1997 Floods in the Red River of the North and Missouri River Basins in North Dakota and Western Minnesota

INTRODUCTION

Record floods devastated many communities along rivers and streams in the Red River of the North (Red River) and Missouri River Basins in North Dakota and western Minnesota during the spring of 1997. Record snowfall over much of the region during the winter of 1996-97 along with added precipitation from a late-spring blizzard on April 5-6, 1997, caused the worst flooding in several areas in more than 100 years. Thousands of people were forced to flee their homes, some permanently, as floodwaters and severe weather caused nearly 2 billion dollars in damages to the region.

Little Missouri River, western North Dakota.

The U.S. Geological Survey (USGS), one of the principal Federal agencies responsible for the collection and interpretation of water-resources data, works with other Federal, State, and local agencies to ensure that accurate and timely data are available for making decisions regarding the public's welfare (a listing of cooperators in the Red River Basin is given on page 8). This report presents preliminary water-resources data on the 1997 floods that were obtained from selected streamflow-gaging stations located in the Red River and Missouri River Basins (fig. 1).

WINTER OF 1996-97

The winter of 1996-97 was one of the most brutal on record for the upper Great Plains. Record snowfalls were recorded throughout North Dakota and western Minnesota, creating conditions conducive to major flooding. The heaviest snowfalls occurred along the main stems of the Red River and the Missouri River and were about 300 percent of normal, which is about 35 to 40 inches (in.) during a typical year (fig. 2). In the winter of 1996-97, Fargo, N. Dak., and Moorhead, Minn., located on the Red River, reported about 117 in. of snowfall, and Grand Forks, N. Dak., and East Grand Forks, Minn., also located on the Red River, reported more than 98 in. of snowfall. In south-central North Dakota, Bismarck, located on the Missouri River, reported about 101 in. of snowfall. Elsewhere in the region, snowfalls were well above the seasonal averages (fig. 3).

In the spring, snowmelt and warm temperatures generally begin in southwestern and western North Dakota and move northeast across the State into Minnesota. In the winter of 1996-97, melting of the snowpack and thawing of the ice began in late March on rivers and streams in the region but were inhibited by a late-spring blizzard that occurred on April 5-6, 1997. This blizzard brought a severe drop in temperatures, winds up to 70 miles per hour (mi/h), and up to 2 feet (ft) of snow with drifts many feet higher in several areas. In southeastern North Dakota and southwestern Minnesota, the blizzard was preceded by wind-driven rain and sleet. The wind and ice toppled trees and power lines, leaving thousands of people without power for days. Loss of power also inhibited the ability of the USGS to collect and transmit data from several streamflow-gaging stations in the region. The additional moisture brought by the blizzard added to the increasing streamflows (flows) in the Red River and Missouri River Basins.

FLOODS OF 1997

Flooding in North Dakota and western Minnesota usually is caused by spring snowmelt, and the severity of the flooding is affected by (1) substantial precipitation in the fall that produces high levels of soil moisture, (2) above-normal snowfall in the winter, (3)

Aerial view of East Grand Forks, Minn.
Photograph by North Dakota State Water Commission.

Sorlie Bridge, Grand Forks, N. Dak.

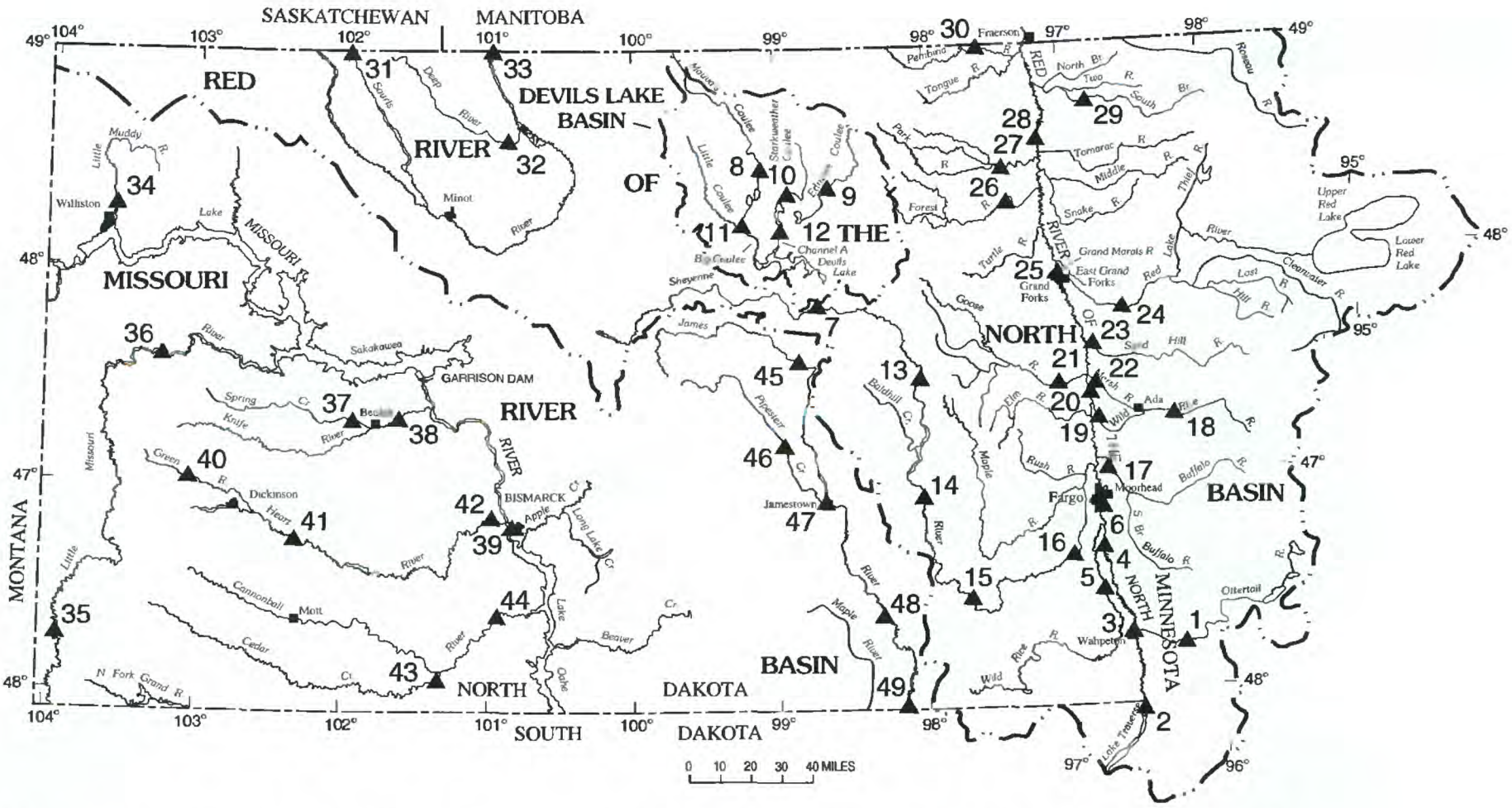

Figure 1. Locations of selected streamflow-gaging stations in the Red River of the North and Missouri River Basins.

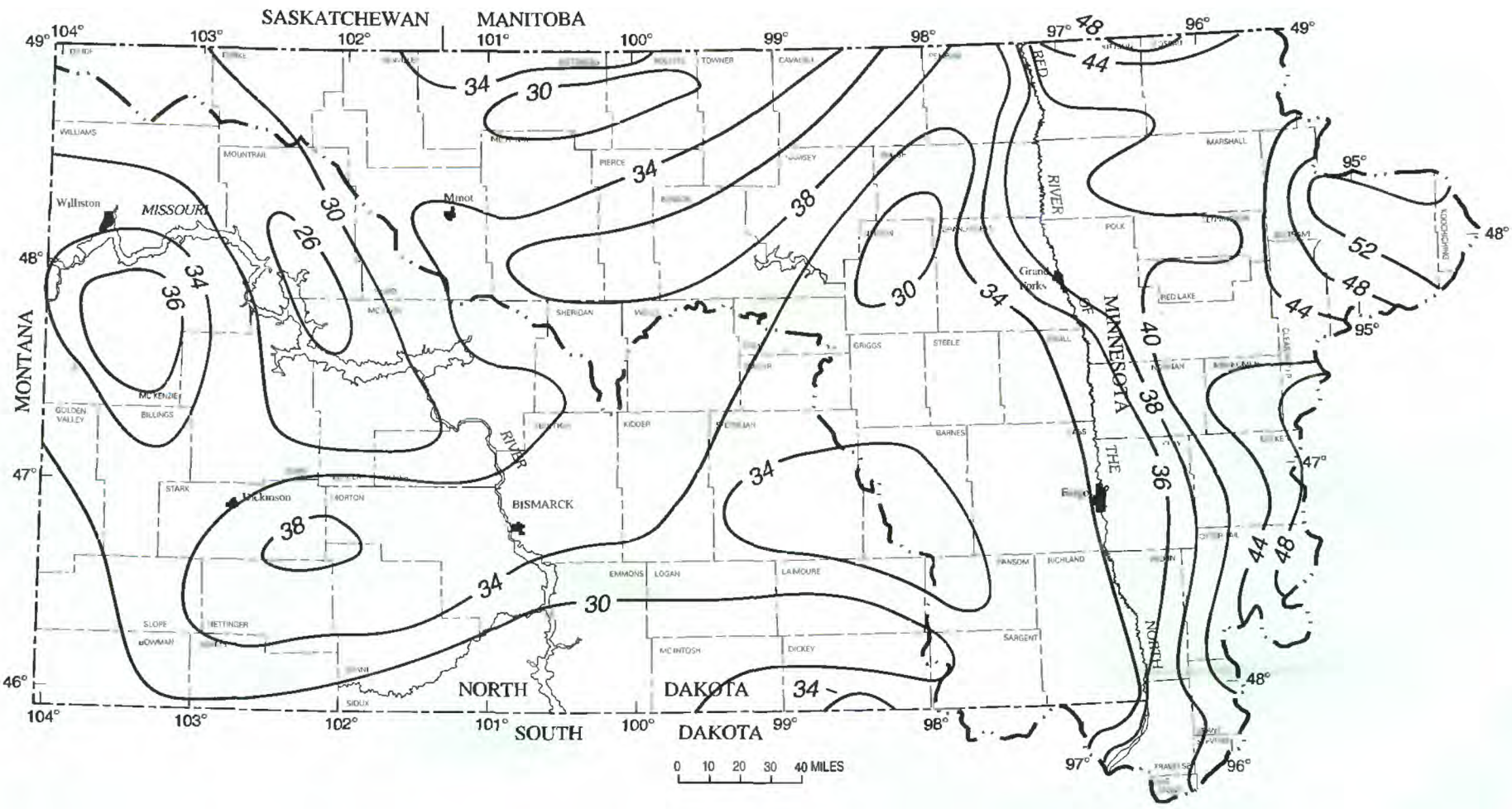

Figure 2. Average annual snowfall, in inches, in the Red River of the North and Missouri River Basins. [Data from National Weather Service, North Dakota State Climatology Office, and Minnesota Division of National Resources State Climatology Office, written commun., 1997.]

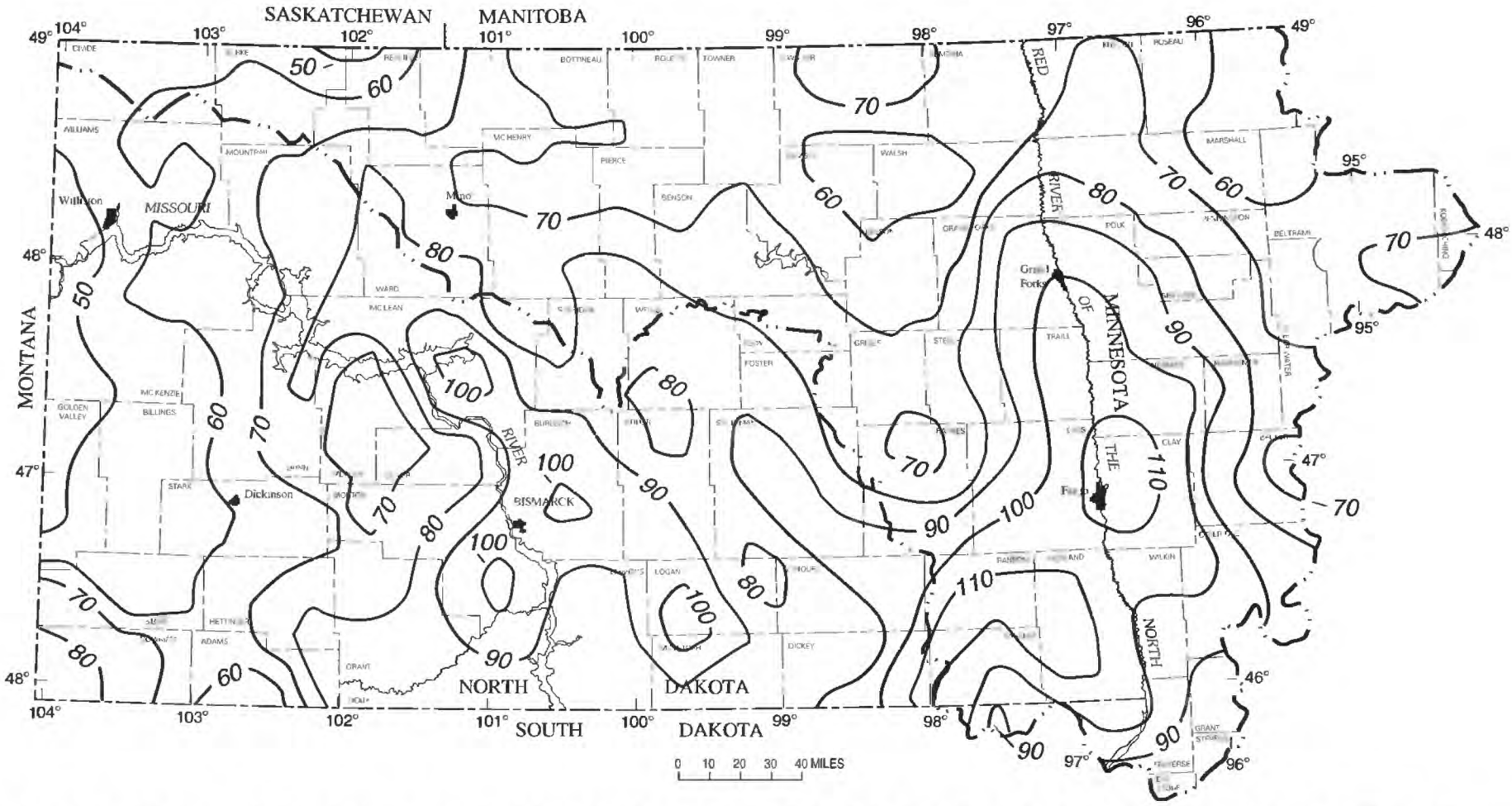

Figure 3. Total snowfall, in inches, from October 1996 through April 1997 in the Red River of the North and Missouri River Basins. [Data from National Weather Service, North Dakota State Climatology Office, and Minnesota Division of National Resources State Climatology Office, written commun., 1997.]

moist, frozen ground that prohibits infiltration of moisture, (4) a late spring thaw, (5) above-normal precipitation during spring thaw, and (6) ice jams (temporary dams of ice) on rivers and streams. Many of these conditions were present in the Red River and Missouri River Basins before and during the floods of 1997.

Stream stages (height of water in a stream above an arbitrarily established datum) and flows measured by USGS personnel at streamflow-gaging stations are used to define a unique relation between stage and flow. This relation, commonly called a rating curve, may not be well defined at extreme high flows because the flows are rare events of short duration and have unstable conditions that often make measurement extremely difficult. Therefore, estimates for some peak flows need to be extrapolated from rating curves extended to known peak stages. The peak flows are used to determine the probability, often expressed in recurrence intervals, that a given flow will be exceeded. For example, a flood that has a 1-percent chance of exceedance in any given year would, on the long-term average, be expected to occur only about once a century; therefore, the flood would be termed the "100-year flood". However, the chance of such a flood occurring in any given year is 1 percent. Thus, a 100-year flood can occur in successive years at the same location. In some instances, recurrence interval estimates can be based on periods of regulated flow or made with historic adjustments when historic data are available.

Historical peak stages and peak flows and the 1997 peak stages, peak flows, and recurrence intervals are shown in table 1. The streamflow-gaging stations are listed in downstream order by station number, and station locations are shown in figure 1. Revisions to the current peak stages and peak flows given in this preliminary report may occur as site surveys are completed and additional field data are reviewed in the upcoming months.

Because it is difficult to accurately determine recurrence intervals, particularly for sites that have short periods of record, ranges are given within which the recurrence intervals for the 1997 floods are likely to fall (table 1). A study of the Red River Basin hydrology that includes an analysis of both systematic and historic peaks is planned. The goal of the study will be to reduce the uncertainty in the estimated recurrence intervals given in this preliminary report.

Red River of the North Basin

The Red River Basin includes eastern and north-central North Dakota and western Minnesota. The headwaters of the Red River are in northeastern South Dakota, and the mouth is in Canada. At Emerson, Manitoba, near the Canadian boundary, the drainage area for the Red River Basin is about 40,200 square miles (mi^2). The basin is relatively flat and has a shallow river channel. The Red River is one of the few rivers in the United States to flow directly north. Because of the flatness of the basin, the shallow river channel, and the northerly flow, the timing of spring thaw and snowmelt can greatly aggravate flooding. Snow in the headwaters of the Red River Basin begins to melt first, when areas downstream remain largely frozen. This melt pattern can cause ice jams to form, and substantial backwater (water that is retarded, backed up, or turned back in its course because of an obstruction or an opposing current) can occur as flow moves north toward the ice jams and frozen river-channel ice.

Recurrence intervals for peak flows on the main stem of the Red River ranged from 50 to 500 years. On April 6, 1997, the stage of the Red River at Wahpeton, N. Dak., was 19.42 ft, which is 1.47 ft higher than the record set in 1989. On April 15, 1997, 9 days later, flow was 12,800 cubic feet per second (ft^3/s), and the stage was 19.22 ft. The recurrence interval for the April 15 peak flow was between 100 and 200 years. On April 8, 1997, most of the 1,700 people in Ada, Minn., were forced to flee their homes as overland flow from the flooding Marsh and Wild Rice Rivers inundated the town. Freezing temperatures from the late-spring blizzard caused a layer of ice to form over the flooding waters, trapping and then suffocating livestock. On April 17, 1997, flow on the Red River at Fargo, N. Dak., and Moorhead, Minn., was 28,000 ft^3/s. The recurrence interval for this peak flow was between 50 and 100 years. On April 18, 1997, the stage was 39.62 ft, which exceeded the record of 39.10 ft set 100 years earlier. On April 18, 1997, flow on the Red River at

Table 1. Historical peak stages and peak streamflows and 1997 peak stages, peak streamflows, and recurrence intervals for selected streamflow-gaging stations in the Red River of the North and Missouri River Basins, North Dakota and western Minnesota

[1997 flood data are considered preliminary and are subject to revision; ft^3/s, cubic feet per second; C, current year; --, not available; <, less than]

Site number (fig. 1)	Stream, place of determination, and USGS station number	Drainage area (square miles)	Period of known peaks	Maximum peaks previously known from period of record				Maximum peaks during 1997 flood				
				Date	Stage (feet)	Date	Streamflow (ft^3/s)	Date	Stage (feet)	Date	Streamflow (ft^3/s)	Recurrence interval (years)
RED RIVER OF THE NORTH BASIN												
1	Otter Tail River below Orwell Dam near Fergus Falls, Minn. (05046000)	1,830	1931-C	06-17-1953	[a]5.60	06-17-1953	1,710	04-15-1997 05-25-1997	4.61 4.63	04-15-1997 05-25-1997	1,490 1,500	[b]10-25
2	Bois de Sioux River near White Rock, S. Dak. (05050000)	1,160	1942-C	04-19-1969	[c]15.07	04-19-1969	3,770	--	--	04-16-1997	7,810	200-500
3	Red River of the North at Wahpeton, N. Dak. (05051500)	4,010	1897 1942-C	1897 04-05-1989	[d]17.00 17.95	1897 04-10-1969	[d]10,500 9,200	04-06-1997 04-15-1997	19.42 19.22	-- 04-15-1997	-- 12,800 [e]2,200	100-200
4	Red River of the North at Hickson, N. Dak. (05051522)	4,300	1976-C	04-07-1989	35.81	04-07-1989	12,900	04-14-1997 04-16-1997	36.85 37.60	04-14-1997 04-16-1997	13,300 12,400	50-200
5	Wild Rice River near Abercrombie, N. Dak. (05053000)	2,080	1897 1933-C	1897 04-11-1969	27.50 24.58	-- 04-11-1969	-- 9,540	04-17-1997	25.12	04-17-1997	9,350	[b]25-100
6	Red River of the North at Fargo, N. Dak. (05054000)	6,800	1882 1897 1902-C	04-11-1882 04-07-1897 04-15-1969	[d]36.10 [d]39.10 37.34	04-11-1882 04-07-1897 04-15-1969	[d]20,000 [d]25,000 25,300	04-17-1997 04-18-1997	39.54 39.62	04-17-1997 04-18-1997	28,000 27,600	50-100
7	Sheyenne River near Warwick, N. Dak. (05056000)	2,070	1950-C	04-18-1956	[a]7.83	04-14-1969	4,660	04-21-1997	8.14	04-21-1997	3,940	10-25
8	Mauvais Coulee near Cando, N. Dak. (05056100)	387	1954-C	04-25-1979	11.18	04-25-1979	2,660	04-20-1997	11.10	04-20-1997	2,530	10-50
9	Edmore Coulee near Edmore, N. Dak. (05056200)	382	1956-C	07-30-1993	87.76	07-30-1993	1,180	04-24-1997	87.93	04-24-1997	1,770	10-50
10	Starkweather Coulee near Webster, N. Dak. (05056239)	310	1980-C	04-06-1989	10.05	08-11-1987	570	04-24-1997	7.67	04-26-1997	774	25-100
11	Big Coulee near Churchs Ferry, N. Dak. (05056400)	2,510	1950-C	04-23-1995	7.62	04-23-1995	1,450	06-02-1997	9.92	05-05-1997	2,280	[f]50-100

12	Channel A near Penn, N. Dak. (05056410)	930	1984-C	08-15-1993	43.67	08-15-1993	1,560	05-03-1997	45.62	05-03-1997	1,960	--
13	Sheyenne River near Cooperstown, N. Dak. (05057000)	6,470	1945-C	04-18-1996	19.13	04-17-1950	7,830	04-24-1997	18.59	04-24-1997	5,290	10-25
14	Sheyenne River at Valley City, N. Dak. (05058500)	7,810	1882 1897 1919 1938-C	04-1882 04-21-1996	20.00 18.78	04-21-1996	5,250	04-19-1997	18.70	04-19-1997	4,820	[b]25-50
15	Sheyenne River at Lisbon, N. Dak. (05058700)	8,190	1950 1957-C	04-13-1996	[a]19.20	07-01-1975	5,270	04-05-1997	19.29	04-05-1997	6,100	25-50
16	Sheyenne River near Kindred, N. Dak. (05059000)	8,800	1947 1950-C	1947 07-06-1975	22.10 21.66	04-30-1996	5,100	04-30-1997	21.27	04-30-1997	5,570	25-50
17	Buffalo River near Dilworth, Minn. (05062000)	1,040	1931-C	07-02-1975	27.10	07-02-1975	13,600	04-15-1997 04-17-1997	-- 22.86	04-15-1997 04-17-1997	8,370 [a]5,300	25-50
18	Wild Rice River at Twin Valley, Minn. (05062500)	888	1909-17 1931-C	07-22-1909	20.00	07-22-1909	9,200	04-15-1997	15.27	04-15-1997	9,300	100-200
19	Wild Rice River at Hendrum, Minn. (05064000)	1,600	1944-C	04-21-1979	[a]32.30	04-10-1978	9,350	04-18-1997	33.73	04-18-1997	10,500	[b]25-100
20	Red River of the North at Halstad, Minn. (05064500)	21,800	1936-37 1942-C	04-22-1979	39.00	04-22-1979	42,000	04-19-1997	40.74	04-19-1997	71,500	100-200
21	Goose River at Hillsboro, N. Dak. (05066500)	1,203	1904, 06 1931-C	04-21-1979	16.76	04-21-1979	14,800	04-05-1997	15.47	04-05-1997	7,990	25-50
22	Marsh River near Shelly, Minn. (05067500)	151	1944-C	04-19-1979	[c]23.36	04-19-1979	4,880	04-10-1997	22.73	04-18-1997	4,220	10-25
23	Sand Hill River at Climax, Minn. (05069000)	426	1943-C	04-23-1979	[g]32.79	04-14-1965	4,560	04-20-1997	39.29	04-20-1997	3,410	25-50
24	Red Lake River at Crookston, Minn. (05079000)	5,280	1897 1902 1904-20 1922-C	04-12-1969	27.33	04-12-1969	28,400	04-17-1997 04-18-1997	28.40 23.58	04-17-1997 04-18-1997	27,800 26,000	50-100
25	Red River of the North at Grand Forks, N. Dak. (05082500)	30,100	1882-C	04-10-1897	50.20	04-10-1897	85,000	04-18-1997 04-22-1997	52.21 54.35	04-18-1997 04-22-1997	136,900 114,000	200-500

Site number (fig. 1)	Stream, place of determination, and USGS station number	Drainage area (square miles)	Period of known peaks	Maximum peaks previously known from period of record				Maximum peaks during 1997 flood				
				Date	Stage (feet)	Date	Streamflow (ft^3/s)	Date	Stage (feet)	Date	Streamflow (ft^3/s)	Recurrence interval (years)
RED RIVER OF THE NORTH BASIN--Continued												
26	Forest River at Minto, N. Dak. (05085000)	740	1944-C	04-19-1948 04-18-1950	11.80 11.80	04-18-1950	16,600	04-04-1997 04-20-1997	9.11 5.95	-- 04-20-1997	-- 2,040	2-5
27	Park River at Grafton, N. Dak. (05090000)	695	1932-C	04-19-1950	20.13	04-19-1950	12,600	04-21-1997	15.37	04-21-1997	5,240	[b]5-10
28	Red River of the North at Drayton, N. Dak. (05092000)	34,800	1936-37 1941-C	04-28-1979	43.66	04-28-1979	92,900	04-25-1997	45.56	04-25-1997	123,000	200-500
29	South Branch Two Rivers at Lake Bronson, Minn. (05094000)	444	1929-37 1941-47 1954-C	04-05-1966	18.23	04-05-1966	5,410	04-22-1997	13.92	04-22-1997	4,070	10-25
30	Pembina River at Neche, N. Dak. (05100000)	3,410	1904-08 1910-15 1919-C	04-20-1979	[a]23.64	04-20-1950	10,700	04-21-1997 04-26-1997	24.51 23.93	04-21-1997 04-26-1997	13,700 14,600	50-100
31	Souris (Mouse) River near Sherwood, N. Dak. (05114000)	8,940	1927 1930-C	04-10-1976	25.15	04-10-1976	14,800	04-02-1997	19.70	04-02-1997	2,550	--
32	Deep River near Upham, N. Dak. (05123510)	975	1951 1958-80 1985-C	04-12-1969	18.18	04-12-1969	6,760	04-05-1997	13.46	04-05-1997	1,000	5-10
33	Souris (Mouse) River near Westhope, N. Dak. (05124000)	16,900	1930-C	04-26-1976	19.16	04-26-1976	12,600	04-25-1997	14.15	04-25-1997	3,900	[b]5-10
MISSOURI RIVER BASIN												
34	Little Muddy River below Cow Creek near Williston, N. Dak. (06331000)	875	1955-C	03-27-1960	13.57	04-18-1979	9,180	03-27-1997	11.79	03-27-1997	5,220	10-25
35	Little Missouri River at Marmarth, N. Dak. (06335500)	4,640	1939-C	03-31-1952	23.40	03-23-1947	45,000	03-21-1997	11.30	03-21-1997	8,530	<2
36	Little Missouri River near Watford City, N. Dak. (06337000)	8,310	1935-C	03-25-1947	24.00	03-25-1947	110,000	03-21-1997	13.84	03-21-1997	18,600	2-5

37	Spring Creek at Zap, N. Dak. (06340000)	549	1924 1945-C	03-15-1972	20.70	04-07-1952	6,130	03-25-1997	11.83	03-25-1997	1,530	2-5
38	Knife River at Hazen, N. Dak. (06340500)	2,240	1930-33 1938-C	06-24-1966	27.01	06-24-1966	35,300	03-23-1997	26.93	03-23-1997	20,400	25-50
39	Missouri River at Bismarck, N. Dak. (06342500)	186,400	1928-C	03-31-1881 04-06-1952 12-18-1979	31.60 27.90 [a]14.24	-- 04-06-1952 07-13-1975	-- 500,000 68,900	07-25-1997	14.00	07-25-1997	59,600	50-100
40	Green River near New Hradec, N. Dak. (06344600)	152	1964-C	03-22-1978	[a]17.60	05-09-1970	4,120	03-22-1997	8.68	03-22-1997	914	2-5
41	Heart River near Richardton, N. Dak. (06345500)	1,240	1905-21 1938 1943-C	03-30-1912 04-16-1950	41.95 28.05	-- 04-16-1950	-- 23,400	03-22-1997	23.68	03-22-1997	13,300	25-50
42	Heart River near Mandan, N. Dak. (06349000)	3,310	1924 1928-33 1937-C	04-04-1952	[a]25.75	04-19-1950	30,500	03-23-1997	19.82	03-23-1997	19,000	[b]10-25
43	Cedar Creek near Raleigh, N. Dak. (06353000)	1,750	1939 1962-C	03-28-1978	13.95	03-28-1978	13,400	03-24-1997	14.18	03-24-1997	13,700	50-100
44	Cannonball River at Breien, N. Dak. (06354000)	4,100	1935-C	04-19-1950	22.30	04-19-1950	94,800	03-24-1997	20.28	03-24-1997	27,800	25-50
45	James River near Grace City, N. Dak. (06468170)	1,060	1969-C	03-21-1996	16.18	07-28-1993	3,520	04-24-1997	11.82	04-24-1997	3,080	5-10
46	Pipestem Creek near Pingree, N. Dak. (06469400)	700	1974-C	03-17-1995	11.70	03-17-1995	3,180	04-19-1997	11.17	04-19-1997	2,980	10-25
47	James River at Jamestown, N. Dak. (06470000)	2,820	1928 1933 1938-39 1943-C	04-11-1969	16.94	05-13-1950	6,390	04-09-1997	10.54	04-09-1997	1,450	[b]10-25
48	James River at LaMoure, N. Dak. (06470500)	4,390	1950-C	04-14-1969	16.17	04-14-1969	6,800	04-02-1997	15.56	04-02-1997	5,800	[b]25-50
49	James River at Dakota Lake Dam near Ludden, N. Dak. (06470875)	5,480	1982-C	04-19-1996	13.97	04-19-1996	2,850	04-19-1997	15.24	04-19-1997	4,980	25-50

[a] Backwater from aquatic vegetation, ice, and/or debris.
[b] Recurrence interval based on regulated period.
[c] From floodmark.
[d] Extreme outside period of record.
[e] Overland flow to the Wild Rice River Basin about 7 miles upstream of gage.
[f] Calculation based on reduction in drainage area from 2,510 to 1,690 square miles upon completion of Channel A in 1979.
[g] Floodmark, backwater from Red River of the North.

Grand Forks, N. Dak., was 136,900 ft^3/s, and the stage was 52.21 ft, which is more than 2 ft higher than the record set in 1897. The recurrence interval for this peak flow was between 200 and 500 years. The stage continued to rise to 54.35 ft on April 22, 1997. In the meantime, a fire demolished several buildings in flooded downtown Grand Forks, N. Dak. Grand Forks and its sister city, East Grand Forks, Minn., were completely evacuated by this time. On April 25, 1997, flow on the Red River at Drayton, N. Dak., was 123,000 ft^3/s, and the stage was 45.56 ft, which is 1.90 ft higher than the record set in 1979. The recurrence interval for the April 25 peak flow was between 200 and 500 years.

In addition to flow on the main stem, peak flow on many rivers and streams tributary to the Red River had 10-year or greater recurrence intervals during the 1997 floods. The recurrence interval for flow on the Bois de Sioux River near White Rock, S. Dak., was between 200 and 500 years, and the recurrence interval for flow on the Wild Rice River at Twin Valley, Minn., was between 100 and 200 years. The recurrence interval for flow on the Red Lake River at Crookston, Minn., was between 50 and 100 years. The Red Lake River normally accounts for almost 35 percent of the Red River's flow.

Devils Lake is a closed subbasin within the Red River Basin. Devils Lake discharges no water until the lake level reaches 1,457 ft above sea level (asl), the lowest outlet elevation. Since 1993, the lake level has risen rapidly in response to above-normal precipitation and runoff. The rising water has inundated homes, businesses, and agricultural lands and has caused roads to be closed. On April 16, 1997, Devils Lake reached 1,438.4 ft asl, equaling the previous record set in 1867. Because of the heavy runoff this spring, the lake level continued rising to 1,442.97 ft asl on July 26, 1997, the highest level in at least 130 years.

Missouri River Basin

The Missouri River Basin includes western and central North Dakota. The headwaters of the Missouri River are in Montana and Wyoming, and the mouth is in eastern Missouri. Of the 529,000 mi^2 in the basin, about 9 percent are located in North Dakota. The Missouri River flows into North Dakota from the west and exits south into South Dakota. Flow on the river is regulated by a series of dams built on its main stem. Garrison Dam, which is located in North Dakota, was built in 1952 and is the third largest dam in the United States. The reservoir, which forms Lake Sakakawea, has a maximum capacity of 24,100,000 acre-feet (acre-ft) and is managed by the U.S. Army Corps of Engineers who regulates the release of water from the dam. The dams were built, in part, to control flooding on the Missouri River.

In 1997, spring runoff began earlier in western and central North Dakota than in eastern North Dakota. Flow from rivers and streams tributary to the Missouri River caused the stage of the Missouri River at Bismarck, N. Dak., to continually increase through the spring and early summer. Because of heavy snowpack in the northern Rocky Mountains and a late spring thaw, high flow continued through mid-summer. On July 25, 1997, the peak stage at Bismarck was 14.00 ft, which is 0.24 ft less than the post-Garrison Dam record set on December 18, 1979. Flow on July 25, 1997, was 59,600 ft^3/s, which was the second highest flow since the completion of Garrison Dam. The recurrence interval for the peak flow was between 50 and 100 years. In order to accommodate the higher flow through the main-stem system, the U.S. Army Corps of Engineers continued releasing about 59,000 ft^3/s at Garrison Dam for several weeks.

In addition to flow on the main stem, peak flow on many rivers and streams tributary to the Missouri River had recurrence intervals exceeding 10 years. Ice jams on many of the rivers and streams caused flooding in several areas in western and central North Dakota. The Knife River flooded several homes in Beulah, N. Dak. On March 23, 1997, flow on the Knife River at Hazen, N. Dak., was 20,400 ft^3/s, and the stage was 26.93 ft, which is 0.08 ft less than the record set in 1966. The recurrence interval for the March 23 peak flow was between 25 and 50 years. On March 24, 1997, flow on Cedar Creek near Raleigh, N. Dak., was 13,700 ft^3/s, and the stage was 14.18 ft, which is 0.23 ft higher than the record set in 1978. The recurrence interval for the March 24 peak flow was between 50 and 100 years. On March 24, 1997, flow on the Cannonball River at Breien, N. Dak., was 27,800 ft^3/s, and the stage was 20.28 ft, which is about 2 ft less than the peak of record. The recurrence interval for the March 24 peak flow was between 25 and 50 years. The Cannonball River was responsible for flooding areas in Mott, N. Dak.

The headwaters of the James River are in central North Dakota. The river flows south through South Dakota before flowing into the Missouri River. Since 1993, many areas along the James River experienced flooding. On April 9, 1997, flow on the James River at Jamestown, N. Dak., was 1,450 ft^3/s, and the stage was 10.54 ft. The recurrence interval for this peak flow was between 10 and 25 years. On April 19, 1997, flow on the James River at Dakota Lake Dam near Ludden, N. Dak., was 4,980 ft^3/s, and the stage was 15.24 ft, which is 1.27 ft higher than the record set in 1996. The recurrence interval for the April 19 peak flow was between 25 and 50 years.

In the Red River Basin, the USGS works in cooperation with the U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, International Joint Commission of the U.S. State Department, U.S. Fish and Wildlife Service, U.S. Bureau of Indian Affairs, Minnesota Department of Natural Resources, North Dakota State Water Commission, North Dakota Department of Health, Cass County Joint Water Resource District, Devils Lake Basin Joint Water Resource Board, Red River Joint Water Management Board, Red River Watershed Management Board, and Southeast Cass Water Resources District.

For additional information on the 1997 flood and related topics, contact the following Internet sites:

USGS, North Dakota District	http://srv1dndbmk.cr.usgs.gov
North Dakota State Water Commission	http://water.swc.state.nd.us
North Dakota State University	http://www.ndsu.nodak.edu/fargoflood
University of Minnesota, State Climatologist	http://www.soils.agri.umn.edu/research/climatology
University of North Dakota	http://www.rwic.und.edu/flood

For more information contact any of the following:

For water information:
District Chief
821 East Interstate Avenue
Bismarck, ND 58501
(701) 250-4601

For more information on all USGS reports and products (including maps, images, and computerized data), call 1-800-USA-MAPS.

Additional earth science information can be found by accessing the USGS "Home Page" on the World Wide Web at "http://www.usgs.gov".

Kathleen M. Macek-Rowland, 1997

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