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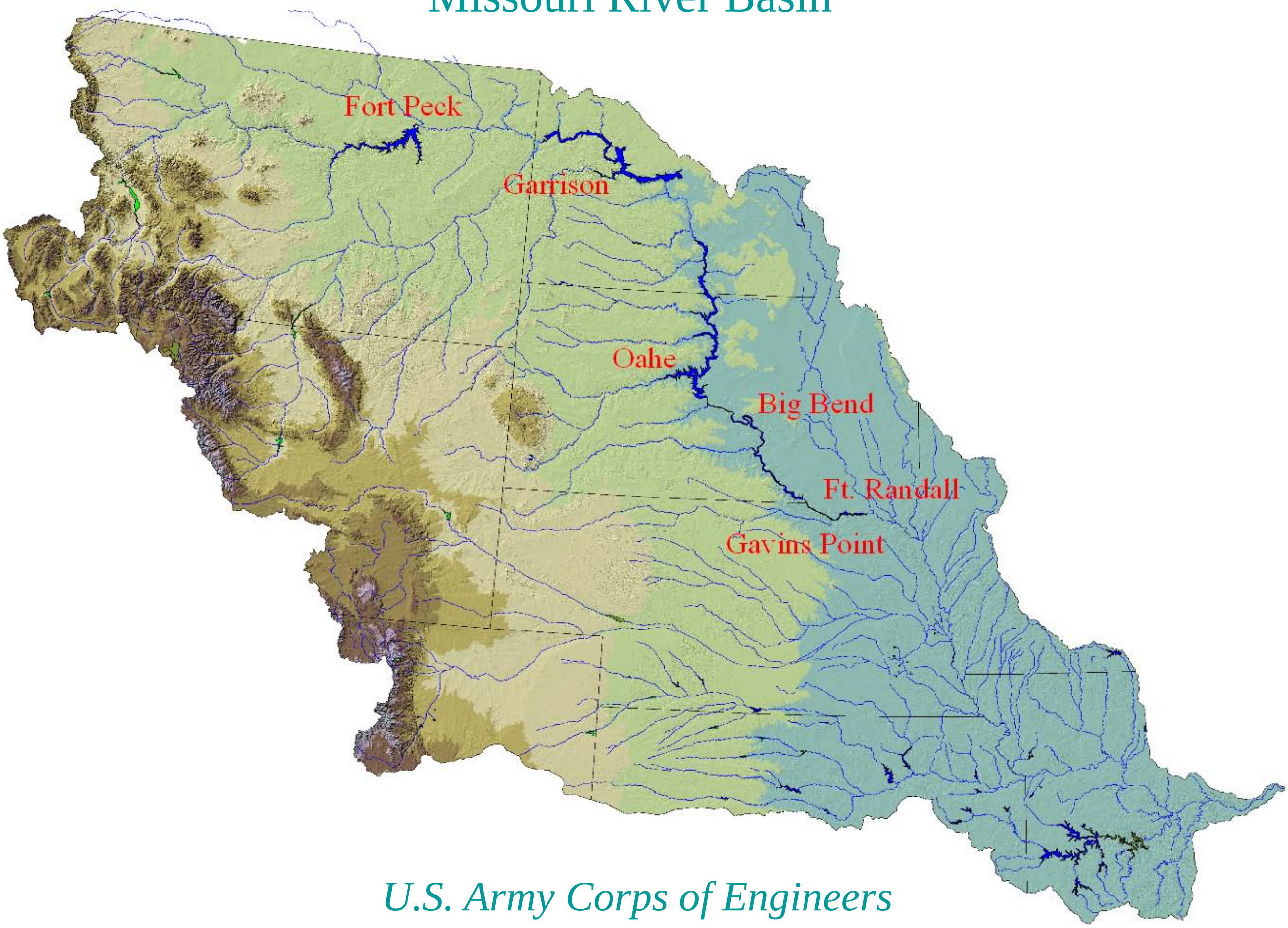
Northwestern Division

Missouri River Mainstem Reservoir System

Summary of Actual 2009 Regulation

Missouri River Basin



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

September 2010

MISSOURI RIVER MAINSTEM RESERVOIRS

Summary of Actual 2009 Regulation

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LIST OF ABBREVIATIONS AND ACRONYMS

ACHP	Advisory Council on Historic Preservation
AOP	annual operating plan
AF	acre-feet
B	Billion
BOR	U.S. Bureau of Reclamation
cfs	cubic feet per second
COE	Corps of Engineers
Council	National Council Lewis and Clark Expedition Bicentennial
CWA	Clean Water Act
CY	calendar year (January 1 to December 31)
EA	Environmental Assessment
EIS	Environmental Impact Statement
elev	elevation
ESA	Endangered Species Act of 1973
ft	feet
ft msl	feet above mean sea level
FY	fiscal year (October 1 to September 30)
GIS	Geographic Information System
GWh	gigawatt hour
KAF	1,000 acre-feet
Kcfs	1,000 cubic feet per second
kW	kilowatt
kWh	kilowatt hour
M	million
MAF	million acre-feet
MRBA	Missouri River Basin Association
MRNRC	Missouri River Natural Resources Committee
MRBWM	Missouri River Basin Water Management
msl	mean sea level
MV	motor vessel
MW	megawatt
MWh	megawatt hour
M&I	municipal and industrial
NEPA	National Environmental Policy Act
OPPD	Omaha Public Power District
PA	2004 Programmatic Agreement
plover	piping plover
pp	powerplant
P-S MBP	Pick-Sloan Missouri Basin Program
RM	river mile
ROD	record of decision
Service	U.S. Fish and Wildlife Service

SHPO	State Historic Preservation Officer
SRST	Standing Rock Sioux Tribe
SR-FTT	Steady Release – Flow-to-Target
SWE	snow water equivalent
System	Missouri River Mainstem Reservoir System
tern	interior least tern
THPO	Tribal Historic Preservation Officer
TMDL	Total Maximum Daily Load
TRO	temporary restraining order
tw	tailwater
USBR	U.S. Bureau of Reclamation
USGS	United States Geological Survey
VERS	Visitation Estimation Reporting System
WCSC	Waterborne Commerce Statistics Center
Western	Western Area Power Administration
yr	year

DEFINITION OF TERMS

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

Cubic foot per second (cfs) is the rate of discharge representing a volume of 1 cubic foot passing a given point during 1 second and is equivalent to approximately 7.48 gallons per second or 448.8 gallons per minute. The volume of water represented by a flow of 1 cubic foot per second for 24 hours is equivalent to 86,400 cubic feet, approximately 1.983 acre-feet, or 646,272 gallons. 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 2009 Regulation

I. FOREWORD

This document contains a summary of the actual regulation of the Missouri River Mainstem Reservoir System (System) for the 2009 Calendar Year (CY). Two other reports related to System regulation are also available, the "System Description and Regulation", and "Final 2008-2009 Annual Operating Plan". All three reports can be obtained by contacting the Missouri River Basin Water Management Division (MRBWM) of the U.S. Army Corps of Engineers' Northwestern Division 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 basin map is presented on ***Plate 1*** and the pertinent data for the System is shown on ***Plate 2*.**

II. REVIEW OF REGULATION – JANUARY-DECEMBER 2009

A. General

During 2009 the System was regulated in accordance with the Master Water Control Manual (Master Manual) and the applicable provisions of the Final 2008-2009 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. A summary of the significant events during 2009 is given in the following paragraphs.

B. Precipitation and Water Supply Available in 2009

The 2009 runoff year marked the second year of above average runoff conditions following the drought of 2000-2007 in the Missouri River basin. Runoff during the 2009 runoff year was 33.7 MAF, 136% of normal. Runoff is discussed in more detail in Section II.B.4 of this report.

1. Plains Snowpack

Plains snowpack during October and November included some moderate to heavy accumulations. Montana and North Dakota received significant snowfall from a storm that occurred October 11-12, 2008 with recorded depths ranging from 6-9 inches, the equivalent of 1-2 inches of snow water equivalent (SWE). This resulted in a significant band of snow extending across the Yellowstone River basin into western North Dakota, which melted by the end of October 2008. November 2008 was generally drier than average with above normal temperatures throughout the Northern Plains. A significant winter storm occurred over western South Dakota and North Dakota November 6–7, 2008 resulting in 1-2 inches of SWE, which remained through the end of November.

In December 2008, a series of small-scale winter storms produced abundant snow across the Northern Plains. The most notable winter storm December 13–14 dropped 10-11 inches of snow over Glasgow, MT and Williston, ND, and over 12 inches of snow over Bismarck, ND. Bismarck recorded snowfall 18 days in December while Great Falls, MT recorded snowfall 17 days. Monthly snowfall totals were 30.5 inches in Great Falls, 32.0 inches in Williston, and 33.3 inches in Bismarck. The December 31, 2008, NOAA's National Operational Hydrologic Remote Sensing Center (NOHRSC) estimated 1.6 and 1.9 inches of SWE at Glasgow and Bismarck, respectively, and 3.0-4.5 inches of SWE in the upper James River basin on December 31, 2008. The December 31, 2008 Plains SWE is depicted in ***Figure 1***.

The active winter weather pattern continued into the first 15 days of January 2009 producing 12.3 inches of snow in Great Falls, MT; 16 inches of snow in Bismarck, ND; and 8-10 inches of snow across South Dakota. In February 2009 significant winter snow storms produced 8-18 inches of snow in western North Dakota, and 8-10 inches in northeast Montana, eastern North Dakota and northern South Dakota. Precipitation as SWE in South Dakota was 1-3 inches. At the end of February, light snow covered most of the Missouri River basin above Kansas City, MO. In North Dakota, SWE ranged from 3-4 inches, with the greatest accumulations in excess of 5 inches across central North Dakota including the Pipestem Creek and James River basins.

March 2009 brought heavy snow and some rain to most areas of the Northern Plains, in particular western South Dakota and North Dakota. Following light to moderate snow accumulations during the first 20 days of March, the Northern Plains experienced a significant warm up March 20–23, which caused rapid melting of some plains snow cover and some river ice breakup. This was followed by fairly significant rainfall that turned into snow March 23-24. Bismarck, ND received 0.75 inches of rain followed by 8.1 inches of snow (0.78 inches of SWE), while Jamestown, ND received 1.44 inches of total precipitation. Rapid City, SD received 11.5 inches of snow and a total liquid equivalent of 1.61 inches. A second significant snow storm occurred March 29-31 from western Montana through South Dakota resulting in new snowfall accumulations ranging from 4-18 inches (0.25 to 1.0 inch of SWE). Bismarck received 17.1 inches of snow contributing to a monthly snowfall total of 29.7 inches, which was the second snowiest March in history. Aberdeen, SD, received 12.2 inches of snow (0.72 inches of SWE) contributing to a March total of 16.0 inches, while Rapid City received 12.5 inches of snow (0.4 inches of SWE) contributing to a March total of 26.8 inches. Other locations that received significant March snowfall included Billings, MT (16.9 inches), Great Falls, MT (12.0 inches), and Pierre, SD (11.1 inches). The March 31, 2009 Plains SWE is depicted in ***Figure 2***.

Figure 1. December 31, 2008 plains snow water equivalent (inches) computed by NOAA NOHRSC.

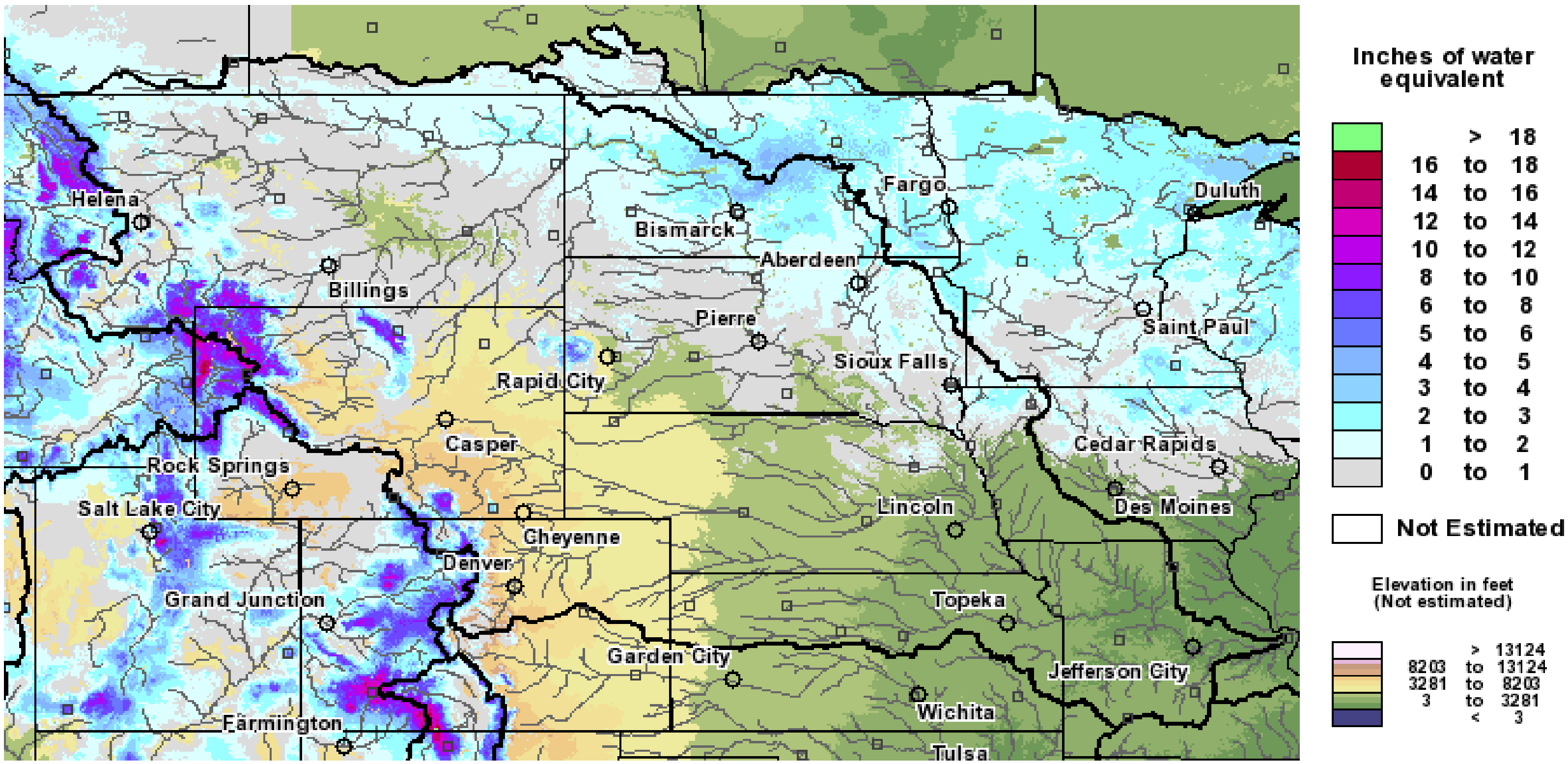
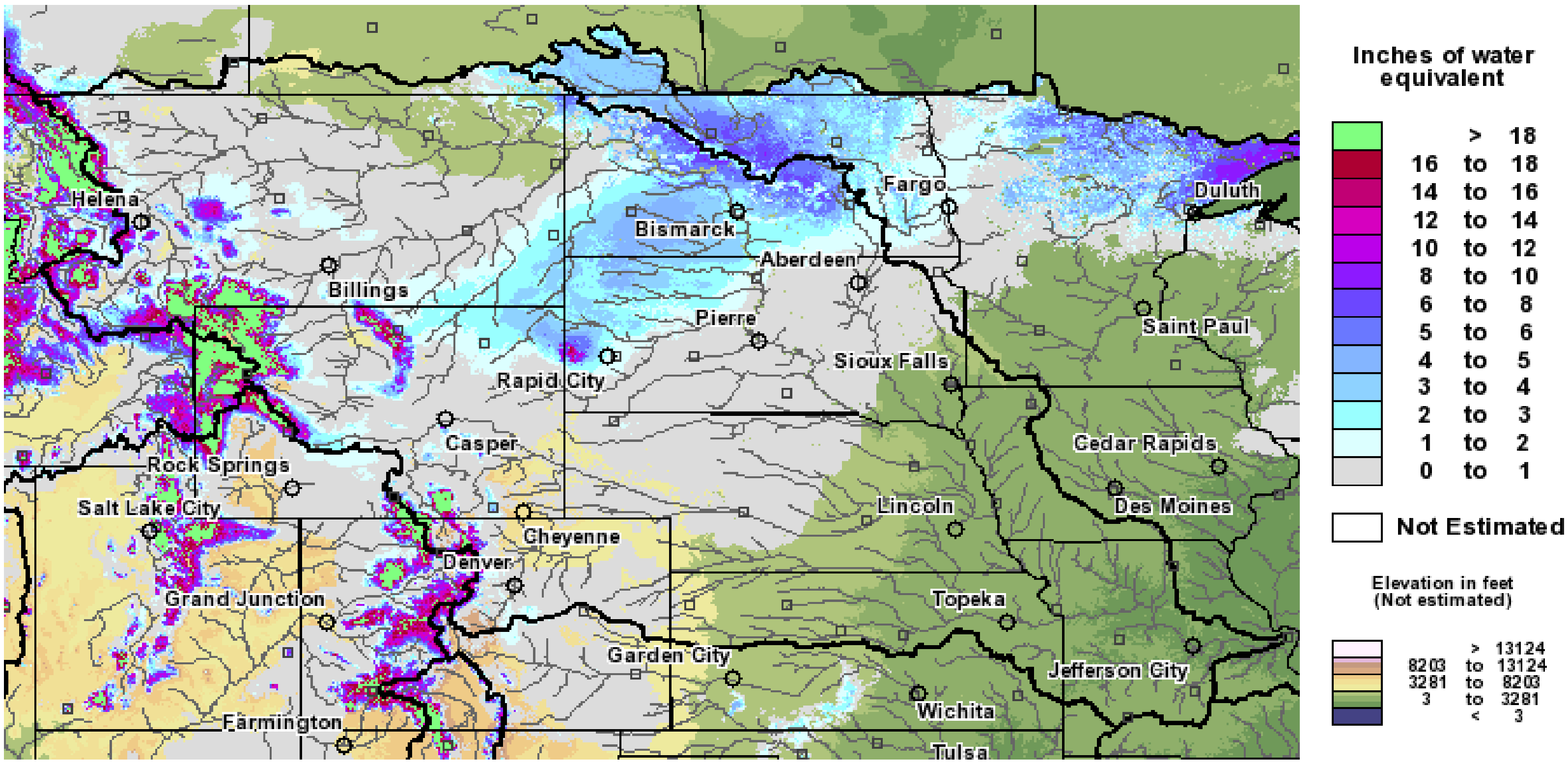


Figure 2. March 31, 2009 plains snow water equivalent (inches) computed by NOAA NOHRSC.



At the end of March, only light snow cover was present in northern Nebraska, but snow depth and SWE was much greater in South Dakota and North Dakota. In the Missouri River basin from Oahe Dam to Fort Randall Dam and the James River basin, snow representing 1.5-3.0 inches of SWE covered the plains. In western South Dakota including the Grand and Moreau River basins, SWE ranged from 2-3 inches and as much as 3-5 inches in 40 percent of this area. The northern Black Hills contained 10-15 inches of SWE. In the Knife and Heart River basins of North Dakota, SWE ranged from 3-5 inches. The heaviest SWE according to NOHRSC extended along a path from north of Williston, ND, to Jamestown, ND. Per runoff models, the verified SWE ranged from 4-6 inches with many areas possibly containing up to 8 inches of SWE.

2. Mountain Snowpack

a. Fall 2008

In Montana, the mountain snowfall season was quite variable early, but statewide mountain snowpack was below average and slightly below last year. December precipitation was 120% of normal. Mountain snow water content was 96% of average and 90% of the previous year.

In Wyoming, snow water equivalent (SWE) across the state was near average. The SWE average for the state was 97% of normal. In December, precipitation in the basins ranged from 84% of average to 137% of average.

The 2008 year ended with the mountain snowpack 96% of normal in the reach above Fort Peck and 94% of normal in the reach from Fort Peck to Garrison.

b. January 2009

In Montana, January mountain precipitation was 89% of average. Normally about 60% of the seasonal snowpack is in place by the end of January. Statewide, mountain snowpack was 93% of average and 91% of the previous year.

Generally, the SWE across Wyoming was about average for January. The SWE in the northwestern portion of the state was about 97% of normal, and the northeastern portion of the state was 142% of normal. The southeastern area was 104% of normal and the southwestern area was 105% of normal.

The month of January ended with the mountain snowpack 96% of normal in the reach above Fort Peck and 101% of normal in the reach from Fort Peck to Garrison.

c. February 2009

In Montana, February mountain precipitation was 67% of normal. Statewide snowpack was 87% of average and 81% of the previous year. Even though the overall snowpack was below normal, a couple of small basins were above average.

In Wyoming, the SWE across the state were near average for February at 96% of normal. The SWE varied from 90% of normal in the northwestern portion of the state to 120% in northeastern Wyoming. February precipitation was below average across most of Wyoming.

The month of February ended with the mountain snowpack 84% of normal in the reach above Fort Peck and 98% of normal in the reach from Fort Peck to Garrison.

d. March 2009

In Montana, mountain precipitation during March was 135% of average. Mountain snowpack statewide was 100% of average and 91% of the previous year.

During March, the mountain snowpack SWE across Wyoming was near average at 98% of normal. The SWE in the northwestern portion of the state was 97% of normal, and the northeastern portion was 111% of normal. The mountain snowpack SWE in the southeast and southwest areas were 100% and 94% of normal, respectively. March precipitation was above average across most of Wyoming.

The month of March ended with the mountain snowpack 102% of normal in the reach above Fort Peck and 102% of normal in the reach from Fort Peck to Garrison.

e. April 2009

In Montana, mountain precipitation during April was 105% of normal. Cooler temperatures delayed the commencement of mountain snowmelt. As a result, mountain snowpack in April was 110% of average and 89% of the previous year.

Generally, the SWE across Wyoming was near average for April, with water content about 103% of average. Across the state SWE was 104%, 103%, and 99% in the northeast, southeast, and southwest portions of the state, respectively. Mountain SWE was 106% in the northwest part of Wyoming. April's precipitation was above average across most of Wyoming.

The month of April ended with the mountain snowpack at 99% of normal in the reach above Fort Peck and 97% of normal in the reach from Fort Peck to Garrison. Snowpack peaked on April 17, 2009 for both the above Fort Peck and the Fort Peck to Garrison reaches. The reach above Fort Peck peaked at 106% and the Fort Peck to Garrison reach peaked at 110% of the normal April 15 peak.

f. May 2009

In Montana, May mountain precipitation was 63% of average. Unseasonably warm temperatures experienced in late May accelerated the snowmelt. Mountain snowpack ended the month 92% of normal and 62% of the previous year.

The SWE across Wyoming was below average at 61%. The SWE in the northwestern portion of the state was 71% of normal and the northeastern portion was 38% of normal. The southeast and southwest areas were 57% and 55% of normal, respectively. May's precipitation was significantly below average across all of Wyoming.

As the month of May ended, the mountain snowpack was 62% of the normal April 15th peak in the reach above Fort Peck and 55% of the normal April 15th peak in the reach from Fort Peck to Garrison, representing a rapid snowmelt as well as a near normal snowpack.

g. Summary

Over the course of the winter season, the mountain snowpack above Fort Peck was below normal until the end of March when it climbed above normal for the remainder of the season. The mountain snowpack in the Fort Peck to Garrison reach was near to above normal for the entire season. The mountain snowpack in the reach above Fort Peck peaked on May 4 at 109% of the normal peak accumulation. The mountain snowpack in the reach between Fort Peck and Garrison peaked on April 17 at 110% of the normal peak accumulation. The normal date for snow accumulation to peak is April 15. The 2008-2009 mountain snow accumulation and melt for the reaches above Fort Peck and Fort Peck to Garrison are illustrated in ***Figure 3***.

3. Weather Conditions

In general precipitation during the 2009 calendar year was normal to above normal in the Missouri River basin. ***Figure 4*** depicts percent of normal precipitation for the months of February, March, October and December 2009 in the Missouri River basin. Areas of the Missouri River basin received well-above normal precipitation during these months, which greatly influenced the annual runoff pattern and volume in the Missouri River. In other months, basin-wide precipitation was generally normal. Areas of above normal precipitation contributed to higher than average runoff into the Missouri River and the System. The weather summaries in the following sections describe significant weather events by month in the Missouri River basin.

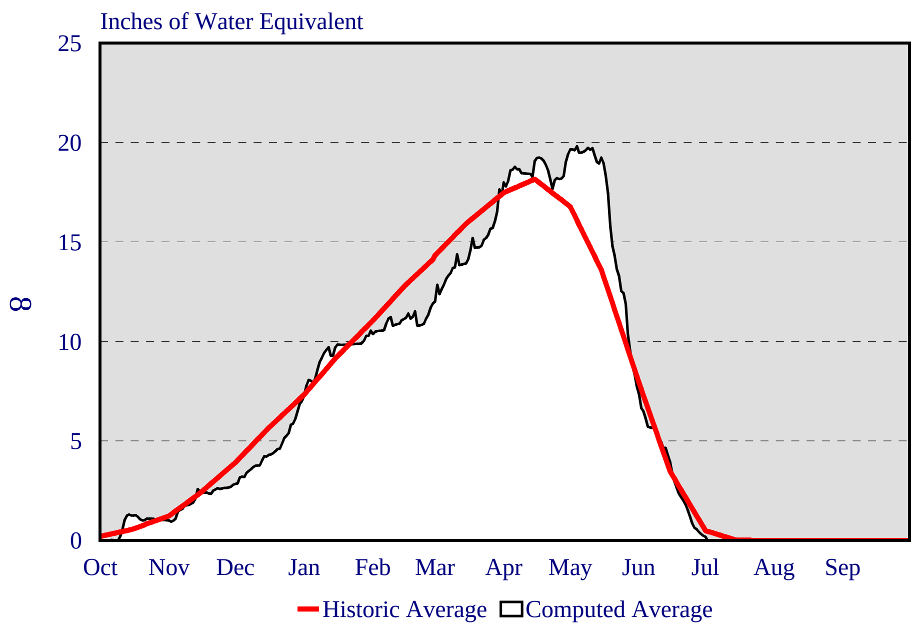
Figure 5 depicts drought magnitudes as defined by the National Drought Mitigation Center at the beginning of January, April, July and October 2009. On January 6, 2009, an area of moderate drought existed in southwest North Dakota with traces of dryness throughout the Rocky Mountains. Throughout the year areas of dryness would persist; however, areas of drought diminished because of normal to above normal precipitation.

a. January 2009

Weather in January was reflective of the active December 2008 weather in the Northern Plains. Heavy snowfall accumulations ranged from 12 inches in Great Falls, MT to 16 inches in Bismarck, ND while northern South Dakota received 8-10 inches.

Missouri River Basin Mountain Snowpack Water Content 2008-2009

Total Above Fort Peck



Total Fort Peck to Garrison

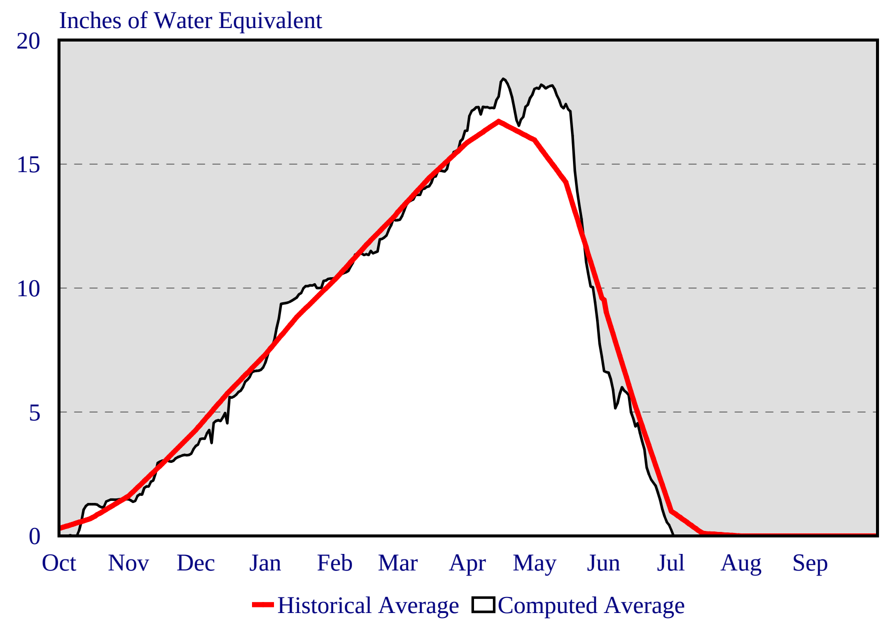


Figure 3. The mountain snowpack in the reach above Fort Peck peaked at 109% of the normal peak accumulation on May 4. The mountain snowpack in the reach between Fort Peck and Garrison peaked at 110% of the normal peak accumulation on April 17. The Missouri River basin mountain snowpack normally peaks near April 15.

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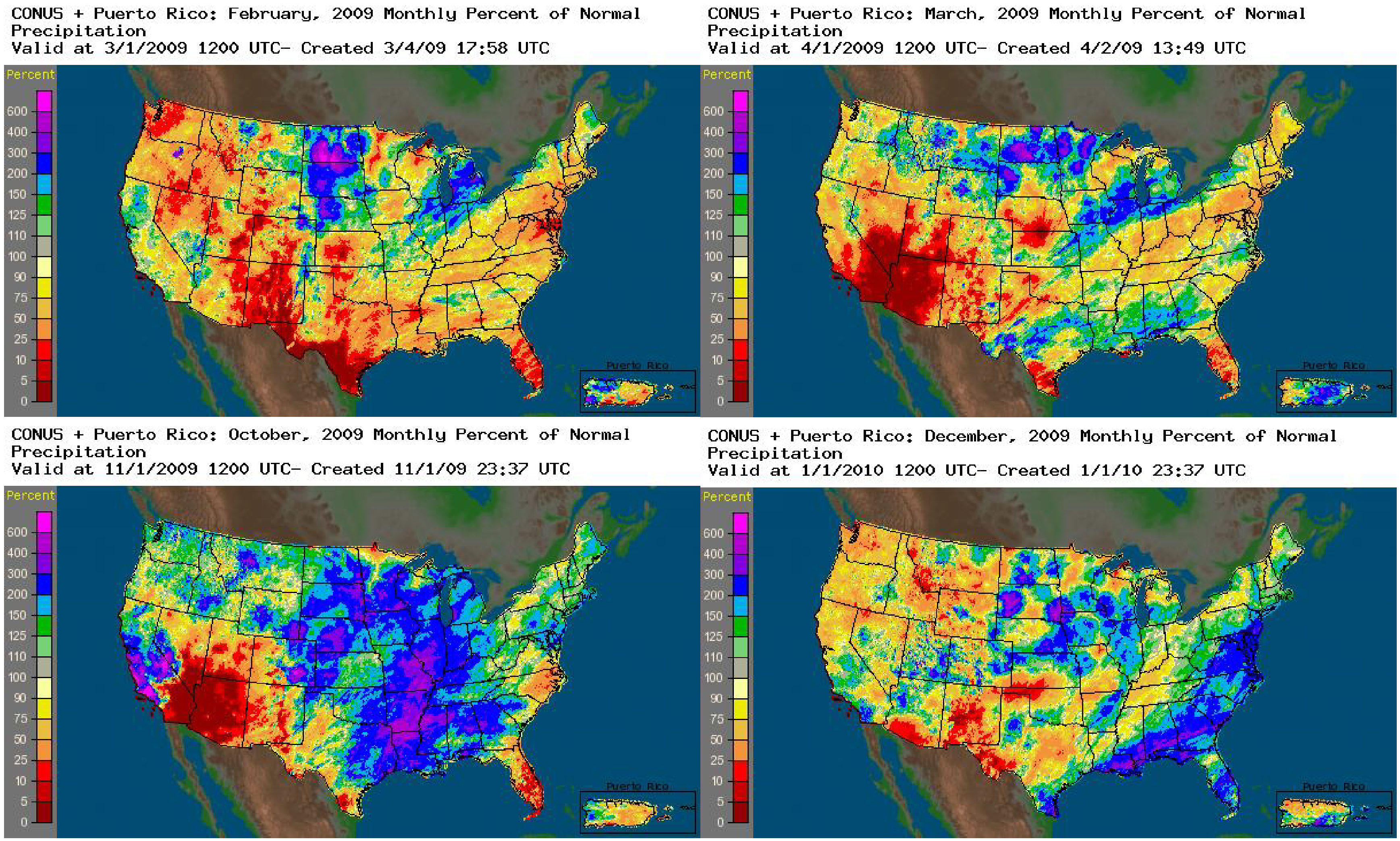
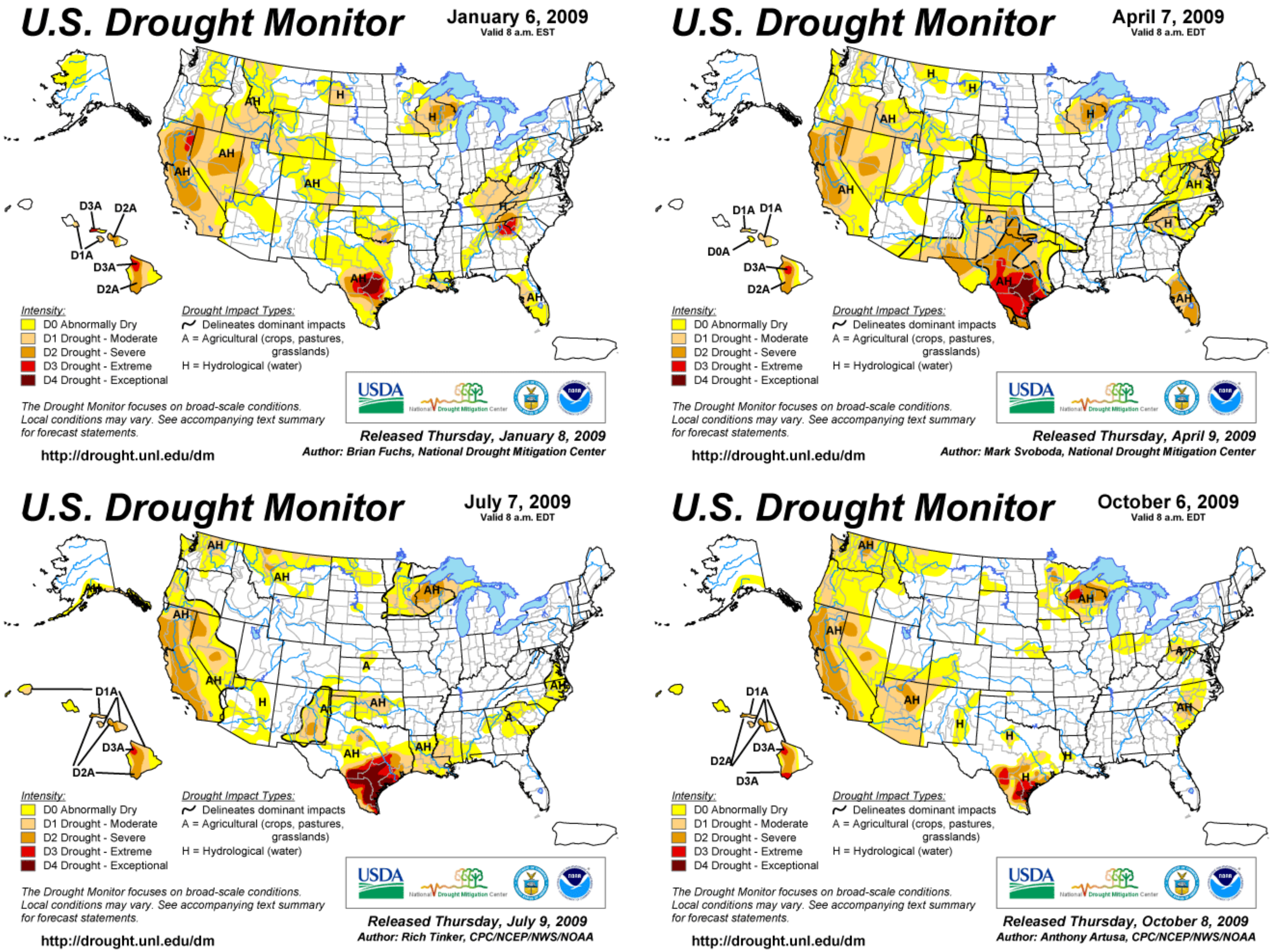


Figure 4. Percent of normal precipitation maps for the months of February, March, October, and December 2009 as reported by the NOAA.

Figure 5. The National Drought Mitigation Center's Drought Maps for early January, April, July, and October 2009.



Precipitation accumulations were below normal to near normal in the mountains of Montana and northwest Wyoming, but greater than 150% of normal in North Dakota and central Wyoming. The Missouri River basin below Rulo, NE was very dry, receiving less than 25% of normal precipitation. Temperatures during the month were 3-5°F below average north and east of the Missouri River from Fort Peck to St. Louis, MO. West of the Missouri River, temperatures were 3-5°F above normal. Warmer temperatures began to slow the accumulation of mountain snowpack during the first half of the month, a trend that would continue until March 2009.

b. February 2009

The Missouri River basin was hit with significant winter storms February 9–10 and February 25–28. The first storm produced 0.5-1.5 inches of SWE from western Nebraska into central North Dakota. As the storm left the region, a second storm produced moderate rainfall in the lower Missouri River basin. The second storm produced heavy accumulations of snow in northern and eastern South Dakota and Nebraska.

February precipitation accumulations as a percent of normal are shown in ***Figure 4.*** In general the region extending from western Nebraska into North Dakota received greater than 200% of normal monthly precipitation, while Colorado, Wyoming and Montana received less than 50% of normal precipitation. Despite the large storm in the lower basin, precipitation was about average. Temperature departures were generally 3-5°F warmer than normal with the exception of northern South Dakota and Montana, and North Dakota which experienced temperatures that were 5-7°F below normal.

c. March 2009

During March significant snow accumulated in the Dakotas while relatively heavy rain occurred late in the month over the lower Missouri River basin. During the first three weeks of March precipitation was very limited in the Missouri River basin; however, portions of the lower Kansas and Missouri River basins received 0.5-2.0 inches March 7 and 9. Early month snowfall in Jamestown, ND brought the March snowfall accumulation to 14 inches.

A significant warm up occurred March 20–23 causing rapid melting of part of the existing plains snow cover in western North Dakota. Daily high temperatures reached 80°F in Grand Island, NE; 74°F in Miles City, MT; and 77°F in Rapid City, SD. After the warm up, a significant winter storm March 23-24 moved through the Northern Plains producing 0.75 inches of rain followed by 8.1 inches of snow (0.78 inches of SWE) in Bismarck, ND. Jamestown, ND received 1.4 inches of total liquid equivalent, while Rapid City, SD received 1.6 inches. SWE ranging from 1.5-2.5 inches was measured in the Cheyenne and Moreau River basins just east of the Black Hills. This storm also produced as much as 2 inches of rainfall in the Kansas and lower Missouri River basins. Temperatures during this period were 12°F below normal, leading to ice jams from floating river ice in North Dakota. A second significant snow storm March 29–31, produced snow with SWE amounts ranging from 0.25-1.0 inch in Montana and the

Dakotas. Rapid City, SD received 12 inches of snow while Bismarck, ND received 11.8 inches of snow and Mitchell, SD received 12.8 inches of snow.

Overall March accumulations of precipitation ranged from 1.5-4.0 inches of moisture in parts of the Dakotas, while mountainous areas received greater than 5.0 inches of moisture in some locations. March snowfall in Bismarck, ND totaled 29.7 inches, which is the second snowiest March on record. The lower basin including southern Iowa, eastern Kansas and much of Missouri received 4-6 inches of precipitation. Significant precipitation accumulations in March included 2.7 inches at Bismarck (1.9 inches above normal); 1.6 inches at Jamestown (0.7 inches above normal); 2.0 inches at Lander, WY (1.6 inches above normal); 4.8 inches at Topeka, KS (2.2 inches above normal); and 4.6 inches at Kansas City, MO (2.2 inches above normal).

March precipitation accumulations shown in ***Figure 5*** were greater than 150% of normal in western Montana, the Dakotas, and northern Missouri; however, Nebraska, Colorado, and northern Montana received between 25% and 50% of normal precipitation. Overall monthly temperatures for the basin were well below normal, especially in North Dakota which average 7-9°F below normal. Along with the increased mountain precipitation, mountain snowpack accumulated at a faster rate near the end of March.

d. April 2009

The month began with a large winter storm April 3–6 that caused widespread, heavy snow across all mountain states, then moved into South Dakota, Nebraska and Iowa. SWE amounts in excess of 0.5 inches were common, and 1-2 inches of SWE occurred over much of South Dakota, Nebraska, and Iowa. Rapid City, SD reported 15.5 inches of snow (1.3 inches of SWE) while Mitchell, SD reported 10.3 inches of snow (1.1 inches of SWE). As of April 4, Bismarck, ND's total season snowfall was 100.2 inches, second only to 101.6 inches observed in 1996 – 1997. In the Missouri River basin below Omaha a strong spring storm system produced heavy rainfall ranging from 2-5 inches April 26–27. A large spring snow storm affected Montana and northern North Dakota April 29-30, producing up to 2.5 inches of precipitation in northeast Montana. This storm also produced a daily record 25.4 inches of snow in Great Falls, MT April 27–29 and 4-5 feet in the eastern slopes of the northern Rockies. In contrast, dry conditions persisted in the Heart, Knife, James, Big Sioux and Little Sioux River basins.

Precipitation departures 200% to 300% above normal occurred in northeast Montana, western South Dakota, western Nebraska, eastern Wyoming, northeast Colorado and Kansas. Significant monthly precipitation accumulations included Rapid City with 3.7 inches (1.8 inches above normal); Cheyenne, WY with 3.6 inches (2.1 inches above normal); Topeka, KS with 7.1 inches (4.0 inches above normal); and Kansas City, MO with 7.1 inches (3.7 inches above normal). Bismarck, ND received only 0.7 inches of precipitation (0.8 inches below normal), and Sioux City, IA received 1.6 inches of precipitation (1.1 inches below normal).

e. May 2009

Significant rainfall from an outbreak of thunderstorms occurred May 15–16 in northeast Kansas and northern Missouri. Heavy rainfall amounts ranging from 3-4 inches occurred along the Missouri River from St. Joseph to Waverly, MO while similar amounts occurred in the upper Grand and Chariton River basins. A second significant storm produced 1 to 2 inches of rain across North Dakota before moving through lower parts of the Missouri River basin May 25–27.

May precipitation sharply contrasted to April precipitation as most areas of the Missouri River basin received less than 75% of normal precipitation. The driest areas included eastern Kansas and Nebraska, South Dakota, Wyoming and Montana, which received less than 50 percent of normal precipitation. Temperatures were generally 1-3°F cooler than normal in the Dakotas, 1-3°F above normal in Montana, Wyoming and Colorado, and near normal in Nebraska, Kansas, and Missouri.

Significant monthly precipitation departures below normal included 2.3 inches at Pierre, SD; 2.8 inches at Sioux City, IA; 3.4 inches at Topeka, KS; and 2.6 inches at Kansas City, MO.

f. June 2009

June was wetter than normal across the Central Rockies in Montana and Colorado, much of Nebraska, central North Dakota, and parts of the lower Missouri River basin. Much of the precipitation was spread across the entire month; however, significant localized accumulations occurred June 15–16 in the lower Missouri River basin and in Bismarck, ND, which received 5.8 inches. Significant monthly totals include 7.9 inches at Bismarck, ND (5.4 inches above normal); 4.7 inches at Rapid City, SD (1.9 inches above normal); 5.3 inches at Sioux City, IA (1.7 inches above normal); 6.9 inches at Kansas City, MO (2.4 inches above normal); and 6.4 inches at St. Louis, MO (2.7 inches above normal).

Average monthly temperatures were 3-5°F below normal in much of the basin above Sioux City, IA and 1-3°F above normal in the basin below Kansas City, MO.

g. July 2009

July brought very timely rain with storms occurring July 3-4 in Nebraska and the lower basin states. On July 4, Columbia, MO received 4.2 inches of rain. From July 7–8 a large storm originating in northern Montana produced 1-2 inch rains in Montana, North Dakota, eastern South Dakota and Nebraska and western Iowa. Rainfall in western Montana, central Wyoming and northeastern Colorado was greater than 150% of normal. Great Falls, MT received 3.6 inches (2.2 inches above normal) and Denver, CO received 3.6 inches (1.4 inches above normal). Topeka, KS and Columbia, MO received 7.8 and 7.1 inches of rainfall, respectively (4.0 and 3.3 inches above normal). In contrast, precipitation in eastern Nebraska was 2 inches below normal.

Once again temperatures were cooler than normal throughout the Missouri River basin. In the center of the basin, temperatures were 5-7°F below normal while in the western states, temperatures were generally 1-3°F below normal.

h. August 2009

August was wetter than normal in most areas except northwest Montana, central North Dakota, and the central Rockies. The Missouri River basin maintained its below normal temperature trend through August with temperatures 3-5°F below normal in the Plains states and 1-3°F below normal in the mountain states.

A major storm occurred over northeast Montana, South Dakota, Nebraska, Iowa and Missouri August 15–17. Rainfall amounts in Montana ranged from 1-2 inches, while two-day totals in South Dakota reached 3 inches. One day totals in northeast Nebraska ranged from 3-4 inches. On August 17, 3-5 inches of rain occurred in northern Missouri. Kansas City recorded 3.2 inches and Chillicothe, MO recorded 7.2 inches. Rain continued to occur in the lower basin including areas of 4 inches throughout the Kansas, Grand, and Chariton River basins August 26-27.

i. September 2009

September was a very dry month in Montana, Wyoming, and Colorado. This dryness spread throughout western North and South Dakota into eastern Nebraska and western Iowa. Rainfall was generally 50% to 75% of normal. Greater than 150% of normal precipitation occurred in northeast Colorado, the Kansas River basin, eastern Missouri, northeast South Dakota and central North Dakota.

Heavy rain occurred in an area between Sioux City, IA, which recorded 3.1 inches and Columbia, Missouri from September 2-4. Significant rainfall amounts of 1.5-4.0 inches occurred in the Osage and lower Missouri River basins on September 22. A very large area of rain occurred over the Colorado, Kansas, and Nebraska tri-state area with amounts ranging from 0.75-1.5 inches. At the end of the month very early season snowfall following significant rain occurred as a strong weather system passed through the Northern Plains into the lower Missouri River basin. Bozeman, MT recorded 5.5 inches of snow on September 30, while on October 1, Fargo, ND recorded 2.0 inches of rain.

Temperatures during the month were 1-3°F cooler than normal in Kansas, Nebraska and Missouri, but drastically warmer in the Dakotas, Wyoming and Montana. In the northern tier, average daily temperatures were 5-9°F warmer than normal. Although warm weather dominated the region, cold air moved into the northern tier at the end of the month. A daily record low temperature of 29°F was recorded at Pierre, SD.

j. October 2009

October was a wet month throughout the Missouri River basin as shown on ***Figure 4***. The Dakotas, Nebraska, much of Kansas, Iowa, and Missouri received from 150% to 200% of normal precipitation, while Montana, Wyoming and Colorado received between 100% and 200% of normal precipitation.

The month began with 0.25-0.75 inches of rain in the Northern Plains, with as much as 1.5 inches of precipitation in eastern South Dakota and North Dakota. Another significant storm produced 0.75-1.0 inch of rain and snow across Wyoming and southern Montana on October 5 and 1.0-1.5 inches in western South Dakota. This storm continued on October 6 producing 1.0-1.5 inches in eastern South Dakota and southern North Dakota. From October 8-10, a fall storm produced snow in Nebraska and very heavy rain in central Missouri. North Platte, NE recorded 13.8 inches of snow over two days. Columbia, MO recorded 5.4 inches of rain and St. Louis, MO recorded 3.3 inches of rain from October 8–9. Temperatures during this week were 12-15°F below normal over the entire basin. Billings, MT recorded four consecutive daily record low temperatures from October 9–12. Another storm October 21–23 produced moderate rain in Nebraska, South Dakota, western Iowa, Kansas and Missouri. Columbia and St. Louis, MO received 1.5 and 2.0 inches of rain, respectively. Over a three-day period Sioux City, IA received 2.6 inches of rain and Omaha, NE received 1.4 inches of rain. The last major storm of the month from October 26–30 produced more than one foot of snow in eastern Wyoming, Colorado, and western Nebraska. As it moved through the Plains it produced rainfall totals ranging from 0.5-1.5 inches through central Missouri and a two-day total of 2.9 inches in St. Louis, MO. Average temperatures for the month were 7-9°F below normal over most of the Missouri River basin.

k. November 2009

One storm affected primarily the lower basin from November 15–18, 2009. Three-day rainfall totals included 2.7 inches at St. Louis, MO; 1.8 inches at Columbia, MO; 3.0 inches at Chillicothe, MO; 1.7 inches at St. Joseph, MO; and 1.8 inches at Kansas City, MO. Temperature departures for the month were 7-9°F above normal. Overall precipitation was 25% to 50% of normal with the exception of northern Missouri which received slightly above normal precipitation.

l. December 2009

Precipitation in December was above normal in the Plains and below normal in the Rocky Mountains in Montana and Wyoming. Departures from normal were greater than 150% above normal throughout most of North Dakota, South Dakota, Nebraska, and Iowa. Precipitation in the Big Sioux River basin was greater than 400% of normal. Mean daily temperatures were 5-9°F below normal over most of the Missouri River basin while temperature departures in Montana, western Nebraska, and western North and South Dakota were more than 9°F below normal.

A major winter storm affecting the basin occurred December 6–9 spreading light snow from Montana through the Midwest, eventually producing heavy snow in northern Kansas, eastern Nebraska, and Iowa. Snowfall amounts ranged from 11 inches in Sioux City, IA to 15 inches near Omaha, NE while accumulated SWE ranged from 0.5-1.25 inches in the affected areas. A second storm December 23–27, 2009 spread heavy snow across South and North Dakota, eastern Nebraska and western Iowa. Also, a significant mix of rain and snow occurred in Kansas and Missouri. Five-day total snowfall accumulations included 13.8 inches at Bismarck, ND; 18.7 inches at Sioux Falls, SD; 20.7 inches at Sioux City, IA; 11.5 inches at Omaha, NE; 12.8 inches at Lincoln, NE; 11.1 inches at Topeka, KS; and 9.1 inches at Kansas City, MO. Significant five-day liquid equivalent precipitation accumulations included 1.4 inches at Sioux Falls, SD; 1.6 inches at Sioux City, IA; 1.4 inches at Omaha, NE; 1.3 inches at Topeka, KS; 1.2 inches at Kansas City, MO; 1.9 inches at Columbia, MO; and 2.2 inches at St. Louis, MO.

4. 2009 Calendar Year Runoff

Runoff for the period January through December 2009 for the basin above Sioux City, Iowa, totaled 33.7 MAF, 136% of normal runoff based on the historical period of 1898-2008, as shown in ***Table 1***. The 33.7 MAF in 2009 represents only the second year with above normal runoff since 1999, as shown on ***Figure 6*****.** Monthly runoff during 2009 above Sioux City, IA varied from a low of 71% in December to a high of 210% in April. ***Figure 7*** indicates the monthly variation of runoff for CY 2009.

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Table 1
2009 Calendar Year Runoff for Selected Reaches

Reach	1898 – 2008 Average Runoff Volume (in 1000 AF)	Calendar Year 2009 Runoff Volume (in 1000 AF)	Percent of Average Runoff
Above Fort Peck	7,213	6,829	95
Fort Peck to Garrison	10,612	12,141	114
Garrison to Oahe	2,373	7,881	332
Oahe to Fort Randall	883	877	99
Fort Randall to Gavins Point	1,681	1,959	117
Gavins Point to Sioux City	2,023	4,021	199
TOTAL ABOVE SIOUX CITY	**24,785**	**33,708**	**136**
	1967–2009 Average Runoff		
Sioux City to Nebraska City*	7,600	7,890	103
Nebraska City to Kansas City*	11,630	12,390	106
Kansas City to Hermann*	23,940	38,030	159
TOTAL BELOW SIOUX CITY*	**43,170**	**58,310**	**135**

** Runoff in the reaches from Sioux City to Hermann is not adjusted to 1949 depletion levels. Averages are taken from USGS Water Data Reports for the period 1967-2009.*

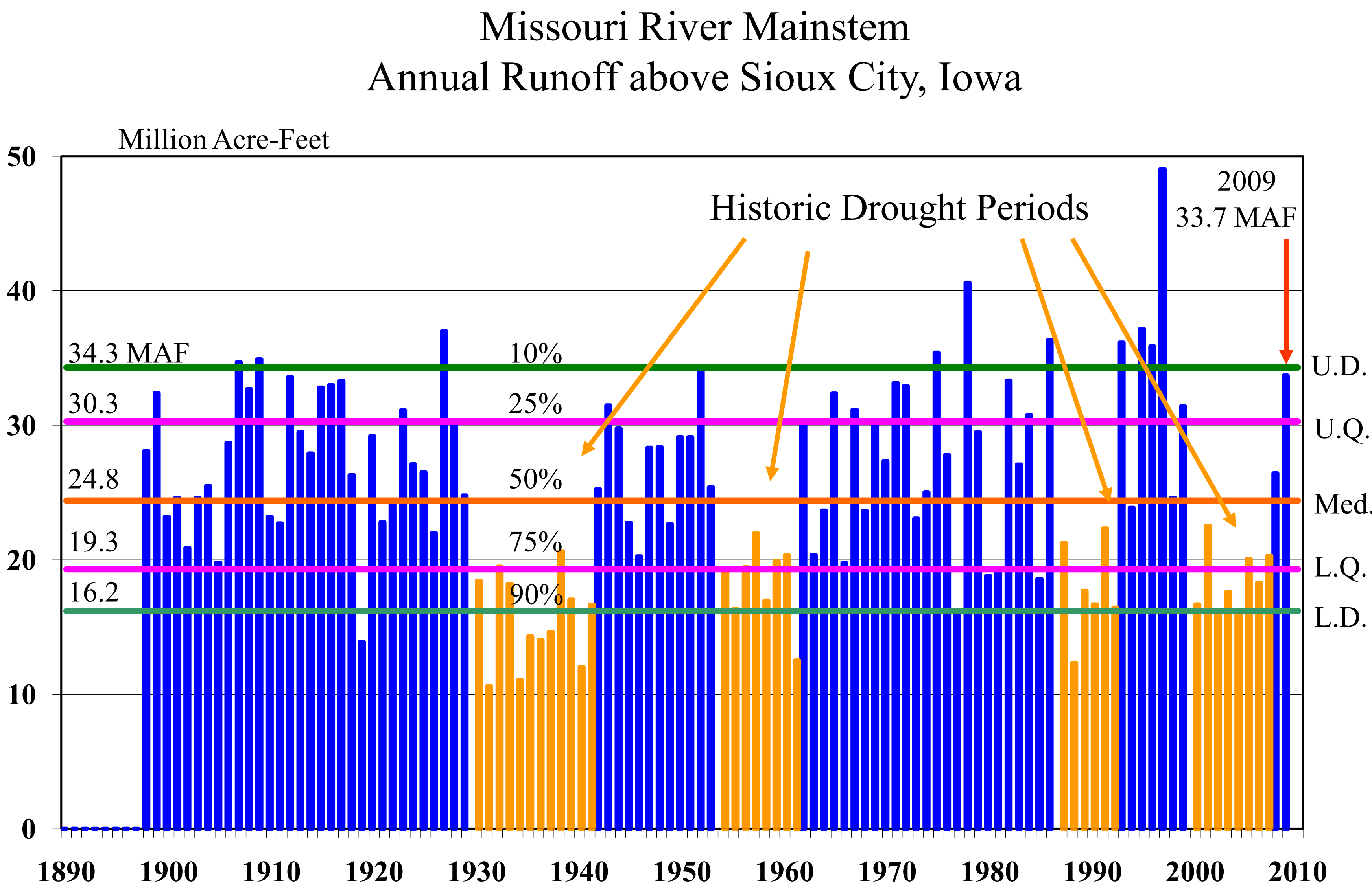


Figure 6. Missouri River Annual Runoff above Sioux City, Iowa.

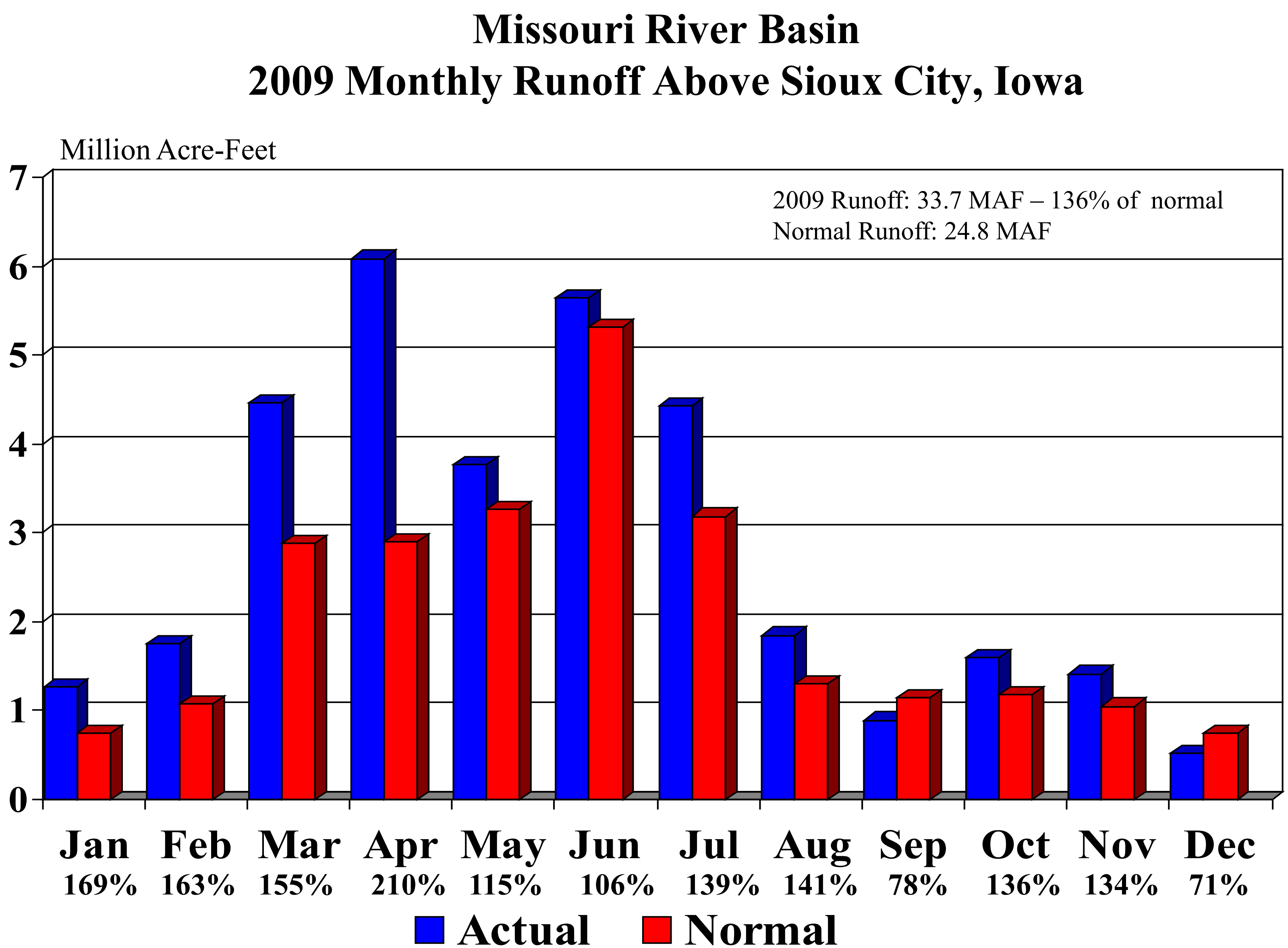


Figure 7. Missouri River Basin 2009 Monthly Runoff above Sioux City, Iowa.

The observed monthly runoffs for 2009 from Fort Peck downstream to Sioux City, IA by major river reach are presented in ***Table 2***. The table lists the runoff by month and reach and is the basic compilation of the runoff into the System. 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 progressed and the actual runoff accumulated, the forecast 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

C. System Regulation – January to December 2009

1. System Regulation January to December 2009

The System storage increased through the first seven months of 2009 and peaked on July 20, 2009 at 57.7 MAF. The System storage began the year at the annual minimum of 43.9 MAF on January 1. This was 10 MAF above the record low of 33.9 MAF established on February 8, 2007. The March 1 system storage was above the storage level required to run the March spring pulse.

The March 15 System storage was 46.0 MAF, which was above the navigation season preclude level of 31.0 MAF. Per the Master Manual, since the March 15 storage level was between 49.0 and 31.0 MAF, the navigation service level was set at minimum service.

The plan for the System releases to support the 2009 navigation season during the threatened and endangered (T&E) tern and plover nesting season was the Steady Release – Flow-to-Target (SR-FTT) plan. The SR-FTT release plan calls for Gavins Point releases to be set at an initial steady rate and then adjusted higher or lower during the nesting season to meet downstream flow targets, if necessary. Depending on where the initial steady release is set, this regulation can provide more T&E habitat early in the nesting season and saves additional water in the upper three reservoirs, when compared to a Steady Release (SR) plan. The SR-FTT plan also reduces the potential for flooding nests and exceedance of the anticipated incidental take for listed terns and plovers when compared to a Flow-to-Target (FTT) plan.

Flow support for the 2009 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. System releases during April ranged from 15,000 to 18,000 cfs. Downstream tributary inflow between Nebraska City and Kansas City was significant from March through August. The minimum service flow targets at Sioux City (25,000 cfs) were met for most of the navigation season except for 5 days in April when there were no barges in this reach of the Missouri River.

Table 2
Missouri River Basin
Calendar Year 2009 Runoff above Sioux City, Iowa

Values in 1,000 Acre Feet

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
JAN 2009	359	400	29	117	129	237	1,034	1,271	1,271
NORMAL	312	261	12	25	100	40	710	750	750
DEPARTURE	47	139	17	92	29	197	324	521	521
% OF NORM	115%	153%	242%	468%	129%	593%	146%	169%	169%
FEB 2009	339	353	498	217	188	165	1,595	1,760	3,031
NORMAL	360	356	90	49	130	92	985	1,077	1,827
DEPARTURE	-21	-3	408	168	58	73	610	683	1,204
% OF NORM	94%	99%	553%	443%	145%	179%	162%	163%	166%
MAR 2009	514	1,063	2,098	165	198	425	4,038	4,463	7,494
NORMAL	596	1,003	567	209	206	299	2,581	2,880	4,707
DEPARTURE	-82	60	1,531	-44	-8	126	1,457	1,583	2,787
% OF NORM	86%	106%	370%	79%	96%	142%	156%	155%	159%
APR 2009	514	1,352	3,212	229	242	539	5,549	6,088	13,582
NORMAL	649	1,080	481	144	180	360	2,534	2,894	7,601
DEPARTURE	-135	272	2,731	85	62	179	3,015	3,194	5,981
% OF NORM	79%	125%	668%	159%	134%	150%	219%	210%	179%
MAY 2009	1,130	1,209	547	32	169	677	3,087	3,764	17,346
NORMAL	1,081	1,245	312	147	186	292	2,971	3,263	10,864
DEPARTURE	49	-36	235	-115	-17	385	116	501	6,482
% OF NORM	105%	97%	175%	22%	91%	232%	104%	115%	160%
JUN 2009	1,411	3,100	421	53	170	493	5,155	5,648	22,994
NORMAL	1,612	2,667	423	152	178	286	5,032	5,318	16,182
DEPARTURE	-201	433	-2	-99	-8	207	123	330	6,812
% OF NORM	88%	116%	100%	35%	96%	172%	102%	106%	142%
JUL 2009	849	2,393	368	79	181	560	3,870	4,430	27,424
NORMAL	819	1,776	179	57	137	218	2,968	3,186	19,368
DEPARTURE	30	617	189	22	44	342	902	1,244	8,056
% OF NORM	104%	135%	206%	139%	132%	257%	130%	139%	142%
AUG 2009	397	748	247	64	147	245	1,603	1,848	29,272
NORMAL	353	604	65	39	115	131	1,176	1,307	20,675
DEPARTURE	44	144	182	25	32	114	427	541	8,597
% OF NORM	112%	124%	380%	164%	128%	187%	136%	141%	142%
SEP 2009	226	311	75	26	105	152	743	895	30,167
NORMAL	333	452	111	38	111	99	1,045	1,144	21,819
DEPARTURE	-107	-141	-36	-12	-6	53	-302	-249	8,348
% OF NORM	68%	69%	68%	68%	95%	154%	71%	78%	138%
OCT 2009	476	519	150	74	194	191	1,413	1,604	31,771
NORMAL	385	523	66	5	120	78	1,099	1,177	22,996
DEPARTURE	91	-4	84	69	74	113	314	427	8,775
% OF NORM	124%	99%	227%	--	162%	245%	129%	136%	138%
NOV 2009	397	520	157	-118	209	249	1,165	1,414	33,185
NORMAL	384	398	67	6	118	76	973	1,049	24,045
DEPARTURE	13	122	90	-124	91	173	192	365	9,140
% OF NORM	103%	131%	234%	0%	177%	328%	120%	135%	138%
DEC 2009	217	173	79	-61	27	88	435	523	33,708
NORMAL	329	247	0	12	100	52	688	740	24,785
DEPARTURE	-112	-74	79	-73	-73	36	-253	-217	8,923
% OF NORM	66%	70%	--	--	27%	169%	63%	71%	136%
Calendar Year Totals									
	6,829	12,141	7,881	877	1,959	4,021	29,687	33,708	
NORMAL	7,213	10,612	2,373	883	1,681	2,023	22,762	24,785	
DEPARTURE	-384	1,529	5,508	-6	278	1,998	6,925	8,923	
% OF NORM	95%	114%	332%	99%	117%	199%	130%	136%	

The minimum service flow targets at Omaha (25,000 cfs), Nebraska City (31,000 cfs), and Kansas City (35,000 cfs) were met throughout the navigation season.

On April 1 System storage was 48.9 MAF, 11.8 MAF more than the previous year's April 1 System storage. The May 1 System storage was 53.3 MAF, above the storage level required to run the May spring pulse.

Early spring rainfall and plains snowmelt produced a March-May runoff of 14.3 MAF above Sioux City, which was 158% of normal. Runoff volumes above Sioux City for June and July were higher than normal: 5.6 MAF (106% of normal) and 4.4 MAF (139% of normal), respectively. The June-July runoff was a result of mountain snowpack runoff as well as significant rainfall runoff. Mountain snowpack peaked at 109% of normal above Fort Peck and 110% of normal between Fort Peck and Garrison.

As per the Master Manual, the July 1 water in storage check of 56.8 MAF resulted in the navigation flow support increasing to full service and the navigation season ending December 1 near the mouth at St. Louis, MO. System storage peaked on July 20 at 57.9 MAF. This was 12 MAF higher than the 2008 peak of 45.9 MAF on August 3, 2008. The end-of-July System storage was 57.7 MAF, 11.9 MAF higher than the 2008 end-of-July storage and 0.6 MAF less than 1967-2009 end-of-July average (58.3 MAF). System storage declined steadily through the remainder of the year. End-of-month storages were: August, 57.1 MAF; September, 55.9 MAF; October, 55.1 MAF; November, 54.9 MAF; and December, 54.3 MAF. The end-of-December System storage was 10.3 MAF more than the previous year and 1.7 MAF more than 1967-2009 end-of-December average. During 2009 the carryover multiple-use zones at both Garrison and Oahe refilled and only Fort Peck remained below the normal operating level as a result of the 2000-2007 drought.

2. Fort Peck Regulation – January to December 2009

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 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 3 lists the average monthly inflows and releases in cfs and the end-of-month (EOM) pool elevation in ft msl for Fort Peck for 2008 and 2009 as well as the averages since the System first filled in 1967.

Table 3
Fort Peck – Inflows, Releases, and Elevations

Month	Ave Monthly Inflow (cfs)			Ave Monthly Release (cfs)			EOM Elevation (ft msl)		
	2009	2008	1967-2009	2009	2008	1967-2009	2009	2008	1967-2009
January	7,000	4,300	7,200	5,500	5,500	10,700	2209.9	2198.9	2227.2
February	8,200	5,100	8,700	6,000	5,400	11,100	2210.5	2198.8	2226.5
March	8,900	6,400	11,800	4,200	5,100	8,000	2212.1	2199.2	2227.6
April	10,000	5,000	10,300	4,100	6,000	7,400	2214.1	2198.8	2228.3
May	16,300	11,900	15,100	5,900	7,600	9,000	2217.6	2200.3	2229.9
June	13,100	28,400	18,700	6,200	6,800	9,700	2219.8	2208.3	2232.3
July	9,600	12,300	12,100	6,500	6,800	10,000	2220.5	2210.0	2232.5
August	7,400	6,800	7,800	6,500	7,000	9,900	2220.4	2209.3	2231.4
September	6,900	7,000	7,800	5,400	6,100	8,800	2220.0	2209.3	2230.6
October	8,700	6,800	7,300	4,200	4,100	8,000	2220.5	2209.8	2230.0
November	6,800	6,700	7,100	4,200	4,200	8,400	2220.9	2210.2	2229.3
December	6,000	4,900	6,500	4,300*	5,800	9,500	2221.1	2209.7	2228.2

* monthly minimum of record

b. Winter Season 2009

The Fort Peck reservoir level began 2009 at elevation 2209.6 ft msl, 24.4 feet below the base of annual flood control zone and 10.2 feet higher than the previous year. The minimum reservoir level occurred on January 1 at 2209.6 ft msl, 11.2 feet higher than the 2008 minimum.

c. Winter River and Ice Conditions Below Fort Peck

No special release reductions were required to prevent ice-jam flooding downstream of Fort Peck Dam. The average monthly discharges for December 2008 and January and February 2009 were all below average with monthly averages of 5,800 cfs, 6,000 cfs, and 5,900 cfs respectively. Ice-cover formation on the Missouri River began on December 18, 2008 when the Missouri River stage rose over 3.5 feet in the Wolf Point, MT area. The stage at Wolf Point peaked near 5.2 feet on March 29, 2009, which is well below the flood stage of 13.0 feet. The Missouri River at Culbertson, MT peaked on April 8, 2009 at a stage of 7.8 feet, which is well below the flood stage of 19.0 feet. No reports of ice-affected flooding on the Missouri River below Fort Peck Dam were recorded during the 2009 winter season. The Fort Peck reservoir (Fort Peck Lake) froze over on December 25, 2008 and was free of ice on April 19, 2009.

d. Spring Open Water Season 2009

Releases averaged 4,100 cfs in April, 5,900 cfs in May, and 6,200 cfs in June. Sufficient inflows combined with low releases adequate to meet the minimum flow requirements for downstream irrigation resulted in a slow and steadily rising pool elevation from the end of March (2212.1 ft msl) to the end of June (2219.8 ft msl) during the forage fish spawn.

e. Summer Open Water Season 2009

Summer release rates, which are generally higher than spring releases due to the increased demand for hydropower, averaged 6,500 cfs from July through mid-September. These below average releases were set to meet minimum requirements for downstream irrigation. Inflows were also below average for July, August, and September. The Fort Peck pool rose in July (2219.8 to 2220.5 ft msl) then slowly declined during August and September to 2220.0 ft msl.

f. Fall Open Water Season 2009

Releases were reduced from approximately 6,500 cfs to near 4,000 cfs in mid-September, when irrigation ceased for the season. Releases were maintained near this minimum level during October, November, and December to conserve water. The December average release of 4,300 cfs set a minimum of record for the month. Inflows for October, November, and December were about average. The average inflows coupled with minimum releases resulted in the pool elevation rising during these three months to 2221.1 ft msl by the end of December.

g. Summary

The highest Fort Peck reservoir level during 2009 occurred on December 31 at 2221.1 ft msl. The lowest reservoir level during 2009 occurred on January 1 at 2209.6 ft msl. The average daily inflow of 9,100 cfs during 2009 was 91% of average (1967-2009). The average daily release of 5,300 cfs during 2009 was 58% of average (1967-2009) and set an average annual minimum of record for releases. In 2009, Fort Peck did not rise into the annual flood control and multiple use zone, which extends from 2234.0 to 2250.0 ft msl.

3. Garrison Regulation – January to December 2009

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 4 lists the average monthly inflows and releases in cfs and the EOM pool elevation in ft msl for Garrison for 2008 and 2009 as well as the averages since the System filled in 1967.

Table 4
Garrison – Inflows, Releases, and Elevations

Month	Ave Monthly Inflow (cfs)			Ave Monthly Release (cfs)			EOM Elevation(ft msl)		
	2009	2008	1967-2009	2009	2008	1967-2009	2009	2008	1967-2009
January	13,300	8,900	15,300	15,700	15,000	22,700	1824.0	1809.1	1831.4
February	13,000	9,900*	18,600	16,100	15,300	23,800	1823.4	1807.6	1830.4
March	22,500	12,800	26,800	10,000*	12,800	19,200	1826.2	1807.6*	1831.9
April	27,200	12,500	22,400	9,000*	12,500	18,800	1830.1	1807.3	1832.5
May	27,700	23,900	28,300	13,300	12,900	20,800	1833.0	1810.2	1833.9
June	45,700	51,300	45,500	15,900	14,300	22,700	1838.8	1819.6	1838.1
July	35,000	39,500	32,200	15,700	13,600	24,100	1842.3	1825.6	1839.3
August	18,500	16,000	18,000	16,000	13,900*	23,900	1842.2	1825.5	1837.7
September	14,400	15,500	16,500	14,800	12,600	20,400	1841.6	1825.6	1836.5
October	14,500	14,500	17,200	12,600	11,000	18,700	1841.5	1825.8	1835.9
November	14,900	13,200	15,900	12,800	11,000	19,600	1841.4	1826.1	1834.8
December	8,500	9,400	13,700	15,100	13,900	20,100	1840.0	1824.7	1833.2

* monthly minimum of record

b. Winter Season 2009

Releases from Garrison were below normal for a ninth consecutive winter season. Garrison began 2009 at 1824.7 ft msl, 13.8 feet higher than the previous year's elevation of 1810.9 ft msl. The 1824.7 ft msl elevation is 12.8 feet below the base of the annual flood control and multiple use zone. The reservoir level declined throughout the winter season to an annual minimum elevation of 1823.3 ft msl on March 2. This elevation was 14.2 feet below the base of the annual flood control and multiple use zone of 1837.5 ft msl. Due to flooding in the Bismarck area, the March average release of 10,000 cfs set a minimum of record for the month. Garrison reservoir (Lake Sakakawea) froze over on December 17, 2008 and was free of ice on April 29, 2009.

c. Winter River and Ice Conditions Below Garrison

The Missouri River in the Bismarck, ND area rose nearly 5 feet on December 14-17, 2008 during river ice cover formation. The ice-cover conditions were generally continuous from the middle of December through mid-March 2009 when inflows from the tributaries coming into the Missouri River caused two large ice jams to form on the Missouri River. One of the two jams was located just downstream of the Knife River confluence, north of Bismarck. The second ice jam was located just downstream of the Heart River confluence. The ice jam located near the Heart River confluence caused water to back up and forced the evacuation of Fox Island and the South Port area in the southern part of Bismarck and Mandan. At the request of the State of North Dakota, releases from Garrison were initially cut from 11,000 cfs to 6,000 cfs on March 23 to help relieve the flooding in Bismarck. On March 24, releases were reduced to 4,000 cfs and then eventually to zero later that afternoon. Releases from Garrison were increased on March 27 from zero to 3,000 cfs, to 6,000 cfs and eventually 9,000 cfs by the afternoon of that same day. This was the longest that releases have been held to zero since the dam was constructed. Releases were then held steady at 9,000 cfs until April 13 when they were again reduced to 5,000 cfs to ease the risk of flooding in the Bismarck/Mandan area caused by high flows from the Knife and Heart Rivers. Releases were increased to 9,000 cfs later in the afternoon on April 16 and held steady until April 21 when all restrictions on releases from Garrison were lifted.

Initially thermal power plants which use the river for cooling were not affected by the zero releases due to the large inflows from the Knife River. However, as flows on the Knife River started to recede two large power plants, the Great River Energy’s Stanton and the Basin Electric’s Leland Olds, both located downstream of the Knife River, were shutdown on March 27. The City of Washburn's water treatment plant intake is located on the Missouri River downstream of the Knife River’s confluence. Without sufficient flows on the Missouri River to dilute the sediment laden water from the Knife River, Washburn's water treatment facility could not effectively eliminate all bacteria from the water. Therefore, residents were being told to boil water before drinking.

The winter peak ice-affected Missouri River stage at Bismarck was 16.1 feet on March 24 due to combination of large inflows from tributaries and ice jams on the Missouri River. This was 0.1 foot above the Bismarck flood stage of 16 feet and 3.1 feet above the Corps’ winter freeze-in stage target of 13 feet.

d. Spring Open Water Season 2009

In 2009, Garrison was given priority during the forage fish spawn in April and May. With the above normal to normal runoff into Garrison from April through June and the below normal releases, Garrison reservoir rose during the critical fish spawning period. The reservoir level on April 1, the beginning of the navigation season, was 1826.2 ft msl. This elevation was 18.6 feet higher than the level at the start of the 2008 navigation season. The Garrison pool level rose significantly during the April to June period (1826.2 to 1838.8 ft msl) and crossed into the annual flood control and multiple use zone for the first time since June 2000. Average inflows for April of 27,200 cfs (121% of average) were well above normal while inflows for May of 27,700 cfs (98% of average) and June of 45,700 cfs (100% of average) were at or near normal. Releases were all well below normal for all three months with the April average release of 9,000 cfs setting a minimum of record for the month.

e. Summer Open Water Season 2009

During June and July the mountain snowpack runoff caused the Garrison pool to rise. During July the pool rose 3.5 feet from 1838.8 to 1842.3 ft msl. The pool level remained fairly level during the months of August and September. Releases during the summer months of July (15,700 cfs, 65% of average), August (16,000 cfs, 67% of average) and September (14,800 cfs, 73% of average) were below normal. July, August, and September inflows were about normal. A daily peaking pattern was established at Garrison during the nesting season to protect terns and plovers nesting below the project. With the return of normal pool elevations to Lake Sakakawea in 2009, the implemented water quality management measures to assist with coldwater fishery habitat in the Garrison reservoir were ended. The plywood barriers were removed from the Garrison Dam intake trash racks in October 2009. See Section II.F.3. of this report for more detailed information. On June 24, 2009 Garrison reservoir reached the base of the annual flood control pool 1837.5 ft msl for the first time since July 2000, marking its recovery from the 2000-2007 drought.

f. Fall Open Water Season 2009

Fall releases were reduced to about 12,500 cfs when irrigation ceased for the season in mid-September. This was followed by higher December releases of about 15,000 cfs to provide hydropower during winter demand increases.

g. Lake Audubon / Snake Creek Embankment

Lake Sakakawea pool levels rose considerably since March 2007 when the 43-foot maximum water level difference between Lake Audubon and Lake Sakakawea required a pool restriction for Lake Audubon to be put into place. The restriction was a result of an underseepage evaluation of the Lake Audubon embankment by the Omaha District. Since that time relief wells have been installed and underseepage issues should not be a factor in future operations of Lake Audubon. In the event the pool difference approaches the 43-foot maximum that was in place in 2007, the Omaha District's Geotechnical Branch will be consulted as to whether or not the 43-foot maximum is still a consideration. Lake Audubon was drawn down to the normal winter level of 1845.0 ft msl in the fall. For comparison, the Garrison reservoir pool elevation was 1840.0 ft msl at the end of December 2009.

h. Summary

The reporting of the annual pumping costs for Buford-Trenton is no longer required. In October 2008 the Secretary of the Army transferred ownership of the two drainage pump units to the Buford Trenton Irrigation District and provided a lump sum payment for operation of the pumps. This was in accordance with the provisions of Section 336(b) of the Water Resources Development Act of 1996 (Public Law 104-303).

The highest Garrison reservoir level during 2009 occurred on August 20 at 1842.6 ft msl, which was 16.2 feet higher than the 2008 peak and the highest peak since 1999. The lowest Garrison reservoir level during 2009 occurred on March 8 at 1823.3 ft msl. The average annual inflow of 21,300 cfs during calendar year 2009 was 95% of average (1967-2009). The average annual release of 13,900 cfs during calendar year 2009 was 66% of average (1967-2009). In 2009, Garrison rose 5.1 feet into the annual flood control zone; utilizing 38% of the available storage which extends from 1837.5 to 1850.0 ft msl.

4. Oahe and Big Bend Regulation – January to December 2009

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 storage, is primarily used for hydropower production, so releases from Oahe are generally passed directly through Big Bend.

Table 5 lists the average monthly inflows and releases in cfs and the EOM pool elevations in ft msl for Oahe for 2008 and 2009 as well as the averages since the System first filled in 1967.

Table 5
Oahe – Inflows, Releases, and Elevations

Month	Ave Monthly Inflow (cfs)			Ave Monthly Release (cfs)			EOM Elevation (ft msl)		
	2009	2008	1967-2009	2009	2008	1967-2009	2009	2008	1967-2009
January	16,100	14,600	23,100	14,800	13,300	20,800	1593.1	1582.3	1598.3
February	25,200	15,400	27,300	10,600*	17,100	18,300	1596.2	1581.8	1600.0
March	47,400	14,500	30,900	12,600	9,700	18,300	1603.7	1583.2	1602.5
April	59,300**	13,700	27,000	12,000	14,700	20,900	1612.5	1582.8	1603.5
May	19,500	17,800	27,200	13,000	10,000	21,500	1613.8	1584.7	1604.4
June	21,000	34,800	28,300	21,000	3,300*	24,800	1613.5	1592.6	1604.6
July	18,700	17,000	26,600	23,600	9,800	29,100	1612.7	1593.9	1603.8
August	18,800	14,200*	25,200	25,600	18,500	32,200	1610.4	1592.4	1601.8
September	15,900	14,300	21,800	29,500	10,300	28,600	1607.6	1593.1	1600.0
October	15,100	12,200	20,100	16,700	13,800	23,500	1606.8	1592.0	1598.9
November	15,200	13,700	20,900	6,800	5,300*	22,000	1608.1	1593.8	1598.4
December	16,000	13,300	20,400	17,500	15,100	20,900	1607.4	1592.9	1598.1

* monthly minimum of record ** monthly maximum of record

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 Missouri River Master Water Control Manual. This agreement also provides that the Corps will coordinate the regulation of Big Bend and the water level of Lake Sharpe with the two Tribes to include the following: the Corps will normally strive to maintain an reservoir level at Lake Sharpe between elevation 1419 ft msl and 1421.5 ft msl; when the level of Lake Sharpe drops below elevation 1419 ft msl or exceeds elevation 1421.5 ft msl, 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 ft msl or rise above 1422 ft msl, or, in the event the water level falls below 1418 ft msl or rises above 1422 ft msl, the Commander, Northwestern Division, 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 2009 the Big Bend reservoir level varied in the narrow range between elevations 1419.6 to 1421.1 ft msl. As per the settlement agreement no additional coordination was necessary.

Table 6 lists the average monthly inflows and releases in cfs and the EOM pool elevations in ft msl for Big Bend for 2008 and 2009 as well as the averages since the System first filled in 1967.

Table 6
Big Bend – Inflows, Releases, and Elevations

Month	Ave Monthly Inflow (cfs)			Ave Monthly Release (cfs)			EOM Elevation (ft msl)		
	2009	2008	1967-2009	2009	2008	1967-2009	2009	2008	1967-2009
January	13,800	12,300	20,500	14,000	12,700	20,500	1420.2	1420.2	1420.5
February	11,600	16,000	18,400	11,200	15,900	18,400	1420.6	1420.3	1420.4
March	12,600	9,200	19,000	12,200	8,800	18,900	1421.0	1420.6	1420.3
April	12,000	13,500	21,300	12,500	13,800	21,000	1420.1	1420.0	1420.5
May	11,400	9,600	21,800	10,700	9,000	21,700	1420.7	1420.3	1420.4
June	19,700	4,800	25,100	19,700	4,200*	24,800	1420.1	1420.6	1420.3
July	22,100	9,300	28,500	21,700	9,300	28,000	1420.3	1420.1	1420.3
August	23,700	16,700	31,700	23,100	15,700	31,100	1420.3	1420.6	1420.3
September	27,600	9,900	28,300	27,000	9,500	27,800	1420.2	1420.6	1420.3
October	16,800	12,900	23,500	16,200	13,100	23,000	1420.8	1420.0	1420.5
November	6,400	5,000*	23,400	6,800	4,400*	21,700	1420.2	1420.4	1420.4
December	17,300	13,900	20,800	17,400	13,700	20,500	1420.2	1420.5	1420.5

* monthly minimum of record

b. Winter Season 2009

Flooding in the Pierre-Fort Pierre area, especially at street intersections in the Stoeser Addition, has been a recurring problem since 1979. High Oahe releases, coupled with the formation of river ice cover in the LaFrambois Island area, have historically caused water to back up into a storm sewer outlet flooding street intersections. The city of Pierre installed a valve on the Stoeser Addition storm sewer in the fall of 1998 to prevent winter flooding; however, Oahe releases will continue to be constrained at times to prevent flooding at other locations. A study, referred to as the Pierre/Ft. Pierre Flood Mitigation Project, was initiated by the Omaha District in the late 1990's and finalized approximately five to seven years later. This project involved the purchase or flood-proofing of homes along the Missouri River that may be impacted by ice-affected Missouri River flows. Approximately 100 homes were purchased and removed and about 20 were flood-proofed. Some home owners chose not to participate in the voluntary project.

No flooding problems were experienced in this area during the winter of 2009. There were no ice events during this winter season in the Pierre/Fort Pierre area on the Missouri River. The Oahe reservoir (Lake Oahe) froze over on January 6, 2009 and was free of ice on March 23, 2009. There were no restrictions on Oahe's releases in the winter of 2009.

Big Bend was regulated in the winter season to follow power peaking requirements with hourly releases varying widely. The daily average flow in 2009 varied between 0 and 28,100 cfs. The Big Bend reservoir (Lake Sharpe) froze over on December 18, 2008 and was free of ice on April 6, 2009.

c. Spring Open Water Season 2009

Releases from Oahe are generally set lower during weekends than on weekdays. The normal regulation is to maintain Oahe average daily releases above 3,000 cfs during weekend daylight hours to enhance downstream fishing and boating use during the recreation season starting in early April. During the spring of 2009, this minimum release rate criterion was re-established for Oahe for the first time since 2001 due to the higher reservoir levels and full navigation flow support. Average monthly releases for April (12,000 cfs, 57% of average) and May (13,000 cfs, 60% of average) were less than normal, but considerably higher than the average monthly releases from the previous year. The average monthly inflow for April was 59,300 cfs, (220% of average) followed by 19,500 cfs for May (72% of average). The average monthly inflow for April of 59,300 cfs, due primarily to runoff from plains snowpack, was the maximum average April monthly inflow of record. On April 14, 2009 Oahe reached the base of the annual flood control pool of 1607.5 ft msl marking the reservoir's recovery from the 2000-2007 drought. The reservoir had last been at this level in May 2000.

Oahe rose during that critical forage fish spawn period from the beginning of April through the first week of June due to the record monthly runoff into Oahe in April and the below normal releases in May and June.

d. Summer Open Water Season 2009

Average monthly releases for June (21,000 cfs, 85% of average), July (23,600 cfs, 81% of average), and August (25,600 cfs, 80% of average) were less than normal, but considerably higher than the average monthly releases from 2008 which were 3,300 cfs (13% of average), 9,800 cfs (34% of average), and 18,500 cfs (57% of average), respectively.

After the Oahe pool reached its peak elevation of 1613.9 ft msl on June 7, the pool level steadily declined through rest of June, July, August, and September. This year's peak was 19.6 feet higher than the 2008 peak (1594.3 ft msl on July 27). The August 1 elevation was 1612.7 ft msl. The September 1 elevation was 1610.4 ft msl, 18 feet higher the previous year's September 1 elevation.

e. Fall Open Water Season 2009

The Oahe reservoir elevation rose slightly from late October through November. Releases were reduced in October to initiate the annual fall drawdown of the Fort Randall reservoir prior to the close of the navigation season. Low Oahe releases were maintained in November to facilitate the Fort Randall drawdown. Higher releases were scheduled in late November and December for winter energy production. Oahe ended 2009 with the pool elevation at 1607.4 ft msl or 0.1 feet below the annual flood control zone.

f. Summary

The highest Oahe reservoir level during 2009 occurred on June 7 at 1613.9 ft msl. The annual minimum pool elevation of 1592.5 ft msl occurred on January 10. This was nearly 11 feet higher than the 2008 minimum elevation of 1581.6 ft msl. The average annual inflow to Oahe of 24,000 cfs was 97% of average (1967-2009). The average annual release from Oahe of 17,000 cfs was 72% of average (1967-2009). In 2009, Oahe rose 6.4 feet into the annual flood control zone, which extends from 1607.5 to 1617.0 ft msl. Big Bend ended the year at 1420.2 ft msl, within the normal regulating range.

5. Fort Randall Regulation – January to December 2009

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 the 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 provide a location to store the water necessary to provide increased winter hydropower energy by allowing an annual fall drawdown of the reservoir to occur 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 7 lists the Fort Randall average monthly inflows and releases in cfs and the EOM pool elevation in ft msl for 2008 and 2009 as well as the averages since the System was first filled in 1967.

b. Winter Season 2009

The Fort Randall daily winter releases ranged from 2,900 to 21,600 cfs. The Fort Randall reservoir (Lake Francis Case) froze over on December 22, 2008 and was ice free on March 20, 2009.

c. Spring Open Water Season 2009

Fort Randall 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 April releases of 12,700 cfs were 60% of normal and the May releases of 16,400 cfs were 66% of normal. These below normal releases corresponded with below normal inflows; April inflows of 16,600 cfs were 70% of normal and May inflows of 12,700 cfs were 52% of normal.

Table 7
Fort Randall – Inflows, Releases, and Elevations

Month	Ave Monthly Inflow (cfs)			Ave Monthly Release (cfs)			EOM Elevation (ft msl)		
	2009	2008	1967-2009	2009	2008	1967-2009	2009	2008	1967-2009
January	17,400	12,900	21,900	10,900	11,800	15,100	1346.8	1343.9	1347.2
February	14,500	19,000	20,100	6,000	9,300	13,300	1352.8	1351.4	1352.2
March	15,100	10,700	21,500	10,800	6,600	15,700	1355.7	1354.4	1356.2
April	16,600	15,500	23,600	12,700	12,000	21,300	1358.3	1356.8	1357.7
May	12,700	11,300	24,400	16,400	9,900	24,700	1355.5	1357.6	1357.3
June	22,100	10,200*	27,500	22,500	6,600*	26,900	1355.0	1359.6	1357.4
July	24,600	10,200	29,400	24,400	15,600	30,500	1355.0	1355.7	1356.3
August	25,700	17,100	32,400	25,600	21,900	33,200	1354.5	1351.3	1355.2
September	29,200	9,800	28,700	28,700	19,600	33,500	1354.5	1342.3*	1351.0
October	17,300	14,500	22,900	26,000	15,500	31,800	1347.4	1341.0	1343.2
November	5,200	6,300	21,600	15,700	6,700	28,200	1337.3	1340.5	1336.6
December	16,600	13,100*	21,600	14,300	12,700	17,100	1339.7	1340.9	1341.1

* monthly minimum of record

d. Summer Open Water Season 2009

A daily peaking pattern was established at Fort Randall during the nesting season to provide flexibility to regulate over a range of releases while minimizing impacts to birds nesting below the project. Peaking started on May 11 and ceased on August 17. Initially, peaking was limited to a continuous 6-hour time frame. By late June, the peaking pattern was divided into 3 hours of peaking followed by a 4-hour period of much lower releases followed by 3 more hours of peaking and then the rest of the day kept at a constant release equal to the 4 hours in between the peaks. This was necessary to try to prevent stages downstream from Fort Randall from rising and affecting bird nests as average daily releases were increased to support System releases from Gavins Point. Fort Randall summer releases were below average: July (24,400 cfs, 80% of average), August (25,600 cfs, 77% of average), and September (28,700 cfs, 86% of normal).

e. Fall Open Water Season 2009

Normal regulation of Fort Randall includes the lowering of the pool level at the end of the navigation season to 1337.5 ft msl, 17.5 feet below the normal summer level, to make room for capture of the winter powerplant releases from the upper reservoirs. During a full navigation season, the pool is maintained above 1353 ft msl through the Labor Day weekend before starting the lowering of the pool. However, in 2009 the pool level was held above 1353 ft msl through the end of September, in an effort to lower Oahe by transferring water to Fort Randall. The lower Oahe elevation was desired for bank stabilization work, however, higher than expected inflows did not allow the planned work due to higher pool elevations. The lowering of the Fort Randall pool was started in October and the pool was lowered to 1337.3 ft msl by the end of November.

f. Summary

The highest Fort Randall reservoir level during 2009 occurred on May 2 at 1358.4 ft msl. The lowest reservoir level during 2009 occurred on December 11 at 1336.5 ft msl. The average annual inflow to Fort Randall of 18,100 cfs was 73% of average (1967-2009). The average annual release from Fort Randall of 17,800 cfs was 73% of average (1967-2009). In 2009, Fort Randall rose into its annual flood control zone, which extends from 1350.0 to 1365.0 ft msl. However, the normal summer regulating pool level at Fort Randall is 1355.0 ft msl.

6. Gavins Point Regulation – January to December 2009

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 less than 500,000 acre-feet, 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 ft msl. Due to the limited storage, releases from Gavins Point must be backed up with releases out of 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 power plant capacity, near 35,000 cfs, are passed through the spillway.

Table 8 lists the Gavins Point average monthly inflows and releases in cfs and the EOM pool elevation in ft msl for 2008 and 2009 as well as the averages since the System was filled in 1967.

b. Winter Season 2009

The Gavins Point average daily release was below the normal winter release rate for the entire winter season. The Gavins Point winter releases varied between 9,000 cfs to 16,000 cfs in December; 12,000 cfs to 15,000 cfs in January; and 10,000 cfs and 12,000 cfs in February. The Gavins Point reservoir (Lewis and Clark Lake) froze over on December 10, 2008 and was free of ice on March 23, 2009.

Table 8
Gavins Point – Inflows, Releases, and Elevations

Month	Ave Monthly Inflow (cfs)			Ave Monthly Release (cfs)			EOM Elevation (ft msl)		
	2009	2008	1967-2009	2009	2008	1967-2009	2009	2008	1967-2009
January	13,200	12,500	17,200	12,900	12,500	17,100	1208.0	1207.0	1207.6
February	9,300	12,200	16,400	10,300	11,800	17,300	1205.7	1207.7	1205.7
March	13,900	10,300	19,700	13,400	10,800	19,700	1207.2	1206.6	1205.6
April	16,900	15,200	25,200	17,000	14,800	25,100	1206.4	1207.1	1205.8
May	18,700	13,700	28,500	18,600	13,100	28,200	1206.4	1208.2	1206.0
June	24,800	11,200*	30,100	24,500	12,000*	29,800	1206.7	1205.9	1206.2
July	26,800	16,800	32,700	26,500	16,300	32,200	1206.9	1206.5	1206.8
August	27,500	23,000	34,900	27,300	22,800	34,500	1206.8	1206.2	1207.3
September	30,500	21,500	35,600	30,100	20,700	35,200	1206.8	1207.4	1207.7
October	29,200	18,500	34,100	28,700	18,200	33,900	1208.1	1207.8	1207.8
November	19,300	9,200	30,500	19,600	9,000	30,500	1207.3	1208.0	1207.6
December	14,800	13,400	19,200	15,800	13,500	19,200	1204.6	1207.5	1207.3

* monthly minimum of record

c. Winter River and Ice Conditions Below Gavins Point

The first signs of floating ice on the Missouri River during the 2009 winter season were noted on December 8, 2008 from Sioux City, IA downstream to Nebraska City, NE. The report showed 2 to 10% floating ice with pads ranging from 1 to 5 feet. On December 9 and 10, the Gavins Point releases were increased from 12,000 cfs up to 14,000 cfs to offset the loss in downstream flow. A second round of extreme cold temperatures in mid-December, required that the Gavins Point release be stepped from 14,000 cfs up to 16,000 cfs on December 15 to 16, 2008. During this sub-zero event, an ice bridge formed upstream from Sioux City and the winter seasons largest volumes of floating ice (20 to 80% coverage) and pad sizes (up to 60 feet in diameter) were observed. The ice bridge caused the Missouri River stage at Sioux City, IA, to drop over four feet, reaching the season's lowest stage of 5.98 feet on December 15. This dip in the Missouri River stage and flows migrated downstream arriving at Kansas City, MO on December 22 causing a drop of less than two feet to its season low of 5.31 feet .

Gavins Point releases were reduced to the 12,000 cfs to 13,000 cfs level near the end of December through early January. The volumes of floating ice fluctuated between 5 to 75% floating ice with pads ranging from 5 to 50 feet through January 20, 2010, at which time the Missouri River was free of floating ice downstream of Sioux City. The ice-free period lasted for about four days until another round of freezing temperatures occurred from January 24-29; lower volumes of floating ice were produced. Ice observers noted floating ice from 5 to 25%, with pads ranging from 5 to 25 feet in size in the Sioux City to Nebraska City, NE reach of the Missouri River. The floating ice diminished from January 29-31.

Another round of single degree temperatures arrived on February 2 and 3 and produced some small volumes of floating ice from 5 to 30% floating ice near Sioux City with pads 5 to10 feet in size. No major changes in stages occurred in the Missouri River; therefore, the Gavins Point releases were held at 11,000 cfs until February 7 when daily high temperatures climbed to an unseasonably warm 50's and 40's ^{o}F. The Gavins Point release were reduced to 10,000 cfs and remained there until February 27, 2009.

The winter's final round of below freezing temperatures came in early March, and floating ice on the Missouri River was last reported on March 13, with 15% coverage and 2 to 5 feet pans in the Sioux City, IA area.

d. Spring Open Water Season 2009

On March 1, 2009, System storage was 45.4 MAF, which was 5.4 MAF above the minimum storage level of 40 MAF needed to conduct a March pulse as per the Master Manual. The March spring pulse from Gavins Point was not conducted in 2009, due to high downstream flows. The combination of downstream flows at Kansas City and the NWS forecast for rain in the lower Missouri River basin would have pushed the Missouri River above the flow limits. The flow limits are the safeguards to reduce or eliminate the pulse to ensure that the two day pulse does not cause downstream flooding of agricultural land along the river.

Flow support for the 2009 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.

The March, April and May average monthly releases were all below normal, though not as low as the historic low levels experienced in 2007. Average monthly releases of 13,400 cfs for March were 68% of average, 17,000 cfs for April were 68% of average, and 18,600 cfs for May were 66% of average. With the much above average March and April rainfall events in the lower basin and above full-service navigation flows for Kansas City, MO from March 24 through December 7, 2009 the system releases were maintained at much lower-than-normal levels, to decrease the risk of downstream flooding.

On April 30, cycling of Gavins Point releases was initiated. Releases were varied from 15,000 cfs up to 23,000 cfs for a few hours each day. Cycling of releases is done to keep the protected least tern and piping plovers nesting high on downstream sandbars while allowing for future System release increases to support navigation. In this case, the cycling was targeted at the reach from Gavins Point Dam to the James River.

The May pulse was conducted in 2009 as shown in ***Table 9*****.** All the requirements were met: the May 1 System storage of 53.3 MAF exceeded the minimum 40 MAF storage, the downstream Missouri River flows limits were forecasted not to be exceeded, the Missouri River water temperature at Yankton exceeded 16^{o}C, and nesting activity by the protected least tern and piping plovers was considered. As shown in ***Table 9***, the May spring pulse of water from Gavins Point Dam began on noon May 18, 2009. Releases were increased from 17,000 cfs to 23,000 cfs and held for two days. Releases were then reduced gradually and reached 18,500 cfs by May 26th. This pulse of water was put into the river from Gavins Point Dam to benefit the endangered pallid sturgeon. After completion of the spring pulse, releases from Gavins Point were cycled with two days near 20,000 cfs followed by one day with 23,000 cfs.

Table 9
May 2009 Spring Rise – System Releases

Date	System Release (cfs)
May 17	17,000
May 18*	20,000
May 19	23,000
May 20*	22,100
May 21*	21,500
May 22	20,500
May 23*	20,200
May 24*	19,700
May 25*	19,300
May 26*	18,700
May 27**	23,000
May 28**	20,000
May 29**	20,000
May 30**	23,000

*Release changes were made at noon each day.
**Release cycling begins May 27 with one day of 23,000 cfs followed by two days with 20,000 cfs.

e. Summer Open Water Season 2009

The summer storms in the lower portion of the basin continued into June. Average monthly System releases were 24,500 cfs for June was more than double the 2008 monthly historic low of 12,000 cfs. For the first half of June, System releases were cycled between 21,000 cfs, the minimum release necessary to meet downstream navigation targets, and 26,000 cfs to in order to discourage endangered birds from nesting at lower levels on exposed sand bars. Due to a unit outage at Gavins Point, spillway releases were made from noon one day to noon the next day to obtain the required hours of the 26,000 cfs release. Later in June, releases were gradually increased to 27,000 cfs. During July the releases ranged from 26,000 cfs to 27,500 cfs to meet downstream navigation targets. July 1 storage check changed the navigation service level from minimum service to full service. The average monthly July release of 26,500 cfs was 5,700 cfs below the normal monthly July release. During August, releases ranged from 26,000 cfs to 28,900 cfs in order to meet navigation targets. The average monthly August release of 27,300 cfs was 79% of average.

f. Fall Open Water Season 2009

System releases were maintained in the 20,000 cfs to 31,500 cfs range in September through the middle of November to meet the downstream full service navigation targets. Releases to support navigation stopped on November 22, 2009, marking the end of a full 8-month navigation season and the first year for a full season length since 2001. In 2008, 2007, 2006, 2005 and 2004 the navigation season was shortened by 30, 35, 44, 48 and 47 days, respectively.

g. Summary

The highest Gavins Point reservoir level during 2009 occurred on October 22 at 1208.5 ft msl. The lowest reservoir level during 2009 occurred on December 29 at 1204.5 ft msl. The average annual inflow to Gavins Point of 20,400 cfs, in 2009, was 75% of average (1967-2009). The average annual release from Gavins Point of 20,400 cfs was 76% of average (1967-2009).

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. Events that occurred in connection with regulation activities during 2009 that may be considered unusual, or recently have come to the attention of MRBWM, are discussed in the following paragraphs.

1. Lawsuits

There were no lawsuits related to regulation of the Missouri River Mainstem System in 2009.

2. Fort Peck Mini-Test and Intrasystem Unbalancing

As described in the 2008-2009 AOP, the Fort Peck "mini-test" and the unbalancing of the three large upper reservoirs were not implemented due to low System storage. When System storage recovers sufficiently, the Corps will consider unbalancing the three upper reservoirs to benefit reservoirs fisheries.

The endangered species modified flow "mini-test," which was designed to monitor the effects of higher spring releases and warmer water released from the Fort Peck spillway, requires a reservoir elevation of approximately 2229 ft msl to avoid unstable flows over the spillway. In previous years, the "mini-test" was not possible because reservoir elevations during May and June were below the spillway crest elevation of 2225 ft msl.

With regard to future implementations of the Fort Peck mini-test, a priority for pallid sturgeon recovery has been placed on the Lower Yellowstone Project at Intake. The Fort Peck mini-test and full test flows will be deferred until the efficacy of the Lower Yellowstone Project has been assessed as discussed in the 2009-2010 AOP.

Unbalancing of the upper three reservoirs to benefit the reservoir fishery per the recommended Missouri River Natural Resources Committee (MRNRC) guidelines, was not done in 2009 because the March 1 reservoir elevations for Fort Peck (2210.5 ft msl) and Garrison (1823.4 ft msl) did not meet the guideline criteria (Plate 3, 2008-2009 AOP).

3. Summary of Drought Impacts

Above normal runoff in 2008 ended the 8-year (2000-2007) drought in the Missouri River basin. During this drought the System storage set a new record low of 33.9 MAF on February 8, 2007, 6.9 MAF below the record low of 40.8 MAF set in the previous drought in January 1991. System storage ended 2009 at 54.3 MAF, 10.3 MAF higher than the previous year. Because the bulk of the carryover multiple use storage is in the upper three reservoirs, Fort Peck, Garrison, and Oahe reservoirs set new record low pool levels during the 2000-2007 drought. The increase in storage during 2008 and 2009 was an improvement from the 2000-2007 drought, greatly reduced the drought impacts that had been felt across the basin. During the 2000-2007 drought some of the municipal, rural, industrial, and irrigation water intakes in the reservoirs and along the river reaches were forced to make modifications to maintain access to the water. Many of the boat ramps were extended, relocated or closed as the reservoir levels declined. During the drought conditions through the mid-2008 the coldwater habitat in the reservoirs was dramatically reduced threatening the viability of the coldwater fisheries. However, with the higher pool elevations in 2009 there was an appreciable increase in the coldwater habitat in the upper three reservoirs. As the lake levels rise, cultural resources are vulnerable to damage from wave action and bank erosion. Cultural resources sites that have eroded are endanger to looting and human disturbance. The noxious weeds have become less problematic as thousands of acres of bare shoreline are cover with water as the lake levels rose in 2009.

The only authorized purpose that is not adversely impacted by the drought is flood control, which is actually enhanced during drought conditions. As a result of the higher reservoir levels improved service was provided to all other authorized purposes. Users who rely on the Missouri River need to closely monitor current and forecasted river and reservoir conditions and take necessary steps to ensure they can function through a wide range of river flows and reservoir levels.

E. Reservoir Elevations and Storage

Reservoir elevations and storage contents of the System reservoirs at the end-of-July 2009 are presented in ***Table 10*** and the same information for end-of-December 2009 is presented as ***Table 11***. The 12-month change columns indicate significant increases in the elevations and storages in the upper three large storage reservoirs with two of the three reservoirs rising into the annual flood control pool.

Table 10
Reservoir Levels and Storages – July 31, 2009

Project	Reservoir Elevation		Water in Storage – 1,000 AF		
	Elevation (ft msl)	12-Month Change (ft)	Total	Above Min. Level*	12-Month Change
Fort Peck	2220.5	+10.5	12,153	8,065	+1,585
Garrison	1842.3	+16.7	19,610	14,630	+4,933
Oahe	1612.7	+18.8	20,427	15,054	+5,421
Big Bend	1420.3	+0.2	1,640	19	+9
Fort Randall	1355.0	-0.7	3,528	2,011	-55
Gavins Point	1206.9	+0.4	364	57	-6

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

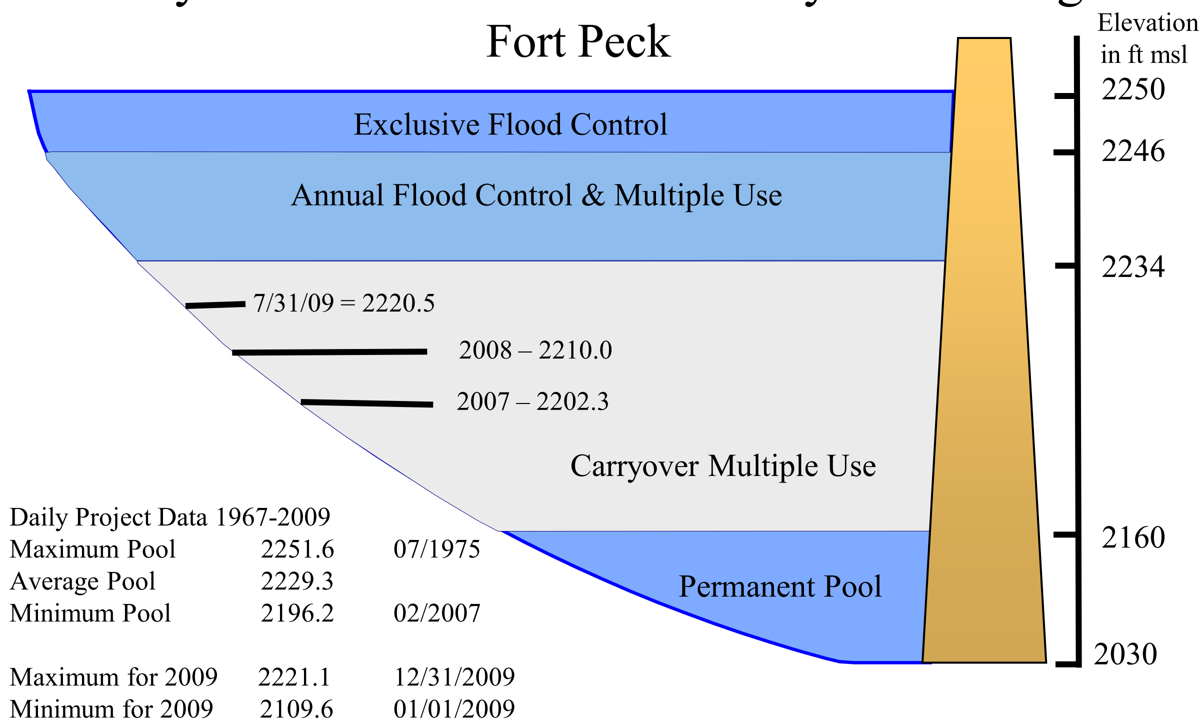
Table 11
Reservoir Levels and Storages – December 31, 2009

Project	Reservoir Elevation		Water in Storage – 1,000 AF		
	Elevation (ft msl)	12-Month Change (ft)	Total	Above Min. Level*	12-Month Change
Fort Peck	2221.1	+11.4	12,266	8,178	+2,012
Garrison	1840.0	+15.3	18,850	13,870	+4,393
Oahe	1607.4	+14.5	18,807	13,434	+4,101
Big Bend	1420.2	-0.3	1,628	7	-22
Fort Randall	1339.7	-1.2	2,415	898	-73
Gavins Point	1204.6	-2.9	310	3	-86

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

Figure 8 show the end-of-July pool elevations for Fort Peck, Garrison, and Oahe plus total System end-of-July storage for 2007 through 2009. Individual tables with the historic maximum, average, and minimum pool elevations for each reservoir are also shown on ***Figure 8.*** During 2009, the upper three reservoirs all had higher July 31 pool levels than 2008. All three reservoirs experienced their historical minimum record pool levels during 2005 or 2006. On July 31, 2009 Fort Peck Lake was at elevation 2220.5 ft msl, 10.5 feet higher than at the same time in 2008. On July 31, 2009 Lake Sakakawea was at elevation 1842.3 ft msl, 16.7 feet higher than at the same time in 2008.

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



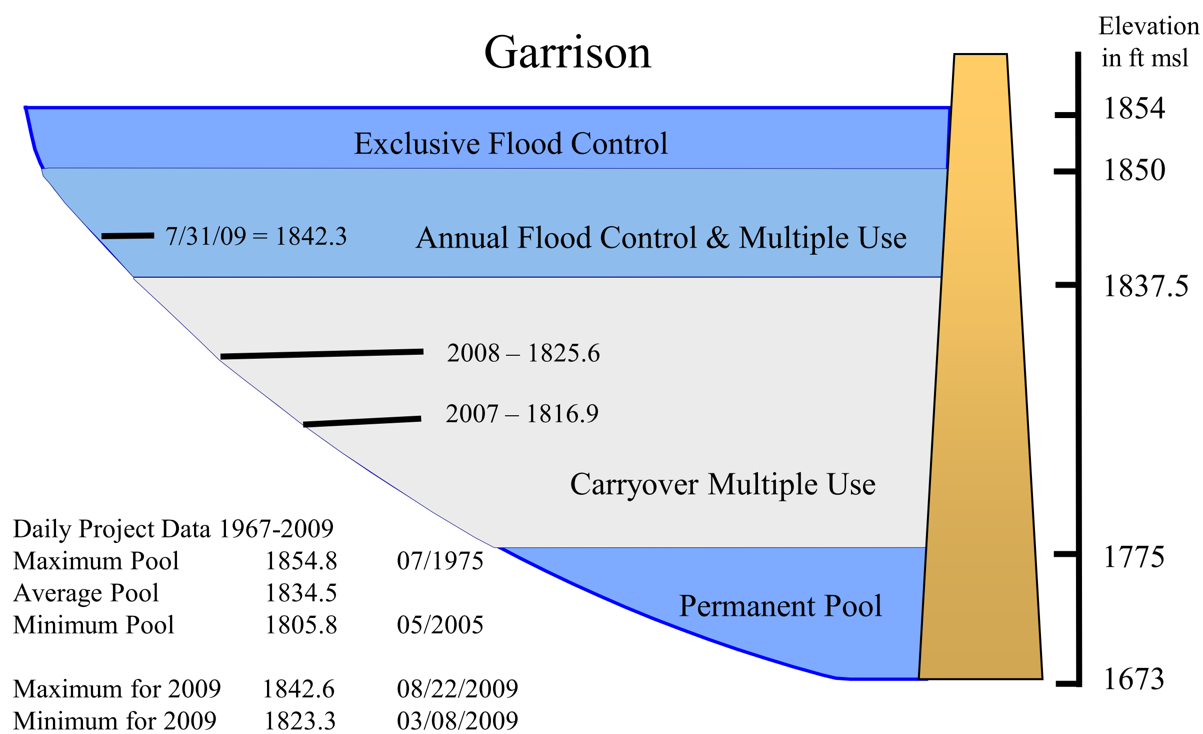
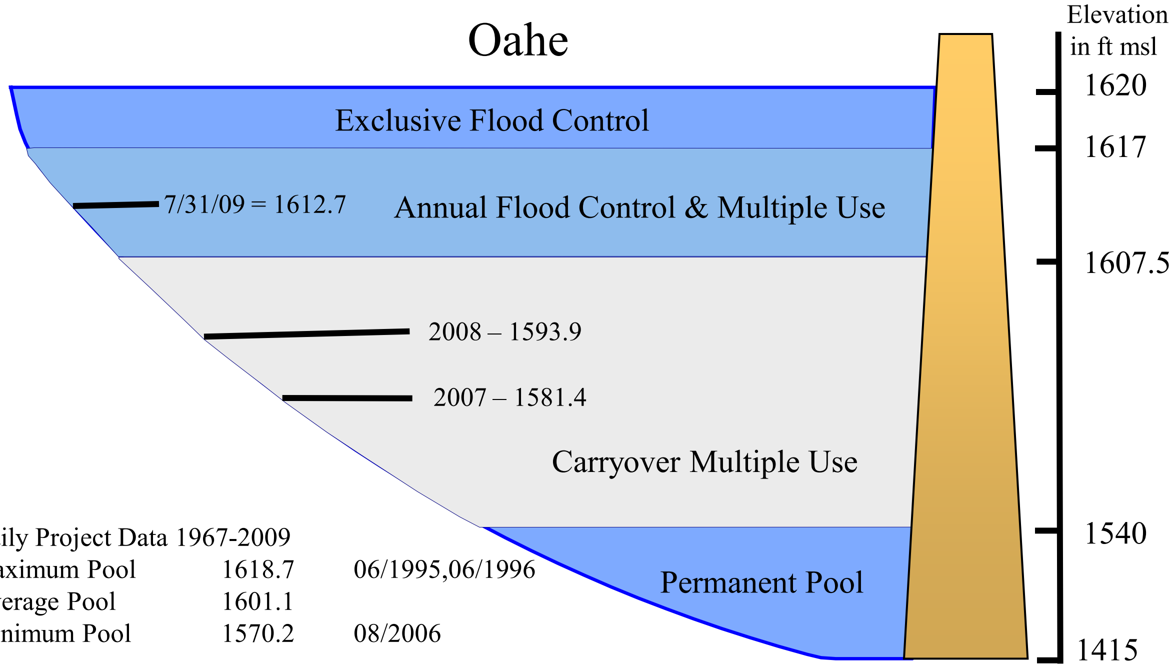


Figure 8. End of July pool elevations for Fort Peck, Garrison, Oahe, and total System Storage.

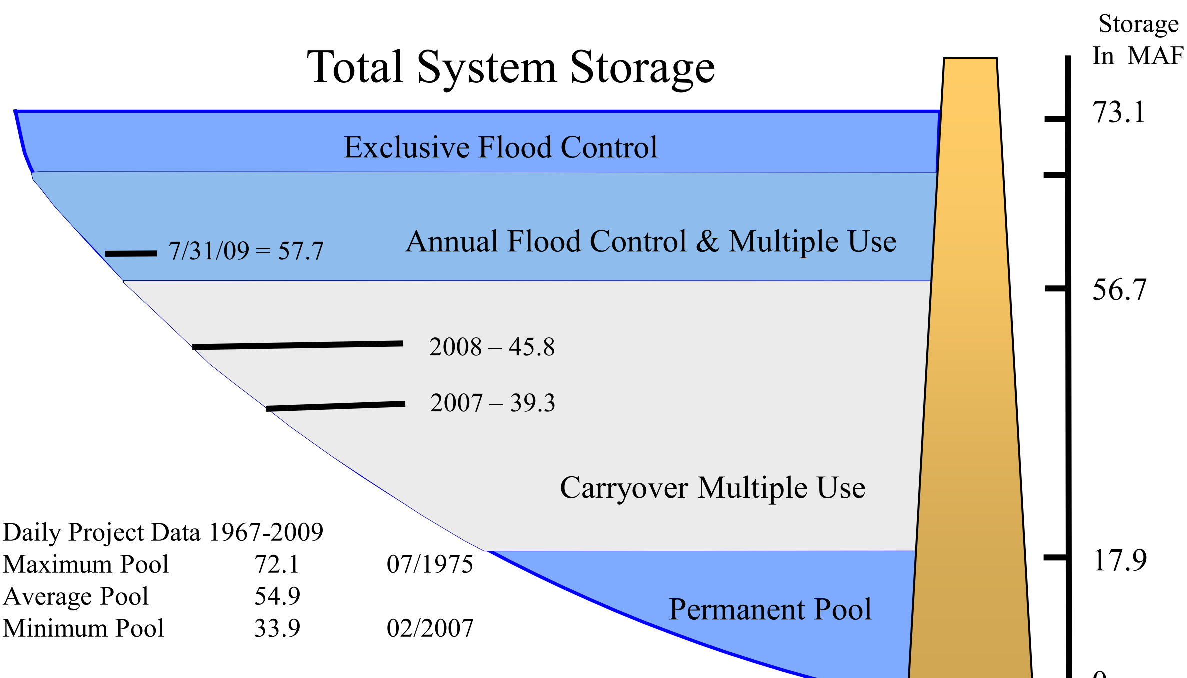
Missouri River System Reservoirs
End of July Pool Elevations and Total System Storage

Oahe



Daily Project Data 1967-2009		
Maximum Pool	1618.7	06/1995,06/1996
Average Pool	1601.1	
Minimum Pool	1570.2	08/2006
Maximum for 2009	1613.9	06/07/2009
Minimum for 2009	1592.5	01/10/2009

Total System Storage



Daily Project Data 1967-2009		
Maximum Pool	72.1	07/1975
Average Pool	54.9	
Minimum Pool	33.9	02/2007
Maximum for 2009	57.9	07/20/2009
Minimum for 2009	43.9	01/01/2009

Lake Oahe was at elevation 1612.7 on July 31, 2009, 18.8 feet higher than at the same time in 2009. The storage gain in Oahe was due to the plains snowmelt in addition to lower-than-normal System releases in March, April and May.

F. Summary of Results

1. Flood Control

Releases during 2009 were influenced by the efforts to refill the reservoir system from the 2000-2007 drought and high downstream runoff from rainfall events.

Mountain snowpack was slightly above normal and plains snowpack was significantly above normal. This resulted in higher than normal inflows from March – July. However, because of adequate flood control storage space being available in the system, high evacuation releases were not necessary during 2009.

The estimated total flood damages prevented by all Corps projects in the basin during 2009 exceeded $4.9 billion ($695 million Omaha District; $4.16 billion Kansas City District). The estimated total flood damages prevented by the System during 2009 was $3.3 billion (***Figure 9A***). The total damages prevented by the System in the Missouri River basin include $425,769,300 in the Omaha District and $2,882,731,600 in the Kansas City District. The unindexed flood damages prevented by the System since construction now total $24.9 billion, the bulk of which was prevented between 1993 and 1999 (see ***Figure 9B***). ***Figure 9B*** indicates the flood damages prevented indexed to 2009. For comparison purposes, ***Figures 9A*** and ***9B*** also include the construction cost of the dams.

***Figure* 10** shows the actual regulated Missouri River flows that were experienced at Sioux City, Nebraska City and St. Joseph and the unregulated flows that would have been experienced if the System and tributary reservoirs had not been in regulation.

2. Irrigation

Federally developed irrigation projects are not being served directly from System reservoirs. The reservoirs, however, are being utilized by numerous private irrigators as well as Federally financed projects that take water from the river. About 900 private irrigators pump directly from the reservoir or river reaches. Releases from the reservoirs during 2009 generally met the needs of irrigators. For the reach downstream of Fort Peck summer releases were held to a daily average of 6,500 cfs with a minimum hourly release of 4,500 cfs to meet the needs of irrigators. At some intakes below Fort Peck dredging was necessary to maintain access to the water. The reduction of releases from Fort Peck and Garrison in September occurred after irrigation was finished for the season.

Missouri River Mainstem Reservoirs Flood Damages Prevented

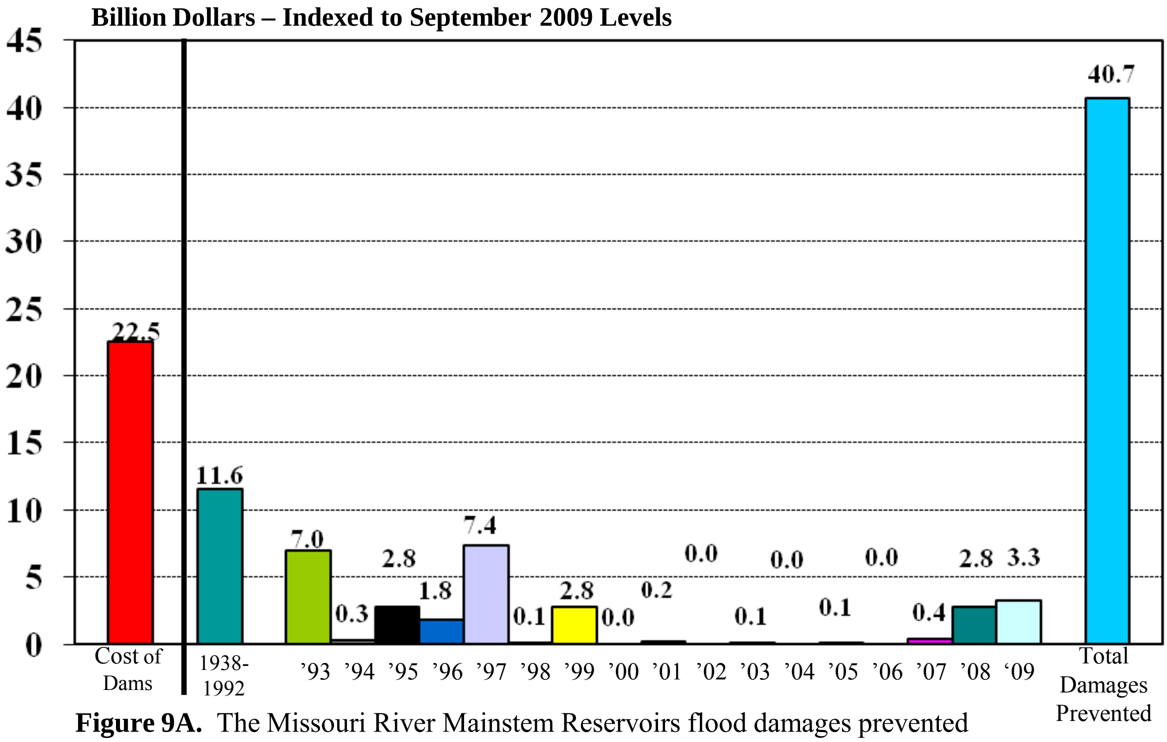


Figure 9A. The Missouri River Mainstem Reservoirs flood damages prevented index to September 2009 levels.

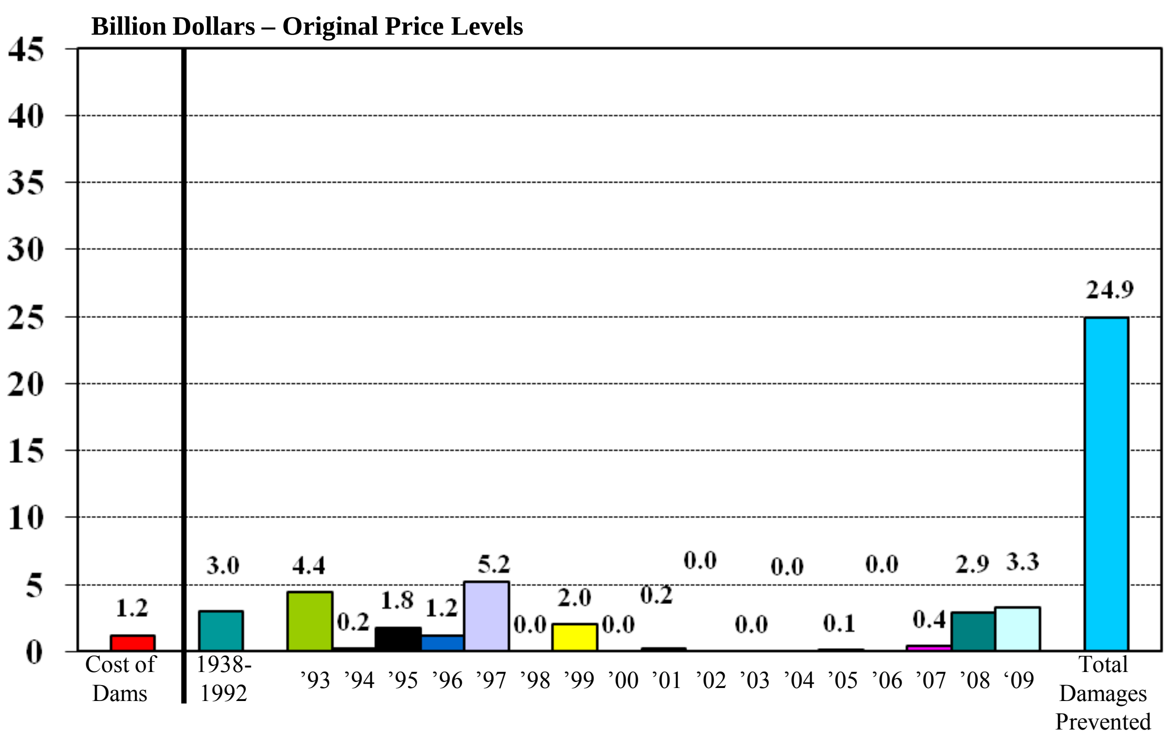
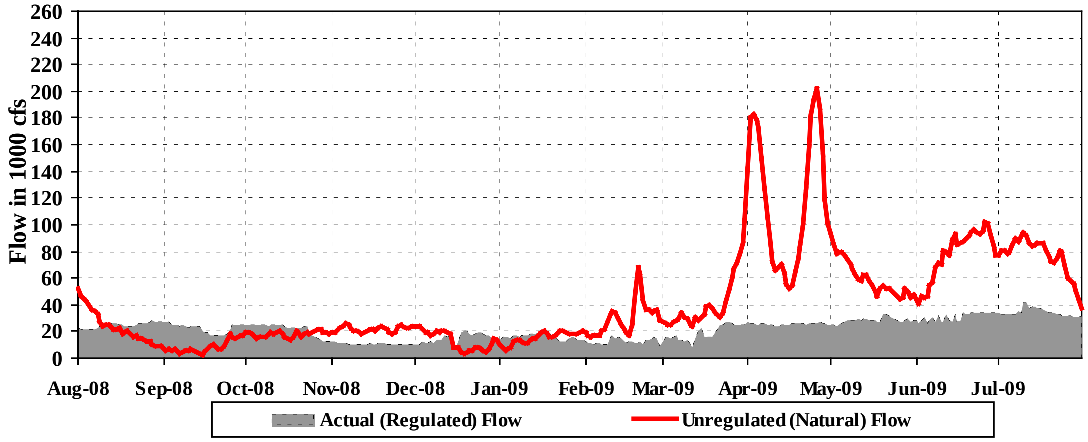
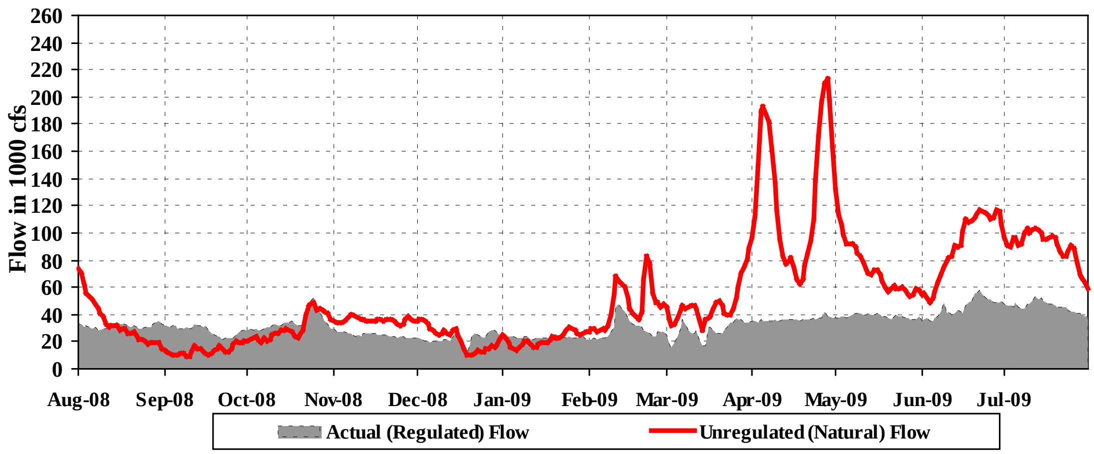


Figure 9B. The Missouri River Mainstem Reservoirs flood damages prevented index to original price levels.

Missouri River at Sioux City, IA – Actual and Unregulated Flows



Missouri River at Nebraska City, NE – Actual and Unregulated Flows



Missouri River at St. Joseph, MO – Actual and Unregulated Flows

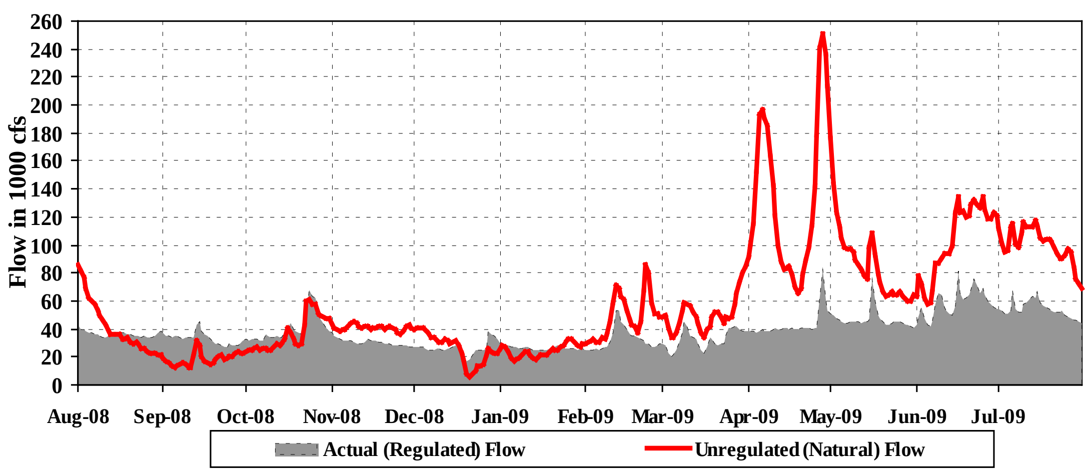


Figure 10. Actual and unregulated flows – Sioux, IA, Nebraska City, NE and St Joseph, MO.

3. Water Supply and Water Quality Control

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. In emergency situations, short-term adjustments to protect human health and safety would be considered to keep M&I intakes functioning. Low reservoir levels during the 2000-2007 drought contributed to both intake access and water quality problems for intakes on Garrison and Oahe reservoirs, including several Tribal intakes; however better runoff in 2008 and 2009 has eliminated concern over many of these intakes. Gains in the Oahe pool level required modification of the Standing Rock Sioux Tribe's temporary intake at Fort Yates to protect it from the rising water levels. The Bureau of Reclamation (BOR) installed the temporary intake after the primary intake failed in November 2003 leaving the community without water for several days. If the drought re-emerges, reservoir pool levels and releases may decline renewing the potential for intake access and water quality problems at both river and reservoir intakes. By the end of 2009, pool levels for all three upper reservoirs were between 20 and 35 feet higher than the record lows set in the current drought.

Due to ice jams on the Missouri River in the vicinity of Bismarck and Mandan in March 2009, the State of North Dakota requested that releases from Garrison be reduced to zero. Initially, thermal power plants which use the river for cooling were not affected by the zero releases due to the large inflows from the Knife River. However, as flows on the Knife River started to recede two large power plants the Great River Energy's Stanton and the Basin Electric's Leland Olds, both located downstream of the Knife River, were shutdown on March 27. The zero flows also affected the City of Washburn's water treatment plant intake located on the Missouri River. Without sufficient flows on the Missouri River to dilute the sediment laden water from the Knife River, Washburn's water treatment facility could not effectively eliminate all bacteria from the water and residents were told to boil the water before drinking.

Intake owners today are generally better prepared to handle periods of low water due to adjustments made to intakes or regulations procedures. The intake owners have made various adjustments to their operations to account for low water levels. 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 were expensive, they have significantly improved the ability of the intakes to operate at lower river stages and reservoir levels.

During 2009, the Omaha District conducted long-term, fixed-station ambient water quality monitoring at the System reservoirs and the lower Missouri River. Water quality conditions of the water discharged through each of the System dams was continuously monitored (i.e., hourly data-logging and monthly sampling). Intensive water quality surveys were conducted at Big Bend and Gavins Point.

The Omaha District was identified eight priority water quality issues that have relevance to the System projects. These identified priority issues are:

1) Determine how regulation of the Missouri River Mainstem System (Mainstem System) dams affects water quality in the impounded reservoir and downstream river. Utilize the CE-QUAL-W2 hydrodynamic and water quality model to facilitate this effort.
2) Evaluate how eutrophication is progressing in the Mainstem System reservoirs, especially regarding the expansion of anoxic conditions in the hypolimnion during summer stratification.
3) Determine how flow regime, especially the release of water from Mainstem System projects, affects water quality in the Missouri River.
4) Determine how current water quality conditions in the Missouri River (e.g., water temperature, turbidity, etc.) may be affecting pallid sturgeon populations in the Missouri River system.
5) Provide water quality information to support Corps reservoir regulation elements for effective surface water quality and aquatic habitat management.
6) Provide water quality information and technical support to the Tribes and States in the development of their Section 303(d) lists and development and implementation of TMDLs at District Projects.
7) Identify existing and potential surface water quality problems at District Projects and develop and implement appropriate solutions.
8) Evaluate surface water quality conditions and trends at District Projects.

Table 12 provides a summary of water quality issues and concerns at each of the System projects, based on Omaha District monitoring and a review of current State water quality reports.

Maintaining coldwater habitat in Lake Sakakawea during late summer has proved to be a challenge during periods of drought. During the six year period 2003 through 2008, pool elevations in Garrison reached levels where reduced hypolimnetic volume of cold water, in concert with the degradation of dissolved oxygen in the deeper water of the reservoir, limited the maintenance of coldwater habitat through the end of the summer thermal stratification period. A return to more normal pool elevations in 2009 allowed cold water habitat to adequately be maintained. Water temperature and dissolved oxygen levels are primary water quality factors that determine the suitability of water for coldwater aquatic life.

Table 12
Water Quality Issues and Concerns

Project	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	Lead Mercury	No	Yes	Mercury	---
• ***Missouri River, Fort Peck Dam to the Milk River***	Yes (MT)	Aquatic Life Cold Water Fishery	Water Temperature	No	No	---	---
• ***Missouri River, Milk River to the Poplar River***	Yes (MT)	Aquatic Life Warm Water Fishery	Water Temperature	No	No	---	---
• ***Missouri River, Poplar River to North Dakota***	Yes (MT)	Aquatic Life Warm Water Fishery	Water Temperature	No	No	---	---
Garrison • Lake Sakakawea	Yes (ND)	Fish and Other Aquatic Biota Fish Consumption	Low Dissolved Oxygen Water Temperature Methyl-Mercury	No	Yes	Mercury	Hypolimnetic 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	No	---	---	---	No	---	---
Big Bend • Lake Sharpe	No	---	---	Yes	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	---	---
• ***Missouri River, Fort Randall Dam to Lewis and Clark Lake***	No	---	---	---	No	---	---
Gavins Point • Lewis and Clark Lake	No	---	---	---	No	---	Sedimentation Emergent aquatic vegetation
• ***Missouri River, Gavins Point Dam to the Big Sioux River***	No	---	---	---	No	---	---
• ***Missouri River, Big Sioux River to Platte River***	Yes (NE)	Aquatic Life	Dieldrin PCBs	No	Yes	Dieldrin PCBs	Summer ambient water temperature (NPDES limitations regarding cooling water discharges)
• ***Missouri River, Boyer River to Council Bluffs water supply intake***	Yes (IA)	Drinking Water	Arsenic	No	No	---	---
• ***Missouri River, Platte River (NE) to Kansas***	Yes (NE)	Recreation Aquatic Life	*E. coli* Dieldrin PCBs	Yes (*E. coli*)	Yes	Dieldrin PCBs	Summer ambient water temperature (NPDES limitations regarding cooling water discharges)

* Information taken from published state Total Maximum Daily Load (TMDL) 303(d) reports and listings as of January 1, 2010.

The State of North Dakota has defined optimal coldwater fish habitat in Lake Sakakawea as being ≤15°C and having dissolved oxygen levels ≥ 5 mg/l. The State recently promulgated the following water quality standards to protect coldwater habitat in Lake Sakakawea:

- A hypolimnetic maximum temperature criterion of 15°C for Class 1 lakes and reservoirs (*i.e.*, Lake Sakakawea) that are thermally stratified.
- Lake Sakakawea must maintain a minimum volume of water of 500,000 acre-feet that has a temperature of 15 °C or less and a dissolved oxygen concentration of not less than 5 mg/l.

Water temperature and dissolved oxygen concentration depth profiles that were measured through water quality monitoring conducted at the Lake Sakakawea during 7-year period 2003 through 2009 were used to estimate the volume of water in the reservoir that meets the optimal coldwater habitat conditions defined by the State of North Dakota. ***Plate 3*** shows estimated reservoir and optimal coldwater habitat volumes by year for 2003 through 2009. Optimal coldwater habitat estimated in the Lake Sakakawea during 2009 was significantly greater compared to the earlier years, and was the only year during the 7-year period that the 500,000 acre-feet minimum water quality standards criterion for optimal coldwater habitat was seemingly met.

The reduction of coldwater habitat in the reservoir is exacerbated by the releases from the Garrison Dam intake structure. Because the invert elevation of the intake portals to the power tunnels (i.e., penstocks) is two feet above the reservoir bottom (1672 ft msl), water drawn through the penstocks comes largely from the lower depths of the reservoir. Thus, during the summer thermal stratification period, water is drawn from the coldwater habitat volume of the reservoir. Three water quality management measures were identified for implementation in an effort to preserve the coldwater habitat in the reservoir. These measures, which were first implemented at Garrison in July 2005 included: 1) installation of plywood barriers to the dam's intake trash racks, 2) utilization of head gates to restrict the opening to the dam's power tunnels, and 3) modification of the daily flow cycle and minimum flow releases from the dam. The three implemented water quality management measures were targeted at drawing water into the dam from higher elevations within the reservoir, and were implemented through September 2009.

With the return of normal pool elevations to Lake Sakakawea in 2009, the implemented water quality management measures were ended. The plywood barriers were removed from the Garrison Dam intake trash racks in October 2009.

Pool levels in Lake Sakakawea recovered to 1825 ft msl in late July 2008. However, ***Plate 3*** indicates that optimal coldwater habitat did not show a similar recovery. Pool levels in Lake Sakakawea were still low in early June 2008 when the thermocline formed in the reservoir sealing off the hypolimnion (i.e., pools levels recovered after the hypolimnion was established). Thus, the higher pools levels seemingly did not occur early enough to allow for an increased hypolimnetic volume. In 2009, Lake Sakakawea experienced normal pool levels throughout the year, and the optimal coldwater habitat estimated to be present in late summer seemingly met the State identified minimum criterion of 500,000 acre-feet.

The initial application of the CE-QUAL-W2 hydrodynamic and water quality model to Lake Sakakawea was completed and a report prepared. The initial application of the model showed good success in predicting pool levels and water temperature and dissolved oxygen conditions for the reservoir. The model was utilized to assess the impact of the implemented water quality measures on preserving optimal coldwater habitat. The modeling indicated the implemented measures had a small but seemingly positive effect in preserving optimal coldwater habitat. A hypothetical high-level reservoir withdrawal for power production was modeled (i.e., reservoir withdrawal was limited to an elevation of 1775 ft msl which is the top of the permanent pool). Based on modeling results, a high-level reservoir withdrawal would significantly increase optimal coldwater habitat in Lake Sakakawea during the summer and increase water temperatures and dissolved oxygen in the Missouri River downstream of Garrison Dam. Efforts are currently underway to further calibrate the CE-QUAL-W2 model to Lake Sakakawea by applying the water quality data collected at the reservoir during 2008 and 2009.

4. Navigation

The first towboat using the Missouri River in 2009 was the *MV Leslie Ann*, owned by Jefferson City River Terminal. The towboat left its moorings at river mile 143 on March 25, 2009 with four empty barges headed to Hannibal, MO on the Mississippi River to load cement. The first towboat to travel upstream of Kansas City, MO occurred on April 14, 2009. The towboat was the *MV Captain Wes Gossett*, owned by Excell Marine. The *MV Captain Wes Gossett's* tow consisted of two loaded barges and two empty barges headed to Nebraska City, NE and then arrived at Blair, NE on April 17, 2009. There were no tows with a Sioux City, IA destination during 2009. The *MV Captain Wes Gossett* made five more trips to Blair during 2009 to load alfalfa pellets at the Consolidated Blenders Terminal for shipment to Guntersville, AL on the Tennessee River. The last towboat to use the Missouri River was again the *MV Leslie Ann* moving empty barges to Washington and Hermann, MO and finally on December 10, 2009 mooring for the winter at Jefferson City River Terminal.

Even though the drought ended in 2007, system storage had not fully recovered and there was minimum navigation service for the first half of the season. On July 1, 2009, the reservoir system storage check, releases were increased to provide full service navigation flows that provided the authorized 9 ft deep x 300 ft wide channel. The improved storage also provided a full 8 month system supported navigation season for the first time since 2003.

Table 13 shows Missouri River tonnage data for 2005 – 2008 compiled by the Waterborne Commerce Statistics Center (WCSC). The total of 5.7 million tons includes 5.4 million tons for sand and gravel, 0.08 million tons for waterways materials, and 0.175 million tons for long-haul commercial tonnage. The reduction of total tonnage of about 1.0 million tons compared to 2007 was due to permit restrictions on the sand and gravel mining companies and the reduced construction business concrete demand from the economic stress that began during 2007. The 175,000 long haul commercial tonnage decreased over 127,000 tons from 2007, a record low since 1949. The largest total

Table 13
Missouri River Tonnage by Commodities (In Thousands of Tons)

Commodity Classification Group	2005	2006	2007	2008
Farm Products	9	12	0	0
Corn	9	12	0	0
Wheat	0	0	0	0
Soybeans	0	0	0	0
Misc Farm Product	0	0	0	0
Nonmetallic Minerals	7540	8043	6283	5415
Sand/Gravel	7540	8043	6281	5415
Misc Nonmetallic	0	0	2	0
Food and Kindred	1	21	28	16
Pulp and Paper	0	0	0	0
Chemicals	7	14	7	5
Fertilizer	4	12	5	4
Other Chemicals	3	2	2	1
Petroleum (including coke)	180	81	132	87
Stone/Clay/Glass	88	67	130	55
Primary Metals	0	0	0	0
Waterway Materials	111	57	101	81
Other	0	0	3	12
Total Commercial	7936	8295	6684	5671
Total Long Haul Commercial	285	195	303	175

tonnage year was 2001, 9.7 million tons. The largest long-haul commercial tonnage year, excluding sand, gravel, and waterway material, occurred in 1977 (3.34 million tons). ***Figure 11A*** shows total navigation tonnage on the Missouri River and ***Figure 11B*** shows the long haul commercial navigation tonnage. Missouri River long-haul commercial tonnage in 2009 is currently estimated to total about 245,000 tons, based on towboat activity and barge counts from the Corps' daily boat reports. ***Figure 12A*** shows the navigation tonnage value of the commodities since 1960, using 2010 present-worth computations. ***Figure 12B*** shows the navigation tonnage value of long-haul commercial commodities since 1960. The ***Figure 11A*****,** ***11B*****,** ***12A*** and ***12B*** tonnages and tonnage values for 2009 are estimates and will change once final WCSC tabulations are available.

Navigation season target flows for past years are given in ***Table 14***. ***Table 15*** shows the scheduled lengths of past reservoir system supported navigation seasons with total tonnage and ton-miles for each year.

Figure 13 presents discharge data at Sioux City, IA; Nebraska City, NE; and Kansas City, MO for the August 2008 through December 2009 period. The three graphs demonstrate that actual flows at these locations are influenced considerably by System releases. Tributaries between Gavins Point and Kansas City provided much inflow during the navigation season.

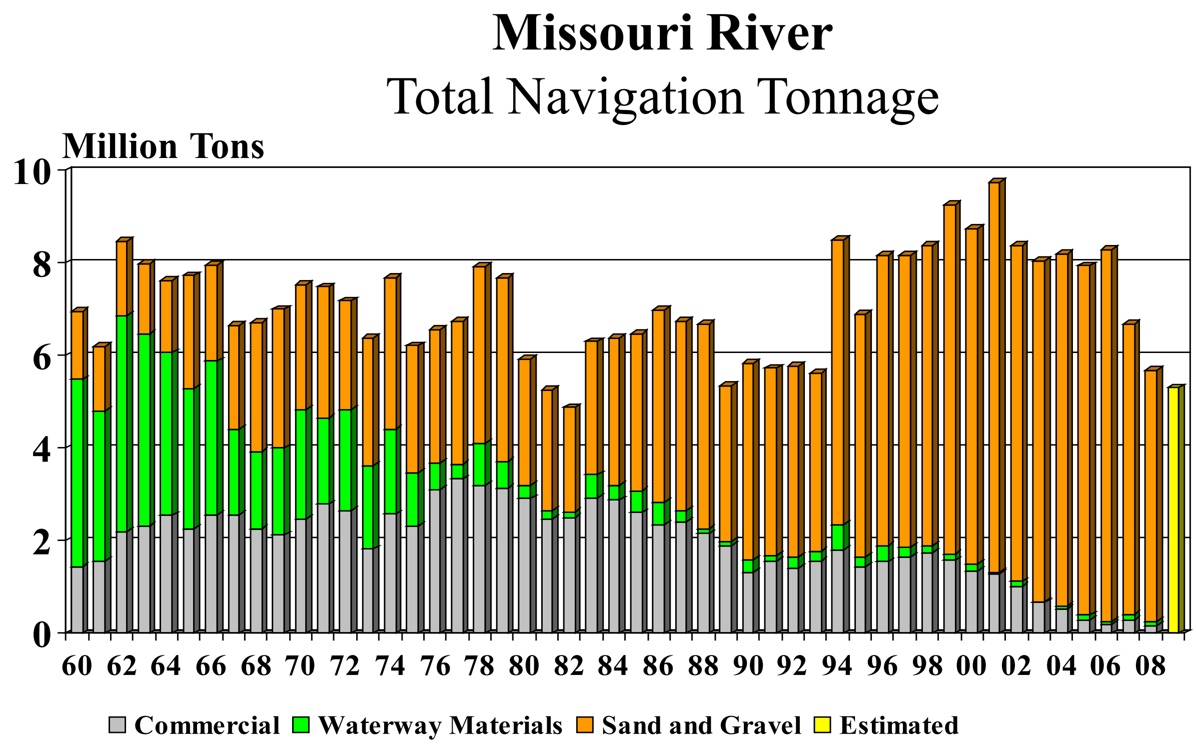


Figure 11A. Missouri River total navigation tonnage from 1960 to 2009 (estimated)

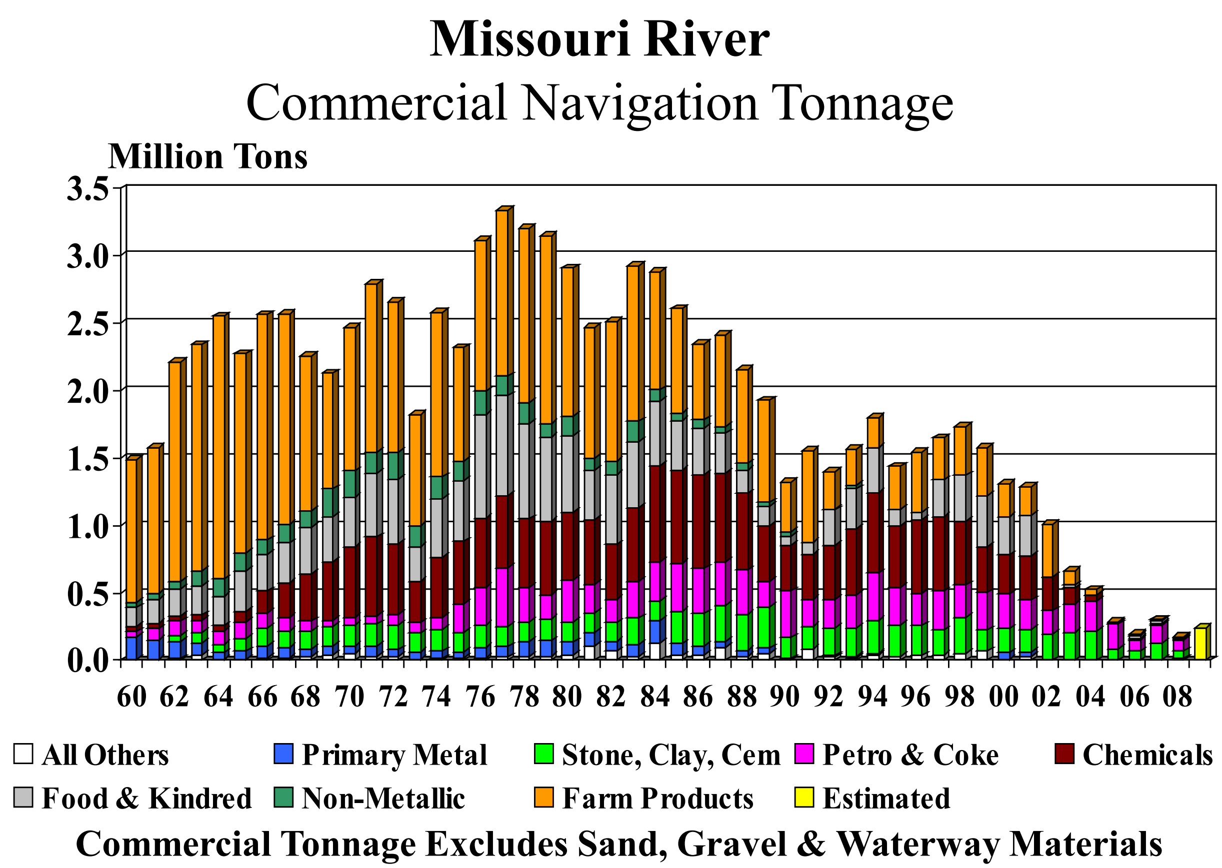


Figure 11B. Missouri River commercial navigation tonnage from 1960 to 2009 (estimated)

Missouri River

Total Navigation Tonnage Value - 2009 Present Worth

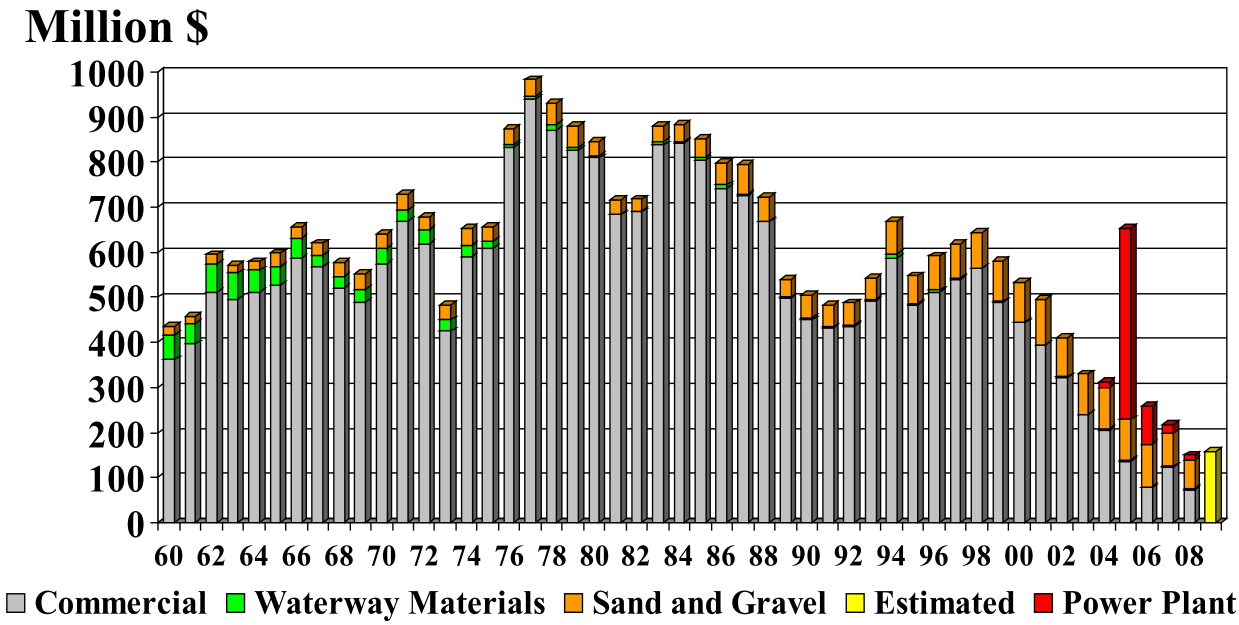
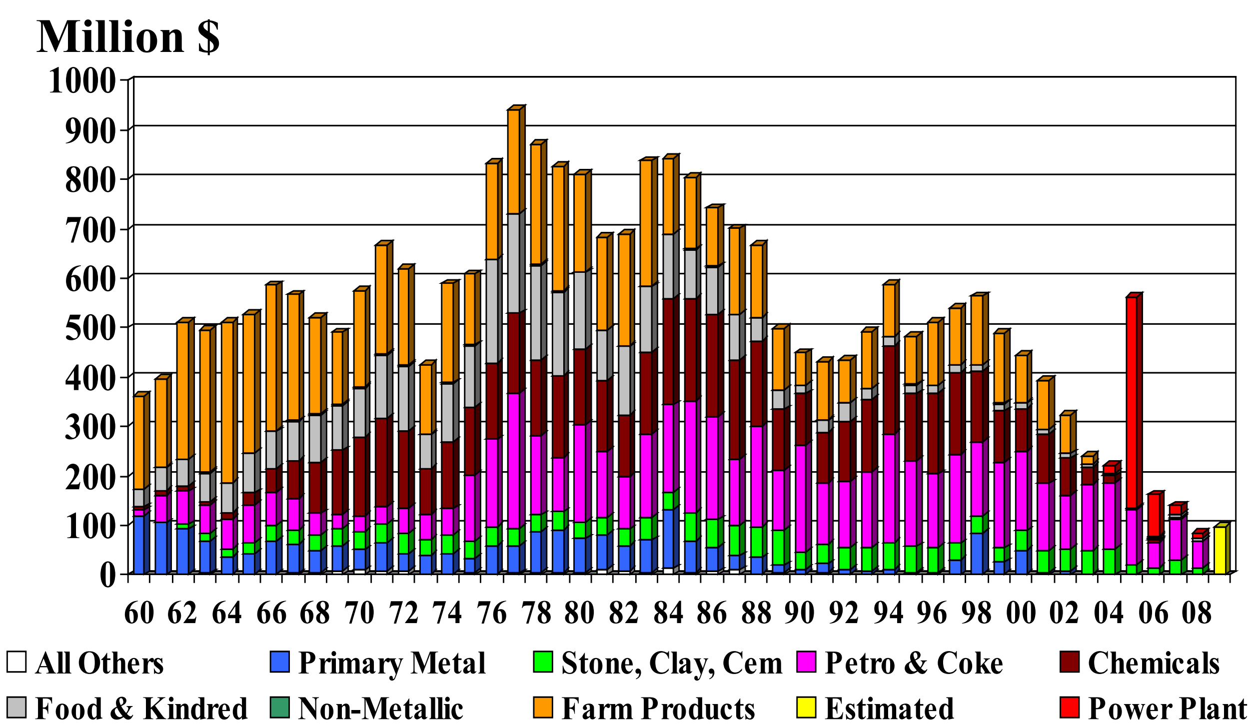


Figure 12A. Total navigation tonnage value using 2010 present worth computations

Missouri River

Commercial Navigation Tonnage Value - 2009 Present Worth



Commercial Value Excludes Sand, Gravel & Waterway Materials

Figure 12B. Commercial navigation tonnage value using 2010 present worth computations

Table 14
Navigation Season Target Flows
in 1,000 cfs

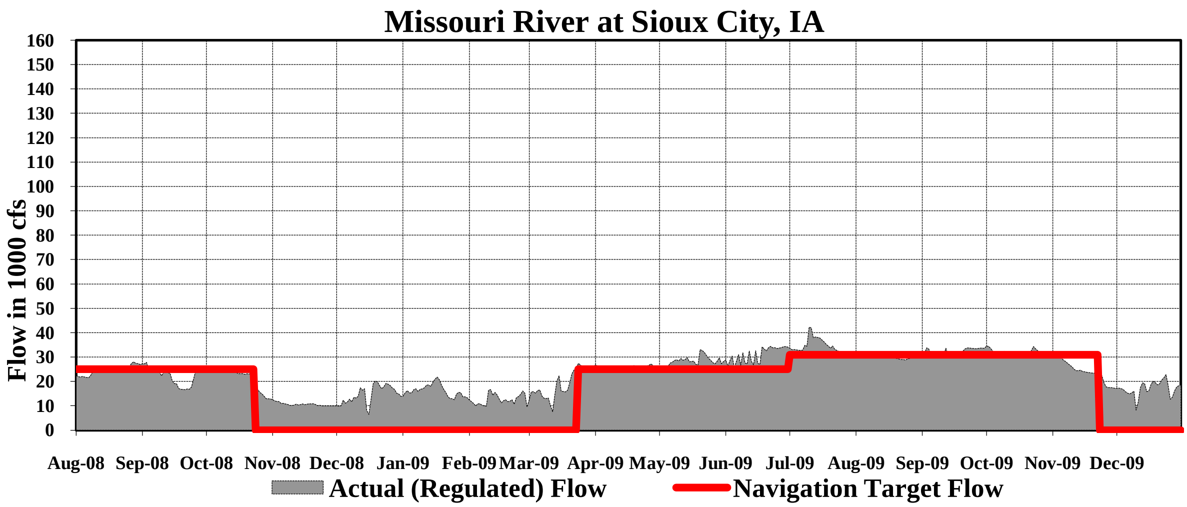
Year	Months	Sioux City	Omaha	Nebraska City	Kansas City
1967	Apr-Jun	28	28	34	38
	Jul-Nov	31	31	37	41
1968	Apr-Nov	31	31	37	41
1969	Apr-Jun(1)	35.0-40.0	35.0-40.0	41.0-46.0	45.0-50.0
	Jul(1)	36	36	42	46
	Aug-Sep(1)	50.0-55.0	50.0-55.0	55.0-60.0	55.0-60.0
	Oct-Nov(1)	40.0-45.0	40.0-45.0	45.0-50.0	50.0-55.0
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)	45.0-50.0	45.0-50.0	50.0-55.0	55.0-60.0
1972	Apr-Nov(1)	40.0-50.0	40.0-50.0	45.0-55.0	50.0-60.0
1973-74	Apr-Nov	31	31	37	41
1975	Apr	31	31	37	41
	May-Nov(1)	35.0-60.0	35.0-60.0	41.0-66.0	45.0-70.0
1976	Apr-Jul(1)	34.0-38.0	34.0-38.0	40.0-44.0	44.0-48.0
	Aug-Dec(1)	31.0-34.0	31.0-34.0	37.0-40.0	41.0-44.0
1977	Apr-Nov	31	31	37	41
1978	Apr	31	31	37	41
	May-Jul(1)	35.0-46.0	35.0-46.0	41.0-52.0	45.0-56.0
	Aug-Nov(1)	46.0-51.0	46.0-51.0	52.0-57.0	56.0-61.0
1979	Apr-Jul(1)	36.0-42.0	36.0-42.0	42.0-48.0	46.0-52.0
	Aug-Nov(1)	31.0-36.0	31.0-36.0	37.0-42.0	41.0-46.0
1980	Apr-Nov	31	31	37	41
1981	Apr-Nov(2)	31	31	37	41
1982	Apr-Sep	31	31	37	41
	Oct	31.0-36.0	31.0-36.0	37.0-42.0	41.0-46.0
	Nov-Dec(1)	36.0-46.0	36.0-46.0	42.0-52.0	46.0-56.0
1983	Apr-Jun	31	31	37	41
	Jul	31.0-36.0	31.0-36.0	37.0-42.0	41.0-46.0
	Aug-Nov(1)	36	36	42	46
1984	Apr-Jun	31	31	37	41
	Jul-Dec(1)	31.0-44.0	31.0-44.0	37.0-50.0	41.0-54.0
1985	Apr-Dec	31	31	37	41
1986	Apr(1)	36.0-41.0	36.0-41.0	42.0-47.0	46.0-51.0
	May-Dec(1)	41.0-46.0	41.0-46.0	47.0-52.0	51.0-56.0
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)	46.0-56.0	46.0-56.0	52.0-62.0	56.0-66.0
1996	Apr(1)	41	41	47	51
	May(1)	41.0-51.0	41.0-51.0	47.0-57.0	51.0-61.0
	Jun-Dec(1)	56	56	62	66
1997	Apr-Dec(5)	*	*	*	*
1998	Apr-Dec(5)	31	31	37	41
1999	Apr-Dec(1)	31.0-43.0	31.0-43.0	37.0-49.0	41.0-53.0
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

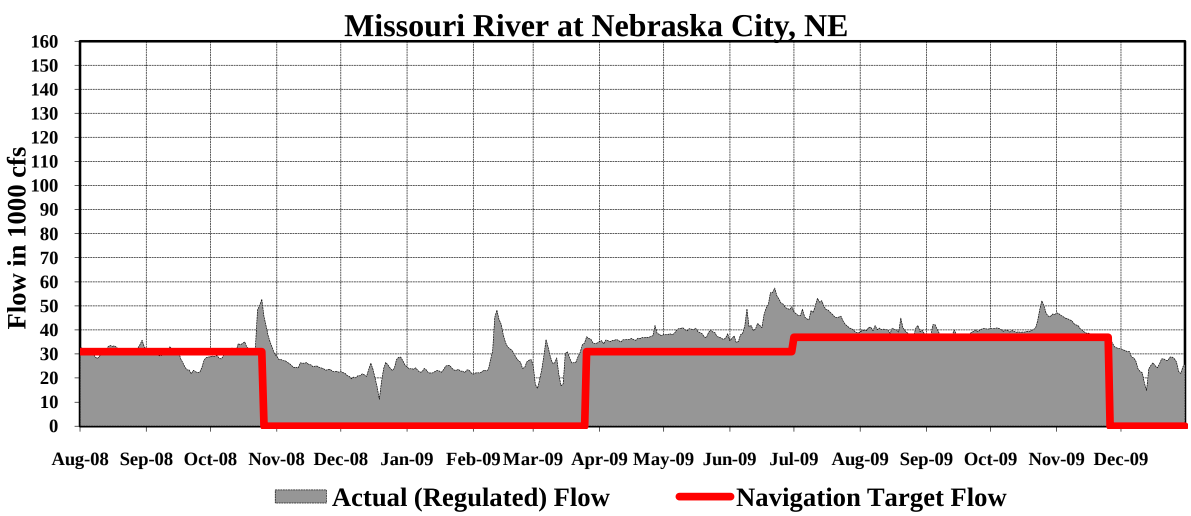
(1) Downstream flow targets above full-service navigation level as a flood control storage evacuation measure.
(2) Full service flows provided for shortened season.
(3) Navigation targets below full service as a water conservation measure.
(4) Navigation targets at minimum service as a water conservation 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 15
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	6 3/4 (11)	174,800	5,670,968	86,203
2009	8	245,000(12)	5,305,000(12)	100,000(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.





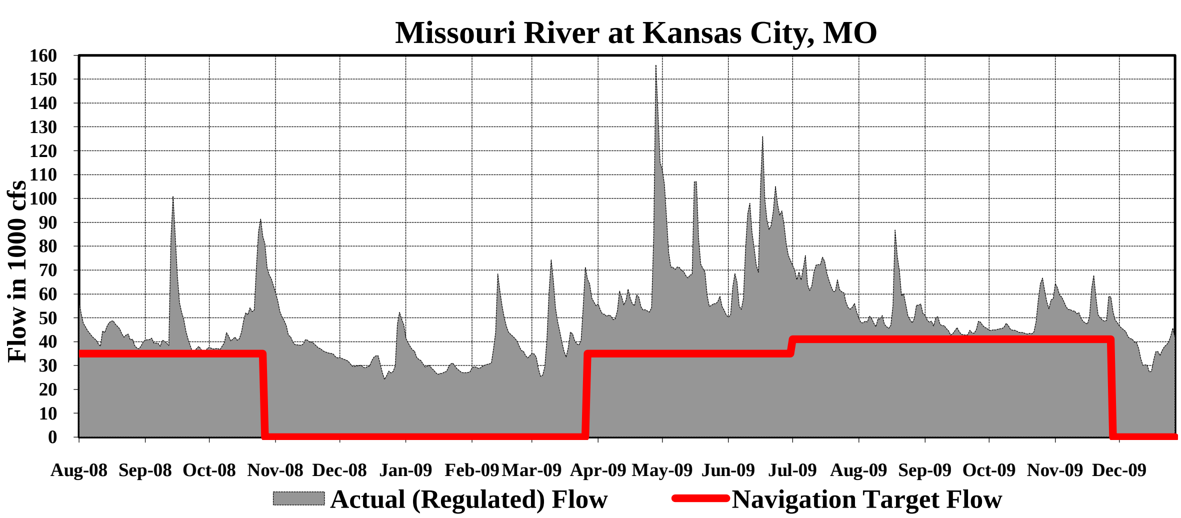


Figure 13. Actual and navigation target flows – Sioux City, IA, Nebraska City, NE, and Kansas City, MO.

Supplemental Missouri River navigation support was provided by releases from Kansas River reservoir projects from October 2 to November 10. The releases were primarily from the Tuttle Creek. Refer to Section II.C. of this report for further discussion on System releases during the 2009 navigation season.

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

The energy generated in 2009 was transmitted over a Federal transmission system that traverses 7,747 circuit miles. This past year, service was provided to over 360 wholesale customers. Customers in a 6-state area receiving direct service include 199 municipalities, 1 Federal agency, 30 state agencies, 28 BOR projects, 5 irrigation districts, 36 rural electric cooperatives, 6 public utility districts, 11 private utilities, 27 Native American Services, and 24 power marketers. Additional benefits were provided by the interconnections to the Southwestern and Bonneville Power Administrations and other areas of the Western Area Power Administration (Western). Statistics from the Omaha Public Power District (OPPD) show that the average customer uses approximately 11,750 kilowatt hours (kWh) of energy annually. Based upon the total System generation of 6.6 billion kWh, the energy generated in CY 2009 by this portion of the Federal power system could have supplied all of the yearly needs of about 562,000 residential OPPD customers. In addition to the clean, renewable energy transmitted to the Midwest area, the hydropower system provides an added measure of stability to the regional power system with the ability to meet full load in 5 seconds or less. Large coal-fired and nuclear units are reinforced by idle hydropower units, typically in 30 seconds. Outside utilities can have access to the hydropower capability within several minutes of a known problem.

The excellent reliability of the hydropower system is indicated by having to maintain a 10% reserve, while thermal power must maintain a 15% reserve. Although the Federal hydropower system that serves the Missouri River region accounts for only 9% of the region's energy, it is large enough to fill gaps and provide a positive benefit to the integrated system.

Generation in 2009 of 6.6 billion kWh was 71% of average since the System first filled in 1967. The total gross generation for 2009 was 6,607,670 MWh, over 1,695,368 MWh higher than the record low of 4,912,302 MWh, set in 2008. Energy generation was much improved in 2009 but still below normal due to the continued recovery of the reservoir system from the drought. While the annual runoff was above normal, the reservoir releases were still below normal. This allowed both Garrison and Oahe to exceed the top of the multipurpose pool for the first time since 2002. Fort Peck power plant releases were held as low as possible, while meeting other purposes for the entire year in an effort to fill its multipurpose pool. Western purchased about 5.2 billion kWh between January 1, 2009 and December 31, 2009, at a cost of $180.0 million to supplement System hydropower production.

System generation with individual project distribution for each calendar year since 1954 is shown on ***Figure 14***. The gross generation from the Federal system (peak capacity and energy sales) for 2009 is shown in ***Table 16***. The tabulations in ***Table 17*** and ***Table 18*** summarize the total gross generation and power regulation 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 16
Gross Federal Power System Generation – January 2009 through December 2009

	Energy Generation 1,000 kWh	**Peak Hour kWh**	**Generation Date**
Corps Power Plants – Mainstem			
Fort Peck	581,171	137,000	01 Oct
Garrison	1,495,848	431,000	28 Aug
Oahe	1,858,099	724,000	22 Aug
Big Bend	691,970	420,000	20 Jun
Fort Randall	1,337,457	353,000	03 Aug
Gavins Point	643,125	113,000	24 Sep
Corps Subtotal	**6,607,670**	**1,869,000**	26 Aug
USBR Power plants			
Canyon Ferry	391,295	55,000	May
Yellowtail*	443,897	115,000	Jun
USBR Subtotal	**835,192**	**170,000**	
Federal System Total	**7,442,862**	**2,039,000**	

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

Mainstem Power Generation 1954-2009

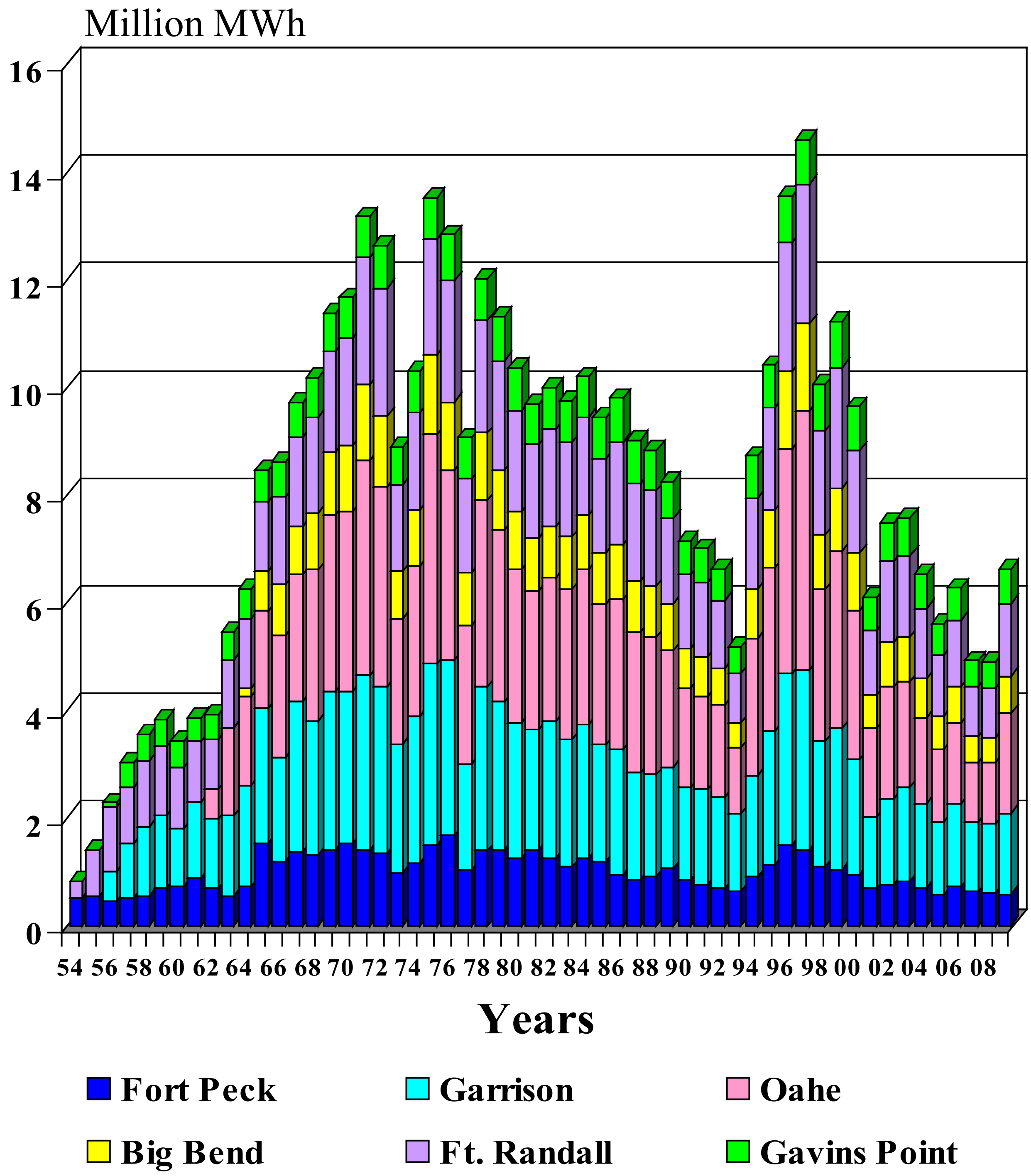


Figure 14. Mainstem power generation by project from years 1954 to 2009.

Table 17

Historical Generation and Load Data - Peaks
Eastern Division, Pick-Sloan Missouri River Program*
Data at plant - 1,000 kW
January 1, 2009 through December 31, 2009

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	1,432		65		1,497		850		2,347	15-Jan	8:00
February	1,063		78		1,141		865		2,006	26-Feb	20:00
March	954		78		1,032		806		1,838	10-Mar	21:00
April	698		57		755		420		1,175	1-Apr	8:00
May	923		127		1,050		401		1,451	28-May	17:00
June	1,294		169		1,463		372		1,835	25-Jun	17:00
July	1,593		118		1,711		300		2,011	27-Jul	15:00
August	1,699		87		1,786		50		1,836	13-Aug	19:00
September	1,719		83		1,802		150		1,952	15-Sep	17:00
October	904		95		999		905		1,904	28-Oct	20:00
November	1,420		100		1,520		558		2,078	30-Nov	19:00
December	1,039		67		1,106		954		2,060	29-Dec	8:00

* This tabulation summarizes the total gross generation and power operations for the Eastern Division marketing area system shown on Table 16.
** During hour of peak total system load

Table 18

Historical Generation and Load Data - Total
Eastern Division, Pick-Sloan Missouri Basin Program*
Data at plant - 1,000 kWh
January 1, 2009 through December 31, 2009

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	407,478		56,894		464,372		607,821		1,072,193
February	355,919		52,564		408,483		518,472		926,955
March	384,486		53,001		437,487		530,451		967,938
April	390,229		66,508		456,737		514,003		970,740
May	499,995		82,936		582,931		456,678		1,039,609
June	659,078		105,319		764,397		399,006		1,163,403
July	747,268		111,528		858,796		301,443		1,160,239
August	780,835		67,084		847,919		265,320		1,113,239
September	802,337		58,131		860,468		234,591		1,095,059
October	607,693		57,474		665,167		376,173		1,041,340
November	379,776		57,873		437,649		481,381		919,030
December	529,602		65,880		595,482		567,073		1,162,555

*Powerplants from Table 16

6. Fish Management

Rainbow smelt are the primary forage species in both Garrison and Oahe. 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 1-foot deep and are subject to desiccation through wave action and slight drops in water level. In the Fort Peck reservoir, a forage fish spawn normally occurs between April 15 and May 30. As per the 2008-2009 AOP, if runoff was not sufficient to keep all pool levels rising during the fish spawn in 2009, the Corps would, to the extent reasonably possible, set releases to result in a steady-to-rising pool level in Lake Sakakawea from April 20 to May 20. Due to plains and mountain snowmelt runoff, Fort Peck and Garrison rose steadily from April through June. Oahe rose quickly during April and the first part of May, and then remained nearly steady through June.

Higher water levels led to improvements in virtually all components of the Lake Sakakawea fishery in 2009. Smelt abundance improved modestly but remained well below desirable levels. Body condition and growth rates of game fish improved substantially from the record lows of the last few years. Natural reproduction of several species including yellow perch, northern pike and sauger was exceptional due to good reservoir inflows and inundation of extensive amounts of flooded vegetation.

In the reservoir Oahe, fish production was excellent in 2009 for all species except shad. The reservoir rose more than 19 feet above the peak in 2008, flooding terrestrial vegetation and providing good young-of-the-year nursery habitat. Indications are for favorable fishing in future years.

The recovery from the 2000-2007 drought continued in 2009, and Lake Sakakawea pool elevations returned to normal. Optimal coldwater habitat estimated in the Lake Sakakawea during 2009 was significantly greater compared to earlier years. The plywood barriers that had been installed on the trash racks on the intake structures were removed in October 2009. More information on the coldwater habitat can be found in the Water Supply and Water Quality Control section. As shown on ***Plate 3***, these measures preserved coldwater habitat through the summer, but the volume of optimal habitat continues to be very low for a few weeks in the late summer.

7. Threatened and Endangered Species

This was the 24th year of reservoir regulation since the piping plover and least tern were Federally listed as threatened and endangered species, respectively. This was the fourth year of operating for the endangered pallid sturgeon per the revised Master Manual. No March pulse from Gavins Point was released in 2009 due to forecasted flows in excess of the downstream flow limits. The May pulse had a peak magnitude of 6,000 cfs for two days. Total releases went from 17,000 cfs prior to the pulse to a peak release 23,000 cfs. Releases were stepped back to the navigation service level of 18,500 cfs over the next 8 days. Refer to Section II. 6. d. for details on the bimodal Spring pulse.

The least terns and plovers nest on sparsely vegetated sandbars, islands, and shoreline of the Missouri River and the reservoirs. Stream gages have been installed on 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 gaging data must be supplemented with observations of nesting activities and conditions to provide the information that is needed for regulation. A dynamic flow routing model has been developed to accurately predict river stages along the river for different combinations of daily and hourly power peaking.

Beginning in 1999, the 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 messages. This database provided vital information again during the 2009 nesting season and proved to be a valuable tool in aiding release decisions benefiting the 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 previously disappointing low fledging. The record fledging that occurred for both species between 1998 and 2005 can be attributed to the large amount of habitat created by the high flows of 1997 and the declining reservoir levels during the 2000-2007 drought. The creation of additional habitat has also allowed greater flexibility in the release levels at the lower two System projects.

During 2009 the majority of plovers were found on the river reaches below Garrison and Gavins Point and to a lesser extent on the shoreline of Oahe reservoir. In recent years, the majority of plovers were found on the shoreline of Garrison and Oahe reservoirs and below Gavins Point. Higher pool levels at Garrison and Oahe reduced habitat in those areas. The majority of the terns nested on habitat in the Gavins Point reservoir and in the river reach below Gavins Point. The 2003 amended Biological Opinion (BiOp) described an anticipated level of loss of tern and plover eggs and chicks due to management of the Missouri River reservoirs. The loss due to reservoir operations in 2009 was less than anticipated in the BiOp. A total of nine Interior Least Tern and 167

Piping Plover eggs were determined to be lost due to water management operations. No chicks were determined to be lost due to water management operations. The rapid rise in the Garrison reservoir elevation due to mountain snowmelt caused the majority of the plover losses. A detailed description of the factors affecting tern and plover nesting, fledge ratios, habitat conditions and creation activities can be found in the Missouri River Recovery Program 2009 Annual Report (www.moriverrecovery.org).

The population distribution and productivity for terns and plovers for 1986 through 2009 are shown on ***Table 19*** and ***Table 20***. Productivity estimates for these birds on the Missouri River does not include least terns and piping plovers raised in captivity. The captive rearing facility had not been utilized since 2002. Adult birds in ***Tables 19*** and ***20*** 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. This ratio is an estimate, as the fate of every single fledgling is impossible to ascertain.

Table 19
Missouri River System
Interior Least Tern Survey Data

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Fort Peck Lake																								
Adults	-	4	3	4	6	10	0	7	9	2	0	0	4	0	0	0	0	2	0	0	2	2	0	0
Fledglings/Pair	-	-	0	3.00	-	0.40	{}	0	0.44	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
Fort Peck to Lake Sakakawea																								
Adults	-	-	18	48	92	66	110	31	58	95	128	162	25	40	13	39	34	38	48	34	36	77	22	46
Fledglings/Pair	-	-	0.33	0	0.17+	0.55+	0.25+	0.45+	1.41+	0.99+	0.33	0.53	.1.52	1.70	0.15	0.97	0.59	0.63	0.50	2.18	1.17	1.38	1.45	0.87
Lake Sakakawea																								
Adults	-	-	7	15	6*	8	29+	17	35	7	27	2	23	9	10	34	21	25	16	26	48	53	14	15
Fledglings/Pair	-	-	0	0	-	-	0.83+	0.12+	0	0	0.15	0	1.04	0.67	0.20	0.76	0.86	0.56	0.88	0.31	0.71	0.72	2.57	1.07
Garrison to Lake Oahe																								
Adults	171	175	142	121	174	195	198	145	217	284	105	41	141	105	105	125	126	144	142	157	139	123	73	108
Fledglings/Pair	-	-	0.93	0.43	0.44+	0.58	0.48	0.28	0.54	0.91	0.08	0.39	1.52	1.50	1.03	1.26	1.83	1.28	1.13	0.73	0.81	1.06	1.34	0.48
Lake Oahe																								
Adults	16*	21*	82	97	100	143	124	125	160	84	74	101	110	57	85	94	106	70	73	131	128	186	111	71
Fledglings/Pair	0.75	1.62	0	0	-	-	0.42	0	0.06	0	0.24	0.16	1.29	0.88	1.01	1.34	1.32	1.20	1.26	0.87	1.14	0.48	0.58	0.96
Ft. Randall to Niobrara																								
Adults	25	60	0	4	26	32	13	38	43	10	2	0	64	124	72	71	84	50	71	76	55	74	58	23
Fledglings/Pair	0.48	0.43	0	0	0.31+	0.63	0.46	0	0	0	0	0	0.94	1.03	1.26	0.14	0.71	0.92	0.37	0.47	0.69	0.30	1.14	0.43
Lake Lewis and Clark																								
Adults	0	0	45	29	63	55	29	76	44	16	28	60	120	76	44	58	46	46	13	4	0	85	225	214
Fledglings/Pair	-	-	0.13	0.62	0.35+	0	1.59	0.97	0	0	0	1.57	2.33	0.21	0.38	1.17	1.04	0.39	0.00	0.00	0.00	1.58	0.67	0.76
Gavins Point to Ponca																								
Adults	181	232	252	210	167	193	187	272	211	93	82	115	148	161	149	232	314	366	359	476	383	410	278	211
Fledglings/Pair	0.26	0.46	0.49	0.55	0.46+	0.26	0.21	0.83	0.48	0.49	0.27	0.90	2.27	2.41	1.72	1.09	1.32	0.75	1.04	1.34	0.63	0.59	1.14	1.00
Total Adults	393	492	549	528	634	702	690	711	777	591	446	481	635	572	551	653	731	741	722	904	802**	1,010	781	696
Fledglings/Pair	0.26	0.46	0.59	0.54	0.38	0.41	0.42	0.50	0.41	0.67	0.21	0.66	1.73	1.42	1.22	1.04	1.27	0.87	0.95	1.09	0.80**	0.75	0.98	0.80

5-Year Running Average Interior Least Tern Fledge Ratio Goal = 0.94

- Data not collected
* Partial Survey Results
{} No Birds Found
\+ Subsampling of Selected Nesting Areas

** includes adults and fledglings from Lake Francis Case
The data does not include least terns and piping plovers raised in captivity. The data represents 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.

Table 20
Missouri River System
Piping Plover Survey Data

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Fort Peck Lake																								
Adults	16	10	20	12	22	25	26	30	4	5	0	0	4	2	0	4	2	17	9	26	20	16	9	12
Fledglings/Pair	-	-	1.70	1.50	3.18	1.20	1.00	0.60	1.50	1.20	0	0	0	2.00	0	1	2	0.35	2.22	1.08	1.2	0.5	0.22	0.33
Fort Peck to Lake Sakakawea																								
Adults	-	-	5	11	17	13	0	4	9	20	24	23	4	5	4	3	2	6	0	2	5	0	0	0
Fledglings/Pair	-	-	0	0.18	0	0	{}	0+	0	3.50	1.00	0.87	1.00	0	0	1.33	0	2.67	0	4	0.4	0	0	0
Lake Sakakawea																								
Adults	-	-	143	57	132	150	108	8	45	24	70	3	119	83	277	424	469	528	738	746	430	399	363	85
Fledglings/Pair	-	-	0	0	-	-	1.50	8.5+	1.24	0	0.57	0.67	1.24	1.25	1.61	1.25	1.65	1.06	1.5	0.89	0.61	0.7	0.68	0.21
Garrison to Lake Oahe																								
Adults	139	160	113	84	71	124	77	127	119	261	45	6	74	139	99	149	119	149	164	220	175	222	218	275
Fledglings/Pair	-	-	0.97	0.26	1.04+	1.13+	1.06+	0.54+	0.87	0.87	0.09	0	1.84	0.88	1.41	1.53	2.03	1.66	1.16	0.8	0.77	0.97	1.37	0.94
Lake Oahe																								
Adults	4*	4*	55	140	88	87	143	66+	85	30	21	31	98	46	141	184	203	301	372	364	331	273	281	158
Fledglings/Pair	-	2.50*	0	0	-	-	0.97+	0.33	0.09	0.93	0.29	1.29	1.06	0.30	1.45	1.41	2.16	1.84	1.41	1.21	0.99	0.62	0.9	0.47
Ft. Randall to Niobrara																								
Adults	11	16	0	0	12	25	8	12	17	0	3	0	33	51	62	38	35	37	42	42	37	21	26	16
Fledglings/Pair	0.18	0.13	0	0	0.67*	0.48	0.75	0	0	0	0	0	1.27	1.02	0.87	0.74	1.03	1.46	0.71	0.81	0.38	0	1	1
Lake Lewis and Clark																								
Adults	0	0	31	18	30	33	6	32	12	4	6	32	84	67	28	34	44	14	0	24	4	20	57	122
Fledglings/Pair	-	-	0.06	0.56	0.67+	0	0	0.06	0.33	0	0	1.25	2.45	0.30	0.5	0.71	1.68	1.57	0	0.17	0.5	1.8	1.37	1.8
Gavins Point to Ponca																								
Adults	172	177	212	122	148	166	112	109	62	63	22	22	49	141	186	218	260	286	262	340	309	300	320	238
Fledglings/Pair	0.05	1.13	0.62	0.21	0.39+	0.35	0.34	1.06	0.61	0.16	0	0	2.20	1.60	2.17	1.85	2.29	1.9	1.87	1.97	0.78	0.39	1.39	1.09
Total Adults	342	367	579	444	521	623	480	388	353	407	191	117	465	534	797	1054	1134	1338	1587	1764	1311	1251	1274	906
Fledglings/Pair	0.06	1.08	0.73	0.32	0.76	0.62	0.94	0.76	0.61	0.84	0.39	0.87	1.61	1.01	1.58	1.41	1.91	1.5	1.49	1.15	0.78	0.66	1.06	0.94

10-Year Running Average Piping Plover Fledge Ratio Goal = 1.22

- Data not collected
* Partial Survey Results
{} No Birds Found
\+ Subsampling of Selected Nesting Areas

The data does not include least terns and piping plovers raised in captivity. The data represents 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.

8. **Recreation and Resource Management**

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 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 the drought. Low pool levels at the upper three reservoirs make some boat ramps unusable, expose large areas of beach and sometimes make areas of the reservoirs unreachable. Thus, low pools adversely affect recreation activities such as boating, fishing, swimming, and camping.

However there were effects downstream as well. The use of the water conservation measure to only provide navigation flow support when commercial tows are scheduled to utilize a reach of the river has negatively impacted some marinas located downstream of the System during the drought. System storage is conserved annually when only those reaches with tows operating in them obtain flow support from the System. This reduced release rate has at times negatively affected marinas from Gavins Point to below Omaha. Most marina operators have chosen to dredge their marinas deeper but those that have not have suffered periods of inoperability as a result of the lower flows.

Due to the improved runoff and low System releases in 2008, and the large runoff in 2009, recreational access at the upper three reservoirs has improved since the drought of 2000-2007. During 2008 the Corps spent approximately $1,366,000 extending and relocating boat ramps to maintain public access where such work was feasible. During 2009 only $5,746 was spent on extending and relocating boat ramps, all of it at Fort Peck. Of the 11 reservoir access areas located on the Fort Peck reservoir, 9 ramps were usable for all or most of the 2009 recreation season. At Garrison, 34 of the 36 reservoir access areas were available for the majority of the recreation season. At Oahe, all 49 access areas in North Dakota and South Dakota were available. 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.

During 2009, public use at these reservoirs totaled 42,038,100 visitor hours, a 2% decrease from 2008. Visitor attendance figures at the System projects from 2006 through 2009 are shown in ***Table 21***. Overall visitation did not change notably from 2008 to 2009. ***Figure 15*** displays recreation related visitor hours at each of the six mainstem projects for the years 1954 through 2009. Although the drought had an impact on visitation during the years from 2000-2007, much of the reduction shown in ***Figure 15*** is attributed to the data collection changes associated with the South Dakota Title VI land transfer mentioned previously. Since the land transfer occurred, the Corps has not collected visitation data consistent with previous years at the recreation sites in South Dakota. The 2009 visitation in South Dakota presented in ***Table 21*** and ***Figure 15*** reflects water-related use on the reservoirs but not the visitation at the campgrounds that were turned over to the State of South Dakota and the Tribes.

Table 21
Visitation at System Reservoirs in Visitor Hours

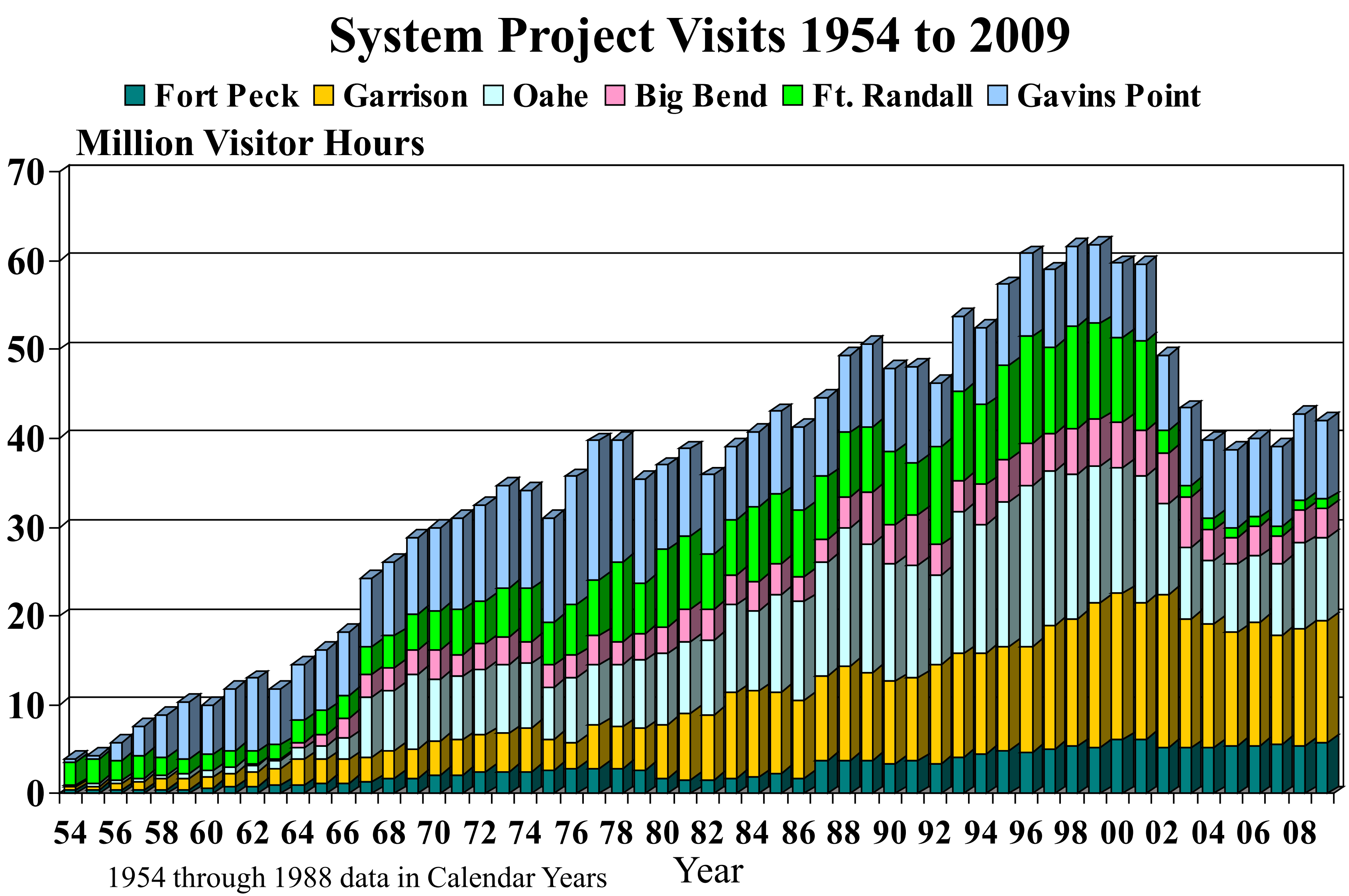
Mainstem Project	2006	2007	2008	2009	Percent Change 2008-2009
Fort Peck	5,374,200	5,630,400	5,443,000	5,820,400	+7 %
Garrison	14,016,900	12,309,600	13,121,800	13,773,900	+5 %
Oahe	7,386,000	8,045,400	9,641,300	9,322,300	-3 %
Big Bend	3,325,000	3,096,900	3,794,000	3,210,200	-15 %
Fort Randall	1,033,400	1,000,100	1,139,800	1,030,900	-10 %
Gavins Point	8,928,300	9,075,100	9,612,300	8,880,300	-8 %
System Total	**40,063,900**	**39,157,500**	**42,752,300**	**42,038,100**	**-2 %**

The reporting method was changed from recreation days to visitor hours in 1987, and the reporting period was changed from calendar year to fiscal year in 1989 for all Corps projects. All Corps projects, including the System projects, are now reporting visitation using the Visitation Estimation Reporting System (VERS).

9. Cultural Resources

As acknowledged in the 2004 Programmatic Agreement (PA) for the Operation and Management of the Missouri River Mainstem System, wave action and the fluctuation of reservoirs levels results in erosion along the banks of the reservoirs. During drought conditions cultural resource sites are exposed as the pool levels decline. Despite higher reservoir levels in 2009 a number of sites were affected. The Corps will continue to work with the Tribes utilizing 36 CFR Part 800 and the PA to address the exposure of sites. The objective of a programmatic agreement is to deal "…with the potential adverse effects of complex projects or multiple undertakings…" The objective of the PA was to collaboratively develop a preservation program that would avoid, minimize, and/or mitigate the adverse effects of the System regulation. All Tribes, whether signatory to the PA or not, may request government-to-government consultation on the regulation of the System and the resulting effect on historic and cultural properties and other resources.

The planned preservation program is outlined by multiple stipulations in the PA. One of the stipulations, or program components, is the 5-year plan. This plan outlines how the Corps will accomplish its responsibilities under the PA and National Historic Preservation Act. The "Draft Five Year Plan, dated February 2005" (see website ***https://www.nwo.usace.army.mil/CR***) is currently being implemented.



1954 through 1988 data in Calendar Years
1989 to 1991 in Fiscal Years
1992 to present in VERS System
2002 to present reflect changed accounting due to Title VI land transfer to State of South Dakota

Figure 15. Recreation related visitor hours at each of the six mainstem projects for the years from 1954 through 2009.

The plan includes inventory, testing and evaluation, mitigation, and other specific activities that will allow the Corps to avoid, minimize, and/or mitigate the adverse effects to cultural sites on the Corps' lands within the System.

Under the terms of Stipulation 18 of the PA the Corps has agreed to consult/meet with the affected Tribes and Tribal Historic Preservation Officers (THPO's), State Historic Preservation Officers (SHPO's), the Advisory Council on Historic Preservation (ACHP) and other parties on the draft AOP. The purpose of this consultation/meeting is to determine whether operational changes are likely to cause changes to the nature, location or severity of adverse effects to historic properties or to the types of historic properties affected and whether amendments to the Corps' Cultural Resources Management Plans and Five-Year Plan are warranted in order to better address such effects to historic properties. A letter, dated August 4, 2009, was sent to the Missouri basin Tribes offering consultation on the 2009-2010 AOP. To date, no requests for consultation have been received; however four Tribes participated in the fall AOP public meetings in October 2009 and the Standing Rock Sioux Tribe provided written input on the draft AOP.

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 241,000 acres	1854 msl 380,000 acres	1620 msl 374,000 acres
27	Max. normal op. pool elev. & area	2246 msl 234,000 acres	1850 msl 364,000 acres	1617 msl 360,000 acres
28	Base flood control elev & area	2234 msl 210,000 acres	1837.5 msl 307,000 acres	1607.5 msl 312,000 acres
29	Min. operating pool elev. & area	2160 msl 89,000 acres	1775 msl 128,000 acres	1540 msl 117,000 acres
	Storage allocation & capacity			
30	Exclusive flood control	2250-2246 971,000 a.f.	1854-1850 1,489,000 a.f.	1620-1617 1,102,000 a.f.
31	Flood control & multiple use	2246-2234 2,704,000 a.f.	1850-1837.5 4,222,000 a.f.	1617-1607.5 3,201,000 a.f.
32	Carryover multiple use	2234-2160 10,700,000 a.f.	1837.5-1775 13,130,000 a.f.	1607.5-1540 13,461,000 a.f.
33	Permanent	2160-2030 4,088,000 a.f.	1775-1673 4,980,000 a.f.	1540-1415 5,373,000 a.f.
34	Gross	2250-2030 18,463,000 a.f.	1854-1673 23,821,000 a.f.	1620-1415 23,137,000 a.f.
35	Reservoir filling initiated	November 1937	December 1953	August 1958
36	Initially reached min. operating pool	27 May 1942	7 August 1955	3 April 1962
37	Estimated annual sediment inflow	17,700 a.f. 1030 yrs.	25,900 a.f. 920 yrs.	19,800 a.f. 1170 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	1670-1680 15,000- 60,000 cfs	1423-1428 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)	1,063	2,268	2,640
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

Plate 2. Summary table contains the engineering data for the Missouri River Mainstem system.

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 61,000 acres	1375 msl 102,000 acres	1210 msl 30,000 acres	1,188,000 acres	26
1422 msl 60,000 acres	1365 msl 95,000 acres	1208 msl 27,000 acres	1,140,000 acres	27
1420 msl 57,000 acres	1350 msl 77,000 acres	1204.5 msl 23,000 acres	986,000 acres	28
1415 msl 51,000 acres	1320 msl 38,000 acres	1204.5 msl 23,000 acres	446,000 acres	29
1423-1422 60,000 a.f.	1375-1365 985,000 a.f.	1210-1208 57,000 a.f.	4,664,000 a.f.	30
1422-1420 117,000 a.f.	1365-1350 1,309,000 a.f.	1208-1204.5 86,000 a.f.	11,639,000 a.f.	31
	1350-1320 1,607,000 a.f.		38,898,000 a.f.	32
1420-1345 1,621,000 a.f.	1320-1240 1,517,000 a.f.	1204.5-1160 307,000 a.f.	17,886,000 a.f.	33
1423-1345 1,798,000 a.f.	1375-1240 5,418,000 a.f.	1210-1160 450,000 a.f.	73,087,000 a.f.	34
November 1963	January 1953	August 1955		35
25 March 1964	24 November 1953	22 December 1955		36
5,300 a.f. 430 yrs.	18,400 a.f. 250 yrs.	2,600 a.f. 180 yrs.	89,700 a.f.	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	1228-1239 5,000-60,000 cfs	1155-1163 15,000-60,000 cfs		44
70	117	48	764 feet	45
None: direct intake	8 - 28' dia., 22' penstocks	None: direct intake		46
	1,074		55,083	47
None	59' dia, 2 per alternate penstock	None		48
8 Fixed blade, 81.8 rpm	8 Francis, 85.7 rpm	3 Kaplan, 75 rpm	36 units	49
67' 103,000 cfs	112' 44,500 cfs	48' 36,000 cfs		50
3 - 67,276, 5 - 58,500	40,000	44,100		51
494,320	320,000	132,300	2,501,200 kw	52
497,000	293,000	74,000	1,967,000 kw	53
976	1,736	728	9,412 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) 1967-2008 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

Corps of Engineers, U.S. Army
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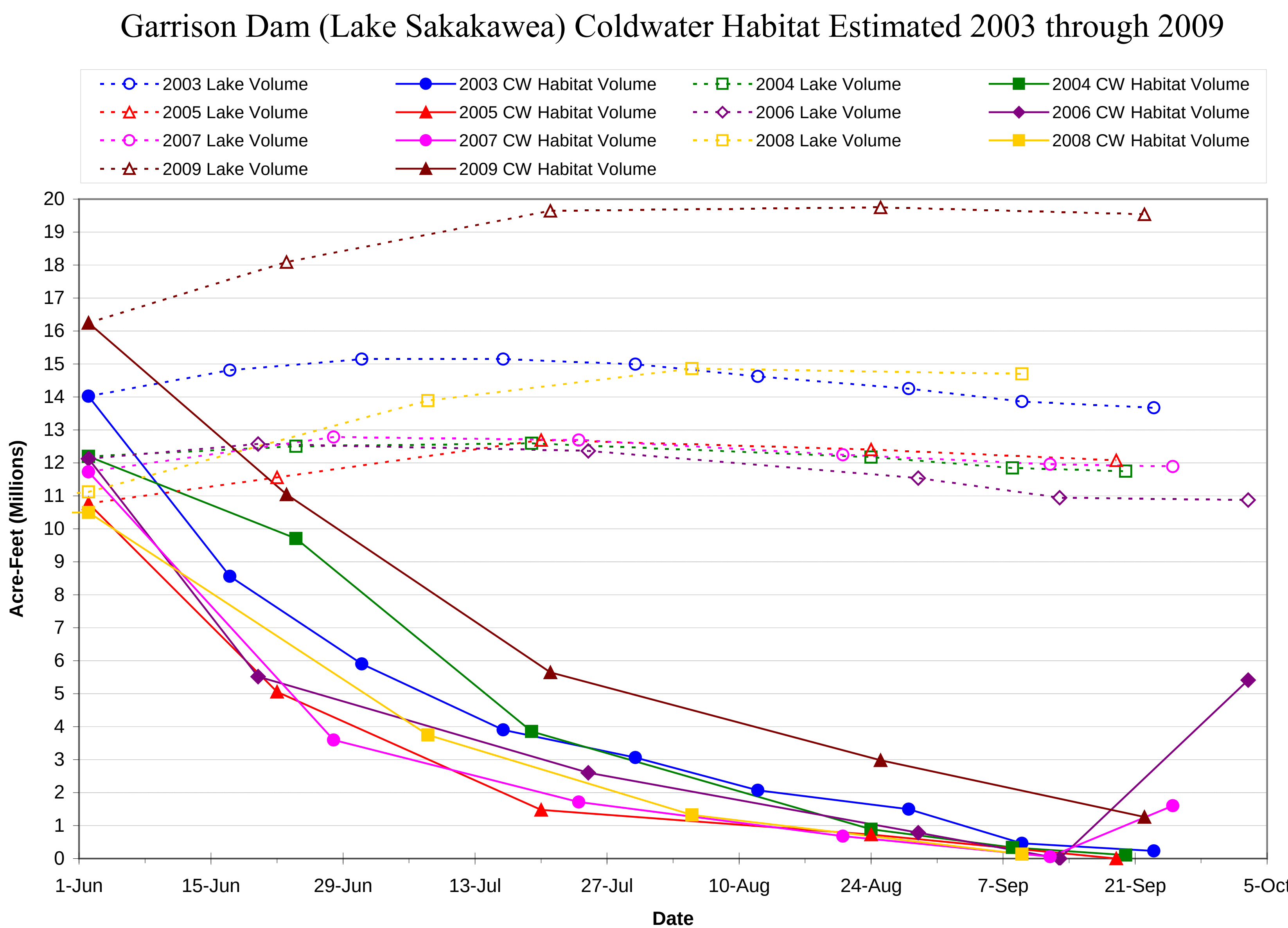

Plate 3. Estimated volume of coldwater habitat in Lake Sakakawea during the 7-year period 2003 through 2009.