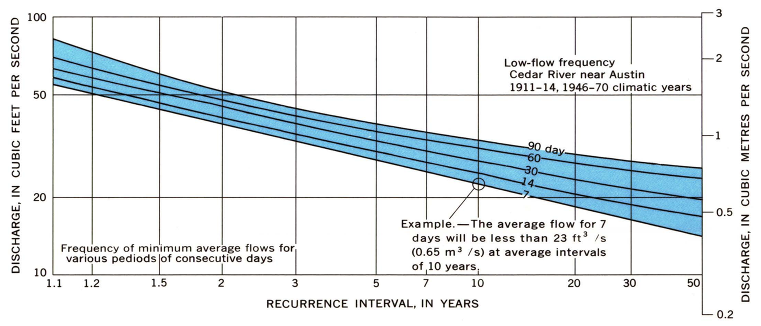
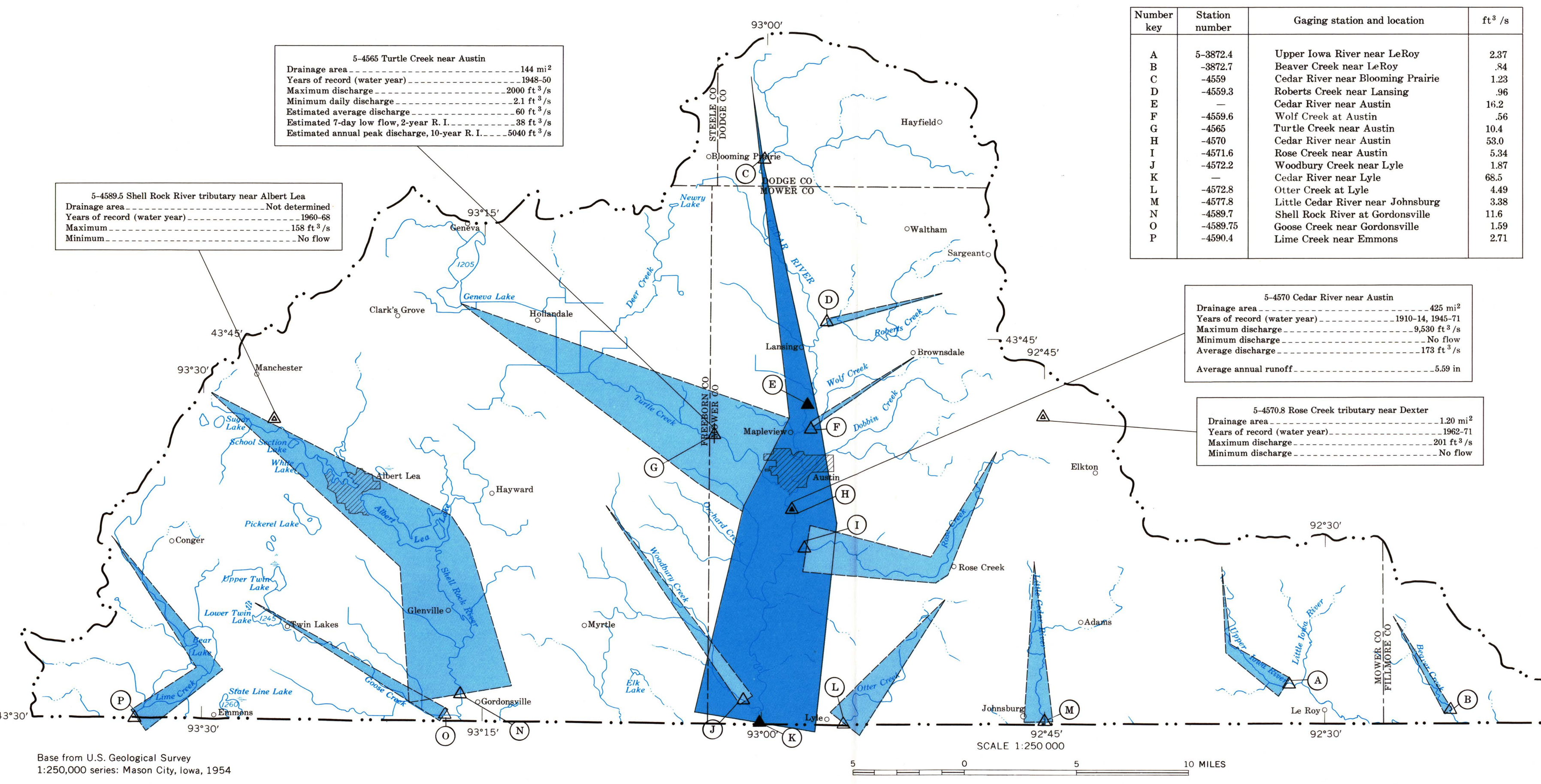
# SURFACE WATER

*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.*

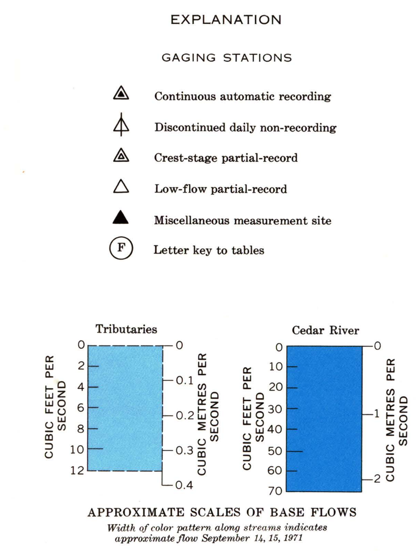


LOW FLOW IS LARGELY FROM GROUND-WATER SOURCES, AND ITS DURATION AND OCCURRENCE ARE CONSIDERED IN THE DESIGN OF WATER SUPPLY, POLLUTION ABATEMENT PROGRAMS, AND RECREATIONAL DEVELOPMENT PROJECTS—*Low-flow frequency curves show the average interval and maximum number of days in which flow would be less than a specified discharge. These curves can be used to predict the probabilities of low streamflows, assuming no change in basin characteristics.*



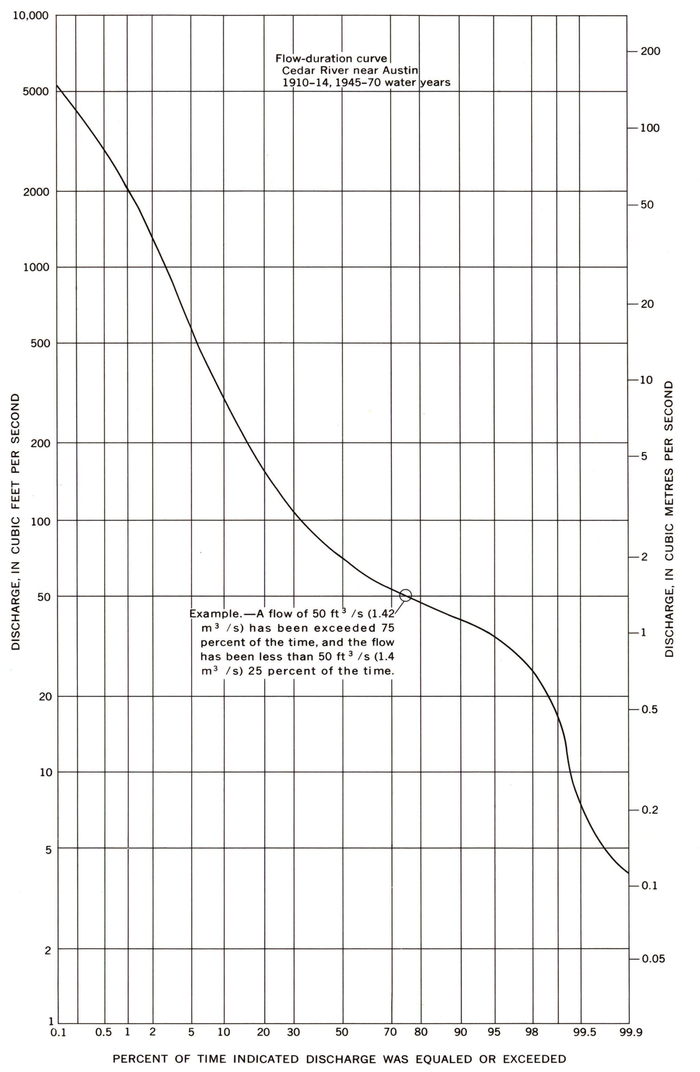
DISCHARGES DURING BASE FLOW PERIOD

| Number key | Station number | Gaging station and location | ft³/s |
|---|---|---|---|
| A | 5-3872.4 | Upper Iowa River near LeRoy | 2.27 |
| B | -3872.7 | Beaver Creek near LeRoy | .64 |
| C | -4559 | Cedar River near Blooming Prairie | 1.25 |
| D | -4559.3 | Roberts Creek near Lansing | .96 |
| E | | Cedar River near Austin | 34.2 |
| F | -4559.6 | Wolf Creek at Austin | .56 |
| G | -4565 | Turtle Creek near Austin | 10.4 |
| H | -4570 | Cedar River near Austin | 52.0 |
| I | -4571.6 | Rose Creek near Austin | 3.34 |
| J | -4572.2 | Woodbury Creek near Lyle | 1.87 |
| K | | Cedar River near Lyle | 66.1 |
| L | -4572.8 | Otter Creek at Lyle | 4.49 |
| M | -4577.8 | Little Cedar River near Johnsburg | 3.26 |
| N | -4589.7 | Shell Rock River at Gordonsville | 11.6 |
| O | -4589.75 | Goose Creek near Gordonsville | 1.59 |
| P | -4590.4 | Lime Creek near Emmons | 2.71 |



THE FLOW DIAGRAM SHOWS DISTRIBUTION OF STREAMFLOW DURING THE BASE-FLOW PERIOD SEPTEMBER 14-15, 1971

*Ground water and lake storage were the major sources of streamflow during the base-flow investigation. A series of discharge measurements was made to determine the distribution of surface-water resources within the given time interval. No measurable precipitation occurred for 5 days prior to this period, so the measured streamflow represents base-flow yields. At the gaging station, Cedar River near Austin, the flow was at the 70 percentile on the flow-duration curve and had a 1.14-year recurrence interval on the 7-day low-flow frequency curve. Average increase in flow of the Cedar River contributed by ground water during this base-flow period was 1.71 ft³/s per river mile [(0.030 m³/s)/km]. The two largest tributaries, Turtle Creek, which joins the Cedar River at Austin, and Shell Rock River in Iowa, had increases in flows of 0.26 ft³/s per river mile [(0.006 m³/s)/km] and 0.55 ft³/s per river mile [(0.010 m³/s)/km].*



THE FLOW-DURATION CURVE OF THE CEDAR RIVER CAN BE USED TO DETERMINE STREAMFLOW AND BASIN CHARACTERISTICS—*A curve with a steep slope throughout denotes a highly variable stream whose flow is largely derived from direct runoff, whereas a curve with a flat slope reveals appreciable surface- or ground-water storage, which tends to equalize the flow. The lower end of the curve is a valuable means for studying the effect of geology on ground-water runoff to the stream. The curve for the Cedar River has a steep slope, both in the high and the low ends, denoting little or no storage, either natural or artificial. The steep slope at the low end denotes little ground-water storage.*

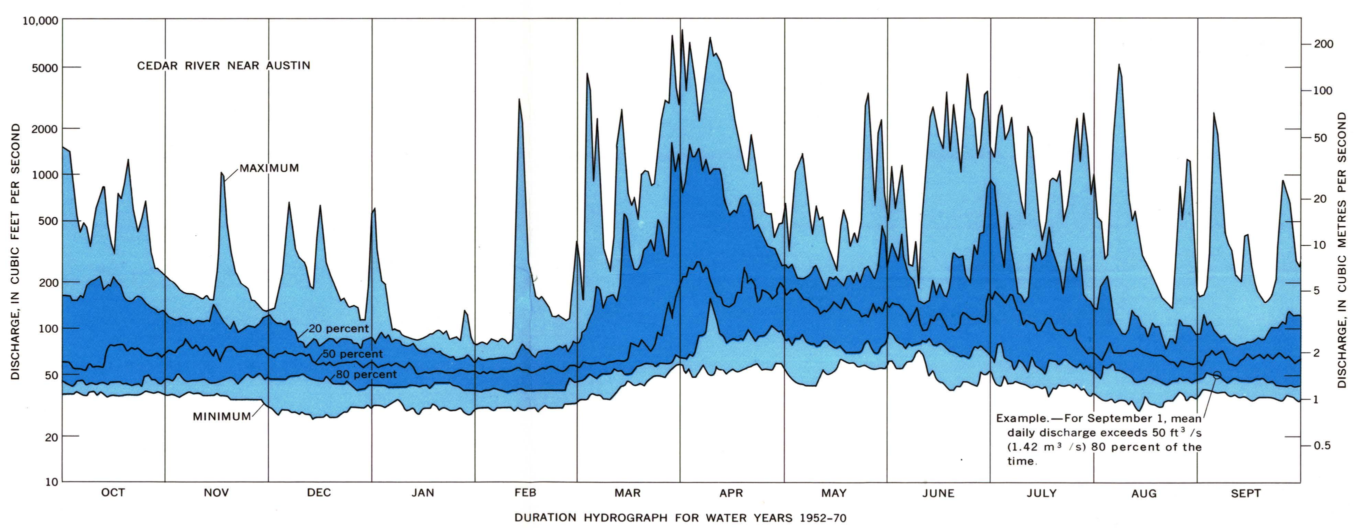
*Duration curves are used to predict the percentage of time a specified discharge will be equaled or exceeded. By subtraction, the percentage of time that flow may be equal to or less than a specified amount may also be predicted.*

LARGE LAKES

Data obtained from Minnesota Department of Natural Resources. All lakes are in Freeborn County

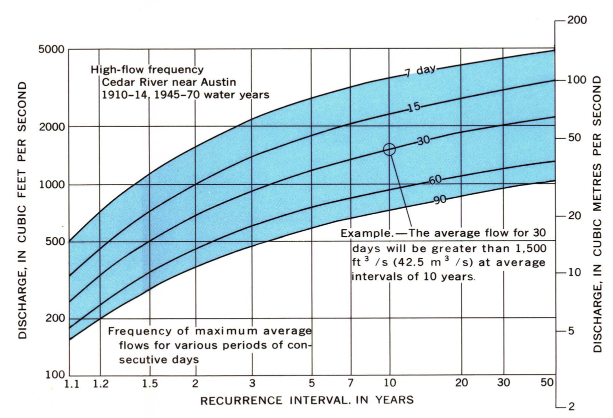
| Name | Surface area (acres) | Depth (feet) Maximum | Depth (feet) Average or Median | Outlet control | Fish and game classification | Remarks |
|---|---|---|---|---|---|---|
| Albert Lea | 2,656 | 6.5 | 3.5 | Dam | Rough fish—bullhead—permanent waterfowl lake. | Managed for bullheads and waterfowl. Has public access. Has large amounts of algae growths. Has winterkill almost annually. |
| Bear | 1,360 | 3.5 | — | Dam | Waterfowl—muskrat. | Sufficient amounts of feed plants for ducks. Has public access. Rough fish abundant. |
| Fountain | 555 | 19 | 5 | Dam | Permanent waterfowl—borderline fish lake. | Has public access. Has winterkill. Rough fish abundant. Recently stocked with adult crappies and northern pike yearlings. Maintained for recreational purposes. |
| Geneva | 1,875 | 8 | 3.5 | Dam | Waterfowl—muskrat. | Has public access. Has winterkill. Rough fish abundant. |
| Pickerel | 715 | 4 | 3 | Dam | Waterfowl—muskrat. | Has public access. Chemically treated in 1966 to eliminate rough fish. Stocked in 1968 with crappie and sunfish yearlings and adults and northern pike yearlings. |
| State Line | 446 | 5 | 3.5 | Dam | Waterfowl—muskrat. | Has public access. Stocked in 1968 with crappie and sunfish yearlings. Has winterkill. |
| Lower Twin | 480 | 4 | 2 | Natural | Waterfowl—muskrat. | No public access. Habitat conditions very good for waterfowl. Has winterkill almost annually. Rough fish abundant. |
| Upper Twin | 677 | 4.5 | 2 | Natural | Waterfowl—muskrat. | No public access. Habitat conditions good for muskrat. Has winterkill almost annually. |

MINNESOTA IS A WATERFOWL BREEDING AREA SECOND TO NONE IN THE MISSISSIPPI FLYWAY—*These lakes, along with many smaller lakes, ponds, wetlands, and potholes are among the best waterfowl producing areas on the continent. Many of the lakes also supply bullhead and crappie fishing but are subject to winterkill almost annually.*

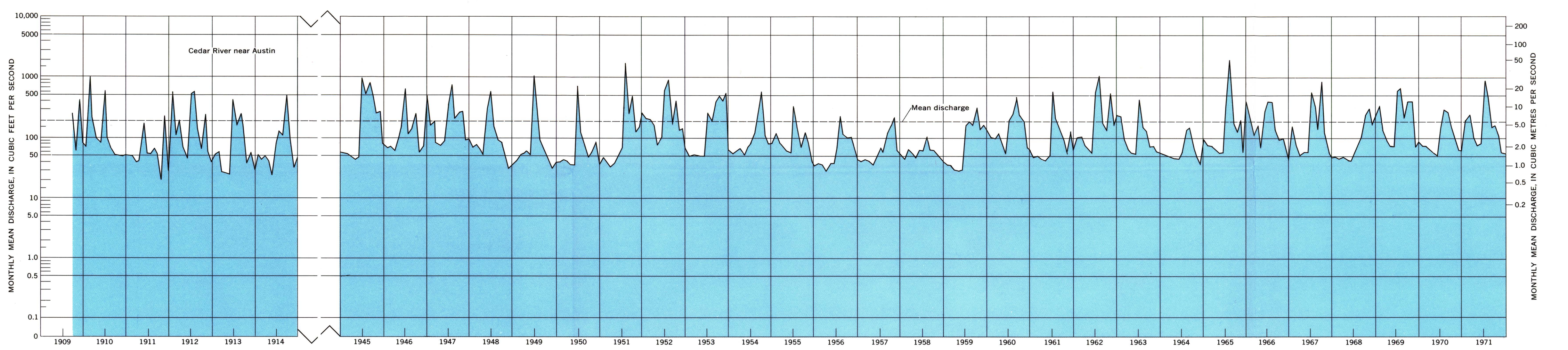


SEASONAL VARIATION OF FLOW FOR CEDAR RIVER NEAR AUSTIN FOR A 19-YEAR PERIOD IS SHOWN BY THE DAILY DURATION HYDROGRAPH

*The smallest range in flow occurs during the end of January and early February, whereas the greatest range is at the end of March and early April. Flows are generally minimal during winter when they are sustained almost entirely by ground-water discharge. Maximum flows generally occur as a result of the spring thaw.*

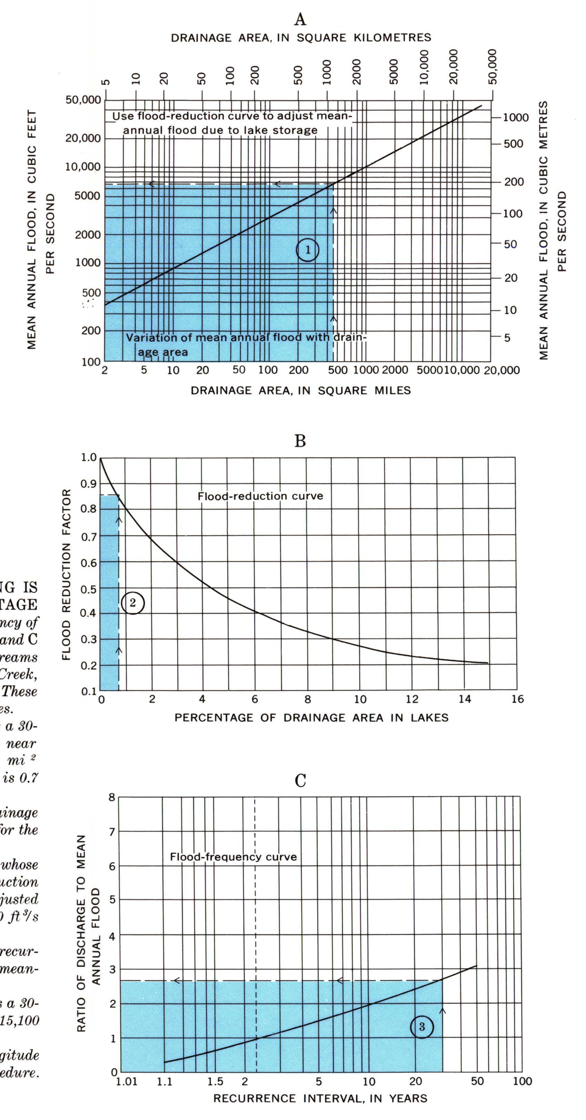


HIGH FLOWS ARE LARGELY DERIVED FROM SNOWMELT, AUGMENTED AT TIMES BY RAINFALL, AND ARE INFLUENCED BY BASIN SHAPE, SIZE, AND TOPOGRAPHY—*However, high flows of short duration may occur at any time as a result of intense storms. High-flow frequency curves are used for design of flood-control structures and in solving problems of reservoir design and operation. They show the average interval in years at which a specified discharge is expected to recur as the high discharge and the maximum number of days during which the flow would be greater than the specified discharge.*



STREAMFLOW IN THE CEDAR RIVER IS VARIABLE AND IS INFLUENCED BY VARIATION OF TEMPERATURE AND PRECIPITATION

*Generally, highest streamflow results from snowmelt in the spring, followed by a recession through late summer, fall, and winter. Low flow occurs during extended periods of sub-freezing weather or deficient rainfall. The lowest monthly mean discharge for the period of record was in July 1911, and the highest was in April 1965.*

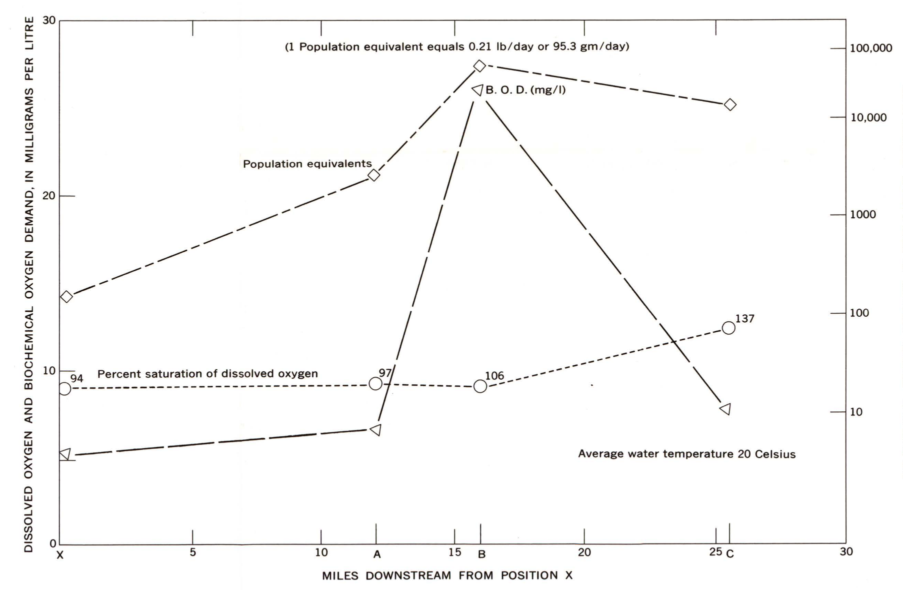


FREQUENCY AND MAGNITUDE OF FLOODING IS RELATED TO DRAINAGE AREA AND PERCENTAGE OF BASIN IN LAKES—*The magnitude and frequency of floods can be determined from the relation curves* A, B, *and* C *(Patterson and Gamble, 1968). These curves refer to streams within the Cedar River watershed but exclude Turtle Creek, Shell Rock River, Goose Creek, and Lime Creek. These streams would require a different set of relation curves.*

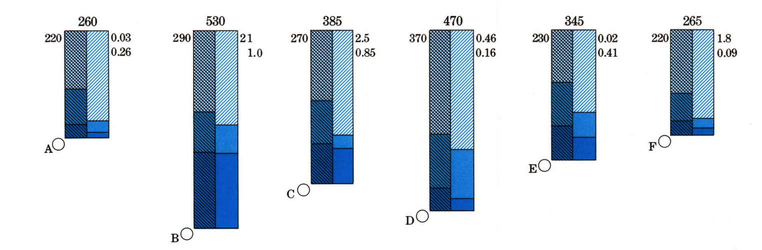
*Example.—Find the magnitude of a flood that has a 30-year recurrence interval for the Cedar River near Austin. The drainage area at this site is 425 mi² (1101 km²), and the area of lakes above the site is 0.7 percent of the total drainage area.*

1. *Relation curve "A" shows that for a drainage area of 425 mi² (1101 km²) the discharge for the mean annual flood is 6,600 ft³/s (187 m³/s).*
2. *Relation curve "B" shows that for a site whose drainage is 0.7 percent lakes, the flood reduction factor is 0.85; thus, the discharge for the adjusted mean-annual flood is 6,600×0.85 or 5,610 ft³/s (159 m³/s).*
3. *Relation curve "C" shows that for a 30-year recurrence interval the ratio of discharge to the mean-annual flood is 2.70.*
4. *Therefore, the magnitude of a flood that has a 30-year recurrence interval is 5,610×2.70 or 15,100 ft³/s (428 m³/s).*

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



WATER QUALITY AT BASE FLOW SEPTEMBER 14–15, 1971

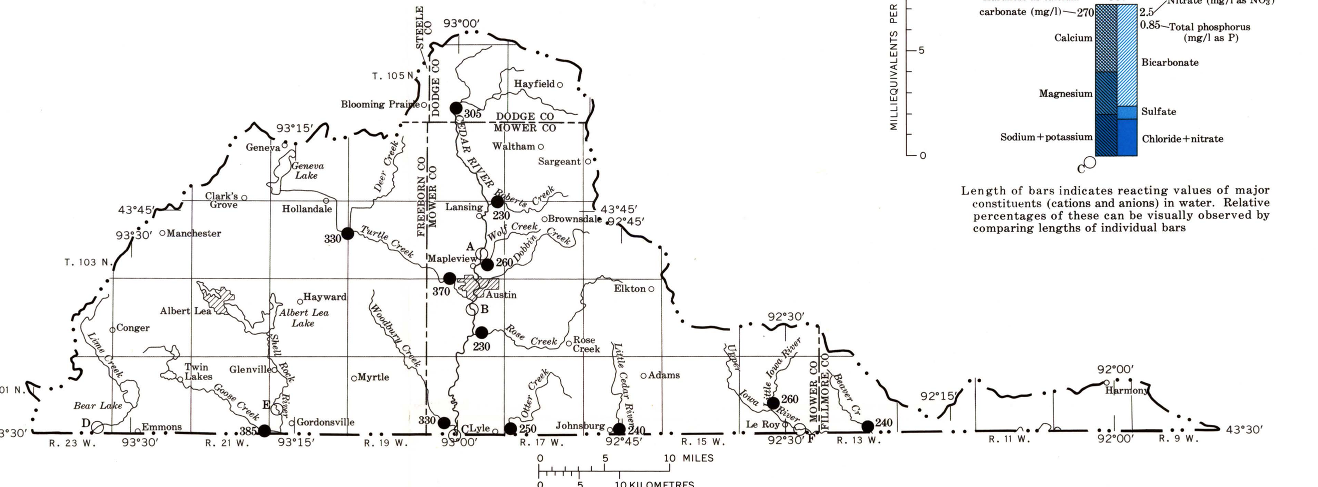


BACTERIAL AND OXYGEN MEASUREMENTS MADE IN THE CEDAR RIVER PROFILE REFLECT ENVIRONMENTAL INFLUENCES UPON WATER QUALITY AND ECOLOGY.

*Total coliform bacteria population (TCBP) in the stream and the time when samples were collected for measurements follow. (See accompanying graph.)*

| *Site* | *Time of day* | *TCBP* |
|---|---|---|
| X | 8:30 AM | 1900 |
| A | 11:30 AM | 550 |
| B | 5:00 PM | 7500 |
| C | 6:30 PM | 1200 |

*Increases in biochemical oxygen demand and total coliform bacteria result from waste disposal to the Cedar River from the Austin area. The contribution of waste nutrients causes an increase in algal growth (floating and attached) during the day. This increased growth effects a rise in percentage of saturation of dissolved oxygen, even though oxygen demand is increased. Oxygen depletion may occur at night and under ice cover, when oxygen consumption by respiration and biochemical oxygen demand exceeds oxygen output by photosynthesis.*

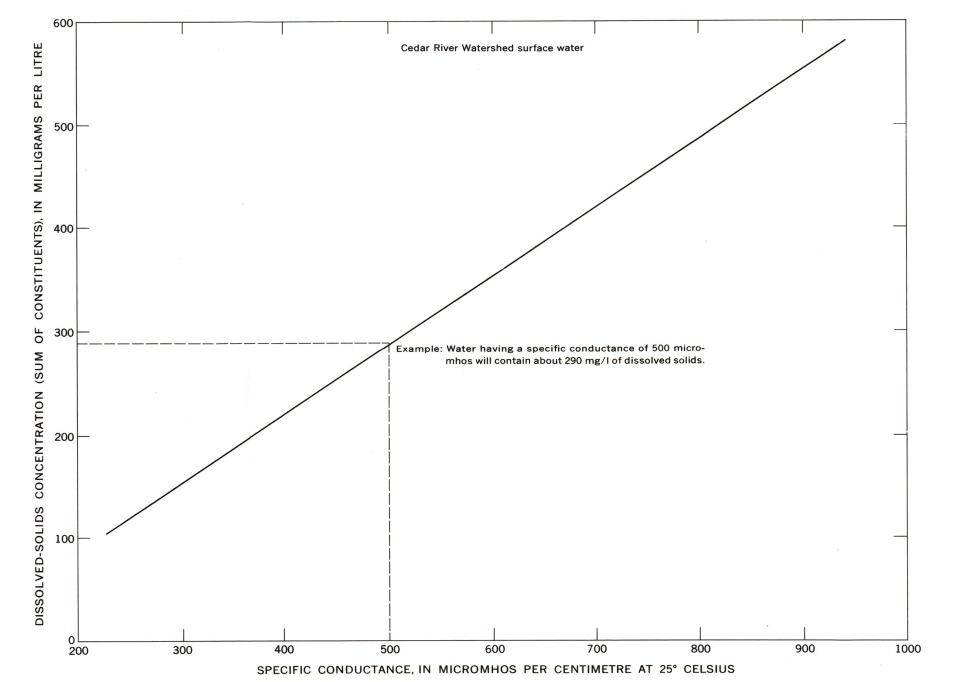


CHEMICAL QUALITY OF SURFACE DRAINAGE IS INFLUENCED BY GLACIAL GEOLOGY AND THE FARMING-INDUSTRIAL ENVIRONMENT OF THE WATERSHED

*Streams that drain the part of the watershed west of the Cedar River contain water with a greater range of dissolved solids and a greater percentage of sulfate than those that drain the part to the east. Samples* (B, C, E) *taken from streams that drain metropolitan areas contain larger percentages of sodium and chloride and larger concentrations of nitrate and phosphorus than samples* (A, D, F) *from other streams.*

*The daily contribution of dissolved solids, chloride, and nutrients to the Cedar River from the metropolitan area of Austin during base-flow period September 14–15, 1971 was estimated to be:*

| | *Short tons/day (1 ton=2,000 lbs)* | *Metric tons/day (1 tonne=2,205 lbs)* |
|---|---|---|
| *Dissolved solids* | *53.7* | *48.7* |
| *Chloride* | *15.2* | *13.8* |
| *Nitrate* | *3.0* | *2.7* |
| *Phosphorus* | *.13* | *.12* |



DISSOLVED-SOLIDS CONCENTRATIONS IN SURFACE WATER MAY BE ESTIMATED FROM MEASUREMENTS OF SPECIFIC CONDUCTANCE

Interior—Geological Survey, Reston, Virginia—1975—W74060

# WATER RESOURCES OF THE CEDAR RIVER WATERSHED, SOUTHEASTERN MINNESOTA

By
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