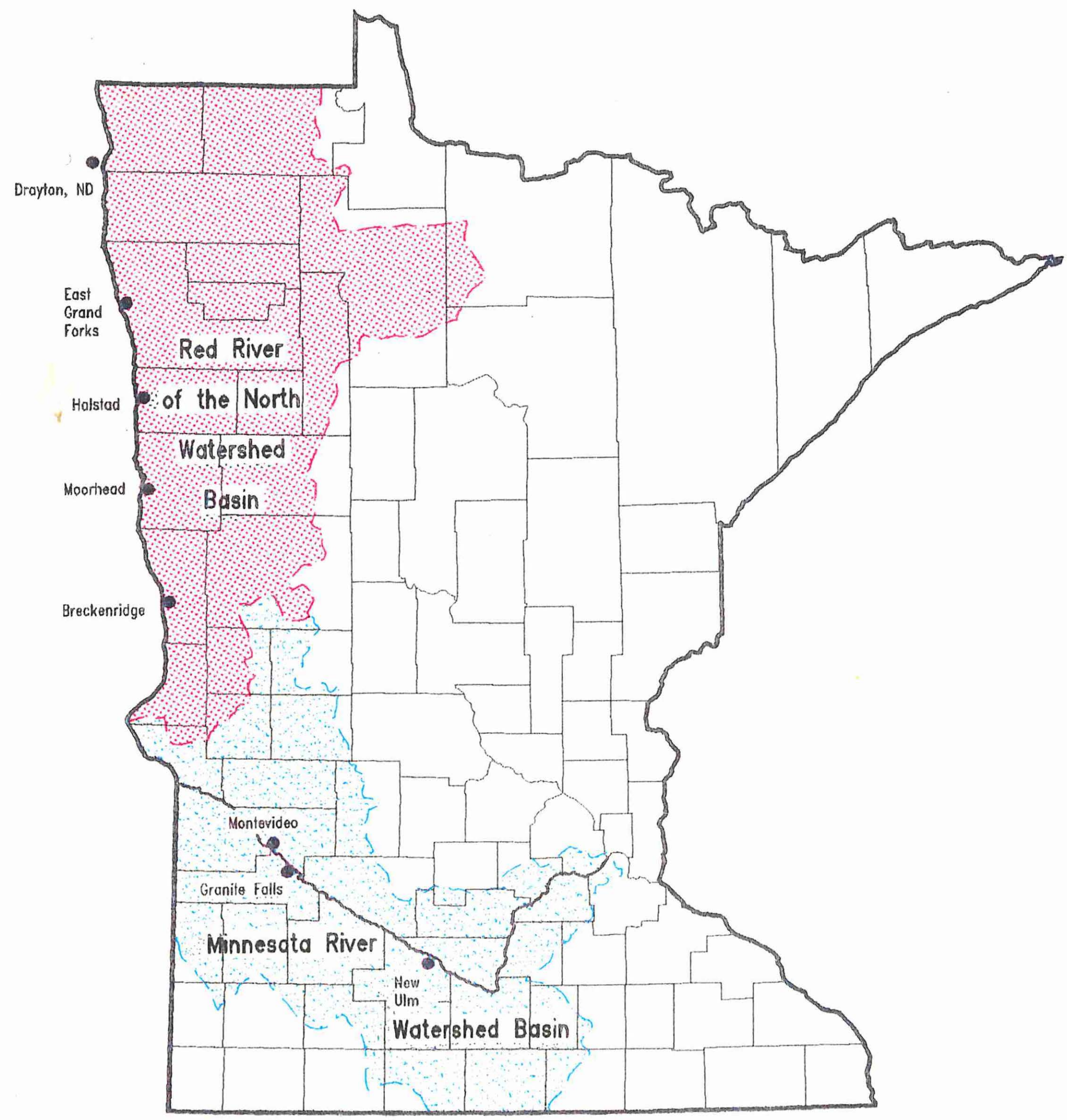
Climatic Conditions and the Resulting 1997 Record Spring Floods on the Upper Minnesota River and Red River of the North in Minnesota



Minnesota Department of Natural Resources
Division of Waters
June 1997

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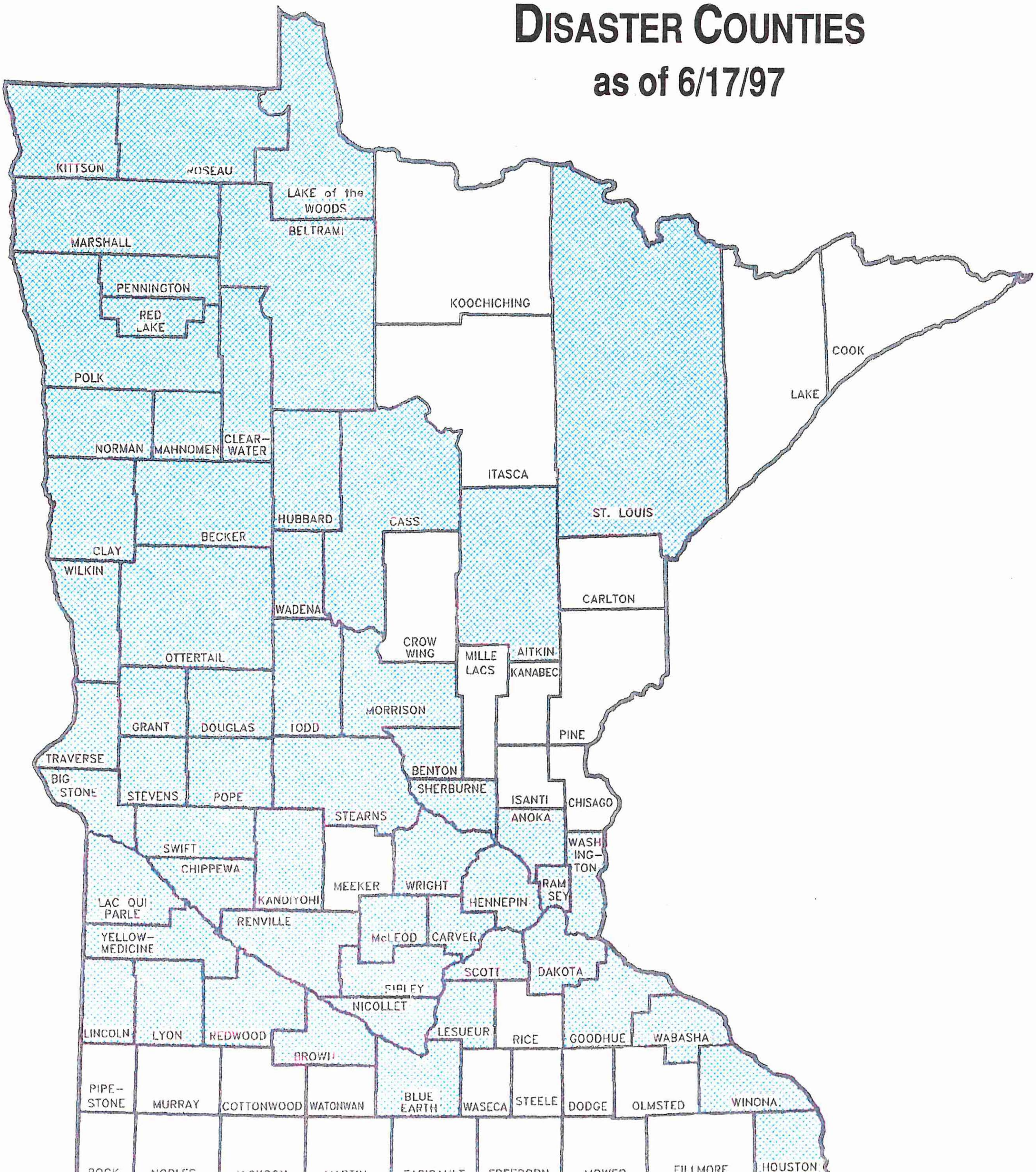
DESIGNATED DISASTER COUNTIES as of 6/17/97



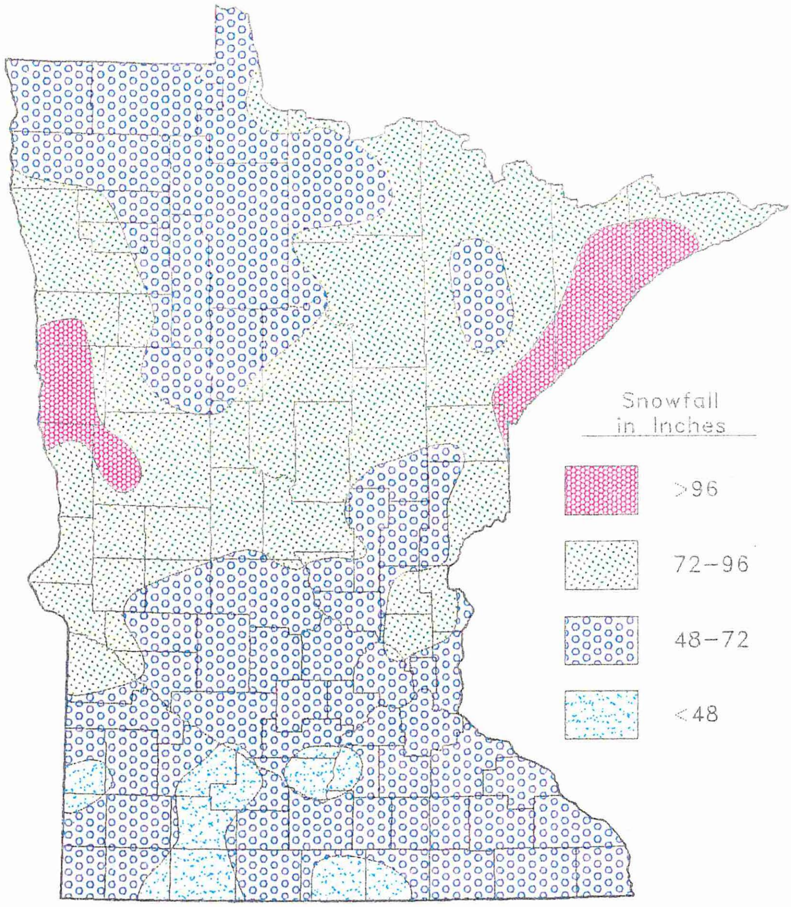
PREFACE

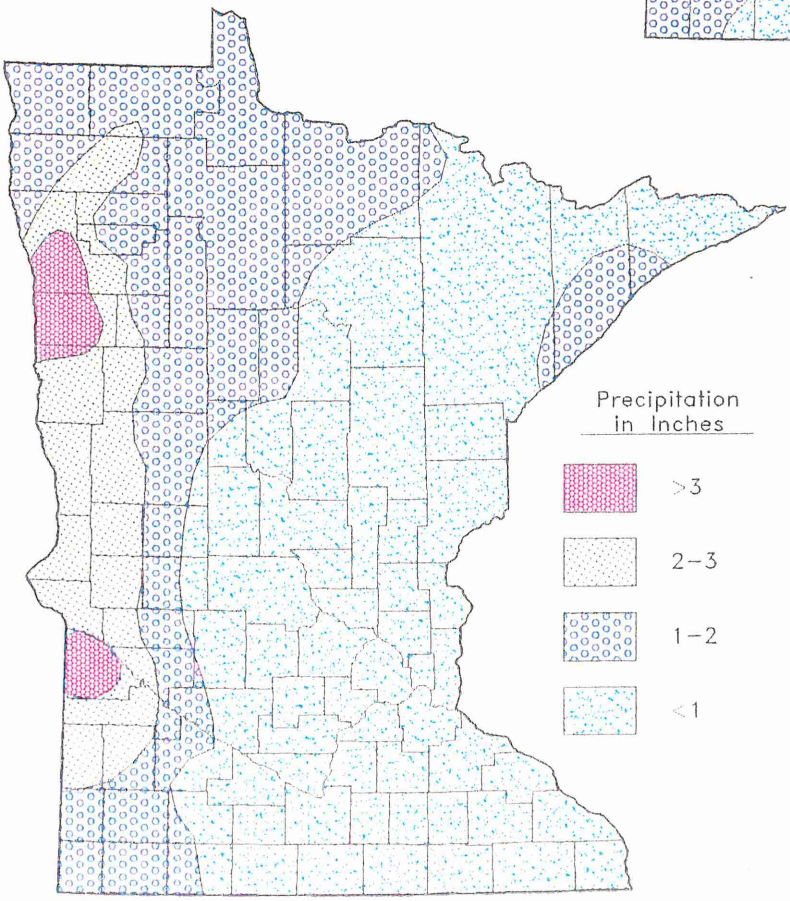
The 1997 spring flooding along the upper reaches of the Minnesota River and Red River of the North broke most existing flood records in Minnesota. The Federal Emergency Management Agency's (FEMA) estimate of public infrastructure damage in Minnesota from the flood was approximately $300 million. Before the water receded, 58 of Minnesota's 87 counties were declared federal disaster areas. The American Red Cross reported that 23,263 families were affected by the massive floods. Total flood damages and associated economic impacts were estimated to be as high as $2 billion.

This summary report presents facts about climatic conditions leading up to the flood and the actual magnitude of the flood waters in some of the hardest-hit river communities. It also provides historic comparisons between this flood and those a century ago. A simplified computer analysis shows what it would have taken to reduce the 1997 Red River peak at Grand Forks/East Grand Forks to 89,000 cfs (the 100-year flood designation used for management ordinances).

Some have identified the drainage of wetlands and agricultural and urban uses of land as factors causing the flood to reach record proportions. Wetlands and land use can have significant effects on how much and how soon water runs off into streams and rivers, particularly when climatic conditions are near average or "normal". However, after receiving record or near-record amounts of precipitation over thousands of square miles of land in the river basin, the resulting runoff volume simply overwhelmed the hydrologic system and made wetland drainage and land use practices relatively insignificant when describing causes of the resulting record flooding.

SNOWFALL OCTOBER 1996 - MARCH 1997





PRECIPITATION APRIL 5 - 6, 1997

Climatic Conditions Leading To The 1997 Spring Flooding

In the post-settlement era, no sequence of extreme precipitation events has impacted as much of the Upper Minnesota River and Red River basins as those experienced during the autumn of 1996 through the spring of 1997. The following events occurred:

Heavy autumn precipitation

- Six or more inches in late October and November
- Many areas four or more inches above normal, saturating the soil

Extraordinary winter snowfall

- Most areas over six feet of snowfall; some over eight feet
- Many areas two to three times the average snowfall

  Fargo/Moorhead received 117 inches of snow as compared to its average of 39 inches and the previous seasonal record of 89 inches
- 1996-97 snowfall exceeded 1896-97 snowfall by 25 to 50 percent in much of Minnesota's portion of the Red River basin

Heavy early spring precipitation

- Two or more inches of precipitation (snow and rain) on April 5-6 in western Minnesota

  Crookston received 3.63 inches. The previous 2-day April record was 2.35 inches
- Normal precipitation for the month of April is less than two inches

April temperatures

- Temperatures 10 degrees above normal for the first week of April and 20 degrees below normal the second week

FLOOD STAGE and DISCHARGE DATA for FLOODED COMMUNITIES

River stages exceeded the 100-year flood elevations identified in local floodplain management ordinances on the Minnesota River above New Ulm and along the entire length of the Red River of the North in Minnesota.

Record high flood stages are shown in the following tables:

Minnesota River

Community	Previous Record (Year)	New Record - 1997
Montevideo	21.68 (1969)	24.48
Granite Falls	12.6 (1969)	15.4
New Ulm	30.5 (1969)	32.23

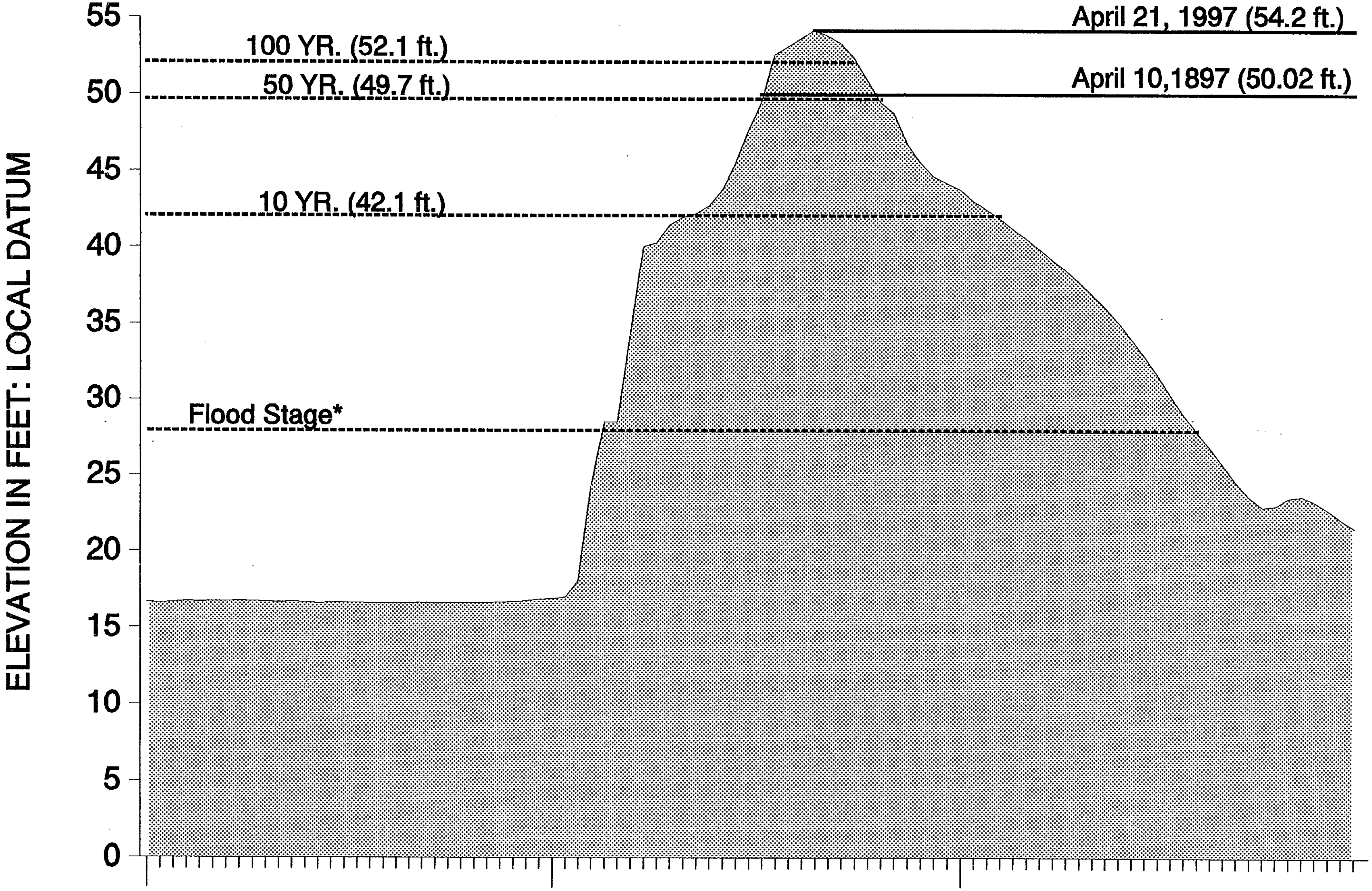
Red River of the North

Community	Previous Record (Year)	New Record - 1997
Breckenridge	17.95 (1989)	19.20
Moorhead	37.34 (1969)	39.75
Halstad	39.00 (1979)	40.67
East Grand Forks	50.02 (1897)	54.20
Drayton , N.D.	43.66 (1979)	45.54

Flood volume measurements taken during the 1997 flood are still being evaluated; however, preliminary results indicate that new record peak flows were recorded at many locations. The U.S.Geological Survey's preliminary calculation of peak mean daily flow (136,900 cubic feet per second) at East Grand Forks was record-setting.

RED RIVER of the NORTH AT GRAND FORKS, ND
STAGE HYDROGRAPH

THIS GRAPH IS BASED ON PROVISIONAL DATA AND SUBJECT TO REVISION.

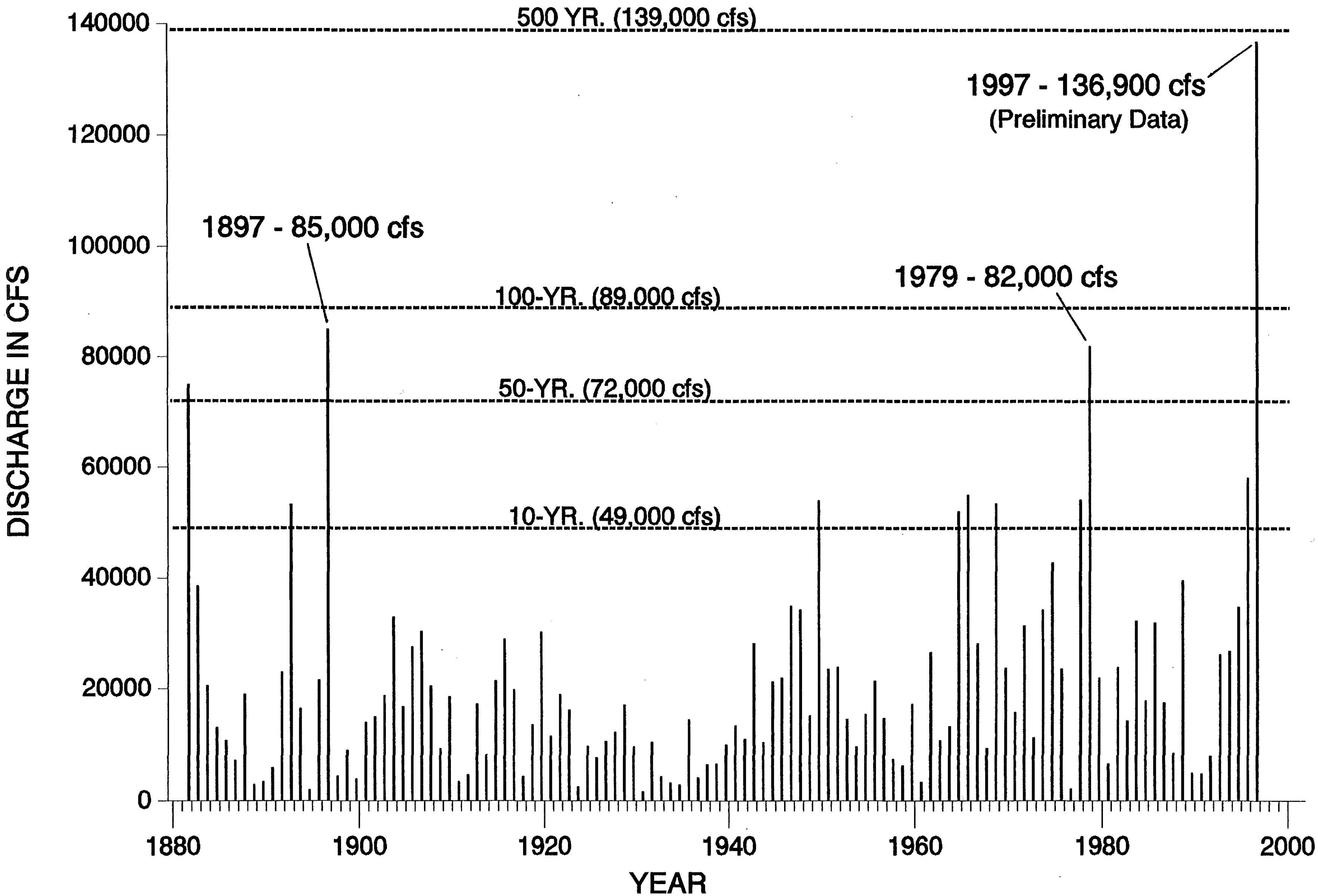


MARCH 1 TO MAY 31, 1997

* FROM NATIONAL WEATHER SERVICE

MDNR - DIVISION OF WATERS

RED RIVER of the NORTH AT GRAND FORKS, ND
HIGHEST ANNUAL INSTANTANEOUS DISCHARGE



MDNR, DIVISION OF WATERS

Simulation To Reduce Flooding In Grand Forks

A simplified analysis was completed by DNR - Waters to estimate the amount of upstream storage that would have been needed to reduce the 1997 flood waters to 89,000 cubic feet per second (cfs) in the Grand Forks area. The 89,000 figure represents the 100-year or 1% chance flood established by FEMA and is currently used for administering the local floodplain management ordinance.

Preliminary U.S. Geological Survey daily flow data indicate that the total volume of water that flowed past Grand Forks/East Grand Forks in April and May 1997 was approximately 5.1 million acre-feet. Water in the snowpack and rainfall during this period was about 8-10 inches on average over the Red River basin upstream of Grand Forks, or approximately 13-16 million acre-feet. Since only about five million acre-feet of river volume was measured, approximately 8-11 million acre-feet were still stored in upstream areas or were dissipated naturally through soil moisture, evaporation or percolation to ground water.

The actual daily flow data for April and May were entered into the HEC-1 computer model. The water volume was routed through simulated reservoirs of various sizes via a trial and error method until the predicted peak discharge was reduced to 89,000 cfs, the 100-year flood mark. (In the modeling exercise, a single simulated reservoir was located on the Red River immediately upstream of Grand Forks.)

The analysis showed that approximately 1.3 million acre-feet of floodwater storage would have been required to reduce the peak flow of 136,900 cfs to 89,000 cfs. The simulated reservoir would have had to contain 1.3 million acre-feet of water, representing the equivalent of a 10-foot deep Mille Lacs Lake - a 132,516 acre lake.

This modeling exercise represents an idealized reservoir located immediately upstream of Grand Forks. In actuality, a single reservoir holding 1.3 million acre-feet of water storage could not be provided. Creation of this amount of storage volume would require storage sites located throughout the basin. Storage sites located farther upstream of the Grand Forks area would provide fewer flood control benefits. Dispersed sites do not capture and contain all runoff from the contributing basin.

Comparisons To Past Floods

The 1997 spring floods on the Minnesota River above New Ulm and on the entire Red River of the North established many new records. Grand Forks/East Grand Forks experienced major urban flood damages when the cities' emergency dikes were overtopped. The current estimate of commercial building and inventory losses in Grand Forks alone is about three-quarters of a billion dollars. Compared to other floods in this area during this century, the 1997 spring flood was unprecedented. The graph on page 4 shows the highest annual instantaneous discharges recorded on the Red River of the North at Grand Forks since 1882.

Records of past floods are used to estimate the probability of equal or greater floods in the future. Unfortunately, flood records on major rivers are poor or nonexistent prior to 1900. Records on smaller rivers and streams are even more limited. This lack of good long-term records makes flood frequency analysis difficult. One way of supplementing recorded flood information is to look for other evidence of past floods, such as written observations found in reports, journals, diaries and newspaper articles. An example of this type of information for the Red River of the North is contained in the April 1897 edition of the U.S. Department of Agriculture publication titled "Climate and Crops: Minnesota Section". This publication summarized Minnesota climate data and discussed climate issues. Part of the publication is reprinted on page 7.

The April 1897 issue was published when the Red River of the North was experiencing a severe flood, and it drew on anecdotal information about earlier Red River basin floods. The accounts provide support to the argument that extreme flood events in large river basins result from extreme climatic conditions and not from the actions of man.

History Of Early Floods In The Red River Valley - April 1897

- excerpted from "Climate and Crops: Minnesota Section", U.S. Department of Agriculture

Some of the oldest inhabitants of this section, in view of the present flood situation, are recalling a statement which was frequently made by Pierre Bottineau, the noted guide and scout, a large portion of whose life was spent in this vicinity and who at one time resided at Red Lake Falls. It was to the effect that people would live to see the day when water in the Red river would reach the level of the prairies on either side.

In this connection a bit of ancient history is decidedly interesting. J.W. Bond, the historian, who came to the Red River Valley in 1851 for the purpose of treating with the Indians for the Red Lake reservation, says they found the valley desolate and barren. Everything was drowned out by the inundations of the river, which had occurred for several successive years. In this book published in 1853 he says of this section: "Along the course of the river, both banks within the margin of the stream, are covered with the thick growth of drowned-out willows, while farther back on the prairie, fine large trees, majestic oaks and elms, are in the same condition; and now stand towering aloft like high, giant skeleton sentinels throwing out their dry leafless limbs across the water as if to guard its passage. Each tree is marked at the height of about 30 feet above the water, by the heavy drift ice during the freshets. In some places the timber merely skirts the river, at others it extends further than the eye can pene trate; and no prairies being visible for miles, all is a desolate solitude of dead and dying skeleton trunks of leafless trees.

No farming whatever is being done here on account of the annual floods in the valley for three years past, the waters having risen to the height of thirty-one and thirty-three feet above the low water mark, flooding all the country and inundating houses at this place (Pembina) to the depth of two or three feet. The ground is destitute of grass, with tall, rank weeds three and four feet in height abounding.

The heaviest floods known in the country occurred in 1824, 1825 and 1826. The last year the water rose sixty-six feet in height and the whole country was completely drowned out.

This produced such universal distress that many of the most wealthy and influential citizens left Selkirk in consequence and made an overland journey across the plains to St. Peters and Galena, near which last place they settled. In 1825 the snow fell the 15th of October in great quantity and remained on the ground. Still more fell during the winter, which was one of the coldest which had passed for twenty-five years. The snow melted suddenly about the last of April. The water had already risen in the streams as high as the banks when the ice, which had scarcely diminished in thickness, was dragged away by the violence of the current, and taking a straight course, rooted up trees and demolished edifices and whatever found itself in its way.

The fish, the principal resource of the inhabitants at this season of the year, were dispersed in this immense extent of water and the fishermen were not able to take them. The bison that were ordinarily found in abundance near the river Pembina went away, and about fifteen persons who had calculated on this resource perished from hunger. The waters did not recede entirely until the 20th of July; when some persons risked sowing barley, which came to maturity."

A similar condition of affairs did not occur again until 1852. Then "the water rose a foot higher than in 1826 (sixty-seven feet above low water), and the losses occasioned by it are still greater." Fencing, grain and property of all kinds was washed away and destroyed.

HYDROLOGIC TERMS

acre-feet: a measure of water volume, one acre-foot being the amount required to cover one acre to a depth of one foot

cfs: cubic feet per second, a common way of expressing river discharge

discharge: the rate of river flow, expressed as a volume of water per unit of time

hydrograph: a graph showing river stage or discharge over a certain period of time

hydrology: the scientific study of the distribution, circulation and properties of the waters of the earth

100-year flood: the flood expected to occur on average once every 100 years, or having a 1% chance of occurring any given year

peak discharge: the highest rate of river flow reached during a flood event

peak stage: the highest river level reached during a flood event

stage: the height of the river surface, usually expressed in feet above a reference elevation

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spring floods on the Upper Minnesota River an
Red River of the North in Minnesota.

For more information, contact Kent Lokkesmoe, Mel Sinn or Dave Ford
Minnesota Department of Natural Resources, Division of Waters
500 Lafayette Road, St. Paul, MN 55155-4032 (612) 296-4800

http://www.dnr.state.mn.us
(see Climatology section)

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