June 2002 Floods in the Red River of the North Basin in Northeastern North Dakota and Northwestern Minnesota

INTRODUCTION

The Red River of the North is a complex river system in the north-central plains of the United States. The river continues to affect the people and property within its basin. During June of 2002, major flooding occurred for the third time in 5 years in the Red River of the North Basin, especially on tributaries in northwestern Minnesota. The worst damage occurred in Roseau, Minn., where about 95 percent of the town was inundated. Extensive damage to roads, bridges, and crops occurred throughout the flooded area in northwestern Minnesota and northeastern North Dakota. Roseau County, Minn., was designated a major disaster area on June 14, 2002, by President Bush and later twelve more counties were added to the disaster declaration. Unlike the 1997 floods, which were the result of record-high, region-wide snowpacks and a late spring blizzard, the June 2002 floods were the result of heavy rainfall that swept across the region on June 9-10 and again on June 22-24, 2002.

Flooding in the Red River of the North Basin commonly 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) 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. Flooding during June 2002, however, was not caused by most factors usually associated with major flooding in the Red River Basin. In fact, precipitation had been below normal since late last summer and as of June 1, 2002, the flooded area was in a moderate drought based on the Palmer Drought Severity Index.

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 at the end of this report). This report presents preliminary meteorologic data provided by the National Weather Service, Grand Forks Office and water-resources 2002 flood data that were obtained from selected streamflow-gaging stations located in the Red River of the North Basin (fig. 1).

Flooding on the Roseau River at Roseau, Minn., June 12, 2002.

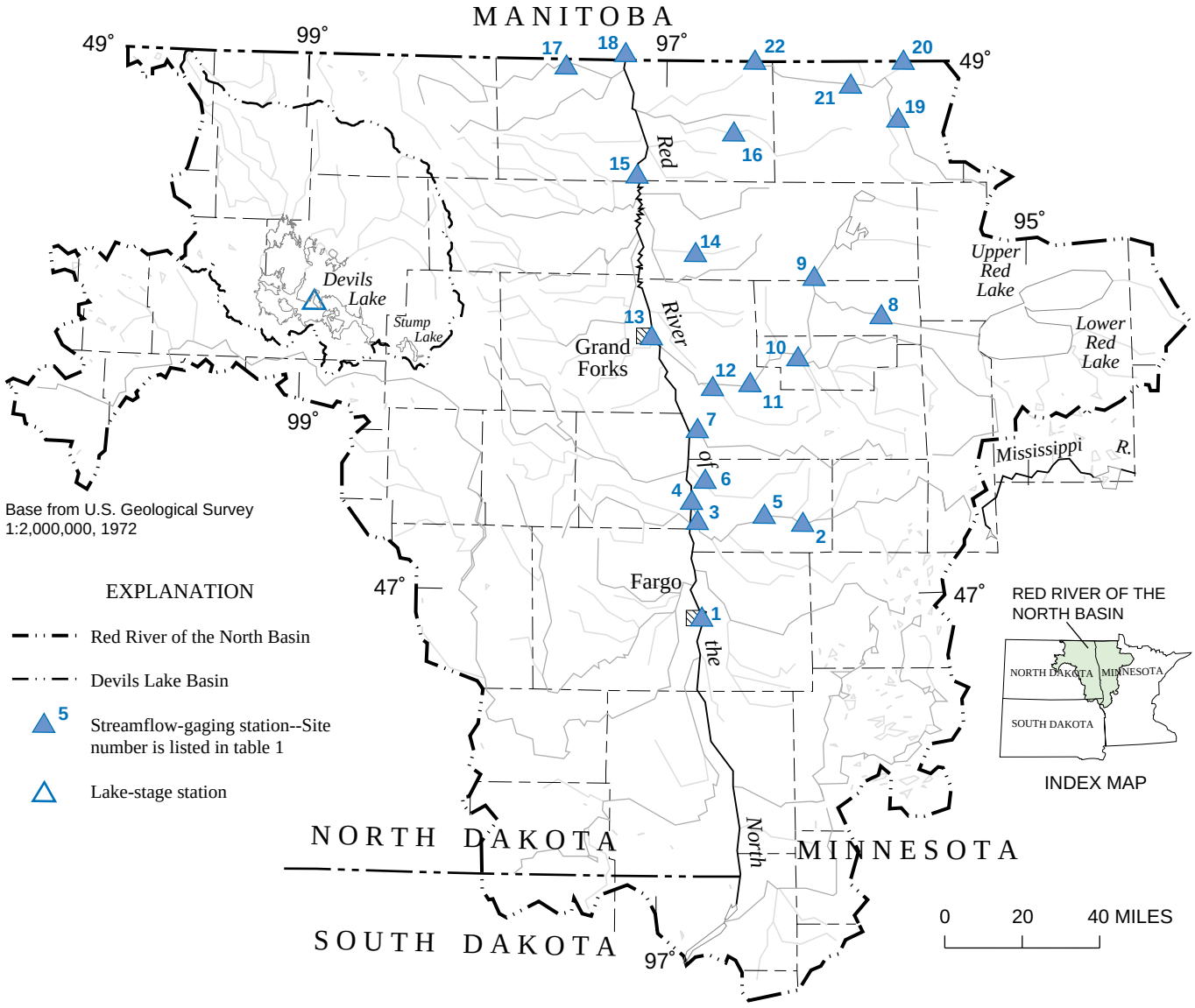

Figure 1. Selected streamflow-gaging stations in the Red River of the North Basin.

Historical peak stages and peak discharges and the June 2002 peak stages, peak discharges, 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. The June 2002 peak stages and peak discharges given in this preliminary report may be revised as site surveys are completed and additional field data are reviewed in the upcoming months. The peak discharges are used to determine the probability, often expressed in recurrence intervals, that a given discharge will be exceeded in the future. 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 a "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.

RED RIVER OF THE NORTH BASIN - June 2002

Meteorologic Conditions

During the early morning of June 9, 2002, a strong low-pressure system was located in southwestern South Dakota with a warm front extending northeastward across southeastern North Dakota and into Minnesota (fig. 2). Very warm and unstable air transported by a southerly low-level jet stream was located south of the warm front. A low-level jet stream located about 5,000 feet above ground surface with southerly wind speeds of 60 miles per hour is a common feature in the Great Plains during the summer. Very moist and unstable air (dew point greater than 60 degrees Fahrenheit) (fig. 2) located south of the warm front was pushed north by the jet stream. As the air was lifted over the front, moisture condensed and helped fuel the continuous thunderstorm development during the early morning of June 9. The almost stationary low-pressure system produced a second round of storms on June 10-11. Precipitation totals for the 3-day storm were greater than 5 inches in many areas, and the maximum storm total was about 10 inches (fig. 3).

Similar meteorologic conditions occurred on June 22-24, when warm and unstable air transported by the southerly low-level jet was

Table 1. Historical peak stages and peak discharges and June 2002 peak stages, peak discharges, and recurrence intervals at selected streamflow-gaging stations in the Red River of the North Basin, North Dakota and Minnesota

[Revisions to the current peak stages and peak discharges given in this preliminary table may occur as site surveys are completed and additional field data are reviewed in the upcoming months; ft^3/s, cubic feet per second; ND, not determined; --, not available]

Site number (fig. 1)	Station name and number	Drainage area (square miles)	Period of previously known peaks	Maximum peaks previously known from period of record				Maximum peaks during June 2002				
				Date	Stage (feet)	Date	Discharge (ft^3/s)	Date	Stage (feet)	Date	Discharge (ft^3/s)	Recurrence interval (years)
1	Red River of the North at Fargo, N. Dak. (05054000)	6,800	1882 1897 1902-2001	04-07-1897 04-18-1997 04-14-2001	[a]39.10 39.72 36.69	04-07-1897 04-17-1997 04-14-2001	[a]25,000 28,000 20,300	06-09-2002	16.71	06-09-2002	2,950	<2
2	Wild Rice River at Twin Valley, Minn. (05062500)	934	1909-17 1931-2001	07-22-1909 04-06-1997 04-07-2001	16.00 15.91 [b]12.63	07-22-1909 04-06-1997 04-08-2001	9,200 10,000 5,250	06-09-2002 06-24-2002	[c]17.40 18.00	06-09-2002 06-24-2002	14,000 19,000	100-200 500
3	Wild Rice River at Hendrum, Minn. (05064000)[d]	1,560	1944-2001	-- 04-21-1979 04-18-1997 04-14-2001	-- 32.30 [e]33.85 [e]31.62	04-10-1978 -- 04-18-1997 04-10-2001	9,350 -- 10,600 9,720	06-13-2002 06-28-2002	[b]28.02 26.48	06-13-2002 06-28-2002	8,520 8,770	10-25 10-25
4	Red River of the North at Halstad, Minn. (05064500)	21,800	1936-37 1942-2001	04-22-1979 04-19-1997 04-15-2001	39.00 40.74 38.44	04-22-1979 04-19-1997 04-14-2001	42,000 71,500 37,900	06-14-2002	20.46	06-13-2002	12,300	2-5
5	Marsh River Ditch near Ada, Minn. (05067050)	--	1985-2001	04-06-1989	16.74	04-06-1989	1,070	06-10-2002	19.02	06-10-2002	1,700	ND
6	Marsh River near Shelly, Minn. (05067500)	220	1944-2001	04-19-1979 04-18-1997 04-10-2001	[c]23.36 [c]25.45 19.24	04-19-1979 04-18-1997 04-10-2001	4,880 [e]4,300 2,380	06-12-2002 06-26-2002	[b]24.92 24.34	06-12-2002 06-26-2002	4,750 5,520	10-25 10-25
7	Sand Hill River at Climax, Minn. (05069000)	420	1943-2001	-- 04-23-1979 04-20-1997 04-14-2001	-- [c,e]32.79 [e]39.40 [b]26.05	04-14-1965 -- 04-20-1997 04-10-2001	4,560 -- [e,f]4,360 3,400	06-10-2002	14.38	06-10-2002	2,250	5-10
8	Red Lake River at High Landing near Goodridge, Minn. (05075000)[d]	2,300	1929-2001	07-03-1975 04-10-1997 04-08-2001	13.44 [b]12.36 11.45	07-07-1975 04-15-1997 04-08-2001	4,060 2,260 2,590	06-11-2002 06-23-2002	8.46 9.30	06-11-2002 06-23-2002	1,510 1,760	ND ND

Table 1. Historical peak stages and peak discharges and June 2002 peak stages, peak discharges, and recurrence intervals at selected streamflow-gaging stations in the Red River of the North Basin, North Dakota and Minnesota--Continued

[Revisions to the current peak stages and peak discharges given in this preliminary table may occur as site surveys are completed and additional field data are reviewed in the upcoming months; ft^3/s, cubic feet per second; ND, not determined; --, not available]

Site number (fig. 1)	Station name and number	Drainage area (square miles)	Period of previously known peaks	Maximum peaks previously known from period of record				Maximum peaks during June 2002				
				Date	Stage (feet)	Date	Discharge (ft^3/s)	Date	Stage (feet)	Date	Discharge (ft^3/s)	Recurrence interval (years)
9	Thief River near Thief River Falls, Minn. (05076000)	985	1909-17 1920-21 1922-24 1928-81 1982-2001	05-13-1950 04-18-1997 04-09-2001	17.38 [b]16.33 [b]16.58	05-13-1950 04-22-1997 04-09-2001	5,610 4,120 [f]3,400	06-10-2002	14.54	06-10-2002	3,400	5-10
10	Clearwater River at Red Lake Falls, Minn. (05078500)	1,380	1909-17 1934-81 1982-2001	04-25-1979 03-06-1983 04-15-1997 04-07-2001	12.38 [b]15.85 11.10 [b]10.75	04-25-1979 -- 04-15-1997 04-12-2001	10,300 -- 7,860 5,590	06-10-2002	7.15	06-24-2002	3,030	2
11	Red Lake River at Crookston, Minn. (05079000)	5,270	1897 1902 1904-20 1922-2001	04-12-1969 04-17-1997 04-09-2001	27.33 [b]28.40 [b]26.51	04-12-1969 04-17-1997 04-10-2001	28,400 [g]28,000 [g]18,000	06-11-2002	20.85	06-11-2002	16,200	5-10
12	Burnham Creek near Crookston, Minn. (05079901)	134	1986-2001	04-15-1997	22.63	04-15-1997	3,000	06-10-2002	21.66	06-10-2002	2,500	ND
13	Red River of the North at Grand Forks, N. Dak. (05082500)	30,100	1882-1997	04-10-1897 04-22-1997 04-14-2001	50.20 [c]54.35 44.87	04-10-1897 04-18-1997 04-11-2001	85,000 [h]137,000 57,800	06-14-2002	36.69	06-14-2002	30,400	5-10
14	Middle River at Argyle, Minn. (05087500)	255	1945 1950-81 1982-2001	05-19-1996 04-19-1997 04-09-2001	[c]18.27 17.96 15.59	05-19-1996 04-19-1997 04-09-2001	5,020 4,330 2,290	06-12-2002	16.30	06-12-2002	2,690	5-10
15	Red River of the North at Drayton, N. Dak. (05092000)	34,800	1936-37 1941-2001	04-28-1979 04-24-1997 04-19-2001	43.66 45.55 41.33	04-28-1979 04-24-1997 04-19-2001	92,900 124,000 55,300	06-18-2002	35.86	06-18-2002	34,700	5-10
16	South Branch Two Rivers at Lake Bronson, Minn. (05094000)	422	1929-37 1941-47 1954-2001	04-05-1966 04-20-1997 04-09-2001	18.23 14.58 13.43	04-05-1966 04-20-1997 04-09-2001	5,410 4,260 3,380	06-14-2002	11.22	06-14-2002	2,730	5-10

Table 1. Historical peak stages and peak discharges and June 2002 peak stages, peak discharges, and recurrence intervals at selected streamflow-gaging stations in the Red River of the North Basin, North Dakota and Minnesota--Continued

[Revisions to the current peak stages and peak discharges given in this preliminary table may occur as site surveys are completed and additional field data are reviewed in the upcoming months; ft^3/s, cubic feet per second; ND, not determined; --, not available]

Site number (fig. 1)	Station name and number	Drainage area (square miles)	Period of previously known peaks	Maximum peaks previously known from period of record				Maximum peaks during June 2002				
				Date	Stage (feet)	Date	Discharge (ft^3/s)	Date	Stage (feet)	Date	Discharge (ft^3/s)	Recurrence interval (years)
17	Pembina River at Neche, N. Dak. (05100000)	3,410	1904-08 1910-15 1919-2001	-- 04-20-1979 04-21-1997 04-09-2001	-- [b]23.64 [b]24.51 [b]19.97	04-20-1950 -- 04-27-1997 04-22-2001	[b]12,800 -- 15,100 4,420	06-12-2002	15.26	06-12-2002	3,460	5
18	Red River of the North at Emerson, Manitoba (05102500)	40,200	1902 1912-29 1929-2001	05-01-1979 04-26-1997 04-24-2001	791.19 792.41 788.79	05-13-1950 04-26-1997 04-25-2001	95,500 133,000 58,300	06-18-2002	780.01	06-18-2002	34,900	2-5
19	Roseau River below South Fork near Malung, Minn. (05104500)	430	1946-2001	04-20-1996 08-02-2001	[b]23.45 19.59	05-19-1996 08-02-2001	7,310 4,090	06-12-2002	26.79	06-12-2002	16,100	>500
20	Sprague Creek near Sprague, Manitoba (05106000)	176	1928-81 2000-01	09-01-1942 11-09-2000	15.31 [c]13.43	04-22-1974 11-09-2000	2,560 1,200	06-11-2002	17.06	06-11-2002	[f]8,600	ND
21	Roseau River at Ross, Minn. (05107500)	1,090	1928-91 1995-2001	05-12-1950 04-26-1997 04-18-2001	18.25 17.30 15.11	05-12-1950 04-26-1997 04-18-2001	6,560 4,670 2,640	06-16-2002	18.82	06-16-2002	10,100	>500
22	Roseau River below State Ditch 51 near Caribou, Minn. (05112000)	1,420	1917 1920-2001	05-19-1950 04-19-1997 05-08-1997 04-11-2001	11.81 [b]11.13 10.74 [b]10.20	05-19-1950 05-08-1997 -- 04-14-2001	4,080 3,320 -- 2,920	06-24-2002	11.91	06-24-2002	4,320	200-500

[a]Extreme outside period of record.
[b]Backwater from aquatic vegetation, ice, debris, or other water source.
[c]From floodmark/high watermark.
[d]Most peaks affected by diversion.
[e]Backwater from Red River of the North.
[f]Estimated.
[g]Approximate value.
[h]Maximum observed flow affected by breakout flow from Red River about 20 river miles upstream of gage. The breakout flow reentered the Red Lake River about 2 miles upstream of the gage.

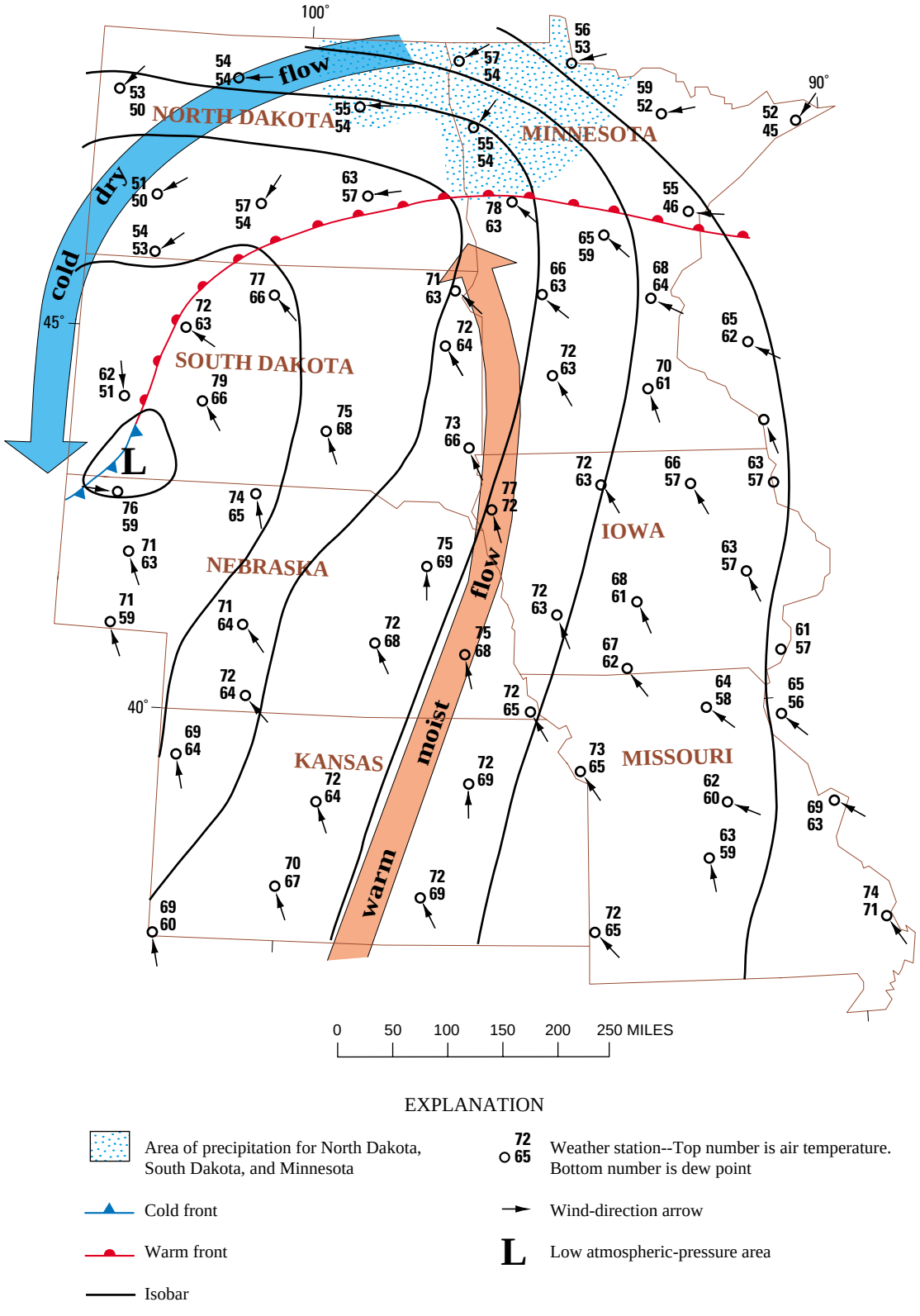

Figure 2. Average weather patterns over the northern plains, June 9-10, 2002. (Data from National Weather Service.)

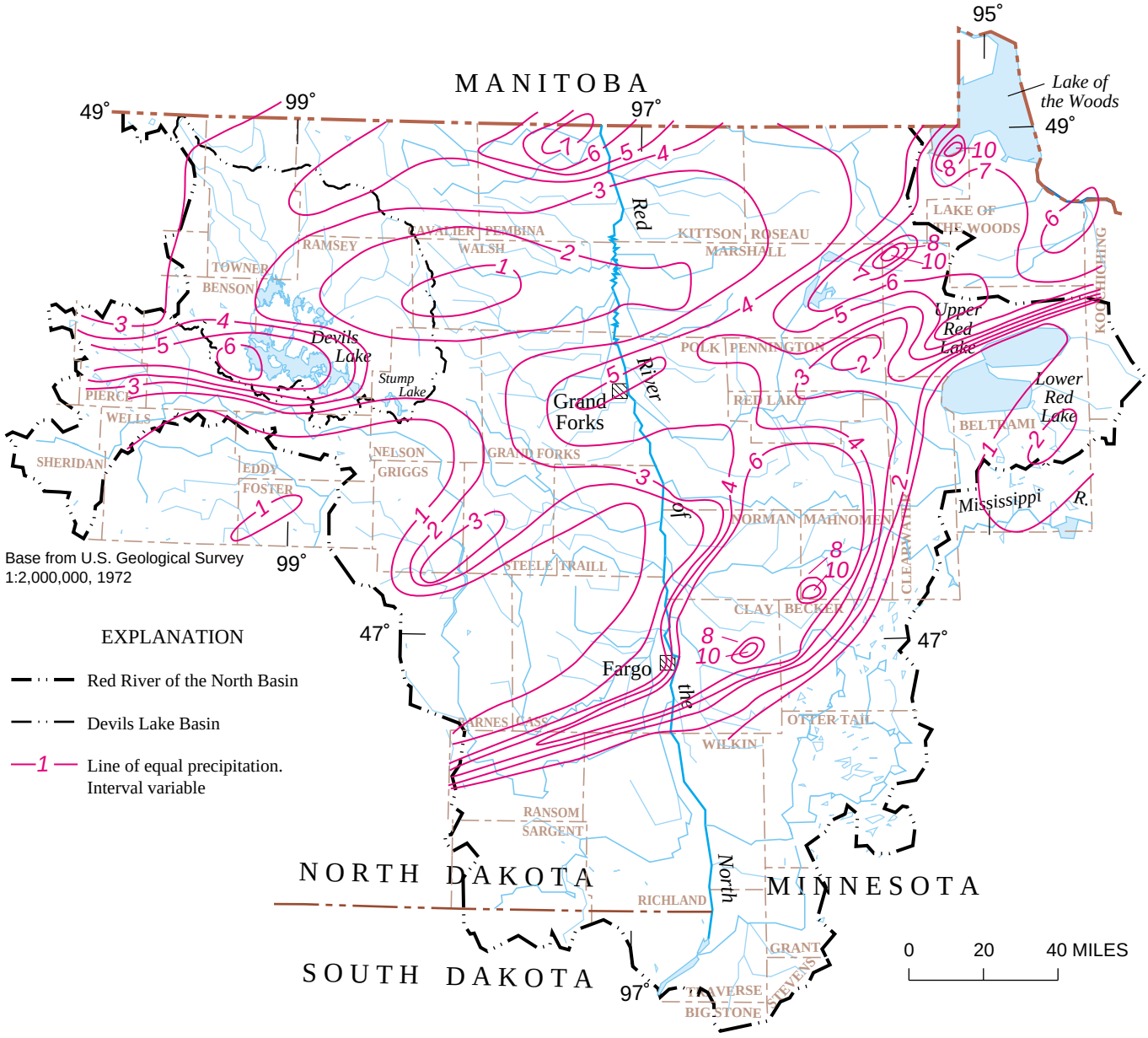

Figure 3. Areal distribution of precipitation, in inches, for the Red River of the North Basin, June 9-11, 2002. (Modified from data and graphics provided by the National Weather Service and the University of North Dakota Regional Weather Information Center.)

pushed up and over a warm front that was draped across west-central Minnesota. Two waves of thunderstorms occurred. The first wave began during the evening on Saturday, June 22 and ended during the day on Sunday, June 23. The second wave developed during the evening on Sunday and tapered off on Monday, June 24. The largest rainfall totals in the first wave occurred in the northern two-thirds of the Red River Valley and northern Minnesota, and the largest rainfall totals in the second wave in the Red River Basin occurred in the Wild Rice River Basin and the headwaters of the Clearwater River Basin (upstream from sites 2 and 10, fig. 1).

Streamflow

Several streamflow-gaging stations recorded peak stages and peak discharges during the June 2002 floods on the Wild Rice, Marsh, and Roseau Rivers. A peak discharge of 14,000 cubic feet per second occurred June 9 on the Wild River at Twin Valley, Minn. (site 2, fig. 1; table 1). The peak discharge on June 9 exceeded the previous peak that occurred in 1997 by 40 percent and had a recurrence interval between 100 and 200 years. Flooding was extensive in Ada, Minn., just downstream of Twin Valley. Flood discharges attenuated downstream of Twin Valley, but a significant peak discharge of 8,520 cubic feet per second occurred June 13 on the Wild Rice River at Hendrum, Minn. (site 3, fig. 1; table 1).

A peak discharge of 19,000 cubic feet per second occurred June 24 on the Wild Rice River at Twin Valley, Minn. The peak discharge on June 24 exceeded the peak on June 9 by 36 percent and had a recurrence interval of about 500 years. The peak discharge of 8,770 cubic feet per second that occurred June 28 on the Wild Rice River at Hendrum (table 1) was slightly greater than the peak discharge that occurred June 13.

The peak stage on the Roseau River below South Fork near Malung, Minn. (site 19, fig. 1; table 1), was about 3.3 feet higher than the previous peak of record, and the peak discharge was 120 percent greater than the previous peak discharge (table 1). The recurrence intervals for the peak discharges on the Roseau River ranged from greater than 500 years for the Roseau River below South Fork near Malung, Minn., and the Roseau River at Ross, Minn. (sites 19 and 21, fig. 1; table 1), to between 200 and 500 years for the Roseau River below State Ditch 51 near Caribou, Minn. (site 22, fig. 1; table 1).

The peak discharge that occurred June 12 on the Marsh River near Shelly, Minn. (site 6, fig. 1; table 1), was the second highest for the period of record and had a recurrence interval between 10 and 25 years. However, the peak discharge that occurred June 26 was 770 cubic feet per second greater than the peak that occurred June 12 (table 1). Peak discharges on most tributaries to the Red Lake River and on the Red Lake River at Crookston, Minn. (sites 8-11, fig. 1; table 1), had recurrence intervals between 5 and 10 years.

No significant streamflow response occurred on the Red River of the North upstream of Fargo (table 1). The peak discharge on the Red River of the North at Grand Forks, N. Dak. (site 13, fig. 1; table 1), was 30,400 cubic feet per second, but discharge never exceeded 2,950 cubic feet per second on the Red River of the North at Fargo, N. Dak. (site 1, fig. 1; table 1). The recurrence intervals for peak discharges determined on mainstem gaging stations downstream of Fargo were between 5 and 10 years (table 1).

The timing of the annual peak discharges indicates that summer peaks of this magnitude are rare at gaging stations on the Red River of the North mainstem. From 1882 through 2001, 24 out of 25 annual peak discharges greater than 30,000 cubic feet per second occurred from March 31 through May 12. Thus, out of 120 years of record only one other annual peak discharge greater than 30,000 cubic feet per second was caused by only rainfall instead of by snowmelt or a combination of rain and snowmelt.

Devils Lake is a 3,810-square-mile closed subbasin within the Red River Basin in North Dakota. At an elevation of about 1,446.5 feet above sea level, Devils Lake begins to spill into nearby Stump Lake (fig. 1). The combined lakes do not spill until the lake level reaches about 1,459 feet above sea level, the lowest natural outlet elevation. When water reaches this level, it spills into the Sheyenne River, a tributary to the Red River of the North, through Tolna Coulee. Within the past 10,000 years, Devils Lake has fluctuated from being dry to spilling over its natural outlet. Since 1993, the lake has risen about 25 feet in response to above-normal precipitation in the basin and below-normal evaporation from the lake surface. During September 2001 through May 2002, below-normal precipitation throughout the Devils Lake Basin produced little runoff into Devils Lake from snowmelt runoff in March and April. Devils Lake peaked at 1,447.3 feet above sea level on May 9, 2002, and declined to 1,446.9 feet above sea level on June 8, 2002. During June 9-11, 2002, direct rainfall on Devils Lake added about 50,000 acre-feet of water to the lake and the lake level increased 0.38 foot or 4.5 inches. During June 12-30, 2002, rainfall and runoff from the Devils Lake Basin caused the lake level to increase another 0.2 foot, and the lake level was 1,447.5 feet on July 1, 2002.

—G.J. Wiche, K.G. Guttormson, S.M. Robinson, and G.B. Mitton, U.S. Geological Survey and B.J. Bramer, National Weather Service

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In the Red River Basin, the USGS works in cooperation with the U.S. Army Corps of Engineers, 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, Minnesota Department of Transportation, Cass County Joint Water Resource District, Devils Lake Basin Joint Water Resource Board, Red River Joint Water Management Board, Red River Watershed Management Board, Southeast Cass Water Resources District, and the City of Grand Forks.

For additional information on the June 2002 floods and related topics, contact the following Internet sites:

USGS, North Dakota District	http://nd.water.usgs.gov/
USGS, Minnesota District	http://mn.water.usgs.gov/
U.S. Army Corps of Engineers	http://www.mvp.usace.army.mil/
National Weather Service	http://www.crh.noaa.gov/fgf/
North Dakota Water Commission	http://www.swc.state.nd.us/
Minnesota Department of Natural Resources	http://www.dnr.state.mn.us/waters/
University of Minnesota - Climate	http://climate.umn.edu/

For more information contact any of the following:

For water information:
District Chief
2280 Woodale Drive
Mounds View, MN 55112-4900
(763) 783-3100

or

District Chief
821 East Interstate Avenue
Bismarck, ND 58503-1199
(701) 250-7401

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".

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