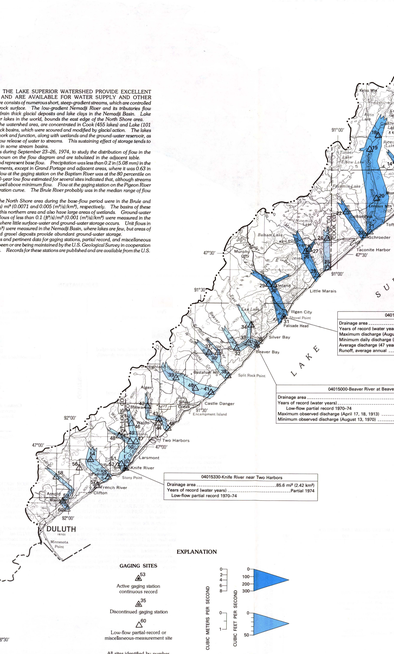
PREPARED IN COOPERATION WITH THE
MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATERS, SOILS, AND MINERALS



# SURFACE WATER




SURFACE-WATER RESOURCES IN THE LAKE SUPERIOR WATERSHED PROVIDE EXCELLENT RECREATION OPPORTUNITIES AND ARE AVAILABLE FOR WATER SUPPLY AND OTHER USES.—*Drainage along the North Shore consists of numerous short, steep-gradient streams, which are controlled by the topography of the Superior Upland. The Superior Upland, which is a remnant of a plateau, rises from northeastward to Lake Superior and shows thick glacial deposits and lake clays in the Nemadji Basin. Lake Superior, one of the largest fresh water lakes in the world, bounds the east edge of the North Shore area.*

*Lakes, covering about 4 percent of the watershed area, are concentrated in Cook (455 lakes) and Lake (101 lakes) Counties. Many occur in bedrock basins, which were scoured and modified by glacial action. The lakes are shallow, with short shoreline development, and are used for recreation. Wetlands are also concentrated in natural reservoirs for the storage and slow release of water to streams. This moderating effect of storage tends to reduce the seasonal variability of flow in some stream basins.*

*Streamflow was measured at 68 sites during September 23–26, 1974, to study the distribution of flow in the watershed. The measurements are shown on the flow diagram and are tabulated in the adjacent table. Streamflow was also measured at 14 sites during September 23–26, 1975, to verify the flows in the table in the 10-day period preceding the measurements, except in Central Drainage and adjacent areas, where it was 0.63 to (16 mm) during September 23–26. Flow at the gaging station on the Baptism River was at the 80 percentile on the flow-duration curve. The 7-day 50-year low flow estimated for several sites indicated that, although streams were in the base-flow range, most were well above minimum flow. Flow at the gaging station on the Pigeon River was at the 60 percentile on the flow-duration curve. The Brule River probably was in the median range of flow also.*

*The largest unit flows measured in the North Shore area during the base-flow period were in the Brule and Pigeon Rivers, with 0.65 and 0.52 (ft³/s) /mi² (0.0071 and 0.005 (m³/s)/km²), respectively. The basins of these two rivers contain many of the lakes in this northern area and also have large areas of wetlands. Ground water contributes to streamflow in the Brule, Pigeon, Baptism, and Poplar Rivers. Ground water contributes in the southern part of the North Shore area, where little surface water and ground water storage occurs. Unit flows in excess of 0.5 (ft³/s)/mi² (0.005 (m³/s)/km²) were measured in the Nemadji Basin, where lakes are few, but areas of wetlands and ground water storage are extensive and contribute streamflow during periods of recession.*

*The map and table show the locations and pertinent data for gaging stations, partial record, and miscellaneous discharge measurements sites that have been or are being maintained by the U.S. Geological Survey in cooperation with several State and Federal agencies. Records for these stations are published and are available from the U.S. Geological Survey office in St. Paul.*

**04010500–Pigeon River at Middle Falls, near Grand Portage**

| | |
|---|---|
| Drainage area | 800 mi² (1058 km²) |
| Years of record (water years) | 1923–74 |
| Maximum discharge (May 5, 1954) | 11,000 ft³/s (312 m³/s) |
| Minimum discharge (Nov. 4, 1940) | 27 ft³/s (0.76 m³/s) |
| Average discharge (51 years) | 526 ft³/s (14.20 m³/s) |
| Runoff, average annual | 11.42 in (290 mm) |

**04012500–Poplar River at Lutsen**

| | |
|---|---|
| Drainage area | 114 mi² (295 km²) |
| Years of record (water years) | 1912–17, 1939–47, 1952–81 |
| Low-flow partial record 1970–74 | |
| High-flow partial record 1973–74 | |
| Maximum discharge (June 9, 1954) | 1,880 ft³/s (53.2 m³/s) |
| Minimum discharge (December 5, 1939) | 2.3 ft³/s (0.07 m³/s) |
| Average discharge (33 years) | 103 ft³/s (2.92 m³/s) |
| Runoff, average annual | 12.27 in (312 mm) |

**04014500–Baptism River near Beaver Bay**

| | |
|---|---|
| Drainage area | 140 mi² (363 km²) |
| Years of record (water years) | 1928–74 |
| Maximum discharge (August 9, 1939) | 8,350 ft³/s (365 m³/s) |
| Minimum daily discharge (January 5, 6, 1940) | 0.4 ft³/s (0.011 m³/s) |
| Average discharge (47 years) | 188 ft³/s (5.158 m³/s) |
| Runoff, average annual | 18.30 in (464 mm) |

**04015000–Beaver River at Beaver Bay**

| | |
|---|---|
| Drainage area | 126 mi² (326 km²) |
| Years of record (water years) | 1913–14, partial 1929–31 |
| Low-flow partial record 1970–74 | |
| Maximum discharge (April 17, 18, 1913) | 2,020 ft³/s (57.2 m³/s) |
| Minimum observed discharge (August 13, 1970) | 0.74 ft³/s (0.02 m³/s) |

**04015330–Knife River near Two Harbors**

| | |
|---|---|
| Drainage area | 85.6 mi² (2.42 km²) |
| Years of record (water years) | Partial 1974 |
| Low-flow partial record 1970–74 | |

| Map key | Station number | Gaging station: partial record, or miscellaneous discharge measurement site | Approximate drainage area (mi²) | Base-flow period September 23–26, 1974: Discharge (ft³/s) | Water temperature (°C) | Estimated dissolved oxygen (mg/L) | 7-day low flow 10-year recurrence interval² (ft³/s) |
|---|---|---|---|---|---|---|---|
| 1 | Pigeon River near Grand Marais | | 127 | 7.5 | 26 | | |
| 2 | Arrow River above Pigeon River in Ontario, Canada | | 195 | 7.9 | 16 | | |
| 3 | 04010500 | Pigeon River at Middle Falls near Grand Portage | 600 | 312 | 10.0 | 50 | 43 |
| 4 | Reservation River near Hovland | | 4.45 | 7.5 | 55 | | |
| 5 | 04013800 | Brule River near Grand Marais | 76.7 | 9.0 | <26 | | |
| 6 | 04010900 | South Branch Brule River near Grand Marais | 31.4 | 7.5 | <26 | | |
| 7 | 04011000 | Brule River near Hovland | 248 | 180 | <26 | 77 | |
| 8 | | Devil Track River near outlet of Devil Track Lake | 7.31 | 8.5 | <26 | | |
| 9 | | Elbow Creek near Grand Marais | 3.20 | 5.5 | 40 | | |
| 10 | 04011500 | Devil Track River near Grand Marais | 77 | 15.4 | 6.0 | 49 | 3.6 |
| 11 | | Cascade River near Croftville | 10.1 | 8.0 | <26 | | |
| 12 | | Cascade River near Lutsen | 22.6 | 5.5 | 40 | | |
| 13 | 04012000 | Cascade River near Grand Marais | 111 | 29.5 | 7.0 | 45 | 4.4 |
| 14 | | Poplar River near Tofte | | 12.6 | 6.5 | 45 | |
| 15 | | Tait River near Lutsen | | 3.61 | 6.5 | 45 | |
| 16 | | Moose River near Lutsen | | 4.71 | 4.0 | 45 | |
| 17 | 04012500 | Poplar River at Lutsen | 114 | 35.8 | 6.0 | 50 | 8.8 |
| 18 | 04012600 | Temperance River near Tofte | | 27.7 | 7.5 | <26 | |
| 19 | | Pouli Creek near Tofte | | 3.02 | 7.0 | 40 | |
| 20 | | Temperance River near Lutsen | | 50.1 | 9.0 | 45 | |
| 21 | 04012700 | Temperance River near Schroeder | 189 | 45.3 | 7.5 | 40 | 12 |
| 22 | | Cross River near Taconite Harbor | | 12.9 | 9.0 | 45 | |
| 23 | 04013000 | Cross River at Schroeder | 91 | 12.9 | 7.0 | 52 | 1.6 |
| 24 | | Caribou River near Taconite Harbor | | 2.75 | 6.0 | 75 | |
| 25 | | Caribou River near Little Marais | | 4.61 | 6.0 | 75 | |
| 26 | | Manitou River near Finland | | 16.1 | 5.0 | 62 | |
| 27 | | Nine Mile Creek near Little Marais | | 3.98 | 7.0 | 55 | |
| 28 | 04013300 | Manitou River near Little Marais | 94 | 13.1 | 6.0 | 62 | 2.3 |
| 29 | | Baptism River at Finland | | 10.4 | 7.0 | 52 | |
| 30 | | East Branch Baptism River at Finland | | 5.46 | 8.0 | 52 | |
| 31 | 04014500 | Baptism River near Beaver Bay | 140 | 21.4 | 7.0 | 62 | 2.4 |
| 32 | | Beaver River near Beaver Bay | | 2.72 | 7.5 | 100 | |
| 33 | | Beaver River near Silver Bay | | 2.82 | 8.5 | 100 | |
| 34 | | East Branch Beaver River near Beaver Bay | | 2.22 | 3.0 | 70 | |
| 35 | 04015000 | Beaver River at Beaver Bay | 126 | 5.01 | 7.5 | 86 | <1 |
| 36 | | East Split Rock River near Beaver Bay | | 0.66 | 8.0 | 95 | |
| 37 | | West Split Rock River near Beaver Bay | | 3.13 | 8.0 | 110 | |
| 38 | | Split Rock River near Beaver Bay | | 4.82 | 8.0 | 115 | |
| 39 | | Gooseberry River near Beaver Bay | | 5.46 | 9.0 | 100 | |
| 40 | | Gooseberry River near Silver Creek | | 6.21 | 7.5 | 112 | |
| 41 | 04015140 | Gooseberry River near Two Harbors | 77 | 7.24 | 8.0 | 100 | <1 |
| 42 | | Stewart River at Stewart | | 1.66 | 7.0 | 100 | |
| 43 | | Stewart River near Stewart | | 2.12 | 7.0 | 112 | |
| 44 | | Little Stewart River near Two Harbors | | 0.04 | 8.0 | 130 | |
| 45 | | Stewart River near Two Harbors | | 2.21 | 7.0 | 125 | |
| 46 | | Knife River near Stewart | 14 | 3.54 | 8.0 | 119 | |
| 47 | | Knife River near Lawrence | 27 | 4.05 | 10.0 | 122 | |
| 48 | | West Branch Knife River near Two Harbors | 14 | 1.60 | 8.5 | 125 | |
| 49 | | West Branch Knife River Tributary near Two Harbors | 4.5 | 0.62 | 8.0 | 135 | |
| 50 | | West Branch Knife River near Knife River | 28 | 2.38 | 9.0 | 140 | |
| 51 | | Knife River near Knife River | 76 | 6.18 | 7.0 | 115 | |
| 52 | | Little Knife River near Knife River | 9.3 | 0.15 | 6.0 | 215 | |
| 53 | 04015330 | Knife River near Two Harbors | 86 | 5.48 | 10.5 | 114 | <1 |
| 54 | | Sucker River near Knife River | | 6.62 | 6.5 | 125 | |
| 55 | 04015340 | Sucker River near Duluth | 34 | 6.53 | 6.5 | 125 | |
| 56 | | French River near French River | 11 | 0.92 | 6.5 | 95 | |
| 57 | 04015350 | French River near Duluth | 18 | 1.68 | 6.5 | 120 | |
| 58 | | Lester River near French River | | 1.83 | 8.5 | 95 | |
| 59 | 04015387 | Amity Creek at Duluth | | 0.62 | 9.0 | 150 | |
| 60 | 04015390 | Lester River at Duluth | 56 | 3.86 | 8.0 | 130 | <1 |
| 61 | | Nemadji River near Nemadji | 20 | 1.61 | 8.5 | 77 | |
| 62 | 04024088 | Nemadji River near Duesler | 55 | 3.03 | 6.5 | 115 | |
| 63 | | Blackhoof River near Nemadji | 28 | 7.31 | 10.5 | 110 | |
| 64 | 04024052 | Blackhoof River near Holyoke | 44 | 24.1 | 6.5 | 125 | |
| 65 | 04024095 | Nemadji River near Holyoke | 118 | 24.5 | 6.0 | 127 | 1.3 |
| 66 | 04024200 | South Fork Nemadji River near Holyoke | 19 | 4.51 | 6.0 | 96 | |
| 67 | | Net River at Holyoke | 27 | 1.83 | 8.0 | 85 | |
| 68 | | Little Net River near Holyoke | 11 | 1.61 | 7.5 | 140 | |

²Lowest average flow for 7 consecutive days, 10-year recurrence interval

STREAM PROFILES REFLECT THE TOPOGRAPHY OF THE WATERSHED.—*The steep topography of the North Shore area is illustrated by profiles of the Baptism and Poplar Rivers. The average gradient of the Baptism from headwaters to mouth is about 58 ft/mi (10 m/km), but the 3-mile reach above the mouth falls at a rate of 133 ft/mi (25 m/km). The Poplar River has an average gradient of 77.5 ft/mi (15 m/km) but falls at a rate of 250 ft/mi (47 m/km) in its lower 4 mi (6.4 km). The steep gradient of streams in the Nemadji River basin is reflected in the Nemadji River profile, with an average gradient (headwaters to Minnesota border) of about 33 ft/mi (6.6 m/km).*

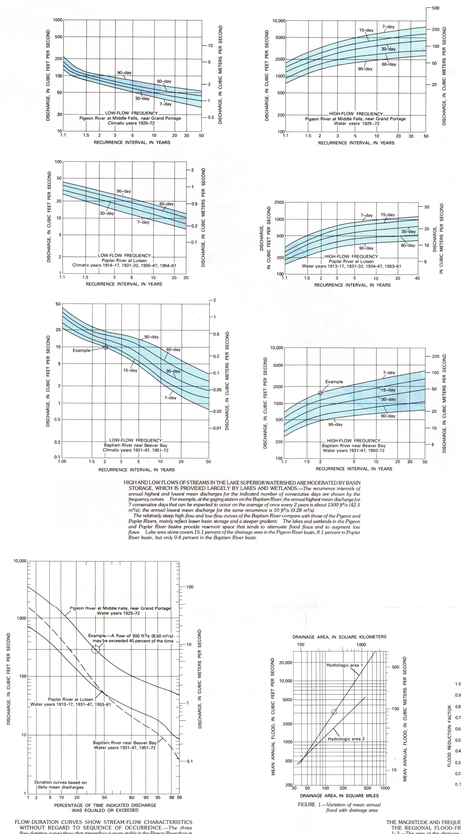






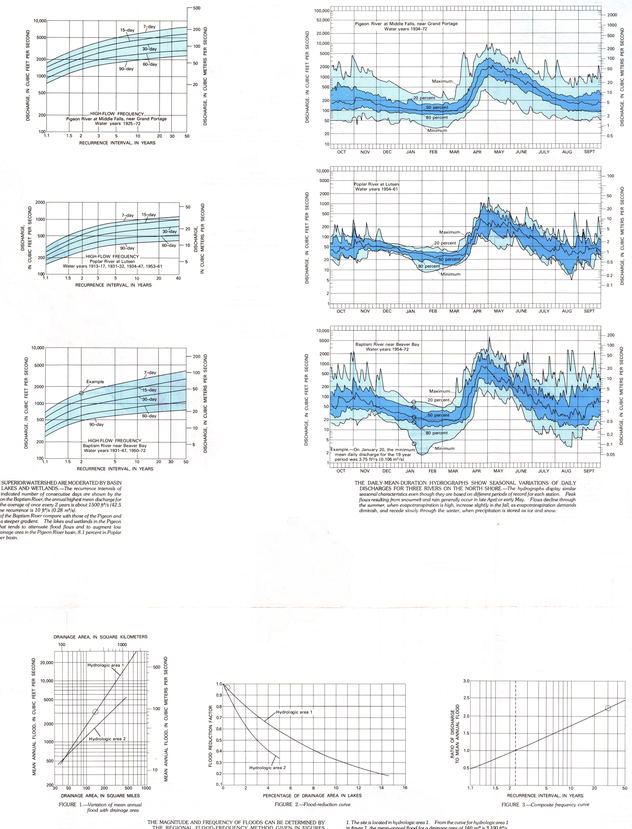



THE STREAMFLOW HYDROGRAPHS SHOW THE MONTHLY-MEAN DISCHARGES BY WATER YEAR (OCTOBER 1 TO SEPTEMBER 30) FOR POPLAR, PIGEON, AND BAPTISM RIVERS.—*Streamflow fluctuated during the year in response to the annual climatic cycle and from week to week because of variations in precipitation and temperature. The annual-maximum monthly-mean discharge for all three rivers has always occurred in April, May, or June. Most of the monthly maximums were in April or May and resulted from runoff from snowmelt and rain. On the Baptism River, for example, the annual-maximum monthly-mean discharge occurred 27 times in April and 19 times in May. The annual-maximum monthly-mean discharge on the Pigeon River occurred 20 times in April, 26 times in May, and 2 times in June. The maximum monthly-mean discharges for the period of record were in 1950 on the Pigeon and Baptism Rivers and in 1956 on the Poplar. The minimum monthly-mean discharges of record were in 1933 on the Poplar, 1940 on the Baptism, and 1968 on the Pigeon River.*

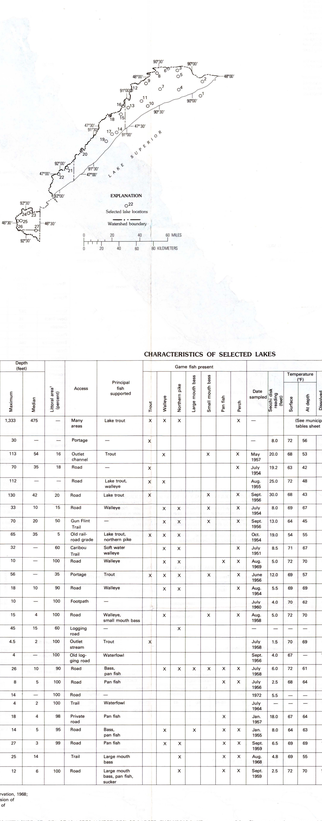



FLOW-DURATION CURVES SHOW STREAM-FLOW CHARACTERISTICS WITHOUT REGARD TO SEQUENCE OF OCCURRENCE.—*The three curves for each station are based on all flows for the period of record, either the Poplar or Baptism Rivers. The flow-duration curves for Poplar and Pigeon Rivers are similar except at the 95 percentile, where the curve for Poplar River breaks downward, showing the extreme minimum flows are not sustained as well as in Pigeon River. The Baptism River, which has lower lakes and wetlands and a steeper gradient than the other two rivers, has a steeper low-flow and high-flow duration curve. The Baptism River tends to be more "flashy", reacting more quickly to runoff resulting from precipitation, and has lower unit flows during extended periods of no precipitation. The Baptism River is probably characteristic of larger streams in the central part of the North Shore area.*

*Low-flow frequency curves are not available for other streams in the watershed, the relative lack of other surface water or ground water storage and the steep gradients in the southern part of the North Shore area might indicate that many of the streams are probably flashy, with relatively high, short-duration flood flows and low base flows.*




THE DAILY-MEAN-DURATION HYDROGRAPHS SHOW SEASONAL VARIATIONS OF DAILY DISCHARGES FOR THREE RIVERS ON THE NORTH SHORE.—*The hydrographs display similar seasonal characteristics even though they are based on different periods of record for each station. Peak flows resulting from snowmelt and rain generally occur in late April or early May. Flows decline through the summer, when evapotranspiration is high, increase slightly in the fall, as evapotranspiration demands diminish, and recede slowly through the winter, when precipitation is stored as ice and snow.*




## CHARACTERISTICS OF SELECTED LAKES

| Map number | Lake name | Surface area (acres) | Depth (feet): Maximum | Depth (feet): Median | Littoral area² (percent) | Access | Principal fish supported | Game fish present: Trout | Walleye | Northern pike | Largemouth bass | Smallmouth bass | Pan fish | Bass | Quality: Date sampled | Temperature (°F): Surface | Bottom | Dissolved oxygen (mg/L) | Total alkalinity (mg/L) | Secchi disk transparency (feet) | Total phosphorus (mg/L) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Superior | 20,364,800 | 1,233 | 475 | — | Many areas | Lake trout | X | X | X | | | | X | — | | | | | | | Downwarped, downfaulted, and eroded basin. Largest freshwater lake in the world. |
| 2 | Taylor | 35 | 30 | — | — | Portage | — | X | | | | | | | — | 8.0 | 72 | 56 | 7.1 | — | — | In Grand Portage Indian Reservation. Water clear. |
| 3 | Rice | 2,112 | 113 | 54 | 16 | Outlet channel | Trout | | X | | | X | X | X | May 1957 | 35.0 | 48 | 53 | 8.4 | 12.5 | — | Bedrock basin. In Boundary Waters Canoe Area. |
| 4 | Trout | 261 | 70 | 35 | 18 | Road | — | X | | | | | | X | July 1954 | 19.2 | 43 | 42 | 8.5 | 1.2 | — | Bedrock basin. In Superior National Forest. |
| 5 | Greenwood | 2,078 | 112 | — | — | Road | Lake trout, walleye | X | X | | | | | | Aug. 1965 | 25.0 | 72 | 48 | 7.3 | 15.0 | 10 | Bedrock basin. In Superior National Forest. |
| 6 | Clearwater (Elmby) | 1,537 | 130 | 42 | 20 | Road | Lake trout | X | | | | X | | X | Sept. 1956 | 30.0 | 48 | 43 | 9.0 | 17.5 | 8.0 | 0.28 | 0.003 | Bedrock basin. In Boundary Waters Canoe Area. |
| 7 | Two Island | 858 | 33 | 10 | 15 | Road | Walleye | X | X | | | X | X | X | July 1954 | 8.0 | 69 | 67 | 7.5 | 21.0 | 0.0 | 1.48 | 0.009 | In Superior National Forest. Brown water. |
| 8 | Poplar | 950 | 70 | 20 | 50 | Gun Flint Trail | — | | X | X | | X | | X | Sept. 1956 | 13.0 | 64 | 45 | 9.1 | 40.0 | 1.0 | 0.44 | 0.020 | Bedrock basin. In Superior National Forest. |
| 9 | Brule | 5,204 | 65 | 35 | 5 | Old rail-road grade | Lake trout, northern pike | X | X | X | | | | | Oct. 1954 | 19.0 | 54 | 55 | 8.8 | 12.5 | 6.0 | 1.30 | 0.001 | In Boundary Waters Canoe Area. |
| 10 | Caribou | 714 | 32 | — | 60 | Caribou Trail | Soft water walleye | | X | X | | | | X | July 1951 | 8.5 | 71 | 67 | 8.0 | 27.4 | 5.0 | 0.46 | 0.008 | Bedrock basin. In Superior National Forest. |
| 11 | White Pine | 374 | 10 | — | 100 | Road | Walleye | | X | X | | | X | X | Aug. 1956 | 5.0 | 72 | 70 | 8.5 | 24.0 | — | — | — | Till basin. In Superior National Forest. |
| 12 | Alton | 1,076 | 56 | — | 35 | Portage | Trout | X | X | X | | X | | X | June 1956 | 12.0 | 69 | 57 | 8.0 | 21.0 | — | — | — | In Boundary Waters Canoe Area. Clear water. |
| 13 | Four Mile | 593 | 18 | 10 | 90 | Road | Walleye | | X | X | | | | X | Aug. 1954 | 5.5 | 69 | 69 | 7.2 | 20.0 | — | — | — | In Superior National Forest. Brown water. |
| 14 | Bassner | 18 | 10 | — | 100 | Footpath | — | | | | | | | | July 1960 | 4.0 | 70 | 62 | 6.1 | 16.0 | 9.0 | 1.05 | 0.029 | Floating bog. Winter kill, inlet spring from hillside. |
| 15 | Crooked | 318 | 15 | 4 | 100 | Road | Walleye, small-mouth bass | | X | | | X | X | X | Aug. 1958 | 5.0 | 72 | 70 | 7.0 | 27.5 | — | — | — | In Superior National Forest. Boulder dam at outlet. |
| 16 | Whitefish | 350 | 45 | 15 | 60 | Logging road | — | | | X | | | | | — | — | — | — | — | — | — | — | — | Till basin. In Superior National Forest. |
| 17 | Leskinen (Lappanen) | 34 | 4.5 | 2 | 100 | Old logging road | Trout | X | | | | | | | July 1958 | 1.5 | 70 | 69 | 6.5 | 30.0 | — | — | — | Bay dam. Winter kill. Swampy area. |
| 18 | Ben | 10 | 4 | — | 100 | Old log road | Waterfowl | | | | | | | | Sept. 1956 | 4.0 | 67 | — | 10.0 | 25.0 | 0.5 | 0.19 | 0.006 | Swampy area. Brown water. Winter kill. |
| 19 | Lax | 273 | 26 | 10 | 90 | Road | Bass, pan fish | | X | X | X | X | X | X | July 1956 | 7.0 | 67 | 61 | 8.5 | 27.5 | 5.0 | 0.15 | 0.011 | Inlet spring from hillside. |
| 20 | Christianson | 158 | 8 | 5 | 100 | Road | Pan fish | | | | | | X | X | July 1956 | 2.5 | 68 | 64 | 7.9 | 26.3 | 14.0 | 0.68 | 0.089 | Forest area. |
| 21 | Paradise | 36 | 14 | — | 100 | Road | — | | | | | | | | 1972 | 5.5 | — | — | — | — | — | — | — | Swampy area. |
| 22 | West Pond | 12 | 4 | 2 | 100 | Trail | Waterfowl | | | | | | | | July 1956 | — | — | — | — | — | — | — | — | Deep marsh. |
| 23 | Vanoch | 82 | 18 | 4 | 98 | Private road | Pan fish | | | | | | X | | Jan. 1957 | 18.0 | 67 | 64 | 9.4 | 55.0 | — | — | — | Forested area. Winter kill. |
| 24 | Hay | 103 | 14 | 5 | 95 | Road | Bass, pan fish | | X | | | X | X | X | Jan. 1956 | 8.0 | 64 | 63 | 9.8 | 12.5 | 6.0 | 0.67 | 0.046 | Forest land and pasturland area. Winter kill. |
| 25 | Sand (Sandy) | 123 | 27 | 3 | 99 | Road | Pan fish | | X | X | | | X | X | Sept. 1956 | 6.5 | 69 | 69 | 11.2 | 17.5 | — | — | — | Forest land, grassland, and spruce bog area. |
| 26 | Twenty-Nine | 47 | 25 | 14 | | Trail | Large mouth bass | | | X | | | X | X | Aug. 1958 | 4.8 | 69 | 55 | 8.0 | 20.0 | — | — | — | Forested area near interstate highway. |
| 27 | Net | 142 | 12 | 6 | 100 | Road | Large mouth bass, pan fish, sucker | | | X | | | X | X | Sept. 1959 | 2.5 | 72 | 70 | 11.0 | 22.5 | — | — | — | Forest land and swampland area. Some development. |

¹Water depth less than 15 feet.
Data from Minnesota Department of Conservation, 1966; Zumberge, 1952; and the files of the Division of Fish and Wildlife, Minnesota Department of Natural Resources.

THE 590 LAKES WITH SURFACE AREA OF 10 ACRES (4 HECTARES) OR LARGER, EXCLUDING LAKE SUPERIOR, MAKE UP ABOUT 6 PERCENT OF THE TOTAL AREA OF THE WATERSHED.—*Most of the lakes are less than 50 acres (20 hectares) in area and are concentrated in Cook and Lake Counties. The lakes tend be shallow, generally less than 15 ft (4.6 m) deep in much of their area. Most of the lake water, especially in the North Shore area, is relatively clear and acid, is low in nutrients, and supports walleye and northern pike, bass, and pan fish. Characteristics of representative lakes in the watershed are tabulated above. The numerous lakes scattered throughout the watershed of the Superior National Forest, Boundary Waters Canoe Area, and several State forests, together with the Lake Superior fishery, and many miles of trout streams, provide excellent recreation.*

## FLOOD-PRONE AREAS




MOST FLOOD PROBLEMS IN THE WATERSHED ARE CONFINED TO HEAVILY POPULATED AREAS.—*The Duluth area probably experiences the most severe flooding. When the level of Lake Superior is high, sustained strong northeasterly winds temporarily raise lake levels at Duluth and flood low-lying areas adjacent to the lake. Duluth also has storm-runoff problems during short intense rains because of steep topography, inadequate storm sewers, and constriction of natural stream channels by culverts.*

# SURFACE-WATER QUALITY

### CHEMICAL ANALYSES, IN MILLIGRAMS PER LITER EXCEPT AS NOTED, OF WATER FROM SELECTED STREAMS AT BASE FLOW

| Map identifier | Station number | Streams and location | Date sampled | Temperature (°C) | Color (Pt-Co units) | Dissolved solids (residue at 180°C) | Bicarbonate | Dissolved chloride | Dissolved sulfate | Dissolved fluoride | Total nitrate nitrogen as N | Total phosphorus as P | Dissolved calcium | Dissolved magnesium | Dissolved sodium | Dissolved potassium | Total hardness as CaCO3 | Dissolved iron | Dissolved manganese | Dissolved boron |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 04010500 | Pigeon River at M.F. near Grand Portage | 9-24-74 | 10.0 | 60 | 45 | 31 | 1.5 | 7.9 | 0.1 | 0.04 | 0.02 | 9.0 | 2.2 | 1.7 | 0.4 | 33 | 0.19 | 0.00 | 0.03 |
| B | 04011500 | Brule River near Hovland | 9-25-74 | — | 50 | 28 | 15 | 1.3 | 5.9 | .1 | .04 | .02 | 5.1 | 1.0 | 1.5 | .2 | 17 | .33 | .01 | .03 |
| C | 04012500 | Poplar River at Lutsen | 9-25-74 | 6.0 | 40 | 50 | 33 | 1.6 | 6.4 | .2 | .10 | .02 | 13 | 3.2 | 2.3 | .3 | 46 | .20 | .00 | .06 |
| D | 04012700 | Temperance River near Schroeder | 9-24-74 | 7.5 | 40 | 39 | 26 | 1.4 | 5.9 | .2 | .01 | .01 | 6.9 | 1.8 | 1.9 | .2 | 25 | .27 | .00 | .07 |
| E | 04013300 | Manitou River near Little Marais | 9-24-74 | 6.0 | 40 | 63 | 48 | 2.8 | 6.4 | .2 | .06 | .02 | 13 | 3.1 | 2.8 | .1 | 45 | .23 | .00 | .05 |
| F | 04014500 | Baptism River near Beaver Bay | 9-23-74 | 7.0 | 60 | 60 | 45 | 3.5 | 6.8 | .2 | .11 | .19 | 11 | 3.8 | 3.6 | .2 | 43 | .16 | .00 | .04 |
| G | 04015000 | Beaver River at Beaver Bay | 9-24-74 | 7.5 | 30 | 78 | 74 | 2.3 | 5.6 | .2 | .08 | .01 | 16 | 5.0 | 3.6 | .5 | 61 | .28 | .01 | .09 |
| H | 04015140 | Gooseberry River near Two Harbors | 9-24-74 | 8.0 | 20 | 88 | 97 | 1.3 | 6.8 | .1 | .05 | .04 | 22 | 6.6 | 3.3 | .3 | 82 | .08 | .01 | .07 |
| I | 04015330 | Knife River near Two Harbors | 9-25-74 | 10.5 | 20 | 112 | 102 | 5.2 | 7.5 | .1 | .01 | .01 | 23 | 7.3 | 5.9 | .4 | 88 | .08 | .01 | .09 |
| J | 04015350 | French River near Duluth | 9-24-74 | 6.5 | 20 | 120 | 114 | 3.3 | 7.5 | .2 | .00 | .04 | 23 | 9.3 | 4.4 | .7 | 96 | .07 | .00 | .05 |
| K | 04024052 | Blackhoof River near Holyoke | 9-23-74 | 6.5 | 10 | 127 | 120 | 3.5 | 8.7 | .1 | .15 | .02 | 27 | 8.8 | 3.5 | .7 | 100 | .23 | .02 | .05 |
| L | 04024088 | Nemadji River near Duesler | 9-23-74 | 8.5 | 70 | 100 | 100 | 3.9 | 8.5 | .2 | .02 | .02 | 24 | 7.6 | 3.8 | 1.4 | 91 | .50 | .01 | .10 |




STREAMS DRAINING THE WATERSHED CONTAIN SOFT TO MODERATELY HARD CALCIUM MAGNESIUM BICARBONATE TYPE WATER WITH DISSOLVED-SOLIDS CONCENTRATIONS OF 45 TO 120 MG/L (MILLIGRAMS PER LITER).—*Dissolved-solids concentrations in streams are a function of base flow (contributed from ground water), especially in streams in the North Shore area, reflects the crystalline-rock environment. Dissolved-solids concentrations in stream water are low except in the southern part of the North Shore area and in the central Nemadji Basin, where glacial lake deposits provide a source for calcium and bicarbonate.*

*Water from most streams meets the 0.3 mg/L recommended limit (U.S. Public Health Service, 1962) in many of the streams. Dissolved iron is related to organic material that also imparts a brown color to the water. Thus, water with color generally contains high concentrations of iron also.*

*Calcium, magnesium, bicarbonate, and sulfate are the principal ions in streams of the watershed. Other ions are generally found in only small concentrations.*

*According to data from the Minnesota Pollution Control Agency, (written commun., 1974) erosive lake clays in the central Nemadji Basin yield excessive amounts of silt to streams that produce average turbidities in excess of 30 Jackson units. Turbidity in streams draining the less extensive lake deposits in the North Shore area seldom exceeds 10 units. In the northern part of the area, where lake clays are absent, turbidity seldom exceeds 2 units.*




SPECIFIC CONDUCTANCE IS DIRECTLY RELATED TO DISSOLVED-SOLIDS CONCENTRATION AND HARDNESS IN SURFACE WATER OF THE WATERSHED.—*Dissolved solids and hardness of surface water can be estimated by measuring specific conductance and estimating dissolved solids and hardness from the graphs. Examples show that water with a conductivity of 150 micromhos per centimeter at 25° C (also will contain about 90 mg/L of dissolved solids and have a hardness of about 70, expressed as milligrams per liter of calcium carbonate.*

# WATER RESOURCES OF THE LAKE SUPERIOR WATERSHED, NORTHEASTERN MINNESOTA

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