SURFACE WATER

Station no. 4-0275
White River near Ashland
Drainage area: 269 square miles
Period of record: 1948-present[1]
Maximum instantaneous discharge: 6,270 cfs
Average discharge, 22 years: 286 cfs
Minimum instantaneous discharge: 3.1 cfs

Station no. 4-0255
Bois Brule River at Brule
Drainage area: 118 square miles
Period of record: 1942-present[1]
Maximum instantaneous discharge: 1,520 cfs
Average discharge, 28 years: 169 cfs
Minimum instantaneous discharge: 67 cfs

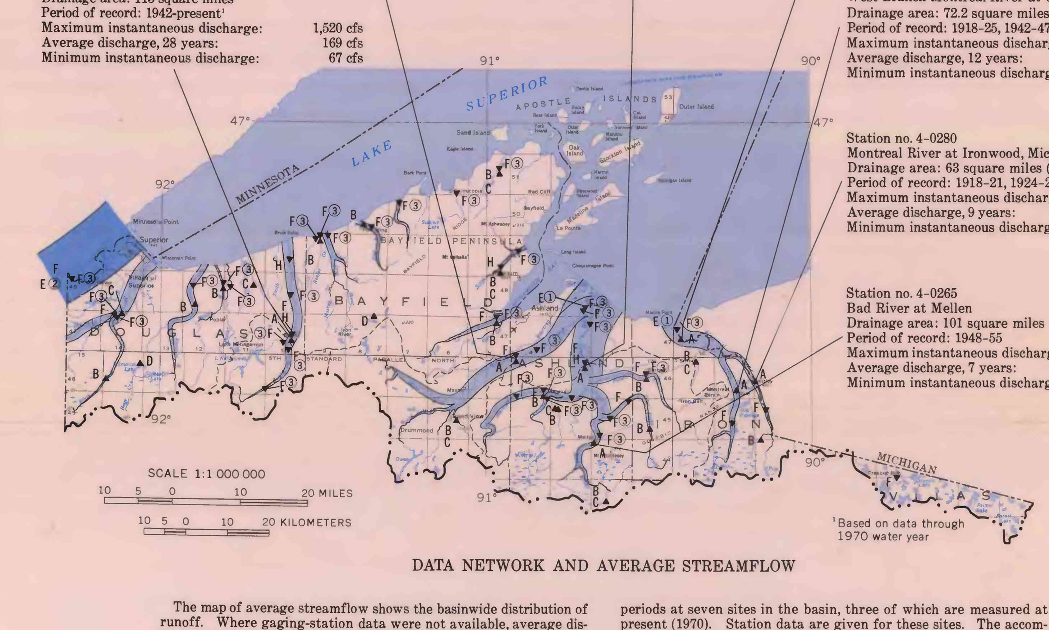
Station no. 4-0270
Bad River near Odanah
Drainage area: 611 square miles
Period of record: 1914-22, 1948-present[1]
Maximum instantaneous discharge: 27,700 cfs
Average discharge, 30 years: 602 cfs
Minimum instantaneous discharge: 49 cfs

Station no. 4-0300
Montreal River near Saxon
Drainage area: 262 square miles
Period of record: 1938-70
Maximum instantaneous discharge: 6,600 cfs
Average discharge, 32 years: 325 cfs
Minimum instantaneous discharge: 2 cfs

Station no. 4-0290
West Branch Montreal River at Gile
Drainage area: 72.2 square miles
Period of record: 1918-25, 1942-47
Maximum instantaneous discharge: 1,550 cfs.
Average discharge, 12 years: 79.5 cfs
Minimum instantaneous discharge: 1.2 cfs

Station no. 4-0280
Montreal River at Ironwood, Mich.
Drainage area: 63 square miles (approximate)
Period of record: 1918-21, 1924-25, 1949-54
Maximum instantaneous discharge: 1,810 cfs
Average discharge, 9 years: 75.3 cfs
Minimum instantaneous discharge: 0.1 cfs

Station no. 4-0265
Bad River at Mellen
Drainage area: 101 square miles
Period of record: 1948-55
Maximum instantaneous discharge: 4,340 cfs
Average discharge, 7 years: 131 cfs
Minimum instantaneous discharge: 3.8 cfs

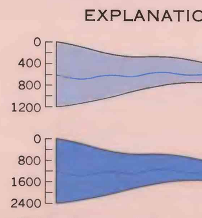


[1]Based on data through 1970 water year

DATA NETWORK AND AVERAGE STREAMFLOW

The map of average streamflow shows the basinwide distribution of runoff. Where gaging-station data were not available, average discharge was estimated by correlating measurements at the low-flow sites with records at nearby gaging stations. Stream discharge has been monitored continuously during several periods at seven sites in the basin, three of which are measured at present (1970). Station data are given for these sites. The accompanying flow-frequency and flow-duration curves are based on these continuous records. Sites of past and present measurements of discharge and other surface-water parameters are shown on the map.

EXPLANATION



Width of pattern indicates approximate average discharge of stream, in cfs (cubic feet per second). Discharge less than 25 cfs not shown

Measurement site symbol*	Parameter measured	Frequency of measurement
A▲	Stream discharge	Continuous
B▲	Low-flow stream discharge	Intermittent
C▲	Floodflow stream discharge	Periodic
D▲	Lake stage	Periodic
E▼	Chemical quality	Monthly
F▼	Chemical quality	Intermittent
H▼	Sediment	Intermittent

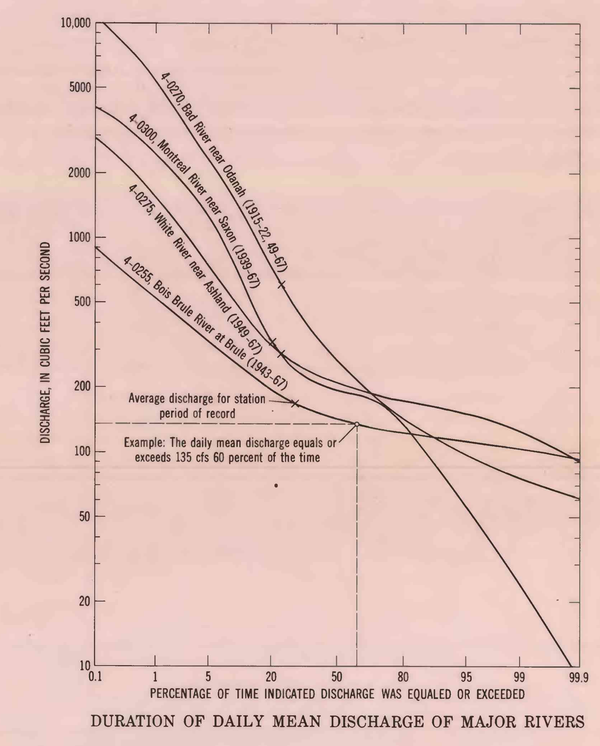
*Letter to left indicates present (1970) measurement; letter to right indicates discontinued measurement

① Operated by the Wisconsin Department of Natural Resources
② Operated by the Minnesota Pollution Control Agency
③ Operated by the U.S. Bureau of Commercial Fisheries
All others, U.S. Geological Survey

Boundary of basin above active continuous record station

Basin divide

Although an annual average of almost 640 billion gallons of surface water flows to Lake Superior from the basin, large quantities of surface water are available for use only from the lake itself and from the short reach of the St. Louis River on the northwestern boundary of the basin. Lake Superior has the largest surface area of any fresh-water lake in the world. Its volume is about 3,000 cubic miles, and the average outflow through regulatory works at Sault Ste. Marie, Mich., is 73,100 cfs (cubic feet per second). Within the basin, only moderate flows (100–200 cfs) are sustained in the White, Nemadji, and Bois Brule Rivers and, to a lesser extent, in the Bad and Montreal Rivers. Many streams are short and have small or intermittent flows. Inland lakes are numerous in the eastern detached part of the basin and in the headwaters of the White and Iron Rivers, but few occur elsewhere. Seven lakes have areas of 1 square mile or more (Wisconsin Department of Natural Resources, 1968a). Water quality in most inland waters and in Lake Superior is good except for some sediment problems.



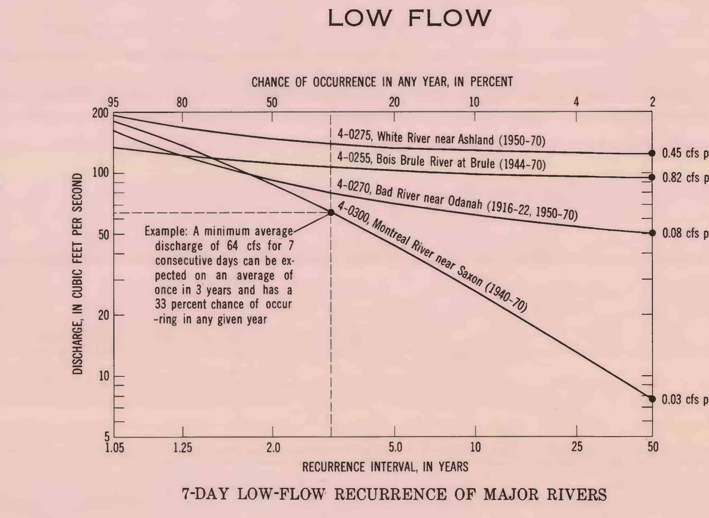
DURATION OF DAILY MEAN DISCHARGE OF MAJOR RIVERS

Flow-duration curves show the percentage of time specified discharges were equaled or exceeded in a given time period. The curves reflect the hydrologic characteristics of the basins and show the probable availability of a given streamflow. Average discharges at the gaging stations represented range from 20- to 29-percent duration in this basin.

The lower part of the duration curves represents low flow at the gaging stations. The flat slopes of the White and, especially, the Bois Brule Rivers indicate a nearly constant and uniform release of stored ground water. The Bois Brule basin has an exceptionally large ground-water storage capacity, considering its size. The very steep lower part of the curve for the Montreal River is a result of small ground-water storage capacity, which causes extremely low flows during drought, as in the 1940's. Ground-water storage in the Bad River basin is small also; its low-flow discharges are smaller than those of the White River near Ashland, although it has twice the drainage area.

High flows at the gaging stations are represented by the upper end of the flow-duration curves. The steep slopes of most of the curves indicate that basin storage is small; thus, short-term high flows are attributed to heavy rainfall or rapid snowmelt. Large ground-water recharge and storage are indicated by the flatter slope of the upper part of the curve for the Bois Brule.

LOW FLOW



7-DAY LOW-FLOW RECURRENCE OF MAJOR RIVERS

A knowledge of low-flow variability of a stream is necessary to determine adequacy of streamflow to supply minimum needs, to maintain reservoir storage, to estimate ground-water discharge, or to estimate a stream's capacity to accommodate and transport waste.

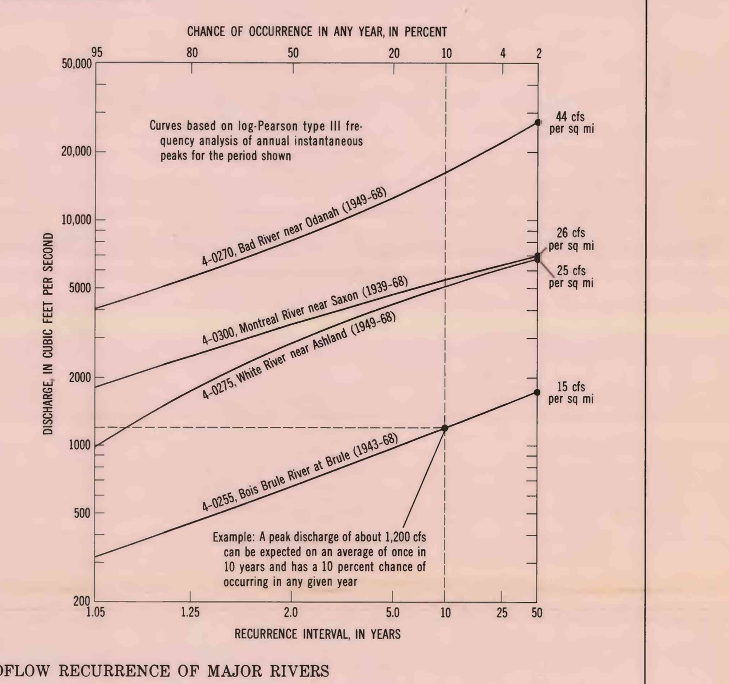
A common low-flow index is the recurrence interval of the lowest average discharge for 7 consecutive days in a year. The low-flow frequency curves give the probable recurrence interval and chance of occurrence in any year of a minimum 7-day average discharge of given magnitude at the gaging stations.

Low-flow discharge depends upon basin size and basin characteristics presented in the section "Distribution of low-flow runoff". Differences in these characteristics and their effect on low-flow runoff are indicated by the differences in discharge per unit area. The 7-day low flow at a 50-year recurrence interval is given in cubic feet per second per square mile for each basin. The Bois Brule and White Rivers have large low-flow runoff unit area because recharge and ground-water storage are large. The Montreal and Bad Rivers have small low-flow runoff because ground-water storage is small and evapotranspiration is higher in their subbasins than in most of the Lake Superior basin. In addition, the record for the Montreal River, unlike the other rivers shown, includes several years in the 1940's when precipitation was below normal; thus, its extremely low flows at large recurrence intervals are not comparable with those for the other streams.

FLOODFLOW

Damaging floods are infrequent, and economic losses are minimal, primarily because of the lack of urban development on the narrow flood plains. Most flooding is near mouths of streams at Lake Superior. The rate of average annual damages was estimated in 1970 to be $224,000—$219,000 urban and $5,000 rural (Great Lakes Basin Commission, written commun., 1971). Damages have occurred from the Bad River at Odanah and Mellen and from a small creek at Bayfield. In addition, highway bridges and culverts on several streams have been damaged or inundated near Lake Superior. The village of Odanah has been resettled 2 miles southeast of its old site since the last major flood on the Bad River in August 1960. Also, a flood-control structure was built at Bayfield in 1954.

Annual peak stages usually occur in the spring due to snowmelt and, occasionally, concurrent rainfall. However, the highest peaks of rec-ord commonly occur in the summer, as a result of widespread and heavy rains of many hours duration. High stages in flat reaches of streams often are increased by backwater from ice or debris jams.



FLOODFLOW RECURRENCE OF MAJOR RIVERS

Flood-frequency curves show the probable recurrence interval of a discharge of given magnitude and the chance of that discharge in any year. Flood discharges generally are related directly to the size of the drainage area and are a result of rapid runoff from precipitation and (or) snowmelt. Differences in discharge per unit area among basins are due mainly to differences in the following: 1) the intensity and duration of precipitation; 2) channel characteristics; 3) land slope; 4) storage capacity in lakes, marshes, and aquifers; 5) soil infiltration; 6) land-use practices; and 7) shape of the drainage basin. The flood-frequency curves shown plot in an order relative to drainage area, but different rates of flood runoff per unit area indicate differences in flood-controlling characteristics. Runoff, in cubic feet per second per square mile, for each basin is shown for the 50-year flood. The Bad River has the highest flood-runoff rate, 44 cfs per sq mi, due primarily to low soil infiltration rates and small basin-storage capacity. Conversely, the Bois Brule River has the lowest flood-runoff rate, 15 cfs per sq mi, due to high soil-infiltration rates and a large ground-water storage capacity. The Montreal and White Rivers have similar drainage areas and 50-year flood-runoff rates, but the larger ground-water storage in the White River basin reduces the magnitude of floods with small recurrence intervals.

A report by Conger (1971) summarizes flood data through 1968 for gaging stations and crest-stage gages and provides methods for estimating flood discharges for selected recurrence intervals on drainage areas as small as 0.5 square mile.

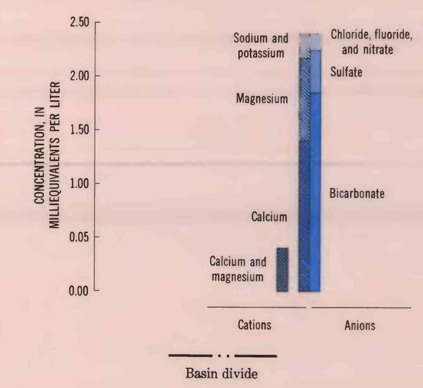
SURFACE-WATER QUALITY

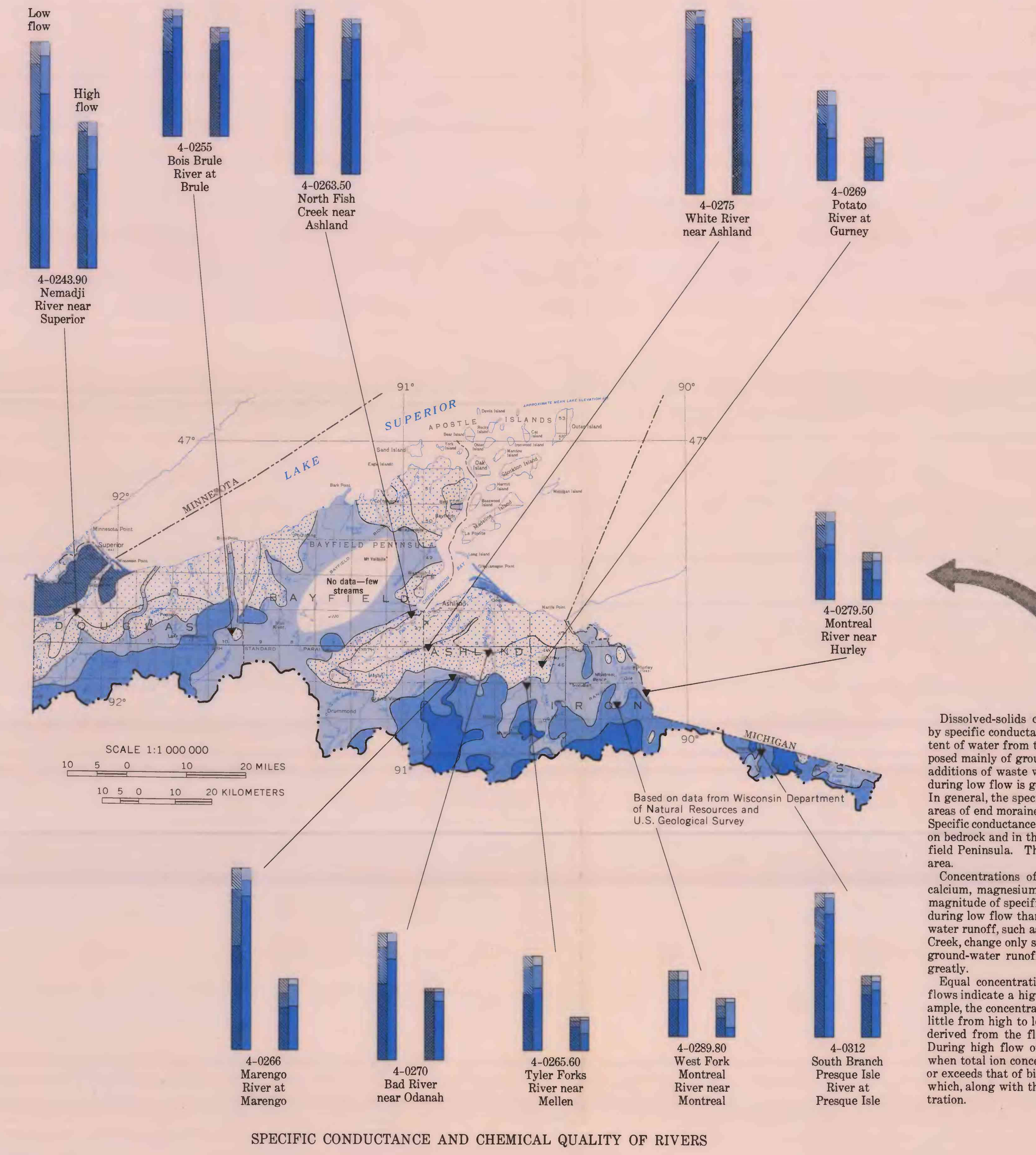
EXPLANATION

SPECIFIC CONDUCTANCE, IN MICROMHOS AT 25°C. OF SURFACE WATER DURING LOW-FLOW CONDITIONS	APPROXIMATE DISSOLVED SOLIDS, IN MILLIGRAMS PER LITER
0–50	0–30
51–100	31–60
101–150	61–90
151–200	91–120
201–400	121–240
More than 400	More than 240

▼ Site of sampling for chemical analysis by U.S. Geological Survey

CHEMICAL ANALYSIS





SPECIFIC CONDUCTANCE AND CHEMICAL QUALITY OF RIVERS

The quality of surface water in the Lake Superior basin is generally good except for high sediment yields in the red-clay area. The amount of dissolved mineral constituents is small. The water is primarily of the calcium magnesium bicarbonate type, and its chemical quality is fairly similar to that of ground water in the glacial drift. Dissolved-solids content varies inversely with stream discharge and is lowest during high streamflow in April, May, and June because overland flow from rainfall or snowmelt dilutes the ground-water runoff in streams. Most streams, except in Bayfield County, are brown because of natural organic matter.

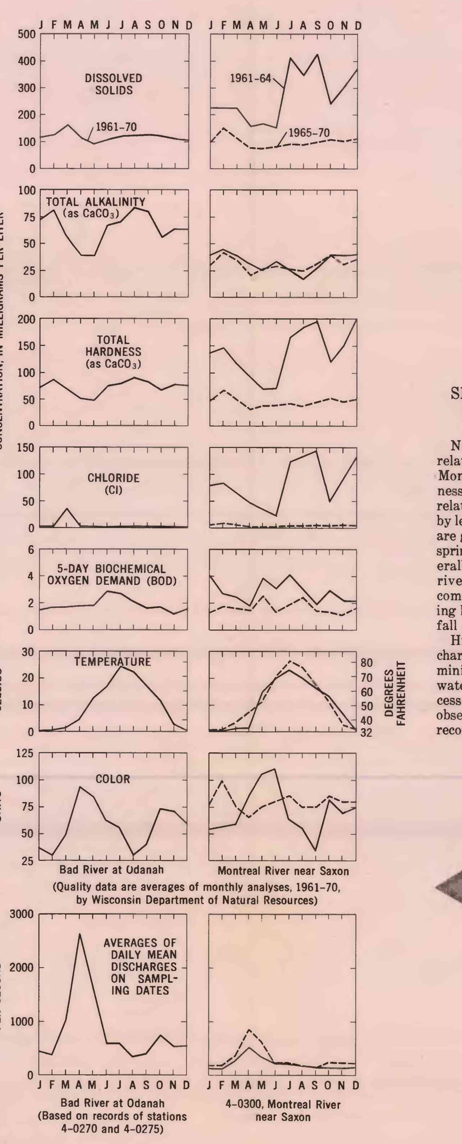
Most streams are unpolluted, but some pollution occurs locally. The Wisconsin Department of Natural Resources' most recent inventory of sources of pollutants (Schraufnagel and others, 1966) gives local sources of industrial and municipal wastes. The St. Louis River is polluted in the reach adjacent to the basin, increasingly so into the Duluth-Superior Harbor (U.S. Federal Water Pollution Control Administration, 1969, p. 21-25).

The water quality of Lake Superior is excellent except for local pollution in shallow water near harbors, and turbid water from stream mouths and wave action in other near-shore areas (U.S. Federal Water Pollution Control Administration, 1969; and Winter, 1968 and 1971).

Dissolved-solids content of streams during low flow, as indicated by specific conductance, is directly related to the dissolved-solids content of water from the glacial drift. This is because low flow is composed mainly of ground-water runoff and in this basin has only minor additions of waste water. The specific conductance of surface water during low flow is generally lower than that of nearby ground water. In general, the specific conductance of water in streams is lowest in areas of end moraine and outwash along the southern basin boundary. Specific conductance is slightly higher in areas of thin ground moraine on bedrock and in the area of thick drift on and southwest of the Bayfield Peninsula. The highest specific conductance is in the red-clay area.

Concentrations of the dominant ions shown on the bar graphs, calcium, magnesium, and bicarbonate, generally correlate with the magnitude of specific conductance shown on the map and are higher during low flow than during high flow. Streams with much ground-water runoff, such as the Bois Brule and White Rivers and North Fish Creek, change only slightly in concentration, whereas those with little ground-water runoff, such as the Nemadji and Bad Rivers, change greatly.

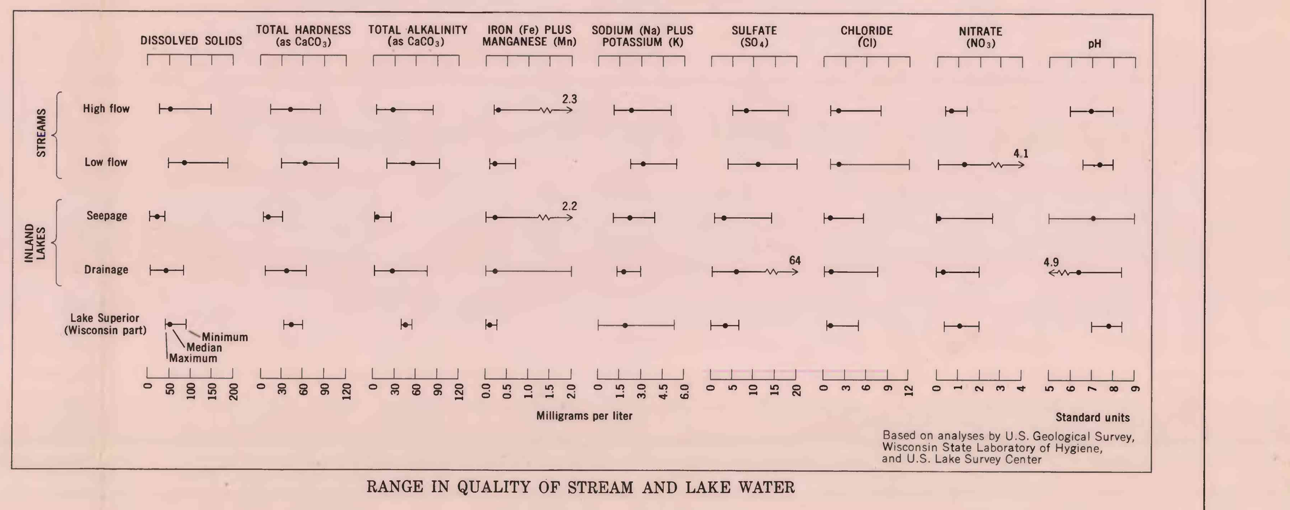
Equal concentrations of a constituent during both high and low flows indicate a higher constituent load during high flow. For example, the concentration of sulfate in most streams is small and varies little from high to low flow. The increased sulfate load is probably derived from the flushing of headwater swamps during high flow. During high flow on the Montreal, Potato, and Tyler Forks Rivers, when total ion concentration is low, the sulfate concentration equals or exceeds that of bicarbonate. Water from the swamps has a low pH, which, along with the dilution effect, lowers the bicarbonate concentration.



SEASONAL VARIATION OF WATER QUALITY AND DISCHARGE OF BAD AND MONTREAL RIVERS

Natural water quality of streams changes seasonally, primarily in relation to discharge, as shown by these graphs for the Bad and Montreal Rivers during 1961-70. Dissolved solids, alkalinity, hardness, and chloride vary inversely with discharge because they have a relatively constant input from ground-water discharge and are diluted by less mineralized overland flow. Concentrations of these parameters are generally higher during winter and summer low flows than during spring or fall high flows. Biochemical oxygen demand (BOD) is generally low, less than 5 mg/l (milligrams per liter). The water in both rivers is colored medium brown mainly by organic matter from decomposed vegetation in headwater swamps. This matter collects during low-flow periods when water movement is slow; in the spring and fall it is flushed out of the swamps by large increases in flow.

Highly mineralized mine drainage from the Montreal area was discharged into the West Fork Montreal River until early 1965, when mining ceased (F. H. Schraufnagel, oral commun., 1972). Thus, the water quality of the lower Montreal River improved significantly after cessation of this discharge. For instance, chloride concentrations observed during 1961-64 ranged from 8 to 305 mg/l, but the maximum recorded in 1965-70 was only 14 mg/l.



RANGE IN QUALITY OF STREAM AND LAKE WATER

This diagram shows the range and median values of several constituents and properties of surface water in the basin. Water from all sources is generally low in dissolved constituents, but median concentrations are somewhat higher in streams than in inland lakes. Most median values also are higher during low flow than during high flow and are higher in drainage lakes than in seepage lakes. (Drainage lakes have surface inlets and outlets; seepage lakes have neither and are sustained almost entirely by ground-water inflow.) A general similarity of Lake Superior water to runoff from the basin is shown by the identical median values of dissolved solids and hardness of water in Lake Superior and in streams during high flow.

SEDIMENT

Erosion, transportation, and deposition of sediment from the red-clay area have produced major long-standing problems, including loss of soil and farm land, field gullying, bank slippage, destruction of fish habitat, muddying of Lake Superior waters, impairment of the quality of water supplies from Lake Superior, and the combined effect of these problems on recreation and tourism.

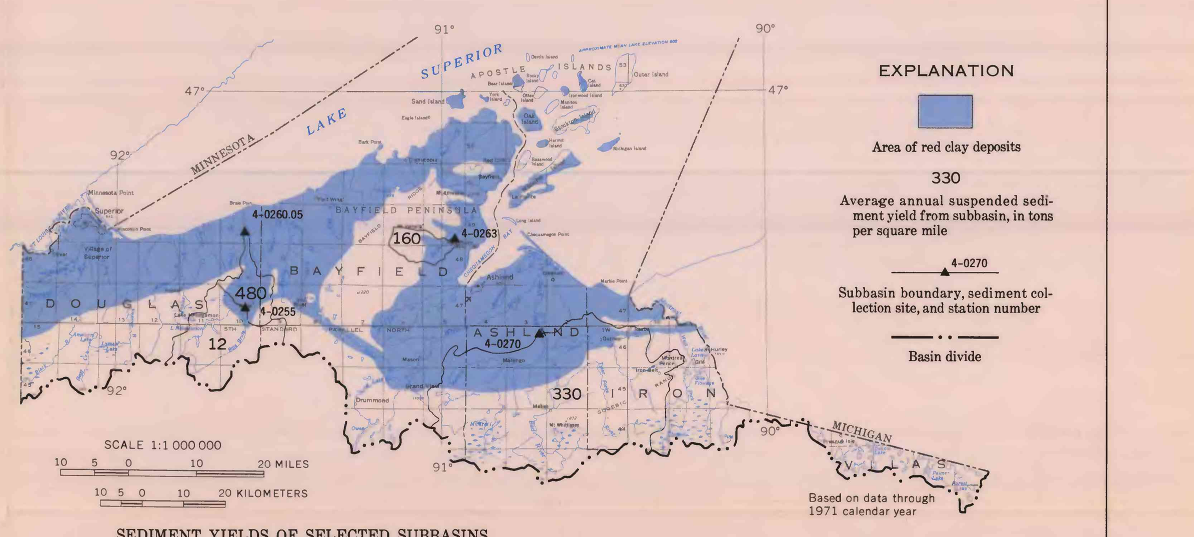
The "red-clay problem" of the Lake Superior basin has been recognized by the State for many years, and, in 1956, State agency directors organized the Red Clay Interagency Committee. Between 1956 and 1967, this committee made field studies and demonstrated methods of stabilizing streams and roadbanks by seeding, mulching, and other methods. These methods were described in several progress reports, the last of which was issued in 1967 (Wisconsin Red Clay Interagency Committee, 1967). The Wisconsin Natural Resources Council of State Agencies (1967) compiled physical data on the basin, discussed surface drainage and related problems, and presented possible solutions and planning considerations. In 1971 Governor Patrick J. Lucey asked the committee to reconvene "…to develop a plan of work involving all appropriate local, state and federal agencies." A report to the Governor (Wisconsin Red Clay Interagency Committee, 1972) summarizes information availability and needs, present and needed controls, agency responsibilities, and recommendations and costs for several resource areas, including agricultural land, highways, shorelands, streambanks, forestland, urban and industrial development, and recreation.

Yields of suspended sediment are high in the red-clay area but are low in the rest of the basin. The red-clay area yields almost 500 tons per sq mi per year on the average, and in places probably yields much more. Elsewhere in the basin, average annual yields are probably 10-40 tons per sq mi. This great difference is shown by the yields at two stations on the Bois Brule River.

The capacity of a stream to carry sediment depends upon the stream velocity and discharge, but the actual load transported also depends upon the availability of sediment. Steep gradients and high velocities of streams in the lake plain cause the streams to have high capacities for sediment transport. Discharge of many of the streams is flashy, and most sediment is transported during short periods. Natural headward erosion by streams in the red-clay area produces large quantities of sediment by rapid downcutting and gullying of the easily erodible lake sediments. Man has accelerated erosion and increased sediment availability by clear cutting of forests, clearing land for agriculture, improper road building and maintenance practices, and intensive grazing of animals on steep slopes and streambanks.

Most suspended sediment in the streams is deposited eventually in Lake Superior. Because the sediment is largely clay and silt, it remains suspended longer than larger or heavier particles and is transported great distances before being deposited on the floor of the lake.

Wave action and man's activities along the shore of Lake Superior have caused large volumes of sediment to enter the lake. Natural bluffs 20–50 feet high border the beach along most of the shoreline because of progressive undercutting of the lake clay by waves. Natural gullying and slumpage are increased by poor land-use practices.



SEDIMENT YIELDS OF SELECTED SUBBASINS

SUMMARY

Moderate to large quantities of good-quality water are available in much of the Lake Superior basin, but, locally, not even small quantities are available. Although ground water is widespread, more surface water is used. Lake Superior, a vast body of good-quality water, is the main source of surface water. Streamflow is not dependable in some places because of low runoff during drought. Moderate to large flows are available in the St. Louis, White, Nemadji, Bois Brule, and Montreal Rivers. Floods are infrequent, and flood damages are small. Lakes are numerous in some areas of end moraine and outwash.

Ground water is available in moderate to large quantities from two sources: glacial sand and gravel, and sandstones. Both sources can yield more than 500 gpm to wells in some areas, but in a few areas even domestic supplies are difficult to obtain. Small supplies generally can be obtained from lava flows.

The quality of both ground water and surface water generally is good. Minor problems of ground-water quality are hardness, locally high iron content, and slightly saline water in some areas of the sandstones. Surface water is generally less hard than ground water but commonly has much color and sediment. Erosion in the red-clay area is the major source of sediment. Contamination of surface water by waste discharge is not a serious problem.

WATER AVAILABILITY AND SUITABILITY

Source / Use and considerations	SURFACE WATER: Lake Superior	St. Louis River	Nemadji, Black, Amnicon, Poplar, and Middle Rivers	Bois Brule River	White, Iron, Flag, Sand, and Sioux Rivers and North Fish Creek	Bad, Marengo, Tyler Forks, and Potato Rivers	Montreal River	Lakes and reservoirs	GROUND WATER: Sand and gravel	Sandstones	Lava flows
Municipal and industrial supplies Quantity—100,000 gallons per day for a population of 1,000 or for a small industry Quality—cost of treatment of surface water for domestic use	Accessible to major urban areas Adequate quantity Generally excellent chemical quality Water soft Very little pollution — Commonly turbid near major river mouths and, occasionally, in all near-shore areas Treatment necessary	Adequate discharge Water moderately hard to soft — Polluted Colored Treatment necessary	Good chemical quality Water moderately hard except in Nemadji River Very little pollution — Only Nemadji River has adequate discharge Water hard in Nemadji River High sediment loads in lower reaches Treatment necessary	Adequate discharge Good chemical quality Water soft Very little pollution — High sediment loads in lower reaches Colored Treatment necessary	Adequate discharge in White River and lower reaches of Iron River and North Fish Creek Good chemical quality Water moderately hard Very little pollution — Moderate to high sediment loads in lower reaches White River colored in lower reach Treatment necessary	Generally adequate discharge in Bad and lower reaches of Marengo and Potato Rivers Good chemical quality Water soft to moderately hard Very little pollution — Occasionally very low flows in lower reach of Bad River Sediment loads high in lower reach of Bad and moderate in lower reaches of Marengo and Potato Rivers Colored Treatment necessary	Adequate discharge in main reaches Generally good chemical quality Water soft — Variable flow in headwater reaches Polluted locally on main stem and West Fork below Hurley and Montreal Colored Treatment necessary	Adequate quantity in large lakes and reservoirs Good chemical quality Water generally soft to moderately hard — Limited areal distribution Easily polluted Colored in drainage lakes and reservoirs Treatment necessary	Some large well yields Good chemical quality Not generally subject to pollution where buried beneath clay or till — Well yields generally small Limited areal extent Generally in isolated buried deposits Commonly high in iron	Large well yields in a few areas Locally artesian Not generally subject to pollution where buried beneath clay or till — Deep wells necessary for large supplies Commonly slightly saline and, occasionally, saline Commonly high in iron	Generally good chemical quality — Well yields inadequate Subject to pollution where glacial drift cover is thin or permeable Commonly high in iron
Rural domestic and stock supplies Quantity—5 gallons per minute, adequate for pressure system Quality—prohibitive cost of treatment of surface water for domestic use	Adequate quantity Generally excellent chemical quality Water soft Very little pollution — Available only to shorelands Commonly turbid near major river mouths and, occasionally, in all near-shore areas Treatment necessary for domestic use	Adequate discharge Water moderately hard to soft — Available only to shorelands Polluted Colored Treatment necessary for domestic use	Adequate discharge Good chemical quality Water moderately hard except in Nemadji River Very little pollution — Available only to shorelands Water hard in Nemadji River High sediment loads in lower reaches Treatment necessary for domestic use	Adequate discharge Good chemical quality Water soft Very little pollution — Available only to shorelands Colored High sediment loads in lower reaches Treatment necessary for domestic use	Adequate discharge Good chemical quality Water moderately hard Very little pollution — Available only to shorelands Moderate to high sediment loads in lower reaches White River colored in lower reach Treatment necessary for domestic use	Adequate discharge Good chemical quality Water soft to moderately hard Very little pollution — Available only to shorelands Sediment loads high in lower reaches of Marengo and Potato Rivers Colored Treatment necessary for domestic use	Adequate discharge Generally good chemical quality Water soft — Available only to shorelands Polluted locally on main stem and West Fork below Hurley and Montreal Colored Treatment necessary for domestic use	Adequate quantity Good chemical quality Water generally soft to moderately hard — Available only to shorelands Easily polluted Colored water in drainage lakes and reservoirs Treatment necessary for domestic use	Well yields generally adequate Good chemical quality Not generally subject to pollution where buried beneath clay or till — Generally in isolated buried deposits Commonly high in iron	Well yields generally adequate Locally artesian Not generally subject to pollution where buried beneath clay or till — Commonly slightly saline and, occasionally, saline Commonly high in iron	Generally good chemical quality — Well yields commonly inadequate Subject to pollution where glacial drift cover is thin or permeable Commonly high in iron
Recreation Adequate public access and user facilities Attractive physical setting and recreation opportunities Water free from pollution, excessive weed growth, odor, and high sediment loads	Good access Scenic shoreline Apostle Islands National Lakeshore Suitable for fishing, limited small craft boating Extensive variety of game fish, including lake, rainbow, and brown trout, and coho salmon Very little pollution — Few harbors of refuge Small craft warnings common Low water and air temperatures limit body-contact activities	Suitable for hunting and boating upstream from harbor — Poor access Limited fishing, swimming Pollution limits body-contact activities	Good access Two State parks Suitable for hunting Trout in some headwater reaches Very little pollution — Very small low flows in headwaters Limited canoeing and fishing High sediment loads in lower reaches	Good access Entire reach in State forest Several campgrounds Excellent canoe trail Large low flows Suitable for fishing and hunting Entire reach is trout stream Very little pollution — High sediment loads in lower reaches	Good access except to Sand River and lower reaches of White River Largely forested; some headwaters in Chequamegon National Forest Large low flows in most reaches Suitable for fishing, hunting; canoeing on White River Local ordinances regulate boat motors on White upstream from Mason Trout in most reaches except in lower reach of White River Warm-water game fish in White River and North Fish Creek Very little pollution — Lower reach of White inaccessible Very small low flows in Sand River and upper reach of North Fish Creek	Good access to Bad River, fair access to Tyler Forks River Largely forested; headwaters in Chequamegon National Forest or county forests Copper Falls State Park on Bad River Good canoe trails on Bad and Marengo Rivers Suitable for fishing, hunting; boating on Bad River Trout in most reaches Warm-water game fish in Bad River downstream from Copper Falls Very little pollution — Poor access to Marengo and Potato Rivers Very small low flows in headwaters except for Marengo River Sediment loads high in lower reach of Bad and moderate in lower reaches of Marengo and Potato Rivers Limited canoeing on Tyler Forks and Potato Rivers	Fair access Largely forested Suitable for fishing, hunting, and boating Trout in most reaches Some warm-water game fish, especially in reservoirs Very little pollution in headwaters — Very small low flows in headwaters Polluted locally on main stem and West Fork below Hurley and Montreal	Fair to good access Suitable for fishing, swimming, boating, and hunting Campgrounds, resorts, and summer cottages along shores — Easily polluted			
Fish and wildlife habitat Adequate depth and quality for game fish Adequate cover for wildlife in or around streams and wetlands	Very little pollution — Low water temperature and nutrient level limit fish productivity	Good cover in marshes along lower reach — Polluted	Good cover in marshes along some headwater reaches Very little pollution — Variable flows High sediment loads in lower reaches	Uniform flow, large low flows Good cover in marshes along some headwater reaches Very little pollution — High sediment loads in lower reaches	Generally uniform flow, large low flows Good cover, especially in sloughs at mouths; and Bibon Marsh on White River Very little pollution — Variable flow and flooding in lower reaches of Sand River and North Fish Creek Moderate to high sediment loads in lower reaches	Good cover in headwater marshes and Bad River Slough Very little pollution — Variable flow; flooding on Bad River Sediment loads high in lower reach of Bad and moderate in lower reaches of Marengo and Potato Rivers	Good cover in headwater marshes Very little pollution in headwaters — Variable flow Polluted locally on main stem and West Fork below Hurley and Montreal	Good cover — Low fish productivity in soft-water lakes Easily polluted			

EXPLANATION

Accessible to major urban areas
Adequate quantity
Generally excellent chemical quality
Water soft
Very little pollution
— Advantages for use

Commonly turbid near major river mouths and occasionally, in all near-shore areas
Treatment necessary
— Limitations for use

General suitability for use: Good; Fair; Poor

This table lists advantages and limitations of various sources without regard for legal limitations. Water withdrawals from streams, lakes, and high-capacity wells (capacity to yield more than 100,000 gallons per day) require permits from the Wisconsin Department of Natural Resources.

AGENCIES HAVING ADDITIONAL INFORMATION

Agency	Geology	Soils	Topography and drainage	Land use	Water budget	Ground- and surface-water relationships	Surface water	Surface-water quality	Pollution	Ground water	Ground-water quality	Water use	Recreation, and fish and wildlife
Center for Lake Superior Environmental Studies, University of Wisconsin-Superior, 109 Barstow Hall, Superior, Wis. 54880								×		×			
Minnesota Pollution Control Agency, 717 Delaware Street S. E., Minneapolis, Minn. 55440								×	×				
Public Service Commission of Wisconsin, 432 Hill Farms State Office Building, Madison, Wis. 53702												×	
U.S. Department of Agriculture, Soil Conservation Service, 4601 Hammersley Road, P. O. Box 4248, Madison, Wis. 53711		×	×	×			×					×	
U.S. Department of the Army, Corps of Engineers St. Paul District, 1217 U.S. Post Office and Custom House, St. Paul, Minn. 55101			×				×		×			×	
U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Lake Survey Center, 630 Federal Building and U.S. Court House, Detroit, Mich. 48226					×		×	×	×				
U.S. Department of the Interior, Bureau of Outdoor Recreation, 3853 Research Park Drive, Ann Arbor, Mich. 48104													×
U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries, 5 Research Drive, Ann Arbor, Mich. 48103								×				×	×
U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Room 630 Federal Building, Fort Snelling, Minn. 55111							×						×
U.S. Department of the Interior, Geological Survey, Water Resources Division, 1815 University Avenue, Madison, Wis. 53706	×		×		×	×	×	×		×	×	×	
U.S. Department of the Interior, National Park Service, 143 South 3rd Street, Philadelphia, Pa. 19100													×
U.S. Environmental Protection Agency, Water Quality Office, 7401 Lyndale Avenue South, Minneapolis, Minn. 55423								×	×				
University of Wisconsin-Extension, Geological and Natural History Survey, 1815 University Avenue, Madison, Wis. 53706	×	×	×		×	×				×	×	×	
University of Wisconsin, Soils Department, Soils Building, Madison, Wis. 53706		×			×								
Wisconsin Department of Agriculture, 801 West Badger Road, Madison, Wis. 53713				×									
Wisconsin Department of Local Affairs and Development, 123 West Washington Avenue, Madison, Wis. 53702				×									
Wisconsin Department of Natural Resources, 4610 University Avenue, P. O. Box 450, Madison, Wis. 53701				×		×	×	×	×	×	×	×	×

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