US Army Corps
of Engineers

Northwestern Division
Missouri River Basin
Water Management Division

Missouri River Main Stem Reservoirs

Summary of Actual Calendar Year 2002 Operations

May 2003

MISSOURI RIVER MAIN STEM RESERVOIRS

Summary of Actual Calendar Year 2002 Operations

List of Figures ii
List of Tables ii
List of Plates ii
List of Abbreviations iii
Definition of Terms iv

I. FOREWORD 1

II. PREVIOUS CALENDAR YEAR DISCUSSIONS 1

III. REVIEW OF REGULATION FROM JANUARY 2002 – DECEMBER 2002 3
- A. General 3
- B. Precipitation and Water Supply Available in 2002 3
  - 1. Plains Snowpack 2001-2002 3
  - 2. Mountain Snowpack 2001-2002 5
  - 3. Weather Conditions January – December 2002 7
  - 4. 2002 Calendar Year Runoff 14
- C. System Operations 19
  - 1. System Operations – January – December 2002 19
  - 2. Fort Peck Operation – January – December 2002 20
  - 3. Garrison Operation – January – December 2002 21
  - 4. Oahe and Big Bend Operation – January – December 2002 22
  - 3. Fort Randall Operation – January – December 2002 24
  - 4. Gavins Point Operation – January – December 2002 25
- D. Non-Routine Operations and Other Items Pertaining to System Regulation 27
  - 1. Description of April and May 2002 System Regulation to Comply With 2002 Lawsuits 27
  - 2. Fort Peck 29
  - 3. Gavins Point 29
- E. Reservoir Releases and Storage 31
- F. Summary of Results 31
  - 1. Flood Control 31
  - 2. Irrigation 32
  - 3. Water Supply and Water Quality Control 32
  - 4. Navigation 39
  - 5. Power – Eastern Division, Pick-Sloan Missouri Basin Program (P-S MBP) 45
  - 6. Fish Management 53
  - 7. Endangered and Threatened Species 53

8. Recreation and Resource Management.....55

LIST OF FIGURES

1 Mountain Snowpack Water Content Missouri River Basin, Winter 2001 - 2002 9
2 Palmer Drought Severity Maps.....10
3 Percent Normal Precipitation Maps 11
4 Missouri River Main Stem Annual Runoff at Sioux City, Iowa.....16
5A 2001 Missouri River Runoff Above Sioux City, Iowa 17
5B 2002 Missouri River Runoff Above Sioux City, Iowa 17
6A Cumulative Flood Damages Prevented.....35
6B Annual Flood Damages Prevented.....35
7 Sioux City, Nebraska City, and St. Joseph Regulated and Unregulated Flows.....36
8 End-of-July Lake Elevations and Total System Storage 42-43
9 Missouri River Total Tonnage and Commercial Tonnage 47
10 Missouri River Flows at Sioux City, Nebraska City and Kansas City 50
11 Main Stem Power Generation.....52
12 Missouri River Main Stem Project Visitor Hours 58

LIST OF TABLES

I Upper Missouri River Basin Runoff for Calendar Year 2001 2
II 2001 Calendar Year Runoff for Selected Reaches.....3
III Upper Missouri River Basin Runoff for Calendar Year 2002 18
IV Reservoir Levels and Storages – July 31, 2002 31
V Reservoir Levels and Storages – December 31, 2002 31
VI Water Quality Issues and Concerns 36
VII Tonnage by Commodities 41
VIII Navigation Season Target Flows 48
IX Missouri River Navigation Tonnage and Season Length 49
X Gross Power System Generation 51
XI Historical Generation and Load Data.....54
XII Historical Generation and Load Data.....54
XIII Missouri River Main Stem Least Tern and Piping Plover Survey Data 57

LIST OF PLATES

1 Missouri River Basin Map
2 Summary of Engineering Data – Missouri River Main Stem Reservoirs
3 Dissolved Oxygen Depth Profiles

LIST OF ABBREVIATIONS

AOP -	annual operating plan
ac.ft. -	acre-feet
AF -	acre-feet
B -	Billion
cfs -	cubic feet per second
COE -	Corps of Engineers
CY -	calendar year (January 1 to December 31)
EA -	Environmental Assessment
EIS -	Environmental Impact Statement
elev -	elevation
ESA -	Endangered Species Act of 1978
ft -	feet
FWS -	U.S. Fish and Wildlife Service
FY -	fiscal year (October 1 to September 30)
GIS -	Geographic Information System
GWh -	gigawatt hour
KAF -	1,000 acre-feet
Kcfs -	1,000 cubic feet per second
kW -	kilowatt
kWh -	kilowatt hour
M -	million
MAF -	million acre-feet
MRBA -	Missouri River Basin Association
MRNRC -	Missouri River Natural Resources Committee
msl -	mean sea level
MW -	megawatt
MWh -	megawatt hour
NEPA -	National Environmental Policy Act
plover -	piping plover
pp -	powerplant
RM -	river mile
tern -	interior least tern
tw -	tailwater
USGS -	United States Geological Survey
yr -	year

DEFINITION OF TERMS

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

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

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

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

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

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

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

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

MISSOURI RIVER MAINSTEM RESERVOIR SYSTEM

Summary of Actual Calendar Year 2002 Operations

I. FOREWORD

This document contains a summary of the actual operation of the Missouri River Mainstem Reservoir System (System) for the 2002 Calendar Year (CY). Two other reports related to System operation are also available. All three reports, this "Summary of Actual Calendar Year 2002 Operation," "System Description and Operation," and "Annual Operating Plan, 2001-2002," can be obtained by contacting the Missouri River Basin Water Management Division at 12565 West Center Road, Omaha, Nebraska 68144-3869, phone (402) 697-2676. The reports will also be available on the Northwestern Division website at www.nwd-mr.usace.army.mil/rcc <http://www.nwd-mr.usace.army.mil/rcc>.

A basin map is presented on ***Plate 1*** and the pertinent data table for the Missouri River System is shown on ***Plate 2***.

II. PREVIOUS CALENDAR YEAR DISCUSSIONS

This section presents information from the previous CY that was not in final form during the previous Annual Operating Plan (AOP) Summary Report and thus serves as the final report of that information for historical purposes. Also included are any significant water management issues that were not able to be fully discussed in the last reporting period.

Precipitation and Water Supply Available in 2001.

Final Calendar Year 2001 Runoff. Since last year's Summary of Operations report, the final runoff figures were compiled for Calendar Year (CY) 2001. The basin continued to experience a second year of drought during 2001, the annual runoff above Sioux City was 22.5 million acre-feet (MAF), 89 percent of the normal 1898-1998 average but 24 percent more than 2000. Monthly runoff ranged from a high of 156 percent of normal in April to a low of 52 percent of normal in September, as shown on ***Table I***. This table is prepared on the first of each month to indicate the historic and forecasted runoff for the year. The 2001 annual reach runoff, expressed as a percentage of the historic 1898-1998 average, is presented in ***Table II***.

Table I
Missouri River Basin
Final Calendar Year 2001 Runoff with Holdouts Update
Historic

Reach Above	Fort Peck	Garrison	Oahe	Fort Randall	Gavins Point	Sioux City	Summation above Gavins Point	Summation above Sioux City	Accumulated Summation above Sioux City
				Values in 1000 Acre Feet					
	(Historic)								
JAN 2001	313	348	146	67	157	83	1,031	1,114	1,114
NORMAL	315	260	10	20	100	35	705	740	740
DEPARTURE	-2	88	136	47	57	48	326	374	374
% OF NORM	99%	134%	1460%	335%	157%	237%	146%	151%	151%
FEB 2001	234	263	117	46	92	115	752	867	1,981
NORMAL	365	360	90	50	125	85	990	1,075	1,815
DEPARTURE	-131	-97	27	-4	-33	30	-238	-208	166
% OF NORM	64%	73%	130%	92%	74%	135%	76%	81%	109%
MAR 2001	395	1,054	1,085	375	360	436	3,269	3,705	5,686
NORMAL	610	1,010	580	220	205	300	2,625	2,925	4,740
DEPARTURE	-215	44	505	155	155	136	644	780	946
% OF NORM	65%	104%	187%	170%	176%	145%	125%	127%	120%
APR 2001	313	733	505	542	437	2,060	2,530	4,590	10,276
NORMAL	665	1,115	500	145	180	340	2,605	2,945	7,685
DEPARTURE	-352	-382	5	397	257	1,720	-75	1,645	2,591
% OF NORM	47%	66%	101%	374%	243%	606%	97%	156%	134%
MAY 2001	432	537	140	222	247	1,242	1,578	2,820	13,096
NORMAL	1,120	1,280	320	145	185	275	3,050	3,325	11,010
DEPARTURE	-688	-743	-180	77	62	967	-1,472	-506	2,086
% OF NORM	39%	42%	44%	153%	134%	451%	52%	85%	119%
JUN 2001	574	1,290	290	113	127	690	2,394	3,084	16,180
NORMAL	1,655	2,715	435	160	180	270	5,145	5,415	16,425
DEPARTURE	-1,081	-1,425	-145	-47	-53	420	-2,751	-2,331	-246
% OF NORM	35%	48%	67%	71%	71%	256%	47%	57%	99%
JUL 2001	460	985	357	18	182	464	2,002	2,466	18,646
NORMAL	835	1,815	180	60	135	215	3,025	3,240	19,665
DEPARTURE	-375	-830	177	-42	47	249	-1,023	-774	-1,019
% OF NORM	55%	54%	198%	31%	135%	216%	66%	76%	95%
AUG 2001	256	245	237	-2	63	267	799	1,066	19,712
NORMAL	360	625	65	40	115	130	1,205	1,335	21,000
DEPARTURE	-104	-380	172	-42	-52	137	-406	-269	-1,289
% OF NORM	71%	39%	365%	-6%	55%	205%	66%	80%	94%
SEP 2001	150	34	116	45	66	201	411	612	20,324
NORMAL	345	470	115	40	110	95	1,080	1,175	22,175
DEPARTURE	-195	-436	1	5	-44	106	-669	-563	-1,852
% OF NORM	43%	7%	101%	113%	60%	212%	38%	52%	92%
OCT 2001	156	352	24	-69	56	154	519	673	20,997
NORMAL	400	525	70	10	120	75	1,125	1,200	23,375
DEPARTURE	-244	-173	-46	-79	-64	79	-606	-527	-2,379
% OF NORM	39%	67%	34%	-690%	47%	205%	46%	56%	90%
NOV 2001	243	219	95	-53	94	189	598	787	21,784
NORMAL	390	410	65	10	120	75	995	1,070	24,445
DEPARTURE	-147	-191	30	-63	-26	114	-397	-283	-2,662
% OF NORM	62%	53%	146%	-530%	78%	252%	60%	74%	89%
DEC 2001	213	182	29	50	127	152	601	753	22,537
NORMAL	335	255	0	10	100	45	700	745	25,190
DEPARTURE	-122	-73	29	40	27	107	-99	8	-2,654
% OF NORM	64%	71%	7250%	500%	127%	338%	86%	101%	89%
lendar Year Totals									
	3,739	6,242	3,141	1,354	2,008	6,053	16,484	22,537	
NORMAL	7,395	10,840	2,430	910	1,675	1,940	23,250	25,190	
DEPARTURE	-3,656	-4,598	711	444	333	4,113	-6,766	-2,654	
% OF NORM	51%	58%	129%	149%	120%	312%	71%	89%	

TABLE II 2001 CALENDAR YEAR RUNOFF FOR SELECTED REACHES
(In 1,000 Acre-Feet)

Reach	1898 – 1998 Normal Runoff Volume	Calendar Year 2001 Runoff Volume	Percent of Normal Runoff
Above Fort Peck	7,395	3,739	51
Fort Peck to Garrison	10,840	6,242	58
Garrison to Oahe	2,430	3,141	129
Oahe to Fort Randall	910	1,354	149
Fort Randall to Gavins Point	1,675	2,008	120
Gavins Point to Sioux City	1,940	6,053	312
TOTAL ABOVE SIOUX CITY	25,190	22,537	89
Sioux City to Nebraska City	7,750	7,440	96
Nebraska City to Kansas City	12,330	11,450	93
Kansas City to Hermann	24,550	24,250	99
TOTAL BELOW SIOUX CITY*	44,630	43,150	97

- *Reaches from Sioux City to Hermann are not adjusted to 1949 depletions. Averages are taken from USGS Water-Data Reports for the period 1967-2001.

III. REVIEW OF REGULATION FROM JANUARY 2002 - DECEMBER 2002.

A. General

During this period, the System was regulated in accordance with the applicable provisions of the 2001-2002 AOP, which was made available for review and comment by representatives of State and Federal agencies, as well as the general public and specific interest groups. A summary of the significant events during this past year is given in the following paragraphs.

B. Precipitation and Water Supply Available in 2002.

1. Plains Snowpack 2001-2002.

The winter of 2001-2002 was relatively mild until March 2002, and the snow cover on the plains was discontinuous for most of the season. Unlike the winter of 2000-2001, frequent warm-ups removed most of the snow cover between winter storms, resulting in little permanent plains snowpack. The first significant snow of the plains snow season occurred in the eastern half of North Dakota on October 24, 2001. The snow largely melted by month's end as warm air returned to the region. Little snow fell until after November 15, 2001, when a storm spread snowfall over the high plains adjacent to the Rockies and the Black Hills.

More snow fell between November 23 and 27, 2001, as a series of snowstorms blanketed the high plains and produced a band of heavy snow across Nebraska and South Dakota. The largest amount reported in the basin from the multi-day storm was 15 inches at Mitchell, South Dakota, but many areas from Colorado northeastward to Minnesota accumulated 6 to 9 inches. Warm weather in early December melted most of the plains snow cover by December 10, 2001, with the exception

of the eastern Dakotas, where 2 to 5 inches of snow remained on the ground in the James River Basin. Little snow fell until around Christmas 2001, and the James River snowpack continued to shrink. More seasonal weather arrived in time for Christmas, as a cold Canadian air mass brought light snow from the Rocky Mountains to the Mississippi River. Additional snow fell across the Dakotas, and a storm brought snow to eastern Nebraska and western Iowa before year's end. Most of the non-mountainous areas of the Missouri River Basin reported less than 6 inches on the ground at the end of December 2001.

The January 2002 thaw arrived early in the month, with record high temperatures in the 60's noted as far north as North Dakota by the 8th. Little snow cover remained outside of the James River Basin of the Dakotas by the 10th, where the northern half of that watershed held on to 1 to 4 inches of snow. Cold fronts brought a couple of inches of snow to Montana and the Dakotas before warmer weather returned on January 22nd and melted most of it. By the end of January, even the James River Basin of eastern North Dakota was largely snow free. Scattered areas of snow cover of from 1 to 7 inches remained on the high plains watersheds of western North Dakota and Montana at the end of January. A significant winter storm crossed the south-central basin on the last day of January, bringing heavy snow to parts of Kansas, Nebraska, Iowa, and northwest Missouri. The heaviest amount reported was 13.5 inches at Grand Island, Nebraska.

The snow cover was short-lived in the southern basin, as warm weather returned by February 5, 2002. The ice cover that had formed on rivers in Nebraska broke up under the pressure of melting snow, producing some lowland flooding along the Loup River near Monroe, Nebraska. Winter weather made a brief return on February 8 and 9, as a strong cold front, accompanied by high winds and light snow, crossed the basin. Snow accumulations were restricted to the high plains of eastern Montana and Wyoming where 2 to 4 inches were reported. Following that storm, nearly all of the plains snow cover melted by February 18, as record warmth spread over the central U.S., pushing temperatures into the upper 50's as far north as Cut Bank, Montana. An abrupt change in the jet stream during the last week of the month resulted in a return to winter conditions across the basin. A series of storms brought light snow to the high plains of Colorado, southern Wyoming, and western Kansas and Nebraska. Additional snow fell across Montana and the Dakotas by February 25. Colder temperatures allowed the snow to stay on the ground through the end of the month.

The light snow cover was soon joined by more significant snow in early March 2002. A major winter storm pushed out onto the plains on March 1, dumping up to 10 inches of snow in a wide band from eastern Colorado through Nebraska, Kansas, Iowa, and Missouri. Bitterly cold temperatures behind the storm and a series of reinforcing cold fronts, accompanied by light snow, allowed the snow to continue to accumulate over the basin. Most of the Missouri River Basin had snow cover by March 4, with continuous snow cover reported from Helena, Montana to St. Louis, Missouri. The second week of March featured a sharp contrast between the northern and southern parts of the basin. The majority of the snow cover melted south of Nebraska, while additional snow fell across the plains of Montana and North Dakota. By March 11, a large area of the northern plains had a snow cover of 5 to 10 inches in depth. Another major winter storm crossed the plains on March 13-15, dumping 2 feet in parts of eastern Wyoming and 1 to 2 feet across southern South Dakota and northern Nebraska. South of that storm track, warmer weather caused

all of the snow to melt by the 18th. The snow cover slowly eroded over Montana and the Dakotas, but 2- to 7-inch depths remained over much of the northern plains by the last week of March.

Winter continued unabated over the far northern plains into April 2002, with subzero temperatures and more light snow reported across Montana and North Dakota by the 4th. Winter finally loosened its grip on the northern part of the basin by the second week of April as warm air pushed north to the Canadian border, ending the 2001-2002 plains snow season.

2. Mountain Snowpack 2001-2002.

Mountain snowpack during the 2001-2002 winter season was about 90 percent of normal above Fort Peck and about 80 percent of normal in the reach between Fort Peck and Garrison. The fact that it was that high was largely due to an above average snowfall from April through June 2002 in the northern Rockies. For most of the season, snowfall lagged well behind normal amounts and seemed to be similar to the 2000-2001 season, with accumulations well below normal above Garrison. Basins in Colorado and southern Wyoming did not fair well, with snowpack in the Platte River Basin finishing the season nearly 40 percent below normal.

Snow began to accumulate seasonally in the high country of Montana, Wyoming, and Colorado in the early fall of 2001. More significant snowfall was reported in the northern Rockies during the third week of October 2001, as the weather pattern began to change, allowing Pacific moisture to reach the drought-stricken northwestern U.S. By November 1, 2001, the new mountain snowpack was above average in Montana and Wyoming but well below average in Colorado. The snowpack was slow to accumulate though, as several weeks of well above normal temperatures during November caused the mountain snow cover to erode. By the end of November, most Montana snow courses reported near-normal precipitation, but below normal snow water equivalent values due to the amount that was lost to melting or fell as rain during the warm early fall.

On December 1, 2001, the snowpack was only 75 percent of normal above Fort Peck and about 70 percent of normal in the reach between Fort Peck and Garrison. Snow cover in the headwaters of the Platte River ranged from 50 percent to 67 percent of normal. Colder weather and a strong Pacific storm allowed the mountain snowpack to build seasonally during early December 2001. More snow fell over the northern Rockies between December 12 and 14, adding 2 feet of snow in some areas of Montana. By January 1, 2002, the snowpack above Fort Peck and Garrison continued to be below normal, but had lost little ground, with both basins rated at about 70 percent of normal. The drainage area in the upper Platte River Basin gained ground and was about 70 percent of normal on January 1, 2002.

During January 2002, the majority of the winter storms tracked across the northern Rockies, leaving disappointing amounts of snow south of the Yellowstone watershed. The western Milk and St. Mary River Basins actually nosed above normal by February 1, 2002, and the upper Yellowstone River Basin gained a little over 80 percent of normal. Gains were also reported on the upper Missouri River Basin during the month of January, with snow water equivalent values in the 80 to 85 percent range. The remainder of the Yellowstone River Basin held its own and contained about 75 percent of normal snow water content on February 1, 2002. The Platte River Basin deteriorated to around 60 percent of normal, as major storms continued to bypass the southern

Rockies. The headwaters area of the South Platte Basin snowpack was less than 50 percent of normal by February 1, 2002.

Rocky Mountain snowfall during February 2002 was normal, with most basins neither gaining nor losing ground against historical averages by March 1. The mountain snowpack "percent of normal" values were virtually unchanged from 1 month earlier.

The snowpack in the northern Rockies gained along with the plains snowpack during the month of March 2002. Strong winter storms combined with record low temperatures, resulted in most basins in Montana and Wyoming gaining ground on historical averages. By April 1, 2002, the basins above Fort Peck averaged 85 to 90 percent of normal, and most of the sub-basins above Garrison were in the 80 to 85 percent range. The snow water content in the upper Milk and St. Mary River Basins in northwestern Montana was above average. The Platte River Basin remained in the 55 to 65 percent of normal range, with the significant winter storms continuing to follow a more northerly track and periodic melting eroding snowpack at lower elevations in the southern Rockies.

The disparity between north and south widened by May 1, 2002, as above normal temperatures caused early melting of the snow in Colorado and southern Wyoming. At the same time, some watersheds above Fort Peck reached or exceeded seasonal normals. The Sun, Teton and Marias River Basins weighed in at 133 percent of normal snow water content by the first of May. The overall basin average above Fort Peck was slightly above normal. The reach between Fort Peck and Garrison finished April just below average, with the lower elevation basins and the Wind River Basin holding about 75 percent of normal snow cover and the upper Yellowstone River Basin near 90 percent of historical average snow cover on May 1. The Milk River Basin, with significant low level snow cover, had 237 percent of normal snowpack. The Platte River snow courses declined due to the rapid advance of spring during the drought year, with May 1 values in the 30 to 48 percent of normal range. The South Platte River Basin recorded its lowest snow water equivalence for May 1 since 1981.

By June 1, 2002, most of the snow had melted in the southern Missouri River Basin headwaters, but significant snow remained in Montana. The basins above Fort Peck generally held 80 to 95 percent of normal snowpack, with a few sub-basins in northwest Montana well above seasonal averages. Between Fort Peck and Garrison, the earlier than normal mountain snowmelt eroded snow pack to well below normal values for June 1. The snowpack in the upper Platte River Basins was nearly gone at the beginning of June 2002.

Overall snow water content totals recorded during the entire snow season ending July 1, 2002 showed a marked gradation from northwest to southeast. The Milk, St. Mary, Sun, Teton, and Marias River Basins received up to 125 percent of average precipitation. Most basins above Fort Peck finished the season in the 90 percent of normal range. Moving downstream, most watersheds in the reach between Fort Peck and Garrison had 75 to 90 percent of normal precipitation. The headwater area of Platte River Basin, on the other hand, finished the season with less than two-thirds of normal precipitation. The 2001-2002 mountain snow accumulation and melt above Garrison are illustrated in ***Figure 1***.

3. Weather Conditions January-December 2002.

The cold weather pattern over eastern Canada deepened and built southwestward across the Missouri River Basin during the first week of January 2002. Precipitation was limited to flurries except in the Rocky Mountains, where moderate amounts of snow fell. The cold snap was short lived, as record warmth returned to the basin by January 7, as Chinook winds moved out of the Rockies and onto the plains. Havre, Montana warmed from –14° F to 62° F in less than a day, as strong winds pushed the warm air eastward. Numerous record highs were set on January 8, including an unseasonable 63° F at Bismarck, North Dakota. Conditions remained dry and warm through mid-month. Record warmth and generally dry conditions again spread across the basin after January 22. Record high temperatures were noted across parts of Nebraska and Iowa on the 25th and 26th, with Norfolk, Nebraska reaching 77° F and Sioux City, Iowa reaching 71° F on the 26th. Meanwhile, cold, windy, and dry conditions plagued the wheat-producing areas of the northern plains. A storm at month's end dumped a band of snow exceeding 10 inches across southern Nebraska and Iowa. Grand Island recorded 13.5 inches by the time the storm ended on January 31. By late January, drought, or abnormally dry, conditions were reported across more than one-half of the Missouri River Basin, as shown on the January 22 Drought Monitor in ***Figure 2***.

Temperatures reached the upper 50's as far north as western South Dakota during the first week of February 2002. By the 5th, the ice began to go out of streams in Nebraska. Ice jams were reported on the lower Loup River near Monroe, Nebraska. Warm and dry conditions continued through mid-month on the plains, with many areas setting record highs. Temperatures reached the upper 50s across large areas of South Dakota and Montana by the second week of February. Arctic air pushed south across the basin by the last week of February. Record warmth reached as far north as North Dakota ahead of the front. Helena, Montana reported 58° F on the 22nd, and Yankton, South Dakota reached 72° F on the 23rd. The polar air mass was followed by a series of storms that brought snow to parts of the plains. Other areas missed the precipitation. Normally snowy Aberdeen, South Dakota recorded only 0.03 inches of precipitation in February, nearly equaling a drought record 0.02 inches set in 1934. Temperatures plunged to below -25° F across much of Montana, including a record -39° F at West Yellowstone, Montana on the 26th. Sub-zero lows behind the late winter storm were reported as far south as Kansas at the end of February. Runoff for February was 85 percent of normal.

March came in like a "lion" and stayed that way, with a late winter snowstorm moving across the central plains at the start of the month. Grand Island, Nebraska picked up 10 inches of snow on the 1st from that storm. A reinforcing shot of cold air followed the storm with subzero lows again pushing southward. Laramie, Wyoming fell to -25° F on the 2nd, and Grand Island, Nebraska recorded its first subzero low of the winter. A second, powerful cold front followed the first one, causing temperatures to plunge again by the 8th. Cut Bank, Montana recorded a late winter record low of -34° F, as Arctic air poured into the northern plains. Although the coldest air from the second front was confined to Montana and North Dakota, temperatures remained below normal over most of the basin, and parts of South Dakota picked up an additional 2 to 4 inches of snow during the second week of March. The cold and damp weather continued through mid-month, with more heavy snow falling across parts of Wyoming, South Dakota, and northern Nebraska. Some of the heavier snowfall totals from the March 13-15 storm included 24 inches at

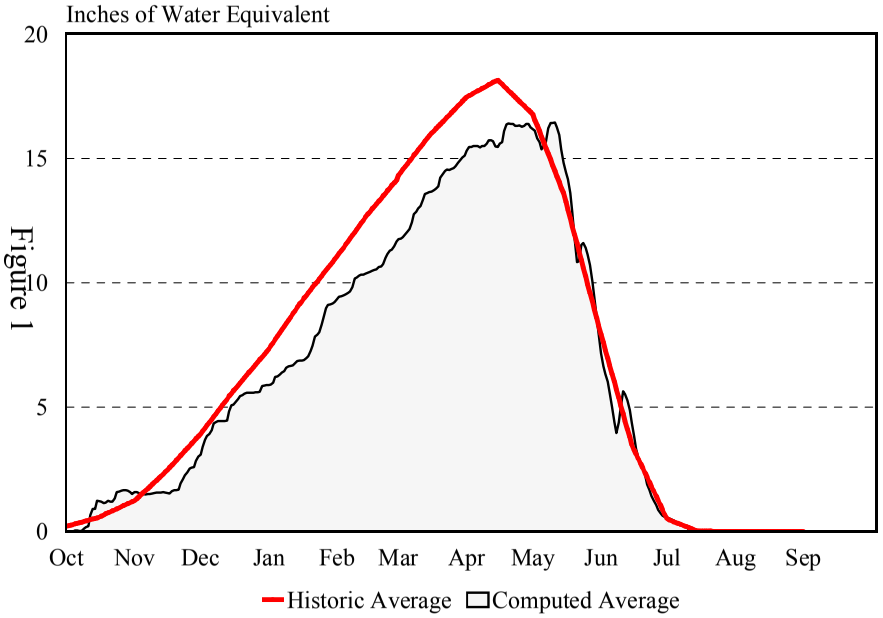
Lusk, Wyoming, 19 inches at Valentine, Nebraska, and 15 inches at Kennebec, South Dakota. Temperatures plunged below zero as far south as Chadron, Nebraska on the 16th. Another arctic air mass pushed into Montana as the first day of spring approached. By March 23, another round of record lows were observed, with Cut Bank reporting -27° F and Miles City with -22° F. March was so cold in Montana that Great Falls recorded 12 days with subzero low temperatures in the first 24 days of March. Temperatures warmed towards the end of the month but generally remained below normal. Another snowstorm pushed across Kansas and Nebraska, with Goodland, Kansas picking up 6 inches and Lincoln, Nebraska recording 8 inches on the 25th. Cold and drier than normal conditions resulted in abnormally low basin runoff in March, with only 41 percent of normal recorded.

Winter held its grip over the northern plains at the start of April 2002. Temperatures dipped to zero or below across northern Montana on April 2 and 3, and frost or freezing temperatures were reported across Kansas and Missouri by the 4th. The cold was accompanied by 2 to 4 inches of snow across parts of Montana and North Dakota. By the second week of April, a warm and dry air mass spread over the central U.S. While the warmth was a welcome change to the wintry conditions, the effect of months of below normal precipitation across most of the Missouri River Basin became more evident. Northeastern Kansas and adjacent states were the exception, with as much as 3 inches of rain reported.

The third week of April 2002 featured a contrast between the Rocky Mountain states and the remainder of the basin, as a strong cold front pushed into the northwestern U.S. Temperatures pushed above 90° F as far north as South Dakota, while temperatures in the Rockies remained below normal and some areas picked up significant snowfall. Sioux City, Iowa reached 96° F on the 15th. In contrast, Billings, Montana picked up 1.75 inches of precipitation from 14 inches of snow between April 15 and 18. Additionally, the temperature contrast along the front set the stage for some severe storms and much needed rainfall in eastern Nebraska and adjacent states. Cooler weather returned, along with more precipitation for Kansas and Missouri during the last week of April. Temperatures fell to as low as 11° F as far south as Alliance, Nebraska on the 25th. The severity of the drought was evident on the 3-month precipitation map in ***Figure 3*** and the April 9 Drought Monitor in ***Figure 2***. It was noteworthy that the accumulated February-April precipitation map showed below normal precipitation for nearly 100 percent of the Missouri River Basin.

Mountain Snowpack Water Content
Missouri River Basin
Winter 2001 - 2002

Total Above Fort Peck



Total Fort Peck to Garrison

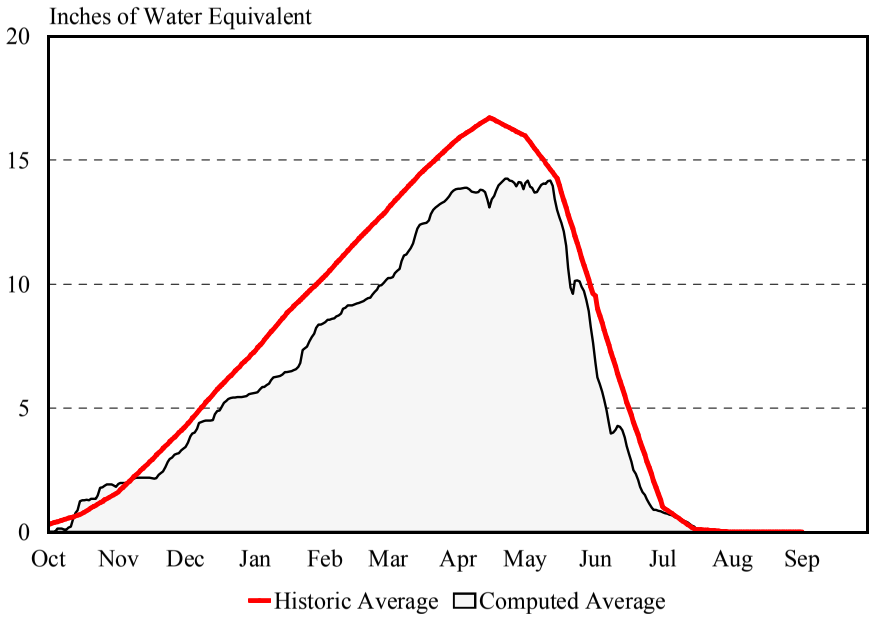


Figure 1

Snowpack peaked on May11, 2002 at 91 percent of the normal peak accumulation in the reach above Fort Peck, and at 84 percent of the normal peak accumulation in the reach between Fort Peck and Garrison on April 22, 2002

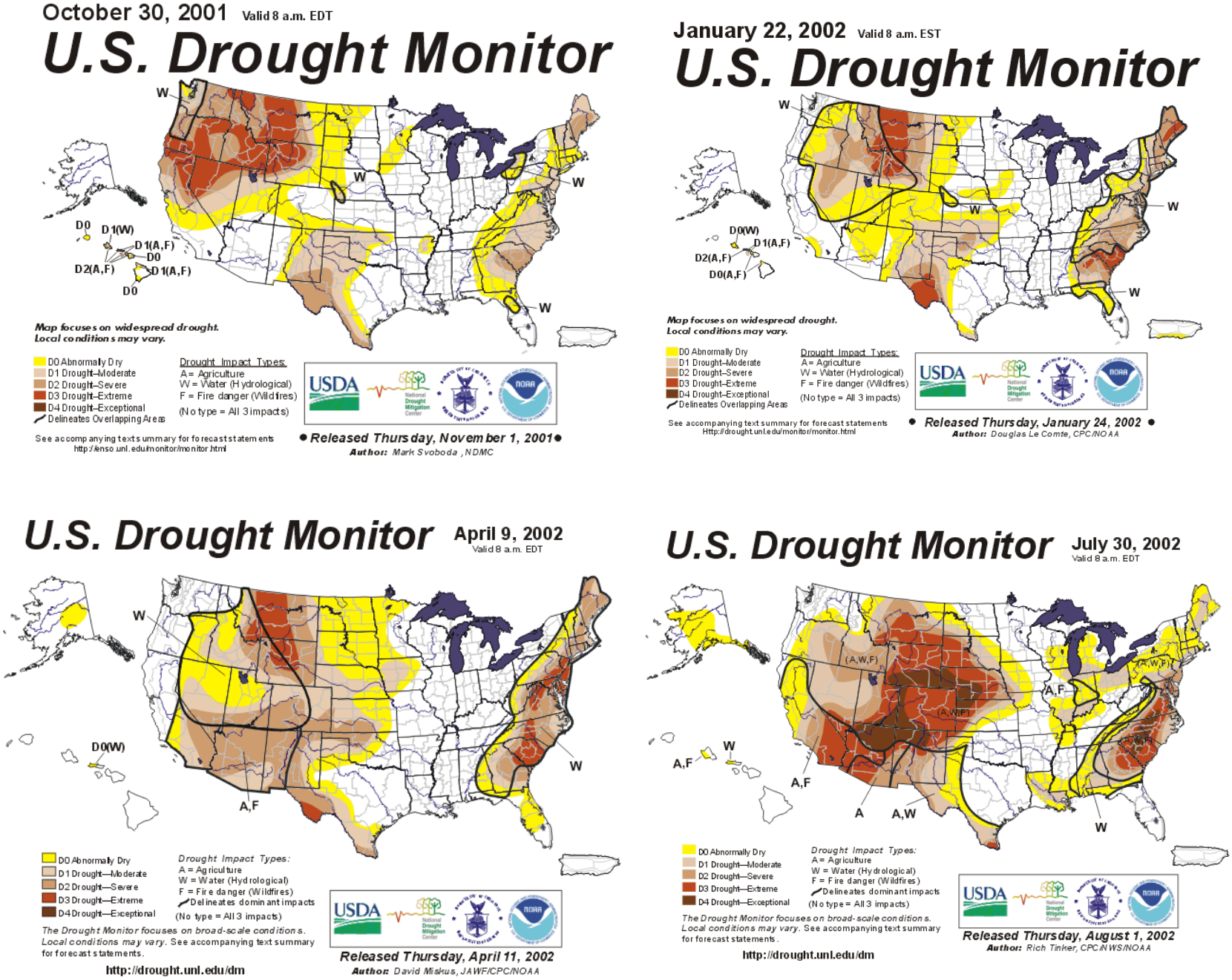

October 30, 2001 Valid 8 a.m. EDT
U.S. Drought Monitor
W
W
W
W
D0
D1(W)
D1(A,F)
D0
D2(A,F)
D1(A,F)
D0
Map focuses on widespread drought.
Local conditions may vary.
D0 Abnormally Dry
D1 Drought–Moderate
D2 Drought–Severe
D3 Drought–Extreme
D4 Drought–Exceptional
Delineates Overlapping Areas
Drought Impact Types:
A= Agriculture
W = Water (Hydrological)
F = Fire danger (Wildfires)
(No type = All 3 impacts)
See accompanying text summary for forecast statements
http://enso.unl.edu/monitor/monitor.html
USDA
Released Thursday, November 1, 2001
Author: Mark Svoboda, NDMC
January 22, 2002 Valid 8 a.m. EST
U.S. Drought Monitor
W
W
W
W
D0(W)
D1(A,F)
D2(A,F)
D0(A,F)
Map focuses on widespread drought.
Local conditions may vary.
D0 Abnormally Dry
D1 Drought–Moderate
D2 Drought–Severe
D3 Drought–Extreme
D4 Drought–Exceptional
Delineates Overlapping Areas
Drought Impact Types:
A= Agriculture
W = Water (Hydrological)
F = Fire danger (Wildfires)
(No type = All 3 impacts)
See accompanying text summary for forecast statements
Http://drought.unl.edu/monitor/monitor.html
USDA
Released Thursday, January 24, 2002
Author: Douglas Le Comte, CPC/NOAA
U.S. Drought Monitor
April 9, 2002
Valid 8 a.m. EDT
W
W
D0(W)
A,F
D0 Abnormally Dry
D1 Drought—Moderate
D2 Drought—Severe
D3 Drought—Extreme
D4 Drought—Exceptional
Drought Impact Types:
A = Agriculture
W = Water (Hydrological)
F = Fire danger (Wildfires)
Delineates dominant impacts
(No type = All 3 impacts)
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 11, 2002
Author: David Miskus, JAWF/CPC/NOAA
U.S. Drought Monitor
July 30, 2002
Valid 8 a.m. EDT
(A,W,F)
(A,W,F)
(A,W,F)
A,F
W
A,F
A,F
A
A,W
W
D0 Abnormally Dry
D1 Drought—Moderate
D2 Drought—Severe
D3 Drought—Extreme
D4 Drought—Exceptional
Drought Impact Types:
A= Agriculture
W = Water (Hydrological)
F = Fire danger (Wildfires)
Delineates dominant impacts
(No type = All 3 impacts)
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, August 1, 2002
Author: Rich Tinker, CPC/NWS/NOAA

Figure 2

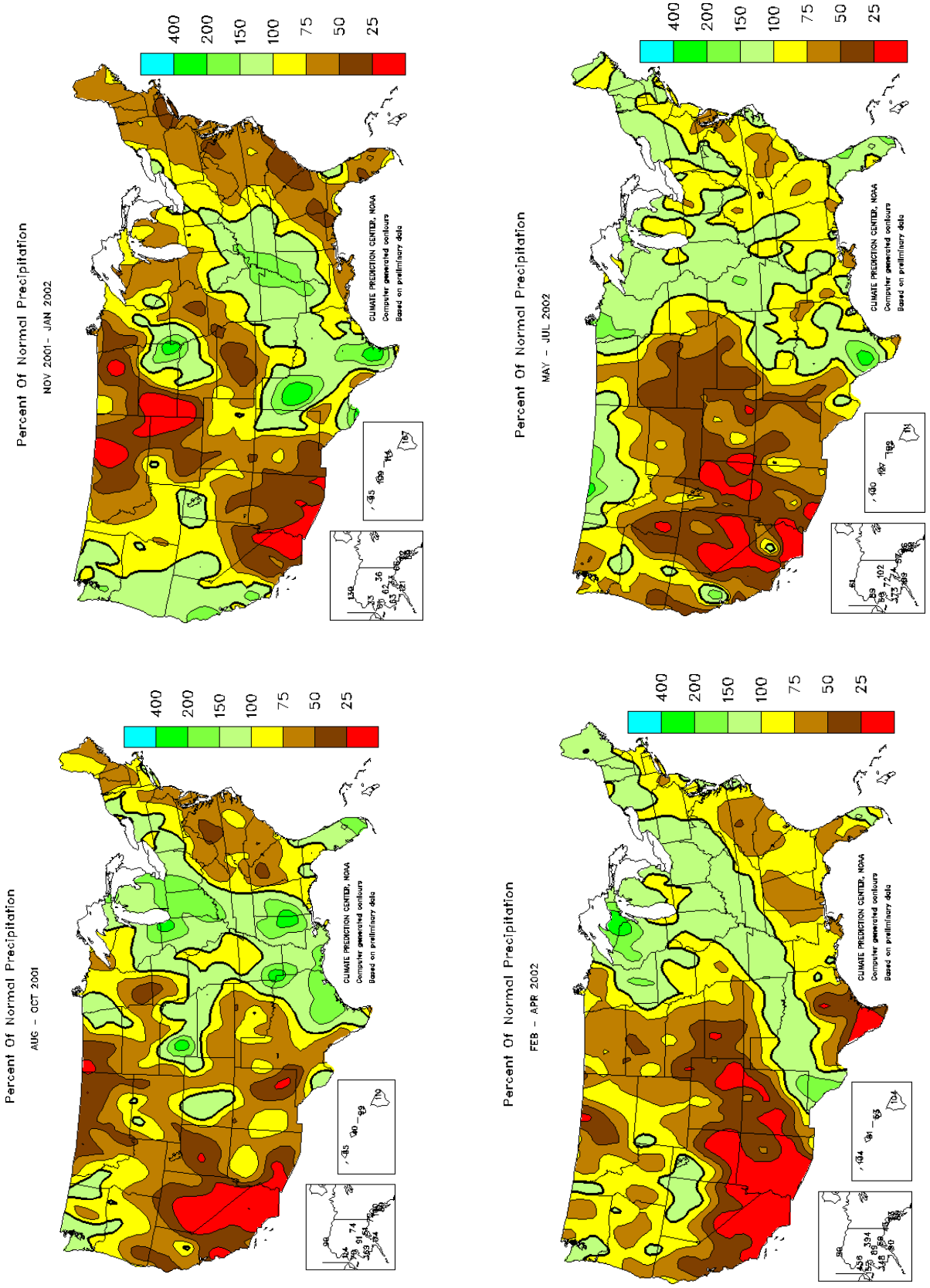

Percent Of Normal Precipitation
NOV 2001 - JAN 2002
Percent Of Normal Precipitation
MAY - JUL 2002
Percent Of Normal Precipitation
AUG - OCT 2001
Percent Of Normal Precipitation
FEB - APR 2002
400
200
150
100
75
50
25
CLIMATE PREDICTION CENTER, NOAA
Computer generated contours
Based on preliminary data

Figure 3

May 2002 began, as April ended, with cooler than normal temperatures across the Missouri River Basin. Precipitation during the first week was generally less than an inch and was limited to a band from eastern Montana through western Iowa. The contrast in temperatures continued into the second week of May, with the northern states colder than normal and the southern states hot. The contrast brought heavy rainfall from eastern Kansas through Missouri, where more than 4 inches fell in many locations during the week. Pleasant Hill, Missouri received 8.38 inches of rain from May 5 through 12. Beneficial rains of 2 to 4 inches were also reported in parts of eastern Nebraska and southern Iowa as well. Much of Montana received its precipitation in the form of snow. Glasgow, Montana received over 6 inches of snow during the first 11 days of May, and record low temperatures were noted in Nebraska and Iowa, among them 11° F at Sidney, Nebraska. The cool weather lingered into the middle of May over the northern plains. Conditions also became dryer, with significant precipitation confined to the Ozarks and central Missouri. A record-setting cold snap brought frost or freezing temperatures to the northern part of the basin on the heels of yet another Arctic front during late May. Glasgow, Montana and Williston, North Dakota both reported over an inch of snow on the 22nd. More significant snow was reported at higher elevations in the Rockies, and moderate-to-heavy rain was reported from southeast Nebraska to the mouth of the Missouri River. Warmer weather spread over the basin from southwest to northeast during the last few days of May. Hot summer temperatures were common in the southwestern part of the basin at the end of May. On May 31, a record high temperature of 106° F was set at McCook, Nebraska.

June 2002 began with a continuation of the late spring hot weather. A cold front pushed as far south as South Dakota and stalled out, separating hot weather to the south from cooler weather to the north and generating widespread rainfall throughout much of the basin. Cut Bank, Montana reported 3.78 inches of rainfall in the first 9 days of June. Havre and Helena, Montana also reported more than 3.5 inches of precipitation by June 10. Colder temperatures spread over the western part of the basin north of the strong cold front. Laramie, Wyoming reported 27° F on June 11 behind the cold front. Much of the basin, with the exception of South Dakota and western Nebraska, received precipitation during the first half of June. Colorado remained very dry, as evidenced by wild fires that spread in the mountains west of Denver, Colorado, burning more than 100,000 acres of timber by June 17. West-central South Dakota finally received rainfall during the third week of June and temperatures were generally above normal from the Canadian border to St. Louis, Missouir. The heat intensified after the 20th, with temperatures pushing above 100° F on several days across most of the high plains. Bismarck, North Dakota had a scorching high temperature of 111° F on June 28th. Precipitation during the last week of June was spotty and resulted from isolated severe thunderstorms. Rolla, Missouri had 2.33 inches of rain and other areas in the Osage and Gasconade River Basins received from 1 to 2 inches. Even with the hot temperatures, mountain snowmelt flows were rapidly receding as the bulk of the snowpack had already melted by the last week in June.

July 2002 was hot and dry, punctuated only by isolated severe thunderstorms. One of those storms dumped roughly 8 inches of rain around Ogallala, Nebraska on the 5th and 6th, causing flash flooding on the South Platte River and washing out Interstate 80 bridges over a normally dry draw. Record setting heat again pushed into the high plains by the end of the second week of July, intensifying drought conditions. Billings, Montana reached a record high of 107° F on July 4th just beating the previous record of 106° F set in 1937. Billings broke this new record by 1° F on July 14th reaching 108° F. Miles City, Montana reached 110° F on July 14, tying its all-time record

high. The relentless hot and dry weather continued into the third week of July, and precipitation was generally limited to the Rocky Mountain states, where monsoon-type moisture fueled afternoon and nighttime thunderstorms. Kennebec, South Dakota reached 109° F on the 20th and Omaha, Nebraska reached 104° F 2 days in a row on the 20th and 21st. The hot and dry weather pattern began to ease somewhat in Montana and North Dakota near the end of July, but retained its tight grip on the remainder of the basin. Temperatures again reached 110° F, this time at Hill City in northern Kansas on the 25th. Russell, Kansas hit 108° F 2 days in a row on the 25th and 26th, as the desert-like weather continued. The intensity of the mid-summer drought was evident, as Scottsbluff and Chadron, Nebraska had no rain during the first 28 days of July. North Platte, Nebraska had only 0.13 inches for the month, 6 percent of normal. The Drought Monitor map for July 23, shown in ***Figure 2***, details the extent of severe and exceptional drought across the western part of the basin. The contrast between the northern plains and the central plains became even more pronounced at the end of July, as nighttime temperatures dipped below 40° F in parts of Montana and North Dakota, while searing temperatures continued over South Dakota, Nebraska, Kansas, and eastern Colorado. Valentine, Nebraska and Academy, South Dakota reached 110° F on July 31 to end a very hot and dry month in the Missouri River Basin. Precipitation for the basin during the May-July 2002 period is shown in ***Figure 3***. The Platte River, which normally flows at greater than 3,500 cfs during the warmest part of the summer, dropped to less than 900 cfs at Louisville, Nebraska near the mouth.

The beginning of August 2002 was a reversal of the hot and dry conditions that persisted throughout the summer. As the month began, the area of extreme drought encompassed nearly all the states of Wyoming, Colorado, and Nebraska. Exceptional drought had spread east over Nebraska and northwestern Kansas as a high pressure system strengthened its grip on the western U.S. and northern Mexico during July, which prevented precipitation from reaching the Midwest. This changed in August, and much of the basin received welcomed significant rain and, in some locations, the rainfall resulted in runoff. Sioux City, Iowa had 2.97 inches of rainfall in the first 10 days of August, and Norfolk, Nebraska had 4.23 inches. The Milk River Basin experienced heavy rain and a stream flow rise that resulted in reduced flows from Fort Peck Dam. Wolf Point rainfall totaled just over 4 inches, with 2.85 inches falling on August 7. Although the rainfall amounts were, for the most part, significant, parched soils mostly soaked up the rain. Very little measurable runoff occurred; however, there were exceptions. Some areas in Kansas and Missouri received over 5 inches of rain in a 36-hour period, as the cool fronts moved across the basin early in the month. The Big Sioux River Basin received almost 6 inches of rain, and the river rose sharply. Watertown, South Dakota broke its August daily record with a 4.32-inch rainfall on August 20, breaking the previous August record of 3.37 inches. It was also Watertown's second wettest day of record behind 7.14 inches total on May 27, 1931. Even the Missouri River rose to above minimum service levels the third week of August due to the recent rainfall near the river. Drought conditions, therefore, retreated slightly during the month in Nebraska, Kansas, and Missouri. Columbia, Missouri's 8.49 inches represented its fifth wettest August rainfall total to date. The final week in August was dry and hot over much of the basin.

September 2002 began with temperatures rising above 100° F in western South Dakota and Kansas. The Osage River Basin received 3 inches of precipitation on September 1, and northwestern Kansas received 1 to 2 inches. The storm track shifted northward. Montana and North Dakota received heavy precipitation, but drier, warmer conditions prevailed south of there.

The Big Horn River Basin in Wyoming and many areas in Colorado had 2 to 3 inches of rainfall by mid-month. The drought also spread into western Missouri early in September; this was short lived. By mid-month, most locations were receiving significant rainfall, and temperatures fell to seasonal conditions. On September 19, the Black Hills in South Dakota received over 3 inches of rain. Rainfall totals of 3 inches or more were recorded for the month in many locations in the Missouri River Basin, and streams generally returned to more normal flow rates.

October 2002 started with welcomed rain and seasonally cooler temperatures. Several areas of the basin received over 2 inches of rainfall during the first week of October. By mid-month, temperatures had warmed considerably, with Bismarck reporting over 80 degrees, and very little precipitation was occurring. Many opportunities for rainfall had passed over the basin, resulting in an expansion of drought, both in severity and extent. During the third week of October, temperatures dropped significantly and snow began falling in Nebraska and Iowa, where 2 to 4 inches occurred on October 23 and 24. Spotty rainfall also occurred in Kansas and Missouri. The month ended with Kearney, Nebraska reporting the coldest October on record -45° F. Miles City, Montana and Sheridan, Wyoming also reported that October was a record cold month, with average monthly temperatures of 39.3^{o} F and 38.0^{o} F, respectively. Great Falls, Montana's daily temperature fell below 32° F on 24 days during the month, breaking the previous record of 23 days set in 1925.

Fluctuating temperatures and moderate precipitation occurred in November 2002. Temperatures were at times well above normal and ended the month at -18° F at Williston, North Dakota and -15° F at Bismarck, North Dakota. A little snowfall occurred but, generally, was melted by the periods of above normal temperatures. The streams generally did not form significant ice cover because the periods of cold temperatures were of short duration. Drought continued to expand in both extent and severity, especially downstream.

During the first week of December 2002, the heaviest snowfalls occurred in Missouri, with St. Louis receiving 3.5 inches. The second week of December was highlighted by temperatures that were 10 to 20° above normal and precipitation of less than 1 inch in Montana. Topeka, Kansas recorded a record high of 70° F on December 15, and Grand Island, Nebraska reported 67° F on the same date. The third week was highlighted by extremely warm temperatures basin-wide. Over 2 inches of precipitation occurred above Harry S. Truman Dam in Missouri, and Bismarck, North Dakota's weekly snowfall totaled 4.2 inches. On December 21, Kansas City, Missouri recorded its 37th consecutive day without measurable precipitation, tying its second longest streak of record. The longest period without rain was 40 days in January 1923. Another extremely dry year, therefore, ended in the Missouri River Basin, with a large portion of the basin in grips of the third year of drought.

4. <u>2002 Calendar Year Runoff.</u>

Calendar Year runoff for the period January through December 2002 for the area above Sioux City, Iowa, totaled 16.0 MAF, 64 percent of the normal runoff for the period of 1898-1998. This was the tenth lowest runoff above Sioux City, Iowa, in the 105 years of runoff recorded in the basin, as shown in ***Figure 4***. Monthly runoff during 2002 above Sioux City, Iowa varied from a

low of 40 percent of normal in March to approximately 99 percent of normal in January. ***Figure 5a*** and ***Figure 5b*** indicate the monthly variation of runoff for CY 2001 and 2002, respectively.

The historic and forecasted monthly runoffs for CY 2002 from Fort Peck downstream to Sioux City, Iowa by major reach are presented in ***Table III***. The table describes the annual runoff by month and is the basic compilation of the month-by-month runoff in the upper basin by reach. This forecast forms a basis for intrasystem balancing of storage accumulated in the projects and is used by the Missouri River Basin Water Management Division on the first of each month to forecast the runoff for the remainder of the year. The monthly accumulation of actual runoff through July and the forecasts through December are shown under the "Summation above Sioux City" column. As the season progresses and the actual runoff accumulates, the forecast becomes more reliable. The majority of the annual runoff has normally occurred by the end of July, and the remainder of the year can be estimated with a fair degree of accuracy.

Missouri River Main Stem
Annual Runoff at Sioux City, Iowa

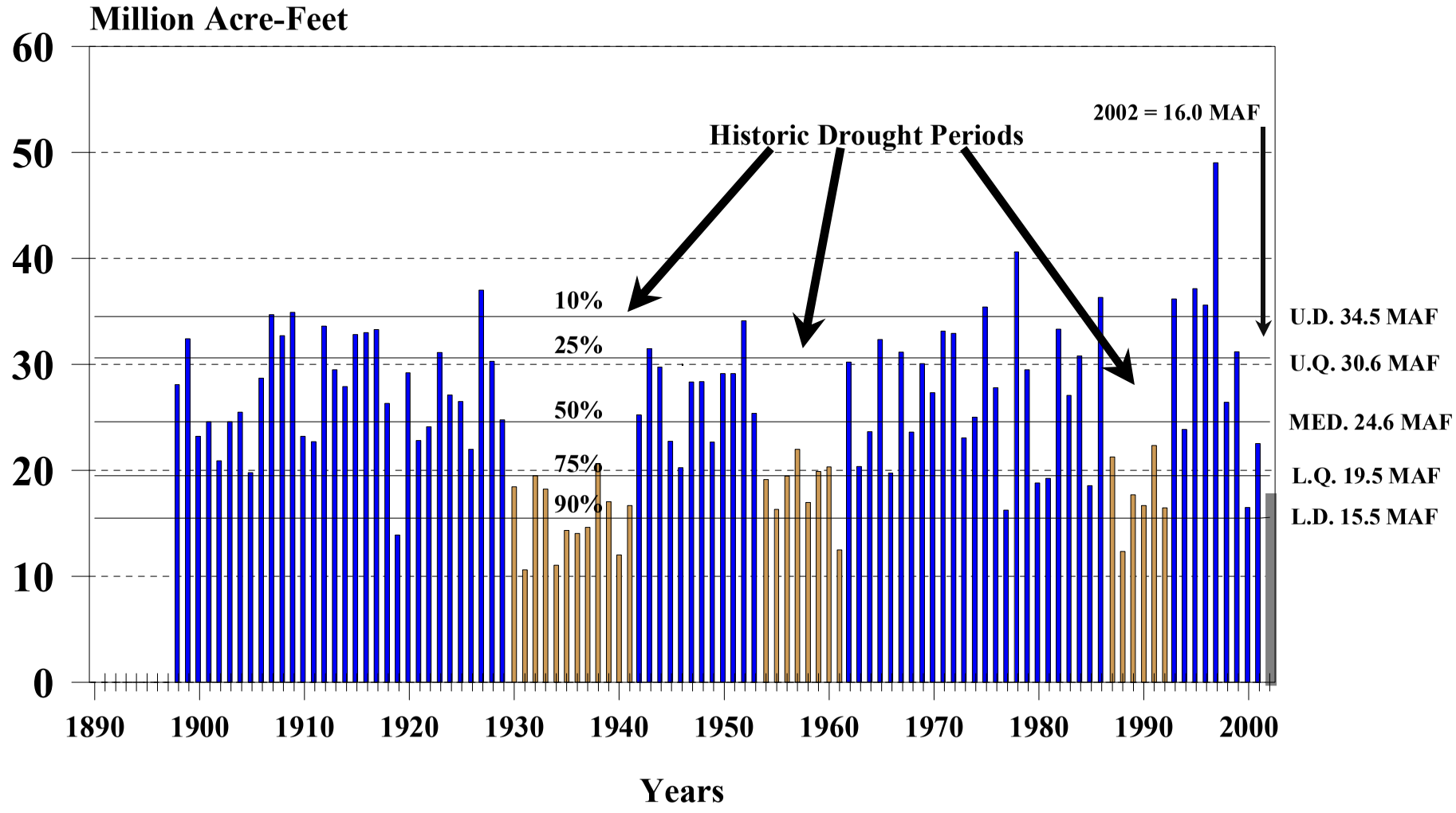


Figure 4
16

2001 Missouri River Runoff
Above Sioux City, Iowa

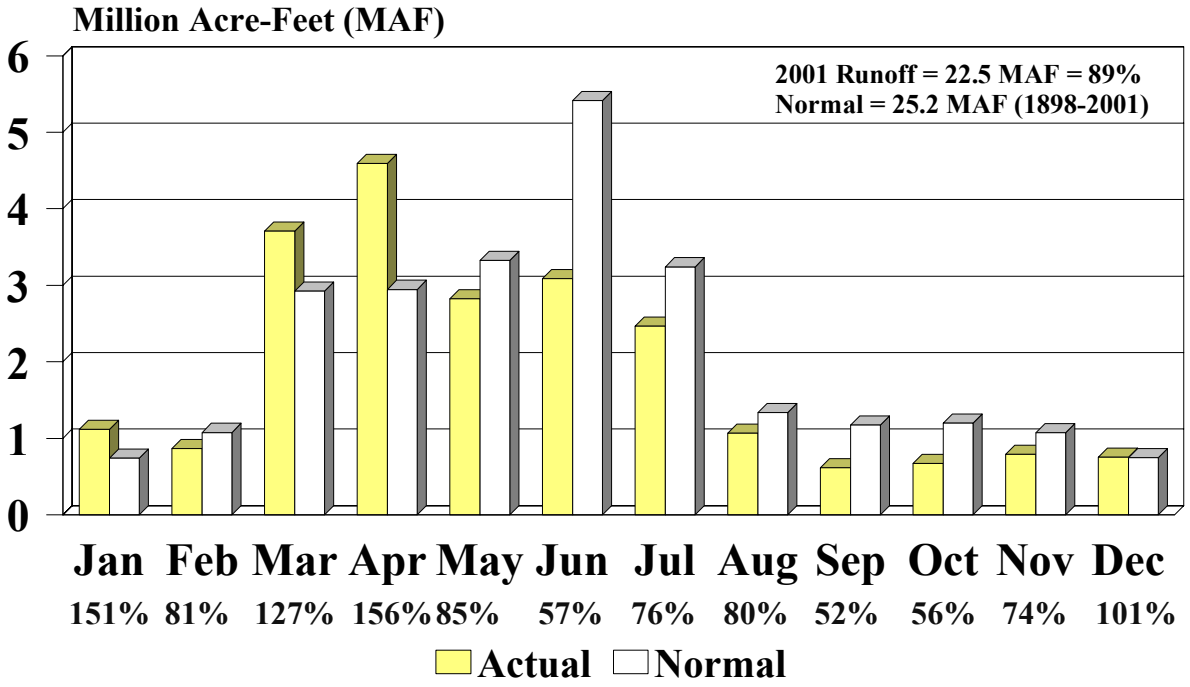


Figure 5A

2002 Missouri River Runoff
Above Sioux City, Iowa

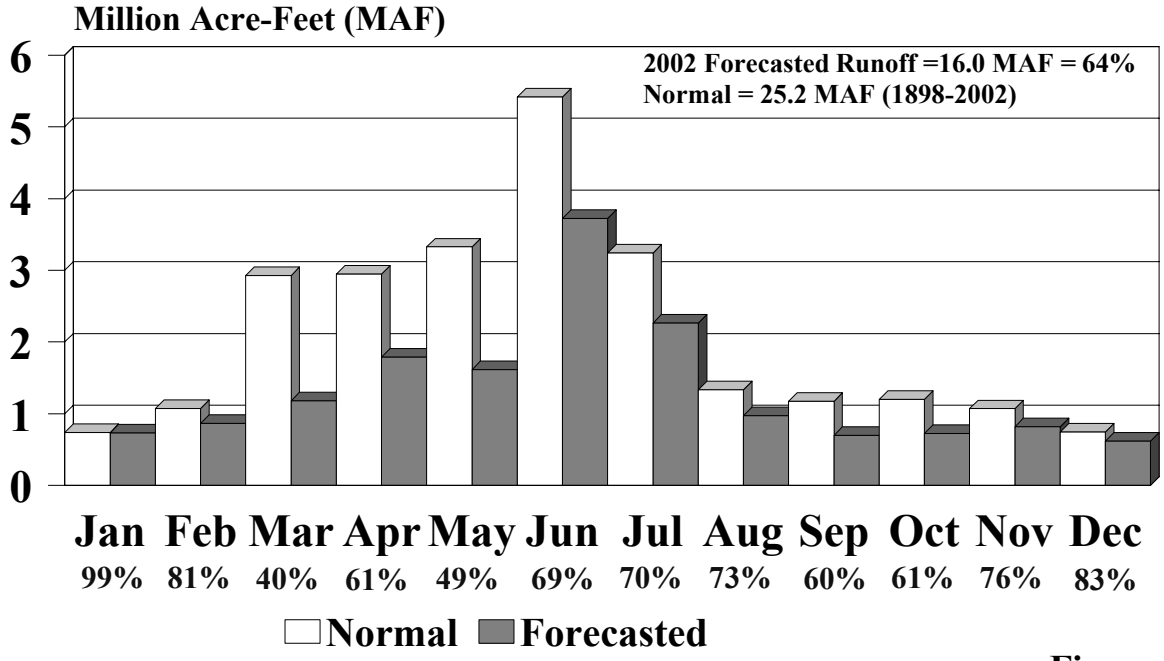


Figure 5B

Table III
Missouri River Basin
Calendar Year 2002
Historic and Forecasted

Reach Above	Fort Peck	Garrison	Oahe	Fort Randall	Gavins Point	Sioux City	Summation above Gavins Point	Summation above Sioux City	Accumulated Summation above Sioux City
				Values in 1000 Acre Feet					
	(Historic)								
JAN 2002	207	184	19	64	138	120	612	732	732
NORMAL	315	260	10	20	100	35	705	740	740
DEPARTURE	-108	-76	9	44	38	85	-93	-8	-8
% OF NORM	66%	71%	190%	320%	138%	343%	87%	99%	99%
FEB 2002	231	232	73	25	138	170	699	869	1,601
NORMAL	365	360	90	50	125	85	990	1,075	1,815
DEPARTURE	-134	-128	-17	-25	13	85	-291	-206	-214
% OF NORM	63%	64%	81%	50%	110%	200%	71%	81%	88%
MAR 2002	268	354	65	97	144	252	928	1,180	2,781
NORMAL	610	1,010	580	220	205	300	2,625	2,925	4,740
DEPARTURE	-342	-656	-515	-123	-61	-48	-1,697	-1,745	-1,959
% OF NORM	44%	35%	11%	44%	70%	84%	35%	40%	59%
APR 2002	413	647	146	85	155	344	1,446	1,790	4,571
NORMAL	665	1,115	500	145	180	340	2,605	2,945	7,685
DEPARTURE	-252	-468	-354	-60	-25	4	-1,159	-1,155	-3,114
% OF NORM	62%	58%	29%	59%	86%	101%	56%	61%	59%
MAY 2002	413	543	118	47	149	343	1,270	1,613	6,184
NORMAL	1,120	1,280	320	145	185	275	3,050	3,325	11,010
DEPARTURE	-707	-737	-202	-98	-36	68	-1,780	-1,712	-4,826
% OF NORM	37%	42%	37%	32%	81%	125%	42%	49%	56%
JUN 2002	1,460	1,861	92	65	65	177	3,543	3,720	9,904
NORMAL	1,655	2,715	435	160	180	270	5,145	5,415	16,425
DEPARTURE	-195	-854	-343	-95	-115	-93	-1,602	-1,695	-6,521
% OF NORM	88%	69%	21%	41%	36%	66%	69%	69%	60%
JUL 2002	824	1,172	93	37	16	121	2,142	2,263	12,167
NORMAL	835	1,815	180	60	135	215	3,025	3,240	19,665
DEPARTURE	-11	-643	-87	-23	-119	-94	-883	-977	-7,498
% OF NORM	99%	65%	52%	62%	12%	56%	71%	70%	62%
AUG 2002	353	266	78	90	14	172	801	973	13,140
NORMAL	360	625	65	40	115	130	1,205	1,335	21,000
DEPARTURE	-7	-359	13	50	-101	42	-404	-362	-7,860
% OF NORM	98%	43%	120%	225%	12%	132%	66%	73%	63%
SEP 2002	239	180	72	82	-15	143	558	701	13,841
NORMAL	345	470	115	40	110	95	1,080	1,175	22,175
DEPARTURE	-106	-290	-43	42	-125	48	-522	-474	-8,334
% OF NORM	69%	38%	63%	205%	-14%	151%	52%	60%	62%
OCT 2002	220	411	57	-88	32	95	632	727	14,568
NORMAL	400	525	70	10	120	75	1,125	1,200	23,375
DEPARTURE	-180	-114	-13	-98	-88	20	-493	-473	-8,807
% OF NORM	55%	78%	81%	-880%	27%	127%	56%	61%	62%
NOV 2002	278	284	103	64	86	3	815	818	15,386
NORMAL	390	410	65	10	120	75	995	1,070	24,445
DEPARTURE	-112	-126	38	54	-34	-72	-180	-252	-9,059
% OF NORM	71%	69%	158%	640%	72%	4%	82%	76%	63%
DEC 2002	236	164	21	44	112	39	577	616	16,002
NORMAL	335	255	0	10	100	45	700	745	25,190
DEPARTURE	-99	-91	21	34	12	-6	-123	-129	-9,188
% OF NORM	70%	64%	5250%	440%	112%	87%	82%	83%	64%
				Calendar Year Totals					
	5,142	6,298	937	612	1,034	1,979	14,023	16,002	
NORMAL	7,395	10,840	2,430	910	1,675	1,940	23,250	25,190	
DEPARTURE	-2,253	-4,542	-1,493	-298	-641	39	-9,227	-9,188	
% OF NORM	70%	58%	39%	67%	62%	102%	60%	64%	

C. System Operations

1. System Operation - January to December 2002

System storage had declined to 53.2 MAF on September 1, 2001, the date when a System storage check is made each year that is used as input in the application of the specific technical criteria of the Master Manual. Winter releases for the 2001-2002 winter season were set at the minimum that is believed necessary to provide adequate water supply downstream of the System, which is 13,000 cubic feet per second (cfs). System storage fell from 49.3 MAF on November 1, 2001 to 48.7 MAF on January 31, 2002. System storage held steady at 48.7 MAF during February 2002 and was 8.4 MAF below the desired 57.1 MAF top of the carryover multiple use zone on March 1, 2002.

Support for the 2002 navigation season was in accordance with the plan presented in the 2001-2002 AOP. The plan included a normal-season opening date, with reduced service flows and a season length based on actual July 1 System water-in-storage. Flow support for the 2002 navigation season began on March 23 at Sioux City, Iowa; March 25 at Omaha, Nebraska; March 26 at Nebraska City, Nebraska; March 28 at Kansas City, Missouri; and April 1 at the mouth of the Missouri River near St. Louis, Missouri. The downstream service level provided was 4,000 cfs less than full service, based on the March 15, 2002 System water-in-storage check. A flow-to-target operation was used during the endangered species nesting season from May through August 15 to maximize water conservation while still meeting all authorized purposes. In the first week of July, the System release needed to be increased, and the Corps was informed by the U.S. Fish and Wildlife Service that to do so would not be covered as an incidental "take" described in its November 2000 Biological Opinion. The Corps elected to not increase releases, and, as a result, flows on the Missouri River did not meet minimum service requirements for the entire 6-week period. At times, releases were more than 7,000 cfs less than minimum service. Increases were initiated on August 15 to meet downstream targets. There were significant problems with the navigation channel conditions after the period of late summer low flows that ultimately resulted in channel dredging in the fall of 2002. The season closed on the normal navigation season closing dates.

On April 1, 2002, System water in storage stood at 51.9 MAF, 0.1 MAF lower than the previous year. System storage made slight gains during just two runoff periods in 2002. The plains snowmelt produced a March-April runoff of 3.0 MAF, much lower than the normal 5.9 MAF runoff. Runoff volumes for May, June, and July were 1.6 MAF, 3.7 MAF, and 2.3 MAF, respectively. Normal for that same time period are 3.3 MAF, 5.4 MAF, and 3.2 MAF, respectively. End-of-month System water in storage was 47.8 MAF for May, 48.8 MAF for June, and 48.2 MAF for July. System water in storage peaked at 48.9 MAF on July 11, 2002, 5.8 MAF lower than the 2001 peak. The end-of-July System water in storage was 48.2 MAF, 13.0 MAF below average. System water in storage then began a steady decline through the late summer and fall months. End-of-month storages were: August, 46.9 MAF; September, 45.5 MAF; October, 44.0 MAF; November, 43.1 MAF; and December, 42.7 MAF. The end of December System water in storage was 6.1 MAF lower than the previous year and 12.2 MAF below average. The end of month water in storage for December also exactly matched the end-of-year water in storage in 1992, the last year

of the previous drought. The end-of-year System water in storage was the third lowest since the system filled in 1967.

Energy generation at the six mainstem powerplants totaled 7.5 billion kilowatt hours (kWh) for the period January 1, 2002 to December 1, 2002, 2.5 billion kWh below the average since the System first filled in 1967. The below normal generation was due to the drought conservation during the winter and low system releases to support minimum service downstream flows during the navigation season.

2. Fort Peck Operation - January to December 2002.

Fort Peck, the third largest Corps of Engineers (Corps) storage reservoir, serves all authorized purposes. Fort Peck's primary functions are: (1) to capture the mountains and the plains snow and localized rainfall runoffs from the large drainage area above Fort Peck, which are metered out at controlled release rates to meet the System 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 operations, thus helping to alleviate large pool increases in Garrison, Oahe, and Fort Randall; and (3) to provide the extra water needed to meet all System authorized purposes that draft storage during low-water years.

Winter 2002. Fort Peck releases averaged 5,000 cfs for January and 5,100 cfs for February. These were record low winter releases for both months, as drought conservation measures were being taken and water was intentionally held in Fort Peck Lake to achieve a better March 1 storage balance.

The Fort Peck reservoir level began 2002 at elevation 2219.2 feet mean sea level (msl), 14.8 feet below the annual flood control zone and 6.7 feet below the elevation the previous year. By the end of February, the lake elevation declined to 2218.6 feet msl, which was 3.7 feet lower than on the same date the previous year. The lake reached the season low of 2218.3 feet msl on March 15, 2002, 15.7 feet below the base of the annual flood control zone.

Winter River and Ice Conditions Below Fort Peck. No special releases were required for prevention of ice-jam flooding, because it was not a threat with the low flows downstream from Fort Peck. Ice formation on the Missouri River began on December 25, 2001, when the Missouri River stage rose over 4.8 feet in the Wolf Point, Montana area. The stage peaked near 7.4 feet on December 26, 2001, which is 3.7 feet below flood stage. The Missouri River at Culbertson, Montana rose over 1.7 feet as the ice formed in this portion of the Missouri River during December 26-29, 2001. The Missouri River stage peaked at 6.2 feet on January 11, 2002 at Culbertson, which was 4.1 feet below the previous year's peak stage. No reports of ice-affected flooding on the Missouri River below Fort Peck Dam were recorded during the 2001-2002 winter season.

Spring and Summer 2002. Releases from Fort Peck averaged 4,600 cfs in March and 4,100 cfs in April, which are below the 6,000 cfs release normally provided to support fish spawning below the dam. This lower release, however, was required to balance the reservoir level with that of the two downstream reservoirs because of lack of significant inflow into the reservoir the

previous 2 years. In May, releases from Fort Peck averaged below normal at 7,300 cfs. June and July's release averages were also below normal, both at 8,600 cfs. The reservoir level of Fort Peck was 2218.5 feet msl at the beginning of the 2002 navigation season, 4.2 feet lower than at the beginning of the 2001 navigation season. The reservoir level peaked on July 17 at 2220.4 feet msl, 2.5 feet lower than the peak the previous summer.

Fall to End of 2002. Releases from Fort Peck averaged 8,800 cfs in August, 6,800 cfs in September, and only 4,700 cfs in October. November releases from Fort Peck averaged 5,600 cfs, and December releases increased to average 9,900 cfs. The releases during the period, except for December, were 3,000 to 4,000 cfs below average in order to balance the Fort Peck reservoir level with Garrison and Oahe. The reservoir level ended the year at 2214.6 feet msl, 4.7 feet lower than at the end of the previous year and 19.4 feet below the base of the annual flood control zone. In 2002, Fort Peck did not rise into the annual flood control zone, which extends from 2234 to 2250 feet msl.

3. Garrison Operation - January to December 2002

Garrison, the largest Corps storage reservoir, is another key player in the operation of the System. Its primary functions are (1) to capture the snowmelt runoff and localized rainfall runoffs from the large drainage area between Fort Peck and Garrison, which are metered out at controlled release rates to meet the System 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 operations, thus helping to alleviate large pool increases in Oahe and Fort Randall; and (3) to provide the extra water needed to meet all mainstem authorized purposes that draft storage during low water years.

Winter 2002. Releases from Garrison were not only below normal for a third consecutive winter season, but were also record lows for the period of January through February. The releases remained near 13,000 cfs from January 1 to March 5, 2002, when releases were decreased to 12,000 cfs to conserve water. Garrison monthly average releases of 13,100 and 13,200 cfs for January and February 2002 were below the monthly averages by 11,200 and 12,300 cfs, respectively.

Garrison began 2002 near elevation 1829.1 feet msl, 8.4 feet below the annual flood control zone and 0.1 feet below the reservoir level on the same date the previous year. The reservoir declined throughout the winter season to an elevation of 1827.6 feet msl by February 28, 2002, which was 9.9 feet below the base of the annual flood control zone. The reservoir level of Garrison was only 0.7 feet lower than on the same date the previous year.

Winter River and Ice Conditions Below Garrison. The Missouri River in the Bismarck, North Dakota area was free of ice problems in the winter months at the beginning of 2002. The ice-cover conditions were intermittent, and a stable permanent winter ice cover never really formed on the Missouri River near Bismarck. Missouri River stages at Bismarck rose over 6 feet during the formation of an ice cover over a 2- to 3-day period from December 23-25, 2001. The peak ice-affected Missouri River stage at Bismarck was 10.2 feet on December 27, 2001. This was well below both the established Bismarck flood stage of 16 feet and the Corps' winter freeze-in stage of

14 feet. The Missouri River then fell below 7 feet by January 15, 2002 as temperatures improved. The Bismarck stage continued to hold between 6 to 7 feet through February 19, but dropped below 5 feet just before a late winter artic cold front arrived. This front was accompanied with below-zero nightly temperatures and resulted in a second rise in stage at Bismarck to just above 9 feet on February 28, 2002.

Spring and Summer 2002. Releases from Garrison during the spring and summer were below normal. Releases in March and April were 12,500 and 10,800 cfs, respectively. No water was transferred to Lake Audubon during this period. Garrison releases averaged 12,800 cfs in May, 20,900 cfs in June, and 20,800 cfs in July. Pool elevations for Lake Sakakawea were 1827.1 feet msl on April 1, 1827.4 on May 1, 1828.2 on June 1, 1831.5 on July 1, and 1831.4 at the end of July. Lake Sakakawea peaked at an elevation of 1831.9 feet msl on July 7, 2002, down 2.5 feet from previous year's peak. Pumping costs associated with the Buford-Trenton project for the period August 1, 2001 through July 31, 2002 were $11,672; the total pumping costs to date are $202,200.

Fall to End of 2002. Releases from Garrison averaged 21,100 cfs in August, 17,500 cfs in September, and only 13,800 cfs in October. November releases from Garrison averaged 18,000 cfs, and December releases increased to average 19,600 cfs. The releases during the period were below average because System release was significantly reduced as a water conservation measure. The reservoir level ended the year at 1822.5 feet msl, 6.7 feet lower than at the end of the previous year and 15.0 feet below the base of the annual flood control zone. In 2002, Garrison did not rise into the annual flood control zone, which extends from 1837.5 to 1850.0 feet msl.

4. Oahe and Big Bend Operation - January to December 2002.

Oahe, the second largest Corps storage reservoir, serves all authorized purposes. Oahe's Reservoir's primary functions are: (1) to capture plains' snow and localized rainfall runoffs from the large drainage area between Garrison and Oahe, which are metered out at controlled release rates to meet the System 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 operations, thus helping to alleviate large reservoir level increases in Big Bend, Fort Randall, and Gavins Point; and (3) to provide the extra water needed to meet all System 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.

Winter 2002. Oahe began 2002 at elevation 1598.5 feet msl and then fluctuated between 1598.5 and 1599.5 feet msl. The reservoir level was around 1.4 feet higher than in January the previous year. Oahe's daily average releases varied from 6,100 to 21,500 cfs during January

through February 2002. The January Oahe average daily release of 13,200 cfs was the second lowest on record, and February's Oahe release tied the record low, set in 1990 at 12,700 cfs.

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 in the LaFramboise 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 as needed to prevent flooding at other locations. No flooding problems were experienced in this area during the winter of 2002.

Big Bend was operated to follow power peaking requirements with hourly releases varying widely. The daily average flow varied between 0 and 22,600 cfs. The reservoir level varied in a narrow range from elevation 1420.2 to 1421.2 feet msl.

Spring and Summer 2002. Releases from Oahe were mostly below normal from April through July. The daily average release for April was 20,600 cfs, down from the 22,100 cfs normal release. May's releases averaged 15,700 cfs, 7,400 cfs below normal; June was 6,500 cfs above average at 32,500 cfs; and July was below the 30,700-cfs average at 27,200 cfs. The higher than normal Oahe June release was required to refill the three downstream mainstem reservoirs following the Temporary Restraining Order (TRO) court cases. Big Bend's releases generally mimic releases from Oahe.

Releases from Oahe are usually considerably lower during weekends than on weekdays. The normal operation is to maintain Oahe's releases above 3,000 cfs during weekend daylight hours beginning in early April. This minimum release criterion is scheduled to enhance downstream fishing and boating use during the recreation season. No minimum Oahe release was imposed in April and May 2002 due to the multiple lawsuits and the need to maintain peaking capability during daytime hours. There have been complaints relating to zero releases from Big Bend on the weekends; however, during the recreation season, Lake Francis Case extends into the Big Bend tailwater area, and establishment of minimum release rates for Big Bend would be of little value to boating or fishing in the tailwaters.

Lake Oahe began the spring period on March 1, 2002 near elevation 1598.9 feet msl and crested at an elevation of 1599.0 feet msl on March 8, 9.8 feet below the previous year's peak and 19.7 feet below the maximum of record experienced on June 25, 1995, at 1618.7 feet msl.

The normal 1-foot weekly fluctuation of Lake Sharpe was scheduled, however, the lake fluctuated between elevation 1417.4 and 1421.1 feet msl during the period. The lower elevation occurred due to flow adjustments to comply with TRO's at other projects.

Fall to End of 2002. Releases from Oahe averaged 29,200 cfs in August, 24,800 cfs in September, and only 17,300 cfs in October. November releases from Oahe averaged 23,500 cfs, and December releases dropped to average 13,800 cfs with the reduced winter system release. The releases during the period were below average because System release was significantly reduced as a water conservation measure. Oahe Reservoir level ended the year at 1584.8 feet msl, 13.7 feet

lower than at the end of the previous year and 22.7 feet below the base of the annual flood control zone. In 2002, Oahe did not rise into the annual flood control zone, which extends from 1607.5 to 1617.0 feet msl. Big Bend ended the year at 1420.6 feet msl, within the normal winter operating range and the same as the previous year. The releases from Big Bend during the fall period matched those releases made from Oahe.

5. Fort Randall Operation - January to December 2002.

Fort Randall, the fourth largest Corps storage reservoir, serves all authorized purposes. Fort Randall's primary functions are: (1) to capture plains snow and localized rainfall runoffs in the drainage area from Big Bend to Fort Randall., which are metered out at controlled release rates to meet the System 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 Oahe for water accumulated in the System when System releases are reduced due to major downstream flood control operations, thus helping to alleviate large pool increases in the very small Gavins Point; (3) to provide a location to store the water necessary to provide increased winter energy to the basin by allowing an annual fall drawdown of the reservoir to occur with a winter refilling operation that is unique to Fort Randall; and (4) to provide the extra water needed to meet all System authorized purposes, particularly navigation and downstream water supply, that draft storage during low water years.

Winter 2002. Fort Randall releases ranged from 8,000 to 14,000 cfs in January 2002, and 8,800 to 13,500 cfs in February 2002. These were the releases necessary to maintain the reservoir elevation for Gavins Point near 1208 feet msl.

Fort Randall releases averaged 10,900 and 10,700 cfs during January and February, respectively, which are well below the normal winter release of 15,000 cfs. These releases were below the long term average by 5,000 and 3,500 cfs for January and February, respectively. The releases varied from 69 percent of normal in January to 75 percent in February. Fort Randall rose from an elevation of 1343.9 feet msl on the first of January to 1348.7 feet msl by the end of February. This was 1.3 feet below the base of the annual flood control zone.

Spring and Summer 2002. Releases from Fort Randall generally paralleled those from Gavins Point and averaged 15,900 cfs in March, 20,200 cfs in April, 20,600 cfs in May, 24,100 in June, and 26,300 cfs in July. Daily average releases varied between 10,100 and 28,200 cfs during this period. Fort Randall was at 1350.3 feet msl on April 1, 2002 and 1351.8 feet msl on May 1, 2002. It peaked at 1355.4 feet msl on July 31, 2002, down 9.9 feet from the previous year's peak. The reservoir level was at 1349.4 feet msl by June 1, 2002 and was at 1355.4 feet msl at the end of July. The May drawdown supported navigation releases while the Preliminary Injunction to not lower Lake Oahe was in effect.

Fall to End of 2002. Releases from Fort Randall averaged 28,800 cfs in August, 30,400 cfs in September, and 29,400 cfs in October. November releases from Fort Randall averaged 22,900 cfs, and December releases dropped to 10,800 cfs. The releases during the period were below average because System release was significantly reduced as a water conservation measure. The reservoir level ended the year at 1342.2 feet msl, 1.7 feet lower than at the end of the previous year.

In 2002, Fort Randall rose into the annual flood control zone, which extends from 1350.0 to 1365.0 feet msl, reaching a peak elevation of 1356.1 feet msl.

6. Gavins Point Operation - January to December 2002.

Gavins Point, the most downstream of the System dams, is primarily used as a re-regulating dam to level out the release fluctuations of the upper dams to serve downstream purposes. With a total storage of only 500,000 acre-feet, it provides very little flood control and is generally maintained in a narrow reservoir elevation band between 1205 and 1207 feet 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 Fort Randall's. Releases greater than the powerplant capacity, near 35,000 cfs, are passed through the spillway.

Winter 2002. On January 1, 2002, the Gavins Point release rate was at 15,000 cfs due to cold temperatures. On January 2, 2002, the Gavins Point release was decreased by 1,000 cfs to 14,000 cfs, and another decrease occurred on January 4 to 13,500 cfs. System release was reduced to 13,000 cfs on January 8 and remained at this level until January 14, when the release was increased by 1,000 cfs for a couple of days. System release returned to the 13,000 cfs level again on January 17 and it was reduced by 500 cfs on January 22 to 12,500 cfs, where it was held through January 27. Following another round of cold weather, the release was increased to 14,000 cfs on January 27 and remained at that rate through the end of January. The Gavins Point release was decreased by 500 cfs increments to 13,500 cfs by February 1 and 13,000 cfs by February 5. It remained at this release rate through the remainder of the 2001-2002 winter season. There were a few days in February that the releases were scheduled higher than 13,000 cfs - 14,000 cfs (1 day), 14,500 cfs (5 days) and 15,000 cfs (2 days) - to maintain a 13,000 cfs rate of flow downstream during river ice-building conditions. These fine adjustments in the winter release were made in anticipation of the sub-zero temperatures and loss of water resulting from additional ice formation downstream from Gavins Point.

The Gavins Point average daily release was below the normal winter release rate for the entire winter season. Average monthly releases were 13,400 cfs for January (4,600 cfs below average) and 13,600 cfs for February (4,800 cfs below average).

During the winter period, the level of Gavins Point was near 1208 feet msl, which is 1 foot higher than the 1207 feet msl target used during the previous 10 winter seasons. The target elevation was lowered to 1206 feet msl at the end of February for future flood control purposes. The maximum pool level reached during the winter period was 1208.5 feet msl on January 8, 2002. The minimum reservoir level of the winter period occurred on January 31, 2002, when Gavins Point reached 1207.2 feet msl.

Winter River and Ice Conditions Below Gavins Point. The Gavins Point winter release rate was varied between 12,500 and 15,000 cfs in January and February 2002. Above normal temperatures during December delayed the ice formation on the Missouri River by about 2 weeks.

The first report of ice occurring on the Missouri River was made on December 28, 2001, with about 50-60 percent floating ice with 3- to 5-foot pads in the Sioux City, Iowa area. There were some downstream reports of minor amounts of floating ice a week earlier. From January 1-9, 2002, the greatest amount of floating ice was 70 percent near Cooper Nuclear Power Plant in Nebraska, near River Mile 532.6, on January 3 with 7 to 8 foot pads. For the rest of the month of January, only minor floating ice was reported. Following a cold wave in late January-early February 2002, reports of ice in the 5 to 50 percent range with 1 to 5 foot pads were reported from Sioux City, Iowa down to Nebraska City, Nebraska. Another round of much warmer temperatures in early February melted the ice on the Missouri River as reports showed no floating ice from February 7-27. A winter cold snap from February 28 through March 5 brought colder, sub-zero temperatures to the basin, and ice formation occurred again. Floating ice from 5 to 75 percent and pad sizes from 5 to 15 feet occurred, with the largest amount in the Omaha, Nebraska reach of the Missouri River.

This was an unusually warm winter with only three periods of floating ice forming on the Missouri River below Gavins Point, all three happening near the end of a winter month. There were no reports of water intake problems this last winter due to ice or ice bridging. Near Kansas City, problems with river access occurred because of the combination of low System release and very low tributary flow.

Spring and Summer 2002. Following the much below normal winter inflows into the System, the Gavins Point release was increased, beginning on March 18, 2002, in preparation for the start of the 2002 navigation season. The March monthly average release rate was 17,800 cfs, 3,300 cfs below normal. The first tow of the 2002 navigation season, the "Omaha," entered the river on March 25. Four tows were operating on the Missouri River on April 1, the first official day of flow support for the 2002 navigation season.

System releases were established based on a March 15 System water-in-storage check. The System release rate for April, May, and June was set to a reduced service level of 4,000 cfs less than full service, due to the reduction in System storage that had occurred during the previous 2 years of drought. In late February, it appeared that the downstream support releases would be about 500 cfs higher, but System storage took a dramatic dip during March, as there was no plains snowmelt runoff of significance in the basin and extremely cold temperatures locked some upstream tributary flows into ice formation. April's Gavins Point monthly release average of 23,200 cfs was 3,500 cfs below normal, and the May's monthly average of 22,700 cfs was 7,500 cfs below normal. In late May, releases were increased to 24,500 cfs, as downstream tributary flows dropped off due to expansion of the drought into the basin area below the System. The Kansas Reservoir System provided flows in support of the Missouri River in June, but this source of water was depleted near the end of June. As predicted, a reduction in Service Level, based on a System water-in-storage check, occurred on July 1. This resulted in establishing downstream flow support at the minimum service level (6,000 cfs less than full service). The rains ended during mid-June, and tributary flows were dramatically reduced during the final 2 weeks of June. Even though the flow targets were lowered by 2,000 cfs, downstream flows dropped more than this amount, which resulted in an increase in System release. June's average release rate was 24,900 cfs and July's rate was 25,500 cfs, which are 6,600 cfs and 8,600 cfs below average, respectively.

No reductions in System releases were made to provide downstream flood control during the spring and summer of 2002. Gavins Point was targeted for elevation 1206 feet msl throughout the spring and summer of 2002; however, the reservoir elevation ranged from 1204.6 to 1207.9 feet msl.

Fall to End of 2002. Releases from Gavins Point averaged 27,600 cfs in August, 29,700 cfs in September, and 29,500 cfs in October. November releases from Gavins Point averaged 24,200 cfs, and December releases dropped to 13,000 cfs. The releases during the period were below average because System release was significantly reduced as a water conservation measure. The reservoir level ended the year at 1207.0 feet msl, 0.4 feet higher than at the end of the previous year.

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

Numerous operations 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 operations during the past year that may be considered unusual, or recently have come to the attention of the Missouri River Basin Water Management Division, are discussed in the following paragraphs.

1. Description of April and May 2002 System Regulation to Comply with 2002 Lawsuits.

Continuation of the drought into the spring of 2002 was evident as March runoff above Sioux City, Iowa was only 41 percent of normal. Runoffs into Fort Peck, Garrison, and Oahe were 46, 36, and 19 percent of normal, respectively, in March. Preliminary April 1 monthly regulation forecasts indicated that April and May runoff would be insufficient to provide steady-to-rising levels at these three large reservoirs during the lake fish spawn, as recommended by the Missouri River Natural Resources Committee (MRNRC) in a letter dated October 26, 2001.

Late March. The MRNRC was contacted in late March, and several regulation scenarios were presented for its consideration. One scenario had Garrison and Oahe falling equally in April and May with a slight rise at Fort Peck. Another held Oahe steady in April and May with a 20,000 cfs Garrison release, but Garrison would have lowered 2.4 feet. The MRNRC requested a study with a maximum 20,000-cfs Fort Randall release with Garrison and Oahe falling equally (0.8 feet). The MRNRC was told that the Master Manual and AOP would be followed with navigation support at 4,000 cfs less than full service, continuing through June. The MRNRC noted that Oahe rose 2.9 feet in April 2001 and another 2.9 feet in May 2001, as a result of reductions in System releases due to a high plains snow pack in the eastern Dakotas.

April 2. The April 1 monthly regulation studies were finalized after the MRNRC made its recommendation, which stated in part, "Although the MRNRC prefers an option which would keep all three lakes stable to rising during April and May, we understand that releases for navigation and

other purposes cannot be reduced sufficiently to make such an option feasible. Therefore, the Corps' preferred option, which forecasts stable or slightly rising levels in Fort Peck and Garrison in April and May and declining levels in Oahe during the same months seems to be the option with the fewest overall negative impacts." This option was implemented and the minimum 4,000 cfs Fort Peck release was continued, and Garrison releases were reduced from 12,000 cfs to a minimum 10,000 cfs release. Steady reservoir levels were maintained during April at Fort Peck and Garrison, but Oahe fell more than 2 feet by April 25.

April 25. South Dakota filed a lawsuit with the U.S. District Court in Aberdeen, SD on April 25 to prevent the Corps from further lowering Oahe during the rainbow smelt spawn. The Corps was asked by the U.S. District Court to identify what could be done to temporarily halt the decline of Oahe Reservoir. The Corps indicated that storage from Fort Randall could be used. After consulting with the State of South Dakota legal representative, the U.S. District Court accepted that measure as a temporary solution until a hearing on the matter could be held. Oahe and Big Bend releases were substantially reduced the evening of April 25 to implement that solution. Daily System generation was reduced from 19,500 MWh to 13,000 MWh, as Oahe releases were scheduled at only 7,500 cfs to assure no further decline in Lake Oahe.

May 1. After hearing arguments, the U.S. District Court in Aberdeen issued a TRO restraining the defendants from lowering Oahe until another hearing could be held on May 9. Oahe and Big Bend releases continued near 8,000 cfs through the next week to comply with the TRO. The level of Fort Randall dropped from elevation 1353.4 feet msl on April 25 to 1350.0 feet msl by May 8 to provide support to navigation.

May 9 and 10. After additional testimony, the U.S. District Court in Aberdeen issued a Preliminary Injunction (PI) prohibiting the Corps from further lowering both Oahe and Fort Randall through May 25. Elevations corresponding to the PI were 1596.2 and 1349.2 feet msl, respectively. Fort Peck releases were increased from 4,000 cfs to 7,000 cfs on May 11; to 9,000 cfs on May 12; and 11,000 cfs on May 13 with a goal of 12,000 cfs on May 14. Likewise, Garrison releases were increased from 10,000 cfs on May 10, to 14,000 cfs on May 11, to 17,000 cfs on May 12, and 20,000 cfs on May 13. Because of the significant travel time between Garrison and Oahe, the lowering of Big Bend below elevation 1420 feet msl was initiated after the PI was issued.

May 12. The State of North Dakota obtained a TRO in the U.S. District Court in Bismarck, North Dakota to prevent the Corps from lowering Garrison below elevation 1827.6 feet msl on Sunday, May 12. Garrison releases were reduced to 10,000 cfs by May 15 to comply with that order. The level of Garrison was frequently affected by wind during the TRO time period, which caused the reservoir elevation to fall below the minimum specified in the TRO. The amount of water in storage never fell below the amount correlating to the non-wind-affected pool level of 1827.6 msl during the TRO time period.

May 13. The State of Montana obtained a TRO on May 13 from the U.S. District Court in Billings, Montana that required the Corps to follow its 3-week forecast dated May 7, 2002. This forecast indicated a 6,000-cfs Fort Peck release through May 16 with an increase to the summer rate of 9,000 cfs on May 17. Nebraska filed suit on May 13 with the U.S. District Court in Omaha,

Nebraska, which issued a TRO to require the Corps to follow Gavins Point (System) releases specified in the Master Manual and the 2001-2002 Annual Operating Plan.

May 14-19. Oahe release reductions since April 25 resulted in an additional one-half foot above the elevation corresponding to the PI (1596.2 feet msl). When Fort Peck and Garrison releases were reduced to comply with the TRO's, Oahe, Big Bend, and Fort Randall releases were all scheduled at 16,000 cfs, beginning Tuesday, May 14. This initiated use of the available storage in Oahe and also drafted Gavins Point nearly 1 foot to elevation 1205.1 feet msl by May 17. Oahe and Big Bend releases were increased to a high of 22,000 cfs on May 17 and 18 to prevent further lowering of Gavins Point.

May 20-21. A strong (up to 50 mph) wind from the southeast caused the Oahe reservoir level recorder reading to fall below elevation 1596.2 feet msl. The State of South Dakota filed a motion for Order to Show Cause with the U.S. District Court in Aberdeen on May 20. The court issued a memorandum on May 21 calling for another hearing on May 24 for the Corps to demonstrate why it should not be held in contempt. An additional declaration was provided to the court to explain how the wind can "set down" (show a lower reservoir elevation at the gage than the average pool level) or "set up" (show a higher reservoir elevation at the gage than the average pool level) large reservoirs. Oahe's elevation fully recovered by May 23 after the wind subsided. The Lower Brule and Crow Creek Tribe sought a TRO on May 21 limiting the lowering of Big Bend to no less than elevation 1419.0 feet msl. The lake level had already dropped well below 1419 feet msl by that time. The U.S. District Court in Aberdeen denied the request for a TRO. The 8th Circuit Court of Appeals issued a stay of the South Dakota, North Dakota, and Nebraska PI on May 22. Oahe and Fort Randall releases were increased beginning May 23 to transfer additional water into Gavins Point for the Memorial Day weekend (May 25-27). After numerous telephone calls from the South Dakota Department of Game, Fish & Parks, the Corps agreed to limit the decline of Lake Oahe through May 31 to assist the rainbow smelt spawn, which was late due to cold temperatures. This delayed the start of the Fort Randall refill by an additional week. An attempt to raise Big Bend by 0.8 foot before the start of the Memorial Day weekend was unsuccessful.

2. Fort Peck

The Fort Peck "mini-test" and the unbalancing of the three large upper reservoirs described in last year's (2001-2002) AOP was not implemented as planned due to low runoff in the upper basin in 2002. The endangered species modified flow "mini-test," which was designed to monitor the effects of higher spring releases and warmer water released from the spillway, required reservoir elevations of approximately 2229 feet msl to avoid unstable flows over the spillway. The "mini-test" was cancelled as reservoir elevations during May and June were approximately 6 feet below the spillway crest elevation of 2225 feet msl. The MRNRC provided recommended guidelines (Table V, 2002-2003 AOP) for unbalancing the upper three reservoirs to benefit reservoir fishery and the endangered interior least tern and threatened piping plover. As a result of the continuing drought conditions, low reservoir elevations, and below normal mountain snow pack on March 1, the guidelines did not recommend implementation measures to unbalance the reservoirs.

3. Gavins Point

The other operation of a non-routine nature occurred during the period from the last week in June 28 to August 14. In June, rainfall downstream was very much below normal and stream flow diminished rapidly during the end of month. The July 1 System water-in-storage check determined that the Corps should reduce downstream flow support from 4,000 cfs less than full service to minimum service (6,000 cfs less than full service). During the week of June 24, the downstream flow-support target moved from Sioux City to Kansas City. Flows on the Kansas River were scheduled to drop from 6,000 cfs to 1,000 cfs, as flood control storage was depleted from the Kansas Reservoir System. Flow support from the Kansas Reservoir System was requested on July 1, with a 3,500 cfs target established at Desoto, Kansas near the mouth. The Desoto, Kansas target was lowered to 3,000 cfs and then to 2,500 cfs in mid-July to extend the support period, and all available storage was used by July 19.

The Kansas Reservoir System flow support was critical during 2002. Nebraska City went below the minimum service flow target level of 31,000 cfs on July 2, and Kansas City went below the minimum service flow target level of 35,000 cfs on July 3. The U.S. Fish and Wildlife Service (USFWS) informed the Corps on Friday, July 5, that the Corps should not move endangered and threatened species' nests to higher ground and/or collect eggs and chicks for captive rearing, to allow for an increase in Gavins Point releases to support downstream flow targets. The USFWS indicated that use of the Corps' captive rearing facility at Gavins Point, to allow increased flows to meet downstream flow targets, would be considered an unauthorized "take" under the Endangered Species Act. Given the opinion of the USFWS, the Corps decided not to increase releases to meet downstream flow targets.

The Corps was operating under a " flow to target plan," which called for increased releases as required to meet downstream flow targets. This "follow target" operation provided a significant additional water conservation measure beyond the "flat release plan" followed in the past. The plan was presented in the 2001-2002 Draft AOP and was selected in the Final AOP after basin-wide coordination for implementation. During the period of late July through mid-August, Missouri flows were at times over 7,000 cfs below minimum service flows at Kansas City. The drought extended and deepened into Nebraska, Kansas and Missouri. Of special significance was that the Platte River flows fell to as low as 900 cfs during this period, further hurting the situation. Negative impacts during the summer period when flows were below minimum service were: all but one tow boat eventually left the river; towing industry suffered $3,500,000 in losses; RiverBarge Excursions cancelled trips up the Missouri River and suffered $1,000,000 in losses; some towboat equipment was damaged; several damaging groundings occurred; a powerplant near Kansas City was not operational because of intake problems during this period; a powerplant in Missouri had to deregulate some of its power units; some powerplants in Nebraska had to obtain thermal permit waivers for the Missouri River to operate; and Missouri River water temperatures exceeded State water quality standards for several days in the State of Missouri. The lower late summer flows, as much as 7,000 cfs below minimum service, left the river in such a poor state that the Missouri River eventually required emergency dredging. This was conducted by the Corps' Dredge Potter at River Mile (RM) 130 and RM 51 from October 9-12 at a cost of $465,000. The dredging was required to maintain a passable river until the close of the 2002 navigation season.

E. Reservoir Releases and Storage

Reservoir elevations and storage contents of the System reservoirs at the end of July 2002 are presented in ***Table IV*** and the same information for CY 2002 is presented as ***TableV***.

TABLE IV RESERVOIR LEVELS AND STORAGES – July 31, 2002

	Reservoir Elevation – feet msl		Water in Storage – 1,000 AF		
	Elevation	12-Month Change	Total	Above Min. Level*	12-Month Change
Fort Peck	2219.0	-3.3	12,247	8,036	-465
Garrison	1831.4	-3.0	16,236	11,256	-943
Oahe	1590.8	-7.9	14,191	8,818	-4,956
Big Bend	1419.6	-1.0	1,668	-14	-45
Fort Randall	1355.4	+0.2	3,572	2,055	6
Gavins Point	1205.7	-0.5	340	19	-11
			48,254	30,170	-6,414

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

TABLE V RESERVOIR LEVELS AND STORAGES – December 31, 2002

	Reservoir Elevation – feet msl		Water in Storage – 1,000 AF		
	Elevation	12-Month Change	Total	Above Min. Level*	12-Month Change
Fort Peck	2219.0	-4.7	11,336	7,125	-816
Garrison	1831.4	-6.7	13,917	8,937	-1,779
Oahe	1590.8	-13.7	12,790	7,417	-3,425
Big Bend	1419.6	0.0	1,722	40	4
Fort Randall	1355.4	-1.7	2,577	1,060	-108
Gavins Point	1205.7	-0.4	384	63	-10
			42,726	24,642	-6,134

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

F. Summary of Results

1. Flood Control

Releases during 2002 were directed at a continuation of the drought conservation measures and were implemented to conserve System water in storage. The water-in-storage crest was less than the base of the annual flood control zone, and mountain snowpack was below average. The expectation was, therefore, for a much below normal runoff, and water conservation measures were implemented to conserve the remaining storage as much as possible.

The estimated total flood damages prevented by the System reservoirs during Fiscal Year (FY) 2002 was only $7.3 million. The $7.3 million total damages prevented in the Missouri River Basin by the System was entirely in the Corps' Omaha District, which is unusual except during significant downstream drought such as occurred in 2002. The damages prevented by the System along the Mississippi River are not yet available. The unindexed flood damages prevented by the System since construction now totals $18.3 billion, the bulk of which was prevented between 1993 and 1999 (see ***Figure 6A***). ***Figure 6B*** indicates the $1.2 billion cost to construct the System dams. Although the System prevents enormous amounts of damage, they are not capable of totally eliminating flooding along the Missouri River. The estimated actual flood damages incurred in the Omaha District along the Missouri River from Fort Peck to Rulo, Nebraska for FY 2002 were $365,000. The bulk of the actual damages incurred were at Bismarck, North Dakota ($365,000), and some damages were also incurred in the states of Nebraska and Montana.

The Kansas City District tributary reservoirs also prevented some flood damages during this past FY. The total damages prevented in the Kansas City District, exclusive of those prevented by the Missouri River System, was $21.6 million.

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

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. Over 400 private irrigators have been granted permits to pump directly from the reservoirs. Releases from the reservoirs during 2002 generally met the needs of irrigators.

3. Water Supply and Water Quality Control

Daily flows generally exceeded minimum requirements for water supply throughout the System during 2002. All water intakes, both along the open river and in the reservoirs, were adequately served during 2002, except during the winter months. A few powerplants and municipalities along the lower river experienced difficulty accessing cooling water when flows, already reduced to the low winter release rate, were further reduced due to ice formation and ice jamming, particularly in the reach between Gavins Point Dam and Sioux City, Iowa. The problems that occurred were access problems because adequate flows existed to meet water supply needs along the river during the reporting period. During the winter of 2001-2002, Neal North Powerplant near Sioux City, Iowa and Nearman Bottoms Powerplant near Kansas City were off line at times due to low river stages caused by river ice conditions. During the winter of 2002-2003, the most significant water supply access problems occurred in the Kansas City area. A combination of factors, such as low winter System releases, degradation of the Missouri River over the years in the Kansas City reach, and very low downstream tributary flows during the winter, left several municipal water suppliers very concerned that they would lose capability to pump Missouri

River water into their facilities. Intake owners today are generally better prepared to handle periods of low water due to adjustments made to intakes or operating procedures as a result of the drought experienced from 1987 through 1992. Some of these adjustments involved 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. These remedial actions were expensive but have significantly improved the ability of the intakes to operate at low river stages.

Daily flows generally exceeded minimum requirements for water quality throughout most of the System during 2002. During the late summer period, when the below minimum service flows were provided due to the concerns over the endangered species nesting, negative impacts occurred to thermal powerplants that use Missouri River water for once-through cooling. Some violations or waivers of thermal permit requirements for powerplants occurred on the Missouri River. Also the State of Missouri thermal water quality standard for water temperature for the Missouri River was violated for several days during the summer of 2002.

Figure 8 shows the end-of-July pool elevation for Fort Peck, Garrison, and Oahe plus total System end-of-July storage for 2001 and 2002. An individual table with the maximum, average, and minimum end-of-July pool elevations for each major reservoir is also shown on this figure. The end-of-July 2002 pool elevations varied from the previous year with Fort Peck being slightly below the year before, Garrison slightly lower, and Oahe significantly lower. On July 31, 2002, Fort Peck (2219.8 feet msl) was 14.2 feet below the top of the carryover multiple use zone and 2.6 feet lower than the 2001 end-of-July level. Garrison (1831.0 feet msl) was 6.5 feet lower than the top of the carryover multiple use zone and 3.4 feet lower than 2001. Oahe (1590.7 feet msl) was 16.8 feet below the top of the carryover multiple use zone and 18.0 feet lower than in 2001. Also shown in ***Figure 8*** are the minimum, maximum, and average pool elevations since the System was fully operational in 1967.

The Omaha District collected water quality data at each of the System projects in 2002. Water quality monitoring was to consist of six monthly samples collected from April to October. Sites to be sampled included a deepwater site on the lake near the dam and a site immediately below the dam in the tailwaters. In some cases, "mid-lake" sites were also to be sampled. Currently, the collected data is stored and managed on a local District database (i.e. DASLER). Efforts are ongoing to upload this information to the Environmental Protection Agency's "STORET" national water quality database. The water quality data collected during 2002 were assessed by the District's Water Quality Unit to identify any water quality concerns, including compliance with State water quality standards. Other water quality information, including State 303(d) and 305(b) Reports, were also reviewed for indications of water quality concerns at the projects.

A significant water quality concern that can occur in reservoirs that thermally stratify in the summer is the depletion of dissolved oxygen levels in the hypoliminion. This is a natural process attributed to the differing density of water with temperature and the utilization of in-lake dissolved oxygen in the decomposition of organic matter and the oxidation of reduced inorganic substances. When density differences become significant, the deeper cooler water is isolated from the surface

and re-oxygenation from the atmosphere. In extreme situations, deeper waters can become anoxic and result in the release of sediment bound substances (e.g., phosphorus, metals, sulfides, etc.) as the oxidation-reduction potential decreases (i.e., becomes more negative). Anoxic conditions can also result in the production of toxic and caustic substances (e.g., hydrogen sulfide, etc.). These conditions can impact aquatic life in the lake and also in waters downstream of the reservoir if its releases are from a bottom outlet. Most fish cannot inhabit water with less than 4 to 5 milligrams per liter (mg/l) dissolved oxygen for extended periods.

To evaluate hypolimnetic oxygen depletion at each of the System reservoirs, dissolved oxygen depth profiles were constructed from the dissolved oxygen measurements taken at the near-dam deepwater sites. The monthly profile that reflected the most oxygen depletion at each project was identified and plotted (***Plate 3***). Only one sampling event occurred at the Big Bend project (June) and it is not displayed in ***Plate 3***, because it is not believed indicative of "worst-case" summer conditions. Only two samplings occurred at Oahe (May and July). The dissolved oxygen profile for the July sampling is shown in ***Plate 3*** for comparison to the other projects, but may not be reflective of "worst-case" conditions. ***Plate 3*** indicates an oligotrophic condition at Fort Peck and Oahe - dissolved oxygen concentrations are fairly consistent and saturated from the surface to the bottom. Garrison shows a sharp decline in dissolved oxygen from 8 to about 5 mg/l at depths between 15 and 25 meters, and stays near 5 mg/l from 25 meters to the bottom. Fort Randall exhibits dissolved oxygen levels between 5 and 6 mg/l from the surface to 20 meters that gradually decrease to about 4 mg/l at 30 meters. There appears to be a shallow layer of water (approximately 1 to 2 meters thick) at the bottom of Fort Randall where the dissolved oxygen levels are near 2 mg/l. Gavins Point is the shallowest of the project lakes evaluated and shows the sharpest dissolved oxygen decline, approaching 2 mg/l near the bottom. Of the lakes evaluated, Gavins Point and Fort Randall show the lowest hypolimnetic dissolved oxygen levels. In both lakes, it appears to be a "near-bottom" condition - only the bottom 1 to 2 meters is below 4 mg/l. The dissolved oxygen situation at Gavins Point appears to be the most serious for possible stronger reduction conditions and any associated problems. It is noted that corrosion problems have been experienced in pumps at the Gavins Point powerhouse and could be an indication of possible hydrogen sulfide concerns. The lower dissolved oxygen concentrations in the deeper waters of Garrison could present a fisheries management concern if a healthy coldwater (i.e., salmonid) fisheries is to be maintained.

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

Missouri River Main Stem

Cumulative Flood Damages Prevented

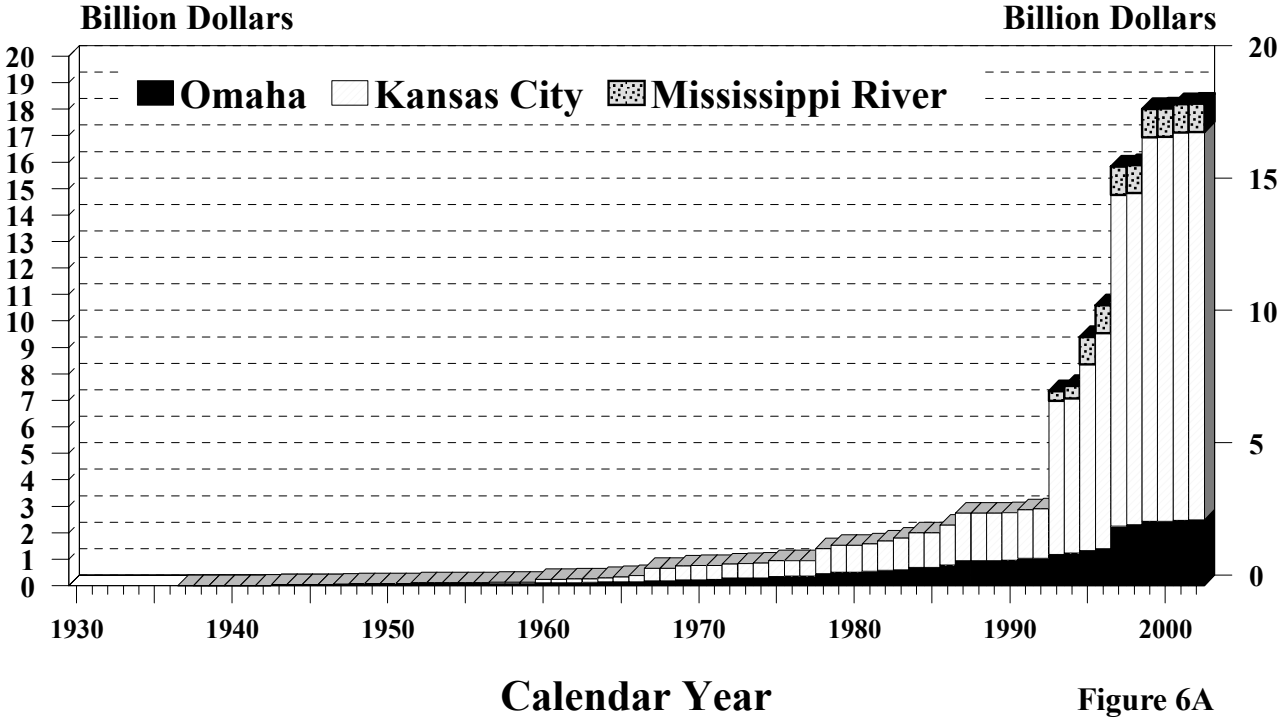


Figure 6A

Annual Flood Damages Prevented

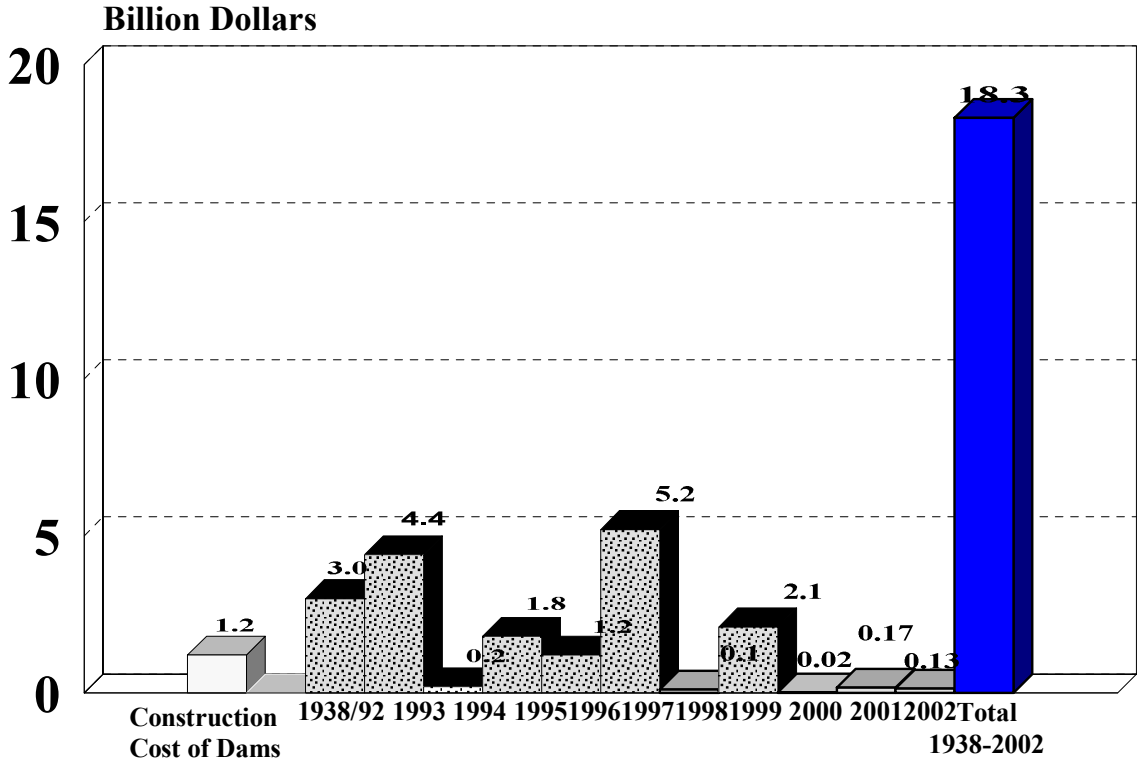
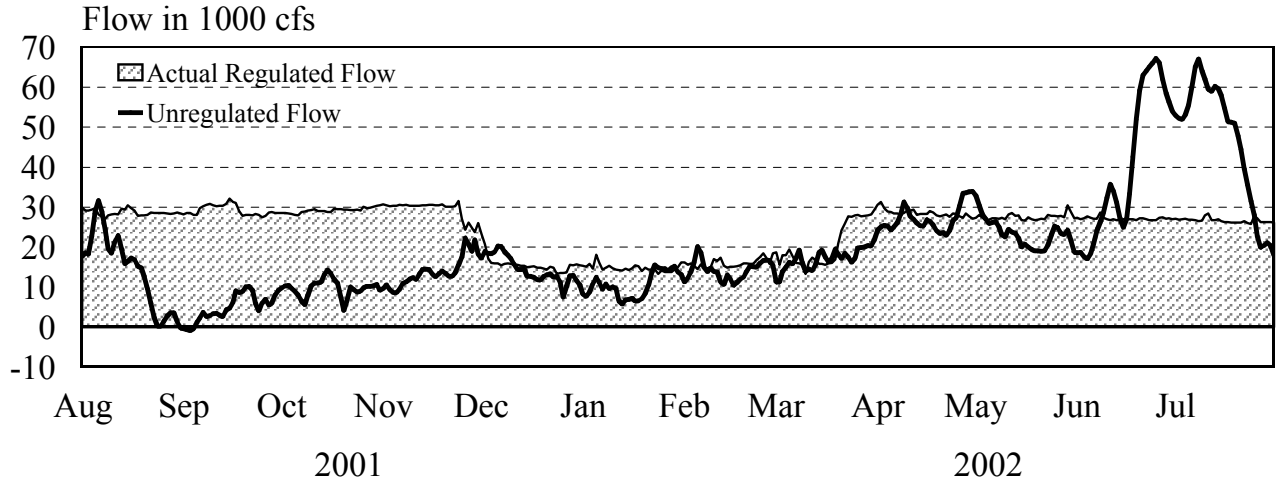
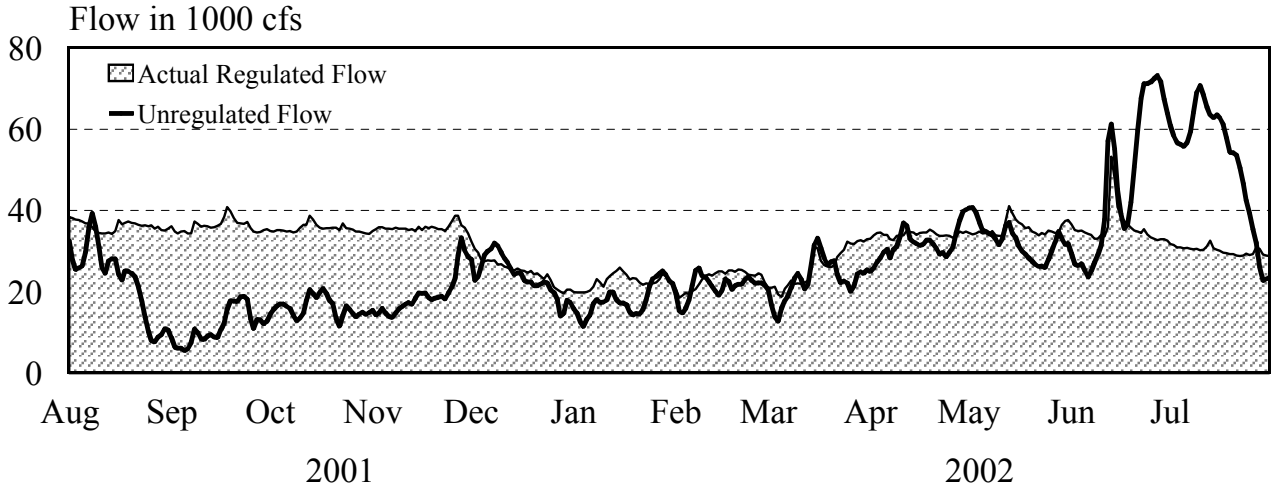


Figure 6B

Sioux City
Regulated and Unregulated Flows



Nebraska City
Regulated and Unregulated Flows



St. Joseph
Regulated and Unregulated Flows

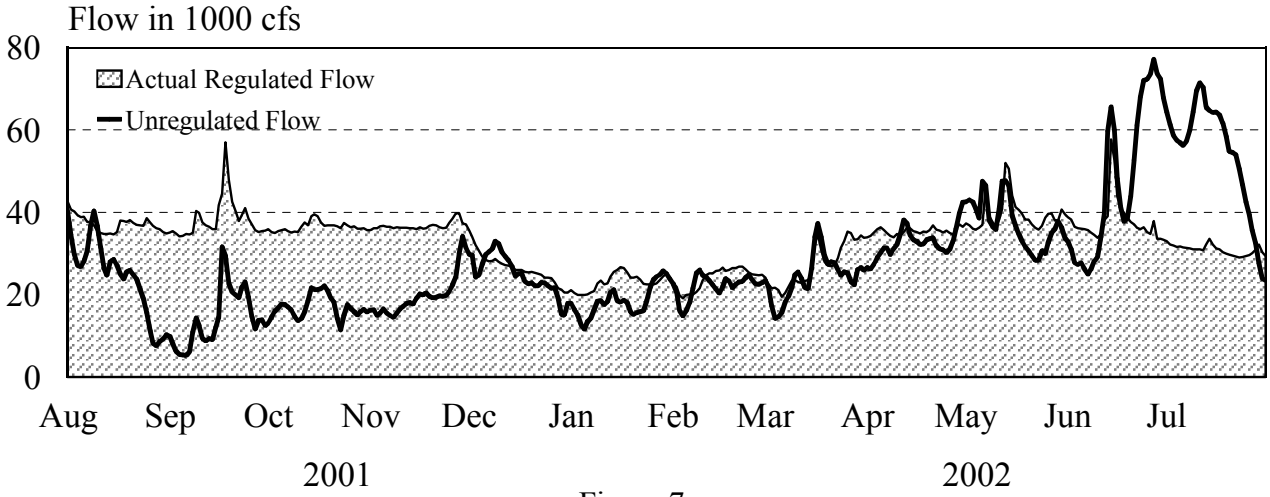


Figure 7

The District's Water Quality Unit is developing a more intensive water quality monitoring program for the System reservoirs. Tentatively, the monitoring program will consist of long term fixed-station monitoring and special-studies monitoring. Long term fixed stations would be located at; 1) an in-lake deepwater site near the dam, 2) a powerhouse site, and 3) a tailwater site. Monitoring at the deepwater site would be monthly from May through September. The powerhouse site would be monitored continuously with automated equipment, and the tailwater site would be monitored every month, weather permitting. A special studies effort that would be implemented on a regular basis is the Rotating Main Stem Project Monitoring Program (RMSPMP). The RMSPMP will intensively monitor water quality at each of the System reservoirs on a 5-year cycle. Special considerations will be given to account for spatial variability in water quality conditions at the project and water quality concerns unique to the projects. Attempts will be made to implement the RMSPMP in 2003 with the first cycle of monitoring tentatively scheduled as follows:

- Gavins Point and Fort Randall (2003)
- Big Bend (2004)
- Oahe (2005)
- Garrison (2006)
- Fort Peck (2007)

This schedule may be modified in 2003 to learn more about concerns for cold water fish habitat in Garrison. Water quality data collected from the RMSPMP will be used to prepare project-specific reports, as identified in ER 1110-2-8154, "Water Quality and Environmental Management for Corps Civil Works Projects."

TABLE VI WATER QUALITY ISSUES AND CONCERNS

Project	TMDL Considerations*					Fish Consumption Advisories		Other Potential Water Quality Concerns**
	On 303(d) List	Impaired Uses	Pollutant/Stressor	Probable Pollutant/Stressor Source	TMDL Completed	Advisory in Effect	Identified Contamination	
Fort Peck • Fort Peck Lake	Yes	Drinking Water Supply Primary Contact Recreation	Lead Mercury Metals Noxious Aquatic Plants	Agriculture Resource Extraction Abandoned Mining Atmospheric Deposition Debris & Bottom Deposits	No	Yes	Mecury	Algal Blooms
• Missouri River immediately below Fort Peck Dam	Yes	Aquatic Life Support Cold Water Fishery – Trout Drinking Water Supply Warm Water Fishery	Flow Alteration Metals Other Habitat Alterations Riparian Degradation Thermal Modifications	Hydromodification Upstream Impoundment Flow Regulation/Modification	No	No	---	---
Garrison • Lake Sakakawea	No	---	---	---	---	Yes	Mercury	Algal Blooms Hypolimnetic Dissolved Oxygen Levels
• Missouri River immediately below Garrison Dam	No	---	---	---	---	Yes	Mecury	---
Oahe • Lake Oahe	No	---	---	---	---	No	---	---
Big Bend • Lake Sharpe	Yes	No Specific Use Identified	Accumulated Sediment	Bad River Watershed	Yes	No	---	---
Fort Randall • Lake Francis Case	No	---	---	---	---	No	---	---
• Missouri River immediately below Fort Randall Dam	No	---	---	---	---	No	---	---
Gavins Point • Lewis and Clark Lake	No	---	---	---	---	No	---	Sedimentation Emergent Aquatic Vegetation Hydrogen Sulfide
• Missouri River immediately below Gavins Point Dam	Yes	Recreation	Pathogens	Agriculture	No	No	---	---

* Information taken from published state Total Maximum Daily Load (TMDL) 303(d) reports and listings.
** Includes significant fish kills and algal blooms.

4. Navigation

The second half of the 2001 navigation season began like the first half with flows at reduced service levels. With System water in storage at 54.7 MAF on July 1, 2001, support to navigation was maintained at a rate of 3,000-cfs-less-than-full service for the remainder of the 2001 navigation season as a continued water conservation measure. This marked the first time since the drought of the late 80's and early 90's that less-than-full-service flows were provided for an entire season. In addition, the season was concluded on the normal closing dates of November 22 at Sioux City, Iowa; November 24 at Omaha, Nebraska; November 27 at Kansas City, Missouri; and December 1 at the mouth. This was the second year since 1994 that the season was not extended 10 days to provide additional navigation service and the evacuation of additional water accumulated in storage.

Like the 2000 late summer and fall navigation season, the lower Missouri River Basin was again in a drought that lasted to the end of the season. This drought caused the downstream tributaries to barely provide adequate flows to sustain navigation from Kansas City to the mouth. The river below Kansas City was challenging to all commercial navigators, especially at River Miles 11.4, 28.3, 51.8, 60.3, 67.9, 108.0, 110.0, 118.6, 133.0, 213.3, and 217.4. The most challenging reach through the summer period was near River Mile 51.8. The Corps' channel reconnaissance crew provided the necessary channel condition assistance to the navigation industry through these troublesome reaches, supplementing the Coast Guard's buoying efforts.

River Mile 9.0 was a very troublesome location late in the navigation season of 2000. Tows were double and triple tripping to get through the reach. On July 16, 2001, the Kansas City District began construction of a new structure to correct the shoaling problem, and it completed the work on July 25, 2001. As a result of this work, no shoaling problems occurred through this reach late in the summer and the fall navigation periods. The last tow to leave the Missouri River at the close of the 2001 navigation season was the LESLIE B., with two empty asphalt barges on November 26, 2001.

Preliminary navigation commodity tonnage of 9.732 million total tons and 1.288 million commercial tons for 2001 was identified by the Waterborne Commerce Statistics Center (WCSC). The WCSC final data for the Missouri River are not normally available until nearly a year after the end of the season. The WCSC final estimate of commercial navigation tonnage on the Missouri River for 2000 was 1.344 million tons. This number does not include sand, gravel, and waterway materials. Principal commodities transported downstream were corn, wheat, sorghum, soybeans, oilseeds, and animal feeds. Major commodities moved upstream were fertilizer, cement, salt, molasses, petroleum products asphalt, iron, and steel. The WCSC final estimate of total tonnage indicates approximately 8.733 million tons were transported. Mining of the sand and gravel is usually within a few miles of the nearest loading facility.

The WCSC estimate for 2001 is 9.732 million tons of which 8.41 million tons was sand and gravel. The largest commercial tonnage season, excluding sand, gravel and waterway material, occurred in 1977 when 3.3 million tons were moved on the Missouri River. Tonnages of commodities shipped during 2000 and 2001 are shown in ***Table VII***.

A summary of tonnage by major commodities for 1960 through 2001 is displayed on the bar graphs shown on ***Figure 9***. The bottom graph shows the commercial commodity tonnage, excluding sand and gravel and waterway materials, while the top graph shows the total Missouri River tonnage. This includes sand and gravel moved on the river, plus waterway materials for navigation project construction and maintenance. Since the navigation project was completed, waterway materials moved have diminished, but the sand and gravel moved has increased greatly over the past years.

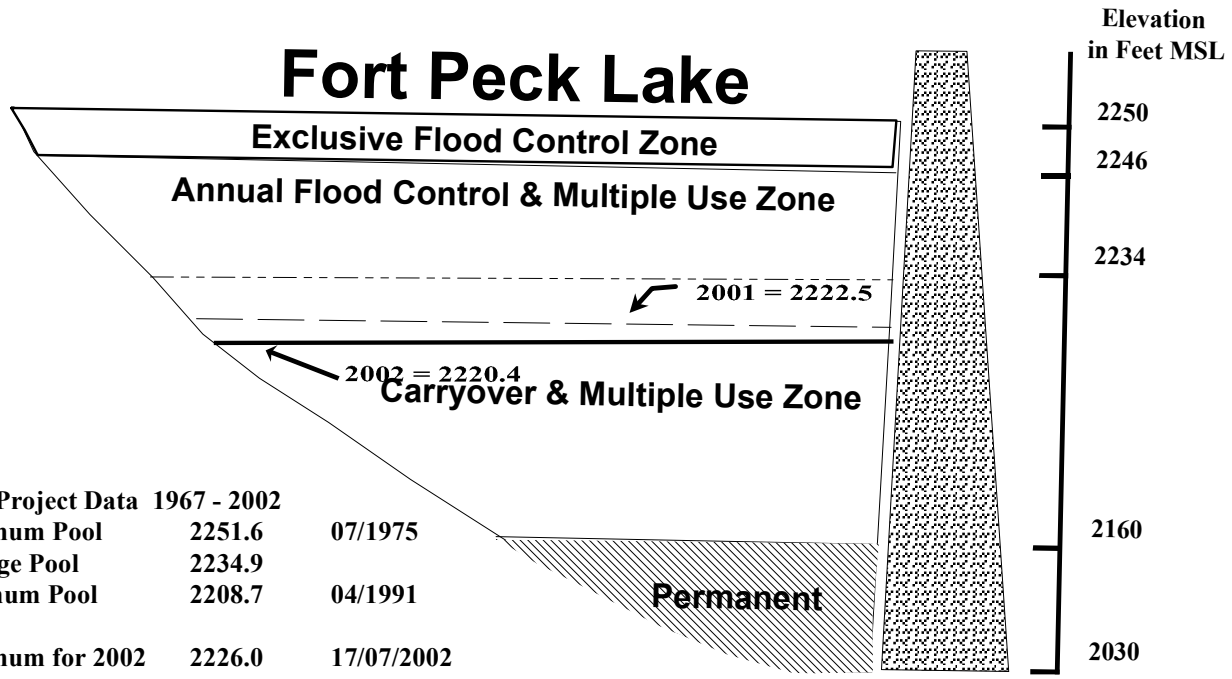
The official 2002 flow support for navigation began on the normal opening dates of March 23 at Sioux City, Iowa; March 25 at Omaha, Nebraska; March 28 at Kansas City, Missouri; and April 1 at the mouth near St. Louis, Missouri. Releases from Gavins Point were increased from 13,000 on March 17, 2002 to 24,500 cfs on March 21 to meet a Sioux City navigation target of 4,000 cfs less than full service, a reduction of 1,000 cfs from the previous season.

TABLE VII **TONNAGE BY COMMODITIES**
MISSOURI RIVER
(In Thousands of Tons)

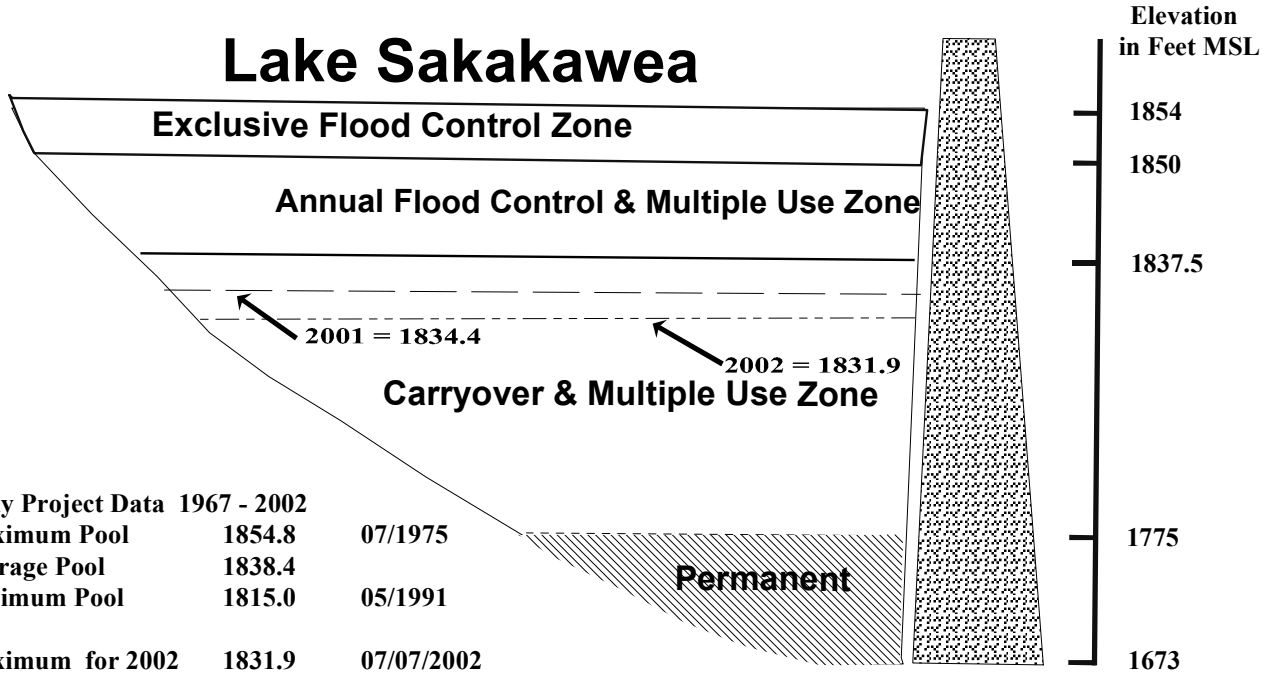
Commodity Classification Group	2000	2001
Grain (Wheat, Corn, Sorghum)	245	212
Other Food and Farm Products (including soybeans)	284	297
Fertilizers and Other Chemicals	289	333
Petroleum Products	256	217
Primary Manufactured Goods	233	199
Other	36	30
Commercial Subtotal	1,343	1,288
Sand and Gravel	7,225	8,410
Waterway Material	164	34
TOTAL	8,732	9,732

The first towboat to enter the Missouri River from the Mississippi River in 2002 was the OMAHA, which is owned by Blaske Marine Services. The towboat entered on March 25, 2002. Coincidentally the towboat JAMIE LEIGH began operation from its winter moorings at Jefferson City, Missouri, and was headed downstream on the same day. On April 1, the first official day of flow support for the 2002 navigation season at St. Louis, Missouri, five tows were operating on the river. The first tow to arrive in Sioux City was the OMAHA on April 7, 2002. A few short-term groundings and occasional bumpings occurred early in the season, as could be expected as the channel adjusted from the lower-than-normal winter release situation. The season progressed normally through the end of April. Releases were not increased to a steady release to be maintained through August during May. A steady release schedule had been followed in previous years in anticipation of higher release requirements to meet flow targets later in the summer. This type of operation minimized the need to move endangered species nests to higher elevations and potentially pick up chicks as release needs from Gavins Point and Fort Randall increased through the summer in a flow-to-target type of operation. The Corps felt that adequate habitat existed to preclude the steady release operation, and the additional water conservation measures provided by following target were warranted with respect to the expanded drought and overall dry basin conditions. Also, the Corps had met the fledge ratio requirements stated in the 2000 Biological Opinion for the endangered least tern and threatened piping plover in the previous 3 years. System storage peaked at 48.9 MAF on July 10, 2002, up ever so slightly from 48.8 MAF in January. The July 1 storage check indicated that navigation support should be reduced to 6,000 cfs less than full service, or minimum service support levels, as a water conservation measure. System storage dropped slowly to 48.2 MAF by August 1. The Kansas River projects of Tuttle Creek, Milford and Perry provided supplemental Missouri River navigation support for about 3 weeks beginning the first week in July.

Missouri River Main
End-of-July Lake Elevations and



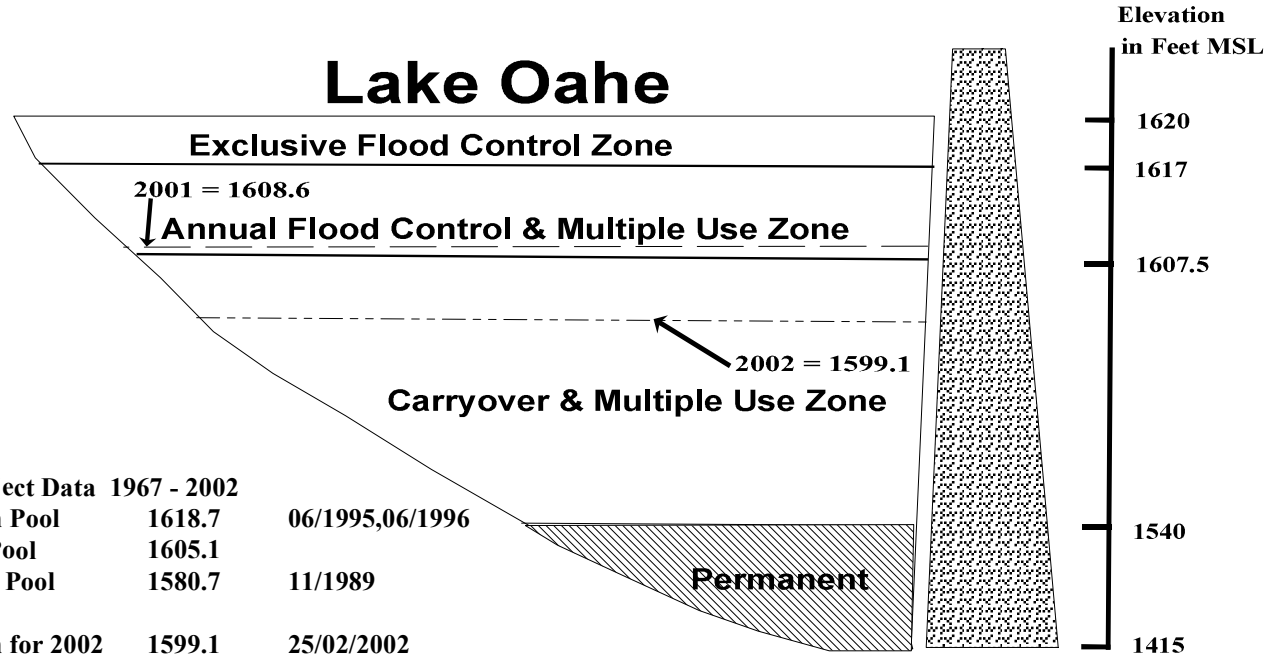
Daily Project Data 1967 - 2002		
Maximum Pool	2251.6	07/1975
Average Pool	2234.9	
Minimum Pool	2208.7	04/1991
Maximum for 2002	2226.0	17/07/2002



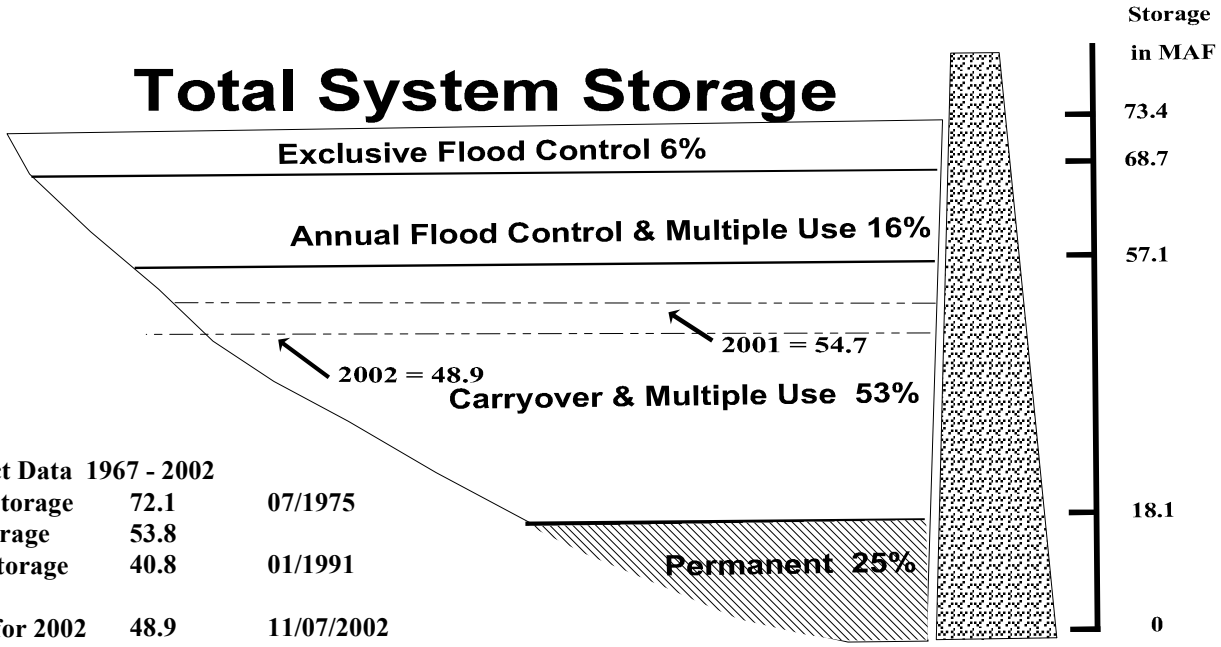
Daily Project Data 1967 - 2002		
Maximum Pool	1854.8	07/1975
Average Pool	1838.4	
Minimum Pool	1815.0	05/1991
Maximum for 2002	1831.9	07/07/2002

Figure 8 A

Stem Reservoirs
Total System Storage



Daily Project Data 1967 - 2002		
Maximum Pool	1618.7	06/1995,06/1996
Average Pool	1605.1	
Minimum Pool	1580.7	11/1989
Maximum for 2002	1599.1	25/02/2002



Daily Project Data 1967 - 2002		
Maximum Storage	72.1	07/1975
Average Storage	53.8	
Minimum Storage	40.8	01/1991
Maximum for 2002	48.9	11/07/2002

Figure 8 B

The Corps did not increase System releases to meet downstream minimum service flow targets from July 3, 2002 to August 14, 2002, the point in time that the endangered species left the river. This is discussed earlier in greater detail under non-routine operations in this document. Coincidentally, the tributary stream flow support in the lower river below the Platte River was nearly zero, because the area was experiencing a record drought. Navigation targets at both Nebraska City, Nebraska and Kansas City, Missouri were missed throughout this period. Flow support from the Kansas River was provided during June but was not provided during the July 3 to August 14 period. As a result of the below-minimum-service flows, towboats began leaving the river. Of the seven using the river, only one remained, the OMAHA. Some tows stayed off the river for as long as 45 days. On average, the six towboats were off the river for 23 days each. On September 1, 2002, the towing industry returned to minimum service operation. The towing industry reported losses of $2 million. An excursion vessel, the RIVER EXPLORER, operated by RiverBarge Excursions cancelled trips planned as far upstream as Sioux City, Iowa, as the river was too low to allow safe passage. Six hundred passengers and several sponsor communities were affected by the decision. River Barge Excursions reported $1 million in losses. The City of Sioux City estimates that it lost revenues of about $0.25 million, as a result of the excursion trip being cancelled to Sioux City. The OMAHA stayed on the river and grounded, damaging a soybean barge and losing the entire cargo when water flooded the barge.

Navigation progressed normally throughout the fall except for several areas below Kansas City, Missouri, where problems associated with the period of summer low flows persisted. The shoaling that developed continued long after flows were increased to adequate levels to support minimum service to navigation. The situation was eventually declared an emergency in early October and the Corps' Dredge Potter was called to perform dredging operations on the Missouri River at both RM 51 and RM 130 at a cost of $435,000. This alleviated the problem areas. Missouri River flow support from the Kansas reservoirs was again used in November 2002. The navigation season progressed to the normal conclusion, ending on 1 December at the mouth.

Navigation season target flows for past years are given in ***Table VIII***. System water in storage peaked at 48.9 MAF on July 10, 2002, 5.8 MAF lower than the previous year's peak and 13.4 MAF below the average peak storage for the period 1967-2001. Reduced service flows (4,000 cfs less than full service) were provided at all target locations until the July 1 Master Manual water-in-storage check, which required a further reduction in downstream flow support to minimum service (6,000 cfs less than full service). This service level was provided until the close of the 2002 navigation season on December 1 at the mouth except for the 6-week period during the endangered species nesting season previously discussed.

Table IX shows the scheduled lengths of past navigation seasons with total tonnage and ton-miles for each year. A full 8-month season was provided in 2002 but during the six week period from the first week in July through mid-August, flows were at less than minimum service due to endangered species nesting concerns as previously discussed in this report. The commercial tonnage figure for 2002 is a preliminary estimate and will likely change once final WCSC tabulations are available late in 2003. Missouri River commercial tonnage in 2002 is currently estimated to total about 1.4 million tons, based on estimates from daily reports of towboat activity.

Figure 10 presents discharge data at Sioux City, Iowa; Nebraska City, Nebraska; and Kansas City, Missouri for the August 2001 through July 2002 period. The three graphs demonstrate that actual flows at these locations are influenced considerably by System releases. Flows during the second half of the 2001 navigation season were at the 3,000 cfs less than full service level at all locations as a water conservation measure. The flows were relatively stable and correlated well with System releases. During the first half of the 2002 navigation season, releases were quite high due to no plains snowpack, but downstream tributaries provided enough support so that the flow target (4,000 cfs less than full service) remained at Sioux City. Flows below Gavins Point were not automatically increased early in May in anticipation of navigation requirement support in August but followed navigation target-flow requirements through the early summer period. Runoff continued to be poor as a low plains snowpack combined with below normal mountain snowpack and significantly below-normal rainfall both above and below the reservoirs to provide lower-decile-type runoff during 2002. This prompted a reduction in System water in storage that resulted in flow support dropping to minimum service on July 1 (6,000 cfs less than full service), based on the July 1 System water-in-storage check under the current Master Manual criteria.

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

The CY 2001 energy generated by basin hydropower units was transmitted over a Federal transmission system traversing 7,745 circuit miles. This past year, service was provided to 382 customers in a 6-state area. Those receiving direct service include 194 municipalities, 5 Federal agencies, 36 state agencies, 28 U.S. Bureau of Reclamation projects, 3 irrigation districts, 34 rural electric cooperatives, 7 public utility districts, 51 private utilities, 23 Native American Service Areas, 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 these numbers, the energy generated in CY 2001 by the portion of the Federal power system supplying energy in the Missouri River region could have supplied all of the yearly needs of 550,000 residential OPPD customers for a retail value of about $510 million.

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

Calendar Year 2001 generation was 61 percent of the average (second lowest) since the System first filled in 1967. Below-normal releases at all powerplants resulted in the below normal generation. Mainstem generation with individual project distribution for each calendar year since 1954 is shown on ***Figure 11***.

Total generation for the period August 2001 through July 2002 was 7.0 billion kWh, 70 percent of the 35-year average dating back to 1967. The gross generation from the Federal system (peak capacity and energy sales) for the August 2001 through July 2002 operating period is shown in ***Table X***. Energy production was below normal for August 2001 through July 2002 due to below normal runoff and reduced System releases. Record low winter 2001-2002 releases were made from the Fort Peck and Garrison powerplants to better balance intra-System storage.

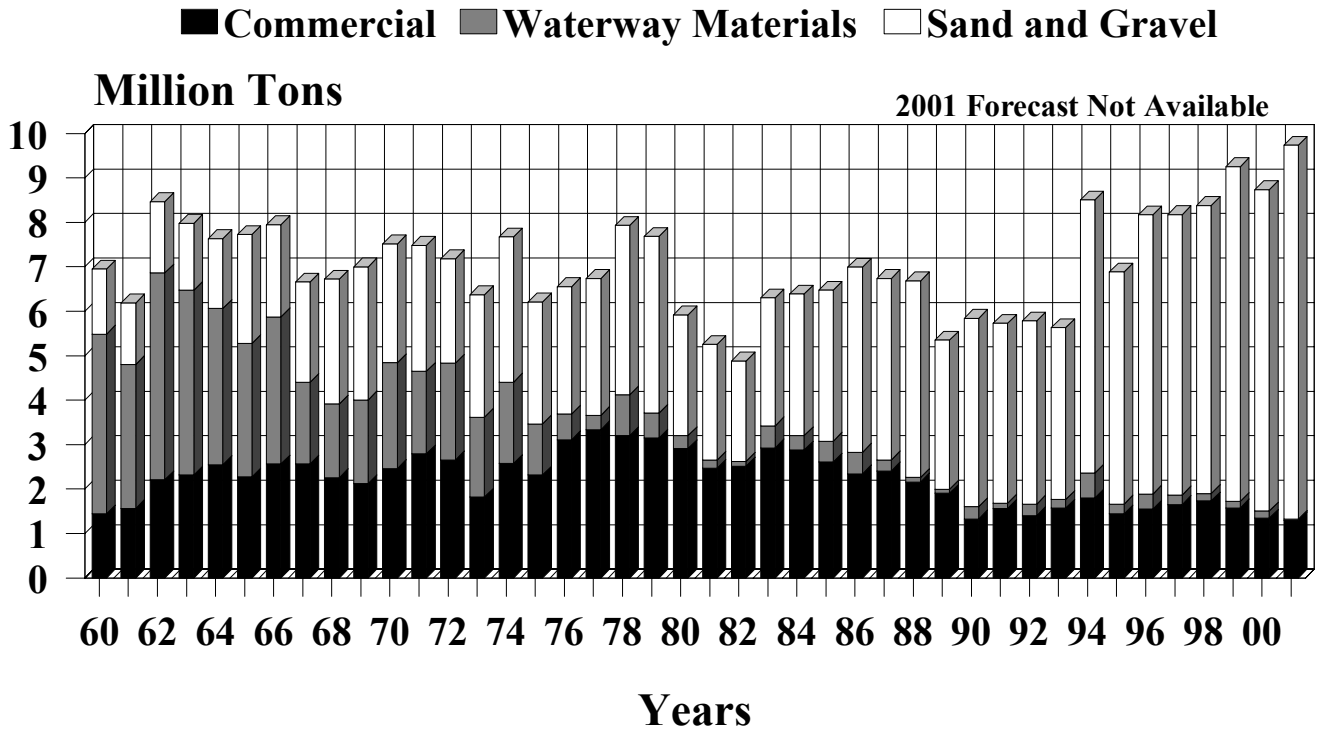
Generation was 1.3 billion kWh for the December through February (2001-2002) winter energy period, 57 percent of the past 35-year average. Western purchased about 1.5 billion kWh over the same period at a cost of $34.7 million to meet its power obligations that could not be met through mainstem hydropower production.

The tabulations in ***Tables XI*** and ***XII*** summarize the total gross generation and power operations 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.

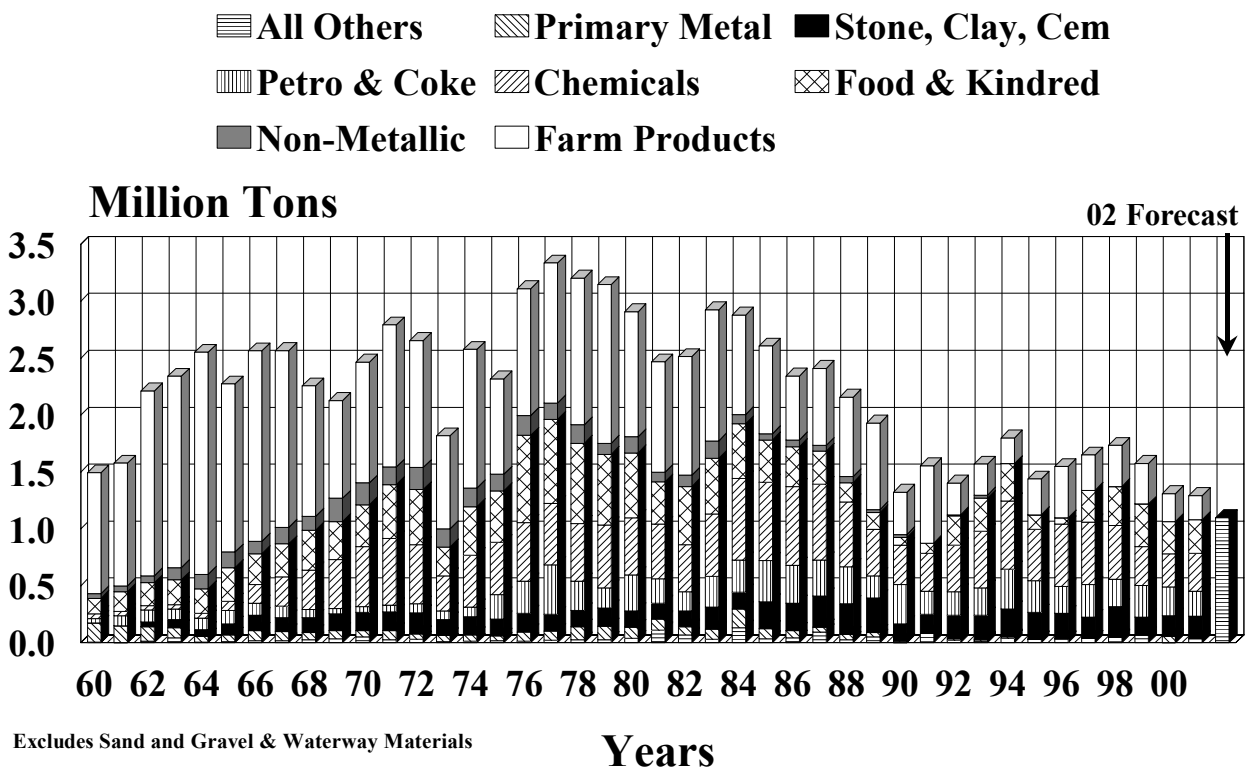
Energy production in 2002 totaled 7.5 billion kWh, only 75 percent of normal due to low System releases in response to the continued drought in the upper basin that has reduced generation at all System powerplants.

Missouri River

Total Navigation Tonnage



Commercial Navigation Tonnage



Excludes Sand and Gravel & Waterway Materials

Figure 9

TABLE VIII
NAVIGATION SEASON TARGET FLOWS
Target Flows, 1,000 cfs

Year	Months	Sioux City	Omaha	Nebraska City	Kansas City
1967	Apr-Jun	28.0	28.0	34.0	38.0
	Jul-Nov	31.0	31.0	37.0	41.0
1968	Apr-Nov	31.0	31.0	37.0	41.0
1969	Apr-Jun (1)	35.0-40.0	35.0-40.0	41.0-46.0	45.0-50.0
	Jul (1)	36.0	36.0	42.0	46.0
	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	31.0	31.0	37.0	41.0
	May-Sep (1)	36.0	36.0	42.0	46.0
	Oct-Nov (1)	40.0	40.0	46.0	50.0
1971	Apr-May (1)	36.0	36.0	42.0	46.0
	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	31.0	31.0	37.0	41.0
1975	Apr	31.0	31.0	37.0	41.0
	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	31.0	31.0	37.0	41.0
1978	Apr	31.0	31.0	37.0	41.0
	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	31.0	31.0	37.0	41.0
1981	Apr-Nov (2)	31.0	31.0	37.0	41.0
1982	Apr-Sep	31.0	31.0	37.0	41.0
	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	31.0	31.0	37.0	41.0
	Jul	31.0-36.0	31.0-36.0	37.0-42.0	41.0-46.0
	Aug-Nov (1)	36.0	36.0	42.0	46.0
1984	Apr-Jun	31.0	31.0	37.0	41.0
	Jul-Dec (1)	31.0-44.0	31.0-44.0	37.0-50.0	41.0-54.0
1985	Apr-Dec	31.0	31.0	37.0	41.0
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	31.0	31.0	37.0	41.0
1988	Apr-Nov (2)	31.0	31.0	37.0	41.0
1989	Apr-Aug (3)	28.0	28.0	34.0	38.0
	Sep-Oct (3)	28.0	28.0	34.0	35.0
1990-93	Apr-Oct (4)	25.0	25.0	31.0	35.0
1994	Apr-Dec	31.0	31.0	37.0	41.0
1995	Apr-May	31.0	31.0	37.0	41.0
	Jun-Dec (1)	46.0-56.0	46.0-56.0	52.0-62.0	56.0-66.0
1996	Apr (1)	41.0	41.0	47.0	51.0
	May (1)	41.0-51.0	41.0-51.0	47.0-57.0	51.0-61.0
	Jun-Dec (1)	56.0	56.0	62.0	66.0
1997	Apr - Dec (5)	*	*	*	*
1998	Apr - Dec	31.0	31.0	37.0	41.0
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

(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 criteria and not adjusted to meet specific navigation targets.

TABLE IX
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) (1)
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	
1992	6-3/4	1,403,000	5,783,000	
1993	8 (8)	1,570,000	5,631,000	615,541
1994	8	1,800,000	8,501,000	774,491
1995	8 (4) (8)	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) (8)	1,576,000	9,252,000	
2000	8	1,344,000	8,733,000	
2001	8	1,288,000 (9)	9,732,000 (9)	
2002	8	1,100,000 (9)		

(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) Main stem reservoir system 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) Preliminary estimate.

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

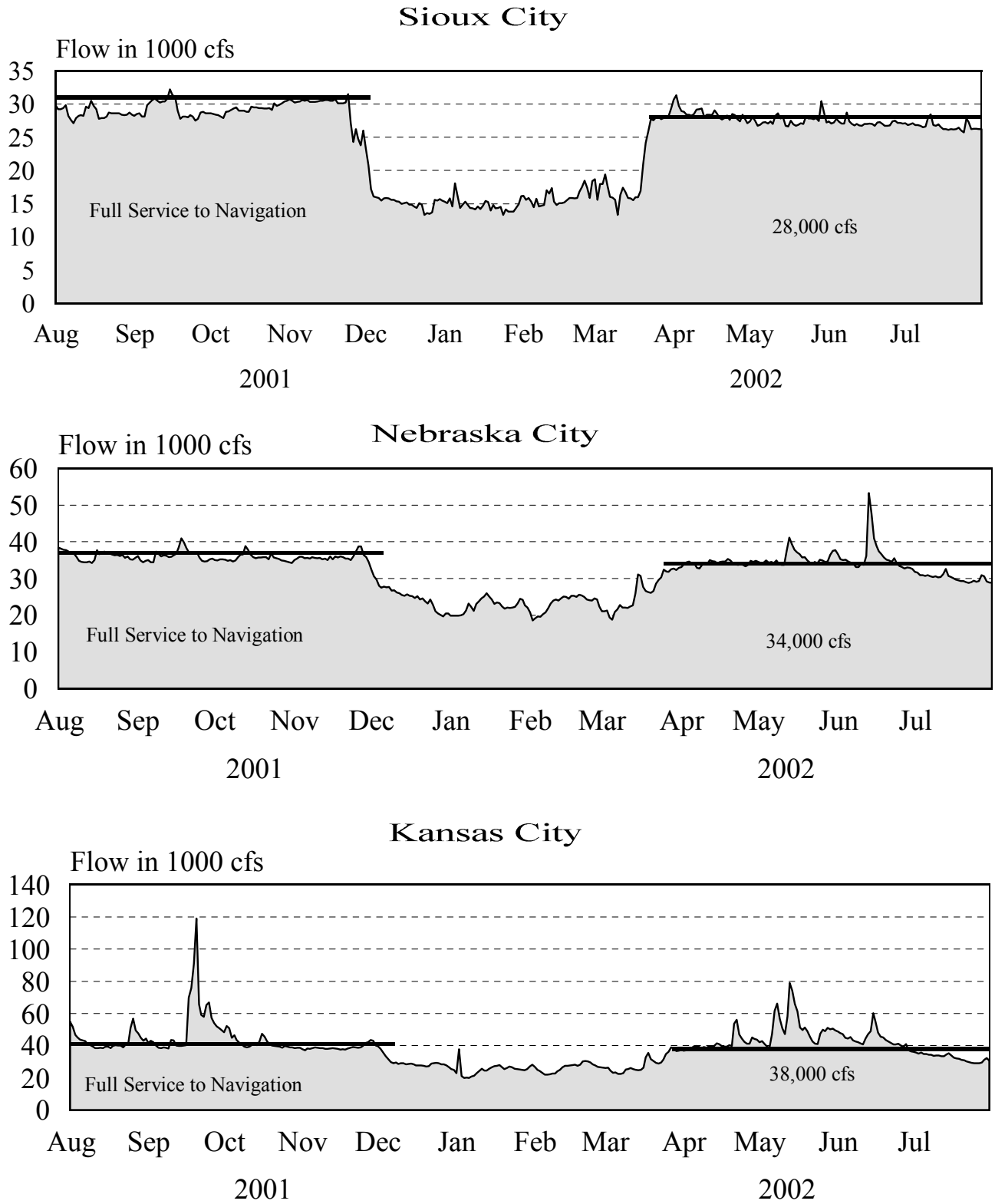


Figure 10

TABLE X GROSS FEDERAL POWER SYSTEM GENERATION
(January 2002 through December 2002)

	Energy Generation 1,000 kWh	Peak Hour kW	Generation Date
Corps Power Plants - Mainstem			
Fort Peck	755,775	151,000	12/21/2002
Garrison	1,609,022	360,000	08/29/2002
Oahe	2,060,901	630,000	04/08/2002
Big Bend	829,884	477,000	09/11/2002
Fort Randall	1,500,102	355,000	09/02/2002
Gavins Point	711,116	114,000	09/29/2002
Corps Subtotal	7,466,800	2,087,000	
USBR Powerplants			
Canyon Ferry	252,205	53,000	11/2002
Yellowtail*	506,410	89,000	2/2002
USBR Subtotal	758,615		
Federal System Total	8,225,415		

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

Main Stem Power Generation
1954 - 2002

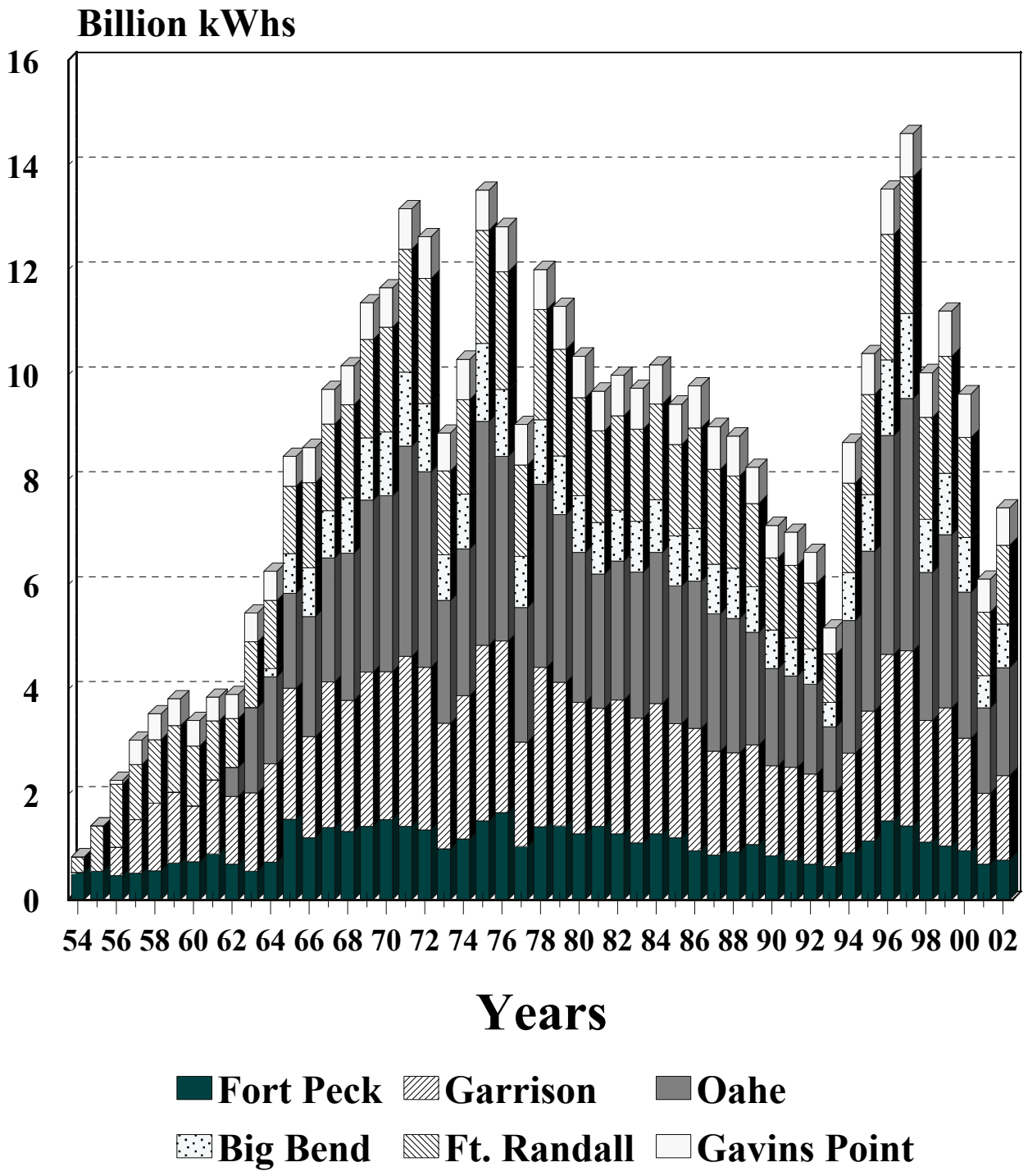


Figure 11

6. Fish Management

Rainbow smelt are the primary forage species in both Garrison and Oahe. Successful rainbow smelt reproduction is highly dependent on stable reservoir levels. 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. Rainbow smelt spawning was again very good in Garrison during the spring of 2002. The smelt hatch was the second highest on record; however, early indications are that survival of young-of-the-year smelt was poor. Early indications are that walleye spawning was only fair. Both numbers and size structure of the walleye population continue to be in good shape as of the summer of 2002. Salmon fishing was excellent during 2002.

Rainbow smelt and yellow perch had the best reproduction in Oahe since 1997. Hydroacoustic surveys revealed, however, that recruitment of smelt to the juvenile life stage was low in 2002.

7. Endangered and Threatened Species

This is the 17th year of operation since the interior least tern and piping plover were Federally listed as endangered and threatened species, respectively. Both the least tern and piping plover nest on sparsely vegetated sandbars, islands, and shoreline on the Missouri River. Stream gages have been installed on the Missouri River to monitor stream 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 closely predict maximum river stages along the river for different combinations of daily discharge and hourly power peaking characteristics.

Beginning in 1999, the Omaha District created a computerized Threatened and Endangered 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 2002 nesting season and proved to be a valuable tool in aiding release decisions benefiting endangered and threatened birds.

Although the Corps prevented inundation of nests following the listing, where possible, and accomplished habitat creation, fledging 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, recent 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 fledge ratios achieved since then can be attributed to the large amount of habitat created by the high flows of 1997. The creation of additional habitat has also allowed greater flexibility in the release levels at the lower two System projects.

TABLE XI

HISTORICAL GENERATION AND LOAD DATA
EASTERN DIVISION, PICK-SLOAN MISSOURI BASIN PROGRAM*
Data at plant - 1,000 kW
January 1, 2002 through December 31, 2002

Period	Corps of Engineers Peak Hour Generation (Gross)	(plus)	USBR Hourly Generation (Gross)	(equals)	Federal Peak Hour Generation (Gross)	(plus)	Interchange and Purchases Received**	(equals)	Total System Load**
January	1,357		33		1,390		1263		2,653
February	1,239		34		1,273		893		2,166
March	1,406		33		1,439		781		2,220
April	1,443		34		1,477		607		2,084
May	1,808		17		1,825		730		2,555
June	1,867		17		1,884		634		2,518
July	1,848		33		1,881		666		2,547
August	1,875		33		1,908		582		2,490
September	1,819		33		1,852		472		2,324
October	1,438		34		1,472		514		1,986
November	1,572		35		1,607		764		2,371
December	1,437		34		1,471		868		2,339

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

TABLE XII

HISTORICAL GENERATION AND LOAD DATA
EASTERN DIVISION, PICK-SLOAN MISSOURI BASIN PROGRAM*
Data at plant - 1,000 kWh
January 1, 2002 through December 31, 2002

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	425,731		36,000		461,731		519,000		980,731
February	380,686		35,000		415,686		508,000		923,686
March	503,906		34,000		537,906		382,000		919,906
April	556,027		31,000		587,027		312,000		899,027
May	561,662		34,000		595,662		271,000		866,662
June	834,066		34,000		868,066		138,000		1,006,066
July	828,316		38,000		866,316		222,000		1,088,316
August	861,032		38,000		899,032		222,000		1,121,032
September	745,607		32,000		777,607		217,000		994,607
October	613,980		31,000		644,980		232,000		876,980
November	643,326		35,000		678,326		260,000		938,326
December	512,461		39,000		551,461		415,000		966,461

*Powerplants from Table XV

For 2002, the majority of piping plovers were found on Garrison, below Gavins Point, and on Oahe. Excellent shoreline habitat existed due to the lower reservoir levels caused by the reduced runoff. A record number of piping plover adults, 1134, were found on the Missouri River System this year yielding the highest fledge ratio and the highest number of chicks ever fledged on the System (46 percent increase over 2001 numbers). That, combined with the 731 adult terns, was also the highest total number of adult birds since System operations for the birds began in 1986. The majority of least terns were found on the Missouri River reaches below Garrison and Gavins Point and on Oahe. Tern nesting also was very successful. The fledge ratio for naturally raised terns was 1.27 fledglings per pair and for plovers the ratio was 1.89 fledglings per pair. The fourth highest fledge ratio and the second highest number of tern chicks fledged were obtained in 2002. This represents a 36 percent increase over 2001 numbers. The fledge ratio for both species exceeded the goals suggested by the U.S. Fish and Wildlife Service in its 1990 Biological Opinion.

Table XIII shows the population distribution and productivity for terns and plovers for 1990 through 2002. Productivity estimates for these birds on the Missouri River in 2002 include only natural nesting. Adult birds in this table are considered breeders even though they may not have had nesting success. The term "fledglings/pair" means the number of young birds produced per breeding pair. This ratio is an estimate, as the fate of every single fledgling is impossible to obtain.

8. Recreation and Resource Management

The Missouri River 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 mainstem. During 2002, public use at these lakes totaled 41,590,500 visitor hours, a 30.3 percent decrease from 2001. The decrease in visitation is directly related to the land transfer and Title VI in South Dakota. Effective April 2002, the Corps' Omaha District received word from Corps Headquarters in Washington, DC that visitation in the recreation areas turned over in fee title would not be counted, and the projects complied with the request. Visitor attendance figures at the lake projects for 2000, 2001, and 2002 are shown in ***Table XIV***. ***Figure 12*** displays recreation related visitor hours at each of the six projects for the years 1954 through 2002. 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 those on the Missouri River mainstem, are now reporting visitation using the Visitation Estimation Reporting System (VERS).

TABLE XIV VISITATION AT SYSTEM RESERVOIRS IN VISITOR HOURS

Mainstem Project	2000	2001	2002	Percent Change 2001-2002
Fort Peck	5,946,100	6,206,400	5,183,100	-16.4
Garrison	16,555,900	15,318,200	17,294,900	+12.9
Oahe	14,623,200	14,308,300	NA*	
Big Bend	5,261,800	5,057,400	NA*	
Fort Randall	9,752,300	10,128,400	NA*	
Gavins Point	8,756,400	8,647,200	NA*	
System Total	60,895,700	59,665,900		

- * The 2002 visitation data for the South Dakota reservoirs is incomplete due to the transfer of many of the recreation areas to the State of South Dakota.

Beginning in January 2003 and running through 2006, the nation will commemorate the 200th anniversary of the Lewis and Clark Expedition. A significant increase in visitation is expected at points of interest along the entire route taken by the Captains and the expedition members. Because the Corps has management responsibilities on more of the route than any other entity (90%) and because of its Army heritage of exploring and mapping the western United States, the Corps will play a key leadership role in the observance of the Lewis and Clark Expedition Bicentennial. The Corps is working with other Federal, Tribal, State, and local governments; the National Bicentennial Council, and the Lewis and Clark Trial Heritage Foundation to ensure that adequate facilities and information are available to accommodate the increased visitation, to ensure a safe visitor experience, to protect the natural and cultural resources, and to plan and coordinate commemorative activities.

Table XIII
Missouri River Main Stem
Least Tern and Piping Plover Survey Data

	Interior Least Tern													Piping Plover												
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Fort Peck Lake																										
Adults	6	10	0	7	9	2	0	0	4	0	0	0	0	22	25	26	30	4	5	0	0	4	2	0	4	2
Fledglings/Pair	0	0.40	0	0	0.44	0	0	0	0	0	0	0	0	3.18	1.20	1.00	0.60	1.50	1.20	0	0	0	2.00	0	1	2
Fort Peck to Lake Sakakawea																										
Adults	92	66	110	31	58	95	128	162	25	40	13	39	34	17	13	0	4	9	20	24	23	4	5	4	3	2
Fledglings/Pair	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	0	0	0	0	3.50	1.00	0.87	1.00	0	0	1.33	0
Lake Sakakawea																										
Adults	6	8	29	17	35	7	27	2	23	9	10	34	21	132	150	108	8	45	24	70	3	119	83	277	424	469
Fledglings/Pair	0	0	0.83	0.12	0	0	0.15	0	1.04	0.67	0.20	0.76	0.86	0	0	1.50	8.50	1.24	0	0.57	0.67	1.24	1.25	1.61	1.25	1.65
Garrison to Lake Oahe																										
Adults	174	195	198	145	217	284	105	41	141	105	105	125	126	71	124	77	127	119	261	45	6	74	139	99	149	119
Fledglings/Pair	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	1.04	1.13	1.06	0.54	0.87	0.87	0.09	0	1.84	0.88	1.41	1.53	2.03
Lake Oahe																										
Adults	100	143	124	125	160	84	74	101	110	57	85	94	106	88	87	143	66	85	30	21	31	98	46	141	184	203
Fledglings/Pair	0	0	0.42	0	0.06	0	0.24	0.16	1.29	0.88	1.01	1.34	1.32	0	0	0.97	0.33	0.09	0.93	0.29	1.29	1.06	0.30	1.45	1.41	2.16
Ft. Randall to Niobrara																										
Adults	26	32	13	38	43	10	2	0	64	124	72	71	84	12	25	8	12	17	0	3	0	33	51	62	38	35
Fledglings/Pair	0.31	0.63	0.46	0	0	0	0	0	0.94	1.03	1.26	0.14	0.71	0.67	0.48	0.75	0	0	0	0	0	1.27	1.02	0.87	0.74	1.03
Lake Lewis and Clark																										
Adults	63	55	29	76	44	16	28	60	120	76	44	58	46	30	33	6	32	12	4	6	32	84	67	28	34	44
Fledglings/Pair	0.35	0	1.59	0.97	0	0	0	1.57	2.33	0.21	0.38	1.17	1.04	0.67	0	0	0.06	0.33	0	0	1.25	2.45	0.30	0.5	0.71	1.68
Gavins Point to Ponca																										
Adults	167	193	187	272	211	93	82	115	148	161	149	232	314	148	166	112	109	62	63	22	22	49	141	186	218	260
Fledglings/Pair	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	0.39	0.35	0.34	1.06	0.61	0.16	0	0	2.20	1.60	2.17	1.85	2.29
Total Adults	634	702	690	711	777	591	446	481	635	572	551	653	731	521	623	480	388	353	407	191	117	465	534	797	1054	1134
Fledglings/Pair	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	0.76	0.62	0.94	0.76	0.61	0.84	0.39	0.87	1.61	1.01	1.58	1.41	1.91

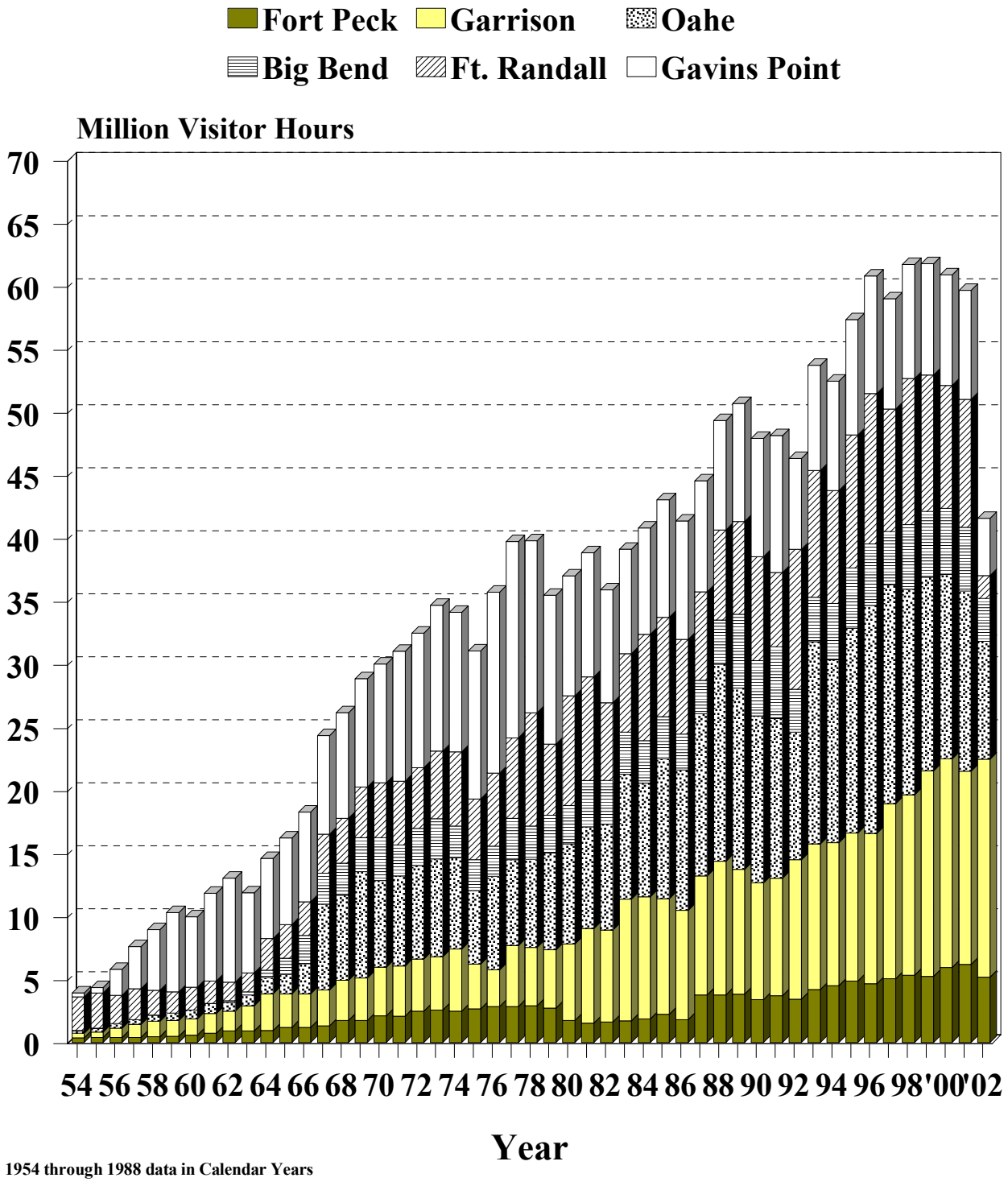
Ten Year Interior Least Tern Fledge Ratio Goal = 0.70

Fifteen Year Piping Plover Fledge Ratio Goal = 1.13

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

The data does not include least terns and piping plovers raised in captivity. The data represents only wild fledged birds.

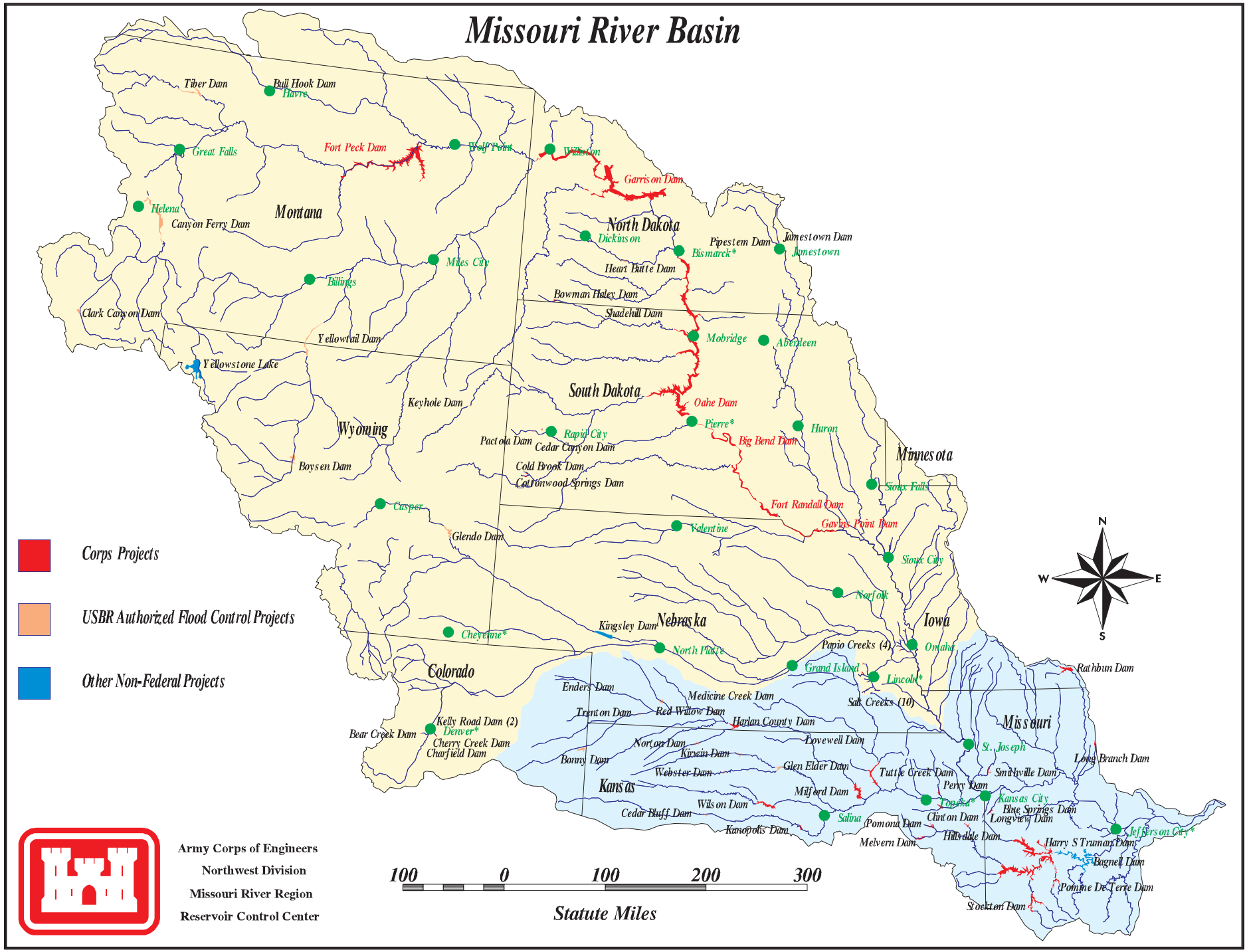
Missouri River Main Stem
Project Visitor Hours
1954 to 2002



1954 through 1988 data in Calendar Years
1989 to 1991 in Fiscal Years
1992 to present in VERS System.

Figure 12

Missouri River Basin



Army Corps of Engineers
Northwest Division
Missouri River Region
Reservoir Control Center

Plate 1

Summary of Engineering Data -- Missouri River Main Stem Reservoirs

Item No.	Subject	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
	Dam and Embankment			
10	Top of dam, elevation in feet msl	2280.5	1875	1660
11	Length of dam in feet	21,026 (excluding spillway)	11,300 (including spillway)	9,300 (excluding spillway)
12	Damming height in feet (5)	220	180	200
13	Maximum height in feet (5)	250.5	210	245
14	Max. base width, total & w/o berms in feet	3500, 2700	3400, 2050	3500, 1500
15	Abutment formations (under dam & embankment)	Bearpaw shale and glacial fill	Fort Union clay shale	Pierre shale
16	Type of fill	Hydraulic & rolled earth fill	Rolled earth filled	Rolled earth fill & shale berms
17	Fill quantity, cubic yards	125,628,000	66,500,000	55,000,000 & 37,000,000
18	Volume of concrete, cubic yards	1,200,000	1,500,000	1,045,000
19	Date of closure	24 June 1937	15 April 1953	3 August 1958
	Spillway Data			
20	Location	Right bank - remote	Left bank - adjacent	Right bank - remote
21	Crest elevation in feet msl	2225	1825	1596.5
22	Width (including piers) in feet	820 gated	1336 gated	456 gated
23	No., size and type of gates	16 - 40' x 25' vertical lift gates	28 - 40' x 29' Tainter	8 - 50' x 23.5' Tainter
24	Design discharge capacity, cfs	275,000 at elev 2253.3	827,000 at elev 1858.5	304,000 at elev 1644.4
25	Discharge capacity at maximum operating pool in cfs	230,000	660,000	80,000
	Reservoir Data (6)			
26	Max. operating pool elev. & area	2250 msl 246,000 acres	1854 msl 380,000 acres	1620 msl 374,000 acres
27	Max. normal op. pool elev. & area	2246 msl 240,000 acres	1850 msl 364,000 acres	1617 msl 360,000 acres
28	Base flood control elev & area	2234 msl 212,000 acres	1837.5 msl 307,000 acres	1607.5 msl 312,000 acres
29	Min. operating pool elev. & area	2160 msl 90,000 acres	1775 msl 128,000 acres	1540 msl 117,000 acres
	Storage allocation & capacity			
30	Exclusive flood control	2250-2246 975,000 a.f.	1854-1850 1,489,000 a.f.	1620-1617 1,102,000 a.f.
31	Flood control & multiple use	2246-2234 2,717,000 a.f.	1850-1837.5 4,222,000 a.f.	1617-1607.5 3,201,000 a.f.
32	Carryover multiple use	2234-2160 10,785,000 a.f.	1837.5-1775 13,130,000 a.f.	1607.5-1540 13,461,000 a.f.
33	Permanent	2160-2030 4,211,000 a.f.	1775-1673 4,980,000 a.f.	1540-1415 5,373,000 a.f.
34	Gross	2250-2030 18,688,000 a.f.	1854-1673 23,821,000 a.f.	1620-1415 23,137,000 a.f.
35	Reservoir filling initiated	November 1937	December 1953	August 1958
36	Initially reached min. operating pool	27 May 1942	7 August 1955	3 April 1962
37	Estimated annual sediment inflow	18,100 a.f. 1030 yrs.	25,900 a.f. 920 yrs.	19,800 a.f. 1170 yrs.
	Outlet Works Data			
38	Location	Right bank	Right Bank	Right Bank
39	Number and size of conduits	2 - 24' 8" diameter (nos. 3 & 4)	1 - 26' dia. and 2 - 22' dia.	6 - 19.75' dia. upstream, 18.25' dia. downstream
40	Length of conduits in feet (8)	No. 3 - 6,615, No. 4 - 7,240	1529	3496 to 3659
41	No., size, and type of service gates	1 - 28' dia. cylindrical gate 6 ports, 7.6' x 8.5' high (net opening) in each control shaft	1 - 18' x 24.5' Tainter gate per conduit for fine regulation	1 - 13' x 22' per conduit, vertical lift, 4 cable suspension and 2 hydraulic suspension (fine regulation)
42	Entrance invert elevation (msl)	2095	1672	1425
43	Avg. discharge capacity per conduit & total	Elev. 2250 22,500 cfs - 45,000 cfs	Elev. 1854 30,400 cfs - 98,000 cfs	Elev. 1620 18,500 cfs - 111,000 cfs
44	Present tailwater elevation (ft msl)	2032-2036 5,000 - 35,000 cfs	1670-1680 15,000- 60,000 cfs	1423-1428 20,000-55,000 cfs
	Power Facilities and Data			
45	Avg. gross head available in feet (14)	194	161	174
46	Number and size of conduits	No. 1-24'8" dia., No. 2-22'4" dia.	5 - 29' dia., 25' penstocks	7 - 24' dia., imbedded penstocks
47	Length of conduits in feet (8)	No. 1 - 5,653, No. 2 - 6,355	1829	From 3,280 to 4,005
48	Surge tanks	PH#1: 3-40' dia., PH#2: 2-65' dia.	65' dia. - 2 per penstock	70' dia., 2 per penstock
49	No., type and speed of turbines	5 Francis, PH#1-2: 128.5 rpm, 1-164 rpm , PH#2-2: 128.6 rpm	5 Francis, 90 rpm	7 Francis, 100 rpm
50	Discharge cap. at rated head in cfs	PH#1, units 1&3 170', 2-140' 8,800 cfs, PH#2-4&5 170'-7,200 cfs	150' 41,000 cfs	185' 54,000 cfs
51	Generator nameplate rating in kW	1&3: 43,500; 2: 18,250; 4&5: 40,000	3 - 109,250, 2 - 95,000	112,290
52	Plant capacity in kW	185,250	517,750	786,030
53	Dependable capacity in kW (9)	181,000	388,000	534,000
54	Avg. annual energy, million kWh (12)	1,163	2,472	2,908
55	Initial generation, first and last unit	July 1943 - June 1961	January 1956 - October 1960	April 1962 - June 1963
56	Estimated cost September 1996 completed project (13)	$158,428,000	$299,938,000	$346,521,000

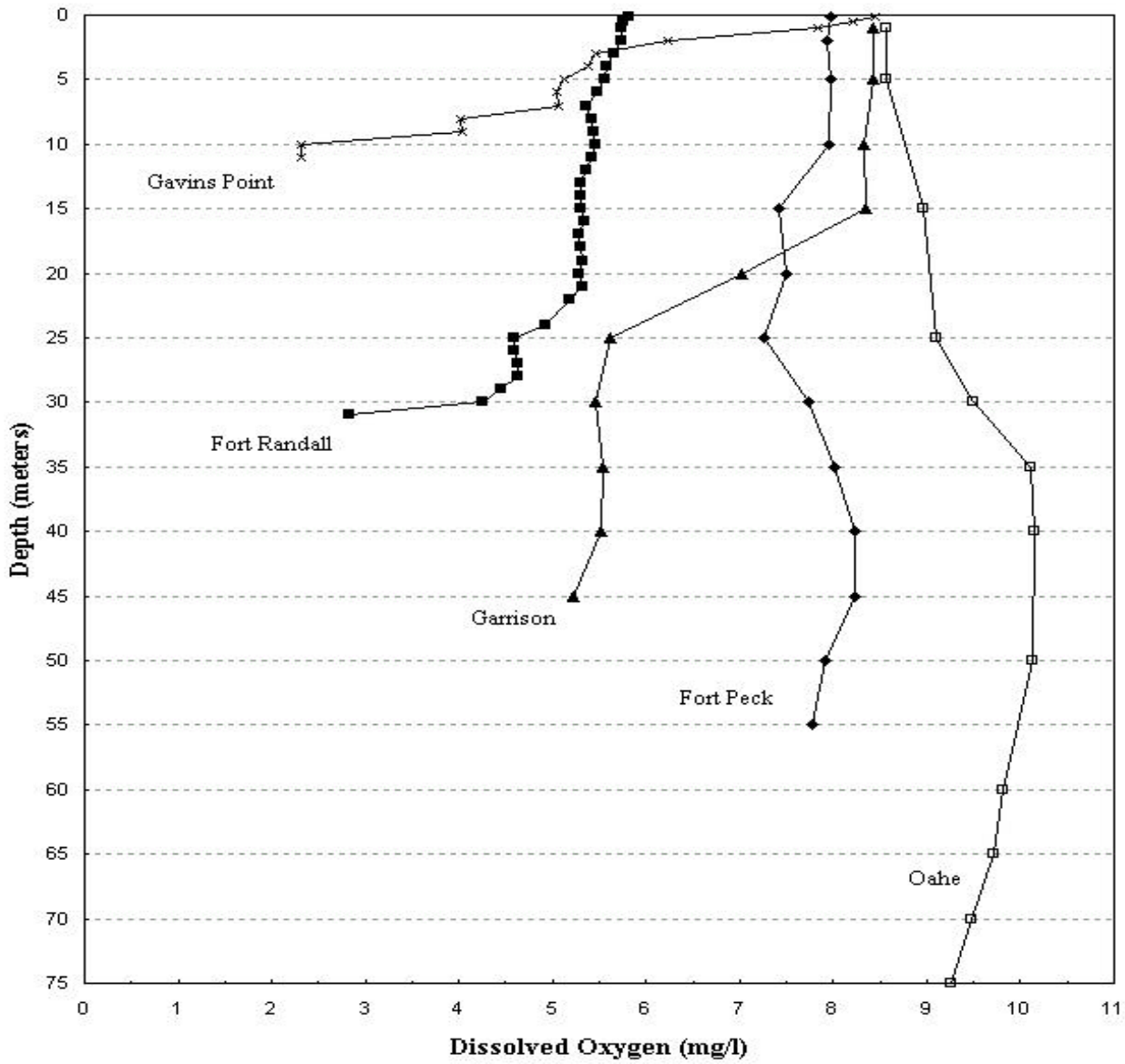
Summary of Engineering Data -- Missouri River Main Stem Reservoirs

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 31,000 acres	1,194,000 acres	26
1422 msl 60,000 acres	1365 msl 95,000 acres	1208 msl 28,000 acres	1,147,000 acres	27
1420 msl 57,000 acres	1350 msl 77,000 acres	1204.5 msl 24,000 acres	989,000 acres	28
1415 msl 51,000 acres	1320 msl 38,000 acres	1204.5 msl 24,000 acres	450,000 acres	29
1423-1422 60,000 a.f.	1375-1365 985,000 a.f.	1210-1208 59,000 a.f.	4,670,000 a.f.	30
1422-1420 117,000 a.f.	1365-1350 1,309,000 a.f.	1208-1204.5 90,000 a.f.	11,656,000 a.f.	31
	1350-1320 1,607,000 a.f.		38,983,000 a.f.	32
1420-1345 1,682,000 a.f.	1320-1240 1,517,000 a.f.	1204.5-1160 321,000 a.f.	18,084,000 a.f.	33
1423-1345 1,859,000 a.f.	1375-1240 5,418,000 a.f.	1210-1160 470,000 a.f.	73,393,000 a.f.	34
November 1963	January 1953	August 1955		35
25 March 1964	24 November 1953	22 December 1955		36
4,300 a.f. 430 yrs.	18,300 a.f. 250 yrs.	2,600 a.f. 180 yrs.	92,500 a.f.	37
	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
1351-1355(10) 25,000-100,000 cfs	32,000 cfs - 128,000 cfs 1228-1239 5,000-60,000 cfs	1155-1163 15,000-60,000 cfs		44
70	117	48	764 feet	45
None: direct intake	8 - 28' dia., 22' penstocks	None: direct intake		46
	1,074		55,083	47
None	59' dia, 2 per alternate penstock	None		48
8 Fixed blade, 81.8 rpm	8 Francis, 85.7 rpm	3 Kaplan, 75 rpm	36 units	49
67' 103,000 cfs	112' 44,500 cfs	48' 36,000 cfs		50
3 - 67,276, 5 - 58,500	40,000	44,100		51
494,320	320,000	132,300	2,435,650 kw	52
497,000	293,000	74,000	1,967,000 kw	53
1,055	1,861	756	10,215 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	$1,161,068,000	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) 1967-1999 Average
(13) Source: Annual Report on Civil Works Activities of the Corps of Engineers. Extract Report Fiscal Year 1996.
(14) Based on Study 8-83-1985

Corps of Engineers, U.S. Army
Compiled by
Northwestern Division
Missouri River Region
May 2000



Dissolved oxygen depth profiles measured at the main stem projects by the Omaha District during 2001 that reflect the most oxygen depletion.