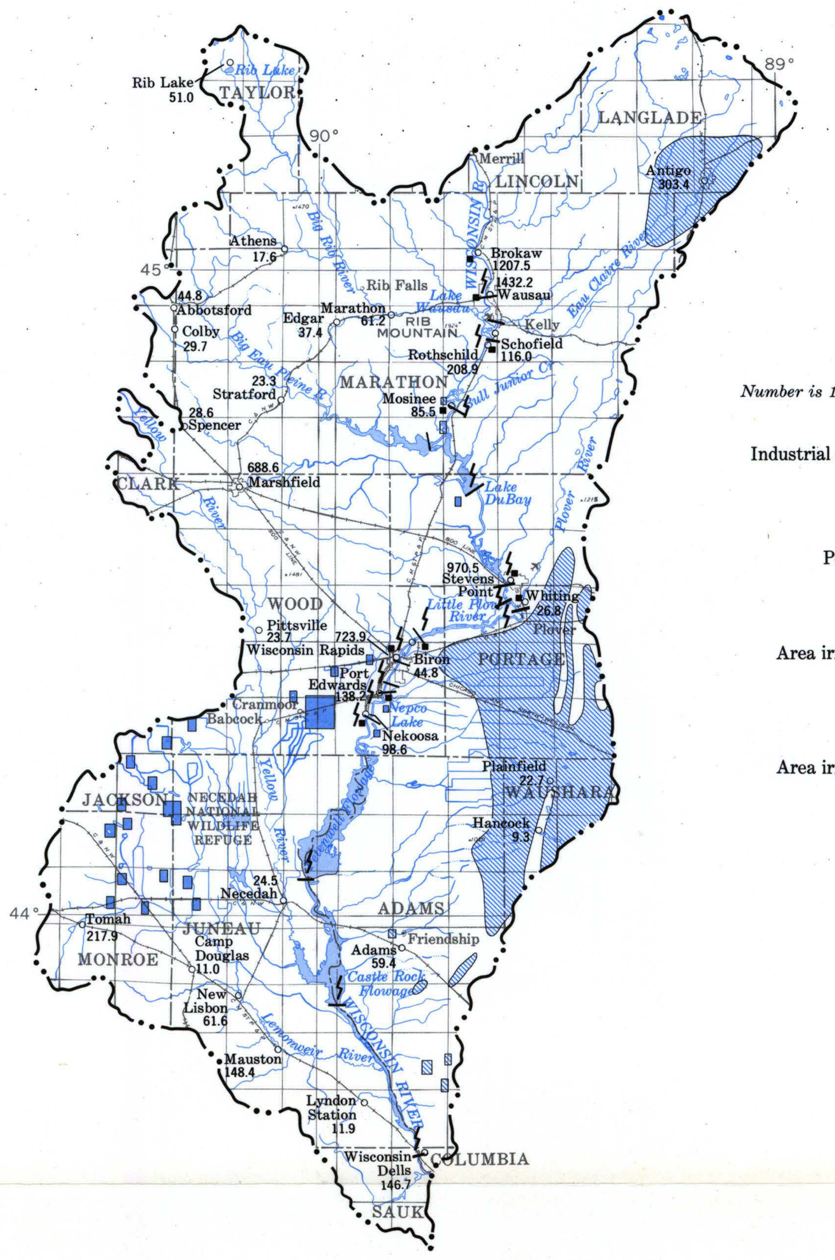
WATER USE IN 1967



EXPLANATION

688.6
Public water supply
Number is 1967 pumpage, in millions of gallons per day

Industrial area with high use of ground or surface water

Power-generation site with dam

Area irrigated by ground water for growing vegetable crops

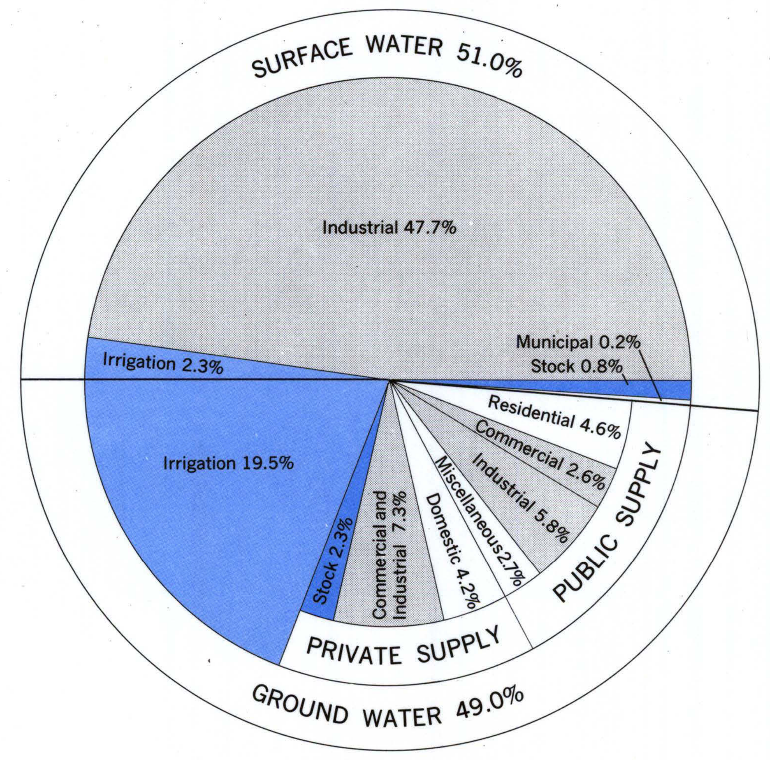
Area irrigated by surface water for growing cranberries

Area boundary

Reservoirs

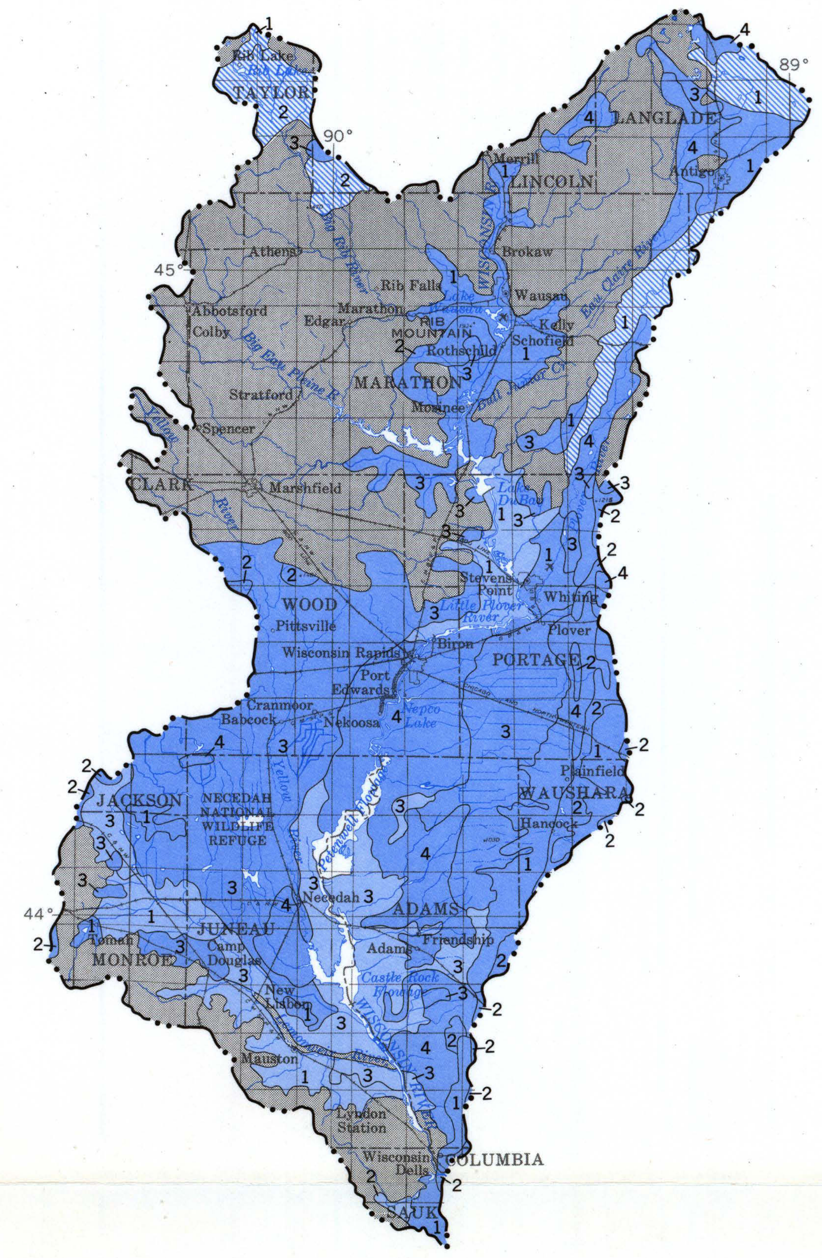
Basin boundary

SCALE: 1:1 000 000
10 5 0 10 20 MILES
10 5 0 10 20 KILOMETERS



ESTIMATED TOTAL WATER USE IN 1967 44.3 BILLION GALLONS OR AN AVERAGE OF 121 MILLION GALLONS PER DAY

SOIL SUITABILITY FOR IRRIGATION



EXPLANATION

Good:
1 — Level, permeable, with water table deeper than 4 feet
2 — Limited to level areas in uplands
3 — Limited to areas that have been improved by drainage
4 — Limited to areas that can be improved by drainage

Fair:
1 — Level to undulating, moderately permeable; depth to water table 1 to 4 feet
2 — Clayey
3 — Clayey and sandy with mixed drainage conditions

Fair to poor:
1 — Limited to level areas intermixed with undrained wetlands
2 — Limited to level areas intermixed with poorly-drained depressions

Poor:
Irregular terrain, low permeability, or depth to water table less than 1 foot

Area boundary

Basin boundary

SCALE: 1:1 000 000
10 5 0 10 20 MILES
10 5 0 10 20 KILOMETERS

The physical characteristics that determine the soil's suitability for irrigation are topography, soil permeability, and depth to the water table.

For optimum irrigability the topography of the land should be level to allow uniform distribution of water and to prevent water runoff. Soils should be permeable so that the water can infiltrate and percolate to the root zone; and the depth to the water table should be 4 feet or more so that plant roots remain in the zone of aerated soil for proper assimilation of oxygen and nutrients.

Excluded from the physical characteristics but related to irrigability are soil fertility (beyond the scope of this report), frost danger, and water availability. Frost is an ever-present danger throughout most of the area, and developers would be well advised to plan thoroughly before undertaking any large agricultural venture. Water availability is discussed in the surface- and ground-water sections.

Soils within the basin may be divided into three major classifications according to their suitability for irrigation—good, fair, and poor (F. C. Hole, written commun., 1968). Good conditions for irrigation are in the glacial-outwash, glacial-lake, and alluvial areas; fair soils are in low areas near the main rivers; and poor soils exist in areas of glacial ground moraine and in the bedrock uplands. A fourth, mixed classification of good to poor soils is in some of the pitted glacial outwash and end moraines.

The map at the left shows the distribution of these soil classifications within the basin.

MUNICIPAL PUMPAGE IN 1967

Municipality	County	Population	Pumpage (million gallons)						Source
			Residential	Commercial	Industrial	Miscellaneous	Total ground water	Total surface water	
Abbotsford	Marathon	1,171	14.8	9.8	15.4	4.8	44.8	0	Unconsolidated deposits.
Adams-Friendship	Adams	1,861	31.4	13.9	5.2	8.8	[2]59.4	0	Sandstone.
Antigo	Langlade	9,691	113.0	55.9	59.7	74.8	303.4	0	Unconsolidated deposits.
Athens	Marathon	770	6.9	7.1	0	3.6	17.6	0	Do.
Biron	Wood	726	12.3	<.1	23.5	9.0	44.8	0	Do.
Brokaw	Marathon	319	19.3	1,187.9		.4	[2]1,207.5	0	Do.
Camp Douglas	Juneau	489	[2]5.3	[2]1.1	0	[2]4.6	[2]11.0	0	Sandstone.
Colby	Marathon	1,085	10.5	4.6	9.9	4.7	29.7	0	Unconsolidated deposits.
Edgar	Marathon	803	8.8	4.0	15.9	8.7	37.4	0	Do.
Hancock	Waushara	367	3.7	2.6	0	3.0	9.3	0	Do.
Lyndon Station	Juneau	335	3.4	1.2	0	7.4	[2]11.9	0	Sandstone.
Marathon	Marathon	1,022	13.0	5.8	38.8	3.6	61.2	0	Unconsolidated deposits.
Marshfield	Wood	14,153	189.8	165.4	162.3	171.2	[2]688.6	0	Do.
Mauston	Juneau	3,531	[2]54.9	[2]46.4	[2]5.5	[2]41.6	[2]148.4	0	Sandstone.
Mosinee	Marathon	2,067	35.3	7.4	17.6	25.2	85.5	0	Unconsolidated deposits.
Necedah	Juneau	691	7.8	8.6	0	8.1	24.5	0	Sandstone.
Nekoosa	Wood	2,515	38.8	9.0	26.8	24.0	98.6	0	Unconsolidated deposits.
New Lisbon	Juneau	1,337	18.1	13.9	0	29.6	61.6	0	Sandstone.
Pittsville	Wood	661	6.0	3.4	1.5	12.9	[2]23.7	0	Unconsolidated deposits.
Plainfield	Waushara	660	14.3	5.0	1.5	1.9	22.7	0	Do.
Port Edwards	Wood	1,849	31.5	26.9	45.0	34.7	[2]78.8	[2]59.4	Unconsolidated deposits and Nepco Lake.
Rib Lake	Taylor	794	6.1	3.2	2.9	38.9	0	[2]51.1	Rib Lake.
Rothschild	Marathon	2,550	71.3	0	95.6	42.0	208.9	0	Unconsolidated deposits.
Schofield	Marathon	3,038	34.4	25.2	39.1	17.3	116.0	0	Do.
Spencer	Marathon	897	11.2	3.6	2.2	11.5	[2]28.6	0	Do.
Stevens Point	Portage	17,837	380.5	196.3	148.5	245.3	[2]970.5	0	Do.
Stratford	Marathon	1,106	10.1	6.4	1.5	5.2	[2]23.3	0	Do.
Tomah	Monroe	5,321	75.7	50.4	18.4	73.4	217.9	0	Sandstone.
Wausau	Marathon	31,943	558.8	242.7	414.4	216.2	[2]1,432.2	0	Unconsolidated deposits.
Whiting	Portage	854	9.6	.8	6.2	10.2	26.8	0	Do.
Wisconsin Dells	Columbia	2,105	35.9	71.4	0	39.4	146.7	0	Sandstone.
Wisconsin Rapids	Wood	15,042	270.9	167.7	207.4	77.9	723.9	0	Unconsolidated deposits.
Totals		127,590	2,103.4	1,159.8 1,187.9	1,364.8	1,259.9	6,965.2	110.5	

[1]All pumpage figures are rounded to the nearest 0.1 million, and summation of itemized figures may not equal total.
[2]1966 pumpage.

GROUND WATER

About 21.7 billion gallons of ground water were used in 1967, or an average of about 60 million gallons per day. Excluding power generation, this was about 49 percent of the area's total water use.

About 40 percent of the ground water pumped in 1967 was used for irrigation. Estimated use was about 8.6 billion gallons (26,500 acre feet), compared to 2.6 billion gallons (8,000 acre feet) in 1960 and only 0.6 billion gallons (1,700 acre feet) in 1953. Most of the present irrigation with ground water is in the central sand plain, and most of the water is taken from sand and gravel deposits.

Public supply accounted for the second largest use of ground water in 1967. The estimated 6.96 billion gallons were distributed in the following amounts: industrial, 2.56 billion gallons; residential, 2.04 billion gallons; commercial, 1.14 billion gallons; and miscellaneous, 1.22 billion gallons. The table above shows how the individual communities distributed their water in 1967. Almost 100 percent of the water for public supply was from ground water. Less than 10 percent of the public supply ground water was pumped from the sandstone, and the remainder was taken from the sand and gravel deposits.

Another 6.1 billion gallons of ground water were used in 1967 by those who supplied their own water from private wells. Domestic wells supplied about 1.9 billion gallons, commercial and industrial wells about 3.2 billion gallons, and stock wells about 1.0 billion gallons.

Although about 21.7 billion gallons of ground water were withdrawn for use in 1967, only about 9 billion gallons were consumed, and the remainder was returned to the water system. Most of the consumed water, about 7 billion gallons, was evapotranspiration from irrigated soil and plants. Most of the remaining 2 billion gallons was lost by stock watering and industrial and commercial uses.

SURFACE WATER

The main uses of surface water in the central Wisconsin River basin are for industry, power generation, irrigation, recreation, and disposal of sewage. A small amount is used for municipal supply. In 1967 industrial, irrigation, municipal, and stock uses were about 22.6 billion gallons.

Industry uses the largest amount of water in the study area—more than 93 percent of the surface water used and about 54 percent of the total water used in 1967. Most of this use (21 billion gallons) is by 10 paper manufacturing plants along the rivers. The plants use water from the Wisconsin River for processing and for cooling, and they change the quality of the water as a result of their operations. Used water is warmer than before use, and is usually contaminated with various wastes. Most industries return their used water to rivers after treatment.

Generation of electric power is also one of the principal uses of surface water. Along the central part of the Wisconsin River 15 plants generate electric power. Six of these plants are public hydroelectric plants and nine are operated by paper mills. The water is used and reused to generate power as it passes downstream, but this use has no harmful effect on either water quality or quantity.

The second largest withdrawal use of surface water is for irrigation of cranberries. In 1967 this use was estimated at about 1 billion gallons or 3,000 acre feet. In addition to irrigation, large amounts of water are diverted and used for cranberry culture—frost protection, harvesting, and washing. Much of this water is lost by evaporation, but the remainder is returned directly to streams with increased concentrations of impurities. The Cranmore area west of Wisconsin Rapids used about 4.4 billion gallons from the Wisconsin River for cranberry culture during the 1967 growing season.

The recreational use of water is a growing industry in the State of Wisconsin. The Wisconsin River and its numerous large reservoirs and many tributaries afford abundant recreational opportunities for boating, swimming, and water skiing. Also, fish and wildlife abound in the nearby lakes, making much of the area ideally suited for fishing and hunting. Trout, especially suited to cold water, are abundant in the outwash areas where ground-water runoff is high. When properly used for recreation, there is no effect on water quality or quantity.

Only two municipalities used surface water as a source of supply in 1967. Rib Lake took all of its water from Rib Lake, and Port Edwards used water from Nepco Lake to supplement its ground-water supply. Most of this water was returned directly to surface-water bodies after use and treatment.

The controversial subject of sewage disposal is becoming more important as the growing population uses more water and imposes larger sewage loads on major streams. Concurrently the same population demands cleaner streams for recreation, wildlife, health, and beauty. The importance of rivers for sewage disposal is shown by the number of municipalities and industries that use the rivers for this purpose. In 1967 more than 30 cities and 20 major industries within the study area discharged their effluent directly into surface waters.

REFERENCES

Bean, E. F., 1949, Geologic map of Wisconsin: Wisconsin Geol. and Nat. History Survey.
Ericson, D. W., 1961, Floods in Wisconsin—magnitude and frequency: U.S. Geol. Survey open-file report, 109 p.
Harder, A. H., and Drescher, W. J., 1954, Ground-water conditions in southwestern Langlade County, Wisconsin: U.S. Geol. Survey Water-Supply Paper 1294, 39 p.
Hole, F.D., Beatty, M.J., Milfred, C.J., Lee, G.B., and Klingelhoets, A.J., 1968; Overlay Soil Map of Wisconsin, 1:250,000: University of Wisconsin, Geological and Natural History Survey.
Holt, C. L. R., Jr., 1965, Geology and water resources of Portage County, Wisconsin: U.S. Geol. Survey Water-Supply Paper 1796, 77 p.
Martin, Lawrence, 1932, The physical geography of Wisconsin: Wisconsin Geol. and Nat. History Survey Bull. 36, 608 p.
Schraufnagel, F. H., 1965, Wisconsin surface water quality, 1961–1964: Wisconsin State Board of Health, p. 51–55.
Schraufnagel, F. H., Montie, L. A., Lueschow, L. A., and Kozel, Charles C., 1964, Report on an investigation of the pollution in the upper Wisconsin River drainage basin made during 1963 and in early 1964: Wisconsin State Board of Health, 31 p.
Searcy, J. K., 1959, Flow duration curves: U.S. Geol. Survey Water-Supply Paper 1542–A, 33 p.
Sheerar, L. L., 1963, A model for river regulation, an address given at Am. Soc. Civil Engineers conference, Milwaukee, Wis.: Wisconsin Valley Improvement Co., 19 p.
Summers, W. K., 1965, Geology and ground-water resources of Waushara County, Wisconsin: U.S. Geol. Survey Water-Supply Paper 1809–B, 32 p.
Thornthwaite, C. W., and Mather, J. R., 1957, Instructions and tables for computing potential evapotranspiration and the water balance—Publications in climatology, v. 10, no. 3: Centertown, N. J., Drexel Inst. of Technology, pp. 181–311.
Thwaites, F. T., 1940, Buried Precambrian of Wisconsin: Wisconsin Acad. Sci., Arts and Letters Trans., v. 32, pp. 233–242.
———1943, Pleistocene of part of northeastern Wisconsin: Geol. Soc. America Bull. v. 54, p. 87–144.
———1956, Glacial features of Wisconsin; map compiled from published and unpublished data, scale—1:1,000,000.
U.S. Geological Survey, 1959, Compilation of records of surface waters of the United States, Part 5, Hudson Bay and upper Mississippi River basins through September 1950: U.S. Geol. Survey Water-Supply Paper 1308, p. 386–407.
———1964, Surface-water records of Wisconsin, 1963: Water Resources Division, 154 p.
———1964, Compilation of records of surface waters of the United States, Part 5, Hudson Bay and upper Mississippi River basins October 1950 to September 1960: U.S. Geol. Survey Water-Supply Paper 1728, p. 272–286.
———1965, Surface-water records of Wisconsin, 1964: Water Resources Division, 197 p.
U.S. Public Health Service, 1962, Drinking water standards, 1962: U.S. Public Health Service Pub. 956, 61 p.
U.S. Weather Bureau, Climatological data, Wisconsin 1931–1964: U.S. Dept. of Commerce Ann. Summaries.
Weeks, E. P., Ericson, D. W., and Holt, C. L. R., Jr., 1965, Hydrology of the Little Plover River basin, Portage County, Wisconsin, and effects of water resource development: U.S. Geol. Survey Water-Supply Paper 1811, 78 p.
Wisconsin Conservation Department, 1964, Wisconsin lakes: Publication 218–64 of the Wisconsin Conserv. Dept., 67 p.
Wisconsin State Board of Health, 1962, Public water works and sewerage systems in Wisconsin: Wisconsin State Board of Health, 20 p.
Young, K. B., 1963, Flow characteristics of Wisconsin streams: U.S. Geol. Survey open-file rept., 151 p.

SUMMARY AND CONCLUSIONS

ADEQUACY OF WATER RESOURCES

Each of eight water sources is evaluated for present and future adequacy. The quantity and quality of each source is considered, as well as recharge, inflow, and general suitability

Purpose \ Source	Wisconsin River and major lakes and reservoirs	Big Eau Pleine, Big Rib, and Yellow Rivers	Lemonweir River	Eau Claire River	Little Plover River	Sand and gravel deposits	Consolidated sandstone	Glacial moraines
Municipal and industrial supply	Supplies water to municipal wells by induced recharge. Yields as high as 1,000 gpm. Sufficient quantity for use by paper mills including cooling and manufacturing. / Treatment necessary for municipal uses, and some industrial uses. Transports sewage.	Reservoir storage sites could provide adequate amounts for small users. / Rivers may go dry or nearly dry at times of greatest need.	Adequate for moderate supplies. / Treatment necessary for municipal and some industrial uses.	Adequate for moderate to large supplies through induced infiltration. / Treatment necessary for municipal and some industrial uses.	/ Generally inadequate for municipal or industrial supply.	Adequate for municipal and industrial supply. Yield may exceed 1,000 gpm. / Excessive iron locally. Easily polluted from surface.	Adequate for municipal and industrial supply. Yield may exceed 1,000 gpm. / Excessive iron locally.	/ Inadequate for municipal or industrial supply, except for isolated sand and gravel within or under moraines.
Rural domestic and stock supply	Adequate for stock. / Treatment necessary for domestic use.	Adequate for stock. / Treatment necessary for domestic use.	Adequate for stock. / Treatment necessary for domestic use.	Adequate for stock. / Treatment necessary for domestic use.	Adequate for stock. / Treatment necessary for domestic use.	Adequate for rural domestic supply and stock. / Excessive iron locally. Easily polluted from surface.	Adequate for rural domestic supply and stock. / Excessive iron locally.	Usually adequate for domestic supply and stock. / Yield determined by variable thickness and variable permeability.
Irrigation supply	Adequate quantity and quality for irrigation of areas near the river. /	Adequate for limited use as irrigation supply. / Rivers may go dry or nearly dry at times of greatest need.	Adequate for limited use as irrigation supply. /	Adequate for limited use as irrigation supply. /	Adequate for limited use as irrigation supply. /	Adequate for irrigation. Yield may exceed 1,000 gpm. /	Adequate for irrigation. Yield may exceed 1,000 gpm. /	/ Inadequate for irrigation except for isolated sand and gravel within or under moraines.
Recreation	Suitable for boating, fishing, water skiing, and some swimming. / Sewage and industrial waste may affect fish life and limit human contact for swimming.	Suitable for fishing and some swimming. / Rivers may go dry or nearly dry at times of greatest demand.	Suitable for fishing and some swimming. /	Suitable for fishing and some swimming. / Small size limits boating and water skiing.	Suitable for fishing and some swimming. / Small size limits boating and water skiing.			
Fish and wildlife habitat	Suitable for wildlife along banks, and generally for fish along most of length. / Sewage and industrial waste may affect fish life along limited reaches.	Good for fish and wildlife. / Extreme low flows may damage fish population.	Excellent for fish and wildlife. /	Excellent for fish and wildlife. /	Excellent for fish and wildlife. /			

EXPLANATION

Good for fish and wildlife. — Desirable features above the line
Extreme low flows may damage fish population. — Undesirable features below the line

Suitability for indicated purpose or use: Good; Fair; Poor

The central Wisconsin River basin contains a large amount of available good quality water—a readily renewable resource that has barely been tapped by man. Ground water is available from three separate sources: highly permeable sand and gravel deposits, highly permeable to moderately permeable consolidated sandstone, and poorly permeable glacial drift. Surface water is available from the Wisconsin River and from numerous tributaries, lakes, and wetlands, although there are legal limitations on withdrawing water from these sources.

Highly permeable sand and gravel deposits are present in the east-central part of the basin, the flat area near Antigo, and in the valleys of the larger rivers. Well yields from these materials commonly range from 500 to over 1,000 gpm, depending upon local variations of aquifer thickness and lithology.

Consolidated sandstone underlies the entire southern half of the basin; it is thin along its northern limit but thickens toward the south. Numerous municipal and irrigation wells each withdraw several hundred gallons of water per minute from the sandstone, and the greatest known well yields exceed 1,000 gpm.

Surface-water resources are varied throughout the area. In the north the land drains quickly, and streams tend toward the extremes of high and low flows. In the south the streams generally have steadier and more dependable flows. The Wisconsin River has a dependable, well regulated flow throughout its entire reach between Merrill and Wisconsin Dells.

The main uses of surface water are for industry, power generation, recreation, irrigation, and sewage disposal. A small amount is used for municipal supplies. In 1967 the total use was about 22.6 billion gallons. The largest user was industry. Ten paper manufacturing plants used about 21 billion gallons of water for processing and cooling; they returned their used water to the river. Fifteen plants generate electric power along the central Wisconsin River. Recreation is increasing the growing use of surface water for fishing, swimming, and boating, with little effect on water quality or quantity. Rib Lake and Port Edwards used surface water for their municipal supplies, and more than 30 cities and 20 industries used the same rivers to carry away their wastes.

Poorly permeable glacial drift, mostly ground and end moraines, covers the northern half of the basin. Usual well yields from this material are less than 50 gpm, commonly only enough for individual domestic or farm use. Higher well yields may occur where wells penetrate rare lenses or stringers of isolated sand and gravel.

Ground-water use was about 21.7 billion gallons in 1967. Thirty-one communities used about 7 billion gallons of ground water for their supplies in 1967. For the same period about 8.6 billion gallons were used for irrigation, and about 6.1 billion gallons were used for all types of private supplies.

The chemical quality of ground water is generally good, although some minor and local problems exist. Iron sometimes exceeds the amount recommended by the U.S. Public Health Service, but it is not a hazard to health. Hardness ranges upward to more than 560 mg/l. The softest water is in glacial outwash and lake sands, and the hardest water is in morainal areas and in the sandstone.

Natural quality characteristics of surface water are the same as for ground water, but they are less concentrated and more variable in amount; impurities are introduced as wastes of man. The concentration of most water quality parameters increases as the amount of streamflow decreases, and the concentration decreases as the amount of streamflow increases. Although chemical and organic quality characteristics make streams less desirable, the impurities as yet seldom reach concentrations high enough to limit normal use by man. Pollution, however, is of growing concern as the population increases.

Base from U.S. Geological Survey
State base map, 1:500,000, 1968

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WATER RESOURCES OF WISCONSIN—CENTRAL WISCONSIN RIVER BASIN

By
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1971