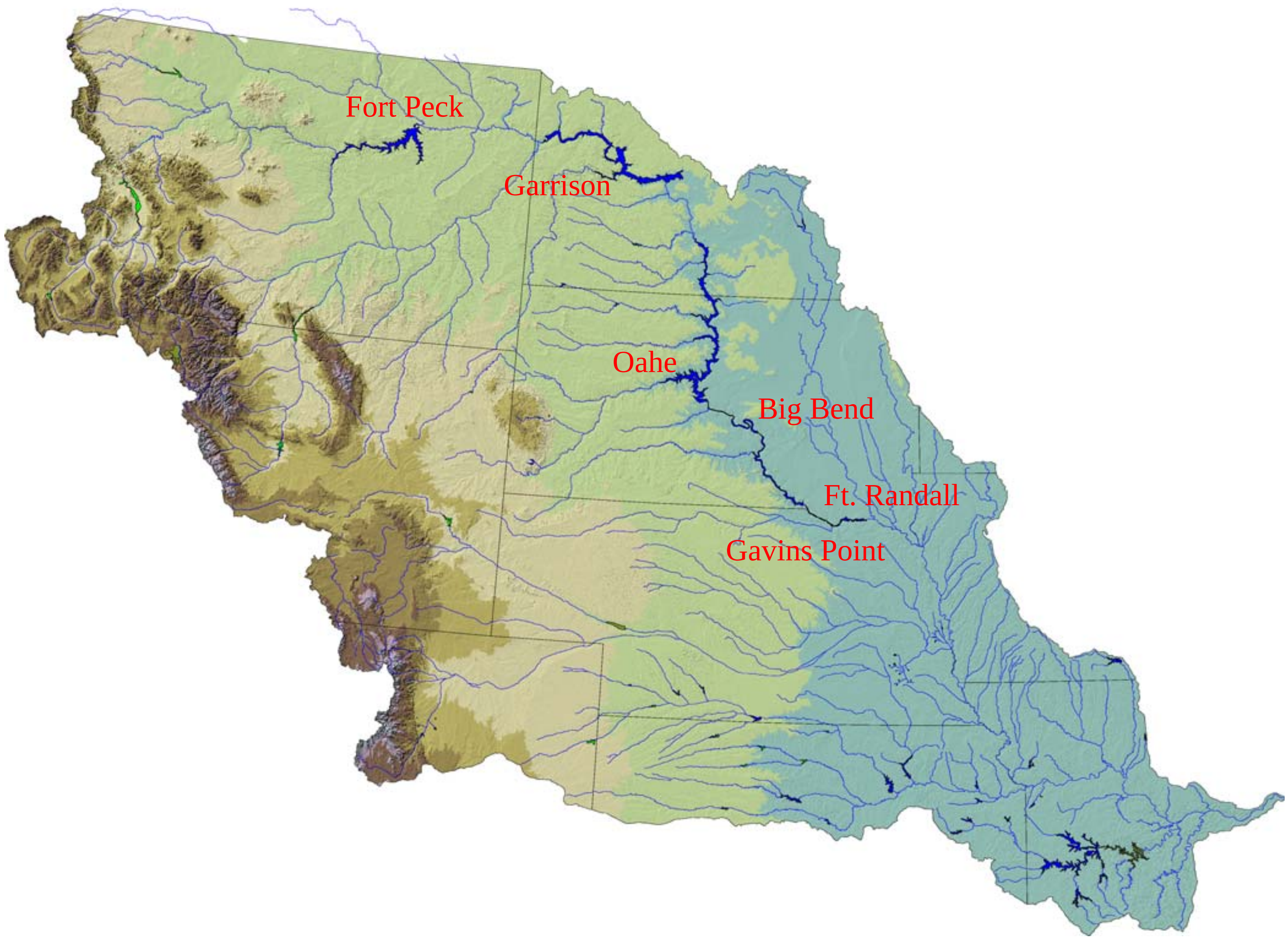
US Army Corps
of Engineers

Northwestern Division

*Missouri River Mainstem Reservoir System*

# Summary of Actual 2008 Regulation

## Missouri River Basin




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

**April 2009**

# MISSOURI RIVER MAINSTEM RESERVOIRS

## Summary of Actual 2008 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 2008 Regulation

## I. FOREWORD

This document contains a summary of the actual regulation of the Missouri River Mainstem Reservoir System (System) for the 2008 Calendar Year (CY). Two other reports related to System regulation are also available, the "System Description and Regulation", and "Final 2007-2008 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 Missouri River System is shown on ***Plate 2.***

## II. REVIEW OF REGULATION – JANUARY-DECEMBER 2008

### A. General

During 2008 the System was regulated in accordance with the Master Water Control Manual (Master Manual) and the applicable provisions of the Final 2007-2008 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 2008 is given in the following paragraphs.

### B. Precipitation and Water Supply Available in 2008

Criteria defining drought can vary. For the purposes of this document we will define a drought period as three or more consecutive years of below-average calendar year runoff into the Missouri River above Sioux City, IA. The 2008 runoff year marked the end of the 8-year (2000-2007) drought in the Missouri River basin. Runoff during the 2008 runoff year was 26.4 MAF, 105% of normal. Runoff is discussed in more detail in Section II.B.4 of this report.

#### 1. Plains Snowpack

November 2007 began with two weeks of warm dry weather across most of the Missouri River basin. The middle part of the month brought cooler weather and some heavier snow across Montana. A daily-record snowfall of 7.8 inches fell in Great Falls on November 19 and a total of 9.7 inches of snow fell from November 18-21. A major winter storm crossed the nation in late November, but snowfall mostly missed the basin. Snowfall occurred again in early December in the northern portions of the basin. In South Dakota, Aberdeen had a daily-record total of 8.5 inches on December 1. Stormy weather brought snow, sleet, freezing rain, and rain to the basin in mid-December. St. Louis, Missouri reported 6.9 inches of snow on December 15. Topeka, Kansas recorded a daily-record snowfall of 9.0 inches on December 22.

January began with mild, dry weather over most of the Plains. A cold front entered the Plains near mid-month. Great Falls, MT set a daily-record snowfall on January 19 (3.5 inches). The cold continued towards the end of the month. From January 20-22, significant snow fell across parts of the northern Plains and the Midwest. In South Dakota, Rapid City set a daily snowfall record for January 20 (3.4 inches). Snow cover was generally less than 2 inches across the majority of the basin at the end of the month.

Cooler weather remained through early February. The cold temperatures were followed with snow across the north-central U.S. Daily-record totals reached 3.4 inches in Pierre, SD and 3.3 inches in Valentine, NE on February 11. Snow depth was generally light across most of the basin at the end of February, with only a few scattered areas with more than 4 inches of snow cover.

Much-above-normal temperatures returned to parts of the basin in early March. However, some snow did fall with daily-record snowfall for March 4 of 10.0 inches in St. Louis, MO. A band of snow across Nebraska produced a daily-record total of 5.4 inches on March 17 in North Platte. Further north in the basin, record snowfall was being recorded. On March 21, Sisseton, SD (10.7 inches) and Fargo, ND (7.6 inches) noted record daily snowfall amounts. On March 26-27, more than a foot of snow blanketed some spots in Hyde and Sully Counties of central South Dakota. Late-March snow blanketed parts of the Plains and upper Midwest, with 8 inches falling in Chadron, NE on the 31st. Daily-snowfall records for March 31 included 3.5 inches in Pierre, SD. By the end of March, plains snow depth was less than 2 inches across most of the basin, with a few small areas with 4 to 6 inches.

In early April, chilly weather, accompanied by snow, prevailed across the northern Plains. Daily-record snowfall totals for April 6 reached 8.0 inches in Mobridge. Days later, the snow turned to rain throughout the basin. By mid-month record warmth prevailed over the western portion of the basin, but was then followed by a large temperature drop and snowfall. Great Falls, MT received 15.1 inches of snow on April 19-20. Great Falls' 9.6-inch snowfall total on April 19 represented its greatest single-day snowfall so late in the year since April 27, 1989, when 10.3 inches fell. Heavy snow developed on April 24-26 from part of Nebraska into Minnesota, resulting in a late-season total of 19.0 inches in Watertown, SD. The storm shattered numerous daily snowfall records in South Dakota, including 11.0 inches at Webster and 9.0 inches at Huron at April 25, followed by 17.0 inches at Clear Lake and 10.0 inches at Pickstown on April 26. By late April, most of the snow cover was melted.

Much heavier snow blanketed the Black Hills of South Dakota towards the end of April and into early May. The unofficial April 30-May 2 total reached 54.5 inches in Lead, 30.0 inches near Spearfish, 28.0 inches in Deadwood, and 13.3 inches in Rapid City. On May 2, Rapid City's 12-inch total eclipsed its single-day snowfall record for May (previously, 10.8 inches on May 7, 1950). Significant storms returned in mid-May. On May 12, Bozeman, MT received a daily-record snowfall of 3.7 inches. By late April, most of the snow cover was melted. Heavy snow also blanketed Riverton, WY where 10.7 inches fell on May 22. Until then, Riverton had never received a daily snowfall in excess of 10 inches after April 22, and had never received more than 7 inches on a single day in May.

Although the snow cover was gone, some snow did fall in June. On Montana's high plains, Great Falls received 6.8 inches of snow on June 11. In the last 60 years, the only later measurable snowfall in Great Falls occurred on June 12, 1969, when 5.1 inches fell.

## 2. Mountain Snowpack

a. Fall 2007

In Montana, the mountain snowfall season was quite variable early, but statewide mountain snowpack was near average. December precipitation was 109% of normal. Mountain snow water content was 90% of average and 114% of the previous year.

In Wyoming, snow water equivalent (SWE) across the state was slightly below average. The SWE average for the state was 87% of normal. In December, precipitation in the basins ranged from 70% of average to 155% of average.

The 2007 year ended with the mountain snowpack 92% of normal in the reach above Fort Peck and 94% of normal in the reach from Fort Peck to Garrison.

b. January 2008

In Montana, January mountain precipitation was 105% of average. Normally about 60% of the seasonal snowpack is in place by the end of January. Statewide, mountain snowpack was 103% of average and 130% of the previous year.

Generally, the SWE across Wyoming was below average for January. Storms covered Wyoming with snow and the outlook began to improve. The SWE in the northwestern portion of the state was about 98% of normal, and the northeastern portion was 91% of normal. The southeastern area was 100% of normal and the southwestern area was 93% of normal. January's precipitation was quite varied across the state. Basin precipitation ranged from 97% of average to 147% of average.

The month of January ended with the mountain snowpack 104% of normal in the reach above Fort Peck and 98% of normal in the reach from Fort Peck to Garrison.

c. February 2008

In Montana, February mountain precipitation was 129% of normal. Statewide snowpack was 107% of average and 123% of the previous year. Even though overall snowpack was above normal, some localized basins were below average.

In Wyoming, SWE amounts across the state were near average for February at 99% of normal. The SWE varied from 99% of normal in the northwestern portion of the state to 107% in southeastern Wyoming. February precipitation was above average across most of Wyoming.

The month of February ended with the mountain snowpack 104% of normal in the reach above Fort Peck and 100% of normal in the reach from Fort Peck to Garrison.

d. March 2008

In Montana, mountain precipitation during March was 88% of average. Mountain snowpack statewide was 108% of average, and 155% of last year.

During March, the SWE across Wyoming was near average at 102% of normal. The SWE in the northwestern portion of the state was about 106% of normal, and the northeastern portion was 108% of normal. The southeast and southwest areas were 105 and 94% of normal, respectively. February precipitation was below average across most of Wyoming.

The month of March ended with the mountain snowpack 102% of normal in the reach above Fort Peck and 105% of normal in the reach from Fort Peck to Garrison.

e. April 2008

In Montana, mountain precipitation during April was below average, 79% of normal. Cool temperatures delayed the mountain snowmelt. Mountain snowpack was above average at 123% and 179% of the previous year.

Generally, the SWE across Wyoming was slightly above average for April, with water content about 108% of average. Across the state SWE was 108% in the northeast, southeast, and southwest portions of the state and 112% in the northwest part of Wyoming. April's precipitation was below average across most of Wyoming.

The month of April ended with the mountain snowpack 162% of normal in the reach above Fort Peck and 158% of normal in the reach from Fort Peck to Garrison due mainly to the delayed melting of the snowpack. Snowpack was 69% of the normal April 15 peak in the reach above Fort Peck, and 77% of the normal peak in the reach from Fort Peck to Garrison.

f. May 2008

In Montana, May mountain precipitation was 139% of average. Seasonably cool temperatures during most of May slowed the snowmelt. Mountain snowpack ended the month 148% of normal and 374% of the previous year.

The SWE across Wyoming was above average at 149%, due in part to a cool spring. The SWE in the northwestern portion of the state was 145% of normal and the northeastern portion was 221% of normal. The southeast and southwest areas were 119 and 111% of normal, respectively. May's precipitation was above average across all of Wyoming.

As the month of May ended, the mountain snowpack was 112% of normal in the reach above Fort Peck and 110% of normal in the reach from Fort Peck to Garrison, representing a delayed snowmelt as well as a near normal snowpack.

g. Summary

Overall snow water content totals recorded during the entire snow season ending July 1, 2008 were above normal. The mountain snowpack in the reach above Fort Peck peaked on April 27 at 111% of the normal peak accumulation. The mountain snowpack in the reach between Fort Peck and Garrison peaked on April 27 at 110% of the normal peak accumulation. The normal date for snow accumulation to peak is April 15. The 2007-2008 mountain snow accumulation and melt for the reaches above Fort Peck and Fort Peck to Garrison are illustrated in ***Figure 1***.

## 3. Weather Conditions

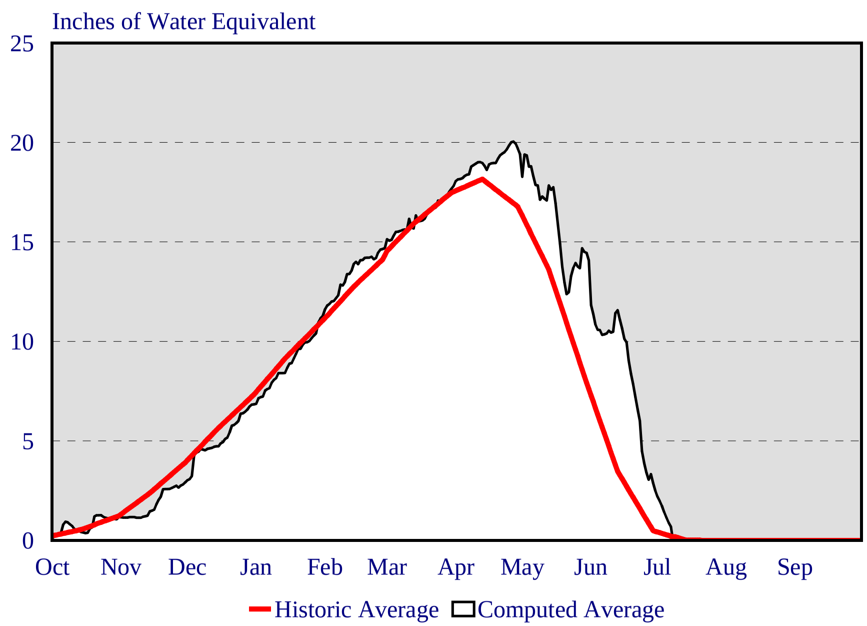
The following weather summaries are from the USDA Weekly Weather and Crop Bulletins. ***Figure 2*** displays the drought magnitude and ***Figure 3*** displays percent of normal precipitation experienced by the basin for April, July and October as well as for 2008. As shown in ***Figure 2***, the year began with abnormally dry to moderate drought conditions in the large portions of Wyoming, Montana, western South Dakota, western North Dakota. By July, most of the basin had returned to normal conditions; western North Dakota, western Kansas and eastern Colorado remained in abnormally dry to moderate drought conditions.

a. January 2008

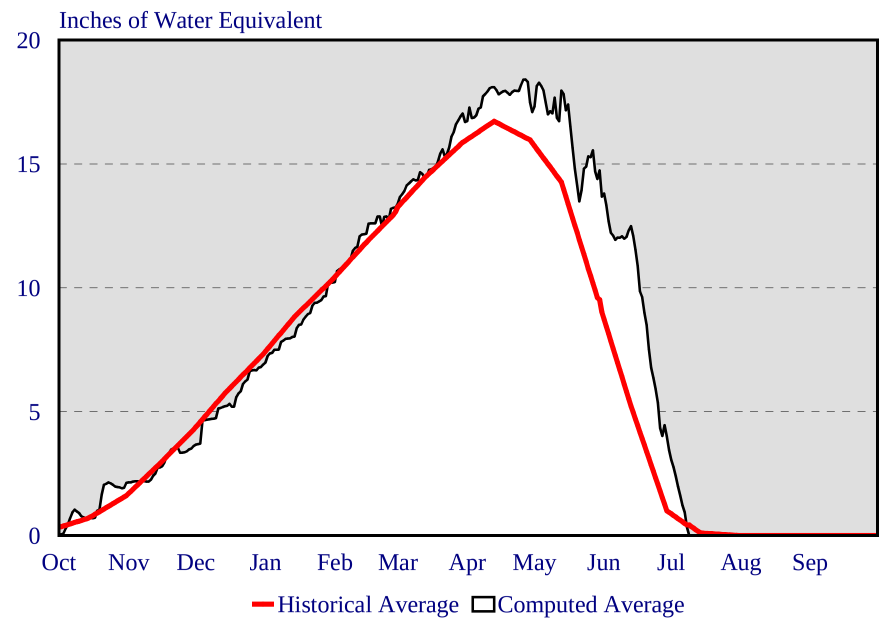
The year began with mild, dry weather over most of the Plains. On January 4, daily-record highs included 55°F in both Billings and Glasgow, MT. On January 6, a daily-record high of 73°F was recorded in St. Louis, MO. A cold front entered the Plains near mid-month and temperatures below 0°F were noted on the central High Plains on January 17 and as far south as northern portions of Kansas and Missouri on January 20. The cold continued towards the end of the month. Cold air blanketed much of the nation, holding

# Missouri River Basin
# Mountain Snowpack Water Content
# 2007-2008

## Total Above Fort Peck

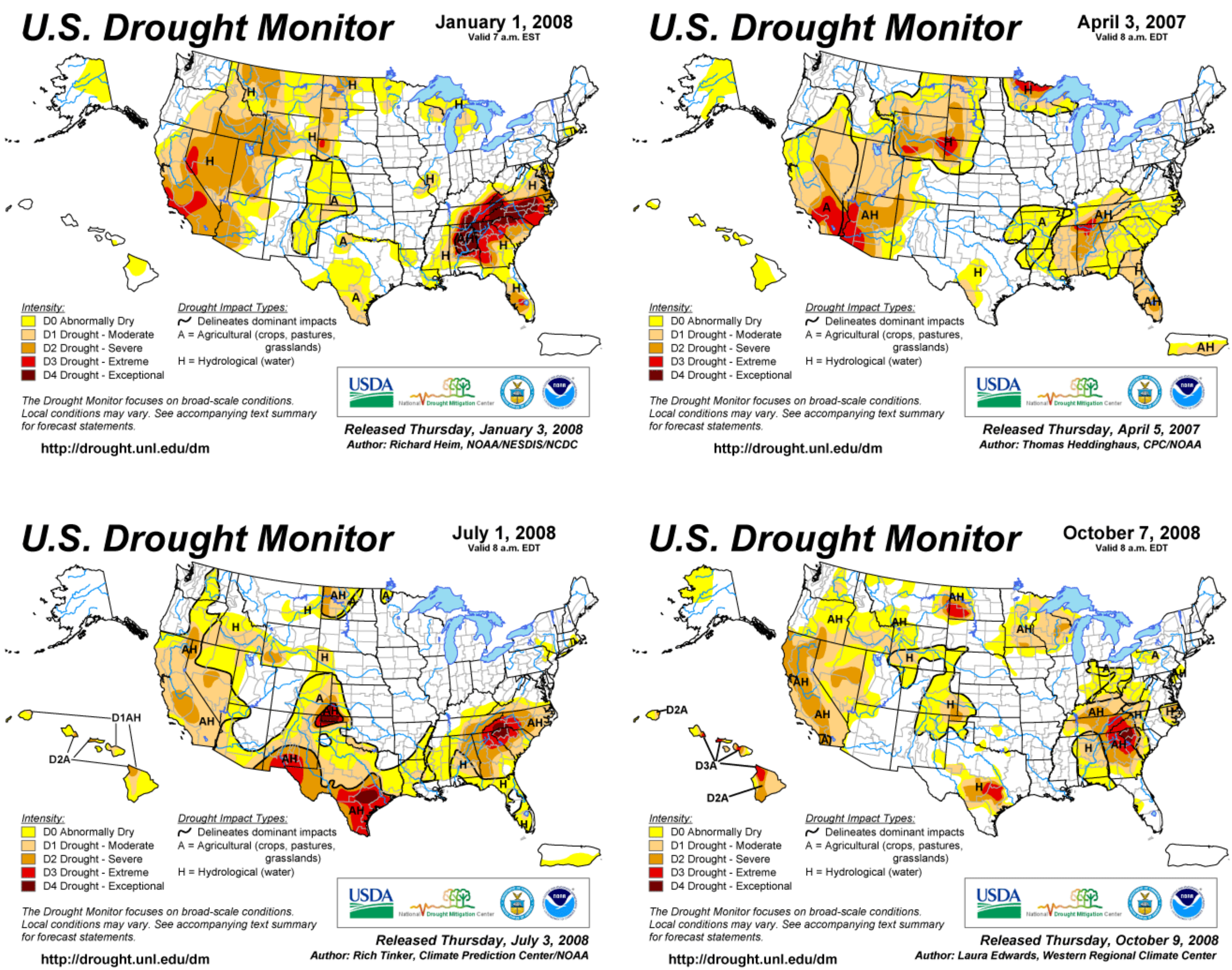



## Total Fort Peck to Garrison




The mountain snowpack in the reach above Fort Peck peaked at 111% of the normal peak accumulation on April 27. The mountain snowpack in the reach between Fort Peck and Garrison peaked at 110% of the normal peak accumulation on April 27. The Missouri River basin mountain snowpack normally peaks around April 15.

Figure 1


U.S. Drought Monitor
January 1, 2008
Valid 7 a.m. EST
Intensity:
D0 Abnormally Dry
D1 Drought - Moderate
D2 Drought - Severe
D3 Drought - Extreme
D4 Drought - Exceptional
Drought Impact Types:
Delineates dominant impacts
A = Agricultural (crops, pastures, grasslands)
H = Hydrological (water)
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.
http://drought.unl.edu/dm
USDA
Released Thursday, January 3, 2008
Author: Richard Heim, NOAA/NESDIS/NCDC
U.S. Drought Monitor
April 3, 2007
Valid 8 a.m. EDT
Intensity:
D0 Abnormally Dry
D1 Drought - Moderate
D2 Drought - Severe
D3 Drought - Extreme
D4 Drought - Exceptional
Drought Impact Types:
Delineates dominant impacts
A = Agricultural (crops, pastures, grasslands)
H = Hydrological (water)
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.
http://drought.unl.edu/dm
USDA
Released Thursday, April 5, 2007
Author: Thomas Heddinghaus, CPC/NOAA
U.S. Drought Monitor
July 1, 2008
Valid 8 a.m. EDT
D1AH
D2A
Intensity:
D0 Abnormally Dry
D1 Drought - Moderate
D2 Drought - Severe
D3 Drought - Extreme
D4 Drought - Exceptional
Drought Impact Types:
Delineates dominant impacts
A = Agricultural (crops, pastures, grasslands)
H = Hydrological (water)
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.
http://drought.unl.edu/dm
USDA
Released Thursday, July 3, 2008
Author: Rich Tinker, Climate Prediction Center/NOAA
U.S. Drought Monitor
October 7, 2008
Valid 8 a.m. EDT
D2A
D3A
D2A
Intensity:
D0 Abnormally Dry
D1 Drought - Moderate
D2 Drought - Severe
D3 Drought - Extreme
D4 Drought - Exceptional
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The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.
http://drought.unl.edu/dm
USDA
Released Thursday, October 9, 2008
Author: Laura Edwards, Western Regional Climate Center



Figure 2

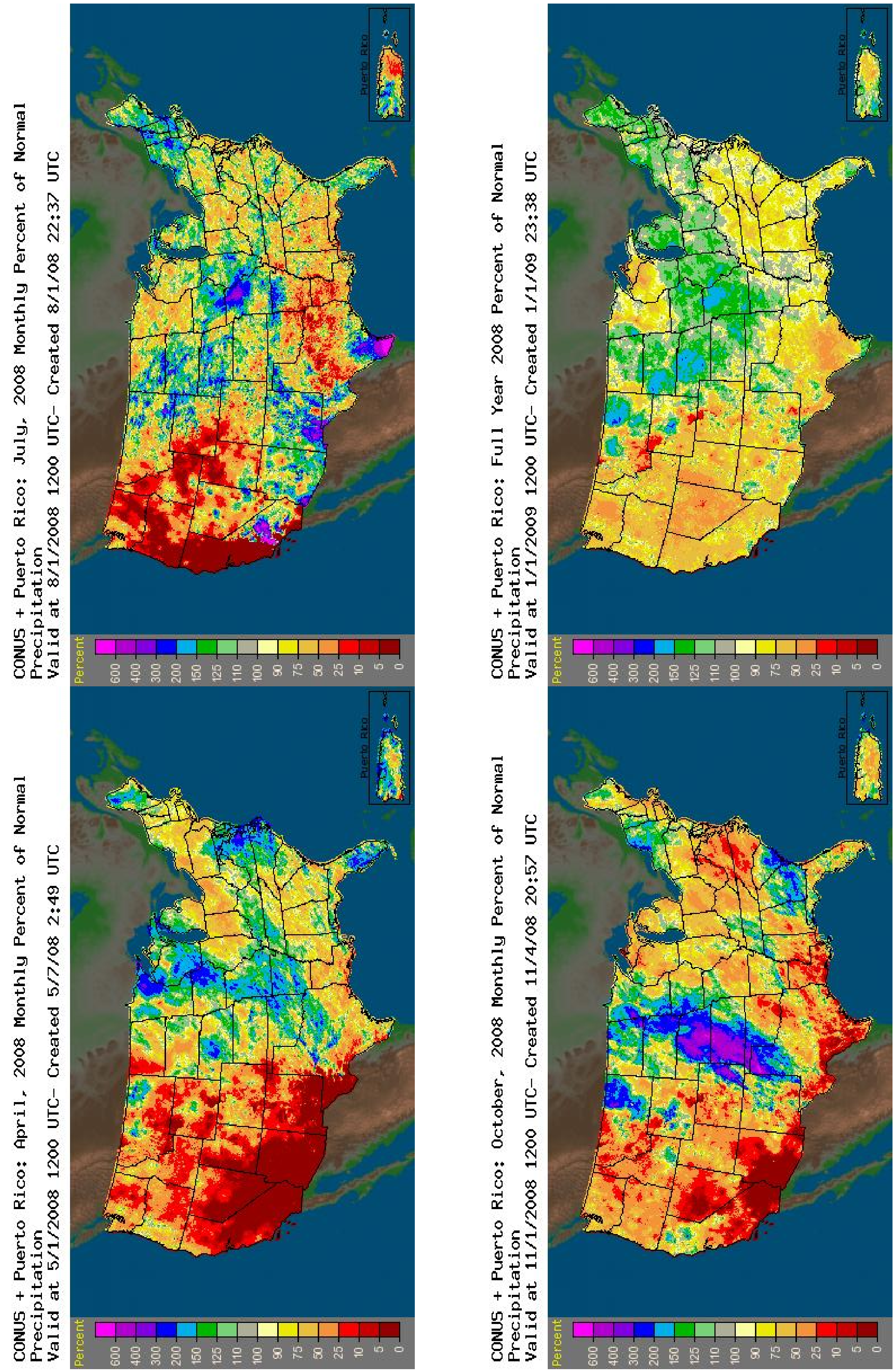

CONUS + Puerto Rico: April, 2008 Monthly Percent of Normal
Precipitation
Valid at 5/1/2008 1200 UTC- Created 5/7/08 2:49 UTC
CONUS + Puerto Rico: July, 2008 Monthly Percent of Normal
Precipitation
Valid at 8/1/2008 1200 UTC- Created 8/1/08 22:37 UTC
CONUS + Puerto Rico: October, 2008 Monthly Percent of Normal
Precipitation
Valid at 11/1/2008 1200 UTC- Created 11/4/08 20:57 UTC
CONUS + Puerto Rico: Full Year 2008 Percent of Normal
Precipitation
Valid at 1/1/2009 1200 UTC- Created 1/1/09 23:38 UTC
Percent
600 400 300 200 150 125 110 100 90 75 50 25 10 5 0
Puerto Rico

Figure 3

weekly temperatures as much as 20°F below normal across the northern Rockies. Temperatures dipped to 0°F or lower as far south as the northern portions of Kansas and Missouri. Daily record lows were recorded in Chadron, NE (-16°F on January 22) and Yankton, SD (-11°F on January 25). The month of January ended with a brief surge of warmth across the lower portion of the basin while the upper basin remained cold. Harlem, MT reported a maximum temperature of -13°F on January 29. Wind chill temperatures below -50°F were noted at several locations in the Dakotas on January 29: Dickinson, ND (-55°F) and Sand Lake, SD (-53°F). Meanwhile, a daily-record high of 73°F was recorded on the same day at St. Louis, MO.

b. February 2008

Cold temperatures maintained through early February across the upper Midwest. Weekly temperatures averaged at least 10 to 15°F below normal. The high temperature for February 10 at Fargo, ND was -12°F. The cold temperatures were followed with snow across the north-central U.S. Daily-record lows for February 20 included -34°F in Devils Lake, ND and -28°F in Watertown, SD. Grand Forks, ND, reported a high of -10°F and a low of -33°F on February 20. Record-high monthly precipitation was record in Springfield, MO (6.41 inches; normal of 2.28 inches) and Vichy-Rolla, MO (4.36 inches; normal of 1.93 inches).

c. March 2008

March began with a daily-record high temperature of 80°F being recorded at both McCook, NE and Garden City, KS. Topeka, KS received a daily-record rainfall (1.10 inches) on March 2. Topeka had just completed its wettest winter on record, with a December-February sum of 8.10 inches, 228% of normal. Further north, a daily-record low temperature of -21°F was recorded on March 7 at Jamestown, ND. Only three days later, warm weather entered North Dakota resulting in a daily-record high of 64°F at Bismarck, ND on March 10. On March 17 a daily-record precipitation total of 1.86 inches was recorded at Wichita, KS. Record rainfall was recorded in Missouri on March 18 – West Plains (5.69 inches) and Springfield (3.93 inches). Springfield's daily rainfall record for March had stood since 1927, when 3.35 inches fell on March 31. Further north in the basin record snowfall was being recorded. In Missouri, Springfield set a precipitation record for the second consecutive month, following February's 6.41-inch total with a 9.40-inch sum in March. Springfield's 2-month total reached 15.81 inches, 259% of normal.

d. April 2008

Chilly weather prevailed early in the month across the northern Plains. Mobridge, SD posted consecutive daily-record lows (11 and 2°F) on April 6-7. Snow came with this cold weather. A daily-record rainfall amount of 1.93 inches fell in St. Joseph, MO on April 8. April 9-11 rainfall totals reached 5.3 inches in Goodland, KS, 6.6 inches in

North Platte, NE, and 10.5 inches in Watertown, SD. By mid-month record warmth prevailed over the western portion of the basin. A daily-record high of 80°F was observed on April 13 in Harlem, MT. On the 14th record highs were observed in Great Falls, MT (79°F) and Helena, MT (78°F). This warmth was followed with a large temperature drop and snowfall. Great Falls, MT received 15.1 inches of snow on April 19-20, followed by temperature lows of -1 and -8°F on April 20 and 21, respectively. Previously, Great Falls' latest sub-zero reading occurred on April 6, 1975, with a low of -6°F. Heavy snow developed on April 24-26 from part of Nebraska into Minnesota. Daily-record lows for April 28 included 16°F in Jamestown, ND and 18°F in Watertown, SD.

e. May 2008

Much heavier snow blanketed the Black Hills of South Dakota towards the end of April. On May 3, a daily-record low of 16°F was noted at Laramie, WY, and Alliance, NE. In Colorado, Denver posted its second-lowest temperature on record in May (21°F), behind 19°F on May 3, 1907. Significant storms produced daily-record rainfall amounts in Broken Bow, NE (1.55 inches on May 10). On May 11, cold weather returned to the basin producing several daily-record lows, including 23°F in Alliance, NE and 24°F in Bismarck, ND. On May 12, Bozeman, MT received a daily-record snowfall of 3.7 inches. Chilly air returned to the High Plains on May 14, when daily-record lows in Colorado included 30°F in Colorado Springs and 32°F in Pueblo. Cool weather continued into the later part of the month in some parts of the basin. Sub-freezing temperatures were most widespread in the upper Midwest on May 21, when Grand Forks, ND noted a daily-record low (27°F). Heavy snow also blanketed Riverton, WY. Elsewhere in Montana, Billings received rainfall totaling at least 0.70 inch on 4 consecutive days (3.83 inches fell from May 21-24) for the first time on record (previously, 2 days on many occasions, most recently on March 29-30, 2006). Similarly in Wyoming, Sheridan received at least 0.35 inch of rain on 4 consecutive days (3.23 inches fell from May 21-24) for the first time (previously, 3 days on several occasions, most recently in June 1995). Widespread severe thunderstorms gradually shifted from the central High Plains on May 22-23 to the southern High Plains and the upper Midwest by May 25. In Nebraska, rainfall was especially heavy on May 23, when daily-record totals included 5.13 inches in McCook, 3.29 inches in Kearney, and 2.77 inches in Broken Bow. For McCook, it was also the wettest May day (previously 3.43 inches on May 21, 1969) and calendar day (previously, 4.08 inches on June 26, 1985) on record. See ***Plate 3*** for a 24-hour radar image of the May 23, 2008 precipitation. On May 27, a freeze struck the northern half of North Dakota and neighboring areas, with a daily-record low being set in Grand Forks (27°F ) and Minot (23°F ). St. Louis, MO received precipitation totaling 29.57 inches (187% of normal) during the first 5 months of the year, breaking its January-May 1927 record of 27.40 inches. With 10.84 inches of rain, it was the third-wettest May in St. Louis behind 12.92 inches in 1995 and 11.20 inches in 1943.

f. June 2008

Heavy rainfall erupted across the northern Plains and the Midwest in the early days of June. Daily-record totals for June 5 included 4.15 inches in Des Moines, IA and 2.09 inches in Huron, SD. See ***Plate 4*** for a 24-hour radar image of the June 5, 2008 precipitation. Unofficially, 40 inches of snow fell from June 10-12 at Badger Pass, MT, while 1 to 2 feet blanketed several other locations in western Montana and the mountains of Wyoming. Even on Montana's high plains, Great Falls received snow on June 11. In the last 60 years, the only later measurable snowfall in Great Falls occurred on June 12, 1969, when 5.1 inches fell. This area of the basin recorded daily-record low temperatures at or below the freezing mark including Great Falls, MT (32°F on June 11) and Sheridan, WY (31°F on June 12). Heavy rain overspread the northern Plains at mid-week and returned to the Midwest a day later. On June 11, daily-record rainfall totals reached 2.62 inches in Jamestown, ND, and 2.14 inches in Sisseton, SD. On June 13 a daily-record total of 3.88 inches was observed in Springfield, MO. Just a week later, Springfield recorded another daily-record total (2.11 inches on June 19). The end of the month showed a great variety in temperature readings in the basin. In Nebraska, Hastings (91°F on June 25) experienced its latest date of the year's first 90-degree reading since June 28, 1982. Daily-record lows dipped to 38°F on June 28 in Havre, MT. June rainfall record were broken in numerous Midwestern locations, including Springfield, MO (13.41 inches, or 267% of normal; previously 12.27 inches in 1928). See ***Plate 5*** for a 24-hour radar image of the June 25, 2008.

g. July 2008

The month began with oppressive heat across portions of the upper basin. Sidney, MT recorded a July 1 high of 97°F. Just a few days later in Montana, Great Falls noted consecutive daily-record lows on July 11-12 (39 and 40°F). Daily-record lows for July 13 were registered at Casper, WY (37°F) and Alliance, NE (39°F). Heavy rain developed across the Midwest resulting in 4.40 inches of rain in Hastings, NE on July 16-17. It was the highest 2-day rainfall in Hastings since August 3-4, 1990, when 5.69 inches fell. A record daily-tying low of 46°F was recorded on July 20 at Sheridan, WY. Just a few days later and a few hundred miles east, Imperial, NE posted a daily-record high for July 23 of 106°F. While the western portion of the basin was experiencing large shifts in temperature during this time period, the eastern portion of the basin was experiencing heavy rainfall. Columbia, MO measured a record-setting total for July 22 (3.23 inches). Additional heavy rain triggered flooding, including a record crest on the Chariton River near Prairie Hill, MO (8.27 feet above flood stage on July 27; previously, 8.01 feet above flood stage on May 13, 2002). Columbia, MO recorded a daily-record rainfall on July 28 (1.52 inches). Elsewhere in Missouri, Springfield surpassed its normal annual precipitation of 44.95 inches by July 26, while St. Louis completed its wettest January-July period on record. Precipitation during the first 7 months of the year totaled 38.96 inches (166% of normal) in St. Louis, edging its January-July 1898 standard of 37.66 inches. Further north in the basin, local heavy showers across the Dakotas resulted in a daily-record precipitation total on July 31 at Sisseton, SD of 1.77 inches.

h. August 2008

The month started with hot weather expanding across much of the nation, concentrating across the Rockies, High Plains and South. Cheyenne, WY noted a monthly record high (98°F on August 1 and 2), previously established with a reading of 96°F on August 6, 1979, and several earlier dates. In Colorado, Denver narrowly missed its all-time-record high of 105°F (104°F on August 1), established on August 8, 1978, and July 20, 2005. However, Denver easily set a record for its longest streak of 90°F heat (previously, 18 days from July 1-18, 1874, and July 6-23, 1901). Denver's stretch with high of 90°F or above reached 24 consecutive days (July 13 – August 5). Farther north, highs topped 100°F on August 1 as far north as Billings (102°F) and Miles City, MT (104°F). A day later, Imperial, NE edged its monthly record of 110°F, set in 1934 (111°F on August 2). Also in Colorado, Grand Junction set a record for consecutive days at or above 90°F (52 days from June 15 – August 5; previously, 51 days in 1901). Missoula, MT set a daily-record high for August 7 (98°F). Despite all the hot weather very heavy rain was also observed in some parts of the basin. A daily-record sum was noted in Cheyenne, WY of 2.02 inches on August 5. Cheyenne's rain, which fell in a 90-minute period, represented its highest single-day total since August 1, 1985, when an astounding 6.06 inches fell. It was also Cheyenne's eighth-wettest day during the last 90 years. Significant rains also soaked parts of the Dakotas, where daily-record totals included 2.05 inches (on August 10) in Watertown, SD, and 3.33 inches (on August 11) in Fargo, ND. In Riverton, WY, rain on August 10 ended a 65-day spell (June 6 – August 9) without measurable precipitation. Huron, SD posted a daily-record total for August 14 (1.90 inches), followed by a record in Cheyenne, WY of 2.07 inches on August 15. In Cheyenne, where statistics have been kept since 1871, the second- and third-wettest August days on record occurred on August 5 and 15 (2.02 and 2.07 inches, respectively). Those totals were also Cheyenne's tenth- and twelfth-highest daily totals on record for any time of the year. During these storms, the maximum temperature was very low. Cheyenne, WY noted a daily-record maximum of 49°F on August 15. It was Cheyenne's coldest day since May 27. Further north and a few days later, triple-digit readings were noted in Montana in such locations as Thompson Falls (104°F on August 18) and Glasgow (103°F on August 19). Large temperature fluctuations were noted in the northern portion of the basin during the last part of the month. On August 24, Grand Forks, ND (39°F) posted a daily-record low. Farther west, triple-digit heat was noted in several locations in Montana – Miles City and Billings noted daily-record highs of 103°F on August 25. However, by August 30, daily-record highs in North Dakota soared to 101°F in Dickinson and 100°F in Bismarck.

i. September 2008

On the northern Plains, daily-record rainfall totals for September 1 included 1.10 inches in Harlem, MT. The following day, record lows for September 2 in Montana dipped to 30°F in both Choteau and Shelby. In Wyoming, Casper posted consecutive daily-record lows of 32°F on September 2-3. By September 4, daily-record lows on the central High Plains included 36°F in Sidney, NE, and 39°F in Pueblo, CO. Sisseton, SD noted consecutive daily-record lows of 37°F on September 8 and 9. Other daily-record lows for September 9 included 36°F in Atlantic, IA, and 42°F in St. Joseph, MO. From September 8-10, the effects of Hurricane Ike were felt in the Midwest. Rainfall records associated with Ike's passage through Missouri on September 14 included 4.58 inches in St. Louis and 4.43 inches in Vichy-Rolla. See ***Plate 6*** and ***Plate 7*** for 24-hour radar images of September 13 and 14, 2008, respectively. In Hermann, MO, the Missouri River (10.44 feet above flood stage on September 16) climbed to its ninth-highest level on record and highest level since May 19, 1995. By September 20, the year-to-date precipitation in St. Louis climbed to 50.03 inches (176% of normal), leaving the city just 4.94 inches shy of its 1982 annual record.

j. October 2008

Local heavy showers dotted the nation's mid-section during early October. Kearney, NE noted a daily record amount of 3.67 inches on October 5. Grand Forks, ND set a daily-record rainfall for October 11 (1.16 inches). Lander, WY received 29.7 inches of snow from October 10-12, representing its greatest October storm and seventh-highest single-storm total on record. In Montana, Billings measured an October 9-13 storm total of 12.9 inches, while Glasgow set an October snowfall record (13.6 inches from October 11-13). Previously, Glasgow's monthly record for October was 11.5 inches, all of which fell on October 12, 1924. Heavy snow fell as far east as western North Dakota, where Williston received 8.4 inches from October 11-13. Meanwhile on the Plains, North Platte, NE experienced its wettest 3-day period in October (2.95 inches of rain from October 11-13) since 1946, when 3.79 inches fell from October 4-6. Butte, MT dipped to 10°F on October 12 and 13, setting records on both dates. Bismarck, ND finally recorded its first autumn freeze with a low of 27°F on October 14, breaking the record established on October 11, 1980. Another storm entered the nation's mid-section in mid-October. October precipitation records were broken in locations such as Hastings, NE (6.16 inches; previously 4.76 inches in 2007), and Dodge City, KS (5.00 inches; previously, 4.94 inches in 1997). Specific daily-record totals for October 22 included 2.31 inches in Kearney, NE, and 2.25 inches in Sioux City, IA. Official snowfall totals for October 23 included 2.0 inches in Goodland, KS, and 1.1 inches in North Platte, NE. On October 26, wind gusts were measured at 66 mph in Pierre, SD and 64 mph in Valentine, NE.

k. November 2008

November began with record warmth prevailing across the nation's mid-section. A daily-record high of 79°F was set on November 2 in Rapid City, SD. A few days later, significant precipitation occurred on the northern Plains. Daily-record totals were reached in Rapid City, SD (2.02 inches on November 6) and in Williston, ND (1.51 inches on November 6). Rapid City also received a daily-record snowfall of 9.0 inches on November 6. Elsewhere in western South Dakota, storm-total snowfall amounts of 2 to 4 feet were reported in locations such as Deadwood, Lead, and Silver City. Heavy snow fell as far east as Bismarck, ND where 9.4 inches accumulated on November 6-7. High winds accompanied the storm, with gusts on November 6 measured as high as 64 mph in Ogallala, NE and 63 mph in Goodland, KS. A gust to 77 mph was reported in Rapid City on November 5. November 10 storms resulted in daily-record precipitation amounts in Nebraska at Imperial (0.83 inch) and Grand Island (0.80 inch). Imperial's precipitation fell in the form of 10.5 inches of snow. By November 18 record warmth briefly spread over the Plains where daily-record highs included 74°F in Flatwillow, MT; 78°F in Denver, CO; and 79°F in Imperial, NE and Rapid City, SD. In Montana, November 18 highs of 71°F at Helena and 70°F at Townsend represented the stations' last observance of a high of 70°F or greater.

l. December 2008

The month started with record-setting warmth in the central High Plains. On December 2, McCook set a daily-record high (70°F), while Billings, MT set a daily-record snowfall (4.6 inches). A few days later, colder weather entered the Plains resulting in a daily-record low of -5°F in Denver, CO on December 4, just 2 days after reaching 69°F. In North Dakota, December 13-14 snowfall totals reached 13.8 inches in Williston and 12.4 inches in Bismarck. In Montana, 10.0 inches of snow blanketed Glasgow on December 13, setting a record for any December day (previously, 8.0 inches on December 9, 1906). Glasgow also measured a northeasterly wind gust of 49 mph. On the night of December 13-14, wind gusts in Nebraska were measured as high as 65 mph in Gordon and 61 mph in Broken Bow. By the morning of December 14, daily-record lows were shattered in Montana locations such as Havre (-33°F), Lewistown (-29°F), and Great Falls (-25°F). On December 13-14, Bismarck, ND, noted consecutive daily-record snowfall totals of 5.9 and 6.6 inches, respectively. Watertown, SD, reported a daily-record snowfall (6.0 inches) on December 14, which was also its first of 9 consecutive days with a low temperature below 0°F. Lows of -30°F in Havre, MT; -20°F in Buffalo, WY; and -19°F in Denver, CO were among the daily records for December 15. Later in the day, higher temperatures for December 15 struggled to reach -16°F in Williston, ND and Glasgow, MT. Even colder air gripped parts of Montana on December 16, when lows plunged to -39°F in Simpson and -35°F in both Harlem and Chinook. On December 22, Sisseton, SD (-22°F), set a daily-record low as did Ord, NE (-17°F). Ord experienced its coldest day since January 16, 2005, when it was -18°F. An all-time monthly snowfall record was recorded in Bismarck, ND (33.3 inches; previously, 31.1 inches in March 1975) and a December snowfall record was observed in Great Falls, MT (30.5 inches; previously, 25.0 inches in 1945). Further south, St. Louis, MO recorded its wettest year on record (57.96 inches, or 150% of normal; previously 54.97 inches in 1982).

## 4. 2008 Calendar Year Runoff

Runoff for the period January through December 2008 for the basin above Sioux City, Iowa, totaled 26.4 MAF, 105% of normal runoff based on the historical period of 1898-1998, as shown in ***Table 1***. The 26.4 MAF in 2008 represents the first above-normal runoff since 1999, as shown on ***Figure 4,*** and marks the end of the longest drought (8-years from 2000-2007) since the drought of the 1930's and early 1940's (12 years from1930-1941). Monthly runoff during 2008 above Sioux City, IA varied from a low of 52% in April to highs of 157% and 155% in June and July, respectively. ***Figure 5*** indicates the monthly variation of runoff for CY 2008.

**Table 1**
**2008 Calendar Year Runoff for Selected Reaches**

| Reach | 1898 – 1998 Average Runoff Volume (in 1000 AF) | Calendar Year 2008 Runoff Volume (in 1000 AF) | Percent of Average Runoff |
|---|---|---|---|
| Above Fort Peck | 7,395 | 6,862 | 93 |
| Fort Peck to Garrison | 10,840 | 10,313 | 95 |
| Garrison to Oahe | 2,430 | 2,771 | 114 |
| Oahe to Fort Randall | 910 | 757 | 83 |
| Fort Randall to Gavins Point | 1,675 | 1,863 | 111 |
| Gavins Point to Sioux City | 1,940 | 3,855 | 199 |
| **TOTAL ABOVE SIOUX CITY** | **25,190** | **26,421** | **105** |
| | | | |
| | **1967–2008 Average Runoff** | | |
| Sioux City to Nebraska City* | 7,390 | 11,220 | 152 |
| Nebraska City to Kansas City* | 11,610 | 15,860 | 137 |
| Kansas City to Hermann* | 23,610 | 19,530 | 83 |
| **TOTAL BELOW SIOUX CITY*** | **42,610** | **46,610** | **109** |

** 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 1967-2008.*

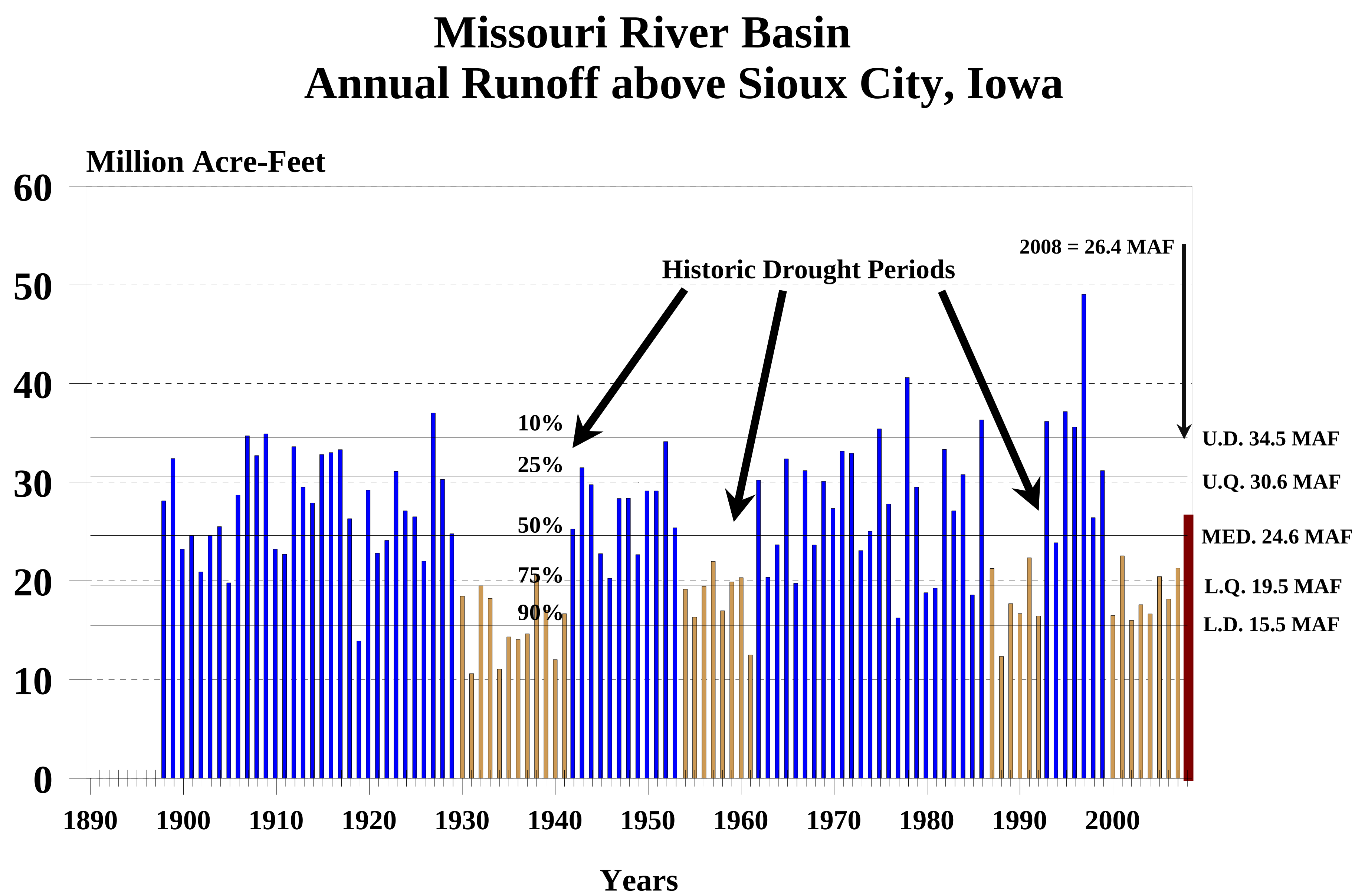
The observed monthly runoffs for 2008 from Fort Peck downstream to Sioux City, IA by major river reach are presented in ***Table 2***. The table lists the runoff by month and reach and is the basic compilation of the runoff into the System. This forecast forms a basis for intra-system balancing of storage 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 progresses and the actual runoff is 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.

The System storage declined throughout the month of January and early February. The System storage reached its yearly low of 36.4 MAF on February 4. The record low of 33.9 MAF was established on February 8, 2007, almost exactly a year earlier. System releases during February were decreased throughout the month from 13,500 cfs on February 1 to 9,000 cfs on February 29.

# Table 2
# Missouri River Basin
# Calendar Year 2008 Runoff above Sioux City, IA

Values in 1000 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 2008 | 200 | 191 | -5 | -42 | 41 | 208 | 385 | 593 | 593 |
| NORMAL | 315 | 260 | 10 | 20 | 100 | 35 | 705 | 740 | 740 |
| DEPARTURE | -115 | -69 | -15 | -62 | -59 | 173 | -320 | -147 | -147 |
| % OF NORM | 63% | 73% | -50% | -210% | 41% | 594% | 55% | 80% | 80% |
| FEB 2008 | 246 | 211 | 7 | 101 | 133 | 247 | 698 | 945 | 1,538 |
| NORMAL | 365 | 360 | 90 | 50 | 125 | 85 | 990 | 1,075 | 1,815 |
| DEPARTURE | -119 | -149 | -83 | 51 | 8 | 162 | -292 | -130 | -277 |
| % OF NORM | 67% | 59% | 8% | 202% | 106% | 291% | 71% | 88% | 85% |
| MAR 2008 | 393 | 456 | 120 | 55 | 261 | 449 | 1,285 | 1,734 | 3,272 |
| NORMAL | 610 | 1,010 | 580 | 220 | 205 | 300 | 2,625 | 2,925 | 4,740 |
| DEPARTURE | -217 | -554 | -460 | -165 | 56 | 149 | -1,340 | -1,191 | -1,468 |
| % OF NORM | 64% | 45% | 21% | 25% | 127% | 150% | 49% | 59% | 69% |
| APR 2008 | 315 | 497 | 102 | 22 | 175 | 418 | 1,111 | 1,529 | 4,801 |
| NORMAL | 665 | 1,115 | 500 | 145 | 180 | 340 | 2,605 | 2,945 | 7,685 |
| DEPARTURE | -350 | -618 | -398 | -123 | -5 | 78 | -1,494 | -1,416 | -2,884 |
| % OF NORM | 47% | 45% | 20% | 15% | 97% | 123% | 43% | 52% | 62% |
| MAY 2008 | 867 | 837 | 310 | 109 | 212 | 521 | 2,335 | 2,856 | 7,657 |
| NORMAL | 1,120 | 1,280 | 320 | 145 | 185 | 275 | 3,050 | 3,325 | 11,010 |
| DEPARTURE | -253 | -443 | -10 | -36 | 27 | 246 | -715 | -469 | -3,353 |
| % OF NORM | 77% | 65% | 97% | 75% | 115% | 189% | 77% | 86% | 70% |
| JUN 2008 | 2,236 | 3,164 | 1,384 | 418 | 326 | 972 | 7,528 | 8,500 | 16,157 |
| NORMAL | 1,655 | 2,715 | 435 | 160 | 180 | 270 | 5,145 | 5,415 | 16,425 |
| DEPARTURE | 581 | 449 | 949 | 258 | 146 | 702 | 2,383 | 3,085 | -268 |
| % OF NORM | 135% | 117% | 318% | 261% | 181% | 360% | 146% | 157% | 98% |
| JUL 2008 | 1,155 | 2,892 | 399 | 77 | 124 | 386 | 4,647 | 5,033 | 21,190 |
| NORMAL | 835 | 1,815 | 180 | 60 | 135 | 215 | 3,025 | 3,240 | 19,665 |
| DEPARTURE | 320 | 1,077 | 219 | 17 | -11 | 171 | 1,622 | 1,793 | 1,525 |
| % OF NORM | 138% | 159% | 222% | 128% | 92% | 180% | 154% | 155% | 108% |
| AUG 2008 | 254 | 529 | 98 | -5 | 95 | 171 | 971 | 1,142 | 22,332 |
| NORMAL | 360 | 625 | 65 | 40 | 115 | 130 | 1,205 | 1,335 | 21,000 |
| DEPARTURE | -106 | -96 | 33 | -45 | -20 | 41 | -234 | -193 | 1,332 |
| % OF NORM | 71% | 85% | 151% | -13% | 83% | 132% | 81% | 86% | 106% |
| SEP 2008 | 254 | 415 | 114 | 3 | 129 | 102 | 915 | 1,017 | 23,349 |
| NORMAL | 345 | 470 | 115 | 40 | 110 | 95 | 1,080 | 1,175 | 22,175 |
| DEPARTURE | -91 | -55 | -1 | -37 | 19 | 7 | -165 | -158 | 1,174 |
| % OF NORM | 74% | 88% | 99% | 8% | 117% | 107% | 85% | 87% | 105% |
| OCT 2008 | 334 | 510 | 74 | 24 | 181 | 179 | 1,123 | 1,302 | 24,651 |
| NORMAL | 400 | 525 | 70 | 10 | 120 | 75 | 1,125 | 1,200 | 23,375 |
| DEPARTURE | -66 | -15 | 4 | 14 | 61 | 104 | -2 | 102 | 1,276 |
| % OF NORM | 84% | 97% | 106% | 240% | 151% | 239% | 100% | 109% | 105% |
| NOV 2008 | 396 | 433 | 175 | 98 | 146 | 107 | 1,248 | 1,355 | 26,006 |
| NORMAL | 390 | 410 | 65 | 10 | 120 | 75 | 995 | 1,070 | 24,445 |
| DEPARTURE | 6 | 23 | 110 | 88 | 26 | 32 | 253 | 285 | 1,561 |
| % OF NORM | 102% | 106% | 269% | 980% | 122% | 143% | 125% | 127% | 106% |
| DEC 2008 | 212 | 178 | -7 | -103 | 40 | 95 | 320 | 415 | 26,421 |
| NORMAL | 335 | 255 | 0 | 10 | 100 | 45 | 700 | 745 | 25,190 |
| DEPARTURE | -123 | -77 | -7 | -113 | -60 | 50 | -380 | -330 | 1,231 |
| % OF NORM | 63% | 70% | 0% | -1030% | 40% | 211% | 46% | 56% | 105% |
| Calendar Year Totals | | | | | | | | | |
| | 6,862 | 10,313 | 2,771 | 757 | 1,863 | 3,855 | 22,566 | 26,421 | |
| NORMAL | 7,395 | 10,840 | 2,430 | 910 | 1,675 | 1,940 | 23,250 | 25,190 | |
| DEPARTURE | -533 | -527 | 341 | -153 | 188 | 1,915 | -684 | 1,231 | |
| % OF NORM | 93% | 95% | 114% | 83% | 111% | 199% | 97% | 105% | |

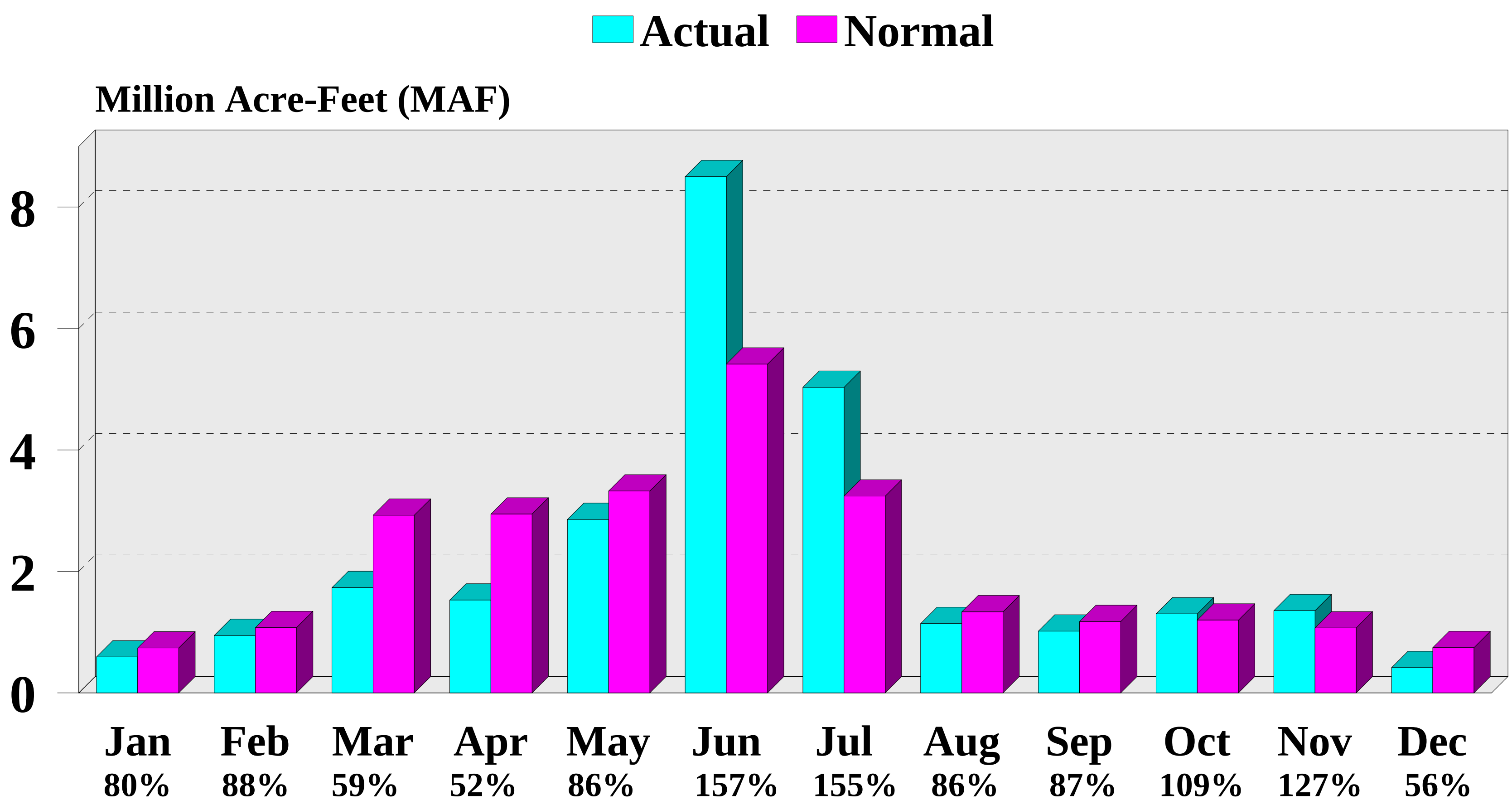


Missouri River Basin
Annual Runoff above Sioux City, Iowa
Million Acre-Feet
60
50
40
30
20
10
0
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Years
Historic Drought Periods
2008 = 26.4 MAF
10%
25%
50%
75%
90%
U.D. 34.5 MAF
U.Q. 30.6 MAF
MED. 24.6 MAF
L.Q. 19.5 MAF
L.D. 15.5 MAF


Figure 4

Figure 5

## Missouri River Basin
## 2008 Monthly Runoff above Sioux City, Iowa




**2008 Runoff : 26.4 MAF - 105% of normal**
**Normal Runoff: 25.2 MAF**

The March spring pulse from Gavins Point was conducted in 2008. The System storage on March 1 was 36.6 MAF, which was 0.1 MAF above the minimum storage level of 36.5 MAF needed to conduct the first March pulse as per the Master Manual. System releases were made as indicated in ***Table 3***.

**Table 3**
**March 2008 Spring Rise – System Releases**

| Date | System Release (cfs) |
|---|---|
| March 24 | 9,000 |
| March 25 | 12,000 |
| March 26 | 13,500 |
| March 27 | 18,000 |
| March 28 | 18,000 |
| March 29 | 17,000 |
| March 30 | 16,000 |
| March 31 | 15,500 |
| April 1 | 15,000 |
| April 2 | 15,000 |
| April 3 | 13,500 |
| April 4 | 12,000 |

The March 15 System storage was 36.9 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 2008 navigation season during the threatened and endangered (T&E) tern and plover nesting season is referred to as 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 for 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 2008 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 12,000 to 19,000 cfs. Downstream tributary inflow between Nebraska City and Kansas City was significant towards the beginning of the navigation season. As a water conservation measure, the flow targets at Sioux City (25,000 cfs), Omaha (25,000 cfs), and Nebraska City (31,000 cfs) were not met in late March and early

April since there was no barge traffic in those reaches. Flow targets at Kansas City (35,000 cfs) were met throughout the navigation season. Starting on April 12, flow targets were met at Omaha and Nebraska City.

On April 1 System storage was 37.1 MAF, 1.2 MAF more than the previous year's April 1 System storage. The May 1 System storage was 37.1 MAF, 2.9 MAF less than the required 40.0 MAF necessary to run the May spring pulse from Gavins Point Dam.

Early spring rainfall and plains snowmelt produced a March-May runoff of 6.1 MAF above Sioux City, which is 67% of normal. Runoff volumes above Sioux City for June and July were significantly higher than normal: 8.5 (157% of normal) and 5.0 (155% of normal) MAF, respectively. The June-July runoff was a result of mountain snowpack runoff as well as significant rainfall runoff. Mountain snowpack peaked at 111% of normal above Fort Peck and 110% of normal between Fort Peck and Garrison.

System storage peaked on August 3 at 45.9 MAF, which is 5.6 MAF higher than the 2007 peak (40.3 MAF on July 4). The end-of-July System storage was 45.8 MAF, 6.5 MAF higher than the 2007 end-of-July storage and 12.5 MAF less than 1967-2008 end-of-July average (58.3 MAF). System storage began a steady decline through the late summer and then gradually increased during the fall once the navigation season ended. End-of-month storages were: August, 45.0 MAF; September, 44.5 MAF; October, 44.4 MAF; November, 44.8 MAF; and December, 44.0 MAF. The end-of-December System storage was 7.1 MAF more than the previous year and 8.5 MAF less than 1967-2008 end-of-December average. As per the Master Manual, the July 1 water in storage check resulted in the navigation season being shortened by 30 days from the normal ending date of December 1 at St. Louis, MO.

## 2. Fort Peck Regulation – January to December 2008

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 4*** lists the average monthly inflows and releases in cfs and the end-of-month (EOM) pool elevation in ft msl for Fort Peck for 2007 and 2008 as well as the averages since the System first filled in 1967.

b. Winter Season 2008

The Fort Peck reservoir level began 2008 at elevation 2199.5 ft msl, 34.5 feet below the annual flood control zone and at the same elevation for the same day the previous year. The minimum reservoir level occurred on May 21 at 2198.4 ft msl, 2.2 feet higher than the 2007 minimum, which was the record low.

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 2007, which was a monthly minimum of record, and January and February 2008 were below average. Ice-cover formation on the Missouri River began on December 5, 2007 when the Missouri River stage rose over 5 feet in the Wolf Point, MT area. The stage at Wolf Point peaked near 6.5 feet on February 14, 2008, which is well below the flood stage of 10.9 feet. The Missouri River at Culbertson, MT peaked on March 23, 2008 at a stage of 8.5 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 2008 winter season. The Fort Peck reservoir (Fort Peck Lake) froze over on January 12, 2008 and was free of ice on April 16, 2008. The 2007 winter's freeze date was also January 12.

d. Spring Open Water Season 2008

The releases averaged 6,000 cfs in April, 7,600 cfs in May, and 6,800 cfs in June. Although Garrison was given top priority in 2008 for a rising pool during the forage fish spawn, it was also possible to provide a rising pool in Fort Peck due to sufficient runoff. Releases in May and June were scheduled to provide rising reservoir levels at Fort Peck and Garrison during the fish spawn while still meeting the minimum flow requirements for downstream irrigation. The reservoir elevation rose slowly and steadily during May (2198.8 to 2200.3 ft msl) and rose significantly during June (2200.3 to 2208.3 ft msl). Average inflows of 11,900 cfs for May were below average (79% of average) while June inflows of 28,400 cfs were significantly above average (150% of average).

e. Summer Open Water Season 2008

Summer release rates, which are generally higher than spring releases due to the increased demand for hydropower, were between 6,100 and 7,000 cfs, well below average. The inflows during the summer months were about average for July and slightly below average for August and September. The Fort Peck pool slowly climbed during July (2208.3 to 2210.0 ft msl) and then slowly declined during August and September (2210.0 to 2209.3 ft msl).

f. Fall Open Water Season 2008

Releases were reduced from approximately 7,000 cfs to 4,000 cfs in late September, when irrigation ceased for the season. Releases were maintained near this minimum level during October and November and then increased to the winter release rate in December, when power demands increased. Inflows for October and November were about average. The average inflows coupled with minimum releases resulted in the pool elevation slightly rising during these two months (2209.3 to 2210.2 ft msl).

g. Summary

The highest Fort Peck reservoir level during 2008 occurred on December 5 at 2210.3 ft msl. The lowest reservoir level during 2008 occurred on May 21 at 2198.4 ft msl. The average annual inflow of 8,800 cfs during 2008 was 88% of average (1967-2008). The average annual release of 5,900 cfs during 2008 was 63% of average (1967-2008). In 2008, Fort Peck did not rise into the annual flood control and multiple use zone, which extends from 2234.0 to 2250.0 ft msl.

**Table 4**
**Fort Peck – Inflows, Releases, and Elevations**

| Month | Ave Monthly Inflow (cfs) | | | Ave Monthly Release (cfs) | | | EOM Elevation (ft msl) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2008 | 2007 | 1967-2008 | 2008 | 2007 | 1967-2008 | 2008 | 2007 | 1967-2008 |
| January | 4,300 | 5,600 | 7,200 | 5,500 | 10,100 | 10,900 | 2198.9 | 2197.5* | 2227.6 |
| February | 5,100 | 7,500 | 8,700 | 5,400 | 10,700 | 11,200 | 2198.8 | 2196.3* | 2226.9 |
| March | 6,400 | 9,400 | 11,900 | 5,100 | 6,300 | 8,100 | 2199.2 | 2197.5* | 2227.9 |
| April | 5,000 | 7,500 | 10,300 | 6,000 | 4,200 | 7,500 | 2198.8 | 2198.8 | 2228.6 |
| May | 11,900 | 11,900 | 15,100 | 7,600 | 6,800 | 9,100 | 2200.3 | 2200.8 | 2230.2 |
| June | 28,400 | 12,800 | 18,900 | 6,800 | 6,100 | 9,800 | 2208.3 | 2203.1 | 2232.6 |
| July | 12,300 | 5,800 | 12,100 | 6,800 | 6,700 | 10,100 | 2210.0 | 2202.3* | 2232.8 |
| August | 6,800 | 4,700 | 7,900 | 7,000 | 7,000 | 10,000 | 2209.3 | 2200.9* | 2231.7 |
| September | 7,000 | 5,300 | 7,800 | 6,100 | 5,100 | 8,900 | 2209.3 | 2200.3 | 2230.8 |
| October | 6,800 | 5,100 | 7,300 | 4,100 | 4,000 | 8,100 | 2209.8 | 2200.3 | 2230.3 |
| November | 6,700 | 4,500* | 7,100 | 4,200 | 3,900 | 8,500 | 2210.2 | 2200.1 | 2229.5 |
| December | 4,900 | 4,500 | 6,600 | 5,800 | 5,300* | 9,600 | 2209.7 | 2199.5 | 2228.4 |

* monthly minimum of record

**3. Garrison Regulation – January to December 2008**

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 5*** lists the average monthly inflows and releases in cfs and the EOM pool elevation in ft msl for Garrison for 2007 and 2008 as well as the averages since the System filled in 1967.

b. Winter Season 2008

Releases from Garrison were below normal for an eighth consecutive winter season. Garrison began 2008 at 1810.9 ft msl, 3.1 feet higher than the previous year's elevation of 1807.8 ft msl. The 1810.9 ft msl elevation is 26.6 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 1807.3 ft msl on March 16. This elevation was more than 30 feet below the base of the annual flood control and multiple use zone of 1837.5 ft msl.

c. Winter River and Ice Conditions Below Garrison

The Missouri River in the Bismarck, ND area rose over 3 feet on November 29-30, 2007 during river ice cover formation. The ice-cover conditions were generally continuous from the end of November 2007 through mid-March 2008. A few periods of open channel occurred during January and March when the area experienced above-normal temperatures. Garrison releases were adjusted according to the downstream channel conditions during melt and ice formation periods. The winter peak ice-affected Missouri River stage at Bismarck was 9.6 feet on February 2. This was well below the Bismarck flood stage of 16 feet and the Corps' winter freeze-in stage target of 13 feet. The Garrison reservoir (Lake Sakakawea) froze over on December 22, 2007 and was free of ice on April 21, 2008. The 2007 winter's freeze date was also December 22 (2006).

d. Spring Open Water Season 2008

In 2008, Garrison was given priority during the forage fish spawn in April and May. Starting in late April, Garrison's releases were made in order to maintain a steady-to-rising Garrison pool level to promote the forage fish spawn in the Garrison reservoir. The Garrison pool level remained fairly level during April due to the incremental runoff between Fort Peck and Garrison and record low System releases. The reservoir level on April 1, the beginning of the navigation season, was 1807.6 ft msl. This elevation was 1.1 feet lower than the level at the start of the 2007 navigation season. The Garrison pool level remained fairly steady through April (1807.6 to 1807.3 ft msl) and then rose slightly during May (1807.3 to 1810.2 ft msl) and significantly during June (1810.2 to 1819.6 ft msl). Average inflows for April of 12,500 cfs (56% of average) and May of 23,900 cfs (84% of average) were below normal. However, inflows for June of 51,300 cfs (113% of average) were above normal.

e. Summer Open Water Season 2008

During June and July the snowpack runoff caused the Garrison pool to rise. During July the pool rose 6 feet from 1819.6 to 1825.6 ft msl. The pool level remained fairly level during the months of August and September. Releases during the summer months of August (13,900 cfs, 58% of average) and September (12,600 cfs, 61% of average) were significantly below normal. August and September inflows, meanwhile, were about normal. A daily peaking pattern was established at Garrison during the nesting season to protect terns and plovers nesting below the project. See Section II.F.3. of this report regarding modifications made to the intake structure to assist with coldwater fishery habitat in the Garrison reservoir.

f. Fall Open Water Season 2008

Fall releases were reduced to the 11,000 cfs range when irrigation ceased for the season in mid-September, followed by higher December releases of around 14,000 cfs to provide hydropower during winter demand increases.

g. Lake Audubon / Snake Creek Embankment

Lake Sakakawea lake levels have risen considerably since March 2007 when the 43-foot maximum water level difference between Lake Audubon and Lake Sakakawea pool restriction was put into place. The restriction was a result of an underseepage evaluation 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 ft msl in the fall.

h. Summary

Buford-Trenton pumping costs totaled $19,364.96 for 2008. The highest Garrison reservoir level during 2008 occurred on November 7 at 1826.4 ft msl, which was 8.1 feet higher than the 2007 peak. The lowest Garrison reservoir level during 2008 occurred on March 16 at 1807.3 ft msl. The average annual inflow of 19,000 cfs during calendar year 2008 was 85% of average (1967-2008). The average annual release of 13,200 cfs during calendar year 2008 was 62% of average (1967-2008). In 2008, Garrison did not rise into the annual flood control zone, which extends from 1837.5 to 1850.0 ft msl.

**Table 5**
**Garrison – Inflows, Releases, and Elevations**

| Month | Ave Monthly Inflow (cfs) | | | Ave Monthly Release (cfs) | | | EOM Elevation(ft msl) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2008 | 2007 | 1967-2008 | 2008 | 2007 | 1967-2008 | 2008 | 2007 | 1967-2008 |
| January | 8,900 | 13,400 | 15,300 | 15,000 | 15,900 | 22,800 | 1809.1 | 1807.0* | 1831.6 |
| February | 9,900* | 15,300 | 18,800 | 15,300 | 15,800 | 24,000 | 1807.6 | 1806.9* | 1830.6 |
| March | 12,800 | 21,400 | 27,000 | 12,800 | 14,800 | 19,500 | 1807.6* | 1808.7* | 1832.0 |
| April | 12,500 | 13,300 | 22,300 | 12,500 | 13,500 | 19,000 | 1807.3 | 1808.6 | 1832.5 |
| May | 23,900 | 30,400 | 28,300 | 12,900 | 13,300 | 21,000 | 1810.2 | 1813.1 | 1833.9 |
| June | 51,300 | 36,100 | 45,500 | 14,300 | 16,000 | 22,900 | 1819.6 | 1818.1 | 1838.1 |
| July | 39,500 | 12,500 | 32,100 | 13,600 | 15,900 | 24,300 | 1825.6 | 1816.9 | 1839.2 |
| August | 16,000 | 9,400 | 18,000 | 13,900* | 16,000 | 24,100 | 1825.5 | 1814.6 | 1837.6 |
| September | 15,500 | 9,800 | 16,500 | 12,600 | 11,600 | 20,500 | 1825.6 | 1813.7 | 1836.4 |
| October | 14,500 | 10,500 | 17,300 | 11,000 | 10,800 | 18,900 | 1825.8 | 1813.2 | 1835.7 |
| November | 13,200 | 10,900 | 16,000 | 11,000 | 10,800 | 19,700 | 1826.1 | 1812.7 | 1834.6 |
| December | 9,400 | 8,900 | 13,800 | 13,900 | 14,900 | 20,300 | 1824.7 | 1810.9 | 1833.0 |

* monthly minimum of record

## 4. Oahe and Big Bend Regulation – January to December 2008

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 6*** lists the average monthly inflows and releases in cfs and the EOM pool elevations in ft msl for Oahe for 2007 and 2008 as well as the averages since the System first filled in 1967.

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 2008, 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 7*** lists the average monthly inflows and releases in cfs and the EOM pool elevations in ft msl for Big Bend for 2007 and 2008 as well as the averages since the System first filled in 1967.

b. Winter Season 2008

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 5 to 7 years later. This project involved the purchase or flood-proofing of homes along the Missouri River that may be affected 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 2008. 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 24, 2008 and was free of ice on March 27, 2008.

Big Bend was regulated in the winter season to follow power peaking requirements with hourly releases varying widely. The daily average flow in 2008 varied between 0 and 30,900 cfs. The Big Bend reservoir (Lake Sharpe) froze over on December 19, 2007 and was free of ice on March 28, 2008.

c. Spring Open Water Season 2008

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 to enhance downstream fishing and boating use during the recreation season. During the spring of 2008, no minimum release rate criteria were established for Oahe. Due to the ongoing drought conditions and ensuing low reservoir levels, making large releases during shorter periods of the day rather than a constant lower release maximized power production during the periods of highest demand. Average monthly releases for April (14,700 cfs, 70% of average) and May (10,000 cfs, 46% of average) were less than normal, but considerably higher than the average monthly releases from the previous year. The average monthly inflows for April (13,700 cfs, 52% of average) and May (17,800 cfs, 65% of average) were also less than normal.

**Table 6**
**Oahe – Inflows, Releases, and Elevations**

| Month | Ave Monthly Inflow (cfs) | | | Ave Monthly Release (cfs) | | | EOM Elevation (ft msl) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2008 | 2007 | 1967-2008 | 2008 | 2007 | 1967-2008 | 2008 | 2007 | 1967-2008 |
| January | 14,600 | 15,600 | 23,200 | 13,300 | 14,900 | 20,900 | 1582.3 | 1572.9* | 1598.4 |
| February | 15,400 | 16,100 | 27,300 | 17,100 | 18,400 | 18,500 | 1581.8 | 1572.3* | 1600.1 |
| March | 14,500 | 19,500 | 30,500 | 9,700 | 8,000* | 18,500 | 1583.2 | 1575.8 | 1602.5 |
| April | 13,700 | 15,200 | 26,200 | 14,700 | 8,600 | 21,100 | 1582.8 | 1577.7 | 1603.3 |
| May | 17,800 | 14,100 | 27,400 | 10,000 | 3,700 | 21,700 | 1584.7 | 1580.5 | 1604.2 |
| June | 34,800 | 22,000 | 28,400 | 3,300* | 12,300 | 24,900 | 1592.6 | 1582.8 | 1604.4 |
| July | 17,000 | 15,600* | 26,800 | 9,800 | 19,400 | 29,200 | 1593.9 | 1581.4 | 1603.5 |
| August | 14,200* | 17,900 | 25,400 | 18,500 | 21,100 | 32,300 | 1592.4 | 1580.1 | 1601.6 |
| September | 14,300 | 13,500 | 22,000 | 10,300 | 8,100* | 28,500 | 1593.1 | 1580.9 | 1599.9 |
| October | 12,200 | 12,100 | 20,200 | 13,800 | 10,600 | 23,700 | 1592.0 | 1580.8 | 1598.7 |
| November | 13,700 | 10,600* | 21,100 | 5,300* | 5,400* | 22,300 | 1593.8 | 1582.3 | 1598.2 |
| December | 13,300 | 15,200 | 20,500 | 15,100 | 13,600* | 21,000 | 1592.9 | 1582.2 | 1597.8 |

* monthly minimum of record

In 2008, Garrison was given priority during the forage fish spawn in April and May. With priority given to Garrison, the Oahe pool level declined slightly in April (1583.2 to 1582.8 ft msl), but rose almost 2 feet in May (1582.8 to 1584.7 ft msl) and almost 8 feet in June (1584.7 to 1592.6 feet msl).

**Table 7**
**Big Bend – Inflows, Releases, and Elevations**

| Month | Ave Monthly Inflow (cfs) | | | Ave Monthly Release (cfs) | | | EOM Elevation (ft msl) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2008 | 2007 | 1967-2008 | 2008 | 2007 | 1967-2008 | 2008 | 2007 | 1967-2008 |
| January | 12,300 | 13,800 | 20,700 | 12,700 | 14,500 | 20,700 | 1420.2 | 1420.1 | 1420.5 |
| February | 16,000 | 17,200 | 18,500 | 15,900 | 16,800 | 18,500 | 1420.3 | 1420.5 | 1420.4 |
| March | 9,200 | 8,200* | 19,200 | 8,800 | 7,600* | 19,100 | 1420.6 | 1421.0 | 1420.3 |
| April | 13,500 | 7,700 | 21,500 | 13,800 | 7,800 | 21,200 | 1420.0 | 1420.7 | 1420.5 |
| May | 9,600 | 3,700 | 22,100 | 9,000 | 3,400 | 22,000 | 1420.3 | 1420.8 | 1420.4 |
| June | 4,800 | 11,600 | 25,200 | 4,200* | 11,600 | 25,000 | 1420.6 | 1420.3 | 1420.3 |
| July | 9,300 | 17,300 | 28,600 | 9,300 | 17,600 | 28,200 | 1420.1 | 1419.6 | 1420.3 |
| August | 16,700 | 20,000 | 31,800 | 15,700 | 19,000 | 31,300 | 1420.6 | 1420.3 | 1420.3 |
| September | 9,900 | 7,100* | 28,300 | 9,500 | 6,400* | 27,800 | 1420.6 | 1420.8 | 1420.3 |
| October | 12,900 | 10,400 | 23,600 | 13,100 | 9,900 | 23,100 | 1420.0 | 1420.7 | 1420.5 |
| November | 5,000* | 5,100* | 23,900 | 4,400* | 4,900* | 22,100 | 1420.4 | 1420.4 | 1420.4 |
| December | 13,900 | 13,100 | 20,900 | 13,700 | 12,300* | 20,600 | 1420.5 | 1420.6 | 1420.5 |

* monthly minimum of record

d. Summer Open Water Season 2008

The Oahe pool level continued to steadily increase through June and July until reaching its peak of 1594.3 ft msl on July 27, 11.1 feet higher than the 2007 peak (1583.2 ft msl on June 21). The August 1 elevation was 1593.9 ft msl, 12.5 feet higher than the August 1, 2007 elevation. The September 1 elevation was 1592.4 ft msl, more than 12 feet higher the previous year’s September 1 elevation. Oahe summer releases were far below average: July (9,800 cfs, 33% of average), August (18,500 cfs, 57% of average), and September (10,300 cfs, 36% of normal).

e. Fall Open Water Season 2008

The Oahe reservoir elevation rose slightly through October and November. Releases were reduced in September 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. The average monthly release for November of 5,300 cfs was the minimum average November monthly release of record.

f. Summary

The highest Oahe reservoir level during 2008 occurred on July 27 at 1594.3 ft msl. The annual minimum pool elevation of 1581.6 ft msl occurred on February 21. This was nearly 10 feet higher than the 2007 minimum elevation of 1571.9 ft msl. The average annual inflow to Oahe of 16,300 cfs was 66% of average (1967-2008). The average annual release from Oahe of 11,700 cfs was 50% of average (1967-2008). In 2008, Oahe did not rise into its annual flood control zone, which extends from 1607.5 to 1617.0 ft msl. Big Bend ended the year at 1421.1 ft msl, within the normal regulating range.

### 5. Fort Randall Regulation – January to December 2008

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 8*** lists the Fort Randall average monthly inflows and releases in cfs and the EOM pool elevation in ft msl for 2007 and 2008 as well as the averages since the System was first filled in 1967.

b. Winter Season 2008

The Fort Randall winter releases ranged from 4,800 to 14,400 cfs. The Fort Randall reservoir (Lake Francis Case) froze over on January 15, 2008 and was ice free on March 21, 2008.

c. Spring Open Water Season 2008

Fort Randall March releases were at reduced levels as Gavins Point releases were maintained at the 9,000 cfs open water release rate prior to the start of the navigation season. 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 12,000 cfs were 56% of normal and the May releases of 9,900 cfs were 40% of normal. These below-normal releases corresponded with below normal inflows; April inflows of 15,500 cfs were 65% of normal and May inflows of 46% of normal.

d. Summer Open Water Season 2008

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 impact to birds nesting below the project. Fort Randall summer releases were far below average: July (15,600 cfs, 51% of average), August (21,900 cfs, 66% of average), and September (19,600 cfs, 58% of normal).

e. Fall Open Water Season 2008

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 winter generation releases from the upper reservoirs. Even during a shortened navigation season such as 2008 (30-day shortening), attempts are made to maintain the Fort Randall pool above 1353 ft msl through the Labor Day weekend. However, in late August higher-than-expected releases from Gavins Point of 25,500 cfs, which were backed up with similar releases from Fort Randall, resulted in the Fort Randall pool being at 1351.5 ft msl at the end of the Labor Day weekend.

f. Summary

The highest Fort Randall reservoir level during 2008 occurred on June 13 at 1362.1 ft msl. The lowest reservoir level during 2008 occurred on October 15 at 1337.0 ft msl. The average annual inflow to Fort Randall of 12,600 cfs was 51% of average (1967-2008). The average annual release from Fort Randall of 12,300 cfs was 50% of average (1967-2008). In 2008, 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.

**Table 8**
**Fort Randall – Inflows, Releases, and Elevations**

| Month | Ave Monthly Inflow (cfs) | | | Ave Monthly Release (cfs) | | | EOM Elevation (ft msl) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2008 | 2007 | 1967-2008 | 2008 | 2007 | 1967-2008 | 2008 | 2007 | 1967-2008 |
| January | 12,900 | 15,300 | 22,000 | 11,800 | 12,700 | 15,200 | 1343.9 | 1346.2 | 1347.2 |
| February | 19,000 | 19,800 | 20,200 | 9,300 | 9,600 | 13,400 | 1351.4 | 1353.5 | 1352.1 |
| March | 10,700 | 10,500 | 21,700 | 6,600 | 4,100* | 15,800 | 1354.4 | 1358.0 | 1356.2 |
| April | 15,500 | 8,900 | 23,800 | 12,000 | 6,900 | 21,500 | 1356.8 | 1359.2 | 1357.6 |
| May | 11,300 | 5,800 | 24,700 | 9,900 | 7,700* | 24,900 | 1357.6 | 1357.6 | 1357.3 |
| June | 10,200* | 14,100* | 27,600 | 6,600* | 15,500 | 27,000 | 1359.6 | 1356.3 | 1357.4 |
| July | 10,200 | 18,200 | 29,500 | 15,600 | 21,100 | 30,600 | 1355.7 | 1354.0 | 1356.3 |
| August | 17,100 | 22,200 | 32,600 | 21,900 | 20,400 | 33,400 | 1351.3 | 1354.8 | 1355.3 |
| September | 9,800 | 6,400* | 28,700 | 19,600 | 20,000 | 33,700 | 1342.3* | 1343.6 | 1350.9 |
| October | 14,500 | 11,900 | 23,100 | 15,500 | 11,500 | 31,900 | 1341.0 | 1343.4 | 1343.1 |
| November | 6,300 | 3,800* | 22,000 | 6,700 | 7,900 | 28,500 | 1340.5 | 1339.2 | 1336.6 |
| December | 13,100* | 14,700 | 21,800 | 12,700 | 10,700 | 17,100 | 1340.9 | 1343.0 | 1341.2 |

* monthly minimum of record

## 6. Gavins Point Regulation – January to December 2008

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 powerplant capacity, near 35,000 cfs, are passed through the spillway.

***Table 9*** lists the Gavins Point average monthly inflows and releases in cfs and the EOM pool elevation in ft msl for 2007 and 2008 as well as the averages since the System was filled in 1967.

b. Winter Season 2008

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 10,500 cfs to 14,000 cfs in December; 8,300 cfs to 14,000 cfs in January; and 9,000 cfs and 13,500 cfs in February. The Gavins Point reservoir (Lewis and Clark Lake) froze over on December 10, 2007 and was free of ice on March 6, 2008.

c. Winter River and Ice Conditions Below Gavins Point

The first signs of floating ice on the Missouri River during the 2008 winter season were noted on November 29, 2007 near Sioux City, IA. On December 3, 15 to 40% floating ice with pads ranging from 3 to 10 feet were noted in the Missouri River in the Sioux City to Omaha, NE reach. The volumes of floating ice fluctuated through the rest of December to January 8, 2008, at which time the Missouri River was free of floating ice downstream of Sioux City. When a round of freezing temperatures occurred from January 13-26, large volumes of ice were produced and resulted in the greatest extent of floating ice reported for the winter season. Ice observations noted floating ice from 5 to 80%, with pads ranging from 5 to 30 feet in the Sioux City to Nebraska City, NE reach of the Missouri River. The floating ice diminished from January 27-30. However, another round of freezing temperatures arrived on January 31 and an ice bridge formed upstream from Sioux City. The Gavins Point release was increased from 12,000 cfs up to 14,000 cfs during this period to offset the loss in downstream flow and also to assist in breaking up the ice bridge. The Missouri River stages dropped as much as 3.5 feet throughout the reach downstream of Sioux City from January 28-30. The Missouri River stage at Sioux City reached its winter low level of 7.06 feet on January 30.

Another round of single degree temperatures arrived on February 10 and produced ice bridging conditions upstream from Ponca, NE. Missouri River stages dropped anywhere from 1 foot to over 1.5 feet in the Ponca, NE to Sioux City reach. The Gavins Point release was increased from the 12,000 cfs to 13,000 cfs on February 7 in anticipation of decreased downstream stages due to ice bridging during this extreme cold period. Starting on February 7, the Missouri River had about 30% floating ice in the Sioux City area of the Missouri River. The reports of floating ice continued until February 28, the last report of floating ice on the Missouri River. The floating ice ranged from 3 to 35% and pans size ranged from 5 to 30 feet. By February 28 only 1% floating ice was reported on the Missouri River between Sioux City and Omaha.

d. Spring Open Water Season 2008

The March spring pulse from Gavins Point was conducted in 2008. The System storage on March 1 was 36.6 MAF, which was 0.1 MAF above the minimum storage level of 36.5 MAF needed to conduct the first-ever March pulse as per the Master Manual.

Flow support for the 2008 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 10,800 cfs for March were 54% of average, 14,800 cfs for April were 59% of average, and 13,100 cfs for May were 46% of average. With large rainfall events in the lower basin in May, System releases were maintained at much lower-than-normal levels, to decrease the risk of downstream flooding. System releases were lowered to 11,000 cfs on May 2 and maintained at that level until May 19.

e. Summer Open Water Season 2008

The summer storms in the lower portion of the basin continued into June. Average monthly System releases of 12,000 cfs for June was a monthly historic low, far lower than the previous record of 16,700 cfs set in 1984. For a large portion of June the System releases were cycled between 10,000 cfs, the minimum release necessary to meet downstream water supply needs, and 13,000 cfs to in order to discourage endangered species from nesting at lower levels on exposed sand bars. During July the releases were increased to meet downstream navigation targets. However, the average monthly July release of 16,300 cfs was half of the normal monthly July release. During August, releases ranged from 18,000 to 25,500 cfs in order to meet navigation targets. The average monthly August release of 22,800 cfs was 66% of average.

f. Fall Open Water Season 2008

System releases were maintained in the 16,000 to 25,500 cfs range in September and the first half of October to meet the downstream minimum navigation targets. Releases to support navigation stopped on October 22, 2008, resulting in a 30-day shortening of the navigation season. In 2007, 2006, 2005 and 2004 the navigation season was shortened by 35, 44, 48 and 47 days, respectively.

g. Summary

The highest Gavins Point reservoir level during 2008 occurred on June 10 at 1208.5 ft msl. The lowest reservoir level during 2008 occurred on April 10 at 1205.0 ft msl. The average annual inflow to Gavins Point of 14,800 cfs, which was also the average annual inflow for 2007, was 54% of average (1967-2008). The average annual release from Gavins Point of 14,600 cfs, which was also the average annual outflow for 2007, was 54% of average (1967-2008).

**Table 9**
**Gavins Point – Inflows, Releases, and Elevations**

| Month | Ave Monthly Inflow (cfs) | | | Ave Monthly Release (cfs) | | | EOM Elevation (ft msl) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2008 | 2007 | 1967-2008 | 2008 | 2007 | 1967-2008 | 2008 | 2007 | 1967-2008 |
| January | 12,500 | 13,500 | 17,300 | 12,500 | 13,900 | 17,200 | 1207.0 | 1207.0 | 1207.5 |
| February | 12,200 | 13,900 | 16,600 | 11,800 | 13,200 | 17,400 | 1207.7 | 1208.2 | 1205.7 |
| March | 10,300 | 9,700* | 19,800 | 10,800 | 10,100* | 19,900 | 1206.6 | 1207.3 | 1205.6 |
| April | 15,200 | 10,300* | 25,400 | 14,800 | 10,200* | 25,300 | 1207.1 | 1207.2 | 1205.7 |
| May | 13,700 | 10,500* | 28,700 | 13,100 | 10,600* | 28,400 | 1208.2 | 1206.5 | 1206.0 |
| June | 11,200* | 17,500 | 30,200 | 12,000* | 17,700 | 29,900 | 1205.9 | 1205.6 | 1206.2 |
| July | 16,800 | 21,500 | 32,800 | 16,300 | 21,100 | 32,300 | 1206.5 | 1206.1 | 1206.8 |
| August | 23,000 | 22,300 | 35,100 | 22,800 | 21,500 | 34,600 | 1206.2 | 1207.3 | 1207.4 |
| September | 21,500 | 21,100 | 35,700 | 20,700 | 20,900 | 35,300 | 1207.4 | 1207.3 | 1207.7 |
| October | 18,500 | 14,800 | 34,200 | 18,200 | 14,500 | 34,000 | 1207.8 | 1207.4 | 1207.8 |
| November | 9,200 | 9,500 | 30,800 | 9,000 | 9,100 | 30,800 | 1208.0 | 1208.0 | 1207.6 |
| December | 13,400 | 12,500 | 19,300 | 13,500 | 12,700 | 19,300 | 1207.5 | 1207.3 | 1207.4 |

* monthly minimum of record

## D. <u>Non-Routine Regulation and Other Items Pertaining to System Regulation</u>

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 soundings, 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 2008 that may be considered unusual, or recently have come to the attention of MRBWM, are discussed in the following paragraphs.

### 1. Lawsuits

On March 24, 2008, the State of Missouri filed a complaint in the United States District Court for the Eastern District of Missouri seeking a temporary restraining order (TRO) and preliminary and permanent injunctions to stop the Corps from implementing the March spring pulse. Missouri alleged that implementation of the spring pulse by the Corps violated the 1944 Flood Control Act and the Administrative Procedures Act. Missouri claimed that subordinating flood control to fish and wildlife operations violated the 1944 Flood Control Act since flood control is a dominant purpose of the Flood Control Act. Missouri also claimed that because there is latitude in the Master Manual to change operations, the Corps' failure to do so when there is downstream flooding that endangers life and property is an abuse of discretion under the Administrative Procedures Act.

Following a three hour hearing in St. Louis on Tuesday, March 25th, Judge Jean Hamilton denied Missouri's request for a TRO. That same day, immediately following Judge Hamilton's ruling Missouri filed a notice of appeal with the 8th Circuit Court of Appeals and requested the Court issue a TRO to enjoin the Corps' planned increase releases from Gavins Point. Later that day the 8th Circuit denied Missouri's TRO request.

Subsequently, the Corps increased releases at Gavins Point to implement the March spring pulse. This pulse increased releases by 5,000 cfs for a two day period. Releases were adjusted from five tributary dams in Missouri and Kansas to eliminate the spring pulse on the Missouri River below Kansas City. A total reduction of 5,100 cfs in releases were made from Milford, Tuttle Creek and Perry dams on the Kansas River tributaries, Clinton Dam on the Wakarusa River, and Smithville Dam on the Little Platte River.

### 2. Master Manual Revision

A summary of the process used in the 2006 revision of the Master Manual to include technical criteria for a Gavins Point spring pulse can be found in the "Summary of Actual 2005 Regulation" report. A Record of Decision (ROD) revising the Master Manual was signed on February 28, 2006.

The Corps is committed to monitoring both the physical and biological impacts of the bimodal spring pulse releases, including the response of the pallid sturgeon to the pulses, further evaluation of interior drainage and groundwater concerns, and potential impacts to cultural resources. Within an overall adaptive management strategy, the results of monitoring will be used to develop future modifications to the criteria. If information becomes available through the research, monitoring, and evaluation processes that indicate a change to the spring pulse technical criteria, then the adaptive management process, including any National Environmental Policy Act (NEPA) work required, will be followed to revise the Master Manual.

### 3. Fort Peck Mini-Test and Intrasystem Unbalancing

As described in the 2007-2008 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 anticipates that both these regulation plans will be implemented. 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. The "mini-test" was not possible in 2008 because reservoir elevations during May and June ranged from 17 to 27 feet below the spillway crest elevation of 2225 ft msl.

The Missouri River Natural Resources Committee (MRNRC) previously has provided recommended guidelines (Table VII, 2006-2007 AOP) for unbalancing the upper three reservoirs to benefit reservoir fishery and the endangered terns and plovers. As a result of the continuing drought conditions and low reservoir elevations, the criteria for unbalancing the reservoirs were not met in 2008.

### 4. 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 2008 at 44.0 MAF, 7.1 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 have set new record low pool levels during the 2000-2007 drought. While the increase in storage during 2008 was an improvement from the past year, impacts of the drought have been felt across the basin. Some of the municipal, rural, industrial, and irrigation water intakes in the reservoirs and along the river reaches have been forced to make modifications to maintain access to the water. Many of the boat ramps have been extended, relocated or closed as the reservoir levels declined. Coldwater habitat in the reservoirs has been dramatically reduced threatening the viability of the coldwater fisheries. Cultural resources, once covered by water, are now exposed and vulnerable to additional erosion and looting. Noxious weeds have become even more problematic as thousands of acres of bare shoreline appear.

The only authorized purpose that is not adversely impacted by the drought is flood control, which is actually enhanced during drought conditions. The negative impacts of drought will be felt even after runoff returns to normal because of the time that will be required to refill the evacuated storage. Full service project releases to all purposes will not resume until the System storage has recovered to near normal levels, however, as System storage increases, improved service will be provided. 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 2008 are presented in ***Table 10*** and the same information for end-of-December 2008 is presented as ***Table 11***. The 12-month change columns indicate significant increases in the elevations and storages in the upper 3 large storage reservoirs.

***Figures 6A*** and ***6B*** show the end-of-July pool elevations for Fort Peck, Garrison, and Oahe plus total System end-of-July storage for 2006 through 2008. Individual tables with the historic maximum, average, and minimum pool elevations for each reservoir are also shown on ***Figures 6A*** and ***6B***. During CY 2008, the upper three reservoirs all had higher July 31 pool levels than 2007. All three reservoirs experienced their historical minimum record pool levels during 2005 or 2006. On July 31, 2008 Fort Peck Lake was at elevation 2210.0 ft msl, 7.7 feet higher than at the same time in 2007. On July 31, 2008 Lake Sakakawea was at elevation 1825.6 ft msl, 8.7 feet higher than at the same time in 2007. Lake Oahe was at elevation 1593.9 on July 31, 2008, 12.5 feet higher than at the same time in 2007. The storage gain in Oahe was due to the lower-than-normal System releases made from March through June, including record low releases in March, April and May. The lower-than-normal System releases were made to offset downstream flooding in the State of Missouri from rainfall runoff and were sufficient to meet navigation targets in reaches being utilized for commercial navigation.

**Table 10**
**Reservoir Levels and Storages – July 31, 2008**

| 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 | 2210.0 | +7.7 | 10,568 | 6,397 | +1,226 |
| Garrison | 1825.6 | +8.7 | 14,677 | 9,697 | +2,163 |
| Oahe | 1593.9 | +12.5 | 15,006 | 9,633 | +2,961 |
| Big Bend | 1420.1 | +0.5 | 1,631 | 10 | +20 |
| Fort Randall | 1355.7 | -1.7 | 3,583 | 2,066 | +138 |
| Gavins Point | 1206.5 | +0.4 | 370 | 49 | +10 |

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

**Table 11**
**Reservoir Levels and Storages – December 31, 2008**

| 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 | 2209.7 | +10.2 | 10,254 | 6,043 | +1,342 |
| Garrison | 1824.7 | +13.8 | 14,457 | 9,477 | +2,309 |
| Oahe | 1592.9 | +10.7 | 14,706 | 9,333 | +2,558 |
| Big Bend | 1420.5 | -0.1 | 1,650 | 29 | -10 |
| Fort Randall | 1340.9 | -2.1 | 2,488 | 971 | -140 |
| Gavins Point | 1207.5 | +0.2 | 396 | 75 | +4 |

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

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

### 1. Flood Control

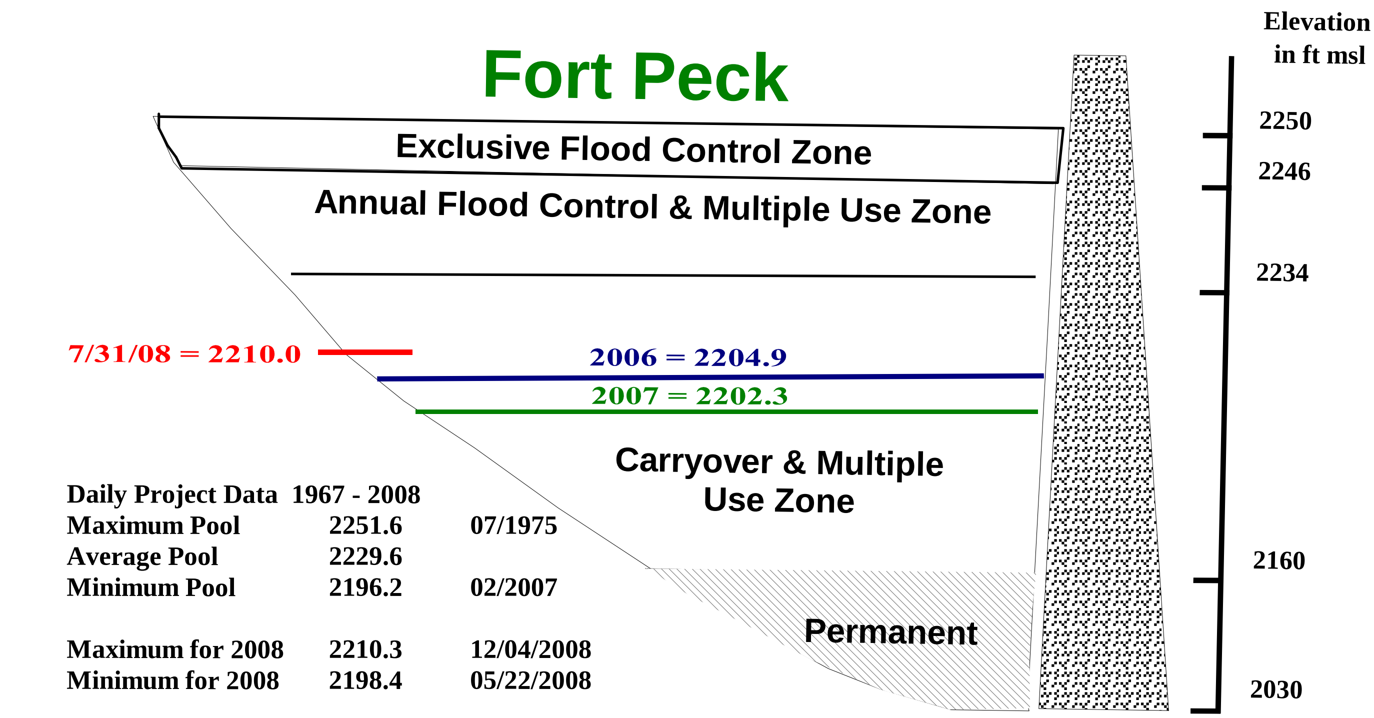
Releases during CY 2008 were influenced by continuation of the drought conservation measures to conserve System storage, and the higher than normal downstream runoff. The storage crest was much lower than the base of the annual flood control zone. Mountain snowpack was near normal, and significant spring rains did lessen drought severity in the basin. Based on the near normal snowpack and little plains snow, the expectation was for a below-normal runoff, and water conservation measures were implemented to conserve the remaining storage according to Master Manual criteria. While runoff was above normal for the first time since 1999, System storage is still recovering from the effects of 8 consecutive years of below normal runoff.

The estimated total flood damages prevented by all Corps projects in the basin during 2008 exceeded $3.3 billion. The estimated total flood damages prevented by the System during 2008 was $2,877,180,000. The total damages prevented by the System in the Missouri River basin include $219,809,000 in the Omaha District and $2,657,371,000 in the Kansas City District. The unindexed flood damages prevented by the System since construction now totals $21.6 billion, the bulk of which was prevented between 1993 and 1999 (see ***Figure 8B***). ***Figure 8A*** indicates the flood damages prevented indexed to 2008. Although the System prevents enormous amounts of damage, it is not capable of totally eliminating flooding along the Missouri River.

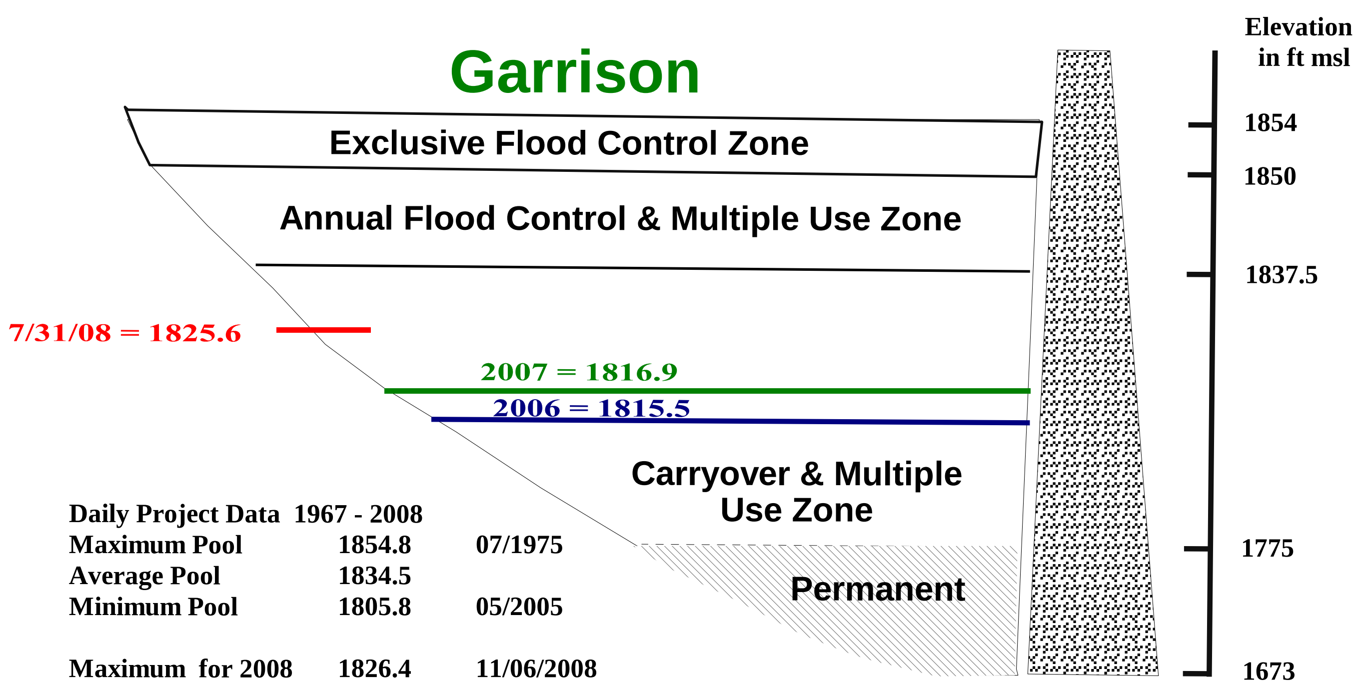
***Figure 7*** shows the actual regulated Missouri River flows that were experienced at Sioux City, Nebraska City and St. Joseph and the unregulated flows that would have been experienced if the System and tributary reservoirs had not been in regulation.

# Missouri River

## End-of-July Pool Elevations



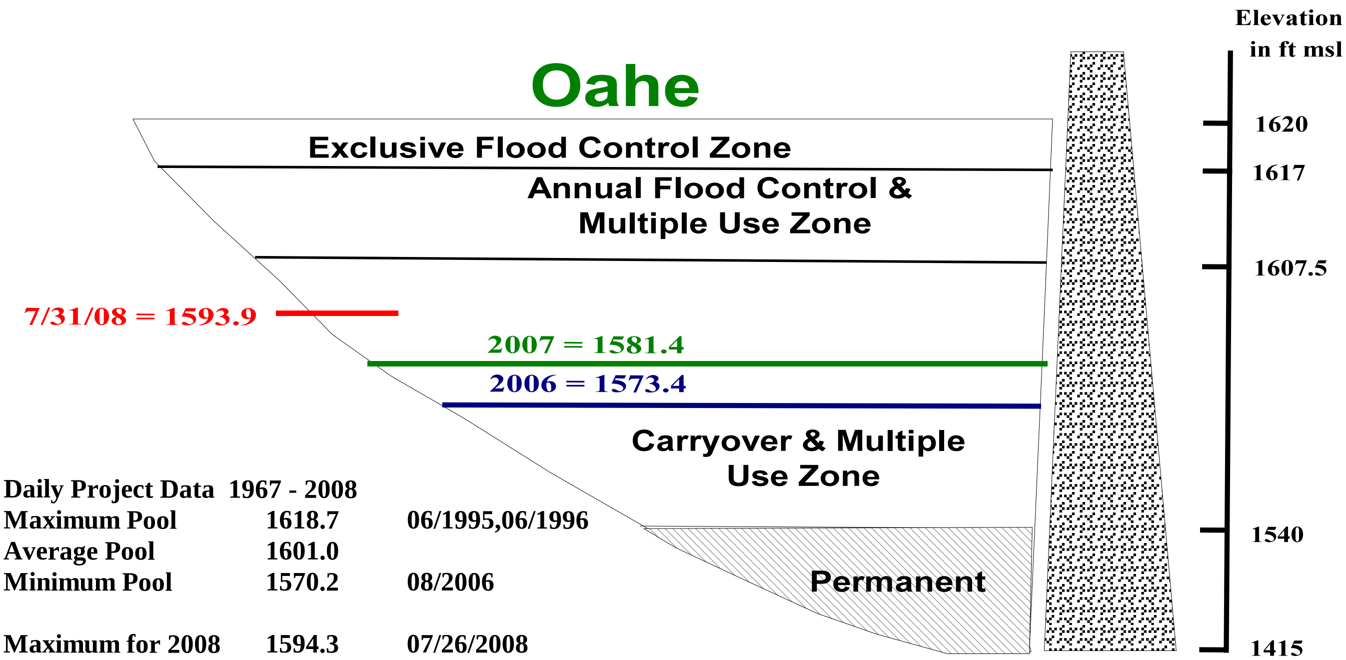

| Daily Project Data 1967 - 2008 | | |
|---|---|---|
| Maximum Pool | 2251.6 | 07/1975 |
| Average Pool | 2229.6 | |
| Minimum Pool | 2196.2 | 02/2007 |
| | | |
| Maximum for 2008 | 2210.3 | 12/04/2008 |
| Minimum for 2008 | 2198.4 | 05/22/2008 |



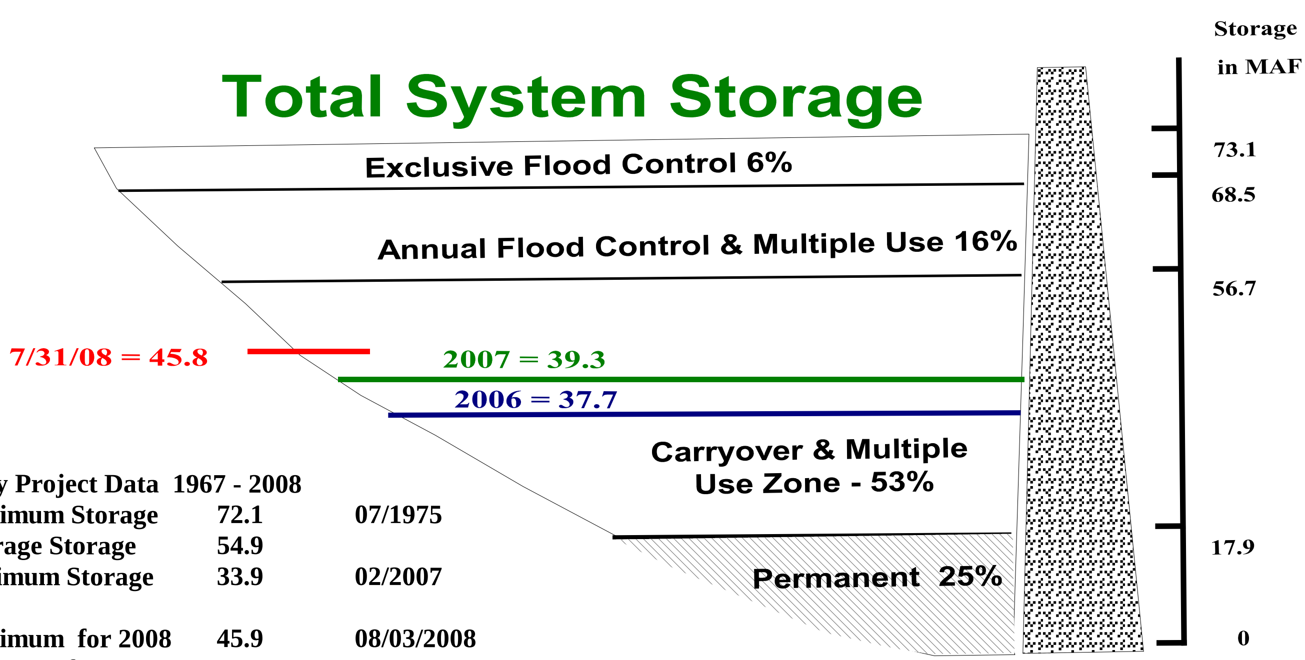

| Daily Project Data 1967 - 2008 | | |
|---|---|---|
| Maximum Pool | 1854.8 | 07/1975 |
| Average Pool | 1834.5 | |
| Minimum Pool | 1805.8 | 05/2005 |
| | | |
| Maximum for 2008 | 1826.4 | 11/06/2008 |
| Minimum for 2008 | 1807.3 | 03/15/2008 |

Figure 6A

# System Reservoirs
## and Total System Storage




| Daily Project Data 1967 - 2008 | | |
|---|---|---|
| Maximum Pool | 1618.7 | 06/1995,06/1996 |
| Average Pool | 1601.0 | |
| Minimum Pool | 1570.2 | 08/2006 |
| Maximum for 2008 | 1594.3 | 07/26/2008 |
| Minimum for 2008 | 1581.7 | 03/07/2008 |



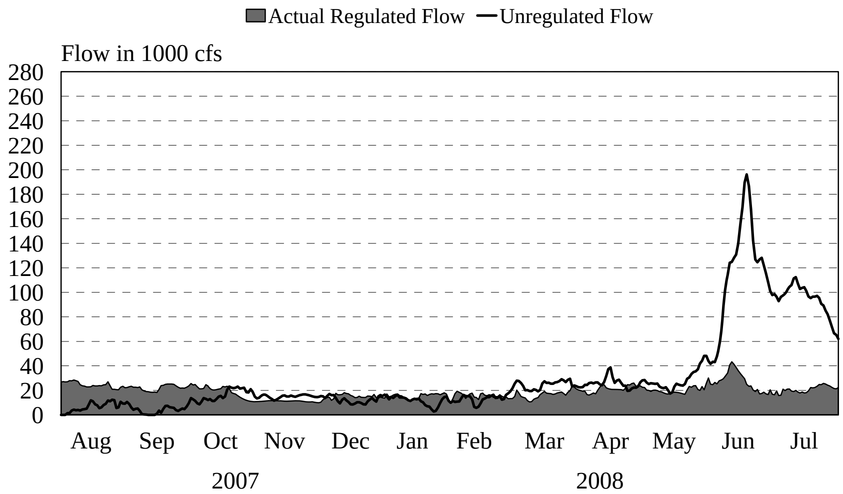

| Daily Project Data 1967 - 2008 | | |
|---|---|---|
| Maximum Storage | 72.1 | 07/1975 |
| Average Storage | 54.9 | |
| Minimum Storage | 33.9 | 02/2007 |
| Maximum for 2008 | 45.9 | 08/03/2008 |
| Minimum for 2008 | 36.4 | 02/04/2008 |



Figure 6B

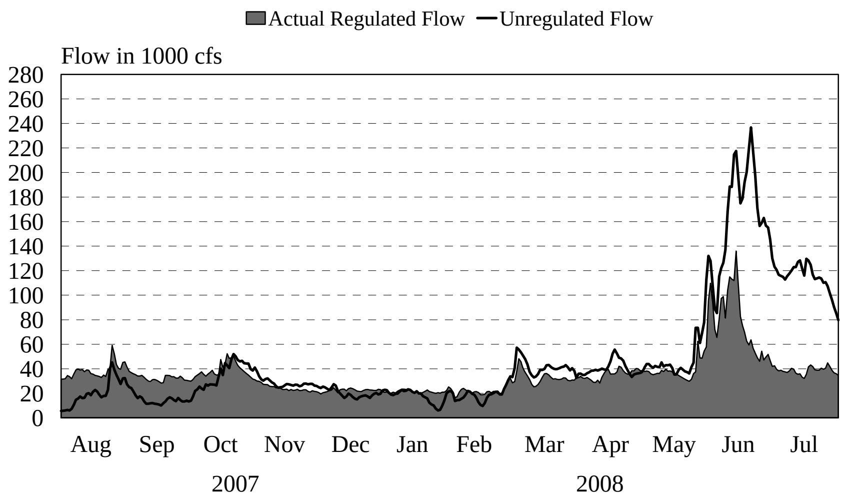
## Sioux City

### Regulated and Unregulated Flows




## Nebraska City

### Regulated and Unregulated Flows




## St. Joseph

### Regulated and Unregulated Flows

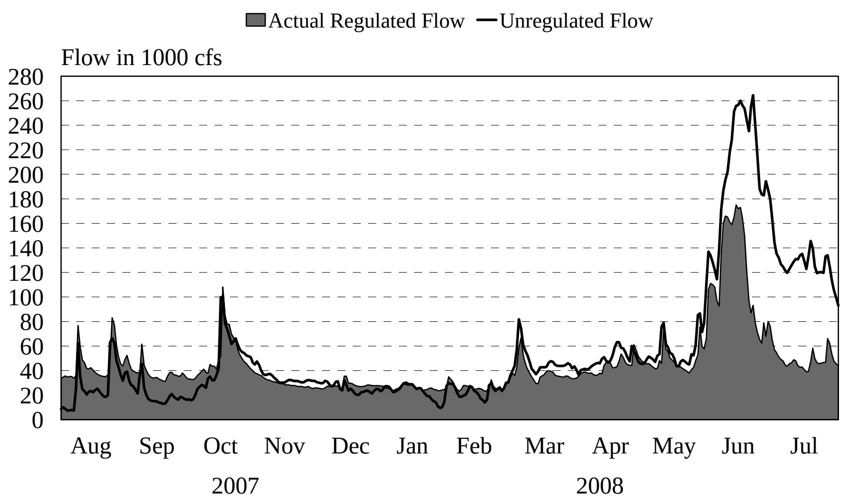
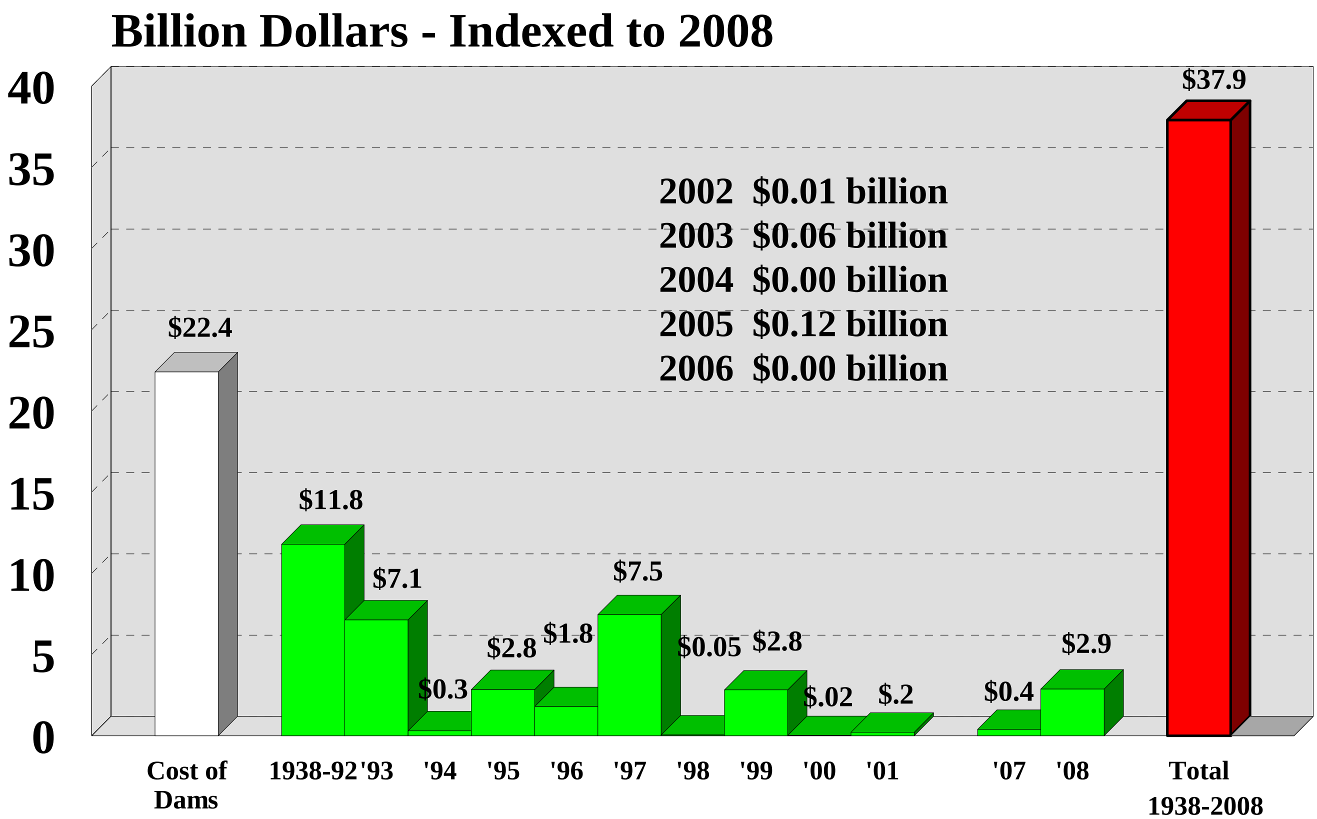



Figure 7

# *Missouri River Mainstem Reservoirs*
# *Flood Damages Prevented*



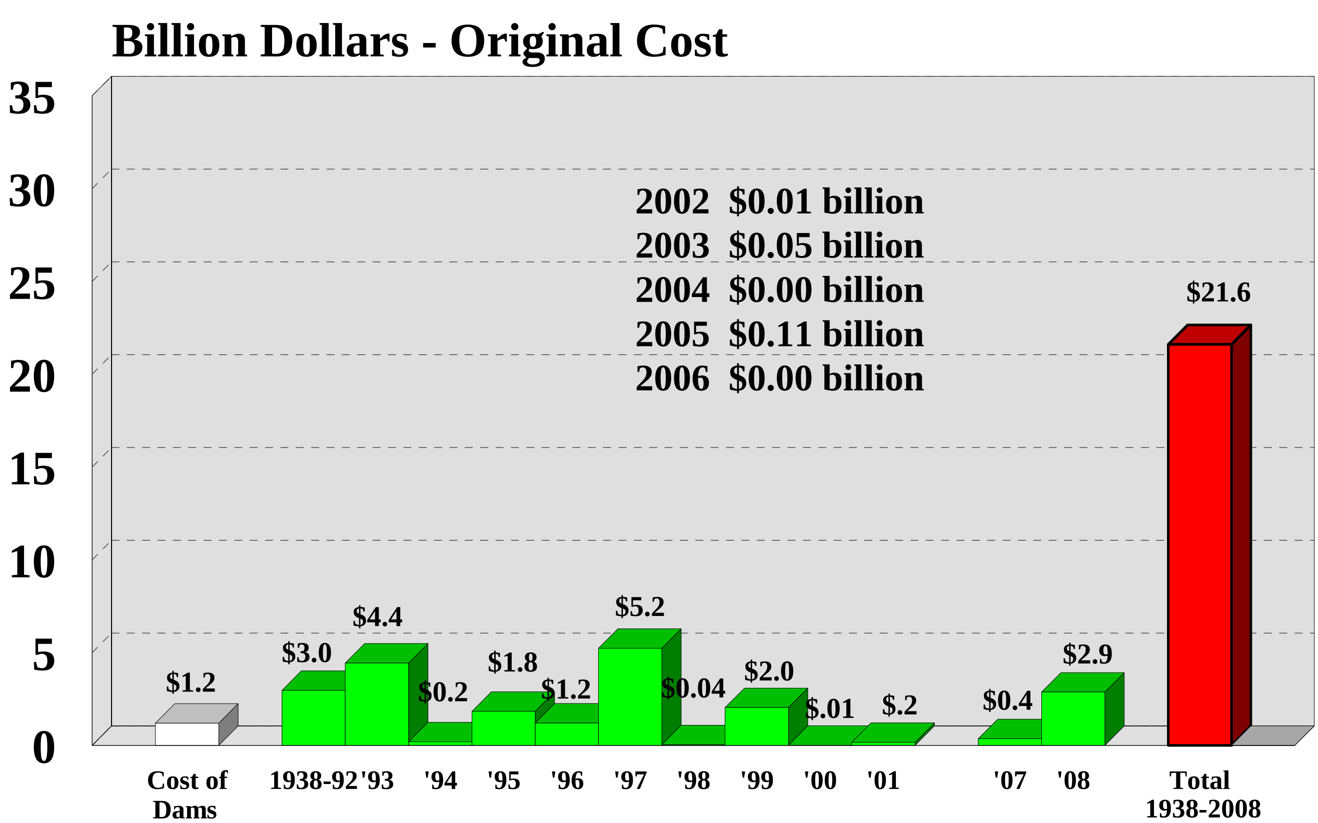






Figure 8B

## 2. Irrigation

Federally developed irrigation projects are not being served directly from System reservoirs. Releases from 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 2008 generally met the needs of irrigators, however the reduction of releases from Fort Peck and Garrison in September may have resulted in an earlier than desired end to the irrigation season in those reaches. Also due to the shortening of the navigation season Fort Randall reservoir was drawn down earlier than normal, which impacted irrigation pumping directly from that reservoir. Low reservoir levels and releases have also resulted in additional pumping costs, difficulty in, or in some cases inability to, access the water, and/or the need to dredge in order to maintain access.

## 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. The Standing Rock Sioux Tribe's (SRST) intake at Fort Yates, ND failed in November 2003, leaving the community without water for several days. The Bureau of Reclamation (USBR) has installed a temporary intake and drilled a well to ensure continued water supply for that community. The USBR has also lowered the intake at Wakpala, SD on the Oahe reservoir. A new intake and wet well located on the south side of the Indian Memorial Recreation Area at Wakpala is currently in the process of being constructed. The new intake will be located in the old river channel. The long-term plan involves the construction of a new water treatment plant south of Kennel, SD. The raw water for this treatment plant will be delivered from the new Wakpala intake. The intake structure and treatment plant will eventually become the primary source of water the entire SRST reservation. The Cheyenne River Sioux Tribe, with assistance from the Corps, relocated their Mni Waste' water intake, which serves over 14,000 residents of and near the Cheyenne River Indian Reservation. The new intake was dedicated in 2008. The Corps has used its emergency authority to lower the intake at Parshall, ND on Garrison reservoir. Other intakes that have been identified as having problems or potential problems include Mandaree, ND and Twin Buttes, ND on Garrison reservoir.

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 2008, the Omaha District conducted long-term, fixed-station ambient 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, Fort Randall and Gavins Point.

The Omaha District has identified seven priority water quality issues that have relevance to the System projects. These identified priority issues and their relative ranking are:

(1) Determine how regulation of the System dams effects 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 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 System projects, affects water quality in the Missouri River.

(4) Provide water quality information to support Corps reservoir regulation elements for effective water quality and aquatic habitat management.

(5) Provide water quality information and technical support to the States in the development of their Section 303(d) lists and development and implementation of Total Maximum Daily Loads (TMDL) at District projects, including the System projects.

(6) Identify existing and potential water quality problems at District projects, and develop and implement appropriate solutions.

(7) Evaluate water quality conditions and trends at District projects.

Note: Relative ranking of priority in parentheses (1 = highest priority).

***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.

## 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<br>Primary Contact Recreation | Lead<br>Mercury<br>Aquatic Plants - Native | No | Yes | Mercury | --- |
| • ***Missouri River, Fort Peck Dam to the Milk River*** | Yes (MT) | Aquatic Life<br>Cold Water Fishery | Flow Regime Alteration<br>Alteration of Littoral Vegetation<br>Riparian Degradation<br>Water Temperature | No | No | --- | --- |
| • ***Missouri River, Milk River to the Poplar River*** | Yes (MT) | Aquatic Life<br>Warm Water Fishery | Flow Regime Alteration<br>Alteration of Littoral Vegetation<br>Riparian Degradation<br>Water Temperature | No | No | --- | --- |
| • ***Missouri River, Poplar River to North Dakota*** | Yes (MT) | Aquatic Life<br>Warm Water Fishery | Flow Regime Alteration<br>Water Temperature | No | No | --- | --- |
| ***Garrison*** | | | | | | | |
| • Lake Sakakawea | Yes (ND) | Fish and Other Aquatic Biota<br>Fish Consumption | Low Dissolved Oxygen<br>Water Temperature<br>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<br>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<br>PCBs | No | Yes | Dieldrin<br>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 to Kansas*** | Yes (NE, IA) | Recreation<br>Aquatic Life | *E. coli*<br>Dieldrin<br>PCBs | Yes<br>(*E. coli*) | Yes | Dieldrin<br>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 December 31, 2008.

Maintaining coldwater habitat in Garrison reservoir during late summer continues to be a challenge due to the effects of the recent 8-year (2000-2007) drought in the western United States. Due to the drought, the reservoir level dropped considerably and impacted that coldwater habitat in the Garrison reservoir during the summer months. The pool elevation of Garrison reached a point where the 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, which is referred to as the thermal stratification period. Water temperature and dissolved oxygen levels are primary water quality factors that determine the suitability of water for coldwater aquatic life.

The State of North Dakota has defined optimal coldwater fish habitat in the Garrison reservoir as being ≤15°C and having dissolved oxygen levels ≥ 5 mg/l. The measured water temperature and dissolved oxygen concentration depth profiles that were obtained through water quality monitoring conducted at the Garrison reservoir during 2003 through 2008 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 8*** shows reservoir and optimal coldwater habitat volumes for 2003 through 2008. Optimal coldwater habitat present in the Garrison reservoir during 2008 appears to have been similar to that present in 2003 through 2007.

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 2 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) modification of 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. Implementation of the three water quality management measures was continued in 2006, 2007, and 2008.

Based on water quality monitoring of the water discharged through Garrison Dam, it was estimated that up to 795,000 acre-feet of water meeting optimal coldwater habitat criteria was prevented from being discharged through Garrison and retained in the reservoir due to the implementation of the water quality management measures in 2008. This compares to the 380,000, 1,020,000, and 830,000 acre-feet of optimal coldwater habitat that was potentially saved in 2005, 2006, and 2007, respectively. Similar to previous years, implementation of the water quality management measures in 2008 warmed the water that was discharged through Garrison Dam during the summer by 2 to 4°C. Although the water quality management measures were implemented to preserve coldwater habitat in the reservoir, they also had the probable benefit of allowing water quality standards criterion established by the State of North Dakota for dissolved oxygen to be met in the Missouri River immediately below Garrison Dam during late summer minimum flow releases.

Pool levels in Garrison Reservoir recovered to approximately 1825 ft msl in late July 2008. However, as indicated on ***Plate 8***, optimal coldwater habitat did not show a similar recovery. Pool levels in the Garrison reservoir were still near record lows 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. If higher pool levels are maintained during the summer months in the Garrison reservoir when the hypolimnion forms, optimal coldwater habitat in the reservoir should benefit.

The initial application of the CE-QUAL-W2 hydrodynamic and water quality model of the Garrison reservoir, as well as preparation of a final report, was completed by the Omaha District during 2008. The initial application of the model showed good success in predicting pool levels, 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 were limited to an elevation of 1775 ft msl, the top of the permanent pool). Based on modeling results, a high-level reservoir withdrawal would significantly increase optimal coldwater habitat in Garrison Reservoir during the summer and increase water temperatures downstream of Garrison.

**4. Navigation**

The first towboat to enter the Missouri River in 2008 was the *MV Leslie Ann*, owned by Jefferson City River Terminal. The towboat entered the Missouri River from the Mississippi River on March 20, 2008 with six empty barges headed for the Jefferson City River Terminal, MO at River Mile (RM) 143. The first towboat to travel upstream of Kansas City, MO was the *MV Claude R*, owned by McDonough Marine Service. The *MV Claude R* load consisted of one barge loaded with $10 million (estimated) of powerplant equipment, such as generators, turbines, and low pressure (LP) casings. The tow arrived on April 29 at the Westin Power Plant (RM 411). There were no tows with a Sioux City, IA destination during 2008. The most upstream tow was the *MV JA Ward*, which arrived at Blair, NE on July 8, 2008 with three empty barges for loading alfalfa pellets at Consolidated Blenders Terminal for shipment to Guntersville, Alabama. The *MV JA Ward* made five trips to Blair, NE during the 2008 navigation season.

Even with the drought ending in 2007, the 2008 navigation season was still impacted with minimum service navigation flow support and a 30-day shortened season. This is because the determination of full or minimum flow support and length of the navigation season is based on System storage.

The Waterborne Commerce Statistics Center (WCSC) data for 2007 shows total Missouri River tonnage of 6.7 million tons. This includes 6.3 million tons for sand and gravel, 0.1 million tons for waterways materials, and 0.3 million tons for long-haul commercial tonnage. The reduction of total tonnage of about 1.6 million tons compared to 2006 was due to permit restrictions on the sand and gravel mining companies and the reduced construction business demand from recent economic stress. The long haul commercial tonnage increased over 100,000 tons from the 2006 record low (since 1952). Although the Missouri River was operated at minimum service flow support, above average inflow from rainfall provided favorable navigation channel conditions downstream of Kansas City, MO. The largest total tonnage year was 2001, 9.7 million tons. The largest long-haul commercial tonnage year, excluding sand, gravel, and waterway material, occurred in 1977 (3.3 million tons). Tonnages of commodities shipped during 2004 through 2007 are shown in ***Table 13***. ***Figure 9A*** shows the value of the commodities since 1960, using 2009 present-worth computations. ***Figure 9B*** shows tonnage value of long-haul commercial commodities since 1960. The commercial tonnage figure for 2008 is an estimate and will change once final WCSC tabulations are available. ***Figure 10*** shows total navigation tonnage on the Missouri River. Missouri River long-haul commercial tonnage in 2008 is currently estimated to total about 351,000 tons, based on towboat activity and barge counts from the Corps' daily boat reports.

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

| Commodity Classification Group | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|
| Farm Products | 41 | 9 | 12 | 0 |
| Corn | 32 | 9 | 12 | 0 |
| Wheat | 5 | 0 | 0 | 0 |
| Soybeans | 1.5 | 0 | 0 | 0 |
| Misc Farm Product | 2.5 | 0 | 0 | 0 |
| Nonmetallic Minerals | 7606 | 7540 | 8043 | 6283 |
| Sand/Gravel | 7606 | 7540 | 8043 | 6281 |
| Misc Nonmetallic | 0 | 0 | 0 | 2 |
| Food and Kindred | 0 | 1 | 21 | 28 |
| Pulp and Paper | 0 | 0 | 0 | 0 |
| Chemicals | 48 | 7 | 14 | 7 |
| Fertilizer | 41 | 4 | 12 | 5 |
| Other Chemicals | 7 | 3 | 2 | 2 |
| Petroleum (including coke) | 216 | 180 | 81 | 132 |
| Stone/Clay/Glass | 221 | 88 | 67 | 130 |
| Primary Metals | 0 | 0 | 0 | 0 |
| Waterway Materials | 60 | 111 | 57 | 101 |
| Other | 0 | 0 | 0 | 3 |
| | | | | |
| Total Commercial | 8192 | 7936 | 8295 | 6684 |
| Total Long Haul Commercial | 526 | 285 | 198 | 303 |

Navigation season target flows for past years are given in ***Table 14***. ***Table 15*** shows the scheduled lengths of past navigation seasons with total tonnage and ton-miles for each year. The 2008 navigation season was shortened 30 days in accordance with the Master Manual.

***Figure 11*** presents discharge data at Sioux City, IA; Nebraska City, NE; and Kansas City, MO for the August 2007 through December 2008 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. Supplemental Missouri River navigation support was provided by releases from Kansas River reservoir projects from September 3 to October 25. The releases were fairly well distributed between the three projects: Tuttle Creek (50%), Milford (25%), and Perry (25%). Refer to Section II.C. of this report for further discussion on System releases during the 2008 navigation season.

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

The energy generated in 2008 was transmitted over a Federal transmission system that traverses 7,745 circuit miles. This past year, service was provided to 360 customers. Customers in a 6-state area receiving direct service include 194 municipalities, 2 Federal agencies, 33 state agencies, 28 BOR projects, 5 irrigation districts, 36 rural electric cooperatives, 7 public utility districts, 30 private utilities, 27 Native American Services, and 1 inter-project sale. 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 11,000 kilowatt hours (kWh) of energy annually. Based upon the total System generation of 4.9 billion kWh, the energy generated in CY 2008 by this portion of the Federal power system could have supplied all of the yearly needs of about 445,000 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.

# Missouri River

## Total Navigation Tonnage Value - 2009 Present Worth

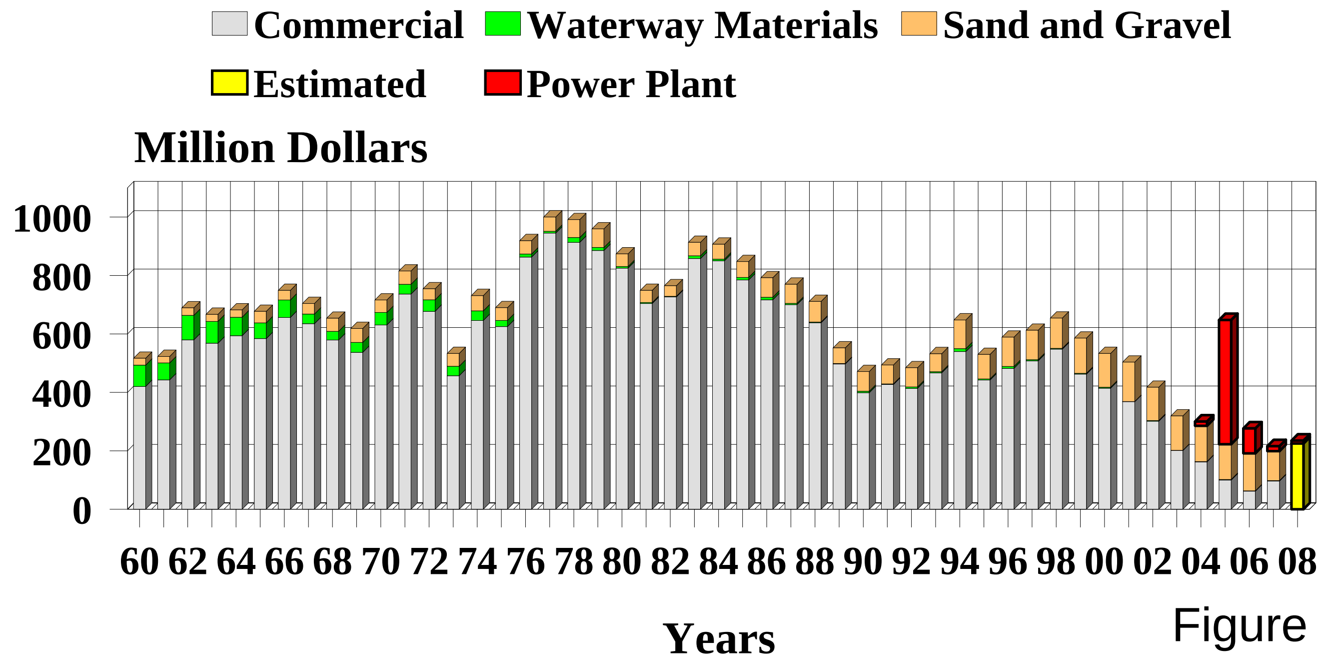
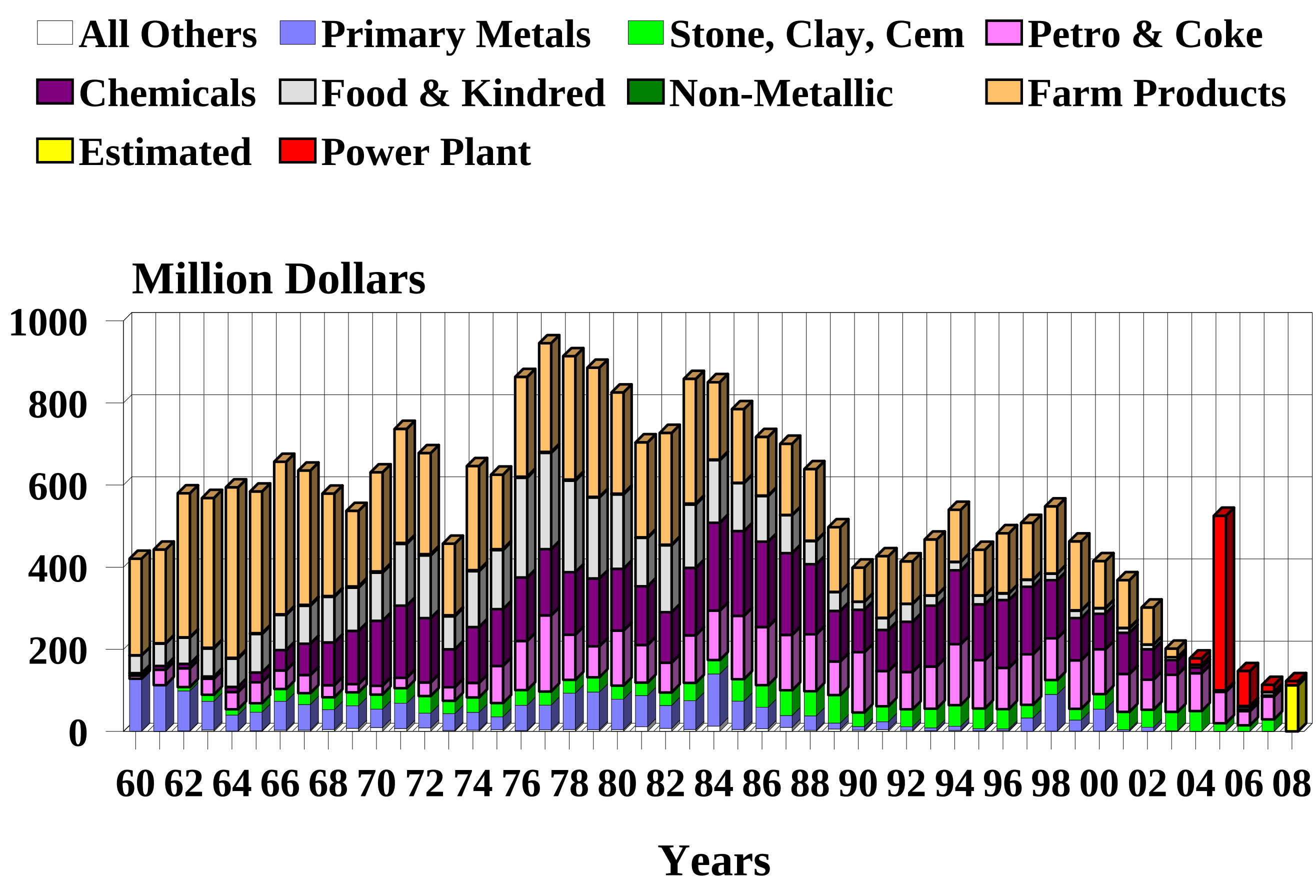



Figure 9A

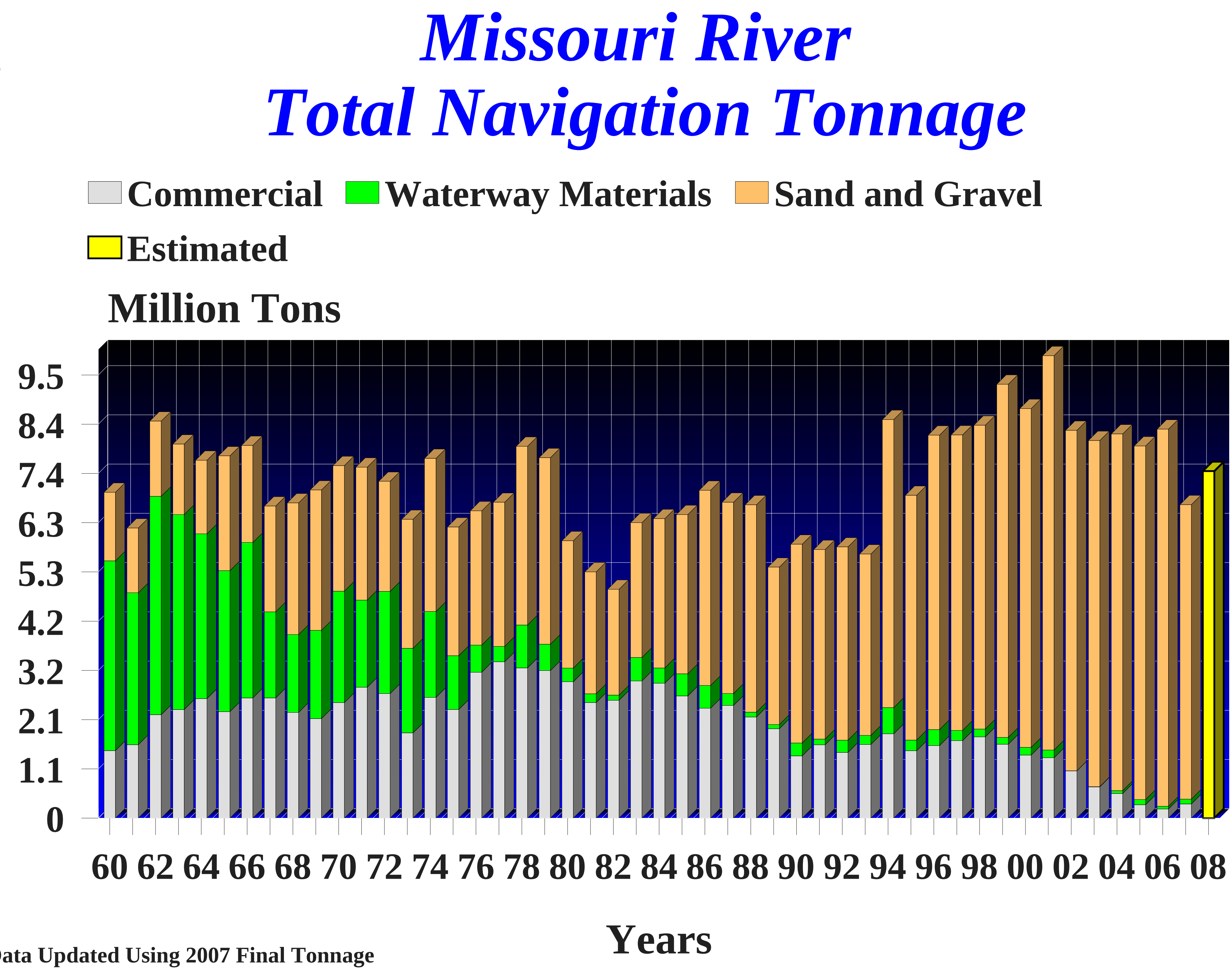
## Commercial Navigation Tonnage Value - 2009 Present Worth




**Commercial Value Excludes Sand, Gravel & Waterway Materials**
**Updated Using 2007 Final Tonnage**

Figure 9B

Figure 10



Missouri River
Total Navigation Tonnage
Commercial
Waterway Materials
Sand and Gravel
Estimated
Million Tons
9.5
8.4
7.4
6.3
5.3
4.2
3.2
2.1
1.1
0
60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 00 02 04 06 08
Years
Data Updated Using 2007 Final Tonnage

## 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 |

(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.

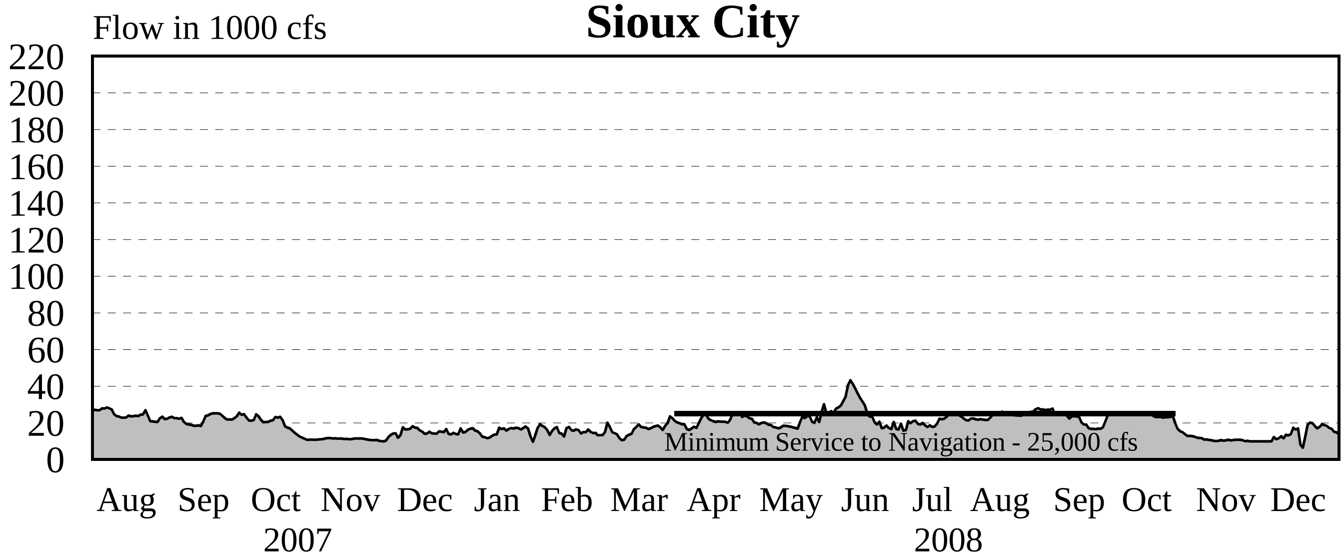
## Table 15
## Missouri River Navigation
## Tonnage and Season Length

| Year | Scheduled Length of Season (Months) | Commercial (Tons) (1) | Total Traffic (Tons) (2) | Total Traffic (1000 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 | 119,117 |
| 2008 | 6 3/4 (11) | 351,000 (12) | 7,401,000 (12) | 150,000 (12) |

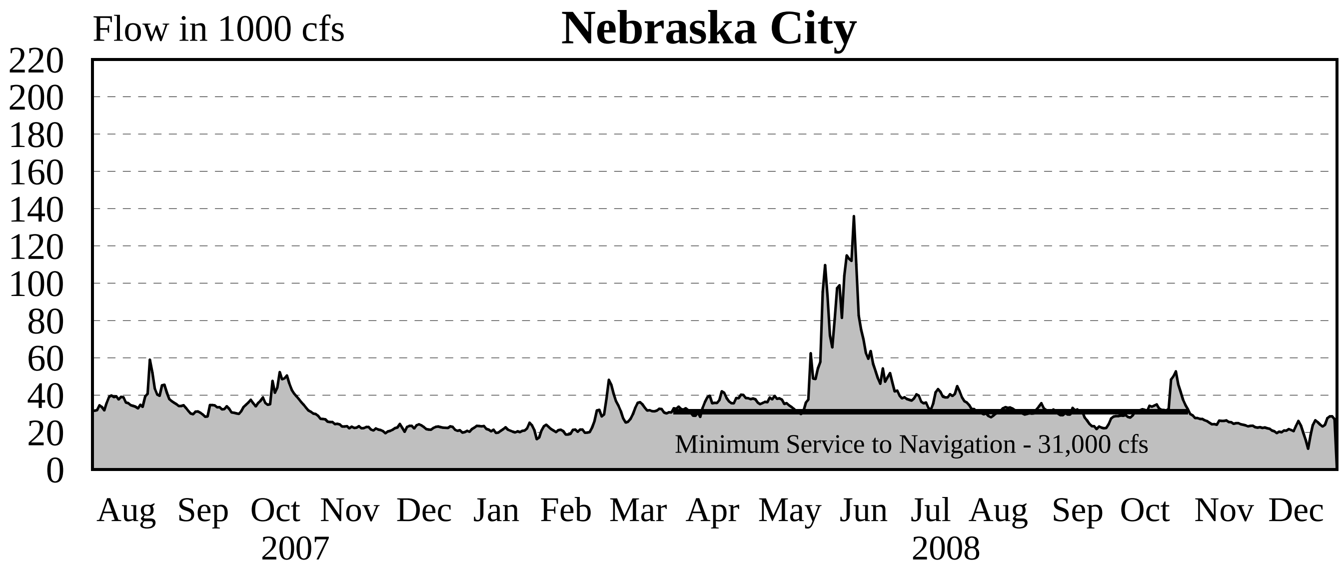
(1) Includes commercial tonnage except for sand and gravel or waterway materials. Tonnage compiled by Waterborne Commerce Statistics Center (WCSC).
(2) Includes commodities; sand, gravel, and crushed rock; and waterway improvement materials. Tonnage by WCSC.
(3) Mainstem Reservoir System first reached 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.

# Missouri River Flows at
# Sioux City, Nebraska City and Kansas City

## Sioux City




## Nebraska City




## Kansas City

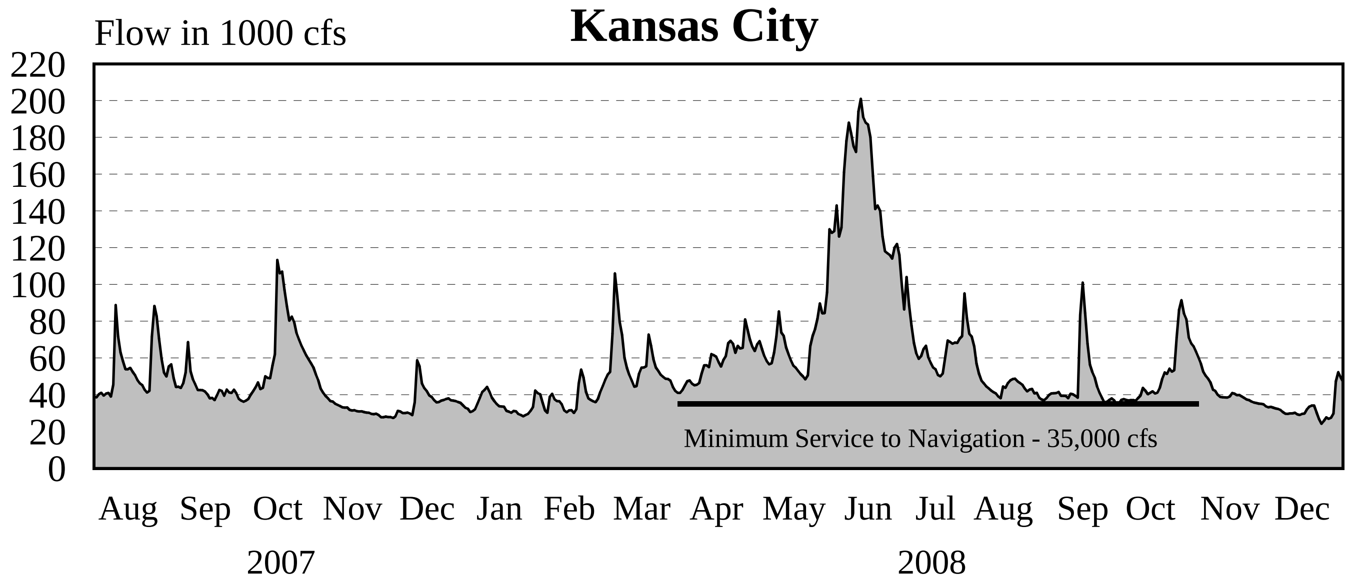





Figure 11

Generation in 2008 of 4.9 billion kWh, a record low, was 52% of average since the System first filled in 1967. The total generation for 2008 was 4,912,302 MWh, just 7,307 MWh less than the previous low 4,919,609 MWh, set in 2007. Energy generation was below normal due to lower than normal pool levels, below normal runoff, and below-normal releases at all powerplants. Western purchased about 5.7 billion kWh between January 1, 2008 and December 31, 2008, at a cost of $311.3 million to supplement System hydropower production.

System generation with individual project distribution for each calendar year since 1954 is shown on ***Figure 12***. The gross generation from the Federal system (peak capacity and energy sales) for 2008 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 2008 through December 2008**

| | **Energy Generation 1,000 kWh** | **Peak Hour kWh** | **Generation Date** |
|---|---|---|---|
| Corps Power Plants – Mainstem | | | |
| Fort Peck | 607,705 | 134,000 | 12 Jun |
| Garrison | 1,270,341 | 345,000 | 18 Jun |
| Oahe | 1,146,007 | 569,000 | 16 Dec |
| Big Bend | 475,035 | 475,000 | 7 Mar |
| Fort Randall | 922,180 | 353,000 | 25 Aug |
| Gavins Point | 490,034 | 93,000 | 27 Aug-2 Sep |
| Corps Subtotal | **4,912,302** | 1,600,000 | 21 Aug |
| | | | |
| USBR Powerplants | | | |
| Canyon Ferry | 336,806 | 57,000 | Jun |
| Yellowtail* | 381,712 | 136,500 | Jun |
| USBR Subtotal | 718,518 | | |
| | | | |
| Federal System Total | 5,630,820 | | |

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

# *Mainstem Power Generation*
# *1954 - 2008*

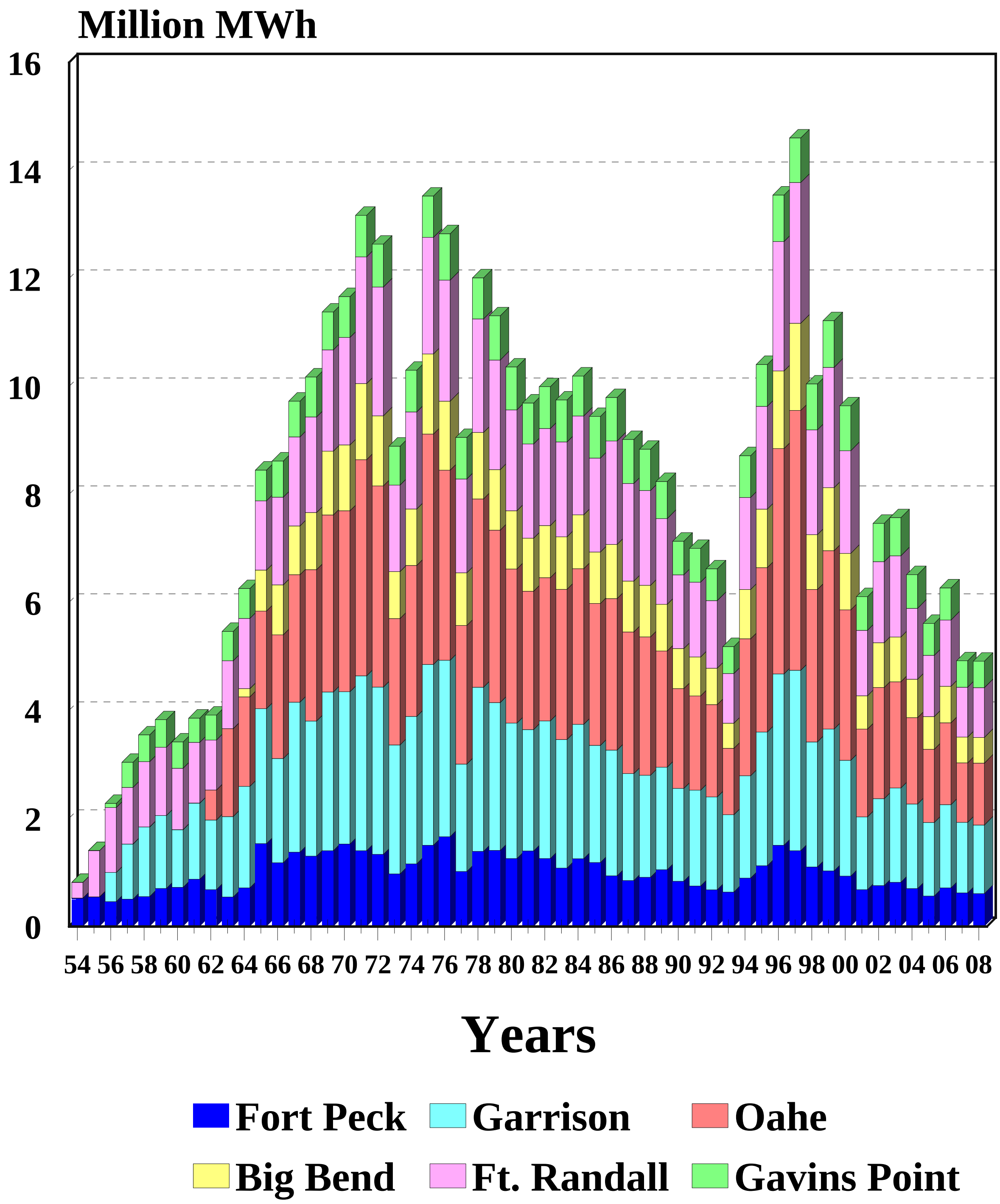





Figure 12

## Table 17

Historical Generation and Load Data - Peaks
Eastern Division, Pick-Sloan Missouri River Program*
Data at plant - 1,000 kW
January 1, 2008 through December 31, 2008

| 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 | 1,085 | | 62 | | 1,147 | | 874 | | 2,021 | 29-Jan | 19:00 |
| February | 957 | | 45 | | 1,002 | | 1,009 | | 2,011 | 11-Feb | 8:00 |
| March | 1,164 | | 46 | | 1,210 | | 703 | | 1,913 | 7-Mar | 8:00 |
| April | 1,110 | | 64 | | 1,174 | | 380 | | 1,554 | 17-Apr | 9:00 |
| May | 746 | | 142 | | 888 | | 810 | | 1,698 | 30-May | 17:00 |
| June | 362 | | 177 | | 539 | | 877 | | 1,416 | 10-Jun | 17:00 |
| July | 846 | | 185 | | 1,031 | | 910 | | 1,941 | 10-Jul | 18:00 |
| August | 1,510 | | 92 | | 1,602 | | 555 | | 2,157 | 6-Aug | 17:00 |
| September | 1,141 | | 83 | | 1,224 | | 50 | | 1,274 | 19-Sep | 18:00 |
| October | 954 | | 82 | | 1,036 | | 730 | | 1,766 | 27-Oct | 20:00 |
| November | 716 | | 83 | | 799 | | 1,150 | | 1,949 | 20-Nov | 19:00 |
| December | 1,160 | | 91 | | 1,251 | | 932 | | 2,183 | 15-Dec | 20:00 |

* 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, 2008 through December 31, 2008

| 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 | 425,430 | | 38,312 | | 463,742 | | 604,665 | | 1,068,407 |
| February | 424,205 | | 37,924 | | 462,129 | | 524,651 | | 986,780 |
| March | 325,941 | | 41,187 | | 367,128 | | 489,338 | | 856,466 |
| April | 423,599 | | 39,870 | | 463,469 | | 419,025 | | 882,494 |
| May | 377,650 | | 52,331 | | 429,981 | | 389,876 | | 819,857 |
| June | 286,429 | | 122,612 | | 409,041 | | 373,927 | | 782,968 |
| July | 444,917 | | 85,488 | | 530,405 | | 466,483 | | 996,888 |
| August | 601,809 | | 59,265 | | 661,074 | | 374,403 | | 1,035,477 |
| September | 449,207 | | 53,641 | | 502,848 | | 369,747 | | 872,595 |
| October | 438,159 | | 56,346 | | 494,505 | | 417,717 | | 912,222 |
| November | 249,630 | | 55,334 | | 304,964 | | 644,027 | | 948,991 |
| December | 465,326 | | 56,871 | | 522,197 | | 631,133 | | 1,153,330 |

*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 2007-2008 AOP, if runoff was not sufficient to keep all pool levels rising during the fish spawn in 2008, the Corps would, to the extent reasonably possible, set releases to result in a steady-to-rising pool level in Lake Sakakawea in April and May. Low runoff in the Plains resulted in the pool dropping slightly during the primary smelt spawn. However beginning in early May, Fort Peck, Garrison, and Oahe reservoirs rose as the mountain snowmelt progressed. The state of North Dakota larval trawls continue to document record low levels of rainbow smelt reproduction. The lack of success is attributed to the lack of suitable spawning substrate and very low volume and quality of nursery and spawning habitat. The standard adult population surveys conducted by the State of North Dakota continued to document poor condition and size structure for walleye, sauger and northern pike since the introduction of rainbow smelt in 1971.

In Oahe, the annual larval smelt surveys revealed larval densities near average. The reservoir rose more than 11 feet above the peak in 2007, flooding terrestrial vegetation and providing good young-of-the-year nursery habitat. The reservoir elevation recovered sufficiently to allow the Whitlock Bay Salmon Spawning Station to be operated for the first time since 2003.

The recovery from the 2000-2007 drought continued to cause a decline in coldwater habitat in the Garrison reservoir. As stated on page 46 of this report, even though the Garrison reservoir elevation increased, the increase in elevation did not increase the coldwater habitat storage. The Corps installed plywood barriers on the trash racks on the intake structures of power plant units 2 and 3 during 2005 and on unit 1 during 2007. In addition, hydropower peaking patterns were adjusted to try to limit the volume of cold water released. As shown on ***Plate 6***, 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 23nd year of reservoir regulation since the piping plover and least tern were Federally listed as threatened and endangered species, respectively. This was the second year of operating for the endangered pallid sturgeon per the revised Master Manual. No May spring pulse was released from Gavins Point Dam in 2008, as there was not enough water in storage per the Master Manual. The March pulse was released at the beginning of the navigation season.

The 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. 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 2008 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 in 1998 and the subsequent above-average and new record fledge ratios achieved since then can be attributed to the large amount of habitat created by the high flows of 1997 and the declining reservoir levels during the current drought. The creation of additional habitat has also allowed greater flexibility in the release levels at the lower two System projects.

During 2008 the majority of plovers were again found on the shoreline of the Garrison and Oahe reservoirs and below Gavins Point. The majority of the terns nested 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 2008 was less than anticipated in the Biological Opinion (BiOp). A total of 32 tern and 256 plover eggs and seven plover 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 2008 Annual Report.

The population distribution and productivity for terns and plovers for 1986 through 2008 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 was not utilized in 2008. Adult birds in this table 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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 |
| Fledglings/Pair | - | - | 0 | 3.00 | - | 0.40 | {} | 0 | 0.44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 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 |
| 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 |
| **Lake Sakakawea** | | | | | | | | | | | | | | | | | | | | | | | |
| Adults | - | - | 7 | 15 | 6* | 8 | 29+ | 17 | 35 | 7 | 27 | 2 | 23 | 9 | 10 | 34 | 21 | 25 | 16 | 26 | 48 | 53 | 14 |
| 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 |
| **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 |
| 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 |
| **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 |
| 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 |
| **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 |
| 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 |
| **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 |
| 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 |
| **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 |
| 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 |
| **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 |
| **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 |

**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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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 |
| 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 |
| **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 |
| 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 |
| **Lake Sakakawea** | | | | | | | | | | | | | | | | | | | | | | | |
| Adults | - | - | 143 | 57 | 132 | 150 | 108 | 8 | 45 | 24 | 70 | 3 | 119 | 83 | 277 | 424 | 469 | 528 | 738 | 746 | 430 | 399 | 363 |
| 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 |
| **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 |
| 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 |
| **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 |
| 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 |
| **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 |
| 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 |
| **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 |
| 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 |
| **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 |
| 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 |
| **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 |
| **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 |

**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, recreation may be adversely affected. Most of the recreational impacts of drought are experienced at the upper three large reservoirs, Fort Peck, Garrison, and Oahe. Due to their relatively small size, the lower three reservoirs are regulated in a similar manner year-to-year and 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, the 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 schedule to utilize a reach of the river has negatively impacted some marinas located downstream of the System during the drought. Significant 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, recreational access at the upper three reservoirs was much improved. During 2008 the Corps spent approximately $1,366,000 extending and relocating boat ramps to maintain public access where such work was feasible. Considerable effort has been required by all parties involved to maintain recreation access to the reservoirs during period of drought. However, in some locations it is impossible to extend or relocate boat ramps due to the local topography. Of the 11 reservoir access areas located on the Fort Peck reservoir, 9 ramps were usable for all or most of the 2008 recreation season. At Garrison, 34 of the total 36 reservoir access areas were available for the majority of the recreation season. At Oahe, 12 of 13 access areas were available on the North Dakota portion of the reservoir although all of these were in river conditions, and 25 of 27 were available on the South Dakota portion in 2008. 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 2008, public use at these reservoirs totaled 42,752,300 visitor hours, a 9% increase from 2007. Visitor attendance figures at the System projects from 2005 through 2008 are shown in ***Table 21***. Overall visitation was up significantly in 2008 and all projects except Fort Peck experienced increases. ***Figure 13*** displays recreation related visitor hours at each of the six mainstem projects for the years 1954 through 2008. Although the drought has had an impact on visitation during the past 7 years, much of the reduction shown in Figure 12 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 2008 visitation in South Dakota presented in ***Table 21*** and ***Figure 13*** 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.

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).

**Table 21**
**Visitation at System Reservoirs in Visitor Hours**

| Mainstem Project | 2005 | 2006 | 2007 | 2008 | Percent Change 2007-2008 |
|---|---|---|---|---|---|
| Fort Peck | 5,445,900 | 5,374,200 | 5,630,400 | 5,443,000 | - 3 % |
| Garrison | 12,698,600 | 14,016,900 | 12,309,600 | 13,121,800 | + 7 % |
| Oahe | 7,700,600 | 7,386,000 | 8,045,400 | 9,641,300 | + 20 % |
| Big Bend | 2,980,900 | 3,325,000 | 3,096,900 | 3,794,000 | + 23 % |
| Fort Randall | 1,103,600 | 1,033,400 | 1,000,100 | 1,139,800 | + 14 % |
| Gavins Point | 8,800,200 | 8,928,300 | 9,075,100 | 9,612,300 | + 6 % |
| **System Total** | **38,729,800** | **40,063,900** | **39,157,500** | **42,752,300** | **+9 %** |

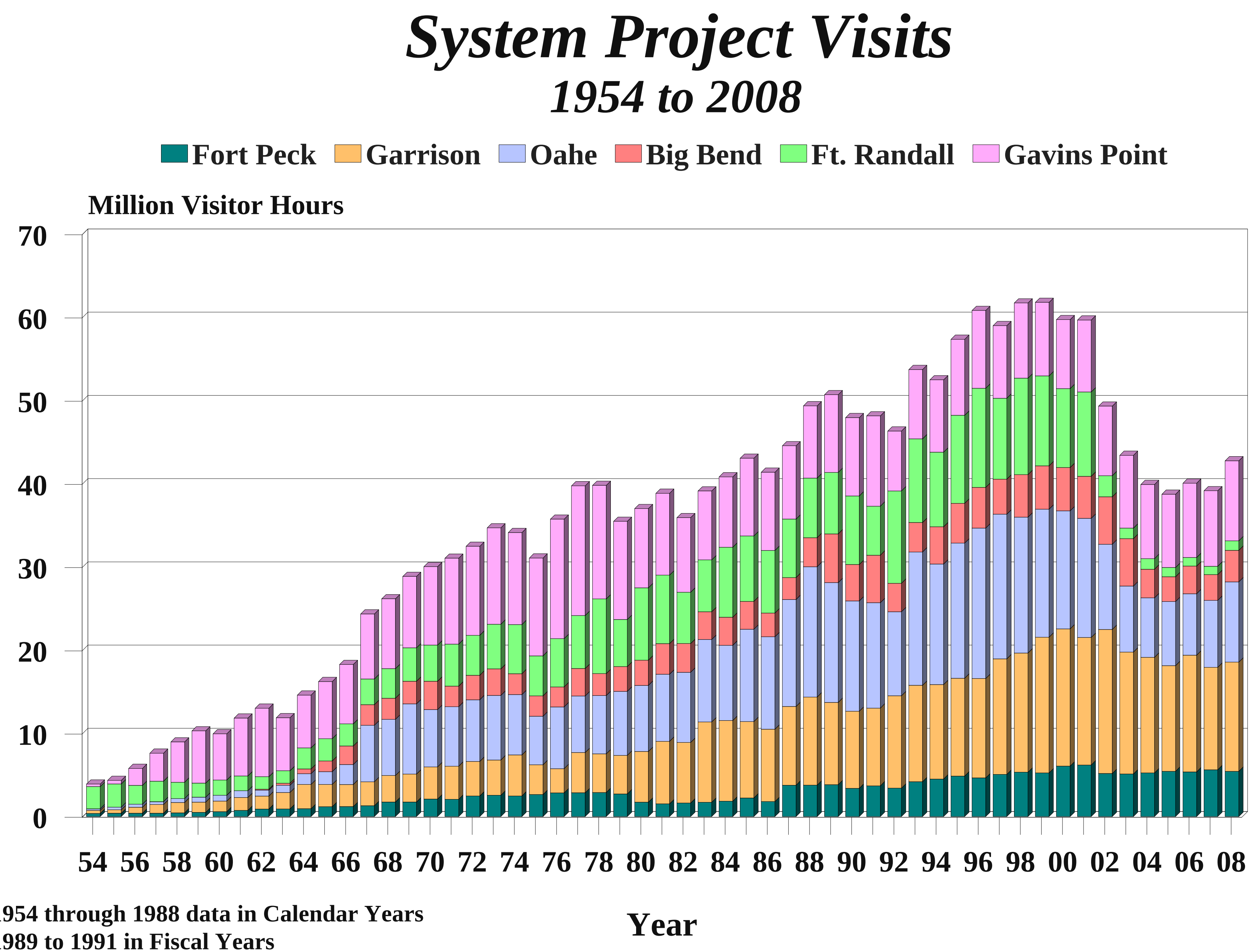
### 9. Cultural Resources

As acknowledged in the 2004 Programmatic Agreement for the Operation and Management of the Missouri River Main Stem System (PA), wave action and the fluctuation of reservoirs levels results in erosion along the banks of the reservoirs. With the drought conditions of recent years, additional cultural resource sites have become exposed as the pool levels have declined. The Corps will continue to work with the Tribes utilizing 36 CFR Part 800 and the PA to address the exposure of these 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. 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 27, 2008, was sent to the Missouri basin Tribes offering consultation on the 2008-2009 AOP. To date, no requests for consultation have been received; however two Tribes participated in the fall AOP public meetings in October 2008 and provided input on the draft AOP. In addition the Great Plains Tribal Chairman's Committee provided written comments on the draft AOP.




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 13

# Missouri River Basin

| | Summary of Engineering Data -- Missouri River Mainstem System | | | |
|---|---|---|---|---|
| **Item No.** | **Subject** | **Fort Peck Dam - Fort Peck Lake** | **Garrison Dam - Lake Sakakawea** | **Oahe Dam - Lake Oahe** |
| 1 | Location of Dam | Near Glasgow, Montana | Near Garrison, ND | Near Pierre, SD |
| 2 | River Mile - 1960 Mileage | Mile 1771.5 | Mile 1389.9 | Mile 1072.3 |
| 3 | Total & incremental drainage areas in square miles | 57,500 | 181,400 (2) 123,900 | 243,490 (1) 62,090 |
| 4 | Approximate length of full reservoir (in valley miles) | 134, ending near Zortman, MT | 178, ending near Trenton, ND | 231, ending near Bismarck, ND |
| 5 | Shoreline in miles (3) | 1520 (elevation 2234) | 1340 (elevation 1837.5) | 2250 (elevation 1607.5) |
| 6 | Average total & incremental inflow in cfs | 10,200 | 25,600 15,400 | 28,900 3,300 |
| 7 | Max. discharge of record near damsite in cfs | 137,000 (June 1953) | 348,000 (April 1952) | 440,000 (April 1952) |
| 8 | Construction started - calendar yr | 1933 | 1946 | 1948 |
| 9 | In operation (4) calendar yr. | 1940 | 1955 | 1962 |
| | <u>Dam and Embankment</u> | | | |
| 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 |
| | <u>Spillway Data</u> | | | |
| 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 |
| | <u>Reservoir Data (6)</u> | | | |
| 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 |
| | <u>Storage allocation & capacity</u> | | | |
| 30 | Exclusive flood control | 2250-2246 922,000 a.f. | 1854-1850 1,489,000 a.f. | 1620-1617 1,102,000 a.f. |
| 31 | Flood control & multiple use | 2246-2234 2,838,000 a.f. | 1850-1837.5 4,222,000 a.f. | 1617-1607.5 3,201,000 a.f. |
| 32 | Carryover multiple use | 2234-2160 10,667,000 a.f. | 1837.5-1775 13,130,000 a.f. | 1607.5-1540 13,461,000 a.f. |
| 33 | Permanent | 2160-2030 4,073,000 a.f. | 1775-1673 4,980,000 a.f. | 1540-1415 5,373,000 a.f. |
| 34 | Gross | 2250-2030 18,500,000 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. |
| | <u>Outlet Works Data</u> | | | |
| 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 |
| | <u>Power Facilities and Data</u> | | | |
| 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 |

# Summary of Engineering Data -- Missouri River Mainstem System

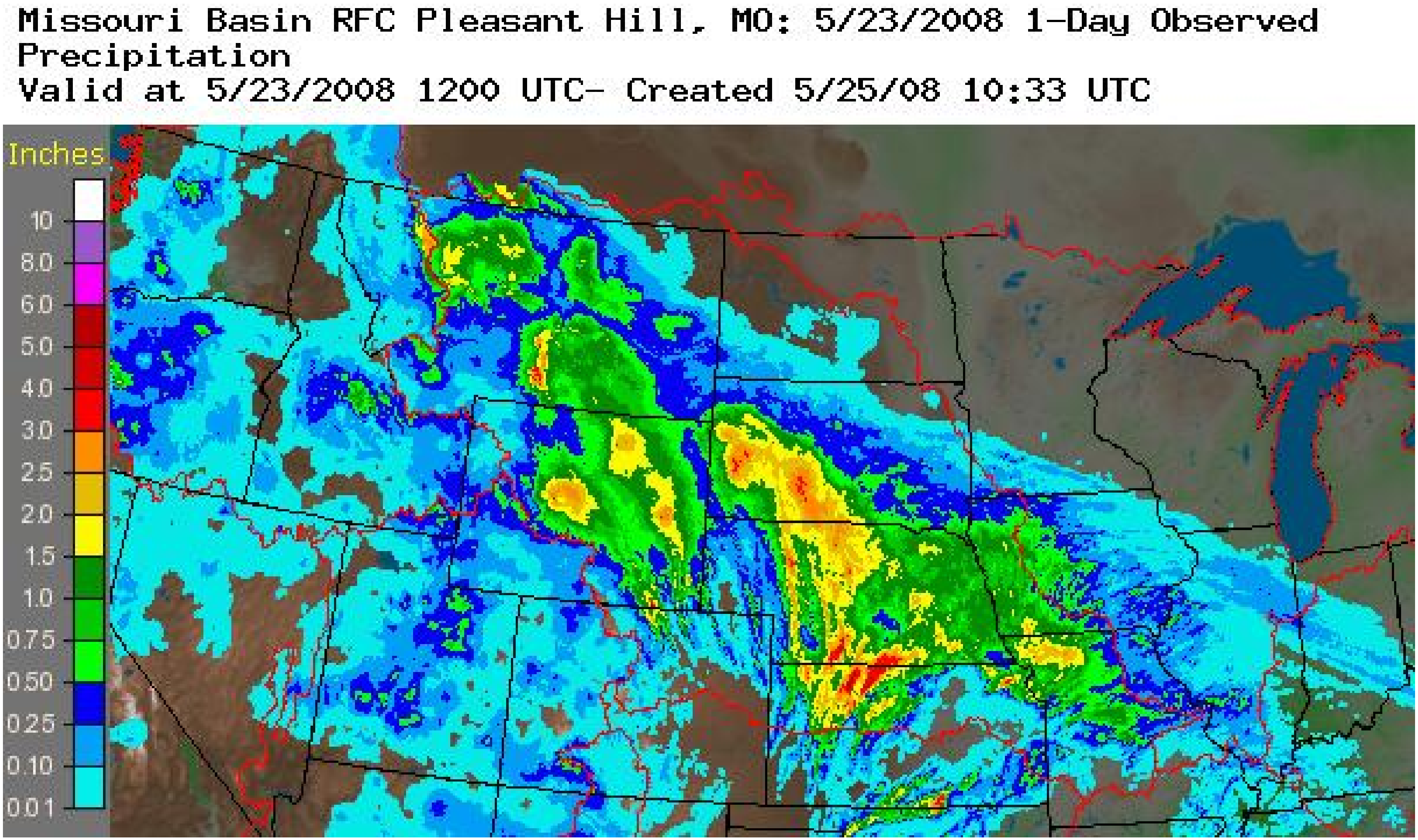
| | Big Bend Dam - Lake Sharpe | Fort Randall Dam - Lake Francis Case | Gavins Point Dam - Lewis & Clark Lake | Total | Item No. |
|---|---|---|---|---|---|
| | 21 miles upstream Chamberlain, SD | Near Lake Andes, SD | Near Yankton, SD | | 1 |
| | Mile 987.4 | Mile 880.0 | Mile 811.1 | | 2 |
| | 249,330 (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. | 4,615,000 a.f. | 30 |
| | 1422-1420 117,000 a.f. | 1365-1350 1,309,000 a.f. | 1208-1204.5 86,000 a.f. | 11,773,000 a.f. | 31 |
| | | 1350-1320 1,607,000 a.f. | | 38,865,000 a.f. | 32 |
| | 1420-1345 1,621,000 a.f. | 1320-1240 1,517,000 a.f. | 1204.5-1160 307,000 a.f. | 17,871,000 a.f. | 33 |
| | 1423-1345 1,798,000 a.f. | 1375-1240 5,418,000 a.f. | 1210-1160 450,000 a.f. | 73,124,000 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 | | | 43 |
| | | 32,000 cfs - 128,000 cfs | | | |
| | 1351-1355(10) 25,000-100,000 cfs | 1228-1239 5,000-60,000 cfs | 1155-1163 15,000-60,000 cfs | | 44 |
| | 70 | 117 | 48 | 764 feet | 45 |
| | None: direct intake | 8 - 28' dia., 22' penstocks | None: direct intake | | 46 |
| | | 1,074 | | 55,083 | 47 |
| | None | 59' dia, 2 per alternate penstock | None | | 48 |
| | 8 Fixed blade, 81.8 rpm | 8 Francis, 85.7 rpm | 3 Kaplan, 75 rpm | 36 units | 49 |
| | 67' 103,000 cfs | 112' 44,500 cfs | 48' 36,000 cfs | | 50 |
| | 3 - 67,276, 5 - 58,500 | 40,000 | 44,100 | | 51 |
| | 494,320 | 320,000 | 132,300 | 2,501,200 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
Compiled by
Northwestern Division
Missouri River Region
January 2009

Plate 3


Missouri Basin RFC Pleasant Hill, MO: 5/23/2008 1-Day Observed Precipitation
Valid at 5/23/2008 1200 UTC- Created 5/25/08 10:33 UTC
Inches
10
8.0
6.0
5.0
4.0
3.0
2.5
2.0
1.5
1.0
0.75
0.50
0.25
0.10
0.01

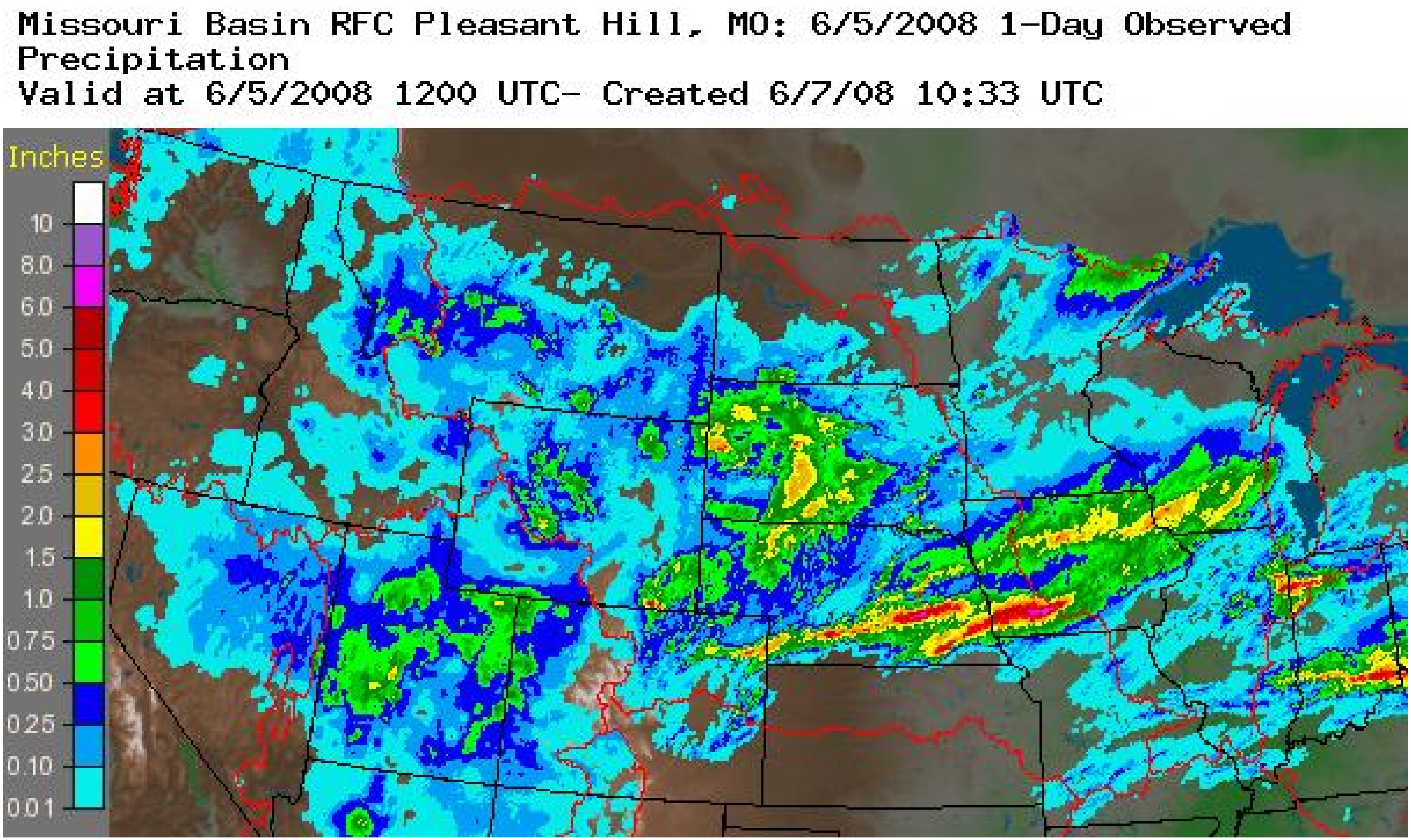
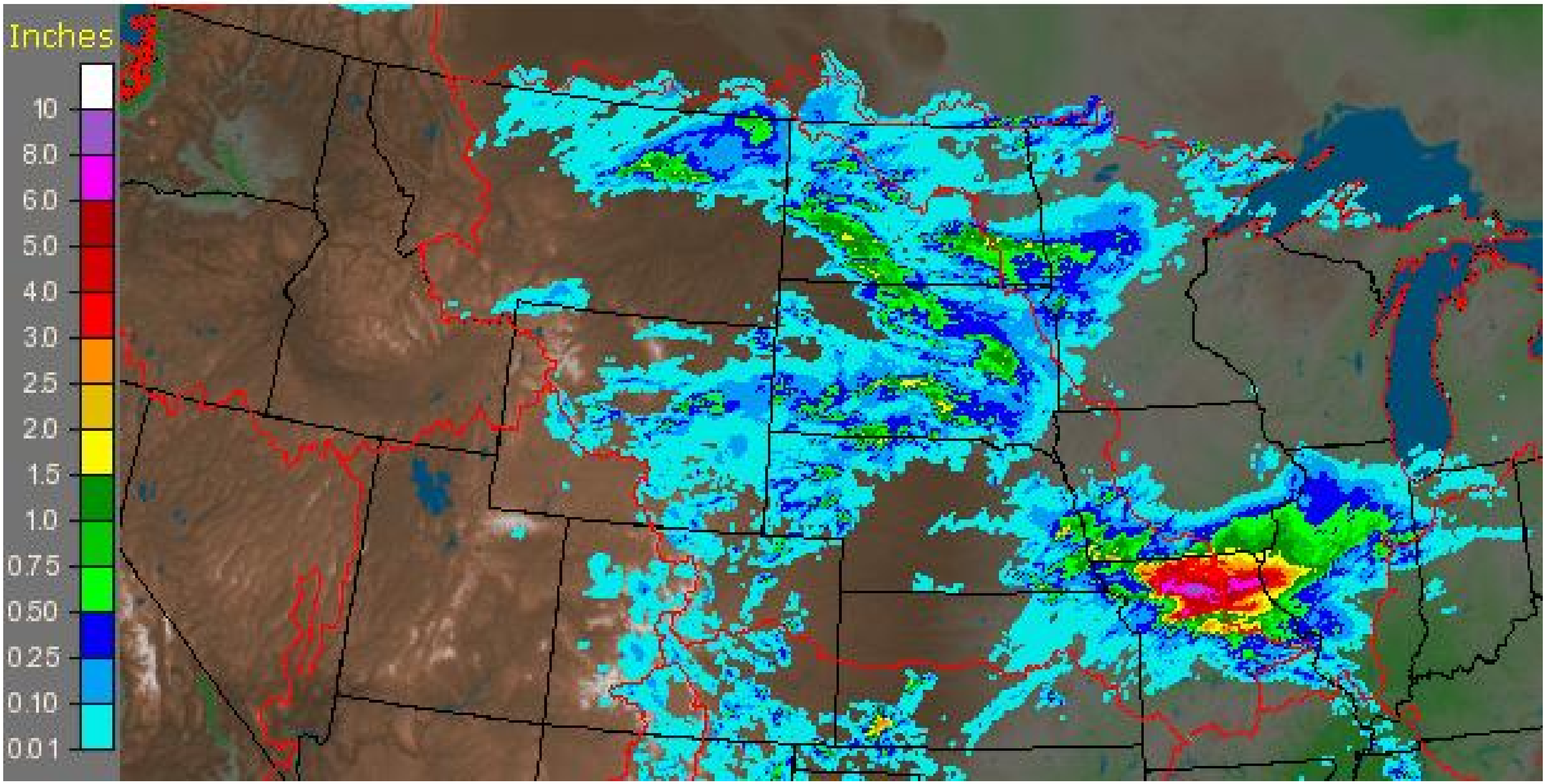

Missouri Basin RFC Pleasant Hill, MO: 6/5/2008 1-Day Observed Precipitation
Valid at 6/5/2008 1200 UTC- Created 6/7/08 10:33 UTC
Inches
10
8.0
6.0
5.0
4.0
3.0
2.5
2.0
1.5
1.0
0.75
0.50
0.25
0.10
0.01

Plate 4

Plate 5

Missouri Basin RFC Pleasant Hill, MO: 6/25/2008 1-Day Observed Precipitation
Valid at 6/25/2008 1200 UTC- Created 6/27/08 10:32 UTC



Missouri Basin RFC Pleasant Hill, MO: 9/13/2008 1-Day Observed Precipitation
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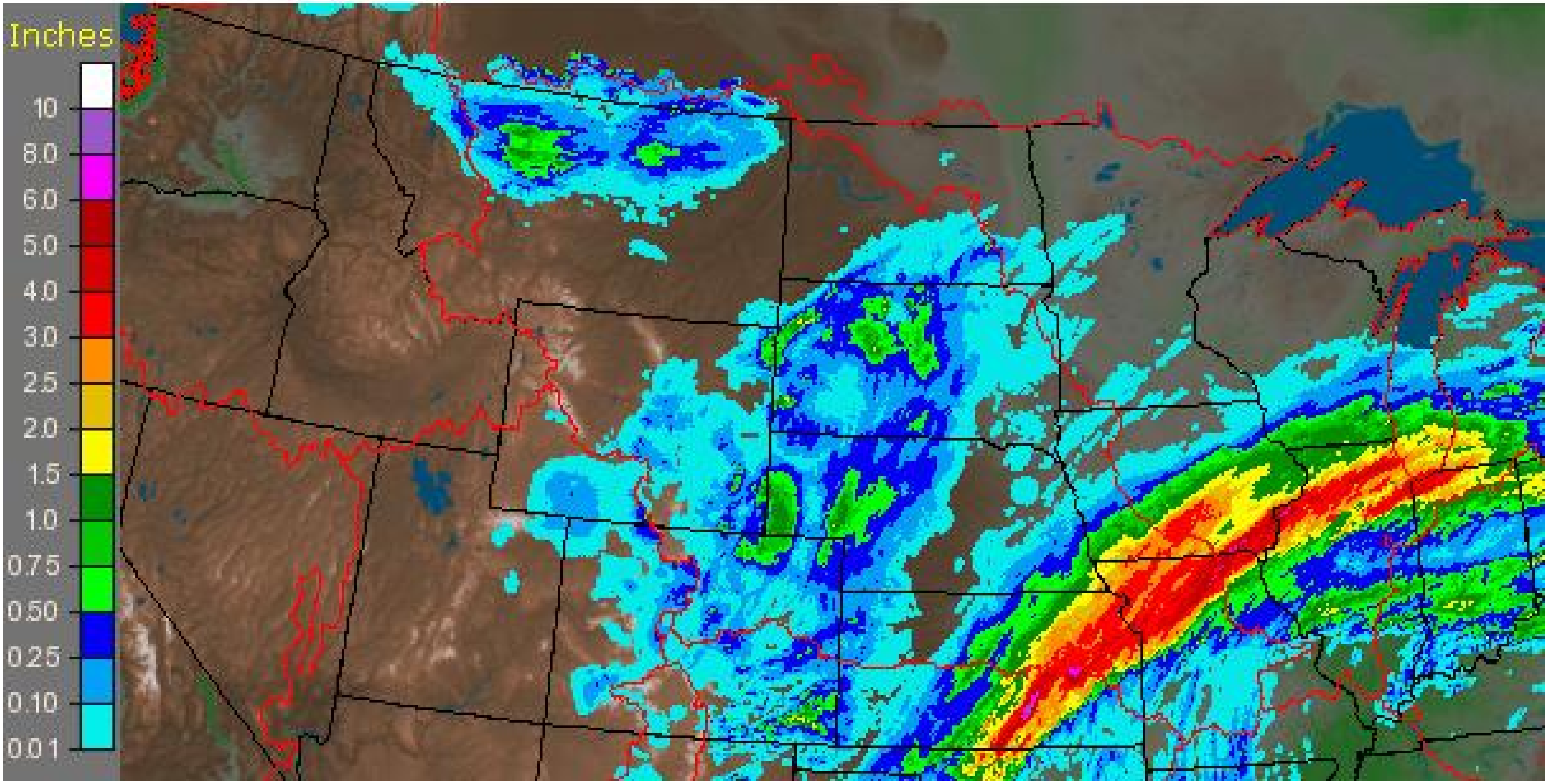


Plate 6

Missouri Basin RFC Pleasant Hill, MO: 9/14/2008 1-Day Observed Precipitation
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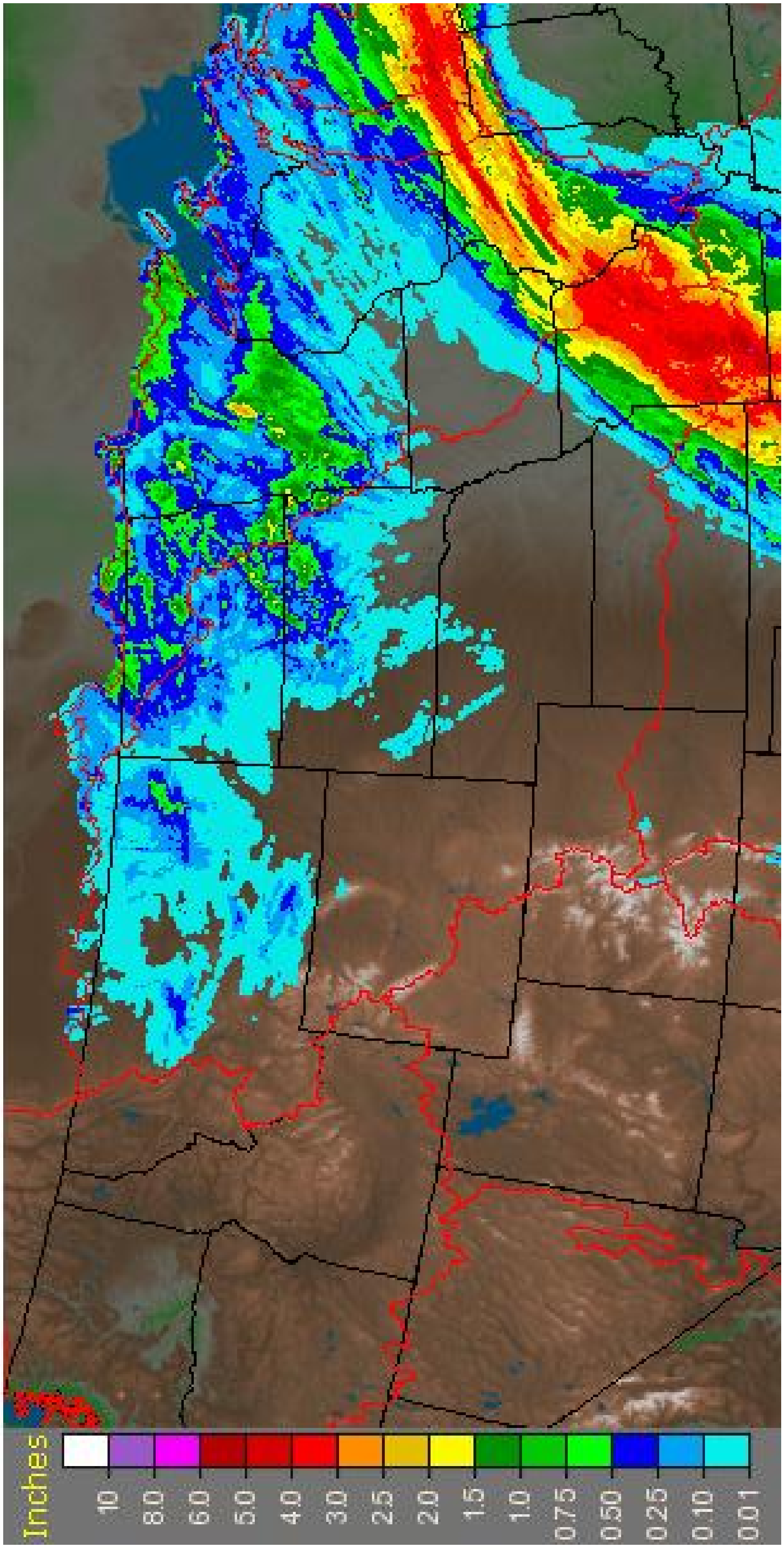
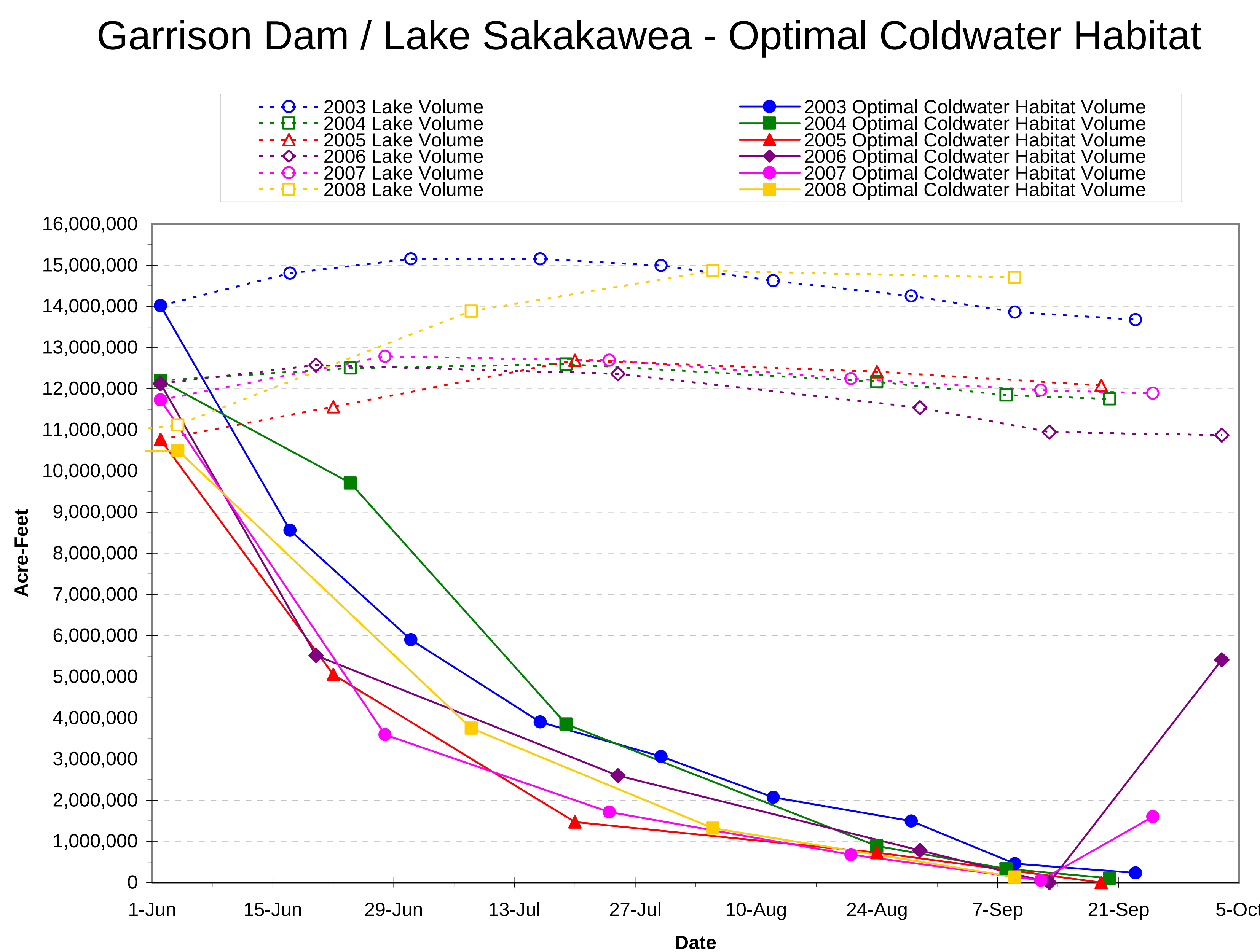



Plate 7



Garrison Dam / Lake Sakakawea - Optimal Coldwater Habitat
2003 Lake Volume
2004 Lake Volume
2005 Lake Volume
2006 Lake Volume
2007 Lake Volume
2008 Lake Volume
2003 Optimal Coldwater Habitat Volume
2004 Optimal Coldwater Habitat Volume
2005 Optimal Coldwater Habitat Volume
2006 Optimal Coldwater Habitat Volume
2007 Optimal Coldwater Habitat Volume
2008 Optimal Coldwater Habitat Volume
Acre-Feet
16,000,000
15,000,000
14,000,000
13,000,000
12,000,000
11,000,000
10,000,000
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
1-Jun
15-Jun
29-Jun
13-Jul
27-Jul
10-Aug
24-Aug
7-Sep
21-Sep
5-Oct
Date


Plate 8