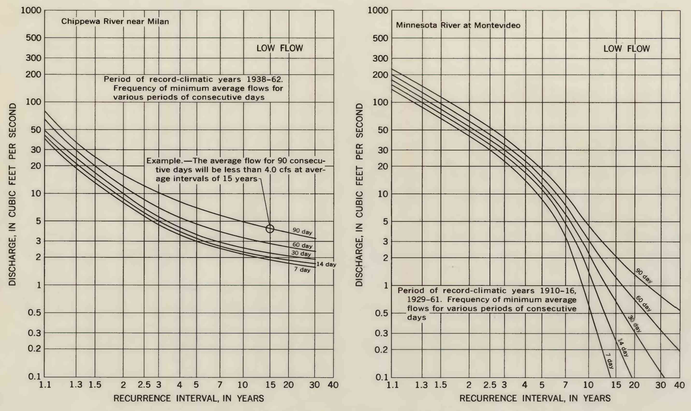
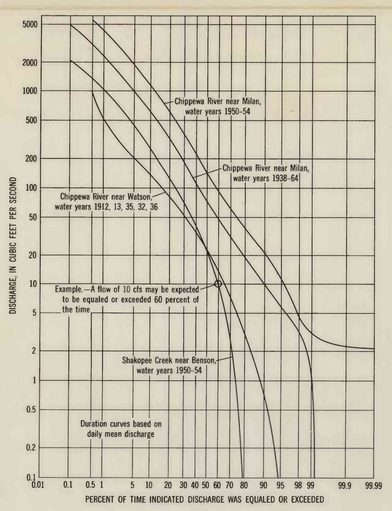
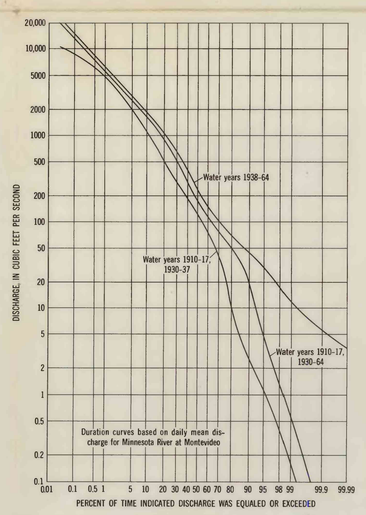
SURFACE WATER



LOW FLOW IS LARGELY DISCHARGE FROM GROUND-WATER SOURCES

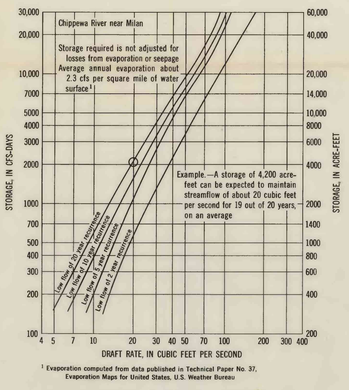
Low flow on the Minnesota River at Montevideo has been affected by release of stored water from Lac qui Parle Reservoir since 1938 and by the low runoff during the drought years of the 1930's. Low-flow frequency curves for other sites on the Chippewa River would differ from those shown for Chippewa River near Milan. Water from glacial deposits would sustain streamflow and lengthen the recurrence interval for a given discharge. Seasonal frequency curves will also differ from those shown. Storage from upstream reservoirs augments the low streamflow on the Minnesota River at Montevideo.





SIMILAR FLOW-DURATION CURVES FOR THE SAME PERIOD INDICATE SIMILARITY OF STREAMFLOW AND BASIN CHARACTERISTICS

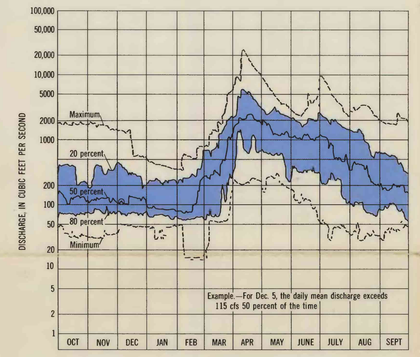
The effect of storage in lakes, swamps, and glacial deposits is shown by the relatively moderate slope of the duration curve for Chippewa River near Milan (water years 1938–64). The sharp downward slope of this curve at the 99 percent point is the result of freezeup. The steep slope of the curve for Shakopee Creek shows the effect of lack of lake and swamp storage when compared with the Chippewa River for the same period (water years 1950–54). The steeper lower end of the curve for Chippewa River near Watson is the result of 5 years of below average runoff. The different shapes of the curve for the Minnesota River at Montevideo for different periods are the result of the drought years of the 30's and the storage in upstream reservoirs beginning in 1937.



[1] Evaporation computed from data published in Technical Paper No. 37, Evaporation Maps for United States, U.S. Weather Bureau

THE APPROXIMATE STORAGE REQUIRED TO MAINTAIN SPECIFIED STREAMFLOW FOR LOW FLOWS OF VARIOUS RECURRENCE INTERVALS IS SHOWN BY THE CURVES

Low streamflow can be augmented by release of water stored during high-flow periods.



THE VARIATION OF DISCHARGE FOR EACH DAY AND THE SEASONAL VARIATION OF DAILY MEAN DISCHARGE IS SHOWN BY THE DAILY DURATION HYDROGRAPH FOR MINNESOTA RIVER AT MONTEVIDEO FOR 1943–61

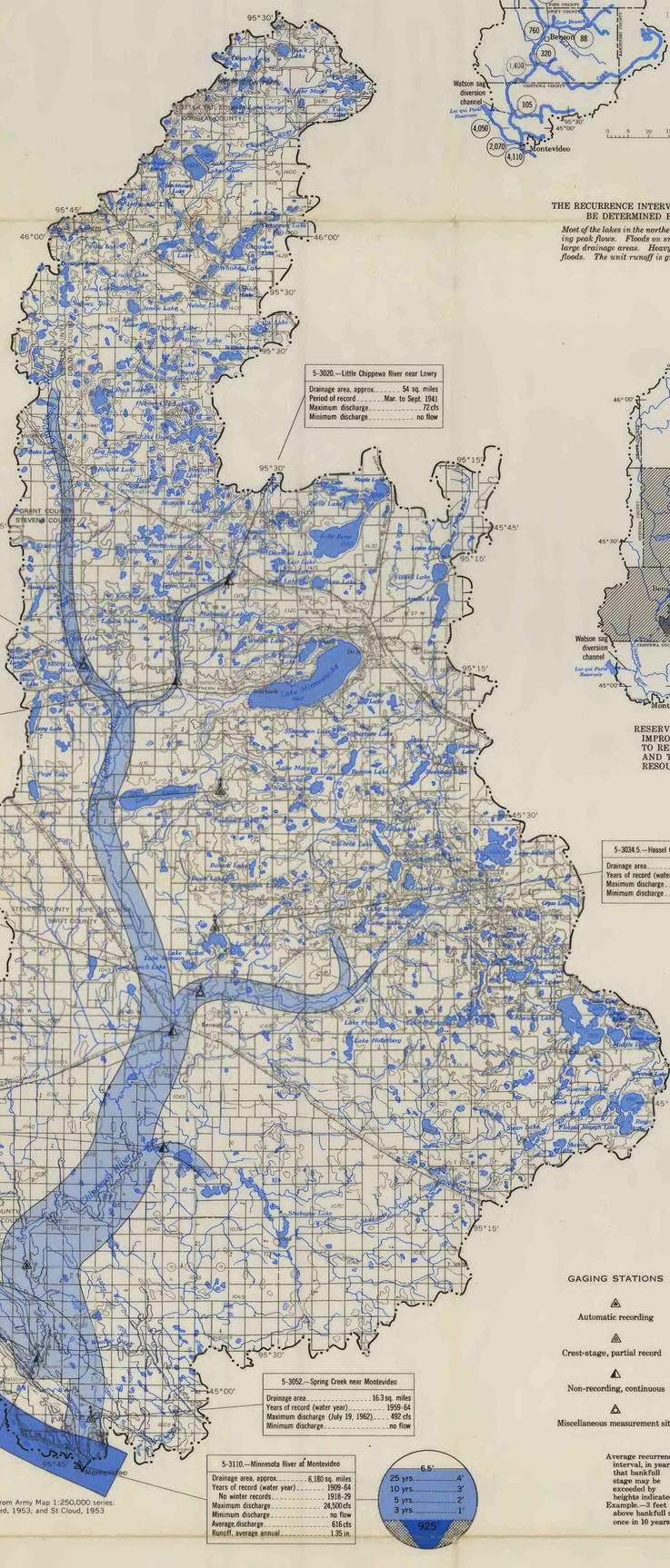
High and low discharges are affected by Lac qui Parle Reservoir. The lowest flows occur in the winter and the highest occur during the spring breakup. The smallest range in daily mean discharge is in January and the greatest is in April.

THE MAJOR LAKES IN THE WATERSHED HAVE RELATIVELY STABLE WATER LEVELS BECAUSE OF GOOD GROUND-WATER CONTRIBUTION AND THEY ARE AN IMPORTANT ALL-SEASON RECREATIONAL RESOURCE

Many of the smaller lakes provide fish and wildlife habitat. Lakes perched above the piezometric surface may dry up during droughts. Although little consumptive use is made of surface water it is potentially a valuable source of water supply.

Name of lake	Surface area (acres)	Length of shoreline (miles)	Depth (feet)		Outlet control	Composition of lake bottom	Type of shoreline	Fish and game classification	Remarks
			Maximum	Median or average					
Emily Lake (Pope County)	2,377	14	5.0	4	Dam washed out; may be replaced.	6 in. of silty clay over hard sand.	Mostly sand.	Migratory waterfowl resting area; rough fish and northern pike.	Dry in 1934; public access owned by State: hard-water lake.
Minnewaska Lake (Pope County)	7,110	20	32	17	Dam.	Shoal areas largely sand with some gravel and rubble.	Some marsh areas. 80 percent of shoreline is developed.	Migratory waterfowl nesting and resting area; large-mouthed bass, panfish, walleyes.	Public access owned by State: hard-water lake.
Norway Lake (Kandiyohi County)	2,764	—	35	—	Natural.	—	Sand and marl.	Northern pike lake—walleyes, bass, panfish.	Hard-water lake; public access.
Florida Lake (Kandiyohi County)	598	—	40	16	Connected to Florida Slough (dam) since Shakopee Creek diverted into lake (1958).	—	Sand, gravel, and rubble.	Large-mouthed bass, panfish, rubble, walleyes, some northern pike.	Hard-water lake; public access.
Florida Slough (Kandiyohi County)	1,644	9.7	6	4	Natural.	Mostly mud.	—	Waterfowl lake—some rough fish; occasional winterkill.	Public access.
Reno Lake (Pope County)	2,612	—	23	17	Natural.	—	80 percent sand and gravel.	Walleye lake—some northern pike, panfish.	Hard-water lake; access by road.
Chippewa Lake (Douglas County)	1,225	—	96	24	Dam.	—	75 percent sand, gravel, and rubble. 25 percent muck.	Walleyes, northern pike, migratory waterfowl resting area.	Hard-water lake.
Aaron Lake (Douglas County)	640	4.8	16	9	Dam on outlet to Moses Lake.	Deeper water mud, shoals 75 percent sand.	—	Large-mouthed bass lake—northern pike and panfish.	Hard-water lake; public road access.
Moses Lake (Douglas County)	821	—	32	16	Dam.	—	85 percent sand and rubble. 15 percent muck.	Walleyes and panfish, some northern pike.	Hard-water lake; public road access.
Lobster Lake (Douglas County)	1,438	—	55	—		—			Was head of Long Prairie River; public road access.
Red Rock Lake, main lake (Douglas County)	708	—	18	10	No outlet.	—	65 percent sand and rubble. 35 percent muck, clay.	Bullheads, panfish, some walleyes, bass.	Hard-water lake connected to Shallow, Lower, and Middle Red Rock Lakes during high water.

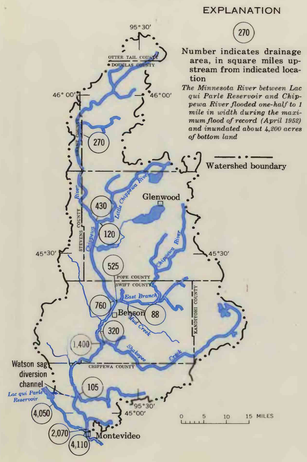
Data obtained from Minnesota Department of Conservation



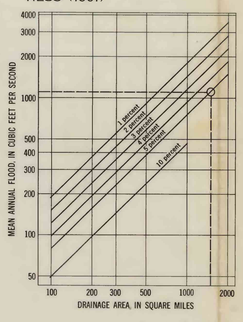
THE AVERAGE FLOW DIAGRAM SHOWS THE MAXIMUM QUANTITY OF WATER IN THE STREAM THAT COULD THEORETICALLY BE DEVELOPED FOR A WATER SUPPLY

Natural streamflow is variable and provision for a constant supply requires storage of high flow. Evaporation and seepage losses and lack of suitable reservoir sites prevent utilization of the maximum quantity available. Part of the flood flow in the lower Chippewa River is diverted through the Watson sag diversion channel into the Lac qui Parle reservoir.

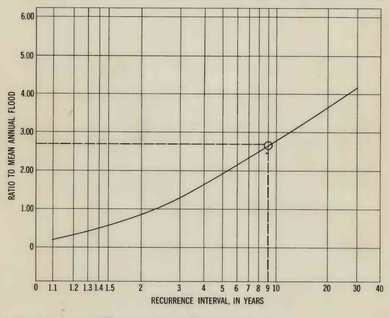
A—SITE MAP



B—RELATION CURVES BETWEEN MEAN ANNUAL FLOOD, DRAINAGE AREA, AND PERCENTAGE OF DRAINAGE AREA IN LAKES MODIFIED AFTER PRIOR AND HESS (1961)



C—FLOOD-FREQUENCY CURVE FOR CHIPPEWA RIVER WATERSHED MODIFIED AFTER PRIOR AND HESS (1961)



Example.—Find the recurrence interval of a flood of 3,000 cfs at a site of 1,500 sq mi drainage area of which 5 percent is lakes

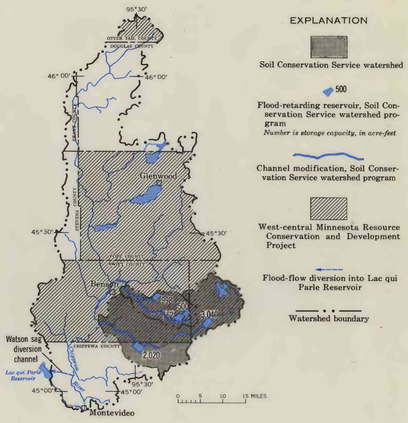
1. The 5 percent curve in graph *(B)* shows that for a drainage area of 1,500 sq mi the mean annual flood is 1,100 cfs
2. The ratio of the 3,000 cfs flood to the mean annual flood of 1,100 cfs is 3,000/1,000 = 2.7
3. Entering graph *(C)* with a ratio of 2.7, the flood-frequency curve shows that the 3,000 cfs flood will occur on an average once every 9+ years

The magnitude of a flood at a specified recurrence interval at this same site can also be found by reversed procedure

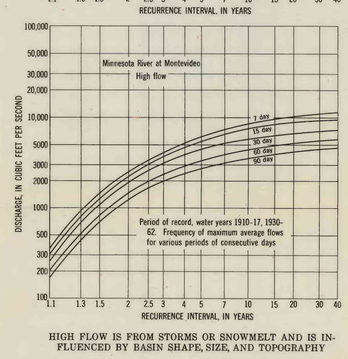
THE RECURRENCE INTERVAL OF A FLOOD OF SELECTED MAGNITUDE OF THE MAGNITUDE OF A FLOOD AT A SPECIFIED RECURRENCE INTERVAL CAN BE DETERMINED BY USE OF DRAINAGE AREA, (MAP *A* FOR SELECTED SITES), RELATION CURVES *(B)*, AND FLOOD-FREQUENCY CURVE *(C)*.

Most of the lakes in the northern and eastern parts of the watershed are effective in reducing peak flows. Floods on small drainage areas differ in characteristics from those on large drainage areas. Heavy local thunderstorm rainfall causes most of the small area floods. The unit runoff is greater for floods on small areas than those on large areas.

Spring Creek near Montevideo (see average flow diagram) is a crest-stage partial record gaging station on a small drainage area. The relation and frequency curves do not apply to the Minnesota River above the Chippewa River because of regulation of peak discharge by the Lac qui Parle Reservoir.

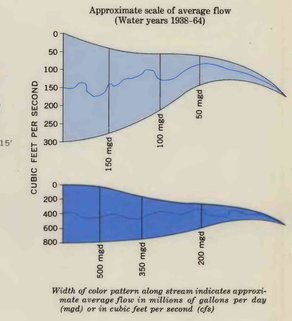


RESERVOIRS, CHANNEL MODIFICATIONS, DITCHING, AND IMPROVED LAND TREATMENT PRACTICES ARE DESIGNED TO REDUCE EROSION, SEDIMENT DAMAGE AND FLOODING, AND TO MAKE BETTER USE OF THE LAND AND WATER RESOURCES.



HIGH FLOW IS FROM STORMS OR SNOWMELT AND IS INFLUENCED BY BASIN SHAPE, SIZE, AND TOPOGRAPHY

Most of the maximum flows on the Chippewa River and Minnesota River between Lac qui Parle Reservoir and Montevideo are from snowmelt augmented at times by rainfall, although occasional summer floods causing crop damage are the most destructive. Damages from high water are affected by the height, duration, and frequency of flooding and the season of the year in which flooding occurs. The frequency and duration of floods are considerations in the design of structures for flood protection and control. High flow on the Minnesota River at Montevideo is affected by reservoir storage and the diversion of floodwater from the lower Chippewa River into Lac qui Parle Reservoir.



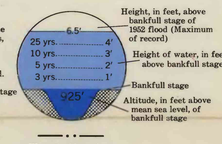
Width of color pattern along stream indicates approximate average flow in millions of gallons per day (mgd) or in cubic feet per second (cfs)

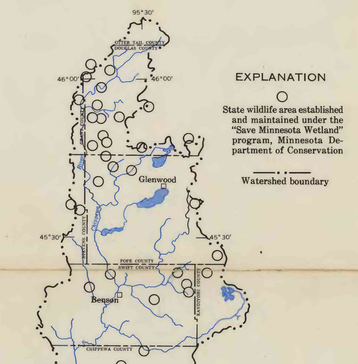
GAGING STATIONS

- Automatic recording
- Crest-stage, partial record
- Non-recording, continuous
- Miscellaneous measurement site

CHARACTERISTICS OF GAGE

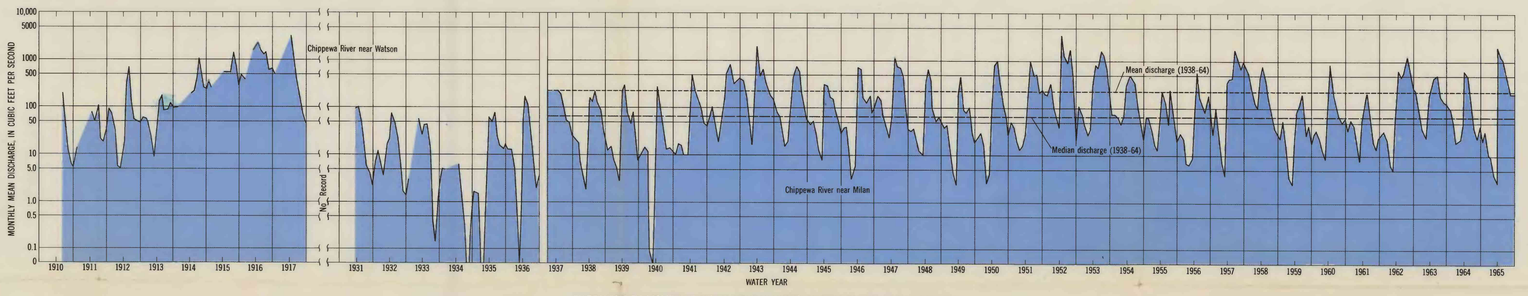
- Base-flow measurements
- Peak-flow measurements
- Unused or abandoned gage





WILDLIFE PROPAGATION AND PUBLIC HUNTING IN WETLAND AREAS ARE MAJOR USES OF SURFACE WATER IN THE WATERSHED

The 33 State wetland wildlife management areas shown on the map are managed to provide maximum wildlife production and public hunting. The lakes and potholes in the wildlife areas provide feeding, nesting, and resting areas for waterfowl, and surrounding drier areas provide habitat for pheasants, small game, and some deer.



VARIATION IN MONTHLY MEAN DISCHARGE IS SHOWN BY THE HYDROGRAPH

Streamflow records collected on the Chippewa River near Milan and near Watson are not considered equivalent records, although they show similar variation in the monthly mean discharge. A 65-day period of no flow occured near Milan, as the result of freezeup, during the winter of 1940. During the severe drought of the 1930's no flow occured near Watson for several months during the winter and open-water seasons, 1933–36.

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1968—W68001

WATER RESOURCES OF THE CHIPPEWA RIVER WATERSHED, WEST-CENTRAL MINNESOTA

By

R. D. Cotter, L. E. Bidwell, W. A. VanVoast, and R. P. Novitzki

1968