebraska City, NE was above average, average in the reach between Nebraska City and Kansas City, MO, and below average in the reach from Kansas City to Hermann, MO.

Figure 18 illustrates the monthly variation of the runoff summation above Sioux City, IA compared to the long-term average variation of runoff based on the 1898-2016 historic period. Runoff in January (154%) and February (205%) was above average due to warmer-than-normal temperatures melting much of the plains snowpack. Runoff in March (112%) and April (96%) was about average. Runoff during these two months was primarily from rainfall runoff. During the May-July period, when mountain snow is melting and spring rains are occurring, runoff in the Garrison reach was above average; however, the rest of the upper basin experienced normal to below-normal runoff. About 50 percent of the annual upper basin runoff historically occurs in the May-July period. In 2017, the May-July upper basin runoff was 13.2 MAF, 110 percent of average. About 20 percent of the annual upper basin runoff historically occurs in the August-December period. In 2017, the August-December upper basin runoff was 6.8 MAF, 124 percent of average.

Table 3
2017 CY Runoff Volumes for Selected Reaches (1,000 acre-feet)

Reach	**1898-2016 Average Runoff**	**2017 CY Runoff**	**% of Average Runoff**
Above Fort Peck	7,219	6,962	96
Fort Peck to Garrison	10,727	14,164	132
Garrison to Oahe	2,497	1,848	74
Oahe to Fort Randall	913	800	88
Fort Randall to Gavins Point	1,694	1,642	97
Gavins Point to Sioux City	2,261	4,144	183
TOTAL ABOVE SIOUX CITY	**25,311**	**29,560**	**117**
	1967-2016 Average Runoff	**2017 CY Runoff**	**% of Annual Runoff**
Sioux City, IA to Nebraska City, NE*	8,018	10,728	134
Nebraska City, NE to Kansas City, MO*	11,572	11,628	100
Kansas City, MO to Hermann, MO*	24,116	21,618	90
TOTAL BELOW SIOUX CITY*	**43,706**	**43,974**	**101**

** Runoff in the reaches from Sioux City, IA to Hermann, MO is not adjusted to 1949 depletion levels. Annual monthly averages are taken from the USGS Water Data Reports for the period 1967-2015.*

Table 4
Missouri River Basin
2017 Runoff above Sioux City, IA

Reach Above	Fort Peck	Garrison	Oahe	Fort Randall	Gavins Point	Sioux City	Summation above Gavins Point	Summation above Sioux City	Accumulated Summation above Sioux City
				Values in 1000 Acre Feet					
	(Actual)								
JAN 2017	296	346	52	103	129	261	926	1,187	1,187
AVERAGE*	312	263	13	30	100	53	718	771	771
DEPARTURE	-16	83	39	73	29	208	208	416	416
% OF AVE	95%	132%	413%	342%	129%	494%	129%	154%	154%
FEB 2017	525	610	211	292	264	376	1,902	2,278	3,465
AVERAGE	363	360	99	56	133	103	1,010	1,113	1,884
DEPARTURE	162	250	112	236	131	273	892	1,165	1,581
% OF AVE	145%	169%	214%	522%	199%	366%	188%	205%	184%
MAR 2017	725	1,520	372	90	168	406	2,875	3,281	6,746
AVERAGE	595	998	581	212	210	325	2,595	2,920	4,804
DEPARTURE	130	522	-209	-122	-42	81	280	361	1,942
% OF AVE	122%	152%	64%	42%	80%	125%	111%	112%	140%
APR 2017	707	1,197	245	131	152	375	2,432	2,807	9,553
AVERAGE	638	1,072	503	145	179	382	2,537	2,919	7,723
DEPARTURE	69	125	-258	-14	-27	-7	-105	-112	1,830
% OF AVE	111%	112%	49%	91%	85%	98%	96%	96%	124%
MAY 2017	1,099	1,969	119	97	210	699	3,494	4,193	13,746
AVERAGE	1,079	1,264	326	149	187	325	3,004	3,329	11,053
DEPARTURE	20	705	-207	-52	23	374	490	864	2,693
% OF AVE	102%	156%	37%	65%	113%	215%	116%	126%	124%
JUN 2017	1,370	3,473	157	47	63	395	5,110	5,505	19,251
AVERAGE	1,630	2,721	449	162	185	327	5,147	5,474	16,526
DEPARTURE	-260	752	-292	-115	-122	68	-37	32	2,725
% OF AVE	84%	128%	35%	29%	34%	121%	99%	101%	116%
JUL 2017	670	2,318	164	9	99	208	3,260	3,468	22,719
AVERAGE	826	1,813	192	58	138	247	3,028	3,275	19,801
DEPARTURE	-156	505	-28	-49	-39	-39	232	193	2,918
% OF AVE	81%	128%	86%	15%	72%	84%	108%	106%	115%
AUG 2017	337	801	268	131	145	227	1,682	1,909	24,628
AVERAGE	360	612	79	42	115	151	1,208	1,360	21,161
DEPARTURE	-23	190	189	89	30	76	474	549	3,467
% OF AVE	94%	131%	338%	309%	126%	150%	139%	140%	116%
SEP 2017	208	336	106	65	108	213	823	1,036	25,664
AVERAGE	328	451	112	38	110	111	1,039	1,150	22,311
DEPARTURE	-120	-115	-6	27	-2	102	-216	-114	3,353
% OF AVE	63%	75%	95%	172%	98%	192%	79%	90%	115%
OCT 2017	298	737	6	-74	154	540	1,121	1,661	27,325
AVERAGE	381	531	72	4	119	92	1,106	1,198	23,508
DEPARTURE	-83	206	-66	-78	35	449	15	463	3,817
% OF AVE	78%	139%	8%	--	130%	590%	101%	139%	116%
NOV 2017	350	371	93	-53	108	242	869	1,111	28,436
AVERAGE	380	391	68	4	118	84	961	1,045	24,553
DEPARTURE	-30	-20	25	-57	-10	158	-92	66	3,883
% OF AVE	92%	95%	136%	--	92%	289%	90%	106%	116%
DEC 2017	377	486	55	-38	42	202	922	1,124	29,560
AVERAGE	326	251	5	12	100	62	695	757	25,310
DEPARTURE	51	235	50	-50	-58	140	227	367	4,250
% OF AVE	116%	193%	--	-306%	42%	327%	133%	148%	117%
				Calendar Year Totals					
	6,962	14,164	1,848	800	1,642	4,144	25,416	29,560	
AVERAGE	7,219	10,727	2,497	913	1,694	2,261	23,049	25,310	
DEPARTURE	-257	3,437	-649	-113	-52	1,883	2,367	4,250	
% OF AVE	96%	132%	74%	88%	97%	183%	110%	117%	

*1898-2016

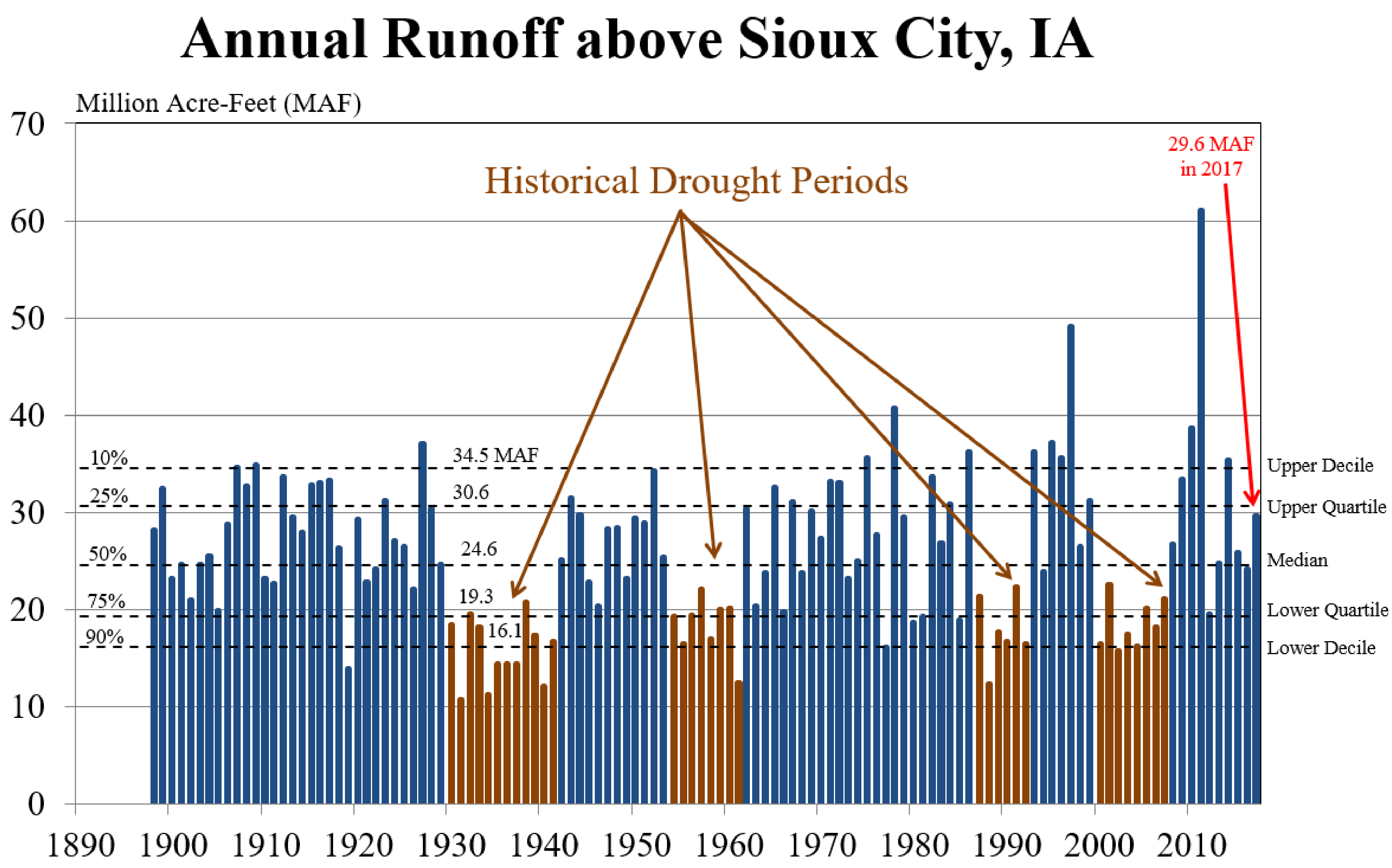


Figure 17. Missouri River Basin annual runoff above Sioux City, IA.

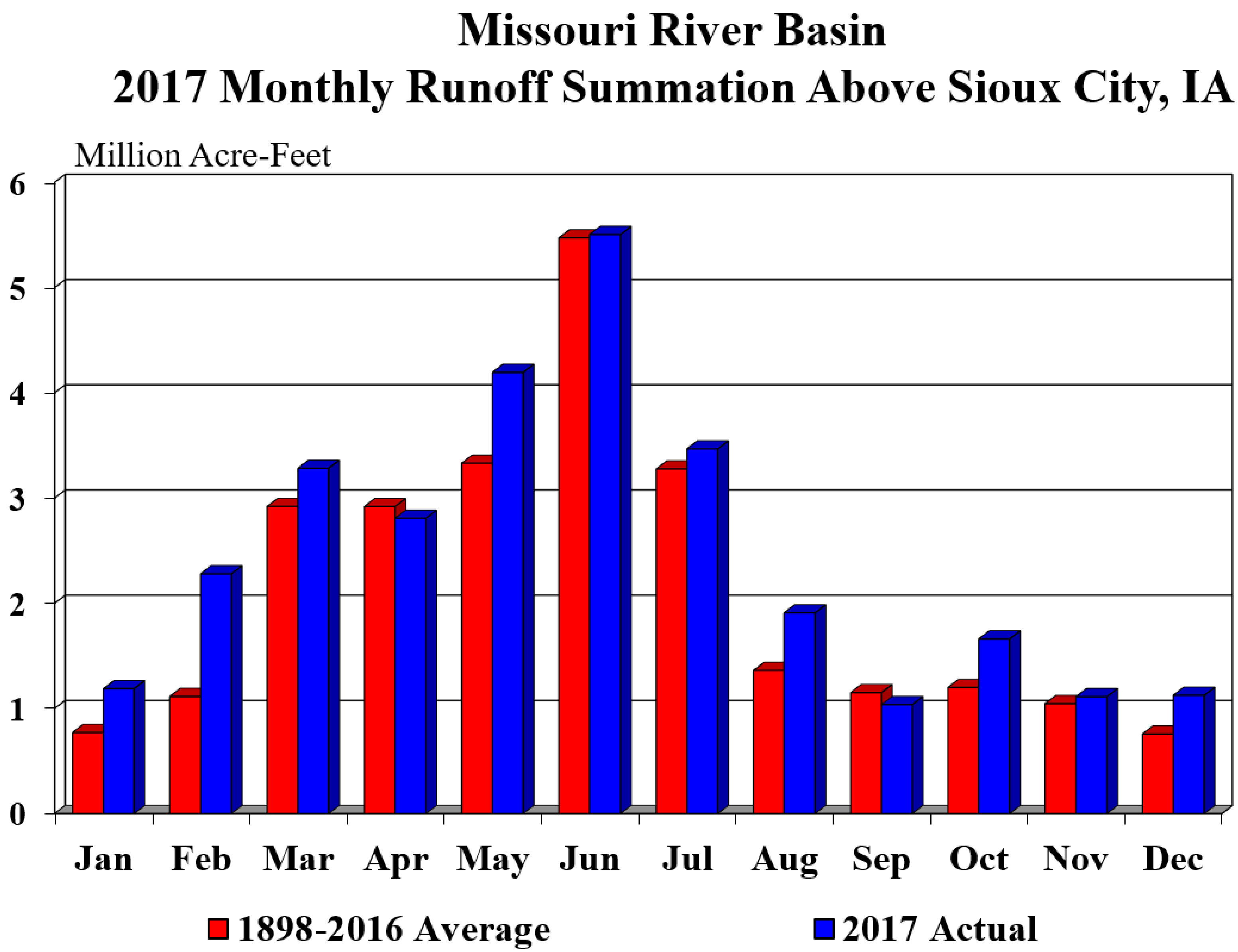


Figure 18. Missouri River Basin 2017 monthly runoff summation above Sioux City, IA.

C. <u>System Regulation – January to December 2017</u>

1. Basin Conditions and System Regulation

Runoff above Sioux City, IA in 2017 was 29.6 MAF, 117 percent of average (***Table 4***). Runoff in 2016 was 24.1 MAF, 95 percent of average. Because System storage was in the Annual Flood Control and Multiple Use Zone almost the entire year, good service was provided to all authorized purposes in 2017.

a. Conditions in January and February

System storage reached 56.1 MAF, the base of the Annual Flood Control and Multiple Use Zone on January 3, when all the stored flood waters from 2016 were evacuated. The 2017 runoff season started in early January when warmer-than-normal temperatures in the upper Basin resulted in some melting of the plains snow. As seen on ***Table 4***, runoff was above average in January and February. On February 1 the mountain snowpack SWE was 77 percent of average in the Fort Peck reach and 104 percent of average in the Garrison reach (see ***Table 2***).

b. Conditions on March 1

On March 1 the System storage was 57.1 MAF, 1.0 MAF above the base of the Annual Flood Control and Multiple Use Zone. There was very light plains snow cover over most of the upper Basin on March 1. Isolated areas of moderate to heavy snowpack were present in central North Dakota. Soil moisture conditions in early March were generally wetter than normal in Wyoming, Montana, North Dakota and South Dakota (***Figure 19***). Soil moisture was very wet in western Wyoming and central and northern Montana. Dry soil moisture conditions were present in eastern Wyoming, western South Dakota, Nebraska, Kansas and Missouri. March-April runoff was expected to be slightly above average in the upper Basin due to 1) the wetter-than-normal soil conditions in Montana, Wyoming and North Dakota and 2) the CPC outlook for above-normal precipitation in March and April. By March 1, mountain SWE increased to 97 percent of average in the Fort Peck reach. In the Fort Peck to Garrison reach, mountain SWE was 132 percent of average, due to above-normal precipitation in the mountains in February (see ***Figure 10***). The March 1 annual runoff forecast was 29.1 MAF, 115 percent of average. Per the Master Manual, the March 15 System storage check of 57.4 MAF set navigation flow support to the full service flow level for the first half of the navigation season. System releases were increased to 26,000 cfs beginning on March 22 to begin full service flow support on the Missouri River at all four downstream navigation target locations.

c. Conditions on April 1

System storage on April 1 was 58.4 MAF, 2.3 MAF above the base of the Annual Flood Control and Multiple Use Zone. Precipitation during the January-March period was well-above normal in Montana, Wyoming and Nebraska, while it was generally normal to below normal in the Dakotas (see ***Figure 14***). Temperatures during the January-March period were below normal in Montana, Wyoming and the western Dakotas (see ***Figure 15***), but were above normal in the eastern Dakotas and the lower Basin. The March runoff summation (***Table 4***) above Sioux City was 3.3 MAF, 112 percent of average, and the accumulated runoff through March was 6.7 MAF, 140 percent of average. Very little plains snowpack remained in early March (see ***Figure 9***).

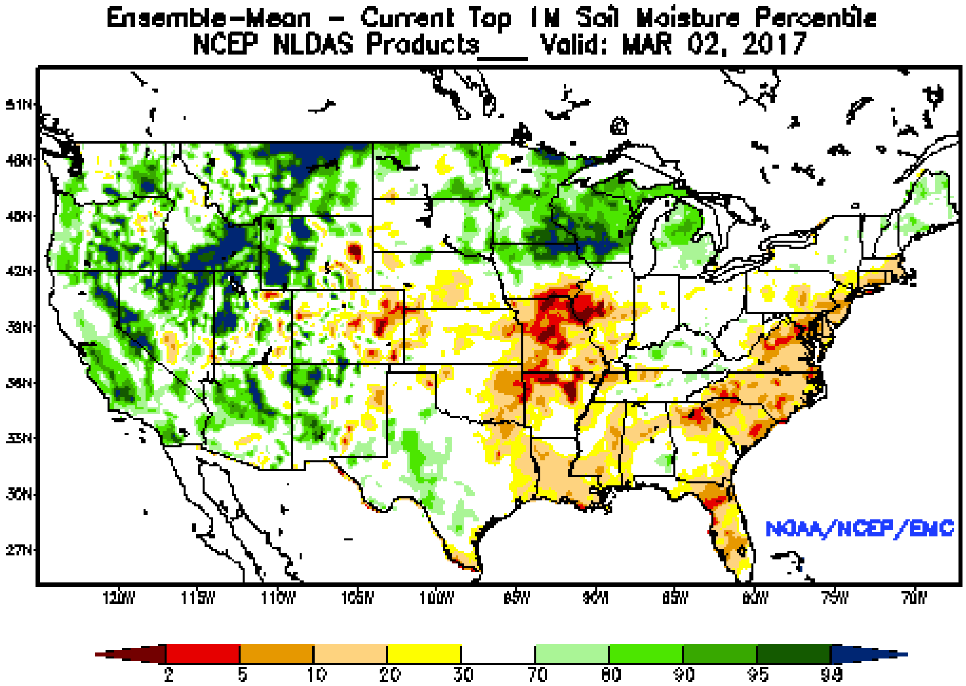


Figure 19. Soil moisture ranking percentile, March 2, 2017. Source: NOAA National Centers for Environmental Prediction, North American Land Data Assimilation Systems.

On April 1, the mountain SWE was 93 percent of the April 1 average above Fort Peck and 133 percent of average in the Fort Peck to Garrison reach. The April 1 annual runoff forecast was 29.4 MAF, 116 percent of average. Although mountain snowpack normally peaks around April 15, snow continued to accumulate in the Fort Peck and Garrison reaches due to above-normal precipitation and below-normal temperatures in the Rocky Mountains. The mountain snowpack SWE peaked on April 29 at 99 percent of the average peak above Fort Peck and on May 2 at 148 percent of the average peak from Fort Peck to Garrison (***Table 2***). April runoff was 2.8 MAF, 96 percent of average.

Based on the April 1 calendar year runoff forecast above Gavins Point, System and tributary storage, and Plate VI-I of the Master Manual, the service level was increased, or expanded, from 35,000 to 40,000 cfs.

In early April (see ***Figure 13)*** Abnormally Dry (D0) drought conditions were present in southwestern Montana, northeastern Wyoming, western South Dakota and southwestern North Dakota. Moderate Drought (D1) conditions were present in northeastern Wyoming and western South Dakota. Soil moisture decreased slightly in the plains due to below-normal precipitation, but soil conditions improved in the mountainous regions including the Black Hills of South Dakota due to mountain precipitation.

d. Conditions on May 1

The May 1 annual runoff forecast was increased to 29.7 MAF, 117 percent of average, due to the high peak snowpack accumulation in the Fort Peck to Garrison reach and the CPC outlook for above-normal precipitation in the upper Basin from May through July. System storage on May 1 was 58.9 MAF, 2.8 MAF above the base of the Annual Flood Control and Multiple Use Zone.

May precipitation was below normal in much of the upper Basin and above normal in the lower Basin (see ***Figure 14***). Although precipitation was generally below normal, localized precipitation in southeastern South Dakota and Nebraska resulted in above-average runoff in the Gavins Point and Sioux City reaches. The seasonal mountain snowmelt began in earnest in May and was the main factor in above-average runoff in the Fort Peck and Garrison reaches. May runoff was 4.2 MAF, 126 percent of average (see ***Table 4***).

e. Conditions in June and July

System storage continued to increase to a June 1 level of 60.3 MAF, 4.2 MAF above the base of the Annual Flood Control and Multiple Use Zone. The June 1 annual runoff forecast was 29.9 MAF, 118 percent of average. June precipitation was well-below average (***Figure 14***) and temperatures were above average in the Basin. June runoff was 5.5 MAF, 101 percent of average. Runoff was 128 percent of average in the Garrison reach and 121 percent of average in the Sioux City reach; however, runoff was well-below average in all other reaches.

As of July 1, System storage was 61.8 MAF, 5.7 MAF above the base of the Annual Flood Control and Multiple Use Zone. System storage peaked at 61.8 MAF on July 10, occupying about 35 percent of the System's 16.3 MAF designated flood control storage space. Based on the July 1 System storage check of 61.8 MAF, the expanded service level was reduced to full service navigation flow support for the second half of the navigation season. The reduction in service level reflected the expansion of drought conditions in the upper Basin. The July 1 annual runoff forecast was reduced to 28.5 MAF, 113 percent of average, due to the rapid decline of the mountain snowpack in June and the rapidly developing Extreme (D3) Drought conditions in the plains. June and July precipitation was well-below normal in the upper Basin. July runoff was 3.5 MAF, 106 percent of average.

f. Conditions from August through December

August 1 System storage was 61.4 MAF, 5.3 MAF above the base of the Annual Flood Control and Multiple Use Zone. The August 1 annual runoff forecast was 27.9 MAF, 110 percent of average and reflected continuing drought development in the upper Basin. August precipitation was well-above normal in the Dakotas, Nebraska and northwestern Iowa, but precipitation was well-below normal in Montana, parts of Wyoming and western South Dakota. As a result of the above-average precipitation in the Dakotas and Nebraska, August runoff was 1.9 MAF, 140 percent of average.

September 1 System storage was 60.4 MAF, 4.3 MAF above the base of the Annual Flood Control and Multiple Use Zone. Based on the September 1 System storage check, the Gavins Point winter release would be at least 17,000 cfs. The September 1 and October 1 annual runoff forecasts were 28.7 MAF, 113 percent of average, and 28.5 MAF, 112 percent of average, respectively. Large areas of heavy precipitation occurred from mid to late September throughout the upper Basin (see ***Figure 14***); however, runoff in September was 1.0 MAF, 90 percent of average, due to continuing drought conditions in the upper Basin. Despite the below normal precipitation in much of the upper Basin in October, October runoff was above average. The October runoff of 1.7 MAF, 139 percent of average, was a result of late September precipitation, some of which fell as snow in the mountains, and was realized as runoff in October.

November 1 System storage was 58.2 MAF, 2.1 MAF above the base of the Annual Flood Control and Multiple Use Zone. The November 1 annual runoff forecast was 29.2 MAF, 115 percent of average. November precipitation in the upper Basin was generally below normal in the plains of northeastern Montana, North Dakota, South Dakota and the entire lower Basin. In contrast, precipitation was above normal in the remainder of Montana and Wyoming (see ***Figure 14***). November runoff was 1.1 MAF, 106 percent of average. To hasten the evacuation of the remaining 2.1 MAF of stored flood waters, the navigation season was extended 10 days and Gavins Point winter releases were set at 21,500 cfs.

December 1 System storage was 57.3 MAF, 1.2 MAF above the base of the Annual Flood Control and Multiple Use Zone. The runoff forecast on December 1 was raised to 29.4 MAF, 116 percent of average. December runoff was 1.1 MAF, 148 percent of average, due to the warmer temperatures in December, which allowed open water conditions to continue on the Missouri River and its tributaries above the System reservoirs. System storage on December 31 was 56.5 MAF, 0.4 MAF above the base of the Annual Flood Control and Multiple Use Zone, which was scheduled to be evacuated during the remainder of the winter season (January-February of 2018).

2. Fort Peck Regulation – January to December 2016

a. General

Fort Peck, the third largest Corps storage reservoir, serves all authorized purposes. Fort Peck's primary functions are: (1) to capture the snowmelt runoff and localized rainfall runoff from the large drainage area above Fort Peck Dam, which are metered out at controlled release rates to meet the authorized purposes while reducing flood damages in the Fort Peck to Garrison reach; (2) to serve as a secondary storage location for water accumulated in the System reservoirs from reduced System releases due to major downstream flood control regulation, thus helping to alleviate large pool increases in Garrison, Oahe and Fort Randall; and (3) to provide the water needed to meet all authorized purposes that draft storage during low-water years.

Table 5 lists the average monthly inflows and releases and the end-of-month (EOM) pool elevation for Fort Peck for 2016 and 2017 as well as the averages since the System first filled in 1967.

Table 5
Fort Peck – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (feet)		
	2017	2016	1967-2016	2017	2016	1967-2016	2017	2016	1967-2016
January	5,900	5,400	7,200	6,700	6,800	10,400	2233.9	2233.8	2227.5
February	9,100	7,200	8,600	5,000	6,200	10,700	2234.9	2234.1	2226.9
March	9,400	5,900	11,600	4,700	6,000	7,800	2236.2	2233.9	2228.0
April	10,300	7,600	10,100	6,300	6,500	7,300	2237.2	2234.2	2228.8
May	15,700	13,600	15,500	8,700	7,400	9,000	2239.1	2235.9	2230.5
June	15,200	9,400	19,300	9,800	8,600	10,400	2240.2	2235.8	2232.8
July	7,200	6,900	12,000	9,900	8,300	10,400	2238.9	2235.1	2232.9
August	6,300	5,500	7,900	10,100	8,000	10,000	2237.5	2233.8	2231.8
September	6,400	6,400	7,700	7,500	6,300	8,800	2236.8	2233.4	2230.9
October	6,300	11,000	7,400	5,800	4,600	7,800	2236.4	2234.8	2230.4
November	6,600	7,000	7,100	6,000	4,900	8,100	2236.0	2235.0	2229.8
December	7,100	4,800	6,500	6,800	6,500	9,200	2235.8	2234.1	2228.7

b. Winter Season 2016-17

The Fort Peck reservoir level was at elevation 2235.0 feet on December 1, 2016, 1.0 foot above the base of the Annual Flood Control and Multiple Use Zone and 0.5 foot above the previous year's level. The reservoir reached elevation 2234.0 feet, the base of the Annual Flood Control Multiple Use Zone, on January 11. During the winter season the average monthly releases from Fort Peck were below average: December 2016 was 6,500 cfs (average is 9,200 cfs); January was 6,700 cfs (average is 10,400 cfs); and February was 5,000 cfs (average is 10,700 cfs). The Fort Peck reservoir froze over on January 3 and was free of ice on April 3.

c. Winter River and Ice Conditions below Fort Peck

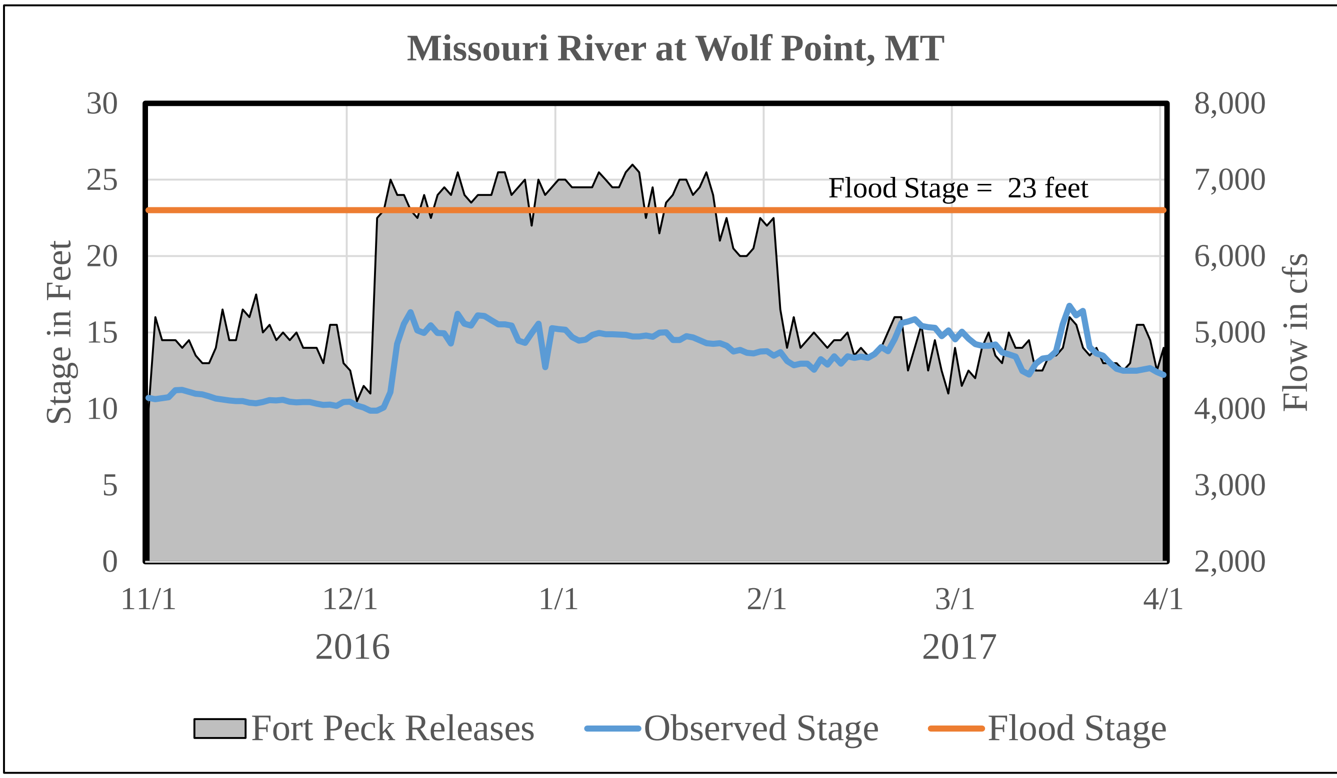
No special release reductions were required due to ice-jam flooding downstream of Fort Peck. Sub-zero (deg F) temperatures were experienced at the beginning of December 2016 and in early January. Ice-cover formation on the Missouri River downstream of Fort Peck resulted in the Missouri River stage rising over 6 feet in the Wolf Point, MT reach from December 6-10, 2016. As seen in ***Figure 20***, the stage then declined to near 15 feet over the next couple weeks and remained in the range of 13 - 16 feet through the winter. The stage increased about 2 feet in late February when air temperatures reached highs between 42 and 51 deg F in the Wolf Point area. Those temperatures resulted in some lower elevation snowmelt and runoff entering the Missouri River from the Milk River upstream of Wolf Point. The end of the winter season occurred around mid-March with air temperatures reaching highs in the upper 40s (deg F). The Missouri River at Wolf Point stage rose to 17 feet on March 18 from ice and snowmelt runoff from the upstream tributaries, such as the Milk River, and from the Missouri River drainage area between Fort Peck Dam and Wolf Point. The USGS reported on March 21 that the ice was out of the Missouri River channel at Wolf Point. The Missouri River stage at Wolf Point remained well below the 23-foot flood stage during the winter. No reports of ice-affected flooding on the Missouri River below Fort Peck were recorded during the 2016-17 winter season.

d. Spring Open Water Season 2017

Inflows in April and May were near average while inflows in June were below average for Fort Peck. Releases from Fort Peck were below average in April and near average in May and June. Average monthly inflows to the reservoir were 10,300 cfs (102 percent of average) in April, 15,700 cfs (101 percent of average) in May and 15,200 cfs (79 percent of average) in June. Fort Peck releases were 6,300 cfs (86 percent of average) in April, 8,700 cfs (97 percent of average) in May, and 9,800 cfs (94 percent of average) in June. Fort Peck reservoir rose 4.0 feet from its March 31 elevation of 2236.2 feet to 2240.2 feet near the end of June, 6.2 feet above the base of the Annual Flood Control and Multiple Use Zone. Fort Peck reservoir rose 2.9 feet during the critical fish spawning period from 2236.2 feet (March 31) to 2239.1 feet (May 31).

e. Summer Open Water Season 2017

Average monthly release rates from Fort Peck were near average during July, 9,900 cfs (95 percent of average) and 10,100 cfs during August (101 percent of average) and were below average in September, 7,500 cfs (85 percent of average). Inflows for that same three-month period were all below average (74 percent of three-month average) with 7,200 cfs, 6,300 cfs, and 6,400 cfs, respectively. Over the three-month period the reservoir level steadily decreased 3.4 feet from 2240.2 feet (June 30) to 2236.8 feet (September 30).



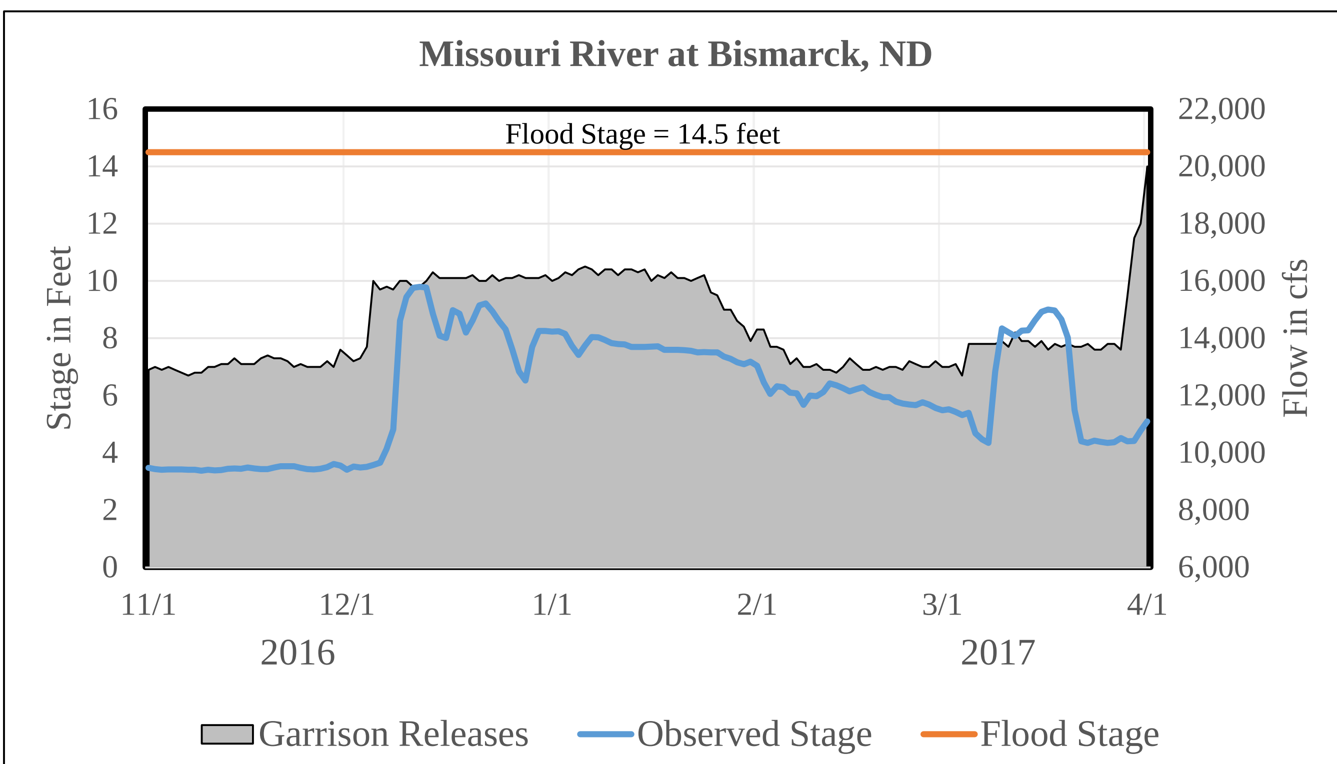


Figure 20. Observed winter ice season stage at Wolf Point, MT and Bismarck, ND and Fort Peck and Garrison releases.

f. Fall Open Water Season 2017

Releases during the fall continued the late summer trend and were below average. Average monthly releases were 5,800 cfs in October (74 percent of average), 6,000 cfs in November (74 percent of average) and 6,800 cfs in December (74 percent of average). The lower-than-average releases were made to balance storage in the upper three reservoirs. Inflows steadily increased during the fall with 6,300 cfs in October (85 percent of average), 6,600 cfs in November (93 percent of average), and 7,100 cfs in December (109 percent of average). The pool elevation decreased 1.0 foot over the three-month period from 2236.8 feet (September 30) to 2235.8 feet (December 31), 1.8 feet above the base of the Annual Flood Control and Multiple Use Zone.

g. Summary

The highest 2017 Fort Peck midnight pool elevation occurred on June 28 at 2240.2 feet, 6.2 feet above the base of the Annual Flood Control and Multiple Use Zone. The lowest 2017 midnight pool elevation was 2233.9 feet on January 17, 0.1 foot below the base of the Annual Flood Control and Multiple Use Zone. The 2017 average daily inflow of 8,800 cfs was 87 percent of average. The 2017 average daily release of 7,300 cfs was 79 percent of average.

3. Garrison Regulation – January to December 2017

a. General

Garrison, the largest Corps storage reservoir, is another key component in the regulation of the System. Its primary functions are (1) to capture the snowmelt runoff and localized rainfall runoff from the large drainage area between the Fort Peck and Garrison dams, which are metered out at controlled release rates to meet the authorized purposes while reducing flood damages in the Garrison to Oahe reach, particularly the urban Bismarck area; (2) to serve as a secondary storage location for water accumulated in the System from reduced System releases due to major downstream flood control regulation, thus helping to alleviate large pool increases in Oahe and Fort Randall; and (3) to provide water needed to meet all authorized purposes that draft storage during low-water years.

Table 6 lists the average monthly inflows and releases and the EOM pool elevation for Garrison for 2016 and 2017 as well as the averages since the System first filled in 1967.

Table 6
Garrison – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (feet)		
	2017	2016	1967-2016	2017	2016	1967-2016	2017	2016	1967-2016
January	13,300	11,500	15,100	15,900	17,400	22,300	1837.5	1838.8	1832.2
February	17,700	15,100	18,400	13,200	19,100	23,400	1838.3	1838.1	1831.2
March	30,700	14,200	26,300	14,000	16,100	19,000	1841.5	1837.9	1832.6
April	27,300	15,200	22,700	26,700	14,900	18,700	1841.5	1837.6	1833.2
May	41,300	29,300	29,600	32,100	18,100	21,600	1843.1	1840.0	1834.7
June	54,100	34,300	47,800	34,400	20,900	24,900	1846.4	1841.9	1838.9
July	33,000	17,700	33,000	33,500	20,300	25,800	1846.2	1841.2	1840.0
August	19,800	12,100	18,400	33,000	20,100	24,900	1843.2	1839.1	1838.2
September	16,700	15,100	16,900	23,500	16,900	20,800	1841.6	1838.4	1837.0
October	17,600	18,400	17,300	16,200	13,000	18,800	1841.3	1839.1	1836.4
November	17,300	17,400	15,800	15,100	13,100	19,600	1841.8	1839.5	1835.3
December	14,500	10,500	13,700	16,500	15,700	19,700	1840.5	1838.1	1833.8

b. Winter Season 2016-17

The Garrison reservoir level was at elevation 1839.4 feet on December 1, 2016, 1.9 feet above the base of the Annual Flood Control and Multiple Use Zone and 1.3 feet below the previous year's level. The reservoir level declined through December and January and reached 1837.5 feet, the base of the Annual Flood Control and Multiple Use Zone, on January 29. The Garrison average monthly winter releases were below average: December 2106 was 15,700 cfs (average is 19,700 cfs); January was 15,900 cfs (average is 22,300 cfs); and February was 13,200 cfs (average is 23,400 cfs). The Garrison reservoir froze over on January 2 and was free of ice on April 14.

c. Winter River and Ice Conditions Below Garrison

The Missouri River in the Bismarck, ND area rose about 6 feet, from a stage of about 4 feet to a stage of about 10 feet, from December 7-11, 2016, during the season's initial river ice formation. This type of rise in stage during river ice formation is normal. The river ice-cover conditions were generally continuous from December 7, 2016 through early February. As seen in ***Figure 20***, the peak winter ice-affected Missouri River stage at Bismarck was just under 10 feet from December 10-13, 2016. The peak stage was more than 4 feet below the Bismarck flood stage of 14.5 feet and more than 3 feet below the Corps' winter freeze-in maximum target stage of 13 feet. The ice cover on the Missouri River in the Bismarck reach remained from December 7, 2016 through early February. In early February open leads on the right bank developed during the short periods of above-freezing daytime highs. A margin of ice cover remained on the left bank until March 20, when the Missouri River was free of ice. The river experienced declining stages through the winter following the initial ice formation in December 2016 until mid-March. In mid-March sub-freezing temperatures resulted in river ice formation. The ice completely covered the river channel from bank to bank for about a week. From March 8-17, the stage rose 5 feet in the Bismarck area due to the refreeze, reaching a peak stage of 9.2 feet. No reports of ice-affected flooding on the Missouri River below Garrison were recorded during the 2016-17 winter season.

d. Spring Open Water Season 2017

Above-average winter precipitation in Wyoming, Montana, and North Dakota contributed to above-normal inflows at Garrison despite below-normal precipitation during the spring. When the plains snowpack completed its melt, the above-normal snowpack in the Fort Peck to Garrison reach began melting, sustaining the above-normal inflows at Garrison through June. With the above-average inflows, the Garrison pool level increased 4.9 feet, from 1841.5 feet (March 31) to 1846.4 feet at the end of June, 8.9 feet above the base of the Annual Flood Control and Multiple Use Zone. Garrison reservoir rose 1.6 feet during the critical fish spawning period from 1841.5 feet (March 31) to 1843.1 feet (May 31). Inflows were 27,300 cfs (120 percent of average) in April, 41,300 cfs (140 percent of average) in May and 54,100 cfs (113 percent of average) in June. Releases were 26,700 cfs in April (143 percent of average), 32,100 cfs in May (149 percent of average), and 34,400 cfs in June (138 percent of average).

e. Summer Open Water Season 2017

Inflows into Garrison reservoir receded to near average rates during July (33,000 cfs; 100 percent of average), August (19,800 cfs; 108 percent of average), and September (16,700 cfs; 99 percent of average). Above-average releases continued during July (33,500 cfs; 130 percent of average), August (33,000 cfs; 133 percent of average), and September (23,500 cfs; 113 percent of average) to evacuate all stored flood waters by the start of next year's runoff season. During the three-month period, the pool crested at 1846.6 feet on July 5, 9.1 feet into the 12.5-foot Annual Flood Control and Multiple Use Zone. Following the crest, the Garrison pool slowly declined 5.0 feet to 1841.6 feet at the end of September. A daily peaking pattern was established at Garrison from May 17 through August 28 to protect T&E species nesting on sandbars below the project.

f. Fall Open Water Season 2017

Inflows were near average during October, November, and December, 17,600 cfs (102 percent of average), 17,300 cfs (109 percent of average), and 14,500 cfs (106 percent of average), respectively. Releases were below average in October (16,200 cfs; 86 percent of average), November (15,100 cfs; 77 percent of average), and December (16,500 cfs; 84 percent of average). Releases were increased in December to provide more winter hydropower generation and in anticipation of the freeze-in of the Missouri River between Washburn and Bismarck, ND, which occurred on December 25. The December 31 Garrison pool elevation was 1840.5 feet, 3.0 feet above the base of the Annual Flood Control and Multiple Use Zone.

g. Lake Audubon / Snake Creek Embankment

During the 2000-07 drought, a restriction was put in place to limit the water level difference between Lake Audubon and Lake Sakakawea to 43 feet. This restriction required a pool restriction for Lake Audubon as a result of an underseepage evaluation of the Lake Audubon embankment by the Corps' Omaha District. Since the Garrison Reservoir has returned to more average elevations following the 8-year drought, this water level difference restriction has not been an issue. Lake Audubon was drawn down to a winter level of 1844.8 feet in the fall.

h. Summary

The Garrison pool elevation peaked at 1846.6 feet on July 5 at midnight, 9.1 feet above the base of the Annual Flood Control and Multiple Use Zone. The lowest Garrison midnight pool level during 2017 occurred on January 29 at 1837.5 feet or at the base of the Annual Flood Control and Multiple Use Zone. The average annual inflow of 25,300 cfs was 110 percent of average. The average annual release of 22,900 cfs was 106 percent of average.

4. Oahe and Big Bend Regulation – January to December 2017

a. General

Oahe, the second largest Corps storage reservoir, serves all authorized purposes. Oahe's primary functions are (1) to capture snowmelt and localized rainfall runoff from the large drainage area between the Garrison and Oahe dams, which are metered out at controlled release rates to meet the authorized purposes, while reducing flood damages in the Oahe to Big Bend reach, especially in the urban Pierre and Fort Pierre areas; (2) to serve as a primary storage location for water accumulated in the System from reduced System releases due to major downstream flood control regulation, thus helping to alleviate large reservoir level increases in Big Bend, Fort Randall and Gavins Point; and (3) to provide water needed to meet all authorized purposes that draft storage during low-water years, particularly downstream water supply and navigation. In addition, hourly and daily releases from Big Bend and Oahe fluctuate widely to meet varying power loads. Over the long term, their release rates are geared to back up navigation releases from Fort Randall and Gavins Point in addition to providing storage space to permit a smooth transition in the scheduled annual fall drawdown of Fort Randall. Big Bend, with less than 2 MAF of total storage, is primarily used for hydropower production, so releases from Oahe are generally passed directly through Big Bend.

Table 7 lists the average monthly inflows and releases and the EOM pool elevation for Oahe for 2016 and 2017 as well as the averages since the System first filled in 1967.

Table 7
Oahe – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (feet)		
	2017	2016	1967-2016	2017	2016	1967-2016	2017	2016	1967-2016
January	16,400	16,100	22,700	18,700	24,800	20,800	1607.9	1607.5	1599.2
February	17,000	23,700	26,800	16,400	17,600	18,200	1608.0	1608.7	1600.8
March	18,500	17,900	30,700	19,000	16,200	18,200	1607.8	1609.0	1603.2
April	29,400	20,900	27,000	26,100	17,700	21,000	1608.3	1609.3	1604.2
May	32,400	20,500	28,200	24,100	8,700	21,900	1609.8	1611.7	1605.3
June	34,800	22,300	30,900	31,500	16,900	26,600	1610.3	1612.2	1605.7
July	33,500	21,500	28,400	33,200	23,500	30,900	1610.2	1611.7	1604.8
August	35,200	20,800	26,500	29,700	24,500	33,400	1610.6	1610.4	1602.9
September	25,900	18,400	22,500	25,100	18,800	29,600	1610.2	1609.8	1601.0
October	16,800	13,500	20,500	17,500	12,700	23,800	1609.5	1609.7	1599.9
November	16,800	14,600	21,000	22,400	15,400	22,500	1608.3	1609.1	1599.3
December	16,100	17,100	20,000	22,700	18,300	20,500	1606.6	1608.4	1599.0

A settlement agreement was approved in an order of dismissal by the United States District Court, District of South Dakota on August 8, 2003, in the case of Lower Brule Sioux Tribe et al. v. Rumsfeld, et al. (Civil No. 02-3014 (D.S.D.)). The agreement provides that the Corps will consult with the Lower Brule Tribe and the Crow Creek Sioux Tribe during any review and revision of the Master Manual. This agreement also provides that the Corps will coordinate the regulation of Big Bend and the water level of the Big Bend reservoir with the two Tribes to include the following: the Corps will normally strive to maintain a Big Bend pool level between elevation 1419.0 feet and 1421.5 feet and, when the level of the Big Bend reservoir drops below elevation 1419.0 feet or exceeds elevation 1421.5 feet, the Chief of MRBWM will provide notice to such persons as the Tribes shall designate in writing. When it is anticipated that the water level will drop below 1418.0 feet or rise above 1422.0 feet or, in the event the water level falls below 1418.0 feet or rises above 1422.0 feet, the Commander, NWD, or his designee, shall immediately contact the Chairpersons of the Tribes or their designees to notify them of the situation and discuss proposed actions to remedy the situation. During 2017 the Big Bend reservoir level varied in the narrow range between elevations 1419.0 feet to 1421.5 feet. As per the settlement agreement, no additional coordination was necessary.

Table 8 lists the average monthly inflows and releases and the EOM pool elevation for Big Bend for 2016 and 2017 as well as the averages since the System first filled in 1967.

Table 8
Big Bend – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (feet)		
	2017	2016	1967-2016	2017	2016	1967-2016	2017	2016	1967-2016
January	17,100	23,400	20,400	17,000	22,500	20,400	1420.8	1421.1	1420.5
February	16,500	16,600	18,200	16,400	16,900	18,200	1420.8	1420.7	1420.4
March	17,600	14,800	18,800	18,200	15,100	18,700	1420.0	1420.2	1420.4
April	24,100	17,900	21,200	23,200	17,200	20,900	1420.7	1420.7	1420.5
May	22,200	8,300	22,000	22,500	8,000	21,800	1420.2	1420.8	1420.4
June	28,900	15,300	26,700	28,800	15,700	26,500	1419.9	1420.1	1420.3
July	30,200	21,700	30,100	29,200	20,900	29,700	1420.6	1420.6	1420.2
August	27,900	23,100	32,700	27,700	22,700	32,200	1420.2	1420.3	1420.2
September	23,500	17,800	29,000	22,600	17,300	28,500	1420.4	1420.1	1420.3
October	15,900	11,800	23,500	15,700	11,000	23,000	1420.2	1420.8	1420.5
November	20,400	14,800	22,200	20,200	14,700	22,100	1420.4	1420.7	1420.4
December	20,500	16,900	20,300	19,800	16,900	20,000	1421.1	1420.6	1420.5

b. Winter Season 2016-17

No ice-induced flooding problems were experienced downstream of Oahe and Big Bend during the 2016-17 winter. A minimum generation of 100 MW, which is approximately a one unit release of 8,000 cfs, was implemented at Oahe from January 4-9 and January 11-19. The one unit minimum ensures that water is always flowing in the Missouri River downstream of Oahe Dam to reduce river ice formation directly below the dam. The Missouri River conditions were closely monitored by the Corps staff.

Unlike the 2015-16 winter season when the Oahe reservoir remained free of an ice cover, the Oahe reservoir froze over on January 15 and was free of ice on March 8.

Big Bend was regulated in the winter season to follow power-peaking requirements and thus hourly releases varied widely. The average daily release during the winter season varied between 0 and 25,200 cfs. The Big Bend reservoir froze over on December 15, 2016 and was free of ice on March 23.

c. Spring Open Water Season 2017

Oahe inflows for the three-month period were below average in March and slightly above average in April and May due to the above-average winter precipitation. March, April, and May monthly inflows were 18,500 cfs (60 percent of average), 29,400 cfs (109 percent of average), and 32,400 cfs (115 percent of average), respectively. Oahe releases were also slightly above average in March-May with a combined average of 23,100 cfs (113 percent of average). Oahe reservoir rose 2.0 feet during the critical fish spawning period from 1607.8 feet (March 31) to 1609.8 feet (May 31).

d. Summer Open Water Season 2017

Oahe inflows remained above average for June through September with a combined average of 32,400 cfs (120% of average). June releases were 31,500 cfs (118% of average), July releases were 33,200 cfs (107% of average), August releases were 29,700 cfs (89% of average), and September releases were 25,100 cfs (85% of average). The reservoir pool rose 0.4 foot during the 4-month period to 1610.2 feet on September 30.

e. Fall Open Water Season 2017

Inflows were below average for October through December. Inflows in October were 16,800 cfs (82 percent of average), 16,800 cfs in November (80 percent of average), and 16,100 cfs in December (81 percent of average). Average monthly releases for October were 17,500 cfs (74 percent of average), and increased during November and December to 22,400 cfs (100 percent of average) and 22,700 cfs (111 percent of average), respectively. The December 31 pool elevation was 1606.6 feet, 0.9 foot below the base of the Annual Flood Control and Multiple Use Zone.

f. Summary

The highest 2017 Oahe midnight reservoir level of 1611.1 feet occurred on September 3, 3.6 feet above the base of the 9.5 foot Annual Flood Control and Multiple Use Zone. The 2017 minimum midnight pool elevation of 1606.6 feet occurred on December 31, 0.9 foot below the base of the Annual Flood Control and Multiple Use Zone. Oahe’s 2017 average annual inflow was 24,400 cfs, 96 percent of average. Oahe’s 2017 average annual release was 23,900 cfs, 100 percent of average. Big Bend’s annual minimum midnight pool elevation of 1419.6 feet was recorded on March 29 and the annual maximum midnight pool elevation of 1421.3 feet was recorded on February 19.

5. Fort Randall Regulation – January to December 2017

a. General

Fort Randall, the fourth largest System reservoir, serves all authorized purposes. Fort Randall’s primary functions are: (1) to capture snow and localized rainfall runoffs in the drainage area between Big Bend and Fort Randall dams, which are metered out at controlled release rates to meet the authorized purposes while reducing flood damages in the Fort Randall reach where several areas have homes and cabins in close proximity to the river; (2) to serve as a primary storage location along with the upstream projects for water accumulated in the System when System releases are reduced due to major downstream flood control regulation, thus helping to alleviate large pool increases in the very small Gavins Point Project; (3) to store the water necessary to increase winter hydropower energy by implementing an annual fall drawdown of the reservoir with a winter reservoir refilling that is unique to Fort Randall; and (4) to provide water needed to meet all authorized purposes, particularly navigation and downstream water supply, that draft storage during low-water years.

Table 9 lists the Fort Randall average monthly inflows and releases in cfs and the EOM pool elevation in feet for 2016 and 2017 as well as the historic averages since the System was first filled in 1967.

Table 9
Fort Randall – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (feet)		
	2017	2016	1967-2016	2017	2016	1967-2016	2017	2016	1967-2016
January	20,300	26,600	22,000	14,900	20,800	15,300	1346.0	1345.4	1347.0
February	21,900	21,400	20,100	11,600	13,900	13,400	1353.4	1351.2	1351.9
March	20,700	17,900	21,600	18,200	13,800	15,700	1355.1	1354.2	1356.0
April	27,500	23,700	23,700	26,000	15,600	21,100	1356.0	1359.6	1357.6
May	25,800	12,300	24,900	25,200	13,200	25,000	1356.1	1358.8	1357.4
June	31,900	17,600	29,600	32,700	20,900	28,400	1355.4	1356.3	1357.8
July	32,100	22,800	31,300	30,800	23,900	32,600	1356.0	1355.2	1356.6
August	31,800	24,800	33,800	29,400	24,200	34,800	1357.1	1355.1	1355.4
September	25,200	19,100	29,800	30,000	20,800	34,500	1353.1	1353.4	1351.3
October	16,100	10,500	23,200	26,300	20,500	32,200	1343.9	1344.7	1343.4
November	21,300	14,700	22,100	27,000	20,400	28,600	1338.3	1338.8	1337.0
December	21,300	18,400	21,200	20,800	16,300	17,200	1338.8	1340.9	1341.0

b. Winter Season 2016-17

No reports of ice-affected flooding on the Missouri River below Fort Randall were recorded during the 2016-17 winter season. Fort Randall's average daily winter release ranged from 7,700 to 18,000 cfs. The Fort Randall reservoir froze over on January 4 and was free of ice on March 17.

c. Spring Open Water Season 2017

The Fort Randall pool elevation was 1353.4 feet on February 28. The pool level rose to its typical spring and summer pool level of 1355.2 feet by early April. Releases were adjusted as needed to back up System releases from Gavins Point and to maintain the Gavins Point pool in the desired range. The average March release of 18,200 cfs was 116 percent of average and the average April release of 26,000 cfs was 123 percent of average. These releases corresponded with inflows of 20,700 cfs in March (96 percent of average) and 27,500 cfs in April (116 percent of average). During May, Fort Randall average inflows were 25,800 cfs (104 percent of average) and releases averaged 25,200 cfs (101 percent of average).

d. Summer Open Water Season 2017

Inflows averaged 31,900 cfs in June (108 percent of average), 32,100 cfs in July (103 percent of average), and 31,800 cfs in August (94 percent of average). Releases from Fort Randall averaged 32,700 cfs in June (115 percent of average), 30,800 cfs in July (94 percent of average), and 29,400 cfs in August (84 percent of average). September releases averaged 30,000 cfs (87 percent of average). September inflows averaged 25,200 cfs (85 percent of average). The Fort Randall reservoir reached its annual peak elevation of 1357.7 feet on August 25. The reservoir was above its typical elevation of 1355.0 feet during July to early September to limit the rise at Oahe.

A daily hydropower peaking pattern is typically established at Fort Randall during the nesting season to provide flexibility to regulate over a range of releases while minimizing impacts to T&E species nesting below the project. A hydropower peaking pattern was not needed during the 2017 nesting season. Due to multiple unit outages during the nesting season, releases from Fort Randall remained generally steady throughout the day because the flood tunnels were utilized.

e. Fall Open Water Season 2017

Normal regulation of Fort Randall includes the lowering of the pool level at the end of the navigation season to 1337.5 feet, 17.5 feet below the normal summer level, to make room for capture of winter powerplant releases from the upper reservoirs. During a full navigation season, the pool is maintained above 1353.0 feet through the Labor Day weekend before starting the lowering of the pool. Inflows and releases were below average in October and near average November-December. On August 31, the pool level was 1357.1 feet. The lowering of Fort Randall pool started after Labor Day and reached its lowest 2017 level on December 5.

f. Summary

The highest 2017 Fort Randall midnight reservoir level of 1357.7 feet occurred on August 25. The lowest 2017 midnight reservoir level was 1337.0 feet on December 5. The average annual inflow was 24,700 cfs, 98 percent of average, and the average annual release was 24,400 cfs, 98 percent of average.

6. Gavins Point Regulation – January to December 2017

a. General

Gavins Point, the most downstream of the System projects, is primarily used for flow re-regulating to smooth out the release fluctuations of the upper projects to better serve downstream purposes. With a total storage of 428,000 acre-feet (AF), it provides only a small amount of flood control and is generally maintained in a narrow reservoir elevation band between 1205.0 and 1208.0 feet. Due to the limited storage, releases from Gavins Point must be backed up with releases from the upper reservoirs. Gavins Point is the key location in the initiation of release reductions for downstream flood control. Even though it has only a small amount of storage space for flood control, this volume is usually adequate to perform significant downstream flood control by coordinating Gavins Point release reductions with the upstream projects. Releases greater than the powerplant capacity, normally near 35,000 cfs, are passed through the spillway.

Table 10 lists the Gavins Point average monthly inflows and releases and the EOM pool elevation for 2016 and 2017 as well as the historic averages since the System was first filled in 1967.

Table 10
Gavins Point – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (feet)		
	2017	2016	1967-2016	2017	2016	1967-2016	2017	2016	1967-2016
January	17,100	21,800	17,400	17,100	22,400	17,300	1207.8	1206.1	1207.5
February	16,500	17,100	16,500	17,000	17,000	17,300	1206.5	1206.2	1205.8
March	20,600	16,300	19,700	20,500	16,200	19,700	1206.5	1206.3	1205.7
April	28,500	19,500	24,900	28,500	19,200	24,800	1206.2	1206.8	1205.8
May	28,000	19,300	28,600	28,100	18,800	28,300	1205.5	1207.7	1206.1
June	33,500	23,300	31,700	33,000	23,900	31,400	1206.3	1206.2	1206.2
July	31,900	25,200	34,700	31,700	25,000	34,300	1206.3	1206.2	1206.7
August	31,300	25,400	36,500	31,000	25,000	36,000	1206.9	1206.6	1207.2
September	31,500	22,600	36,500	31,000	22,200	36,100	1207.5	1207.2	1207.6
October	28,900	22,600	34,400	28,600	22,000	34,200	1207.8	1208.4	1207.8
November	29,200	23,000	30,100	29,100	23,100	30,900	1207.9	1208.0	1207.6
December	21,400	18,000	19,300	22,500	18,000	19,300	1204.7	1207.9	1207.4

* monthly minimum of record ** monthly maximum of record

b. Winter Season 2016-17

Gavins Point releases were near average the entire winter season. Beginning on November 25, 2016 the Gavins Point release was set at 18,000 cfs and was then decreased to 17,000 cfs on January 5. The Gavins Point reservoir froze over on December 10, 2016 and was free of ice on March 7.

c. Winter River and Ice Conditions below Gavins Point

The lowest Sioux City, IA stage recorded during the 2016-17 winter season was 8.5 feet on December 9, 2016, which was 0.2 foot higher than the previous year's low of 8.3 feet. This drop in stage followed two nights of temperatures in the teens (deg F) and two days of maximum air temperatures that were in the 20s (deg F). These conditions resulted in the formation of floating ice in the Missouri River. The first official ice report for the Missouri River below Gavins Point for the 2016-17 winter season was made on December 8, 2016. That report indicated floating ice pans 5 to 10 feet in diameter from Ponca, NE downstream to Omaha, NE, and the ice cover ranged from 5 to 80 percent.

Reports of floating ice were reported in the Sioux City, IA area during three different periods: December 8-27, 2016, January 3-23 and February 6-10. Ice observers noted 5 to 80 percent floating ice with pan sizes ranging from 2 to 30 feet from Sioux City, IA downstream to the Chamois Power Plant near Chamois, MO. No reports of ice-affected flooding or lack of water supply on the Missouri River below Gavins Point were recorded during the 2016-17 winter season.

d. Spring Open Water Season 2017

The bimodal spring pulse from Gavins Point was not conducted in 2017. Since 2012, the Corps and the U.S. Fish and Wildlife Service (USFWS) have been working collaboratively with the Missouri River Recovery Implementation Committee (MRRIC) to aggressively pursue completing the recommendations laid out by the Independent Science Advisory Panel (ISAP). At the center of this effort is the development of the Management Plan/EIS that will establish an overarching adaptive management process for implementation of Corps actions required to avoid jeopardizing all of the listed species in the Missouri River basin. The draft EIS was released for public comment in December 2016. Since the Corps is consulting with the USFWS as this plan is being developed about what management actions are required, the agencies believed it was prudent to forego a spring pulse during the 2017 Missouri River operating season and that this suspension was not likely to have an adverse effect on the listed species.

Per the Master Manual, the March 15 System storage check of 57.4 MAF set navigation flow support to the full service flow level for the first half of the navigation season. The initial Gavins Point release of 26,000 cfs to support navigation was reached on March 22. Flow support for the 2017 navigation season began on March 23 at Sioux City, IA; March 25 at Omaha, NE; March 26 at Nebraska City, NE; March 28 at Kansas City, MO; and April 1 at the mouth of the Missouri River near St. Louis, MO.

Based on the April 1 calendar year runoff forecast above Gavins Point, System and tributary storage, and Plate VI-I of the Master Manual, the service level was increased, or expanded, from 35,000 to 40,000 cfs. With the expanded service level, the navigation flow targets increased accordingly by 5,000 cfs: 36,000 cfs at Sioux City, IA and Omaha, NE; 42,000 cfs at Nebraska City, NE; and 46,000 cfs at Kansas City, MO. Due to the Missouri River at Kansas City exceeding the Missouri River full service flood target flow of 76,000 cfs, the Gavins Point releases were not initially increased to meet the expanded service level ***(Figure 25AB***). Once the forecasted Missouri River flows at the downstream flood targets, Omaha, Nebraska City and Kansas City, had receded below the flood target levels, Gavins Point releases were increased to 30,000 cfs on April 12 to meet the expanded service level at downstream locations.

At the end beginning of May, flows at Nebraska City and Kansas City exceeded their respective flood target levels for the increased service level. Gavins Point releases were reduced from 30,000 to 21,000 cfs at a rate of 3,000 cfs/day from May 1-3 to provide downstream flood risk reduction. After the forecasted flows at the target locations had receded below their respective flood target levels, the Gavins Point releases were increased from May 6-8 to 30,000 cfs at a rate of 3,000 cfs/day.

In order to prevent T&E birds from nesting on low sandbar habitat on the Missouri River downstream of Gavins Point Dam during the May nesting season, two Gavins Point release cycles were conducted. The cycles consisted of a Gavins Point release of 34,000 cfs for one day followed by a release of 30,000 cfs for two days. The cycles also provide flood risk reduction by limiting higher releases to one out of three days.

On May 18, the MRBWM's lower Missouri River forecast indicated that the Missouri River flows at Omaha, Nebraska City and Kansas City would exceed the flood target levels. The Gavins Point releases were reduced over a several-day period from 34,000 cfs to 20,000 cfs to coincide with the time that the flow was peaking at those locations. Once the downstream flows had receded, the Gavins Point release was increased to 34,000 cfs by May 28. Releases were reduced to 33,000 cfs on June 2 and maintained at that rate until July 6.

e. Summer Open Water Season 2017

Based on the July 1 System storage check of 61.8 MAF, the expanded service level was reduced to full service navigation flow support during the second half of the navigation season. The reduction in service level was a result of the expansion of drought conditions in the upper Basin, which resulted in a lowering of the forecasted annual runoff above Gavins Point. In addition, the July 1 System storage check resulted in a normal 8-month navigation season length. The Gavins Point release was reduced to 32,000 cfs on July 7 and further reduced to 31,000 cfs on July 18. Full service flow support was maintained at all target locations through the remainder of the summer.

f. Fall Open Water Season 2016

Based on the September 1 System storage check of 60.4 MAF, the winter release rate from Gavins Point was to be no less than 17,000 cfs. The Gavins Point release was maintained at 31,000 cfs until October 3. In early October, rain in eastern South Dakota, eastern Nebraska and Iowa caused downstream Missouri River tributary flows to increase. The Missouri River flows rose above the full service flood target levels at Omaha, Nebraska City and Kansas City. In order to provide some downstream flood risk reduction, the Gavins Point release was reduced to 26,000 cfs from October 5-17. Releases were increased to 31,000 cfs by October 23.

During November, the Gavins Point release was maintained at 31,000 cfs. Releases were reduced to 28,000 cfs on November 12 and held at that rate until December 3, which provided a 10-day navigation season extension. Higher-than-average runoff during the late summer and fall resulted in the winter System release rate being set at 21,500 cfs. End-of-navigation season release reductions began on December 4, and the winter release was reached on December 8.

g. Summary

The highest Gavins Point midnight reservoir level in 2017 was 1208.3 feet, reached on February 21. The lowest midnight reservoir level in 2016 was 1204.7 feet, reached on December 31. The average annual inflow to Gavins Point was 26,500 cfs, 1,100 cfs below the average inflow of 27,600 cfs. The average annual System release was 26,500 cfs, 1,000 cfs below the average release of 27,500 cfs.

D. Non-Routine Regulation and Other Items Pertaining to System Regulation

Numerous regulation activities are performed each year that, although at one time may have been considered special, are now considered routine. These include release restrictions from a particular project for a period of time to permit hydrographic surveys, to facilitate limited construction within or adjacent to the downstream channel, and to pattern releases to facilitate measurements of downstream discharges and water surface profiles. Two events that occurred recently with a connection to regulation activities are discussed in the following paragraphs.

On March 5, 2014, a takings claim was filed in the United States Court of Federal Claims by approximately 200 plaintiffs against the U.S. Army Corps of Engineers (Corps) for alleged flooding along the Missouri River from 2007 to 2013 (Ideker Farms, Inc., et al. v. U.S.). The claim was amended on October 15, 2014 adding approximately 170 new plaintiffs and CY 2014 flooding claims. The plaintiffs allege that the Corps, in the operation of the Missouri River Mainstem Reservoir System since the Master Manual was updated in 2004 and 2006, in conjunction with habitat creation efforts to comply with the 2003 Amended USFWS Biological Opinion, has caused an increase in flooding along the Missouri River. Plaintiffs contend, therefore, that through these actions the U.S. government has "taken" their property, in violation of the Fifth Amendment of the U.S. Constitution, for which they are entitled just compensation. Phase 1 of the initial trial involving 44 “representative properties” was held for six weeks in March and April 2017 in Kansas City and eight weeks in April through June in Washington D.C. Closing arguments were held for one week in November 2017 in Kansas City and concluded via teleconference in early December.

On February 2, 2015, Natural Resources Defense Council and Defenders of Wildlife filed suit alleging violations of the Endangered Species Act (ESA) by the Corps, U.S. Fish and Wildlife Service (USFWS), and U.S. Bureau of Reclamation (Reclamation) based on operations at Fort Peck on the Missouri River and the Intake Diversion Dam on the Yellowstone River. The plaintiffs later amended their complaint in early 2015 to include allegations of violations of the Clean Water Act and National Environmental Policy Act. Three irrigation districts in Montana joined the lawsuit as defendants. On September 4, 2015, the U.S. District Court in Montana (Great Falls Division) granted plaintiffs’ motion to issue a preliminary injunction, prohibiting the Corps and Reclamation from proceeding with construction of a proposed fish by-pass channel at the Intake Dam on the Yellowstone River. On January 5, 2016, the Court approved the parties joint motion/agreement to stay (or put on hold) the litigation while the Corps and Reclamation complete an Environmental Impact Statement (EIS) on proposed fish passage at Intake dam, to include consideration of an open water fish passage alternative. The Final Environmental Impact Statement was issued in October 2016, a new biological opinion was issued in November 2016 and a Record of Decision was signed in December 2016. On April 29, 2017, the court granted the government’s motion to dissolve the preliminary injunction, but also granted plaintiffs’ motion to file an amended complaint based on the new decision documents. The Fourth Supplemental and Amended complaint was filed on April 20, 2017 and on July 25, 2017, the Court granted plaintiffs’ new motion to issue a preliminary injunction, again prohibiting the agencies from proceeding with the project. On December 21, 2017, the plaintiffs’ filed a memorandum in support of their motion for summary judgment, requesting the Court set aside the approvals for the Intake project and declare the Corps’ ongoing operations at Fort Peck Dam is violating Sections 7 and 9 of the ESA.

E. Reservoir Elevations and Storage

Reservoir elevations and storage levels of the System reservoirs at the end of July 2017 are presented in ***Table 11*** and the same information for the end of December 2017 is presented as ***Table 12***. The upper three reservoirs, Fort Peck, Garrison and Oahe, contain nearly 90 percent of the total System storage and pool levels can vary, especially during high inflow (flood) or low inflow (drought) periods. The lower three reservoirs are generally regulated in such a manner that their pool levels do not fluctuate much from year to year. For the upper three reservoirs, the 12-month change columns for the end of July indicate that Fort Peck and Garrison were higher than the previous year, ranging from 3.8 to 5.0 feet higher, respectively, while Oahe was 1.5 feet lower. By the end of December, Fort Peck and Garrison remained above the base of their respective Annual Flood Control and Multiple Use Zones, ranging from 1.8 to 3.5 feet above their bases. Oahe was 0.9 foot below the base of its Annual Flood Control and Multiple Use Zone.

Table 11
Reservoir Levels and Storages – July 31, 2017

Project	Reservoir Elevation		Reservoir Storage in 1,000 AF		
	Elevation (feet)	12-Month Change (feet)	Total	Above Min. Level*	12-Month Change
Fort Peck	2238.9	+3.8	15,869	11,781	+847
Garrison	1846.2	+5.0	20,576	15,782	+1,625
Oahe	1610.2	-1.5	19,503	14,188	-493
Big Bend	1420.6	+0.0	1,666	35	+2
Fort Randall	1356.0	+0.8	3,494	2,025	+67
Gavins Point	1206.3	+0.1	335	40	+4

Table 12
Reservoir Levels and Storages – Dec 31, 2017

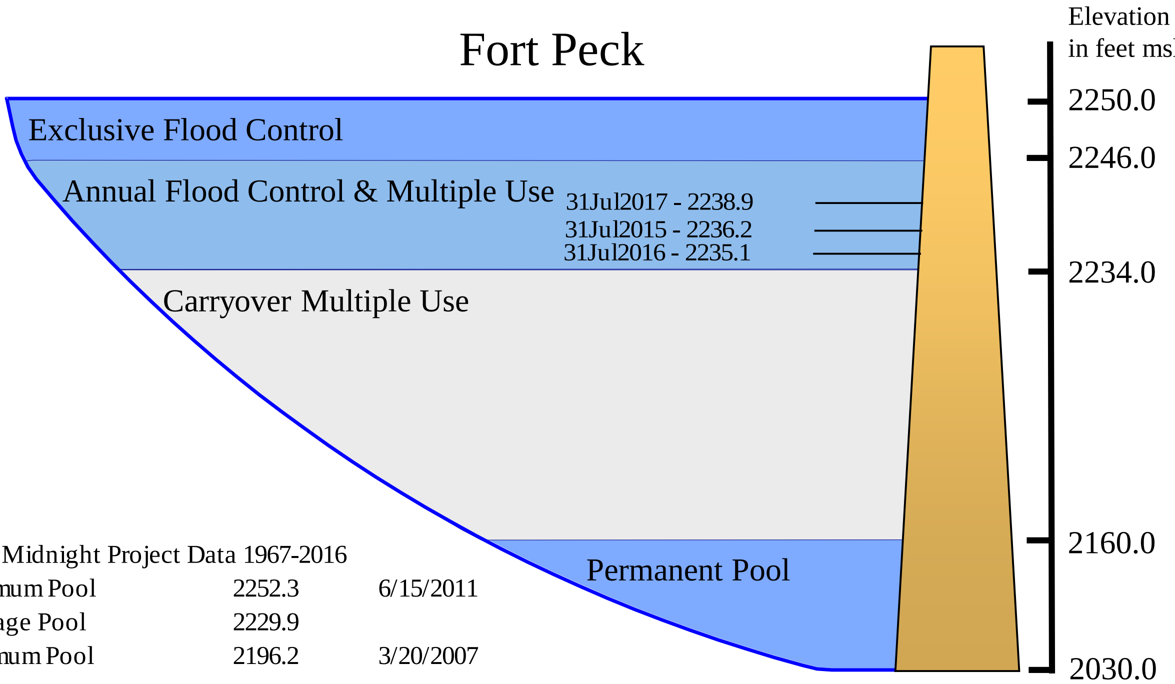
Project	Reservoir Elevation		Reservoir Storage in 1,000 AF		
	Elevation (feet)	12-Month Change (feet)	Total	Above Min. Level*	12-Month Change
Fort Peck	2235.8	+1.7	15,182	11,094	+354
Garrison	1840.5	+2.4	18,713	13,919	+779
Oahe	1606.6	-1.8	18,392	13,077	-570
Big Bend	1421.1	+0.5	1,691	60	+21
Fort Randall	1338.8	-2.1	2,260	791	-122
Gavins Point	1204.7	-3.2	298	3	-74

*Net usable storage above minimum reservoir levels established for power, recreation, irrigation diversions and other purposes.

Figures 21A and ***21B*** show the end-of-July pool elevations for Fort Peck, Garrison and Oahe plus total System end-of-July storage for 2015 through 2017. Individual tables with the historic maximum, average and minimum pool elevations for each reservoir are also shown on ***Figures 21A*** and ***21B.***

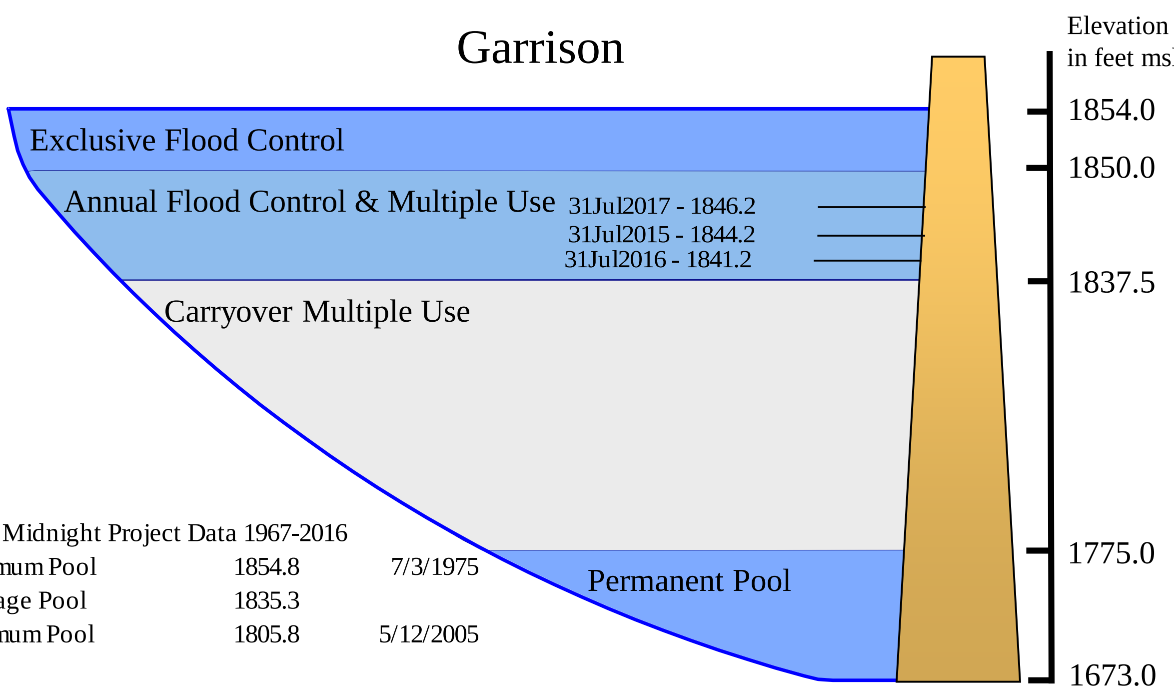
Missouri River System Reservoirs
End-of-July Pool Elevations and Total System Storage

Fort Peck



Daily Midnight Project Data 1967-2016		
Maximum Pool	2252.3	6/15/2011
Average Pool	2229.9	
Minimum Pool	2196.2	3/20/2007
Maximum for 2017	2240.2	6/27/2017
Minimum for 2017	2233.9	1/31/2017

Garrison

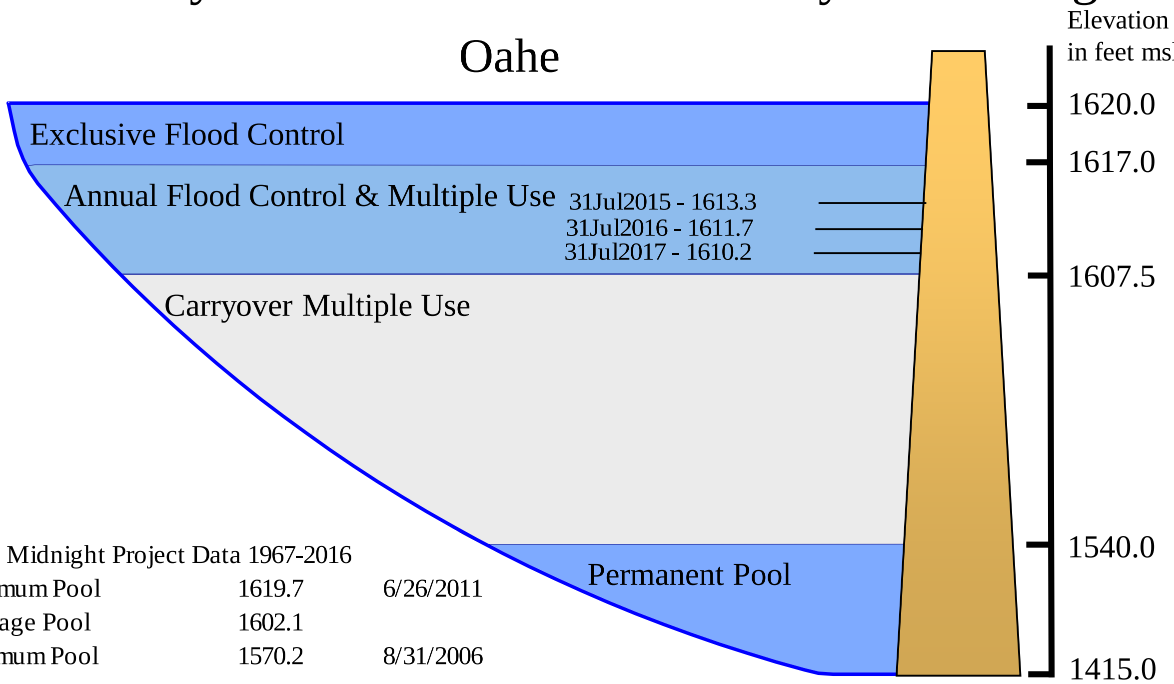


Daily Midnight Project Data 1967-2016		
Maximum Pool	1854.8	7/3/1975
Average Pool	1835.3	
Minimum Pool	1805.8	5/12/2005
Maximum for 2017	1846.6	7/11/2017
Minimum for 2017	1837.5	2/9/2017

Figure 21A. End-of-July pool elevations for Fort Peck and Garrison.

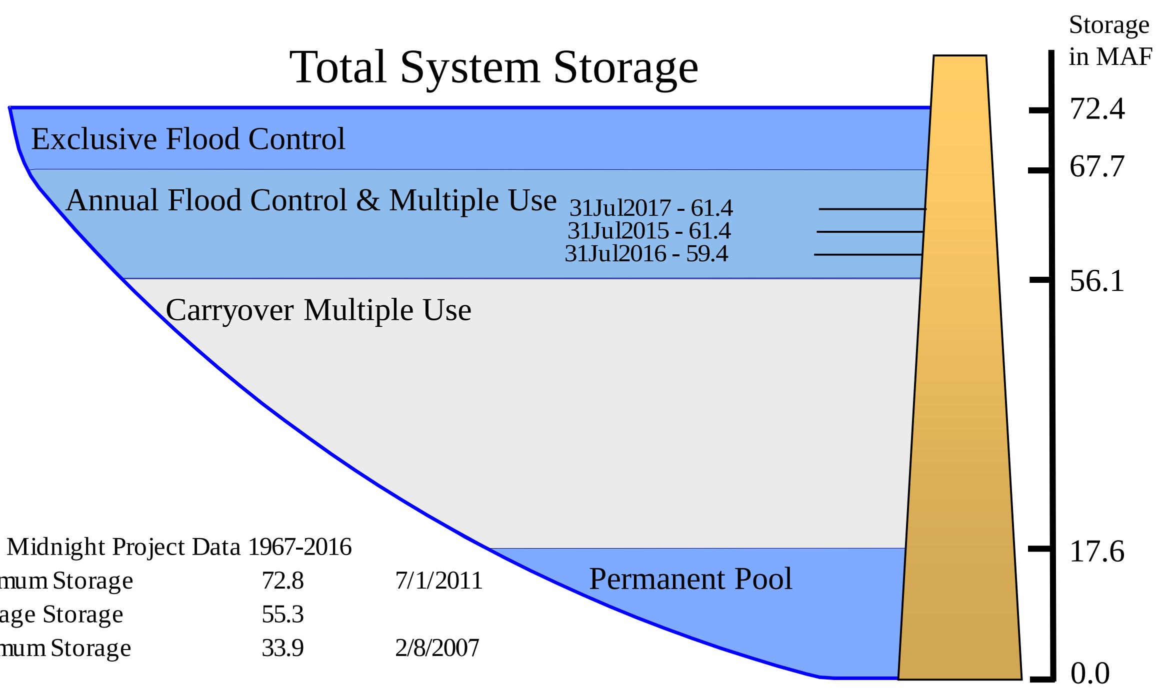
Missouri River System Reservoirs
End-of-July Pool Elevations and Total System Storage

Oahe



Daily Midnight Project Data 1967-2016		
Maximum Pool	1619.7	6/26/2011
Average Pool	1602.1	
Minimum Pool	1570.2	8/31/2006
Maximum for 2017	1611.1	9/4/2017
Minimum for 2017	1606.6	12/30/2017

Total System Storage



Daily Midnight Project Data 1967-2016		
Maximum Storage	72.8	7/1/2011
Average Storage	55.3	
Minimum Storage	33.9	2/8/2007
Maximum for 2017	61.8	7/9/2017
Minimum for 2017	55.9	1/13/2017

Figure 21B. End-of-July pool elevations for Oahe and total System storage.

F. <u>Summary of Results</u>

1. Flood Control

The March 15 and July 1 System storages were 57.4 and 61.8 MAF, respectively. Per the criteria outlined in the Master Manual, full service flow support was provided for the first half and second half of the 8-month navigation season during 2017. Operation of Federal projects during significant runoff events in the Omaha and Kansas City Districts resulted in flood damage reduction. As shown on ***Figures 17A*** through ***17C***, flows at locations downstream of the mainstem projects were significantly reduced due to operation of the mainstem reservoirs.

The total flood damages prevented by all Corps controlled reservoir projects in the Missouri River Basin during 2017 were estimated to be about $451 million ($241 million Omaha District; $210 million Kansas City District). Flood damages prevented by the System reservoirs during 2017 were estimated to be $244 million ($152 million Omaha District; $92 million Kansas City District). The System flood damages prevented indexed to the September 2017 price level is illustrated in ***Figure 22A.*** Since 1938, the total flood control damages prevented by the System were $62.5 billion, an annual average of $781 million, indexed to September 2017 price levels. The total un-indexed flood damages prevented at the original price levels is $35.7 billion, an annual average of $446 million (see ***Figure 22B***). The bulk of the damages prevented occurred during the 6-year period from 1993 to 1999 and the 4-year period from 2008 to 2011. For comparison purposes, ***Figures 22A*** and ***22B*** include the construction cost of the dams. Indexed to 2017 price levels, the dams cost approximately $27.7 billion, whereas the original un-indexed cost was $1.2 billion.

Figures 17A through ***17C*** show the 2017 regulated (actual experienced) and unregulated (with no System reservoirs and tributary reservoirs) Missouri River flows downstream of Fort Peck Dam at Wolf Point, MT, downstream of Garrison Dam at Bismarck, ND, and downstream of Gavins Point Dam at Sioux City, IA, St. Joseph, MO, Boonville, MO and Hermann, MO.

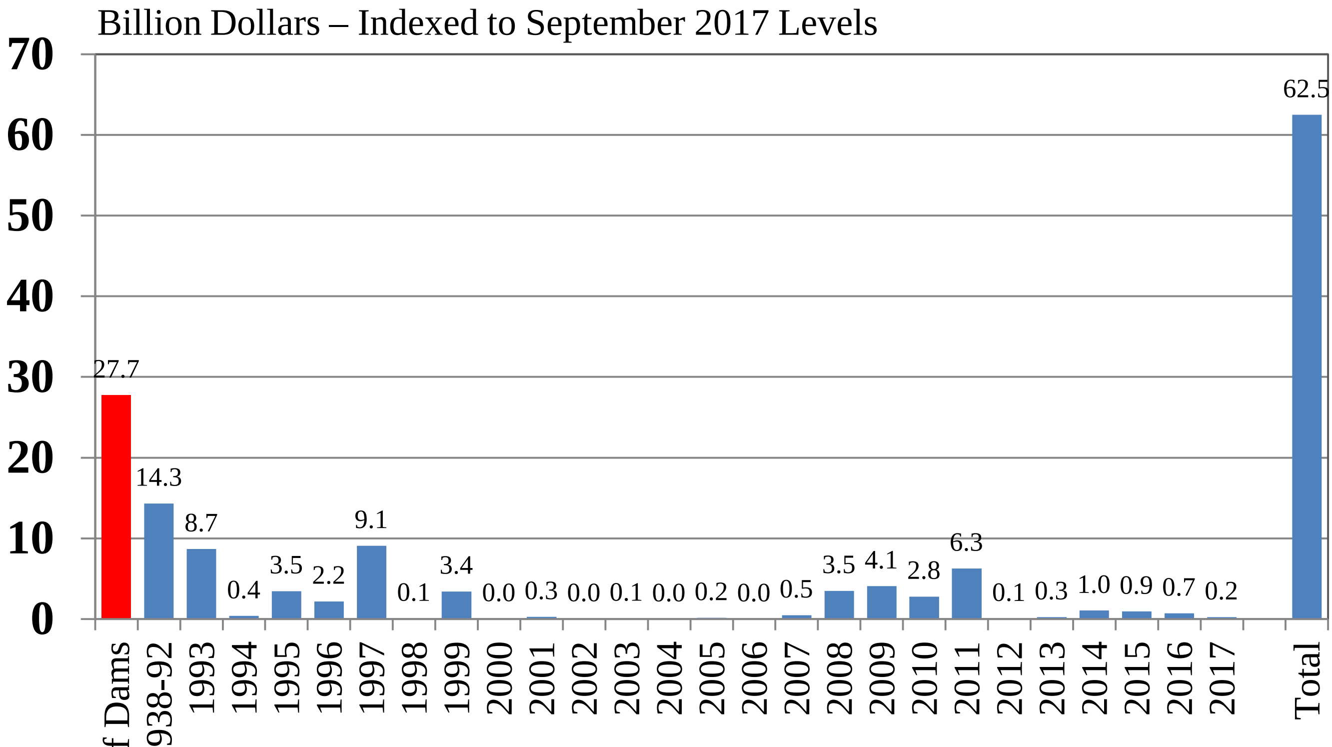


Figure 22A. Missouri River flood damages prevented by the System indexed to September 2017 levels.

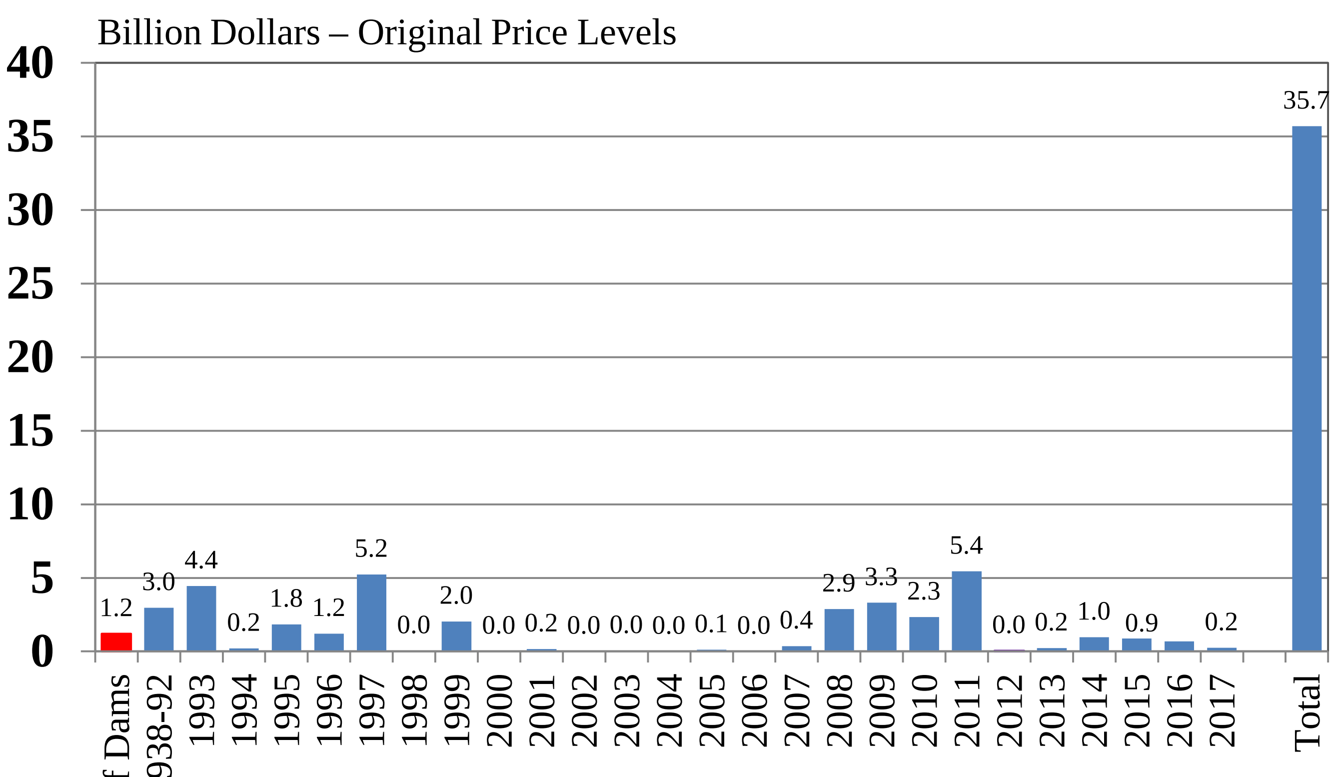


Figure 22B. Missouri River flood damages prevented by the System - original price levels.

2. Irrigation

Federally developed irrigation projects are not being served directly from the System reservoirs. The reservoirs, however, are being utilized by numerous private irrigators as well as Federally financed projects that take water from the Missouri River. About 900 private irrigators pump directly from the reservoirs or river reaches.

3. Water Supply

Problems at municipal and industrial (M&I) intakes located in the river reaches and System reservoirs are related primarily to intake or river access problems rather than inadequate water supply. Intake owners today are generally better prepared to handle periods of low water with adjustments to intakes or regulation procedures. Some of these adjustments involve using warm water to keep ice formation from building up on intake screens; installing new pumps; lowering intakes; installing sediment redirection vanes and ice deflectors; obtaining, or arranging to obtain, alternate sources of water; and cleaning screens more thoroughly and frequently. While these remedial actions are expensive to install and operate, they significantly improved the ability of the intakes to operate at lower river stages and reservoir levels.

Due to the historic releases in 2011, stretches of the Missouri River, specifically reaches directly downstream of the projects, experienced significant channel degradation. During the 2012-13 and 2013-14 winters, minimum releases required some additional coordination with downstream intake owners to ensure that their intakes were operational. The September 1 storage check indicated a winter release of no less than 17,000 cfs, which did not result in any intake access issues.

4. Water Quality Control

a. Overview

During 2017 the Omaha District (NWO) conducted fixed-station ambient water quality monitoring at the mainstem reservoirs and on the lower Missouri River. Water quality conditions of the water discharged through each of the mainstem dams was continuously monitored. More detailed water quality monitoring information is available in the NWO water quality reports on the NWO website at http://www.nwo.usace.army.mil/Missions/WaterInformation/WaterQuality/Reports.aspx

NWO has identified seven priority water quality issues that have relevance to the mainstem reservoirs. These identified priority issues are:

1. Determine how regulation of the mainstem dams and reservoirs affect water quality in the impounded reservoirs. Utilize the CE-QUAL-W2 hydrodynamic and water quality model to facilitate this effort.
2. Evaluate how eutrophication is progressing in the mainstem reservoirs, especially regarding the expansion of hypoxic conditions in the hypolimnion during summer stratification.
3. Determine how flows released from mainstem reservoirs affect water quality in the downstream Missouri River. Utilize the HEC-RAS water quality model to facilitate this effort.
4. Determine how current water quality conditions in the Missouri River (e.g., water temperature, turbidity) may be affecting pallid sturgeon populations in the Missouri River.
5. Provide water quality information to support decision making (e.g., Corps reservoir regulation elements for effective surface water quality and aquatic habitat management, Tribes and States in the development of their Section 303(d) lists and development and implementation of total maximum daily loads (TMDLs) at NWO tributary projects).
6. Identify existing and potential surface water quality problems at NWO tributary projects and develop and implement appropriate solutions.
7. Evaluate surface water quality conditions and trends at NWO tributary projects.

Table 13 provides a summary of water quality issues and concerns at each of the mainstem reservoirs and the lower Missouri River based on NWO monitoring and a review of current State integrated water quality reports.

b. Occurrence of “Two-Story” Fisheries at Mainstem Reservoirs

The Fort Peck, Garrison, and Oahe reservoirs maintain “two-story” fisheries that are comprised of warmwater and coldwater species. The ability of the reservoirs to maintain “two-story” fisheries is due to their thermal stratification in the summer that allows coldwater habitat to be maintained in the deeper, colder region of the reservoir (i.e. hypolimnion). Warmwater fish species inhabit the warmer, shallower areas of the reservoirs (i.e. epilimnion), while coldwater fish species inhabit the hypolimnion. Certain coldwater fish species are used extensively as forage by both coldwater and warmwater predator fish species in the reservoirs. Coldwater

Table 13
Water Quality Issues and Concerns

Project	Total Maximum Daily Load (TMDL) Considerations*				Fish Consumption Advisories		Other Potential Water Quality Concerns
	On 303(d) List	Impaired Uses	Pollutant/Stressor	TMDL Completed	Advisory in Effect	Identified Contamination	
Fort Peck • Fort Peck Lake	Yes (MT)	Drinking Water Supply Recreation	Lead Mercury Aquatic plants - native	No NA**	Yes	Mercury	---
• Missouri River, Fort Peck Dam to the Milk River	Yes (MT)	Aquatic Life Coldwater Fishery	Water temperature Degraded riparian vegetation Other flow regime alterations	No NA**	No	---	---
• Missouri River, Milk River to the Poplar River	Yes (MT)	Aquatic Life Warmwater Fishery	Water temperature Degraded riparian vegetation Other flow regime alterations	No NA**	No	---	---
• Missouri River, Poplar River to North Dakota	Yes (MT)	Aquatic Life Warmwater Fishery	Water temperature Other flow regime alterations	No NA**	No	---	---
Garrison • Lake Sakakawea	Yes (ND)***	Fish Consumption	Methyl-mercury	No	Yes	Mercury	Coldwater fishery during drought conditions. Tailwater dissolved oxygen levels.
• Missouri River, Garrison Dam to Lake Oahe	No	---	---	---	Yes	Mercury	Low dissolved oxygen in Garrison Dam tailwaters (associated with late summer hypolimnetic lake withdrawals).
Oahe • Lake Oahe	Yes (SD)	Coldwater Permanent Fish Life Fish/Wildlife Propagation Recreation Stock Watering	Mercury in Fish Tissue	No	Yes	Mercury	Fish consumption advisory also issued by the State of North Dakota and Cheyenne River Sioux Tribe for Lake Oahe within their jurisdictions.
Big Bend • Lake Sharpe	Yes	Coldwater Permanent Fish Life	Temperature Dissolved Oxygen	No	No	---	TMDL completed for sediment. A nonpoint source management project is being implemented in the Bad River watershed.
Fort Randall • Lake Francis Case	No	---	---	---	No	---	Low dissolved oxygen in Fort Randall Dam tailwaters (associated with late summer hypolimnetic reservoir withdrawals).
• Missouri River, Fort Randall Dam to Lewis and Clark Lake	Yes (NE, SD)	Warmwater Aquatic Life (NE) Warmwater Perm. Fish Life (SD) Fish/Wildlife Propagation (SD) Recreation (SD) Stock Watering (SD)	Mercury in Fish Tissue (NE, SD)	No	Yes (NE, SD)	Mercury	---
Gavins Point • Lewis and Clark Lake	Yes (NE, SD)	Aquatic Life (NE) Warmwater Perm. Fish Life (SD) Fish/Wildlife Propagation (SD) Recreation (SD) Stock Watering (SD)	Chlorophyll-a (NE) Mercury in Fish Tissue (SD)	No	Yes (SD)	Mercury	Sedimentation. Emergent aquatic vegetation.
• Missouri River, Gavins Point Dam to the Big Sioux River	Yes (SD)	Warmwater Perm. Fish Life (SD) Fish/Wildlife Propagation (SD) Recreation (SD) Stock Watering (SD)	Mercury in Fish Tissue	No	Yes (SD)	Mercury	Reduced suspended sediment and turbidity impacts to pallid sturgeon. Assimilative capacity and flow reduction.
• Missouri River, Big Sioux River to Platte River	Yes (NE)	Recreation	*E. coli*	No	No	---	Reduced suspended sediment and turbidity impacts to pallid sturgeon. Assimilative capacity and flow reduction.
• Missouri River, Platte River (NE) to NE-KS Stateline	Yes (MO, NE)	Recreation	*E. coli*	Yes (NE)	No	---	Reduced suspended sediment and turbidity impacts to pallid sturgeon. Assimilative capacity and flow reduction.

* Information taken from published state integrated water quality reports and impaired waters 303(d) listings as of January 1, 2017.
** Impairment identified in Montana's integrated report, but not on 303(d) list for development of a TMDL.
*** Delisted in 2010 for impairment of the designated use "Fish and other Aquatic Biota" (warm water temperature and low dissolved oxygen) when Lake Sakakawea pool elevations recovered from drought conditions.

forage species that inhabit the reservoirs include the rainbow smelt (*Osmerus mordax*) and lake herring/lake cisco (*Coregonus artedi*). Maintaining healthy populations of these coldwater forage fish is important to maintaining both the coldwater and warmwater recreational fisheries in the three reservoirs.

c. Bottom-Withdrawal Reservoirs

Bottom-withdrawal reservoirs have outlet structures located near the deepest part of the reservoir. During the summer thermal stratification period, bottom withdrawal releases cold water from the deep portion of the reservoir that may be hypoxic during latter periods of stratification. Hypoxic conditions in the hypolimnion can result in the release of water with low dissolved oxygen and high levels of nutrients and other constituents. Bottom outlets can cause density interflows or underflows through the reservoir and generally provide little or no direct control over the quality of the water released through the bottom withdrawal. Garrison and Fort Randall are bottom withdrawal projects with both their power and flood tunnels drawing water from the bottom of the impounded reservoirs. Fort Peck Dam has a near-bottom withdrawal (i.e. 60 feet above the reservoir bottom) for the power and flood tunnels. The power tunnels at Oahe Dam draw water at a mid-depth elevation (i.e. 114 feet above the reservoir bottom); however, the flood tunnels draw water from the bottom of the reservoir. The Big Bend and Gavins Point powerplants both draw water from the bottom of the reservoir; however, these are shallower, run-of-the-river reservoirs and water drawn into the powerplants is usually fairly well mixed through the reservoir water column.

d. Fort Peck Reservoir

Fort Peck reservoir is not assigned a coldwater fishery use by the State of Montana in their water quality standards. However, the reservoir supports a stocked put-grow-take salmon fishery and a naturally reproducing lake trout (*Salvelinus namaycush*) and lake cisco fishery; all are considered coldwater species. Since a coldwater fishery is currently supported in Fort Peck reservoir, it is seemingly an existing use to be protected pursuant to the anti-degradation provisions of the Federal Clean Water Act (40 CFR 131.3).

Dissolved oxygen concentrations below Montana's 5 mg/L, 7-day mean minimum water quality standard were monitored at the Fort Peck powerplant for the first time in 2012. A special water quality study was conducted by NWO in 2012 to evaluate the situation. When monitored on September 25, the area immediately downstream of the dam to just beyond the energy dissipation structures was below 5 mg/L dissolved oxygen, while the area from just downstream of the energy dissipation structures through the dredge cuts area was just above 5 mg/L. During 2013-2017 dissolved oxygen in the water discharged through the Fort Peck powerplant remained above the 5 mg/L minimum water quality standard with minimum instantaneous values of 5.4 mg/L (2013), 6.1 mg/L (2014), 5.9 mg/L (2015), 6.5 (2016), and 6.4 (2017). The situation will continue to be evaluated to determine if corrective measures to meet State water quality standards may be needed.

e. Garrison Reservoir

The State of North Dakota's water quality standards classifies Garrison reservoir as a coldwater fishery. To protect the coldwater fishery use the State has promulgated the following water quality standards for Garrison reservoir: a water temperature criterion of ≤ 59 deg F (or 15 degrees C), a dissolved oxygen criterion of ≥ 5 mg/L, and a minimum reservoir volume of 500,000 AF (0.5 MAF) that meets these criteria.

Water temperature and dissolved oxygen depth profiles that were measured during water quality monitoring conducted at Garrison reservoir over the 5-year period 2013 through 2017 were used to estimate the volume of water in the reservoir that meets the coldwater fishery habitat conditions defined by the State of North Dakota. ***Plate 3*** shows estimated reservoir and coldwater fishery habitat volumes, by year, for 2013 through 2017. Water quality monitoring in 2017 indicates that North Dakota's 0.5 MAF minimum water quality standards criterion for coldwater fishery habitat was seemingly met; however, temporal variability in data collected at Garrison does allow for some uncertainty in this measurement.

To better assess the occurrence and support of coldwater fishery habitat in Garrison reservoir the NWO is currently updating their CE-QUAL-W2 hydrodynamic and water quality modeling of the reservoir. A comprehensive water quality report of Garrison reservoir, including application of the CE-QUAL-W2 model and how Corps regulation of the dam and reservoir influence water quality conditions, is planned for completion by mid-2018.

Dissolved oxygen concentrations below North Dakota's 5 mg/L water quality standard have been monitored in late summer at the Garrison powerplant. To date, there is no evidence of current or past fish kills in the Garrison tailwaters. A Special Water Quality Study of the situation is being considered, and the situation will continued to be evaluated to determine if corrective measures to meet State water quality standards may be needed.

f. Oahe Reservoir

South Dakota's water quality standards protect Oahe for a Coldwater Permanent Fish Life Propagation (CPFLP) use (i.e. coldwater fishery). As such, a water temperature criterion of ≤ 65 deg F (or 18.3 degrees C) and a dissolved oxygen criterion of ≥ 6 mg/L have been promulgated by South Dakota to protect the coldwater fishery of Oahe.

The occurrence of coldwater fishery habitat (i.e. water temperature ≤ 18.3 degrees C and dissolved oxygen ≥ 6 mg/L) in Oahe was estimated from water quality monitoring conducted over the 5-year period 2013 through 2017. ***Plate 4*** shows estimated reservoir and coldwater fishery habitat volumes, by year, for 2013 through 2017. At least 2 MAF of coldwater fishery habitat was present in Oahe for all years.

g. Big Bend Reservoir

The State of South Dakota classifies Big Bend for a CPFLP use and currently lists the designated coldwater fishery as impaired due to warm water temperatures and low dissolved oxygen levels, and targets the reservoir for development of a Total Maximum Daily Load (TMDL) in the near future. South Dakota should consider reclassification of Big Bend Reservoir from a coldwater fishery to a warmwater fishery based on a use attainability assessment of "natural conditions". Natural summer water temperatures of the Oahe powerplant discharge, especially during lower pool levels, do not meet the temperature requirements for a CPFLP use in Big Bend.

h. Fort Randall Reservoir

Hypolimnetic water is passed through Fort Randall Dam during power production in the summer and dissolved oxygen levels in the Fort Randall Dam tailwaters fall below South Dakota's water quality standards' minimum dissolved oxygen criterion of 5 mg/L for protection of the designated Warmwater Permanent Fish Life Propagation (WPFLP) use. The low dissolved oxygen levels in the tailwaters are not impairing the designated WPFLP use as regions of refugia exist in the impacted area, and there is no evidence of current or past summer fish kills in the tailwaters attributable to low dissolved oxygen levels. If warranted, low dissolved oxygen levels in the Fort Randall tailwaters, during periods of hypolimnetic releases, could be mitigated by spilling surface water with higher dissolved oxygen concentrations down the spillway. The situation will continue to be evaluated to determine if corrective measures to meet South Dakota's water quality standards may be needed.

i. Gavins Point Reservoir

Gavins Point reservoir is currently identified as impaired by the States of South Dakota and Nebraska in their 303(d) listing of impaired waters. South Dakota identifies impairment to the designated uses of WPFLP, Fish/Wildlife Propagation, Recreation, and Stock Watering due to elevated mercury levels in fish tissue. Nebraska identifies impairment to the use of aquatic life due to high chlorophyll-a levels. Of the six mainstem reservoirs, Gavins Point is exhibiting the most impact from nutrient loading and eutrophication. Eutrophication concerns at Gavins Point will likely increase as the reservoir continues to age. The current estimated volume loss of the Carryover Multiple Use Pool Zone (28 percent) in Gavins Point exceeds the State of Nebraska's criterion (25 percent volume loss) for listing the reservoir as impaired for aesthetics. Gavins Point is not currently listed as impaired for sedimentation by the State of Nebraska.

5. Navigation

a. Barge Traffic

System releases provide navigation flow support in the Missouri River Bank Stabilization and Navigation Project (BSNP). Minimum navigation flow support, which is 6,000 cfs below full service, provides flow to ensure a minimum 8-foot channel depth. Full service navigation flow support provides flow to ensure a minimum 9-foot deep and 300-foot wide channel in the BSNP. Navigation flow support for the first half of the season is determined by the March 15 System storage check. Navigation flow support for the second half of the season, as well as season length, is determined by the July 1 System storage check. System releases are set to meet navigation target flows at four Missouri River locations – Sioux City, Omaha, Nebraska City, and Kansas City.

Based on the March 15 System storage of 57.4 MAF, navigation flow support was at a full service level for the first half of the navigation season.

System storage on April 1 was 58.4 MAF, 2.3 MAF above the base of the Annual Flood Control and Multiple Use Zone. Based on the April 1 calendar year runoff forecast above Gavins Point, System and tributary storage, and Plate VI-I of the Master Manual, the service level was increased, or expanded, from 35,000 cfs to 40,000 cfs.

Based on the July 1 System storage of 61.8 MAF, the expanded service level was reduced to full service level for the second half of the season with a normal 8-month season length. The reduction in service level reflected the expansion of drought conditions in the upper Basin.

On February 19, the year's first commercial load entered the Missouri River at St. Louis, MO. The Corps' Missouri River Project Office at Napoleon, MO recorded 29 loads and no empties being brought into the Missouri River before April 1, the start of the navigation season. The last commercial tow taken off the Missouri River in 2017 was on December 7.

b. Tonnage

Table 14 shows the final Missouri River tonnage data for 2012-16 compiled by the Waterborne Commerce Statistics Center (WCSC). Final navigation data is generally one year behind the summary report reporting year because the WCSC needs an extended period of time to compile the data. The 2016 total of 4.656 million tons includes 3.807 million tons for sand and gravel, 0.290 million tons for waterways materials, and 0.559 million tons for long-haul commercial tonnage. In 2016 the total tonnage increased by 0.254 million tons compared to 2015. The long-haul tonnage at 0.559 million tons is an increased by 0.290 million tons from 2015. The largest long-haul commercial tonnage, excluding sand, gravel and waterway material, occurred in 1977 at 3.34 million tons. ***Figure 23A*** shows total navigation tonnage on the Missouri River. ***Figure 23B*** shows the long-haul commercial navigation tonnage not including sand, gravel and waterway materials. The long-haul commercial tonnage in 2017 is estimated at 0.634 million tons, based on carrier interviews, towboat activity and barge counts from the Corps' daily boat reports. ***Figure 24A*** shows the navigation tonnage value of the commodities since 1960, using 2017 present-worth computations. ***Figure 24B*** shows the navigation tonnage value of long-haul commercial commodities since 1960. The ***Figures 23A***, ***23B***, ***24A*** and ***24B*** tonnages and tonnage values for 2017 are estimates and will change once final WCSC tabulations are available.

Navigation season target flows for past years are presented in ***Table 15***. ***Table 16*** shows the scheduled lengths of past System-supported navigation seasons, with total tonnage and ton-miles for each year. ***Figures 25A*** and ***25B*** present flows at the four navigation flow-target locations. There was no navigation support from the Kansas River projects in 2017.

Table 14
Missouri River Tonnage by Commodity (1,000 Tons)

Commodity Classification Group	**2012**	**2013**	**2014**	**2015**	**2016**
Farm Products	20	12	53	50	231
Corn	0	0	9	34	97
Wheat	0	0	0	3	2
Soybeans	20	12	44	13	133
Misc Farm Product	0	0	0	0	0
Nonmetallic Minerals	3,479	3,664	4,113	3,946	3,826
Sand/Gravel	3,421	3,609	4,072	3,901	3,807
Misc Nonmetallic	61	55	41	45	19
Food and Kindred	0	0	7	0	0
Pulp and Paper	0	0	0	0	0
Chemicals	34	53	64	72	140
Fertilizer	34	53	64	72	140
Other Chemicals	0	0	0	0	0
Petroleum (including coke)	6	54	44	13	68
Stone/Clay/Glass	79	71	85	83	98
Primary Metals	0	0	0	6	3
Waterway Materials	288	251	305	232	290
Other	0	0	0	0	0
Total Commercial	3,906	4,105	4,671	4,402	4,656
Total Long-Haul Commercial	197	245	293	269	559

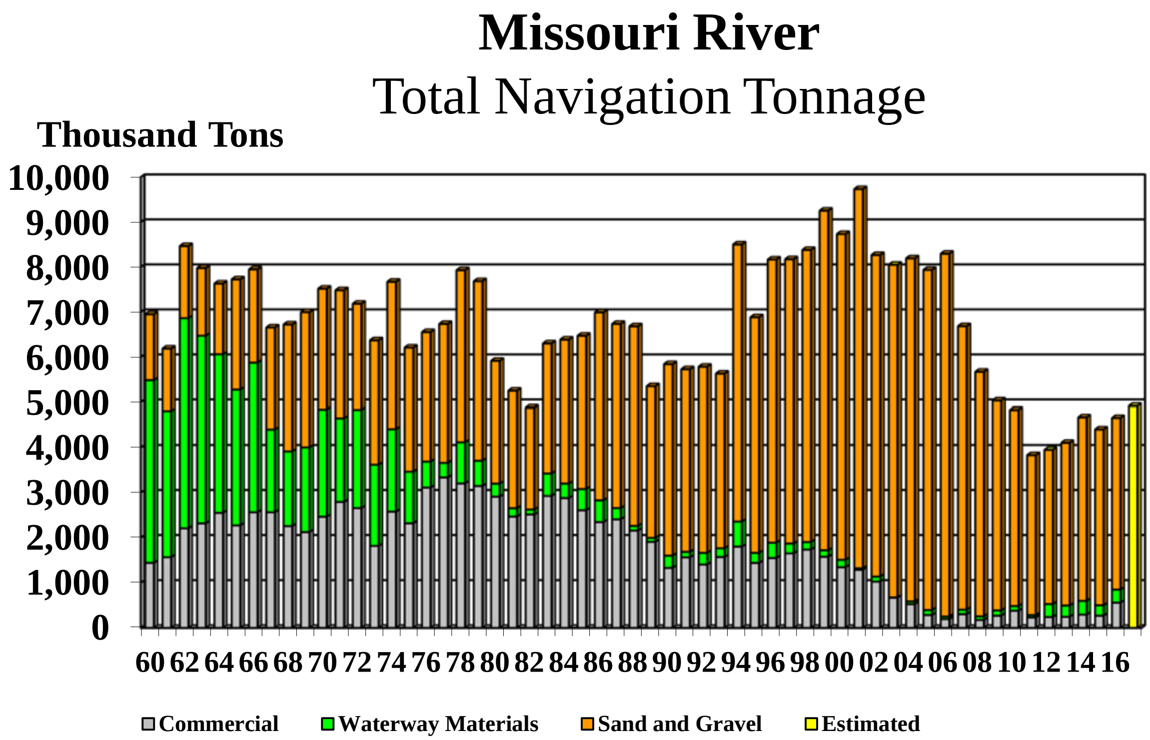


Figure 23A. Missouri River total navigation tonnage from 1960 to 2017 (estimated).

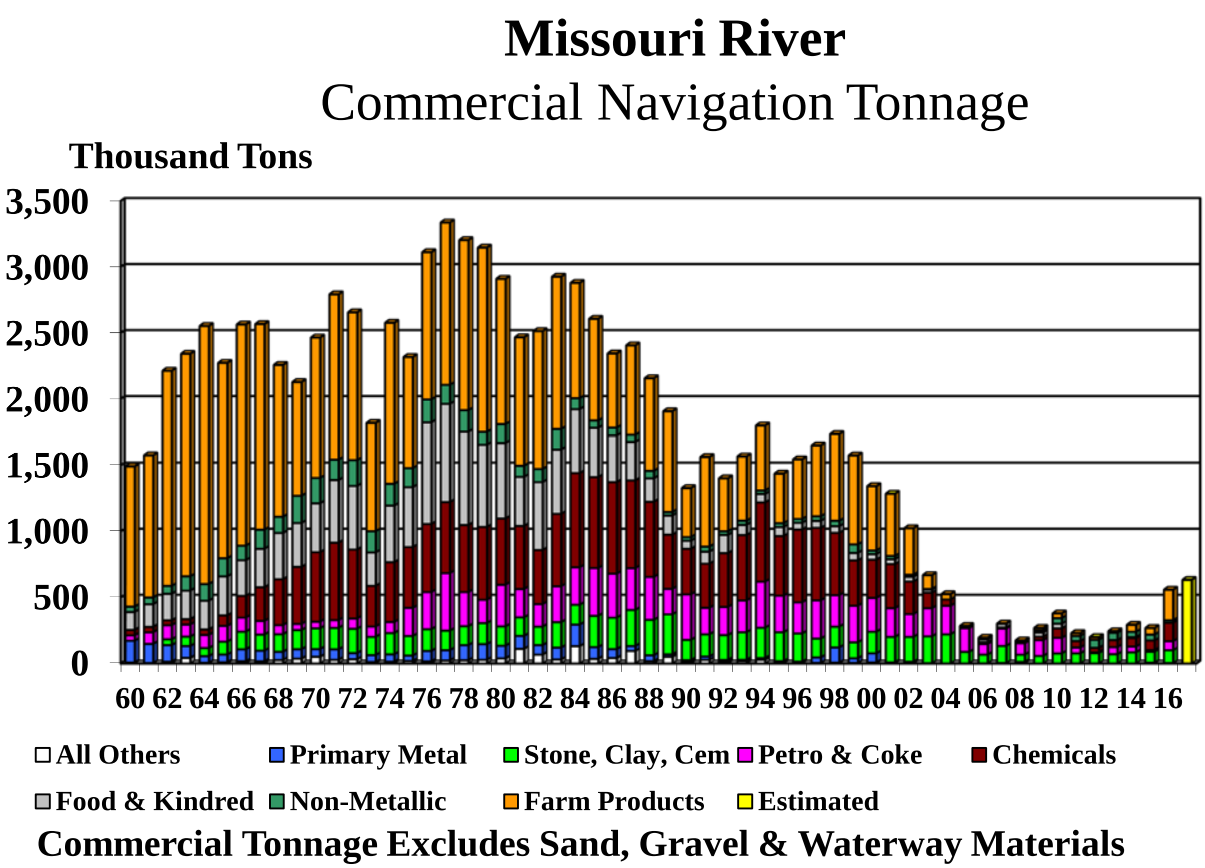


Figure 23B. Missouri River commercial navigation tonnage from 1960 to 2017 (estimated).

Missouri River

Total Navigation Tonnage Value - 2017 Present Worth

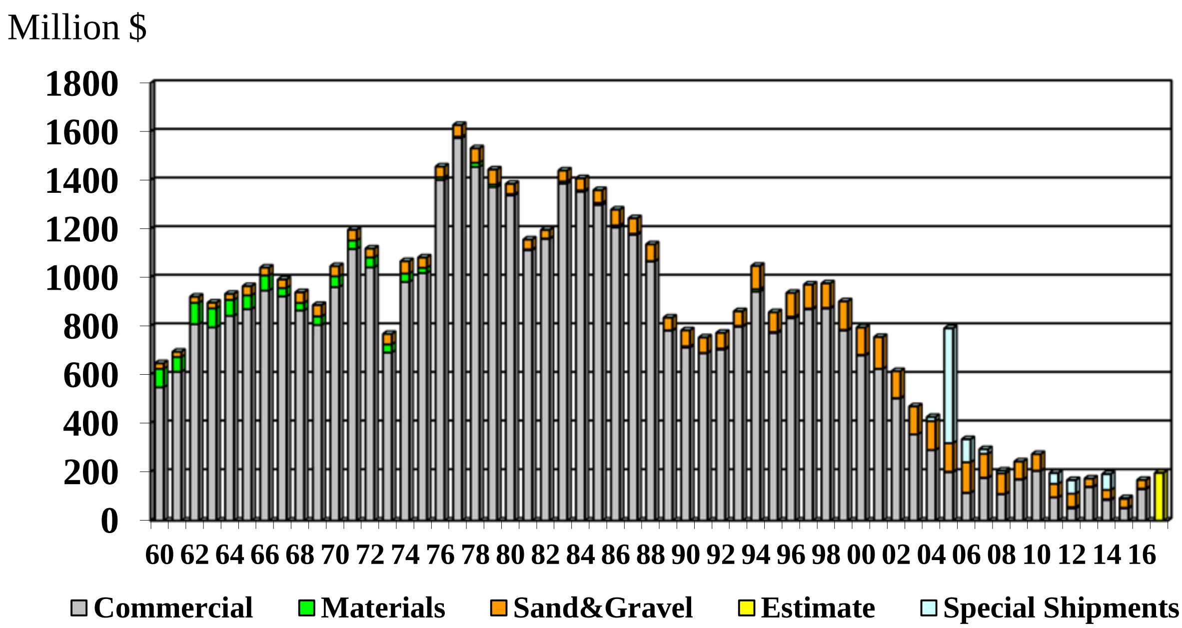


Figure 24A. Total navigation tonnage value using 2017 present worth computations.

Missouri River

Commercial Navigation Tonnage Value - 2017 Present Worth

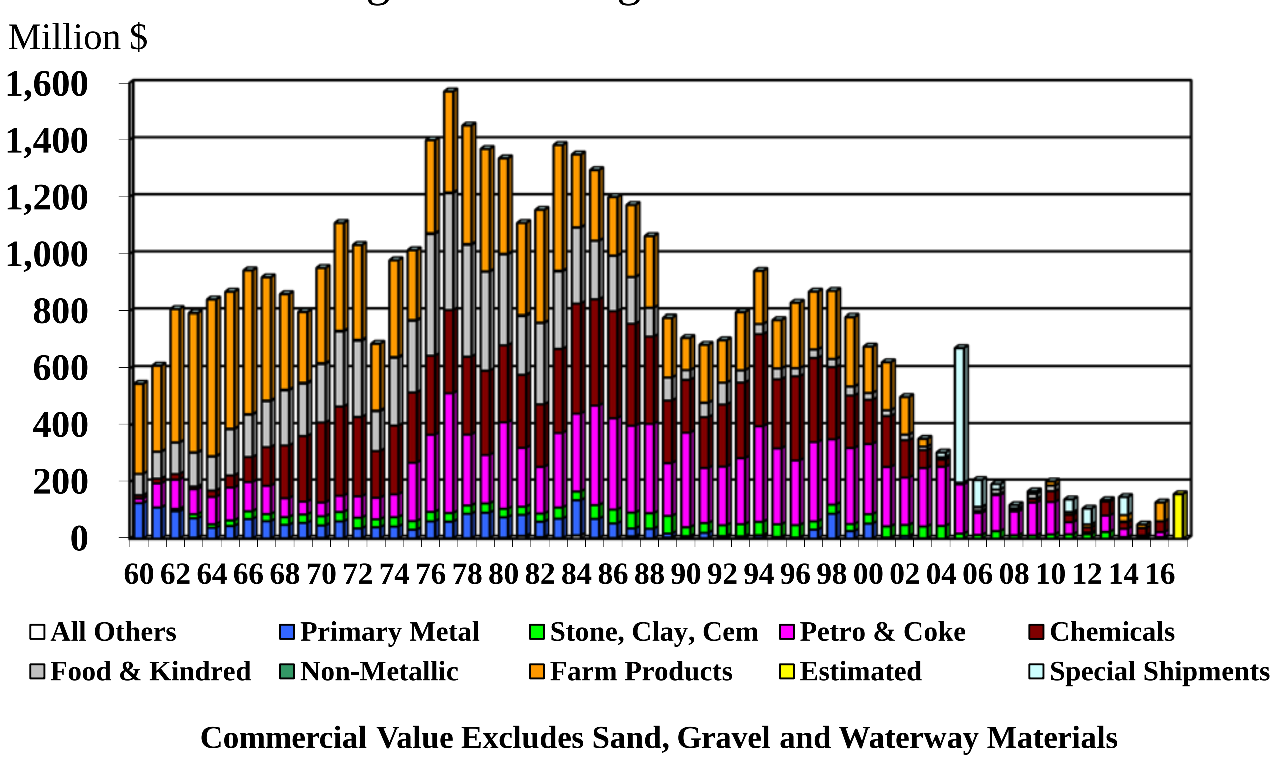


Figure 24B. Commercial navigation tonnage value using 2017 present worth computations.

Table 15
Navigation Season Target Flows
(1,000 cfs)

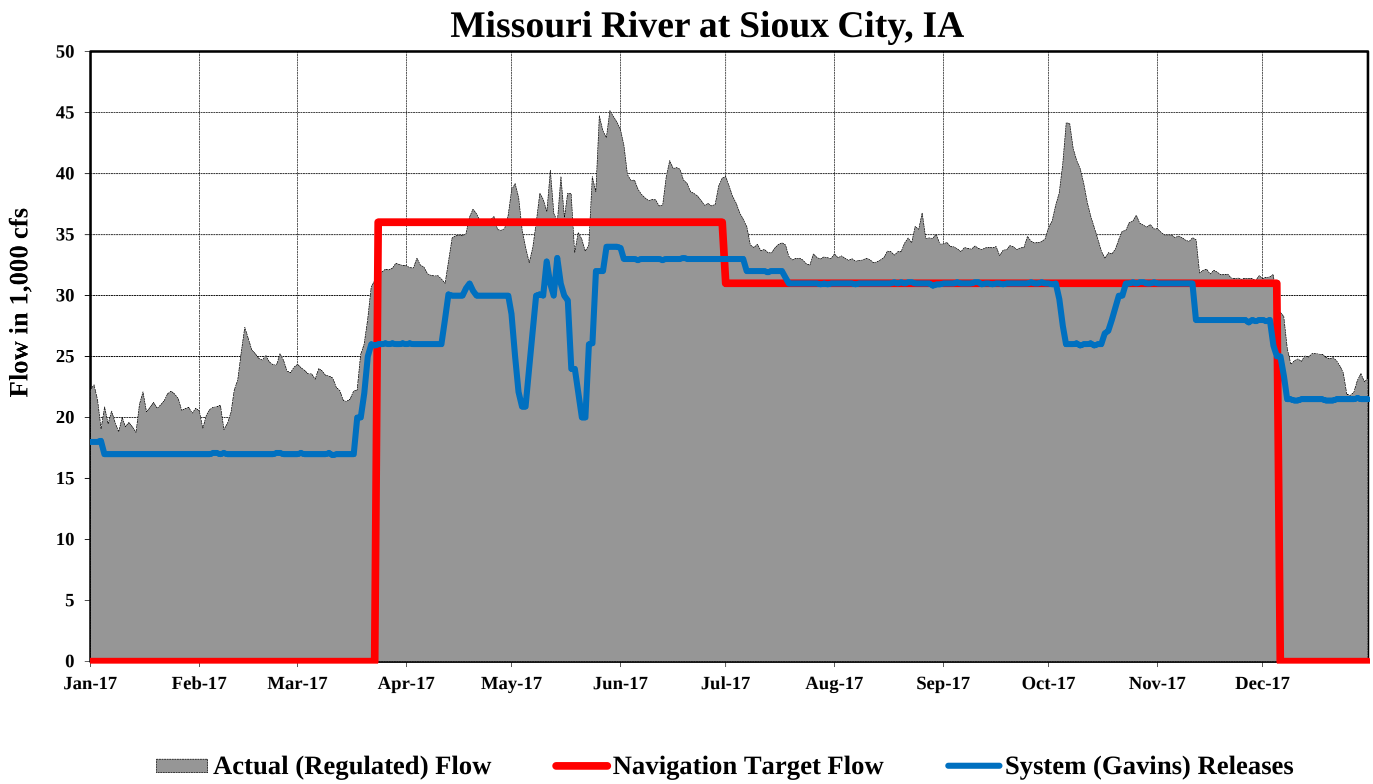
Year	Months	Sioux City	Omaha	Nebraska City	Kansas City
1967	Apr-Jun	28	28	34	38
	Jul-Nov	31	31	37	41
1968	Apr-Nov	31	31	37	41
1969	Apr-Jun(1)	35-40	35-40	41-46	45-50
	Jul(1)	36	36	42	46
	Aug-Sep(1)	50-55	50-55	55-60	55-60
	Oct-Nov(1)	40-45	40-45	45-50	50-55
1970	Apr-May	31	31	37	41
	May-Sep(1)	36	36	42	46
	Oct-Nov(1)	40	40	46	50
1971	Apr-May(1)	36	36	42	46
	May-Nov(1)	45-50	45-50	50-55	55-60
1972	Apr-Nov(1)	40-50	40-50	45-55	50-60
1973-74	Apr-Nov	31	31	37	41
1975	Apr	31	31	37	41
	May-Nov(1)	35-60	35-60	41-66	45-70
1976	Apr-Jul(1)	34-38	34-38	40-44	44-48
	Aug-Dec(1)	31-34	31-34	37-40	41-44
1977	Apr-Nov	31	31	37	41
1978	Apr	31	31	37	41
	May-Jul(1)	35-46	35-46	41-52	45-56
	Aug-Nov(1)	46-51	46-51	52-57	56-61
1979	Apr-Jul(1)	36-42	36-42	42-48	46-52
	Aug-Nov(1)	31-36	31-36	37-42	41-46
1980	Apr-Nov	31	31	37	41
1981	Apr-Nov(2)	31	31	37	41
1982	Apr-Sep	31	31	37	41
	Oct	31-36	31-36	37-42	41-46
	Nov-Dec(1)	36-46	36-46	42-52	46-56
1983	Apr-Jun	31	31	37	41
	Jul	31-36	31-36	37-42	41-46
	Aug-Nov(1)	36	36	42	46
1984	Apr-Jun	31	31	37	41
	Jul-Dec(1)	31-44	31-44	37-50	41-54
1985	Apr-Dec	31	31	37	41
1986	Apr(1)	36-41	36-41	42-47	46-51
	May-Dec(1)	41-46	41-46	47-52	51-56
1987	Apr-Nov	31	31	37	41
1988	Apr-Nov(2)	31	31	37	41
1989	Apr-Aug(3)	28	28	34	38
	Sep-Oct(3)	28	28	34	35
1990-93	Apr-Oct(4)	25	25	31	35
1994	Apr-Dec	31	31	37	41
1995	Apr-May	31	31	37	41
	Jun-Dec(1)	46-56	46-56	52-62	56-66
1996	Apr(1)	41	41	47	51
	May(1)	41-51	41-51	47-57	51-61
	Jun-Dec(1)	56	56	62	66
1997	Apr-Dec(5)	*	*	*	*
1998	Apr-Dec(5)	31	31	37	41
1999	Apr-Dec(1)	31-43	31-43	37-49	41-53
2000	Apr-Jun	31	31	37	41
	Jul-Dec(3)	29.5	29.5	35.5	39.5
2001	Apr-Dec(3)	28	28	34	38
2002	Apr-Jun(3)	27	27	33	37
	Jul-Dec(3)	25	25	31	35
2003	Apr-Nov(4)	25	25	31	35
2004-08	Apr-Oct(6)	25	25	31	35
2009	Apr-Nov(7)	25/31	25/31	31/37	35/41
2010	Apr-Dec(1)	31-43	31-43	37-49	41-53
2011	Apr(1)	31-41	31-41	37-47	41-51
	mid-Apr(1)	41-46	41-46	47-52	51-56
	May(1)	46-56	46-56	52-62	56-66
	mid-May(5)	*	*	*	*
2012	Apr-Dec	31	31	37	41
2013	Apr-Jun(6)	25	25	31	35
	Jul-Dec(3)	28	28	34	38
2014	Apr-Jun(3)	28	28	34	38
	Jul-Dec(1)	31-46	31-46	37-52	41-56
2015	Apr-Dec	31	31	37	41
2016	Apr-Dec	31	31	37	41
2017	Apr-Jun(1)	36	36	42	46
	Jul-Dec	31	31	37	41

(1) Downstream flow targets above full-service navigation level as a flood control storage evacuation measure.
(2) Full service flows provided for shortened season.
(3) Navigation targets below full service as a water conservation measure.
(4) Navigation targets at minimum service as a water conservation measure.
(5) Releases determined by flood control storage evacuation critiera and not adjusted to meet specific navigation targets.
(6) Minimum service targets at Sioux City and Omaha not met during periods when there was no navigation in those reaches.
(7) Minimum service targets at Sioux City were not met during periods when there was no navigation in those reaches.

Table 16
Missouri River Navigation
Tonnage and Season Length

Year	Reservoir System Supported Length of Season (Months)	Commercial (Tons) (1)	Total Traffic (Tons) (2)	Total Traffic (1,000 Ton-Miles) (2)
1967 (3)	8	2,562,657	6,659,219	1,179,235
1968	8 (4)	2,254,489	6,724,562	1,047,935
1969	8 (4)	2,123,152	7,001,107	1,053,856
1970	8 (5)	2,462,935	7,519,251	1,190,232
1971	8 (4)	2,791,929	7,483,708	1,329,899
1972	8 (4)	2,665,579	7,182,841	1,280,385
1973	8	1,817,471	6,370,838	844,406
1974	8	2,576,018	7,673,084	1,227,525
1975	8 (4)	2,317,321	6,208,426	1,105,811
1976	8 (4)	3,111,376	6,552,949	1,535,912
1977	8	3,335,780	6,734,850	1,596,284
1978	8 (4)	3,202,822	7,929,184	1,528,614
1979	8 (4)	3,145,902	7,684,738	1,518,549
1980	8	2,909,279	5,914,775	1,335,309
1981	7 1/4 (6)	2,466,619	5,251,952	1,130,787
1982	8 (4)	2,513,166	4,880,527	1,131,249
1983	8 (4)	2,925,384	6,301,465	1,300,000
1984	8 (4)	2,878,720	6,386,205	1,338,939
1985	8 (4) (7)	2,606,461	6,471,418	1,201,854
1986	8 (4) (7)	2,343,899	6,990,778	1,044,299
1987	8	2,405,212	6,735,968	1,057,526
1988	7 1/2	2,156,387	6,680,878	949,356
1989	6 3/4	1,906,508	5,352,282	796,799
1990	6 3/4	1,329,000	5,841,000	552,509
1991	6 3/4	1,563,000	5,729,000	537,498
1992	6 3/4	1,403,000	5,783,000	593,790
1993	8 (8)	1,570,000	5,631,000	615,541
1994	8	1,800,000	8,501,000	774,491
1995	8 (4)	1,439,000	6,884,000	604,171
1996	8 (4)	1,547,000	8,165,000	680,872
1997	8 (4)	1,651,000	8,172,000	725,268
1998	8 (4)	1,735,000	8,379,000	777,727
1999	8 (4)	1,576,000	9,252,000	699,744
2000	8	1,344,000	8,733,000	628,575
2001	8	1,288,000	9,732,000	566,150
2002	8 (9)	1,009,000	8,266,000	409,980
2003	8 (10)	667,000	8,050,000	256,788
2004	6 1/2 (11)	525,498	8,192,219	181,995
2005	6 1/2 (11)	284,641	7,935,747	129,882
2006	6 1/2 (11)	195,290	8,295,226	84,483
2007	6 3/4 (11)	302,769	6,684,625	119,177
2008	7 (11)	174,800	5,670,968	86,203
2009	8	269,563	5,035,744	114,865
2010	8(4)	379,492	4,829,714	132,747
2011	8(4)	230,439	3,831,925	62,253
2012	8	197,000	3,906,000	56,631
2013	8	244,576	4,104,505	110,280
2014	8(4)	293,125	4,670,661	89,932
2015	8	269,200	4,402,000	78,300
2016	8	559,020	4,655,884	201,943
2017	8	633,620 (13)	4,918,000 (13)	120,000 (12)

(1) Includes commercial tonnage except for sand and gravel or waterway materials. Tonnage compiled by Waterborne Commerce Statistics Center (WCSC).
(2) Includes commodities; sand, gravel, and crushed rock; and waterway improvement materials. Tonnage by WCSC.
(3) Mainstem Reservoir System first reached normal operating storage level in 1967.
(4) 10-day extension of season provided.
(5) 10-day extension and 10-day early opening provided.
(6) Full service flows for shortened season in preference to reduced service.
(7) 10-day extension provided for 1985 season in trade for 10-day delayed support of 1986 season.
(8) Lower Missouri River closed: 57 days in 1993, 20 days in 1995, and 18 days in 1999.
(9) To protect endangered shore birds below Gavins Point Dam, the Corps did not support navigation from July 3 to August 14, 2002. Average days towing industry off the river was 23 days.
(10) 6-day shortening of season to follow CWCP. From Aug 11 to Sep 1 Corps did not support navigation flows to comply with lawsuit to follow 2000 Biological Opinion. Navigation industry left the river during this period.
(11) Season shortening; 47 days, 2004; 48 days, 2005; 44 days, 2006; 35 days, 2007; 30 days, 2008
(12) Estimated using boat report barge counts.
(13) Estimated using WCSC preliminary projections.



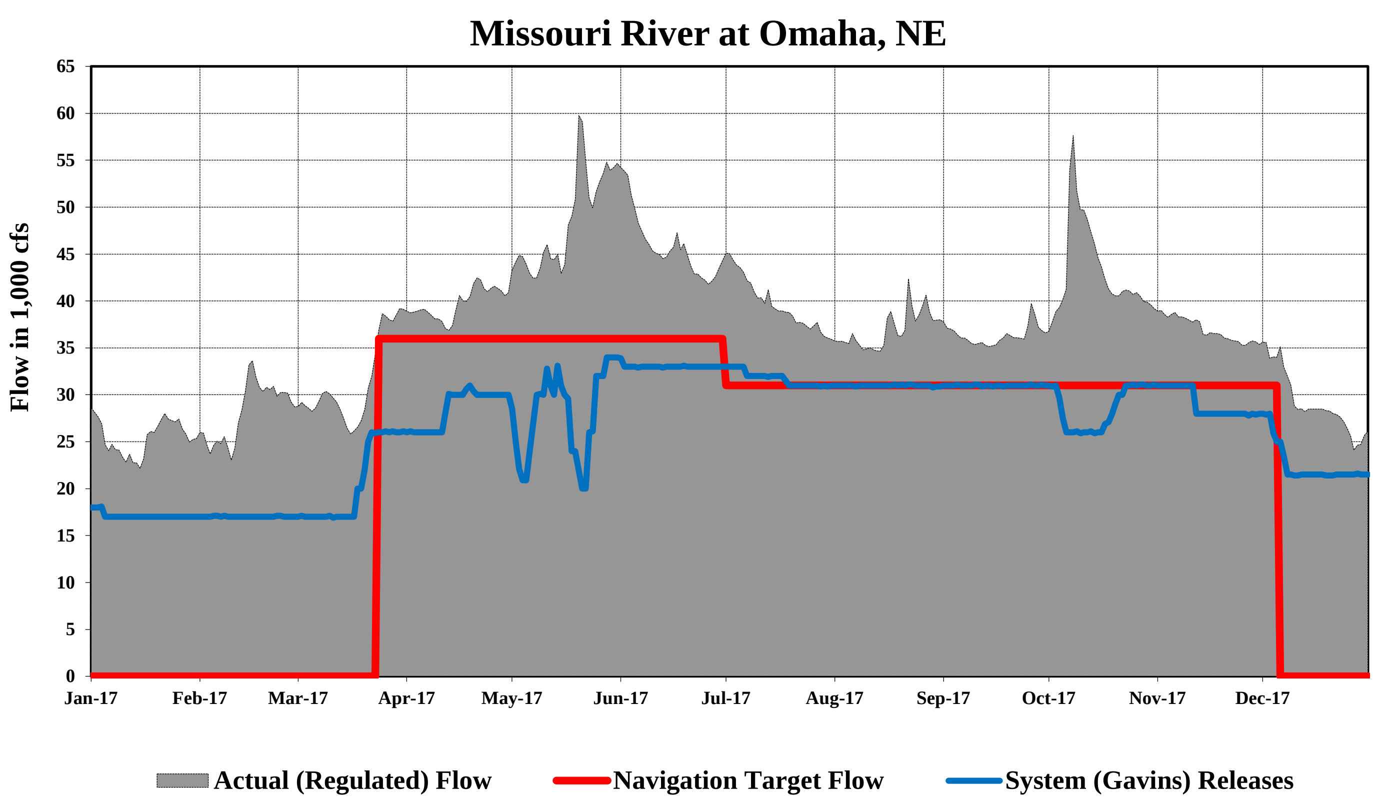
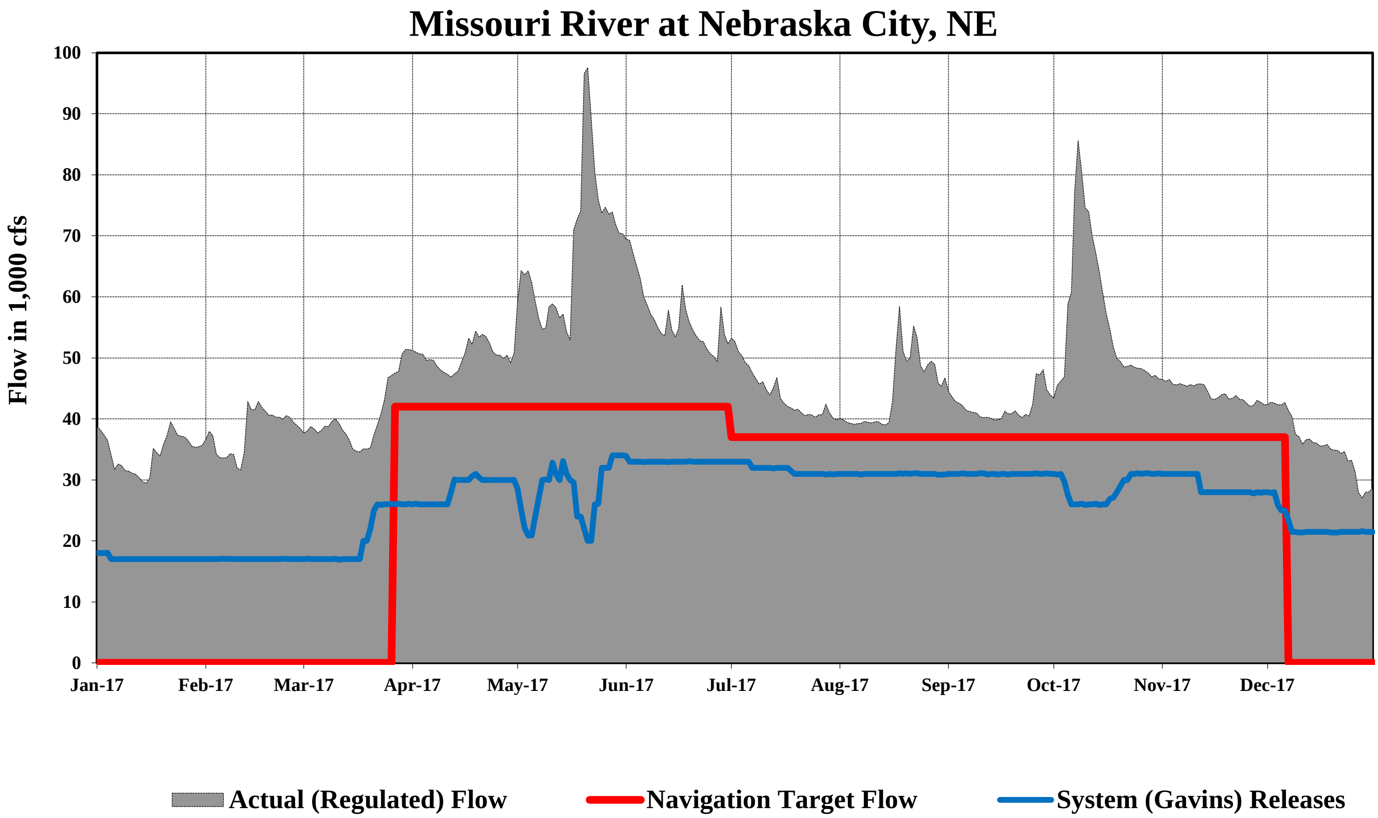


Figure 25A. Actual flow, System releases and navigation target flows – Sioux City, IA and Omaha, NE (calendar year).



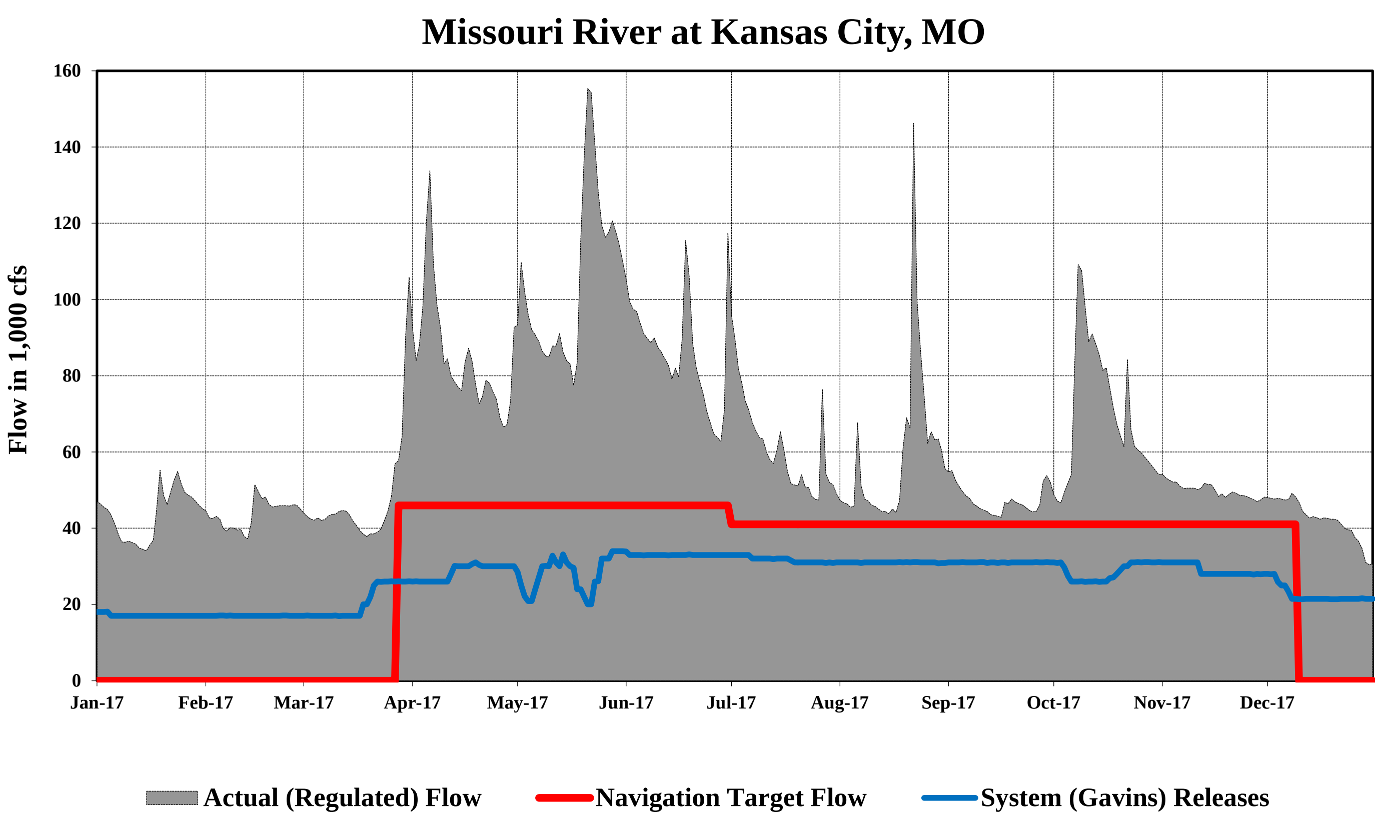


Figure 25B. Actual flow, System releases and navigation target flows – Nebraska City, NE and Kansas City, MO (calendar year).

6. Power – Eastern Division, Pick-Sloan Missouri Basin Program (P-S MBP)

The hydropower energy generated by the system is transmitted over a Federal transmission system that traverses 7,875 circuit miles. On October 1, 2015 Western's transmission system became integrated with the Southwest Power Pool (SPP) regional transmission organization. During 2017, service was provided to over 350 wholesale customers. Customers receiving service include 200 municipalities, 2 Federal agencies, 30 state agencies, 24 USBR projects, 5 irrigation districts, 36 rural electric cooperatives, 6 public utility districts, 9 private utilities, 25 Native American services and 18 power marketers. Additional marketing benefits have been realized with Western becoming an asset owning market participant within the SPP integrated market place in 2017.

Per the Omaha Public Power District (OPPD) statistics, the average OPPD customer uses approximately 11,650 kilowatt hours (kWh) of energy annually. Based on the total System generation of 9.5 billion kWh, the energy generated in 2017 by this portion of the Federal power system could have supplied all of the yearly needs of about 817,000 residential OPPD customers. In addition to the clean, renewable energy supplied to our customers, system hydropower provides an added measure of stability to the SPP regional power system. Large coal-fired and nuclear units are backed up by other SPP member resources and the Federal hydropower generation. Members of the SPP market benefit by being able to call for reserves during emergency events. In addition, hydropower and other SPP generation are integrated with wind generation to provide balance to the SPP system.

The reliability of System hydropower helps to maintain adequate reserves in both the Northwest Power Pool in Western Area Power Administration, Upper Great Plains West (WAUW) and the SPP.

Hydropower generation in 2017 was 9.5 billion kWh, which was 102 percent of average since the System first filled in 1967. The 2017 generation was 1.9 billion kWh more than the 2016 generation of 7.6 billion kWh and 4.6 billion kWh more than the record low of 4.9 billion kWh, generated in 2008. Total generation was near average in 2017 due to a slightly above-normal runoff year in the upper Basin. Western purchased about 1.1 billion kWh between January 1 and December 31, at a cost of $20.3 million, to supplement System hydropower production.

System generation with individual project distribution for each calendar year in million megawatt hours (MWh) since 1954 is shown on ***Figure 26***. The total generation from the Federal system (peak capacity and energy sales) for 2017 is shown in ***Table 17***. The tabulations in ***Table 18*** and ***Table 19*** summarize the peak and total gross generation for the Eastern Division, P-S MBP marketing area system for the past operating year. Actual settlement figures at the end of the billing periods differ somewhat from the calendar month figures shown.

Table 17
Gross Federal Power System Generation – January 2017 through December 2017

	Energy Generation 1000 kWh	**Peak Hour kW**	**Generation Date**
Corps Powerplants – Mainstem			
Fort Peck	841,738	169,000	August 2
Garrison	2,593,529	535,000	May 12
Oahe	2,627,158	701,000	July 21
Big Bend	960,415	324,000	July 14
Fort Randall	1,681,977	267,000	September 2
Gavins Point	812,530	119,000	May 28
Corps Subtotal	**9,517,347**	2,063,000	August 2
USBR Powerplants			
Canyon Ferry	349,694	54,000	April, May & June
Yellowtail*	563,559	95,500	March, October & November
USBR Subtotal	913,253		
Federal System Total	10,430,579		

* Includes only half of total Yellowtail generation, which is marketed by the Eastern Division, P-S MBP.

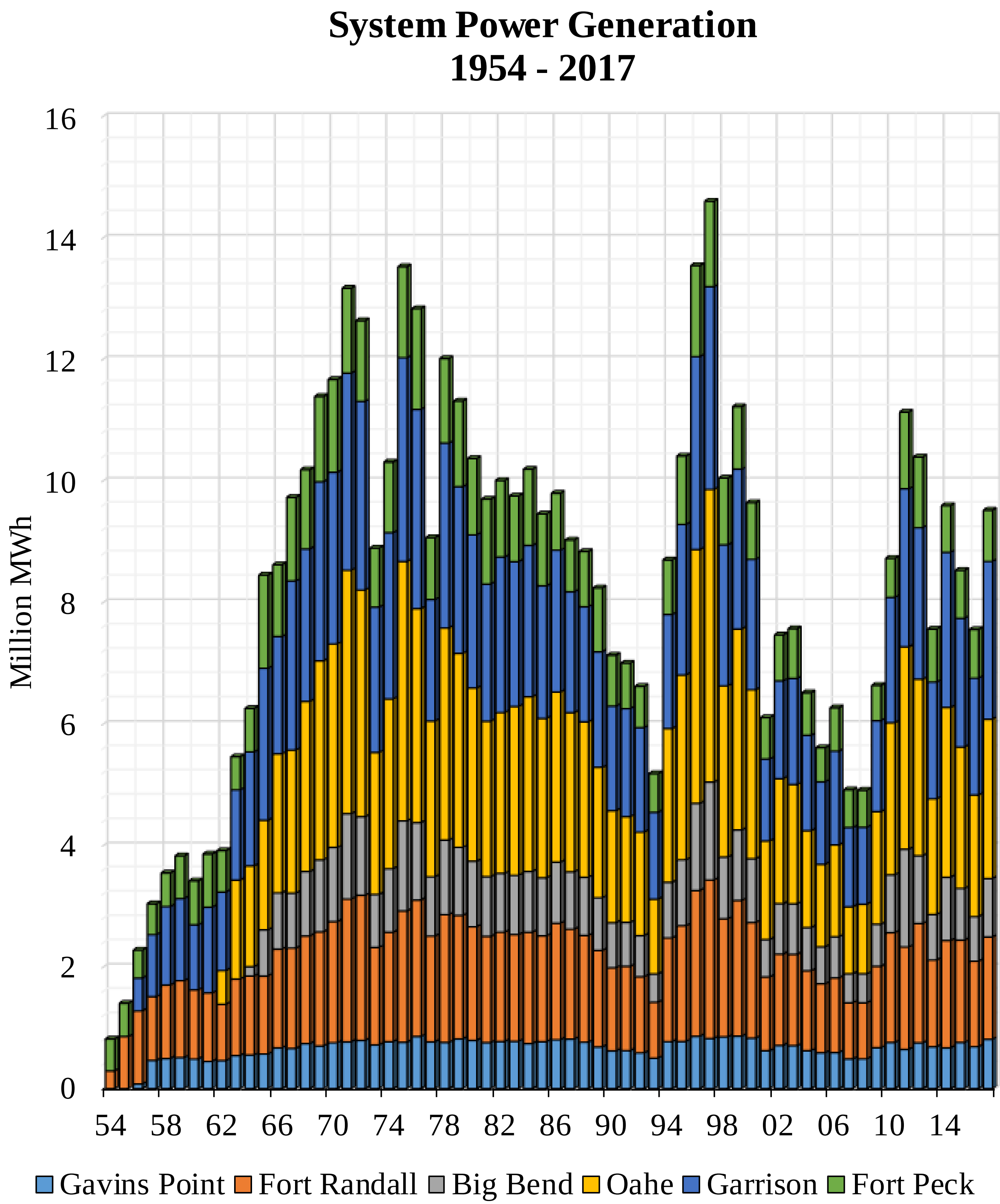


Figure 26. System power generation by project from 1954 to 2017

Table 18
Historical Generation and Load Data – Peaks
Eastern Division, Pick-Sloan Missouri Basin Program*
Data at Plant (1000 kW)
January 1, 2017 through December 31, 2017

Period	Corps of Engineers Hourly Generation (Gross)**	(plus)	USBR Hourly Generation (Gross)**	(equals)	Federal Hour Generation (Gross)**	(plus)	Interchange and Purchases Received**	(equals)	Peak Total System Load	Peak Date	Peak Hour
January	1,243		79		1,322		358		1,680	Jan 13	900
February	1,141		86		1,227		587		1,814	Feb 09	900
March	780		76		856		757		1,613	Mar 02	800
April	1,266		110		1,376		73		1,449	Apr 11	800
May	1,413		124		1,537		0		1,537	May 02	1700
June	1,771		125		1,896		0		1,896	Jun 28	1800
July	1,919		112		2,031		0		2,031	Jul 11	1700
August	2,057		110		2,167		0		2,167	Aug 02	1700
September	1,685		84		1,769		0		1,769	Sep 12	1700
October	1,135		115		1,250		0		1,250	Oct 24	1100
November	1,411		110		1,521		141		1,662	Nov 09	900
December	1,386		111		1,497		289		1,786	Dec 27	1800

* This tabulation summarizes the total gross generation and power operations for the Eastern Division marketing area system shown on Table 17.
** During hour of peak total system load.

Table 19
Historical Generation and Load Data – Total
Eastern Division, Pick-Sloan Missouri Basin Program*
Data at Plant (1000 kWh)
January 1, 2017 through December 31, 2017

Period	Corps of Engineers Generation (Gross)	(plus)	USBR Generation (Gross)	(equals)	Federal Generation (Gross)	(plus)	Scheduled Interchange and Purchases Received	(equals)	Total System Load
January	594,001		38,198		632,199		273,824		906,023
February	461,713		41,323		503,036		358,448		861,484
March	581,633		66,848		648,481		196,697		845,178
April	818,990		75,361		894,351		25,646		919,997
May	897,619		86,168		983,787		-10,759		973,028
June	1,053,326		83,894		1,137,220		1,120		1,138,340
July	1,117,827		40,237		1,158,064		2,924		1,160,988
August	1,061,357		69,544		1,130,901		951		1,131,852
September	854,927		60,138		915,065		11,302		926,367
October	682,433		77,919		760,352		41,277		801,629
November	703,120		69,927		773,047		58,278		831,325
December	690,380		68,222		758,602		130,466		889,068

*Powerplants from Table 17.

7. Recreation

The System reservoirs provide outstanding opportunities for boating, fishing, swimming, camping and other outdoor recreation pursuits. Tourism related to the reservoirs is a major economic factor in all of the states adjoining the System. However, when the reservoirs are drawn down due to extended drought periods, as they were in some recent years, recreation may be adversely affected primarily due to access issues. Most of the recreational impacts of a drought are experienced at the upper three large reservoirs – Fort Peck, Garrison and Oahe. Due to the manner in which they are regulated, the lower three reservoirs are not significantly impacted by drought. Reservoir levels were at near normal levels through the 2017 recreation season and no accessibility problems were reported at mainstem projects' boat ramps.

Access areas at the upper three reservoirs include Corps-owned as well as Tribal, state and privately-owned facilities. In 2002, many of the Federal recreation areas and boat ramps in South Dakota were turned over in fee title to the State of South Dakota and the Bureau of Indian Affairs through the Title VI process. Since the land transfer, both the Federal treasury and the Corps have provided money to the South Dakota Game Fish and Parks, Cheyenne River Sioux Tribe and Lower Brule Sioux Tribe for operations and stewardship of the Title VI lands they received. Congress is also capitalizing a trust fund to cover these costs in the future.

The methodology used for the Corps to determine visitation hours was revised during 2013. No visitation data is available for 2013. Visitation data for 2014-17 is presented in Table 20. The new methodology represents the number of unique individual visits for a specific activity or purpose that people used the reservoir and surrounding lands in any capacity. For example, a group of four people camping for the weekend counts as four visits. Four people pheasant hunting together counts as four visits per day. There are different weights and load factors assigned to different site types. The methodology also add in a certain ratio of dispersed use for areas that the Corps has no feasible way to monitor or meter.

Table 20
Visitation at System Reservoirs (Visits)

Project	2014	2015	2016	2017*
Fort Peck	548,073	407,783	544,689	429,051
Garrison	1,351,900	1,488,471	1,590,185	1,747,553
Oahe	1,934,347	2,361,246	2,411,398	1,859,654
Big Bend	931,574	1,268,595	1,062,289	924,994
Fort Randall	896,671	896,847	836,647	800,651
Gavins Point	2,175,314	2,369,151	1,955,423	1,994,459
System Total	**7,837,879**	**8,792,093**	**8,400,631**	**7,756,362**

*Preliminary estimates.

8. Fish and Wildlife

a. Fish Management

Rainbow smelt are the primary forage species in both Garrison and Oahe reservoirs. Successful rainbow smelt reproduction is dependent on many factors including stable reservoir levels during the smelt spawning period, generally in April and early May. Most eggs are laid in water less than a foot deep and are subject to desiccation through wave action and slight drops in water level.

The near-average and above-average runoff in April and May, respectively, resulted in steady-to-rising pools in the Fort Peck, Garrison, and Oahe reservoirs throughout the spring and early summer.

b. Threatened and Endangered Species (T&E)

(1) Pallid Sturgeon

This was the 13th year of operating for the endangered pallid sturgeon (pallid sturgeon) per the revised Master Manual. The bimodal spring pulse from Gavins Point was not conducted in 2017, as detailed in section II.C.6.d. of this report.

(2) Piping Plovers and Least Terns

Since 1986 the System has been regulated for the piping plover (plover, threatened) and least tern (tern, endangered), when they were federally listed as T&E species. The terns and plovers nest on sparsely vegetated sandbars, islands and shoreline of the Missouri River and the reservoirs. Real-time telemetered streamgaging stations have been installed along the Missouri River to monitor river stages and flows during the nesting season. These gages provide a check, as well as a stage history, throughout the season to help relate the effects of regulation and natural events at intervals along the river. The gage data must be supplemented with observations of nesting activities and conditions to provide the information that is needed for regulation of the reservoirs. A dynamic flow routing model has been developed to predict river stages along the river reaches downstream from the Fort Peck, Garrison, Fort Randall, and Gavins Point dams for different combinations of daily and hourly power peaking. However, only the reach downstream of Garrison dam has been updated with post-2011 Flood cross-sectional data.

Beginning in 1999, Omaha District created a computerized T&E species Data Management System (DMS). Report data, which is updated daily, includes nest records, census and productivity data, site descriptions, field journals and field observations. This database is a valuable tool in aiding regulation decisions benefiting the terns and plovers in years when the reservoirs are regulated to protect nesting terns and plovers.

Although the Corps prevented inundation of nests where possible and created habitat following the listing, fledging ratios continued to be lower than predicted by the USFWS 1990

Biological Opinion until 1998, when fledge ratios exceeded the goal for both species. Predation, habitat degradation, severe weather, nest inundation, record runoff and other factors contributed to the low fledging rates. The record fledging that occurred for both species between 1998 and 2005 is primarily attributed to the large amount of habitat created by the high runoff years of 1995, 1996 and 1997 and the declining reservoir levels during the 2000-07 drought. The creation of additional habitat has also allowed greater flexibility in the release levels at Fort Randall and Gavins Point, the lower two System projects.

The above-average 2017 runoff resulted in rising reservoirs during the nesting season. The rising reservoir levels limited habitat and affected nest success. Known and presumed predation throughout the system was the most common cause of nest failure in 2017. A detailed description of the factors affecting tern and plover nesting, fledge ratios and habitat conditions and creation activities by reservoir and river reach can be found in the Missouri River Recovery Program Annual Adaptive Management Report for 2017 (*www.moriverrecovery.org*).

The population distribution and productivity for terns and plovers for 2000 through 2017 are shown in ***Table 21*** and ***Table 22***, respectively. Data for the period 1986 – 1999 can be found in earlier ***Summary of Actual Regulation Reports***. Productivity estimates for these birds on the Missouri River do not include terns and plovers raised in captivity from 1995 to 2002. Adult bird totals listed in ***Table 21*** and ***Table 22*** are considered breeders even though they may not have had nesting success. The term "fledglings/pair" refers to the number of young birds produced per breeding pair. The fledge ratio is an estimate, as the fate of every single fledgling is impossible to ascertain. Numbers for 2013 were not comparable to the numbers in this table because of the change in survey methodology. However, the estimates can be found in the MRRP 2013 Annual Report.

Table 21
Missouri River System - Interior Least Tern Survey Data

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013***	2014	2015	2016	2017
Fort Peck Lake																		
Adults	0	0	0	2	0	0	2	2	0	0	0	0	0		0	0	0	0
Fledglings/Pair	0	0	0	0	0	0	3	0	0	0	0	0			0	0	0	0
Fort Peck to Lake Sakakawea																		
Adults	13	39	34	38	48	34	36	77	22	46	26	0	0		8	12	10	11
Fledglings/Pair	0.15	0.97	0.59	0.63	0.50	2.18	1.17	1.38	1.45	0.87	1.00	0.00	0.00		0.00	0.00	0	0.00
Lake Sakakawea																		
Adults	10	34	21	25	16	26	48	53	14	15	11	3	14		19	18	52	23
Fledglings/Pair	0.20	0.76	0.86	0.56	0.88	0.31	0.71	0.72	2.57	1.07	0.00	0.00	0.29		0.11	0.89	0.38	0.17
Garrison to Lake Oahe																		
Adults	105	125	126	144	142	157	139	123	73	108	134	0	105		131	157	213	197
Fledglings/Pair	1.03	1.26	1.83	1.28	1.13	0.73	0.81	1.06	1.34	0.48	1.36	0.00	0.99		0.55	1.06	0.24	1.22
Lake Oahe/Lake Sharpe																		
Adults	85	94	106	70	73	131	128	186	111	71	48	39	100		89	93	87	101
Fledglings/Pair	1.01	1.34	1.32	1.20	1.26	0.87	1.14	0.48	0.58	0.96	0.17	1.33	1.06		0.29	0.49	0.25	0.51
Fort Randall to Niobrara																		
Adults	72	71	84	50	71	76	55	74	58	23	10	0	87		99	155	138	145
Fledglings/Pair	1.26	0.14	0.71	0.92	0.37	0.47	0.69	0.30	1.14	0.43	0.00	0.00	1.10		0.73	1.63	1.41	1.05
Lake Lewis and Clark																		
Adults	44	58	46	46	13	4	0	85	225	214	272	231	211		131	164	145	142
Fledglings/Pair	0.38	1.17	1.04	0.39	0.00	0.00	0.00	1.58	0.67	0.76	1.01	0.15	1.43		0.52	1.46	0.98	0.56
Gavins Point to Ponca																		
Adults	149	232	314	366	359	476	383	410	278	211	159	0	209		243	318	416	422
Fledglings/Pair	1.72	1.09	1.32	0.75	1.04	1.34	0.63	0.59	1.14	1.00	1.17	0	1.2		0.79	1.46	0.98	0.85
Total Adults	551	653	731	741	722	904	802**	1,010	781	696	650	273	726		720	917	1061	1041
Fledglings/Pair	1.22	1.04	1.27	0.87	0.95	1.09	0.80**	0.75	0.98	0.80	1.02	0.32	1.19		0.6	1.31	0.8	0.86

- Data not collected
* Partial Survey Results
{} No Birds Found
+ Subsampling of Selected Nesting Areas
** Includes adults and fledglings from Lake Francis Case
*** 2013 data is not added due to survey methodology change. See 2013 MRRP Annual Report for additional information.

Notes: The data do not include least terns and piping plovers raised in captivity from 1995 to 2002. The data represent only wild fledged birds.
From 1990 to 2003 the 10-Year Least Tern Fledge Ratio was 0.70 (1990 and 2000 Biological Opinions).
From 2004 to current 5-year running average goal is 0.94 (2003 Amended Biological Opinion)
Data in this table may differ from previous reports. As information becomes available, this table is updated.
Refer to previous MRBWM Summary Reports for 1986-1999 data.

Table 22
Missouri River System - Piping Plover Survey Data

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013**	2014	2015	2016	2017
Fort Peck Lake																			
	Adults	0	4	2	17	9	26	20	16	9	12	3	2	0		0	4	2	0
	Fledglings/Pair	0	1	2	0.35	2.22	1.08	1.2	0.5	0.22	0.33	0	0	0		0	0	0	0
Fort Peck to Lake Sakakawea																			
	Adults	4	3	2	6	0	2	5	0	0	0	0	0	0		0	0	0	0
	Fledglings/Pair	0	1.33	0	2.67	0	4	0.4	0	0	0	0	0	0		0	0	0	0
Lake Sakakawea																			
	Adults	277	424	469	528	738	746	430	399	363	85	38	24	200		155	252	400	156
	Fledglings/Pair	1.61	1.25	1.65	1.06	1.5	0.89	0.61	0.7	0.68	0.21	0.89	1.67	1.4		0.48	0.73	1	0.31
Garrison to Lake Oahe																			
	Adults	99	149	119	149	164	220	175	222	218	275	287	0	98		221	392	336	266
	Fledglings/Pair	1.41	1.53	2.03	1.66	1.16	0.8	0.77	0.97	1.37	0.94	0.84	0	1		2.05	1.26	0.36	1.3
Lake Oahe/Lake Sharpe																			
	Adults	141	184	203	301	372	364	331	273	281	158	44	20	125		210	251	227	211
	Fledglings/Pair	1.45	1.41	2.16	1.84	1.41	1.21	0.99	0.62	0.9	0.47	0.1	0.4	1.76		0.45	0.49	0.56	0.63
Fort Randall to Niobrara																			
	Adults	62	38	35	37	42	42	37	21	26	16	6	0	43		106	145	173	170
	Fledglings/Pair	0.87	0.74	1.03	1.46	0.71	0.81	0.38	0	1	1	0	0	1.81		1.08	2.34	1.69	1.29
Lake Lewis and Clark																			
	Adults	28	34	44	14	0	24	4	20	57	122	152	134	179		186	188	124	194
	Fledglings/Pair	0.5	0.71	1.68	1.57	0	0.17	0.5	1.8	1.37	1.8	1.25	0.22	1.35		0.57	1.37	1.05	1.23
Gavins Point to Ponca																			
	Adults	186	218	260	286	262	340	309	300	320	238	74	2	137		238	380	570	532
	Fledglings/Pair	2.17	1.85	2.29	1.9	1.87	1.97	0.78	0.39	1.39	1.09	1.86	0	1.82		1.73	2.23	1.69	0.95
Total Adults		797	1054	1134	1338	1587	1764	1311	1251	1274	906	604	182	782		1116	1612	1832	1529
Fledglings/Pair		1.58	1.41	1.91	1.5	1.49	1.15	0.78	0.66	1.06	0.94	1.01	0.43	1.49		1.12	1.4	1.12	0.98

- Data not collected
* Partial Survey Results
{} No Birds Found
+ Subsampling of Selected Nesting Areas
** 2013 data is not added due to survey methodology change. See 2013 MRRP Annual Report for additional information.

Notes: The data do not include least terns and piping plovers raised in captivity from 1995 to 2002. The data represent only wild fledged birds.
From 1990 to 2000 the 15-Year Piping Plover Fledge Ratio Goal was 1.44 (1990 Biological Opinion).
From 2001 to 2003 the goal was 1.13 (2000 Biological Opinion)
From 2004 to current the 10-year running average goal is 1.22 (2003 Amended Biological Opinion)
Data in this table may differ from previous reports. As information becomes available, this table is updated.
Refer to previous MRBWM Summary Reports for 1986-1999 data.

9. Cultural Resources

As acknowledged in the 2004 Programmatic Agreement (PA) for the Operation and Management of the Missouri River Main Stem System, wave action and the fluctuation of reservoirs levels results in erosion along the banks of the reservoirs. Shoreline erosion can have severe effects on cultural resources. During drought conditions, cultural resource sites are exposed as the pool levels decline.

The PA established a shared stewardship philosophy of protection of historic properties. The objective of a PA is to address "…potential adverse effects of complex projects or multiple undertakings…" and to collaboratively develop a preservation program that would avoid, minimize and mitigate the effects of the System regulation. All Tribes, whether signatory to the PA or not, may request government-to-government consultation on System regulation and the resulting effect on historic and cultural properties and other resources.

A Cultural Resource Program Five Year Plan was developed in consultation with Tribes, States, Agencies and interested parties. This plan outlines how the Corps will accomplish its responsibilities under the National Historic Preservation Act and the PA. The plan includes inventory, testing and evaluation, mitigation and other specific activities that will allow the Corps to avoid, minimize and mitigate the adverse effects to cultural sites on the Corps' lands within the System. The "Final Five Year Plan", dated February 2012 (see website http://www.nwo.usace.army.mil/Missions/CivilWorks/CulturalResources.aspx) is currently being implemented.

One consultation meeting on the PA was held during the 2017 reporting period. The purpose of consultation meetings is to engage in communications and discuss whether operational changes are likely to affect historic and cultural properties, identify those properties and discuss how to address those affects.

A letter, dated September 14, 2017, was sent to the Missouri River Basin Tribes offering consultation on the 2017-2018 AOP. To date, no Tribes have requested consultation nor provided verbal or written comments on the AOP. The Corps has semi-annual public meetings where basin stakeholders provide input on the upcoming year's reservoir operations. Four Tribes were recorded participating in the fall AOP public meetings in October 2017.

The Corps actively addresses shoreline erosion which can damage or significantly alter cultural resource sites. During 2017, two Omaha District cultural resource protection projects were planned. The one located at Gavins Point was completed. The planned project at Garrison was not completed in 2017 due to high water and it is now planned for completion in 2018, reservoir conditions permitting. There are also two projects planned at Big Bend during 2018.

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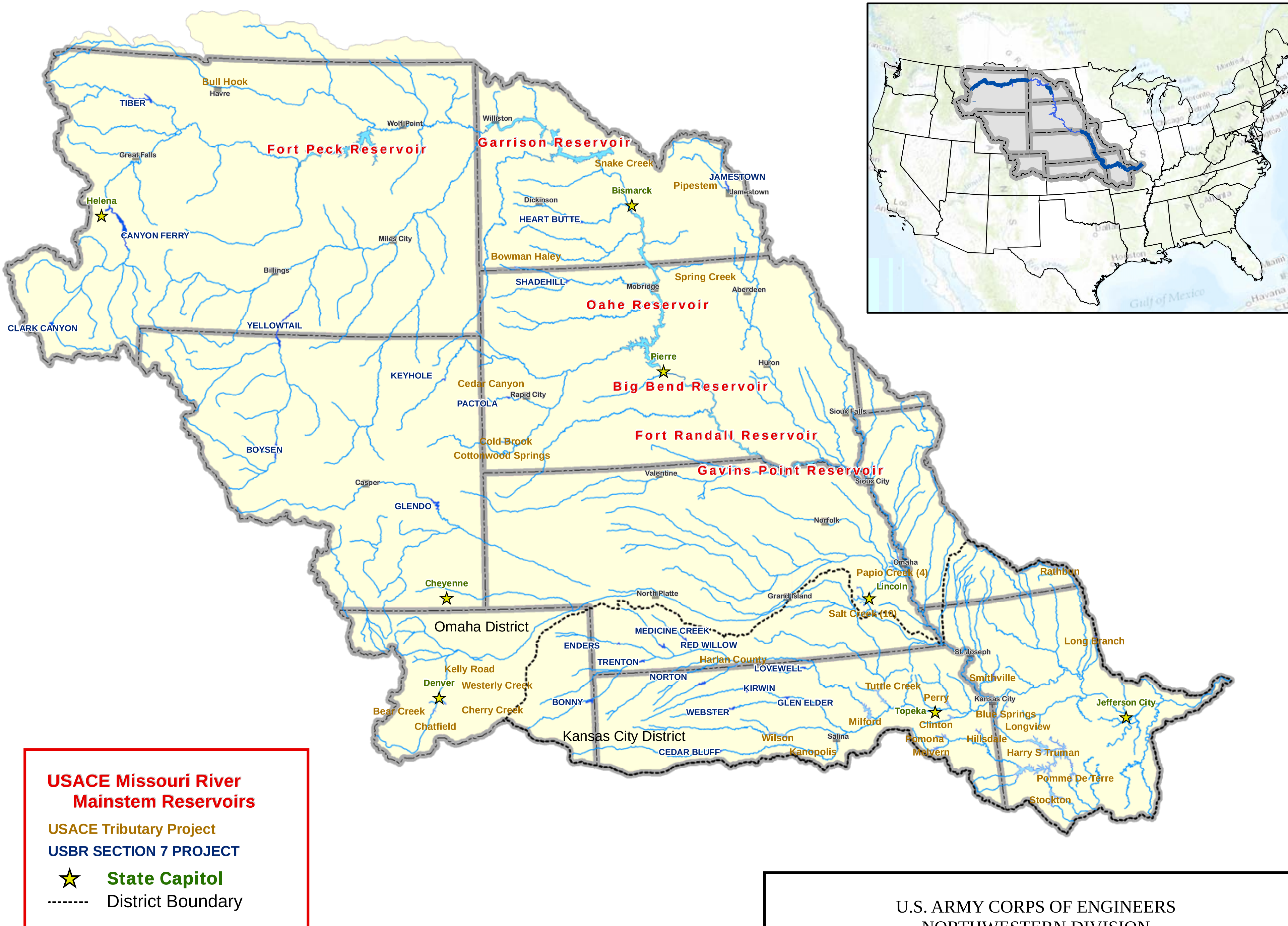

U.S. ARMY CORPS OF ENGINEERS
NORTHWESTERN DIVISION
MISSOURI RIVER BASIN WATER MANAGEMENT DIVISION

PLATE 1. Missouri River Basin Map.

Item No.	Subject	Fort Peck Dam - Fort Peck Lake	Garrison Dam - Lake Sakakawea	Oahe Dam - Lake Oahe
	Summary of Engineering Data -- Missouri River Mainstem System			
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
	Dam and Embankment			
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
	Spillway Data			
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
	Reservoir Data (6)			
26	Max. operating pool elev. & area	2250 msl 245,000 acres	1854 msl 383,000 acres	1620 msl 386,000 acres
27	Max. normal op. pool elev. & area	2246 msl 240,000 acres	1850 msl 365,000 acres	1617 msl 362,000 acres
28	Base flood control elev & area	2234 msl 211,000 acres	1837.5 msl 308,000 acres	1607.5 msl 311,000 acres
29	Min. operating pool elev. & area	2160 msl 89,000 acres	1775 msl 125,000 acres	1540 msl 115,000 acres
	Storage allocation & capacity			
30	Exclusive flood control	2250-2246 971,000 a.f.	1854-1850 1,495,000 a.f.	1620-1617 1,107,000 a.f.
31	Flood control & multiple use	2246-2234 2,704,000 a.f.	1850-1837.5 4,211,000 a.f.	1617-1607.5 3,208,000 a.f.
32	Carryover multiple use	2234-2160 10,700,000 a.f.	1837.5-1775 12,951,000 a.f.	1607.5-1540 13,353,000 a.f.
33	Permanent	2160-2030 4,088,000 a.f.	1775-1673 4,794,000 a.f.	1540-1415 5,315,000 a.f.
34	Gross	2250-2030 18,463,000 a.f.	1854-1673 23,451,000 a.f.	1620-1415 22,983,000 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	17,200 a.f./year 1073 yrs.	21,600 a.f./year 1,086 yrs.	14,800 a.f./year 1553 yrs.
	Outlet Works Data			
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	1669-1677 15,000- 60,000 cfs	1422-1427 20,000-55,000 cfs
	Power Facilities and Data			
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 - 121,600, 2 - 109,250	112,290
52	Plant capacity in kW	185,250	583,300	786,030
53	Dependable capacity in kW (9)	181,000	388,000	534,000
54	Avg. annual energy, million kWh (12)	1,035	2,248	2,610
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.
21 miles upstream Chamberlain, SD	Near Lake Andes, SD	Near Yankton, SD		1
Mile 987.4	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 62,000 acres	1375 msl 102,000 acres	1210 msl 29,000 acres	1,206,000 acres	26
1422 msl 60,000 acres	1365 msl 94,000 acres	1208 msl 25,000 acres	1,146,000 acres	27
1420 msl 58,000 acres	1350 msl 76,000 acres	1204.5 msl 21,000 acres	984,000 acres	28
1415 msl 51,000 acres	1320 msl 36,000 acres	1204.5 msl 21,000 acres	437,000 acres	29
1423-1422 61,000 a.f.	1375-1365 986,000 a.f.	1210-1208 54,000 a.f.	4,674,000 a.f.	30
1422-1420 118,000 a.f.	1365-1350 1,306,000 a.f.	1208-1204.5 79,000 a.f.	11,626,000 a.f.	31
	1350-1320 1,532,000 a.f.		38,536,000 a.f.	32
1420-1345 1,631,000 a.f.	1320-1240 1,469,000 a.f.	1204.5-1160 295,000 a.f.	17,592,000 a.f.	33
1423-1345 1,810,000 a.f.	1375-1240 5,293,000 a.f.	1210-1160 428,000 a.f.	72,428,000 a.f.	34
November 1963	January 1953	August 1955		35
25 March 1964	24 November 1953	22 December 1955		36
3,445 a.f./year 525 yrs.	15,800 a.f./year 334 yrs.	2,700 a.f./year 159 yrs.	77,400	37
	Left Bank			38
None (7)	4 - 22' diameter	None (7)		39
	1013			40
	2 - 11' x 23' per conduit, vertical lift, cable suspension			41
1385 (11)	1229	1180 (11)		42
	Elev 1375 32,000 cfs - 128,000 cfs			43
1351-1355(10) 25,000-100,000 cfs	1228-1237 10,000-60,000 cfs	1153-1161 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
67,275 (15)	40,000	44,100		51
517,470	320,000	132,300	2,501,200 kw	52
497,000	293,000	74,000	1,967,000 kw	53
975	1,720	724	9,336 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

Remarks

(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) 1967-2016 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
(15) 67,275 kW on per unit basis 64,684 kW on facility basis

Corps of Engineers, U.S. Army
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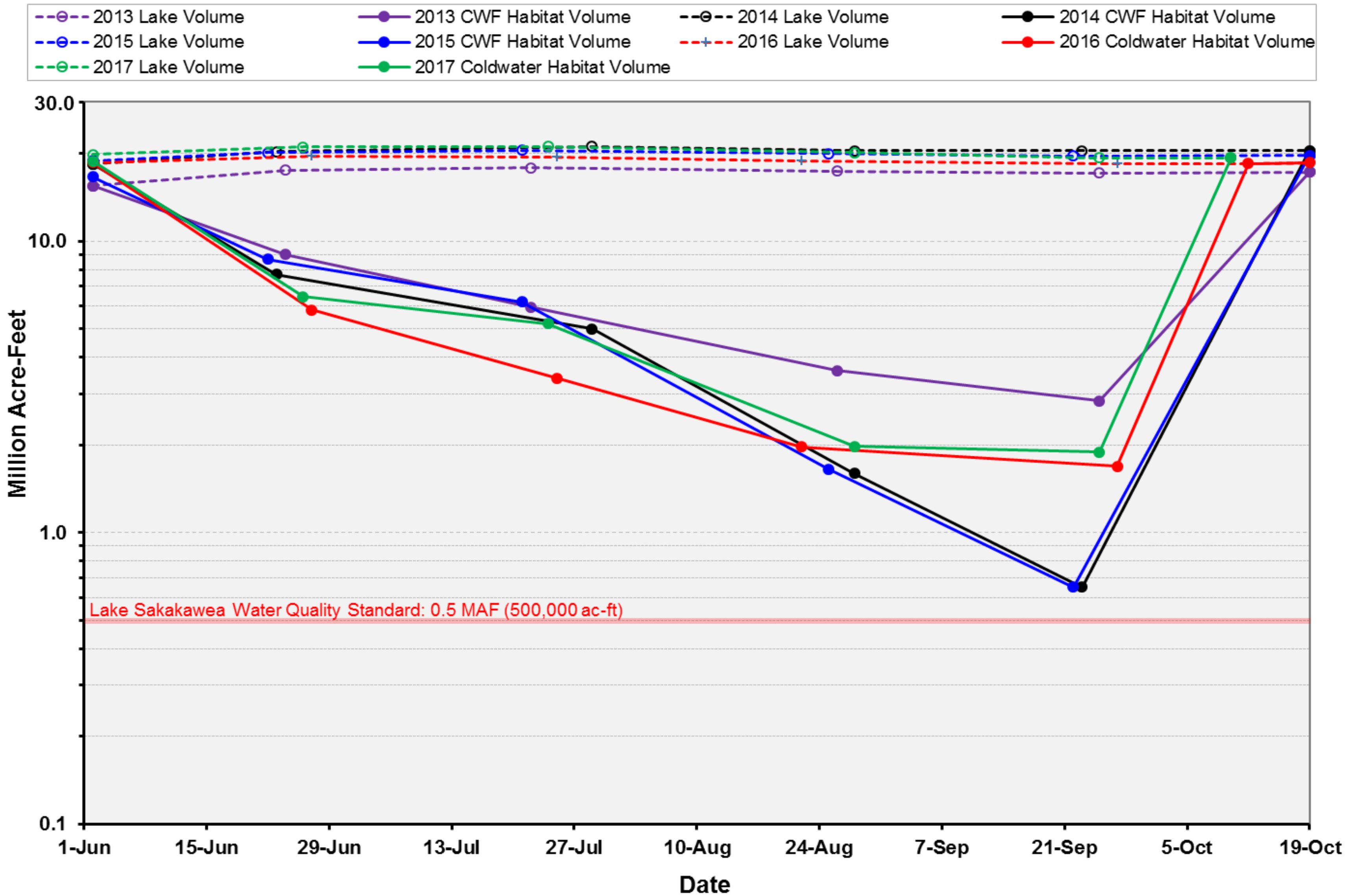

Plate 3. Garrison Reservoir - estimated reservoir and coldwater fishery (CWF) habitat 2013 through 2017.

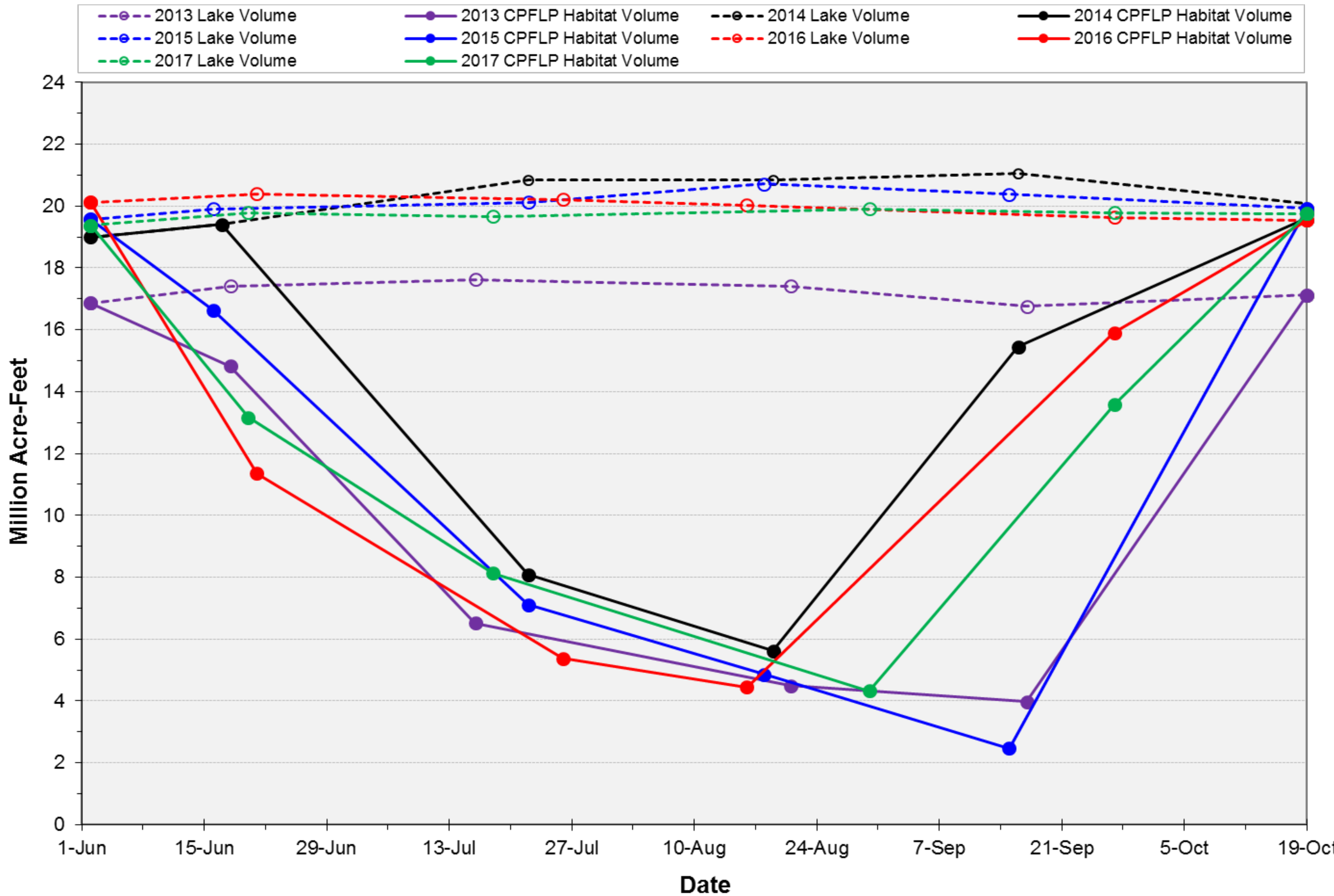

Plate 4. Oahe Reservoir - estimated reservoir and coldwater fishery (CWF) habitat 2013 through 2017.