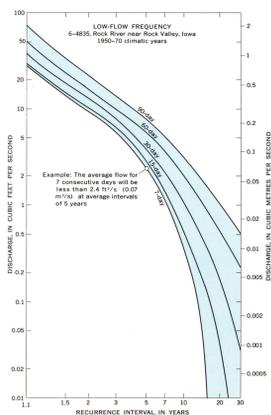
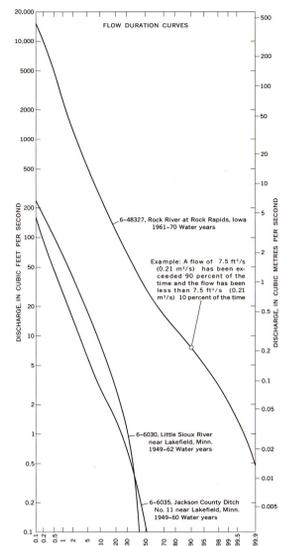


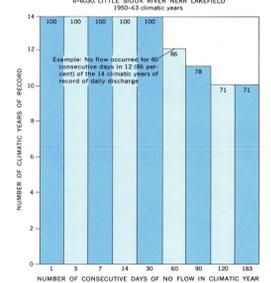
LOW FLOW AND DURATION



KNOWLEDGE OF LOW STREAMFLOW AND ITS FREQUENCY OF OCCURRENCE IS A NECESSITY IN THE ECONOMIC DESIGN OF WATER SUPPLY, POLLUTION ABATEMENT PROGRAMS, AND RECREATIONAL DEVELOPMENT PROJECTS. The slope of the frequency curve is a function of basin storage; the flatter the slope the more available storage. Because most low flows are largely ground-water discharge, the curves are good indicators of ground-water availability. The steep slopes of curves for Rock River near Rock Valley, Iowa, Station 6-4835, about 10 mi (16 km) south of the Minnesota border, indicate a small ground-water reserve. An area smaller reserve would be available upstream on the Rock River in the Minnesota part of the basin.



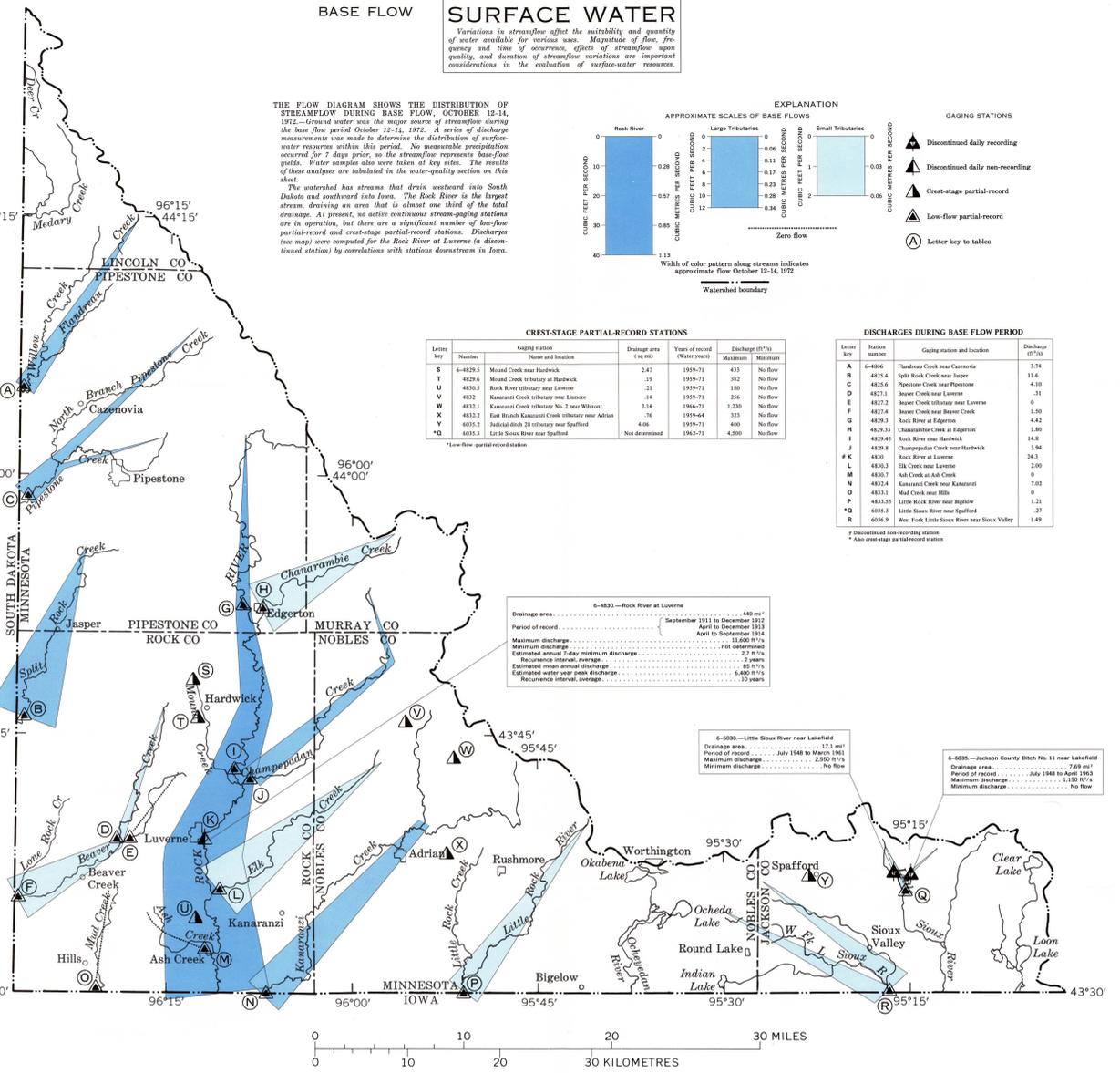
FLOW-DURATION CURVES PROVIDE A CONVENIENT MEANS FOR STUDYING STREAMFLOW AND BASIN CHARACTERISTICS. The curve for the Rock River is steep denoting that flow is highly variable and largely from direct runoff. Jackson County Ditch No. 11 and Little Sioux River, both in the southeastern part of the watershed, show the same characteristics. They only flow about 20 percent of the time. Steepness of the flow-duration curve, especially in the low end of the curve, reveals the lack of both surface- and ground-water storage.



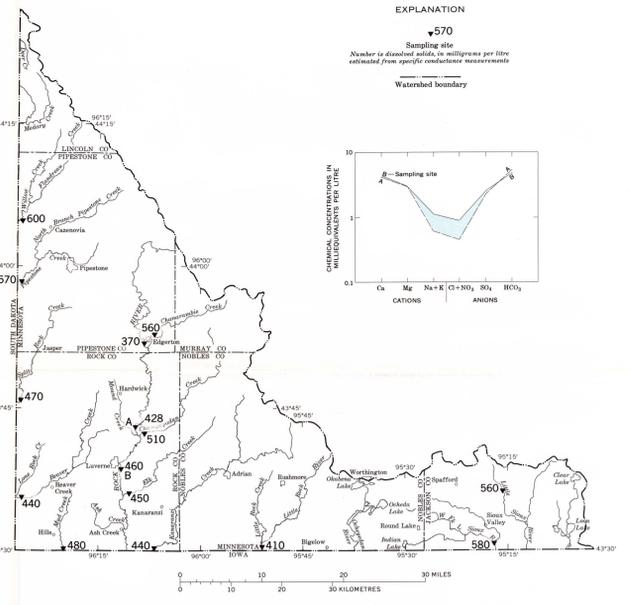
LACK OF NATURAL STORAGE IN THE LITTLE SIOUX RIVER IS SHOWN BY THE MANY CONSECUTIVE DAYS OF NO FLOW OCCURRING MOST YEARS. Example: No flow occurred for 60 consecutive days in 12 (66 percent) of the 11 climatic years of record of daily discharge.

BASE FLOW SURFACE WATER

Variations in streamflow affect the suitability and quantity of water available for various uses. Magnitude of flow, frequency and time of occurrence, effects of streamflow upon quality, and duration of streamflow variations are important considerations in the evaluation of surface-water resources.

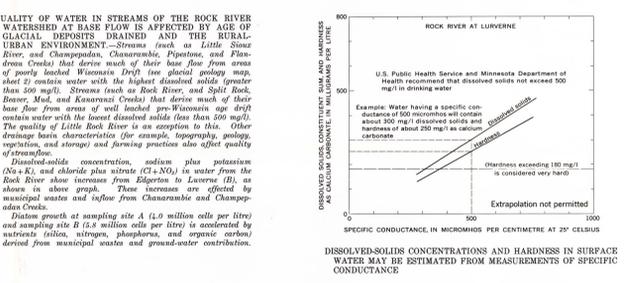


WATER QUALITY AT BASE FLOW



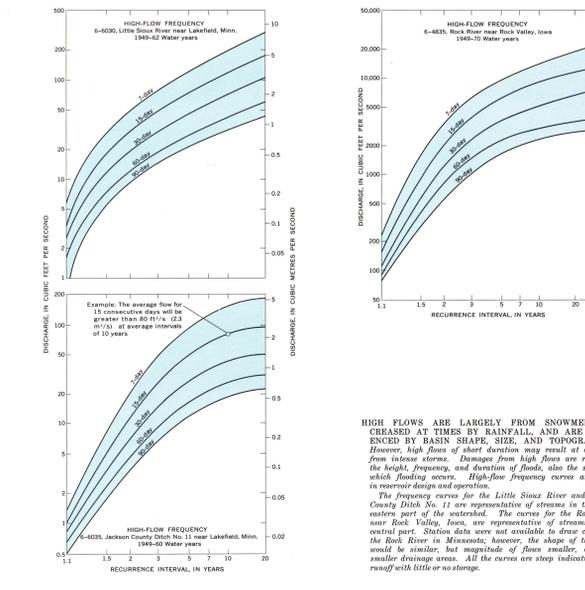
SELECTED CHEMICAL CONSTITUENTS IN ROCK RIVER AT BASE FLOW

Sample site	Dissolved solids (mg/l)	Hardness as calcium carbonate (mg/l)	Total nitrogen (N) (mg/l)	Ammonia nitrogen (N) (mg/l)	Nitrate nitrogen (N) (mg/l)	Organic nitrogen (N) (mg/l)	Total phosphorus (P) (mg/l)	Dissolved orthophosphate (P) (mg/l)
A	428	360	99	..	1.2	..	0.17	..
B	460	370	120	0.07	2.8	2.0	0.54	0.26



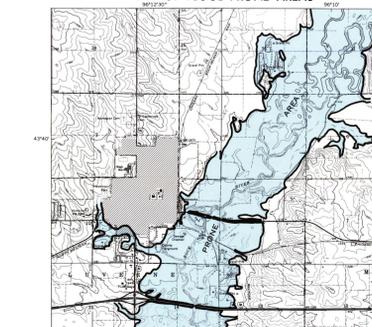
THE SELECTED LAKES ALONG WITH MANY OTHER LAKES, PONDS, AND WETLANDS ARE AN IMPORTANT ALL-SEASON RECREATIONAL RESOURCE. There are approximately 20 lakes in the watershed, almost all located in the northeastern part. They provide fish and wildlife habitats and are used for hunting, fishing, water sports, and general recreation. Although all the lakes are shallow, they do provide perch and warm-water type game fish, but the fish are subject to winterkill almost annually. When this condition exists, almost all the lakes are open by the Minnesota Division of Fish and Game to unrestricted fishing. The shallow, sandy waters are used by breeding and migrating waterfowl, making this one of the better duck hunting areas in the State.

HIGH FLOW AND FLOODS

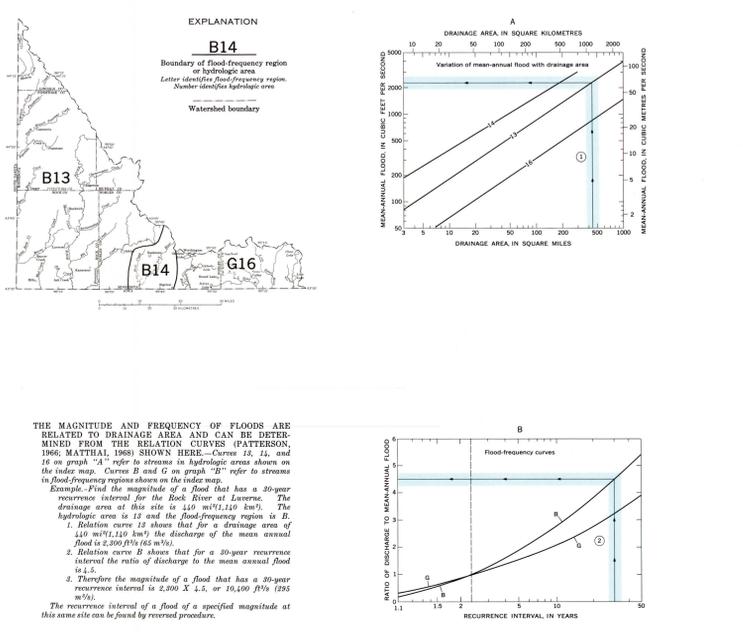


HIGH FLOWS ARE LARGELY FROM SNOWMELT, INCREASED AT TIMES BY RAINFALL, AND ARE INFLUENCED BY BASIN SHAPE, SIZE, AND TOPOGRAPHY. However, high flows of short duration may result at any time from intense storms. Discharges from high flows are related to the height, frequency, and duration of floods, also the season in which flooding occurs. High-flow frequency curves are used in reservoir design and operation. The frequency curves for the Little Sioux River and Jackson County Ditch No. 11 are representative of streams in the southeastern part of the watershed. The curves for the Rock River near Rock Valley, Iowa, are representative of streams in the central part. Station data were not available to draw curves for the Rock River in Minnesota; however, the shape of the curves would be similar, but magnitude of flows smaller, owing to smaller drainage areas. All the curves are steep, indicating rapid runoff with little or no storage.

MAP OF FLOOD-PRONE AREAS



THE MAGNITUDE AND FREQUENCY OF FLOODS ARE RELATED TO DRAINAGE AREA AND CAN BE DETERMINED FROM THE RELATION CURVES (PATTERSON, 1966; MATTHEI, 1968) SHOWN HERE. Curves B, C, and D on graph A refer to streams in high-flow regions shown on the index map. Example: Flood the magnitude of a flood that has a 30-year recurrence interval for the Rock River at Laverne. The drainage area at this site is 445 mi<sup>2</sup> (1,150 km<sup>2</sup>). The hydrologic area is 13 and the flood-frequency region is B. 1. Relation curve B shows that for a drainage area of 445 mi<sup>2</sup> (1,150 km<sup>2</sup>) the discharge of the mean annual flood is 2,200 cfs (62 m<sup>3</sup>/s). 2. Relation curve C shows that for a 30-year recurrence interval the ratio of discharge to the mean annual flood is 1.5. 3. Therefore the magnitude of a flood that has a 30-year recurrence interval is 2,200 x 1.5, or 3,300 cfs (93 m<sup>3</sup>/s). The recurrence interval of a flood of a specified magnitude at this same site can be found by reversed procedure.



THE SELECTED LAKES ALONG WITH MANY OTHER LAKES, PONDS, AND WETLANDS ARE AN IMPORTANT ALL-SEASON RECREATIONAL RESOURCE. There are approximately 20 lakes in the watershed, almost all located in the northeastern part. They provide fish and wildlife habitats and are used for hunting, fishing, water sports, and general recreation. Although all the lakes are shallow, they do provide perch and warm-water type game fish, but the fish are subject to winterkill almost annually. When this condition exists, almost all the lakes are open by the Minnesota Division of Fish and Game to unrestricted fishing. The shallow, sandy waters are used by breeding and migrating waterfowl, making this one of the better duck hunting areas in the State.

Name (county)	Surface area (acres)	Depth (ft)	Outlet	Outlet control	Fish and game classification	Remarks
Chandler (Jackson)	83	7	6	Natural	Waterfowl/muskrat	Used by migrating ducks. No public access. Lake dry in 1934.
Clear (Jackson)	413	9	4	Natural	Warm-water game fish	Artificially maintained as a fish lake through stocking. Has public access. Open to unrestricted fishing some winters. Recently stocked with northern pike, white and creeked, and walleye fry.
Green (Jackson)	222	-	-	Natural	Waterfowl/muskrat	Aquatic-herbicide habitat is excellent. Mostly in low.
Hills (Jackson)	246	3	1.5	Natural	Waterfowl/muskrat	Aquatic-herbicide habitat is excellent. Access possible from road on south shore.
Little Split (Jackson)	434	10.5	1.5	---	Warm-water game fish	Rough fish removed periodically. Open to unrestricted fishing some winters. Recently stocked with northern pike, white and creeked, and walleye fry. Partly in low.
Loon (Jackson)	728	6.5	4	Dam	Waterfowl/muskrat	Has public access. Abundant rough fish.
Paul (Jackson)	117	9	5	Natural	Waterfowl/muskrat-muskrat	Has public access. Rough fish removed periodically. Open to unrestricted fishing some winters. Recently stocked with northern pike, white and creeked, and walleye fry.
Round (Jackson)	947	8	6.5	Dam	Marginal fish and game lake	Has public access. Rough fish removed periodically. Open to unrestricted fishing some winters. Recently stocked with northern pike, white and creeked, and walleye fry.
Shank (Jackson)	243	Less than 6	-	Natural	Waterfowl/muskrat	Good habitat for forbeses. Frequently dry in.
Indian (Jackson)	204	7	-	Dam	Bullhead-walleye	Has public access. Rough fish removed periodically. Open to unrestricted fishing some winters. Recently stocked with northern pike, white and creeked, and walleye fry.
Oscha (Jackson)	1,378	7	4	Dam	---	Has public access. Open to unrestricted fishing some winters. Fish control central on east margin. Good habitat for muskrat.
Oscha (Jackson)	785	15	8	Dam	Warm-water game fish	Rough fish removed periodically. Has public access. Open to unrestricted fishing some winters. Fish control central on east margin. Fish. Most recent were walleye fry and coho salmon.
Split Rock (Popeham)	80	20	6	Dam	---	Has public access. Open to unrestricted fishing some winters. Fish control central on east margin. Fish. Most recent were walleye fry and coho salmon.

Base from U.S. Geological Survey 1:250,000 series, Farmington, Minn., 1954; Sioux Falls, 1955; and Waterloo, 1953, 5. Data.