SURFACE WATER

Station No. 5-4335
Yellowstone River near Blanchardville
Drainage area: 29.1 sq mi
Period of record: 1954-1965

Maximum instantaneous discharge:	2,240	cfs
Average discharge, 12 years:	15.9	cfs
Minimum instantaneous discharge:	1.6	cfs

Station No. 5-4140
Platte River near Rockville
Drainage area: 139 sq mi
Period of record: 1954-present

Maximum instantaneous discharge:	43,500	cfs
Average discharge, 34 years:	93.5	cfs
Minimum instantaneous discharge:	0	cfs
90 percent duration discharge:	32	cfs
Theoretical storage required to maintain 90 percent duration discharge:	15,000	acre-feet

Station No. 5-4135
Grant River at Burton
Drainage area: 287 sq mi
Period of record: 1934-present

Maximum instantaneous discharge:	25,000	cfs
Average discharge, 34 years:	159	cfs
Minimum instantaneous discharge:	21	cfs
Minimum instantaneous discharge:	53	cfs
90 percent duration discharge:		
Theoretical storage required to maintain 90 percent duration discharge:	6,000	acre-feet

Station No. 5-4325
Pecatonica River at Darlington
Drainage area: 274 sq mi
Period of record: 1939-present

Maximum instantaneous discharge:	22,000	cfs
Average discharge, 29 years:	178	cfs
Minimum instantaneous discharge:	17	cfs
90 percent duration discharge:	48	cfs
Theoretical storage required to maintain 90 percent duration discharge:	4,000	acre-feet

Station No. 5-4150
Galena River at Buncombe
Drainage area: 128 sq mi
Period of record: 1939-present

Maximum instantaneous discharge:	29,700	cfs
Average discharge, 29 years:	73.1	cfs
Minimum instantaneous discharge:	0.8	cfs
90 percent duration discharge:	20	cfs
Theoretical storage required to maintain 90 percent duration discharge:	3,000	acre-feet

Station No. 5-4330
East Branch Pecatonica River near Blanchardville
Drainage area: 221 sq mi
Period of record: 1939-present

Maximum instantaneous discharge:	11,700	cfs
Average discharge, 29 years:	136	cfs
Minimum instantaneous discharge:	18	cfs
90 percent duration discharge:	60	cfs
Theoretical storage required to maintain 90 percent duration discharge:	48,000	acre-feet

Station No. 5-4345
Pecatonica River at Martintown
Drainage area: 1040 sq mi
Period of record: 1939-present

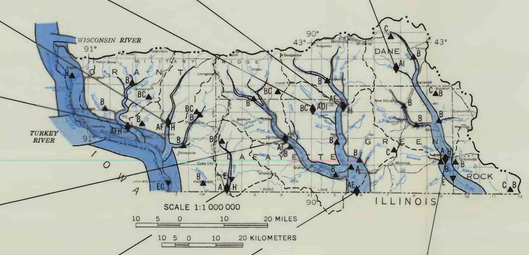
Maximum instantaneous discharge:	15,000	cfs
Average discharge, 29 years:	675	cfs
Minimum instantaneous discharge:	0	cfs
90 percent duration discharge:	230	cfs
Theoretical storage required to maintain 90 percent duration discharge:	24,000	acre-feet

Station No. 5-4360
Mount Vernon Creek near Mount Vernon
Drainage area: 16.1 sq mi
Period of record: 1954-1965

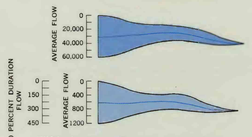
Maximum instantaneous discharge:	940	cfs
Average discharge, 12 years:	16.5	cfs
Minimum instantaneous discharge:	7.1	cfs

Station No. 5-4365
Sugar River near Brodhead
Drainage area: 527 sq mi
Period of record: 1914-present

Maximum instantaneous discharge:	14,800	cfs
Average discharge, 54 years:	334	cfs
Minimum instantaneous discharge:	35	cfs
90 percent duration discharge:	140	cfs
Theoretical storage required to maintain 90 percent duration discharge:	139,000	acre-feet



EXPLANATION



Width of pattern indicates approximate average discharge of stream, in cubic feet per second. Discharge less than 20 cfs not shown

Measurement site symbol	Parameter measured	Frequency of measurement
A	Stream discharge	Continuous
B	Low-flow stream discharge	Intermittent
C	Flood-flow stream discharge	Periodic
D	Lake stage	Periodic
E	Chemical quality	Monthly[1]
F	Chemical quality	Intermittent
G	Chemical quality	Weekly[2]
H	Sediment	Intermittent
I	Sediment	Daily

Letter to left indicates present measurement site; letter to right indicates discontinued measurement site. Records through 1967 water-year

[1] Operated by the Wisconsin Department of Natural Resources
[2] Operated by the Water Quality Office (EPA)
Remaining sites operated by the U.S. Geological Survey

Boundary of basin above active continuous-record station

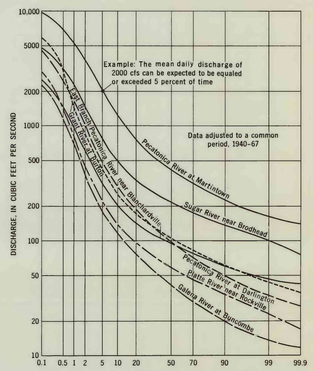
Surface-water divide

DATA NETWORK AND AVERAGE FLOW

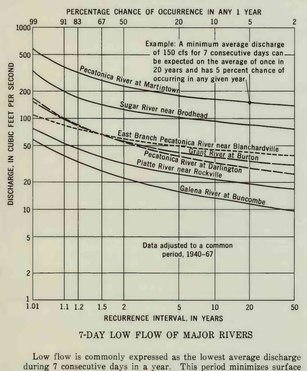
Continuous discharge has been monitored during various periods of time at 10 gaging stations in the study area, seven of which are measured at present. Station data are given for two discontinued stations and the seven active stations through the 1967 water year. The storage figures quoted assume that there is a suitable reservoir site available and that there are no losses of any kind. Sites of past and present measurement of lake stage, water quality, low flow, flood flow, and sediment yield also are shown.

The average-flow diagram, based on the mean of all yearly mean discharges of record, gives a visual impression of basinwide distribution of streamflow. The 90 percent duration discharge (the flow that can be expected to be equaled or exceeded 90 percent of the time) was found to be correlative with average flow at the gaging stations. Locations for storage reservoirs throughout the study area provide opportunity for more regulation of streamflow as the need increases.

Streams in the Pecatonica-Sugar River basin contain abundant water of good chemical quality. About 425 billion gallons of surface water leave the study area each year. The present major use made of this water are as a means of carrying off wastes, as a fish and wildlife habitat, and as a source of recreation. In some places man's use of the water has altered the chemical quality slightly, and the few small reservoirs and farm ponds have only a little effect on the streamflow characteristics. At present, surface water is not used for municipal supplies because the cost of treatment is high and because ground water is adequate at all places where surface water is available. Because the area is well drained, there are no natural lakes in the basin.



DURATION OF DAILY MEAN DISCHARGE OF MAJOR RIVERS



7-DAY LOW FLOW OF MAJOR RIVERS

Low flow is commonly expressed as the lowest average discharge during 7 consecutive days in a year. This period minimizes surface runoff from precipitation and lessens the effect of abnormally low daily discharges due to flow regulation.

Low-flow discharge depends upon basin characteristics such as soil type, rock units, and topography. In small basins these characteristics tend to be of one type and produce distinctive low flows. Larger basins, however, integrate the effects of many small basins having varied characteristics, and the low flows of large basins are more directly related to basin size.

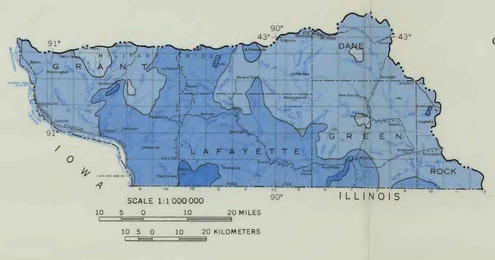
It is evident from the similar shapes of all the curves and their arrangement in order of basin size that basin characteristics other than drainage area have little effect on low flows and are uniform throughout the area. Even in the glaciated eastern one-fifth of the basin, where the geology, soils, and topography differ significantly from the unglaciated western four-fifths, the curve for the Sugar River has a shape similar to the others because of the integrating effect of the large basin.

SURFACE-WATER QUALITY

Surface water in the study area is generally of good quality, although very hard (180 mg/l or greater). The quality of water in some of the mining area is degraded by the addition of mineralized mine water.

The quality of water in some streams, especially in reaches receiving sewage effluent from municipalities, has been degraded locally. Nutrients and biological and chemical contaminants have caused much of this degradation.

Sediment concentrations in the study-area streams are the highest in the State and limit the uses that can be made of the streams.



EXPLANATION

Conductivity in micromhos at 25° Celsius	Approximate dissolved solids, in milligrams per liter
Less than 500	Less than 300
500-600	300-360
600-700	360-420
More than 700	More than 420

Dissolved solids derived by empirical relationship from conductivity

Surface-water divide

The conductivity map above shows the chemical quality of streamflow during a high base-flow period (Sept. 16-18, 1969). The quality of water in streams during base flow generally is similar to that of ground water. Throughout most of this basin the quality is uniform (conductance mostly ranging between 500 and 700 micromhos).

Specific conductance of water is related to the amount and kind of minerals dissolved in the water. In the study area this relationship can generally be expressed by the formula:

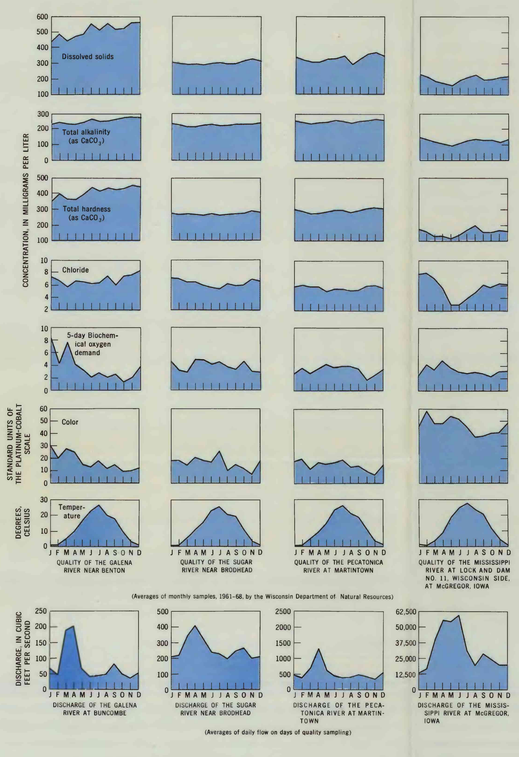
$$\text{Dissolved solids} = \text{specific conductance} \times 0.60$$

This formula represents average conditions, and the numerical relationship varies seasonally and with flow.

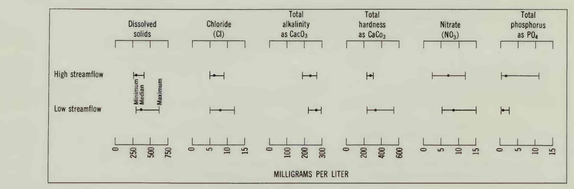
The highest conductance in the study area, more than 700 micromhos, results from mine operations in southwestern Lafayette County and municipal and industrial wastes.

Mississippi River water is less mineralized than the water in any other stream in the study area. The Mississippi River above the study area receives most of its water from areas in eastern Minnesota and northwestern Wisconsin that yield only slightly mineralized water.

SURFACE-WATER QUALITY DURING LOW FLOW



SEASONAL VARIATION OF SURFACE-WATER QUALITY AND DISCHARGE



QUALITY OF WATER OF MAJOR STREAMS

The constituents shown (except phosphorus) have higher concentrations at low flow than at high flow. This is because of dilution of ground-water discharge by overland runoff during high flow. Phosphorus is the exception, being highest during high streamflow, because it is retained by the soil during dry periods and leaches out during excessive precipitation.

Dissolved solids represent total mineralization; it is partly natural in origin and partly a result of man's activities. Although chloride is commonly introduced to streams through sewage effluent, most of the chloride in the study area is from natural sources. Alkalinity represents mainly bicarbonate and, like hardness, is largely natural in origin. Nutrients (nitrate and total phosphorus) are partly introduced through sewage and fertilizers.

Nitrogen and phosphorus are nutrients necessary to stream biota, but excessive concentrations may cause weed-choked channels in streams and obnoxious algae blooms and weedy areas along reservoir shorelines. The critical concentrations given by Sawyer (1947) are 1.3 mg/l inorganic nitrogen as NO_3 and 0.03 mg/l inorganic phosphorus as PO_4. The minimum values of these constituents exceed these concentrations in all streams observed.

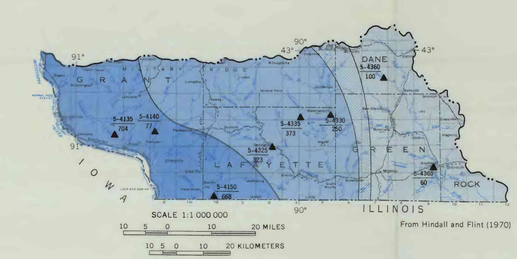
A average chemical quality of streamflow varies seasonally and with discharge. Hardness, dissolved solids, and alkalinity concentrations generally vary directly with each other and inversely to flow. However, during late summer and early fall these parameters vary directly with flow. Hardness and alkalinity make up most of the mineralization in the water. Chloride enters the streams at a constant rate, as evidenced by the reverse relation of chloride concentrations to flow.

Almost all of the oxygen demand in these streams is biologic and varies independently from flow except in the spring, when flood waters wash much debris and waste from shorelines into the streams.

Concentrations of chemical constituents are less in the Mississippi River than in the other streams, although color is higher.

The Pecatonica and Sugar Rivers represent moderately mineralized but unpolluted streams. The mineralization consists largely of hardness and alkalinity. However, in the winter months chloride increases slightly. Color is moderate.

The Galena River has the highest mineralization of the streams sampled. Most of this mineralization is due to hardness and alkalinity, but significant increases in dissolved solids are too great to be accounted for by hardness and alkalinity and may be due to mine drainage or geologic conditions. Nutrients are present in nuisance proportions. Color is not a problem but is always present in noticeable amounts.



From Hindall and Flint (1970)

EXPLANATION

Estimated average annual sediment yield, in tons per square mile

Less than 100

100-200

200-400

Greater than 400

Sediment sampling site
Upper number is station number; lower number is average annual sediment yield, in tons per square mile

Surface-water divide

AVERAGE ANNUAL SEDIMENT YIELD

Sediment carried by streams is a major problem because local erosion is severe and quantities of sediment transported are large. Average annual sediment yields are the largest in the State, with yields ranging from 60 to more than 700 tons per square mile (Hindall and Flint, 1970). Soil types (and parent geologic deposits), land cover, land use, and topography greatly influence the sediment yield.

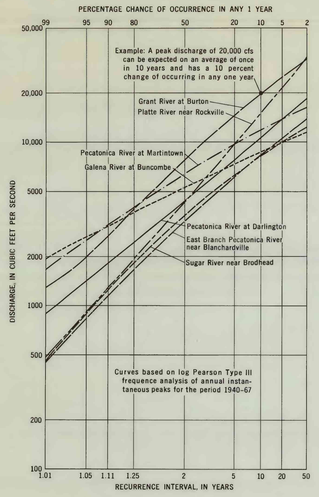
The combination of steep slopes, land cover removed for agriculture and construction, and extensive deposits of easily erodible loess soils provide the conditions for high yields. The highest yields are in the area along the Mississippi River, where the slopes are the steepest and loess deposits are the thickest. Yields decrease in an easterly direction as the slopes become less steep and loess deposits thinner, with the Sugar River basin having the smallest yields in the study area.

FLOODS

High relief of the study area, low infiltration rates, and very little surface storage combine to make flood risks in this area among the highest in the State. On all streams the flood peaks are high but of short duration.

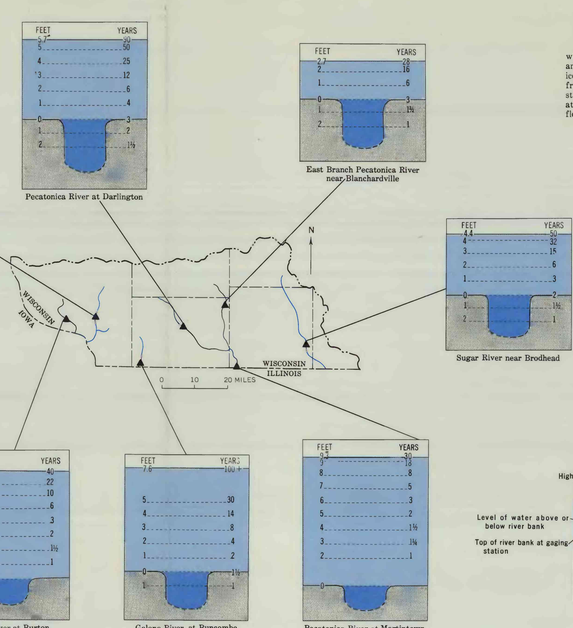
Potentially damaging floods occur frequently but, because there is little flood-plain development, damages resulting from these floods have not been extensive. The greatest losses occur in rural areas to crop and pasture land. The U.S. Army Corps of Engineers (1962) assesses the average annual flood damage in the Pecatonica-Sugar River basin to crop and pasture, rural property, and urban property as $322,700, $107,300, and $89,400, respectively. Major floods occurred in 1914, 1915, 1916, 1929, 1948, 1950, 1959, and 1969.

Most floods in the basin are of two types: 1) Spring floods, which are the result of rapid snowmelt and, occasionally, concurrent rainfall, and 2) summer floods, which are the result of intense storms. Most annual peaks are due to spring snowmelt, but the highest peaks are due to summer thunderstorms.



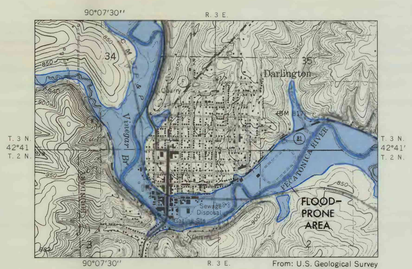
FLOODFLOW RECURRENCE OF MAJOR RIVERS

The magnitude of floodflows in the study area is unpredictable. Because of the steep topography, poor soil infiltration, and very little surface storage, the magnitude of floodflows depends primarily on rainfall patterns, intensity, and duration. Curves in this graph all fall within a narrow range. Their different slopes indicate differences in the characteristics that influence floodflows. A very intense, short duration storm centered over a basin and moving in a general downstream direction produces the largest flood peaks. This type of storm occurs most frequently during the summer and is local in extent.



FLOOD-STAGE FREQUENCY

Flood stage or height depends upon numerous factors including width and depth of stream channel, velocity within the stream channel and on the flood plain, and channel controls such as bridges, dams, ice jams, or natural constrictions. The diagrams at left illustrate the frequency of various high-water stages at long-term stream-gaging stations in the study area. Because controlling factors are different at each site on the stream, these stage diagrams can be used to estimate flood risks only in the vicinity of the gaging stations.



From U.S. Geological Survey Map of Flood-Prone Areas, Darlington and Calamine Quadrangles, 1970

FLOOD-PRONE AREA

The city of Darlington, located on the Pecatonica River, has experienced considerable flood damage. Many businesses, homes, and public facilities within the flood-prone area have been flooded frequently. The above map shows the area occasionally flooded. However, it is possible that floods will occur that exceed the limits outlined on the map.

SUMMARY OF WATER AVAILABILITY AND SUITABILITY FOR VARIOUS USES

Source / Use and criteria	SURFACE WATER: Mississippi River	SURFACE WATER: Platte, Grant, and Galena Rivers	SURFACE WATER: Pecatonica River	SURFACE WATER: Sugar River	GROUND WATER: Sand and gravel aquifer	GROUND WATER: Galena-Platteville aquifer	GROUND WATER: Sandstone aquifer
Municipal and industrial supplies: Quantity—100,000 gallons per day (about 1,000 population or a small industry)	Adequate discharge	Good quality	Adequate discharge	Adequate discharge	Good quality	Good quality	Adequate yields
Quality—meets drinking water standards of U.S. Public Health Service (1962, p. 7). Special industrial criteria may exist. (Federal Water Pollution Control Administration, 1968)	Good quality Water hard Treatment necessary Colored	Inadequate discharges for large uses Treatment necessary for domestic use Some local pollution Variable flow	Good quality Treatment necessary for domestic use Some local pollution Variable flow	Good quality Treatment necessary for domestic use Some local pollution	Water table shallow Locally high yields Limited areal extent Easily polluted Yields variable	Small to moderate yields Locally high iron Easily polluted Unit is unsaturated in many areas	Good quality Underlies entire basin Not subject to pollution Deep wells necessary for large supplies
Rural domestic and stock supply: Quantity—5 gallons per minute	Adequate discharge	Adequate discharge	Adequate discharge	Adequate discharge	Adequate yields	Adequate yields	Adequate yields
Quality—meets drinking water standards of U.S. Public Health Service (1962, p. 7)	Good quality Water hard Treatment necessary	Good quality Water very hard Treatment necessary for domestic use Use limited to riparian land	Good quality Water very hard Treatment necessary for domestic use Use limited to riparian land	Good quality Water very hard Treatment necessary for domestic use Use limited to riparian land	Good quality Water table shallow Limited to glaciated area and Mississippi River Valley Water very hard Easily polluted	Good quality Water in table shallow Used extensively Water very hard Locally high iron Easily polluted	Good quality Locally artesian Underlies entire basin Generally not subject to pollution Water table generally deep Water very hard
Irrigation: Quantity—450, gallons per minute per 40 to 60 acres	Adequate discharge Use limited to riparian land	Adequate discharge Use limited to riparian land Floods	Adequate discharge Use limited to riparian land Floods	Adequate discharge Use limited to riparian land Floods	Water table shallow Locally high yields Limited areal extent Yields variable	Water table shallow Small to moderate yields	Adequate yields Underlies entire basin Water table generally deep
Recreation: Attractive appearance Reasonable access Adequate depth Lack of pollution Odor free Low sediment load	Suitable for fishing, hunting, boating, and swimming Public access at many sites Very little pollution reported Floods	Suitable for fishing Trout in headwaters Very little pollution Boating limited to canoeing during high water Shallow depths Floods High sediment load	Suitable for hunting, fishing, and canoeing Trout in headwaters Very little pollution Boating limited to reservoirs and during high water Floods High sediment load	Suitable for hunting, fishing, and canoeing Trout in headwaters Very little pollution Boating limited to reservoirs and during high water Floods			
Fish and wildlife habitat: Adequate depth Permanence Less than 2,000 milligrams per liter dissolved solids Lack of pollution Low sediment load	Excellent wildlife habitat in marshes and sloughs Extensive variety of game fish Very little pollution Floods	Trout in headwaters Very little pollution Poor to fair wildlife habitat Shallow depths Variable flow Floods High sediment load	Fair wildlife habitat Very little pollution Trout in headwaters Variable flow Floods High sediment load	Good wildlife habitat Very little pollution Trout in headwaters Floods			

EXPLANATION

Adequate discharge
Good quality
Water hard
Treatment necessary
Colored

Advantages for use

Limitations for use

General suitability for use, based on criteria: 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 (more than 100,000 gpd) wells require permits from the Wisconsin Department of Natural Resources

Large amounts of good quality water are available in the Pecatonica-Sugar River basin. Of the 32.8 inches of average annual precipitation that falls on the basin, an average of 8.9 inches or 1,200 mgd runs off as streamflow. This represents the amount of water available for use, although man can also borrow from a "bank" of many times this much water in storage beneath the ground.

The quantity of surface water used in the study area greatly exceeds that of ground water. Surface water is used for fuel-electric cooling (198 mgd), and for recreation, conservation, and waste transport. Ground water is used for all municipal supplies, for most rural supplies, and for most industrial purposes.

Ground water is more widespread than surface water. It is available from three aquifers in the study area: the sandstone aquifer, the Galena-Platteville aquifer, and the sand and gravel aquifer. Any of these is capable of yielding domestic and stock supplies. The sandstone aquifer commonly yields more than 500 gpm to wells, as does the sand and gravel aquifer in the Mississippi River valley. All municipalities have adequate supplies of ground water available for future growth and development. Only the sandstone aquifer is available everywhere in the study area.

Water problems in the study area are minor and are related to water quality and flooding. Both ground and surface water have high natural hardness. High iron and nitrate concentrations are local problems in ground water. Shallow aquifers, whether dolomite, sandstone, or glacial drift, are subject to local pollution by man's wastes from surface sources. Some stream reaches are also polluted by sediment and man's domestic, municipal, and industrial wastes, rendering them less useful as wildlife habitat and for recreational purposes. Although flooding is severe due to the physical setting of the area and lack of flood-control structures, the average annual monetary loss from these floods is small because of very little flood-plain development. The greatest loss is to crops and cropland.

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
The Geological and Natural History Survey, University of Wisconsin—Extension 1815 University Avenue, Madison, Wis. 53706	X	X	X		X					X	X	X	
U.S. Department of the Interior, Geological Survey, Water Resources Division 1815 University Avenue, Madison, Wis. 53706	X		X	X	X	X	X	X		X	X	X	
U.S. Department of Agriculture, Soil Conservation Service 4601 Hammersley Road, P. O. Box 4248, Madison, Wis. 53711		X	X	X			X					X	
Wisconsin Department of Natural Resources 4610 University Ave., P. O. Box 450, Madison, Wis. 53701				X		X	X	X	X	X	X	X	X
U.S. Department of the Army, Corps of Engineers, Rock Island District Clock Tower Building, Rock Island, ILL. 61202			X				X						
Environmental Protection Agency, Water Quality Office 33 East Congress Parkway, Chicago, ILL. 60605								X	X				
Public Service Commission of Wisconsin 432 Hill Farms State Office Building, Madison, Wis. 53702												X	
U.S. Department of the Interior, Bureau of Outdoor Recreation, Lake Central Region 3853 Research Park Drive, Ann Arbor, Mich. 48104													X
U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife Room 620 Federal Building, Fort Snelling, Twin Cities, Minn. 55111											X		X

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