RELATIONSHIP OF NONPOINT-SOURCE DISCHARGES, STREAMFLOW, AND WATER QUALITY IN THE GALENA RIVER BASIN, WISCONSIN

By **Stephen J. Field**

Water-Resources Investigations Report 85-4214

PREPARED BY
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

IN COOPERATION WITH THE
WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Madison, Wisconsin
1986

UNITED STATES DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, *Secretary*

GEOLOGICAL SURVEY
Dallas L. Peck, *Director*

For additional information
write to:

District Chief
U.S. Geological Survey
6417 Normandy Way
Madison, Wisconsin 53719

Copies of this report can
be purchased from:

Open-File Services Section
Western Distribution Branch
U.S. Geological Survey
Box 25425, Federal Center
Lakewood, Colorado 80225
(Telephone: (303) 234-5888)

CONTENTS

ILLUSTRATIONS

TABLES

FACTORS FOR CONVERTING INCH-POUND TO METRIC (SI) UNITS

For readers who prefer to use metric (International System) units rather than the inch-pound units used in this report, conversion factors are listed below.

Multiply inch-pound unit	By	To obtain SI unit
Inch (in.)	25.40	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
pound per square mile (lb/mi^2)	1.751×10^2	kilogram per square kilometer (kg/km^2)
ton per square mile (ton/mi^2)	0.3503	metric ton per square kilometer (t/km^2)
cubic foot per second (ft^3/s)	2.832×10^2	cubic meter per second (m^3/s)
degrees Fahrenheit (°F)	0.555(F−32)	degrees Celsius (°C)

RELATIONSHIP OF NONPOINT-SOURCE DISCHARGES, STREAMFLOW, AND WATER QUALITY IN THE GALENA RIVER BASIN, WISCONSIN

By Stephen J. Field

ABSTRACT

Four small tributaries of the Galena River—Madden Branch tributary, Pats Creek, Apple River, and Madden Branch—that drain nonpoint agricultural sources and that receive no significant point-source discharges were monitored from October 1980 through September 1982 to determine water quality.

Streamflow in the tributaries during the 1981 water year was about 25 percent below normal and, during the 1982 water year, about 38 percent above normal. Precipitation in the basin was near the 30-year normal during the 2-year study period.

The yields of suspended solids, volatile solids, total phosphorus, and ammonia plus organic nitrogen during the 1982 water year were at least twice the yields of the 1981 water year. The greatest suspended-solids yield was 740 tons per square mile from Madden Branch tributary. The greatest yields of volatile solids (70.8 tons per square mile), total phosphorus (2,289 pounds per square mile), and ammonia plus organic nitrogen (8,529 pounds per square mile), were from Madden Branch. The lowest annual yields of suspended solids, volatile solids, total phosphorus, and ammonia plus organic nitrogen for both years were from the Apple River.

Concentrations of many constituents were very high during runoff periods. The highest concentration of ammonia nitrogen—12 mg/L (milligrams per liter)—measured during the study period was in Pats Creek during spring runoff, February 21, 1982. The highest concentration of total phosphorus, 17 mg/L, was measured in Madden Branch tributary during a storm on July 10, 1982. The storm of July 10 exceeded a 100-year recurrence interval of a 1-hour storm intensity for the area.

Dissolved-oxygen concentration sags were noted at three of the monitoring stations during surface runoff. Although not all observed sags caused instream dissolved oxygen to fall to critical levels, one such decline was associated with a fishkill at Pats Creek. In that instance, highly oxidizable material with a biochemical-oxygen demand of 27 milligrams per liter was sampled at peak discharge; 16 hours later, the dissolved oxygen had dropped to 1.2 milligrams per liter.

Concentrations of many constituents exceeded State and Federal water-quality standards. Dissolved-oxygen concentrations were lower than the minimum State standard on numerous occasions at all sites except Madden Branch tributary. Most phosphorus concentrations during periods of surface runoff at all sites exceeded U.S. Environmental Protection Agency standards. Concentrations of ammonia nitrogen potentially exceeded the Wisconsin State standard only once at Pats Creek.

INTRODUCTION

Background

In 1972, Congress mandated, through the Federal Water Pollution Control Act Amendments (FWPCAA)[1] that the surface waters of the United States shall be "fishable and swimmable" by 1983 (U.S. Congress, 1972). In order to reach this goal, the States were required to identify and establish programs to improve stream-water quality. It soon became evident that the water-quality goals established by the FWPCAA of 1972 could not be attained by regulation of point-source pollution only. Indeed, in many areas, pollutants discharged from nonpoint sources constitute the major con-

[1] Enacted under Section 208 of Public Law 93-500.

tribution to water-quality degradation (Donigan and Crawford, 1976).

The Wisconsin Department of Natural Resources (DNR) has been designated as the State agency responsible for water-quality protection in Wisconsin (Wisconsin Department of Natural Resources, 1976) and has a primary role in meeting Section 208 requirements. In order to establish an adequate data base, the U.S. Geological Survey, in cooperation with DNR, began a study in 1977 to define the stream water quality in relation to streamflow in several basins where surface-water quality had been degraded by nonpoint sources. The Steiner Branch basin in Lafayette County of southwestern Wisconsin, the Elk Creek basin (including Bruce Valley Creek) in Trempealeau County of west-central Wisconsin, and the Onion River basin in Sheboygan County of east-central Wisconsin were among the first river basins studied.

In 1978 the Wisconsin Legislature enacted the Wisconsin Nonpoint Source Water Pollution Abatement Program—commonly called the Wisconsin Fund. This program provides cost sharing and technical assistance to individual property owners, cities, and villages in "priority watersheds" for the control of nonpoint sources of water pollution. To be eligible for cost sharing and technical assistance under the Wisconsin Fund, an area must be designated as a priority watershed. The watersheds are selected by regional advisory groups and the State Nonpoint Coordinating Committee. In 1978, the Galena River basin in southwestern Wisconsin was selected as one of the priority watersheds in the State and became eligible in November 1979 to receive special State funds for the control of nonpoint-source pollution.

The Galena River basin is the name used by DNR to describe an area in or near the Galena River basin. One stream studied—the Apple River—is not tributary to the Galena River but is tributary to the Mississippi River. However, to remain consistent with the DNR description for this area, the term "Galena River basin" as used in this report includes the Apple River basin.

The Galena River basin was identified by DNR as having streams where water quality was being severely affected by nonpoint agricultural sources. At one time, some of the best smallmouth bass populations in Midwest streams were found in the Galena River basin (Wisconsin Department of Natural Resources, 1979). Recently, however, the smallmouth bass population has declined significantly.

This report describes the study conducted in the Galena River basin in Lafayette County of southwestern Wisconsin (fig. 1).

In an attempt to determine if the stream water quality of the basin had been degraded, the DNR calculated the biotic index at 55 stream sites in the Galena River watershed. Biotic indexing, as defined by DNR, "is a bioligical monitoring technique which relies on species of arthropods as water quality indicators. To calculate the biotic index, each species is assigned a numeric value ranging from 0 to 5. Species intolerant of pollution receive a low number, while pollution tolerant species are assigned a higher value. One hundred organisms are collected at each sampling site, the organisms are identified and values assigned, the total is divided by 100 to give the biotic index number. A range of values has been calculated indicative of various classes of water quality" (Wisconsin Department of Natural Resources, 1979b).

The stream miles within the Galena River basin were then classified using the above classification system as follows:

Miles of streams	Water quality
6.0	Excellent
20.0	Good
94.0	Fair
70.0	Poor
19.0	Very poor

In 1979, the Galena River basin was selected in Wisconsin to receive special State funds for the control of nonpoint-source pollution. In time, the stream's water quality was expected to improve through the application of land-treatment practices.

An intensive water-quality-monitoring program of the Galena River basin, funded cooperatively by the U.S. Geological Survey and DNR, began in September 1980 and continued through September 1982 (water years 1981 and 1982).[2] Four water-quality/stream-discharge monitoring sites (fig. 1) were selected: Madden Branch tributary near Belmont (05414915), Pats Creek near Belmont(05414894), Apple River near Shullsburg (05418731), and Madden Branch near Meekers Grove (05414920). Basin characteristics for these stations are shown in table 1.

Not all the basins monitored as part of this study were included in the Priority Watershed designation of DNR. Madden Branch tributary, which is part of the Madden Branch gaging-station drainage basin, was designated not to be included in the Priority Watershed plan. The basins of the remaining three monitoring sites, however, were part of the Priority Watershed program and cost-sharing dollars were available to landowners in those basins to implement best-management practices in order to improve the water quality of the streams.

The nutrient loads observed in this study reflect the contribution from nonpoint sources only. Nonpoint loads are the diffuse discharges of pollutants that are not traceable to point sources. Common sources of nonpoint pollution include storm water and snowmelt runoff from urban and rural land surfaces, livestock operations, and construction activities. There are no point sources in the study basins other than substandard septic systems. Because of their minor contribution to the total nutrient load, these substandard septic systems are included under nonpoint sources in this report.

[2] The water year is the 12-month period, October 1 through September 30, and is designated by the calendar year in which it ends and which includes 9 of the 12 months.

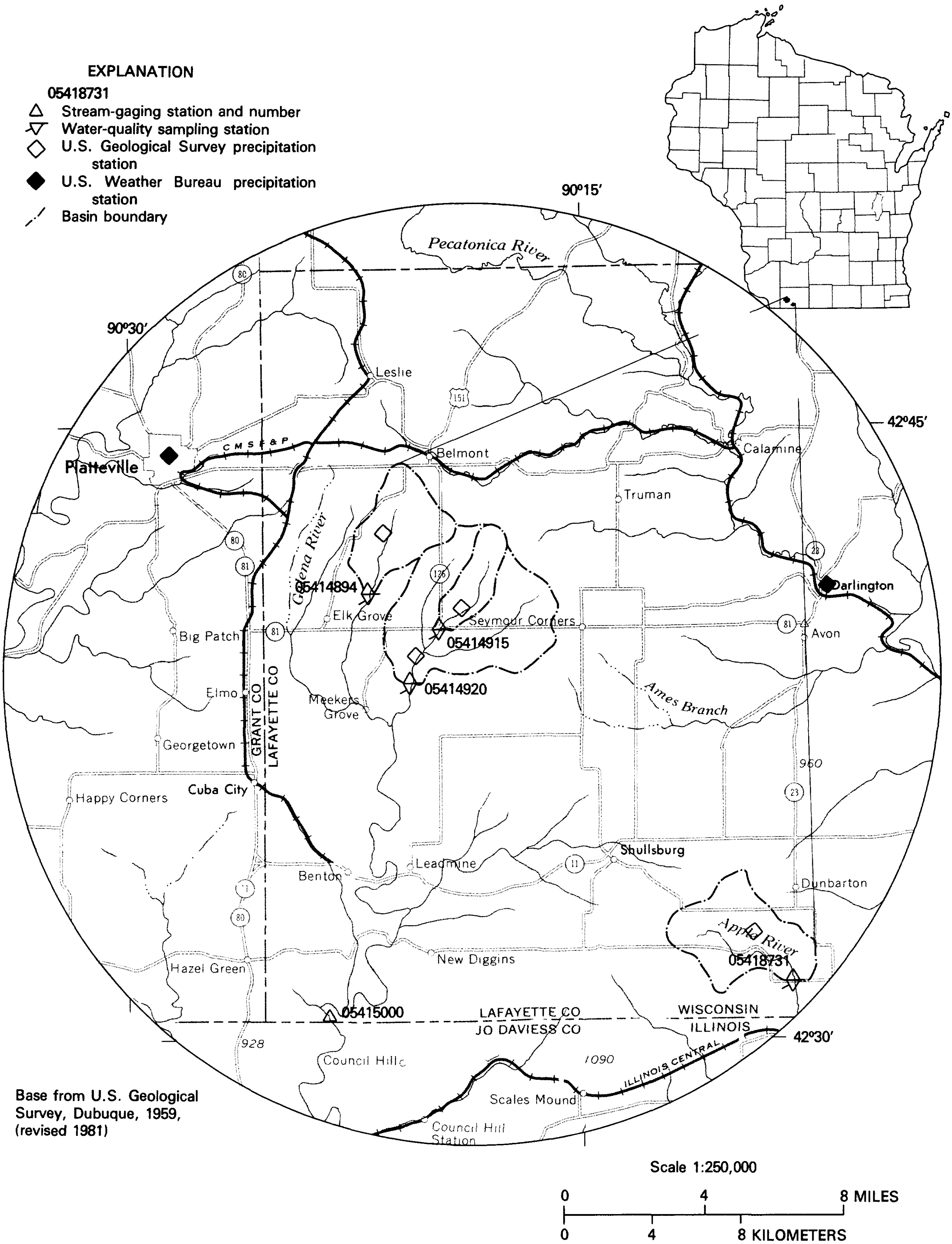


Figure 1. Location of the Galena River basin in Wisconsin and data-collection sites.

Table 1. Basin characteristics for the Galena River basin gaging stations (Information from James Bachhuber, Wisconsin Department of Natural Resources)

Basin characteristic	Madden Branch tributary	Pats Creek	Apple River	Madden Branch
Drainage area (mi^2)	2.83	5.42	9.34	15.1
Stream length (mi)	4.2	4.8	6.3	5.8
Channel slope (ft/mi)				
Total[1]	46	38	36	43
Between 10 and 85 percent points	33	30	21	29
Soil slopes (percent)[2]				
A, B,	65	[3]73	[4]72	57
C	32	23	23	36
D	2	4	5	6
E	1	0	0	1
Percent land in row crops	37	47	67	48
Animal units per square mile[5]	198	602	147	160
Biotic index, fall 1979[6]	2.83	2.94	3.38	3.03
Land under Wisconsin Fund (percent)[7]	0	6	34	15

[1] See figure 2

[2] Category A is 0-2 percent slope, B is 2-6 percent slope, C is 6-12 percent slope, D is 12-20 percent slope, and E is 2-30 percent slope.

[3] 3 percent A slopes, 70 percent B slopes.

[4] 22 percent A slopes, 50 percent B slopes.

[5] See page 7.

[6] See page 2.

[7] See page 2.

Purpose and Scope

The report presents the results of a study to define the relation of water quality to streamflow from nonpoint agriculture sources in the Galena River basin. The scope includes determinations of (1) streamflow, (2) water temperature, and concentrations of dissolved oxygen and dissolved solids; (3) the loadings of suspended solids, volatile solids, phosphorus, and Kjeldahl nitrogen; and (4) miscellaneous water-quality characteristics, including pH, biochemical oxygen demand, and concentrations of trace metals and pesticides.

Acknowledgments

The author would like to thank James Bachhuber, Wisconsin Department of Natural Resources, for his assistance in data collection and project coordination. In addition, we appreciate the cooperation of Keith Wedig, who allowed a gaging station to be installed on his property, and Thomas Lethlean, George Olthafer, Richard Hoppenjan, and Raymond Wall, who allowed precipitation stations to be installed on their property.

PHYSICAL SETTING

Topography and Drainage

The Galena River basin is characterized by rolling topography with deep flat bottom valleys and narrow rolling ridges. Madden Branch tributary, Pats Creek, and Madden Branch, are located about 10-miles southeast of Platteville and flow south-southwesterly to the Galena River, which drains southerly to the Mississippi River. The Apple River, located about 5-miles southeast of Shullsburg, flows southeast across the Wisconsin-Illinois state line, turns abruptly southwest, and drains to the Mississippi River. Total relief in these basins is generally less than 100 feet.

Stream-Channel Characteristics

Madden Branch tributary is the shortest stream—4.2 mi long from the headwaters to the gaging station (fig. 2). The longest stream, 6.3 mi, is the Apple River, but it does not drain the largest area. Average stream-channel slopes range from 36 ft/mi for the Apple River to 46 ft/mi for Madden Branch tributary (table 1). The streams are a series of pools and riffles, and the bed materials consist of sand, silt, clay, and cobbles. During low flow the narrowest stream at the gaging stations is Madden Branch tributary, which averages about 7 ft wide and 0.8 ft deep; the largest stream is Madden Branch, which averages about 15 ft wide and about 1 ft deep.

Although there are no natural lakes in this basin, a manmade recreational impoundment, Beardsley Lake, is on the most northeastern tributary to Madden Branch. The impoundment has a surface area of 22 acres (Wisconsin Department of Natural Resources, 1972) and a drainage area of 1.3 mi^2.

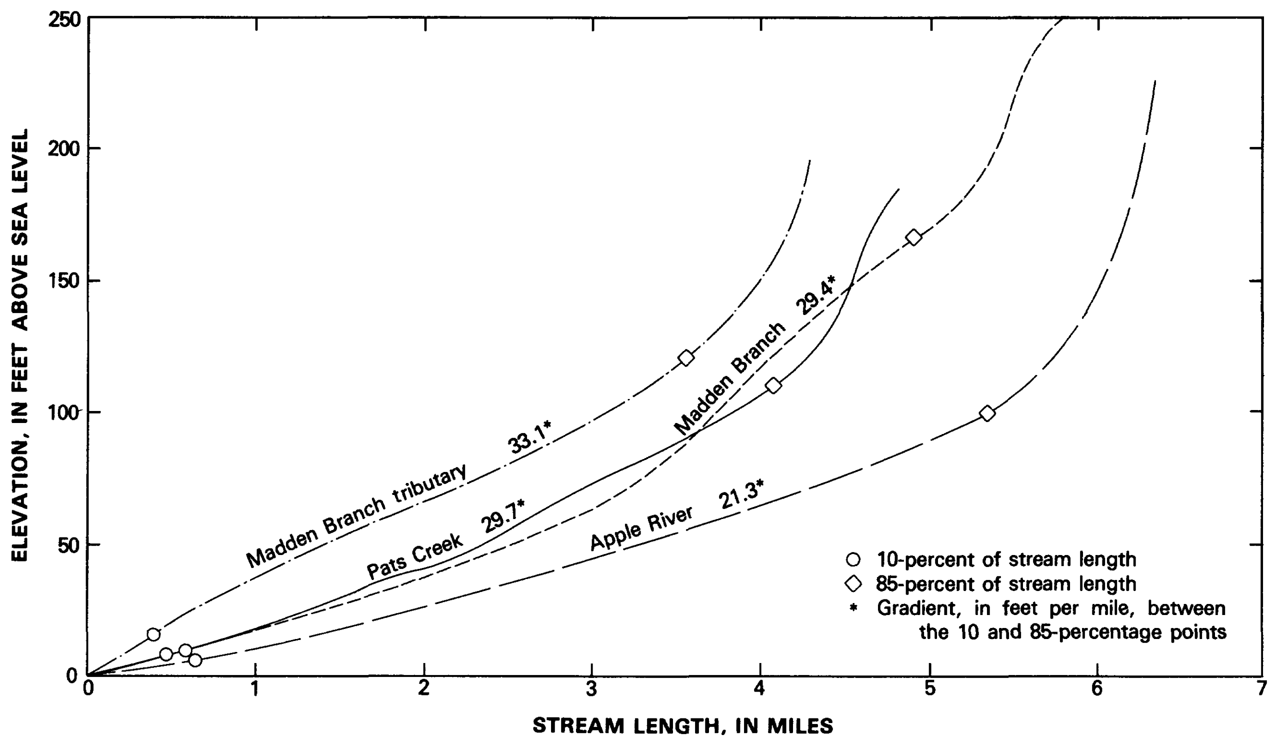


Figure 2. Stream lengths and slopes of the Galena River tributaries upstream of gaging stations.

Climate

The climate of the Galena River basin is a continental type with four distinct seasons (Wisconsin Department of Agriculture, 1961). Temperature and precipitation data are collected at Darlington (fig. 1). Winters are cold and snowy, and summers have periods that are hot and humid. Mean monthly temperature data indicate that January is the coldest month (19.7°F) and July the warmest (72.2°F); mean annual temperature is 47.1°F. The average annual precipitation for the period 1930-59 was 33.32 in. February is the driest month (1.04 in.) and June the wettest (4.88 in.). About 60 percent of the precipitation falls in the period May-September. Snowfall averages 34.5 in. annually.

Geology

The Galena River basin is in the Driftless Area—an area that probably was not glaciated during the Pleistocene Epoch (Thwaites, 1950). The predominant bedrock in the basin is sedimentary rock of Ordovician age. The Maquoketa Shale is the predominant bedrock in the southwestern part of the Apple River subbasin; erosion of the shale to the north and in the other subbasins of the study area exposed the underlying Galena-Platteville unit. The Galena-Platteville unit (Galena Dolomite, Decorah and Platteville Formations, undifferentiated), forms the bedrock throughout most of the study area and is underlain by the St. Peter Sandstone (Mudrey, Brown, and Greenberg, 1982).

Soils

Soils of the Galena River basin are silty loams that have been described by Watson (1966). The uplands are covered by differing thicknesses of loess, and the valley bottoms are covered by silty alluvium. The soil-erodibility factors discussed in the following paragraphs are from U.S. Department of Agriculture (1981) and reflect the degree to which the soil can be eroded, which affects sediment loads in receiving streams.

The general soil associations in each study basin are shown in figure 3. The Madden Branch tributary basin contains only the Tama-Ashdale association. Eighty percent (northeastern parts) of the Madden Branch and Pats Creek basins also contain this soil association; the remainder (southwestern parts) of the basins contain the Fayette-Palesgrove association. Most of the Apple River basin contains a mixture of four major soil associations: the Tama-Ashdale, the Fayette Palesgrove, the Tama-Muscatine-Sable, and the Schapville-Calamine. A relatively small part of the basin contains the Derina-Calamine association.

The Tama-Ashdale association soils are dark-colored, deep silty soils that are underlain by limestone. The Tama soils are on ridges 0.5 to 1 mi wide and the Ashdale soils are on the adjoining side slopes. Slopes are typically long and gentle. On the bottom lands within this association are the Worthen, Huntsville, and Lawson soils. The soil-erodibility factor for these soils is 0.32.

The Fayette–Palesgrove soils also are underlain by limestone and are commonly found on gently sloping ridgetops and moderately steep to steep side slopes or on narrow bottom lands. Fayette soils, the most extensive, and the Palesgrove soils dominate in this association. Most narrow bottom lands are occupied by the Arenzville and Orion soils. The soil erodibility factoı for Fayette soils is 0.37; for Palesgrove soils it is 0.32.

The Tama–Muscatine–Sable association soils are found on the broad ridgetops and are underlain by limestone or shale. Tama soils are found on the more sloping areas and are likely to erode if cultivated. The Muscatine and Sable soils are poorly drained and water moves through them slowly because they are underlain by impervious shale. The erodibility factors for these soils are: Tama soils, 0.32; Muscatine soils, 0.28; and Sable soils, 0.28.

The Schapville–Calamine association is found on ridgetops, steep slopes, and in flat depressions, and is underlain by clay and shale. The Schapville and Calamine soils are dominant in the association but minor areas are occupied by the Keltner soils. Internal drainage is moderately slow to slow because the underlying clay and shale are impervious. The erodibility factor for these soils is 0.32.

The Derinda–Calamine association is light-colored, moderately deep to shallow soils underlain by shale and is found on ridgetops, steep slopes, and on level to gently

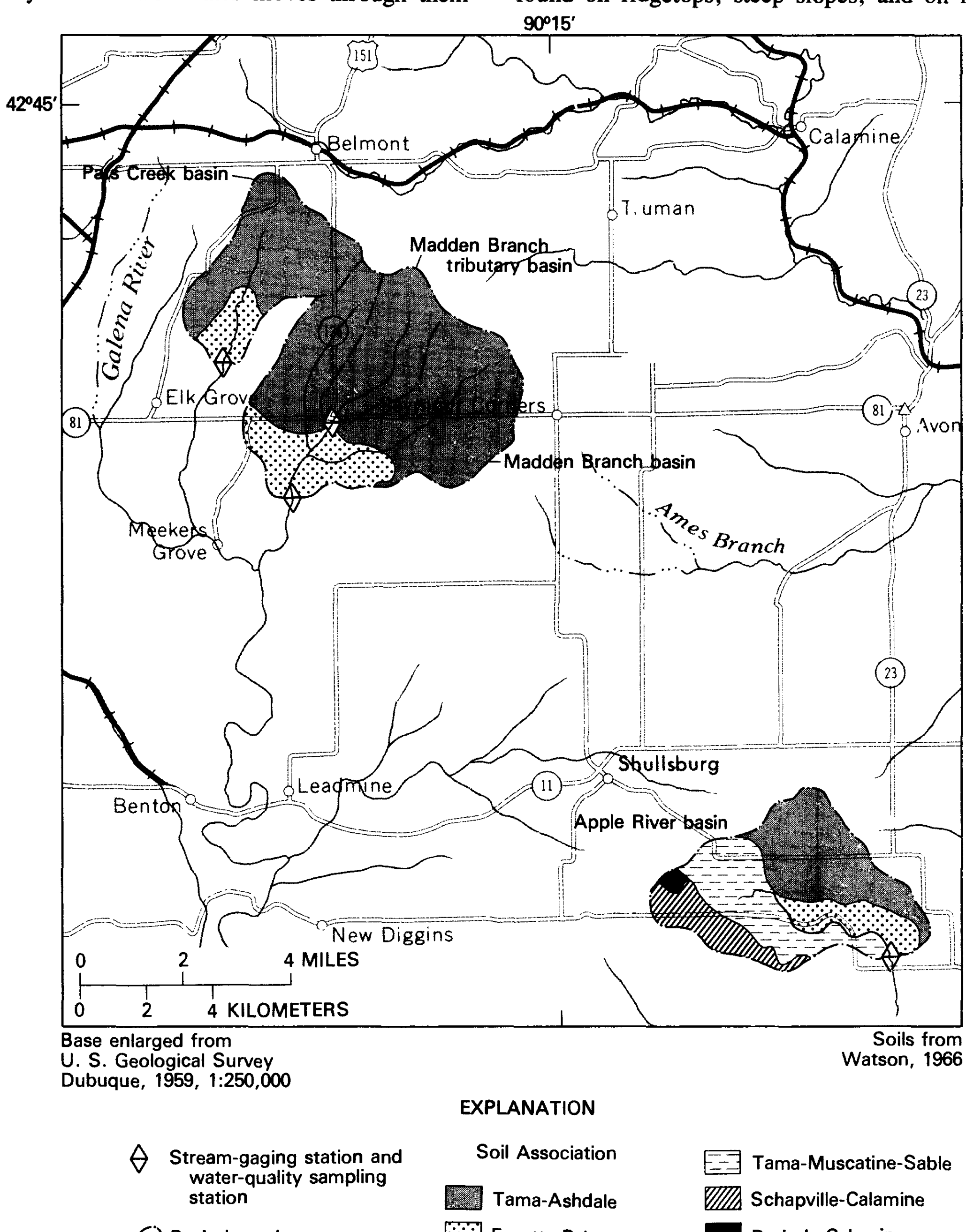


Figure 3. Mapped soil associations at the Galena River basin gaging stations.

sloping low areas. The Derinda and Calamine soils are dominant soils in this association. Internal drainage is moderately slow to slow due to the impervious underlying clay and shale.

Land Use

Agriculture is the principal economic activity in the Galena River basin; dairy farming and cash cropping are the two major uses. The Pats Creek basin supports the highest density of animal units[3] (602 per square mile). The other basins have fewer than 200 animal units per square mile (table 1).

The percent of land in row crops is shown in table 1. All basins have less than 1 percent of the total land in woodlands. The remainder of the land is in either pasture or alfalfa. The Apple River basin has the highest percentage (67 percent) of its land in row crops, primarily corn. Madden Branch tributary has the least amount of land in row crops (37 percent).

METHODS OF STUDY

Continuous monitors of streamflow, water temperature, and specific conductance were installed in September 1980 at Madden Branch tributary, Pats Creek, Apple River, and Madden Branch. Water temperature and specific conductance were recorded by either a U.S. Geological Survey minimonitor or servo-programmer. Dissolved oxygen was recorded by the U.S. Geological Survey minimonitor and a Yellow Springs Instrument Company (YSI)[4] model 36 recorder continuously for selected periods at all sites. Both recorders use a YSI probe with a semipermeable type membrane. pH was recorded by the minimonitor continuously, for a short period, at Madden Branch. Isco Model 1680 refrigerated, automatic, water samplers were installed at all four sites to collect samples during storm runoff for analyses of suspended sediment and nutrient concentrations. A local observer collected weekly suspended-sediment samples during nonstorm periods.

Streamflow characteristics for the monitoring stations in the subbasins were compared with long-term data from the Galena River at Buncombe gaging station. That station, shown in figure 1, has been operated since 1939 and has a drainage area of 125 mi².

Precipitation records were obtained from the National Weather Service (U.S. Department of Commerce, 1979, 1980) for stations located at Platteville and at Darlington (fig. 1). Recording rain gages located near the centers of the study subbasins were operated during ice-free periods.

Samples were kept at 4°C in the Isco samplers until removed for analysis. Generally six samples for nutrients, volatile and total solids, and up to 12 samples for suspended solids were selected throughout the stream-discharge hydrogram for each storm. The nutrient samples were analyzed for concentrations of ammonia nitrogen, nitrite plus nitrate nitrogen, ammonia plus organic nitrogen, and phosphorus at the Wisconsin State Laboratory of Hygiene.

[3] One animal unit equals 1,000 lb live weight.

[4] The use of trade names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

During low and high flows, additional samples were collected using the equal-width-increment method described by Guy and Norman (1970). Although most of these samples were used to define the temporal concentration curve not covered by the automatic sampler, many of these were collected concurrently with the automatically collected samples to insure that the latter represented the average quality of water in the stream cross section. The equal-width-increment samples were analyzed for all of the above constituents plus orthophosphate phosphorus, and 5-day biochemical oxygen demand.

pH was determined in the field at the time of sampling with a Leeds and Northrup Model 7417 or Orion pH meter.

PRECIPITATION

The average annual precipitation for the study basins was determined to be 34.4 in. using data from the U.S. Weather Bureau stations at Platteville and Darlington (fig. 1).

Rain gages were installed near the central part of each basin and were operated from May 4 through October 31, 1981, and from April 1 through September 30, 1982. The monthly totals from these rain gages are shown in table 2 as well as values for the winter months from the Platteville and Darlington stations. In comparing 1981 and 1982 precipitation for the basins, the Apple River basin had the most precipitation for both years. In 1982, the Apple River basin had about 2 in. more precipitation than Madden Branch basin—the basin with the least precipitation. In 1981, the Apple River basin had about 5 in. greater precipitation than the Madden Branch tributary basin—the basin with the least precipitation.

The number of storms of varying precipitation amounts are shown in the following table by individual basins:

Water year	Storm amount (inches)	Number of storms: Madden Branch tributary	Madden Branch	Pats Creek	Apple River
1981	0.5–0.99	12	10	14	10
	1.0–1.99	5	5	5	4
	2.0–2.99	0	0	0	1
	<3.0	0	0	0	1
1982	0.5–0.99	9	6	8	16
	1.0–1.99	4	5	5	3
	2.0–2.99	1	1	1	3
	<4.0	1	1		

Storm Data

Two storms that caused considerable surface runoff are worthy of mention. The first occurred during the 1981 water year while the ground was frozen. A winter storm on February 22 and 23, 1981, produced 1.67 in. of rain at Platteville and 1.96 in. at Darlington.

The single largest storm during the study period occurred on July 10, 1982, in the Madden Branch tributary basin and Madden Branch basins when 4.16 and 4.07 in. of rain, respectively, were recorded. During that storm, the rain gage at Madden Branch tributary recorded 3.35 in. of rain in a 1-hour period; the gage at Madden Branch recorded 3.0 in. These amounts are greater than the 100-year, 1-hour rainfall (2.9 in.) indicated for this area (U.S. Department of Commerce, 1963). In contrast, the Pats Creek and the Apple River basins received only 1.0 in. of rain on this date.

Snowpack

The moisture equivalence of the snowpacks varied considerably from 1981 to 1982. The maximum moisture equivalence of the snowpack during the 1981 water year, as recorded at Madison about 60 mi northeast of the basin, was 0.8 in. (U.S. Department of Commerce, 1981). In contrast, during the 1982 water year the maximum moisture content in the snowpack was 3.1 in. (U.S. Department of Commerce, 1982).

STREAMFLOW

The streamflow data collected as part of this study were used to determine the streamflow characteristics of the study streams at the gaging stations; those characteristics are summarized in table 3. Daily streamflow data for the the stations for the 1981 and 1982 water years are published in "Water Resources Data for Wisconsin, Water Year 1982" (U.S. Geological Survey, 1983).

Table 2. Monthly and yearly precipitation totals for the Galena River gaging stations, 1981 and 1982 water years

Water year	Month	Madden Branch tributary[1]	Pats Creek[1]	Apple River[2]	Madden Branch[1,3]
1981	October	2.04	2.04	1.90	2.06
	November	.96	.96	.81	.96
	December	1.02	1.02	1.09	1.02
	January	.14	.14	.10	.14
	February	2.66	2.66	2.81	2.66
	March	.62	.62	.33	.62
	April	4.80	4.80	3.91	4.80
	May	.97	.74	.67	1.10
	June	5.91	5.57	7.15	5.82
	July	2.82	2.88	3.76	2.61
	August	6.45	6.98	6.70	6.34
	September	4.03	4.78	4.17	3.81
	Total	32.41	33.19	33.40	31.92
1982	October	2.69	2.82	4.46	2.69
	November	1.60	1.60	1.61	1.60
	December	1.08	1.08	.95	1.08
	January	1.72	1.72	2.01	1.72
	February	.16	.16	.16	.16
	March	3.02	3.02	3.17	3.02
	April	1.63	2.17	1.47	1.60
	May	5.46	4.71	6.55	4.96
	June	2.37	2.45	2.22	2.72
	July	7.59	6.59	8.34	9.26
	August	4.11	5.53	5.35	4.74
	September	.86	.98	.91	.89
	Total	32.78	32.82	37.20	34.43

[1] Monthly totals October to April, November and December 1981, January to April 1982—arithmetic average from Platteville and Darlington, U.S. Weather Bureau Stations.

[2] Monthly totals October to April, November and December 1981, January to March 1982,—arithmetic average from Darlington U.S. Weather Bureau.

[3] Monthly total May to October 1981, April to September 1982—arithmetic average of USGS rain gages at Madden Branch and Madden Branch tributary.

Comparison of Streamflow for 1981 and 1982 Water Years

Based on discharges observed at the Galena River near Buncombe gaging station, discharge for the 1981 water year was about 25 percent below average; the 1982 discharge was about 38 percent above average.

Stream discharges for the 1982 water year at the four study gaging stations were about twice that of the 1981 water year, although annual precipitation totals were fairly comparable for both years. This difference in stream discharge can be explained by analyzing the hydrographs for the gaging stations and comparing the precipitation and peak discharges in the basins from year to year.

Hydrograph separations, using a technique described by Linsley, Kohler, and Paulhus, (1975), were made for all stations to explain the increase in the streamflow in the 1982 water year. Base flow[5], surface runoff, and the percent increase in those factors from the 1981 water year to the 1982 water year are summarized in table 4. The separations show that base flow increased an average of 64 percent and surface runoff increased an average of 218 percent.

The Pats Creek hydrograph for total runoff and base flow in the 1981 and 1982 water years are plotted in figure 4 to explain the greater streamflow in the 1982 water year. Base flow increased dramatically in the spring of 1982 compared to 1981, when the high-moisture (3.8 in.) snowpack of 1982 melted. In contrast to the low moisture content (0.8 in.) of 1981, the snowpack probably not only saturated the soils with moisture but recharged the ground-water system as well. The latter is illustrated by the water-table rise in an observation well (Lf-11) located in the Pats Creek basin (fig. 5). After snowmelt (about February 22, 1982) the base-flow segment of the total stream discharge more than doubled from the previous year.

The only storm that produced major runoff during the 1981 water year occurred on February 22. In contrast, in the 1982 water year, three storms in March and one each

[5] Base flow represents ground-water discharge to the stream channel, whereas surface runoff is that runoff entering the channels promptly after rainfall or snowmelt.

Table 3. Summary of streamflow characteristics for the Galena River basin gaging stations

Streamflow characteristic	Madden Branch tributary		Madden Branch		Pats Creek		Apple River		Galena River		
	1981	1982	1981	1982	1981	1982	1981	1982	1981	1982	1939-82
Mean discharge, in cubic feet per second	1.45	2.72	7.86	15.1	2.56	4.95	5.44	11.5	57.7	106	76.9
Mean discharge, in cubic feet per second per square mile	.51	.96	.52	1.00	.47	.91	.58	1.23	.46	.85	.62
Runoff, in inches	6.97	13.03	7.08	13.58	6.41	12.39	7.91	16.67	6.27	11.56	---
Minimum 7-day mean low-flow, in cubic feet per second	.82	.89	4.1	4.9	1.4	1.7	1.8	2.6	32	43	---
Maximum recorded peak discharge, in cubic feet per second	[1]127	[2]1,070	[1]614	[2]3,000	[1]220	[3]376	[4]407	[3]522	[1]2,260	[2]2,880	[4]29,700

[1] February 22, 1981
[2] July 10, 1982
[3] March 12, 1982
[4] June 15, 1981

Table 4. Base-flow and surface runoff, in cubic feet per second, for the Galena River gaging stations, 1981 and 1982 water years

Station's name	Base flow			Surface runoff		
	1981 water year	1982 water year	Percentage increase	1981 water year	1982 water year	Percentage increase
Madden Branch tributary	418	631	51	112	361	222
Pats Creek	731	1,200	63	203	610	200
Apple River	1,560	2,840	82	425	1,340	216
Madden Branch	2,320	3,670	58	545	1,830	235

in July and August resulted in significant runoff. The three storms in March occurred when there was bare soil and almost no vegetation, resulting in the greatest single monthly runoff during the study period. July and August also had storms that resulted in significant runoff.

As previously stated, although precipitation totals were similar from year to year, surface runoff increased by more than 200 percent. To illustrate this difference, a comparison was made of the peaks above base, based on drainage-area size; these peaks for the gaging stations are shown in table 5. In the 1981 water year, all stations had only one peak discharge above the base, except the Apple River which had three peaks. In the 1982 water year more of the precipitation was converted to surface runoff which is indicated by the seven to eight peak discharges above the base.

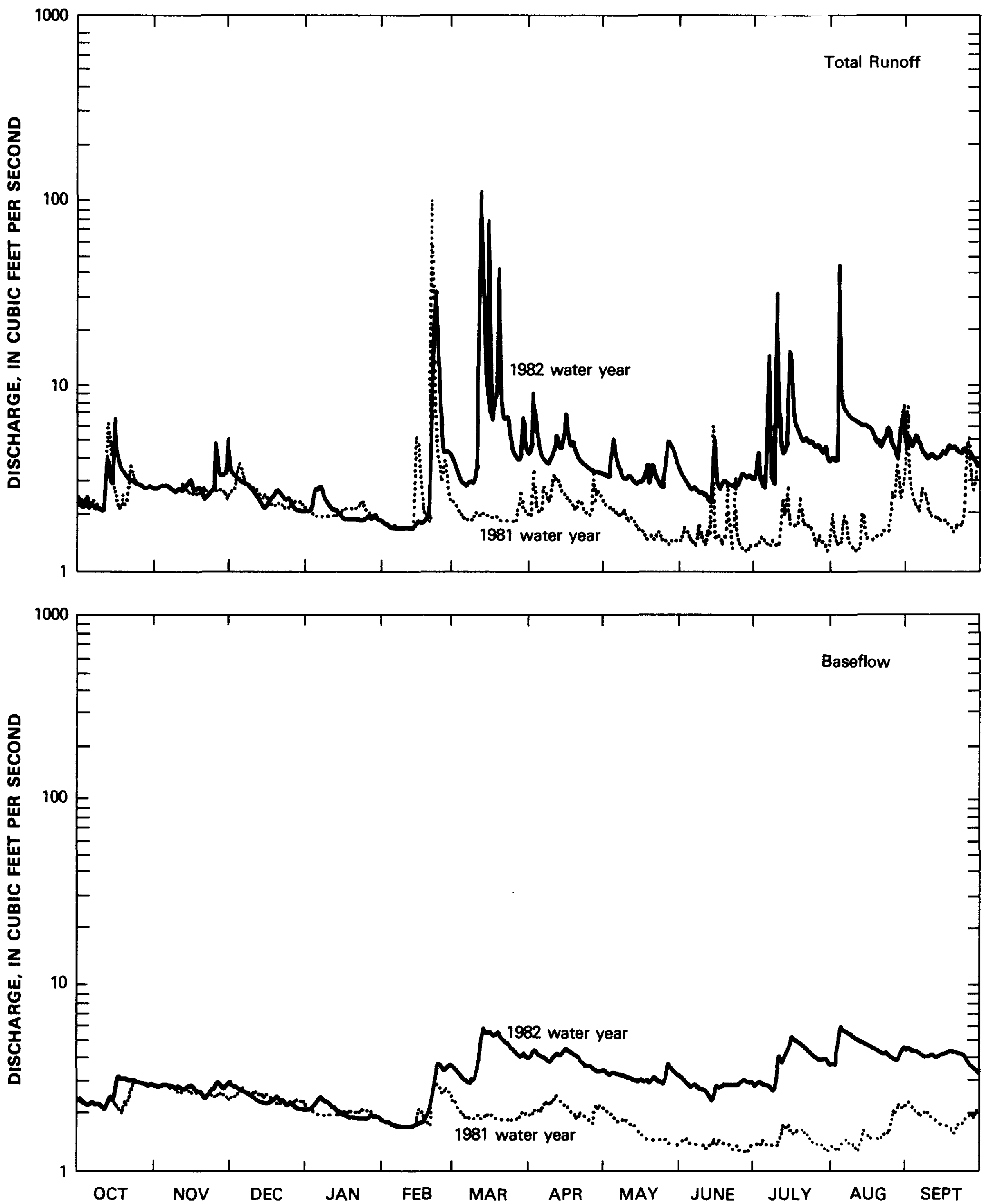


Figure 4. Total runoff and base flow for Pats Creek near Belmont, Wisconsin, 1981 and 1982 water years.

The stream hydrographs for Madden Branch tributary, Madden Branch, and Pats Creek all have similar shapes indicating that the basins have similar characteristics and that they received similar amounts of precipitation. However, the hydrographs for the Apple River gaging station are considerably different—surface runoff has a flatter slope and base flow has a steeper recession.

It was noted during the study that stream discharges in the Apple River remained higher than the other three streams following the discharge peaks. Examination of storm hydrographs indeed shows the recession on the trailing limb to be somewhat flatter than for other streams (fig. 6).

As shown in figure 6, the daily hydrographs for the Apple River generally show double discharge peaks whereas those for Pats Creek exhibit only a single discharge peak. The first peak in the Apple River basin is caused by runoff from the small northern tributary subbasin. This basin has a channel slope (between the 10 and 85 percent points) of 28 ft/mi compared to the channel slope of 21 ft/mi for the main stem of the rest of the basin. Because velocity is a function of channel slope, the runoff from this small northern subbasin arrived at the gaging station first. The first peak is then followed by the runoff from the major part of the basin that has a flatter slope and slower velocities. Although the March 16, 1982, daily hydrograph does not show a double peak, it does show discharges remaining higher than those at Pats Creek.

In contrast to the relatively flat recession of the storm hydrograph for the Apple River, the base-flow part of the hydrograph has a steep recession. The difference in the base-flow recession compared to Pats Creek, which is similar to the other two basins, is shown in figure 7. The steep recession of the base-flow part of the hydrograph is characteristic of a basin with little ground-water discharge and is probably due to the Maquoketa Shale underlying the soils in the southwestern one-half of the basin. This underlying shale prevents water from percolating down to the ground-water table; because of this, streamflows in the Apple River during drought would probably become less than in the other streams.

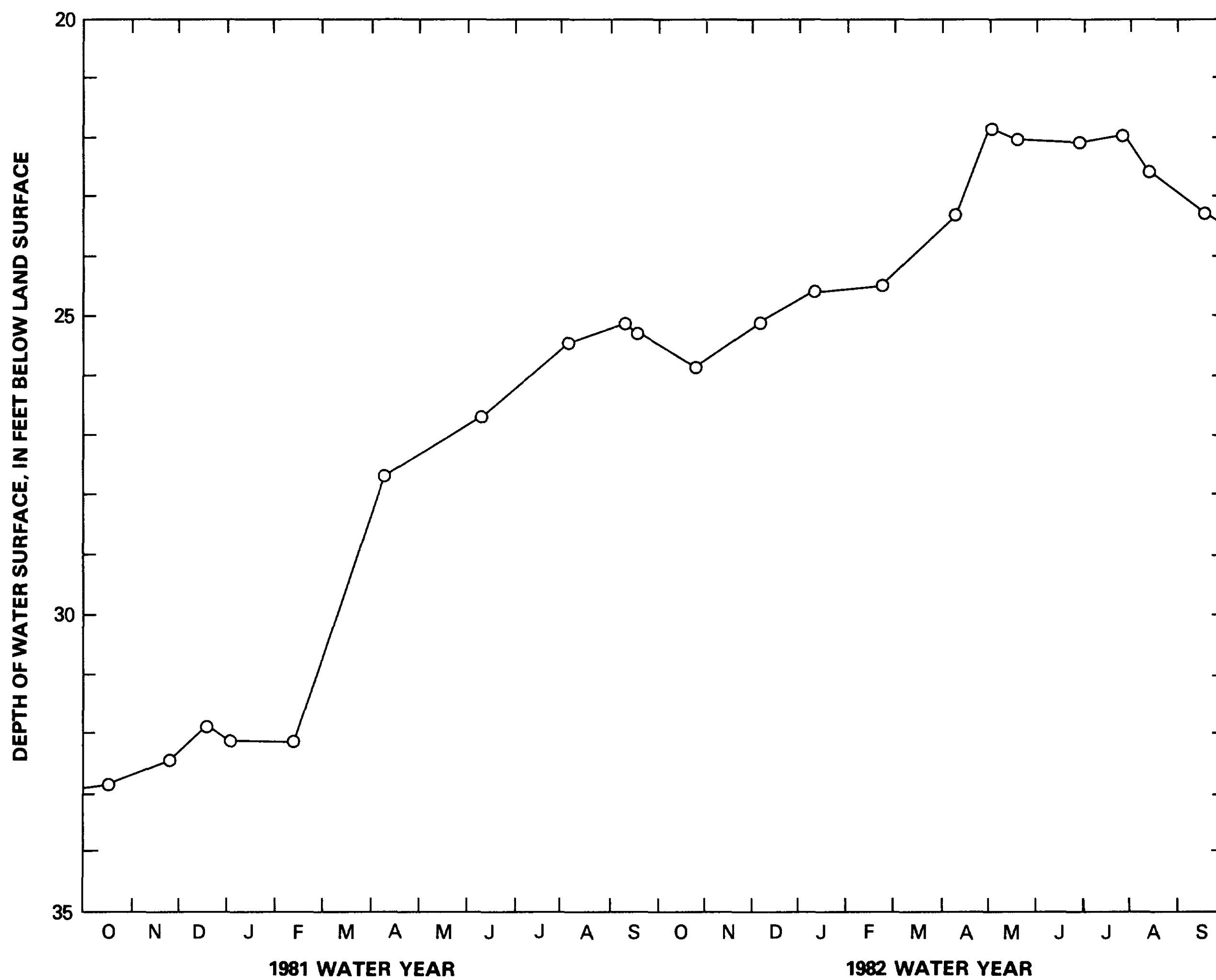


Figure 5. Ground-water levels in an observation well, Lf-11, in the Pats Creek basin, 1981 and 1982 water years.

Table 5. Peak discharges, in cubic feet per second, above a discharge base at the Galena River basin gaging stations

	Madden Branch tributary	Pats Creek	Madden Branch	Apple River
Discharge base	28	54	151	93
			1981 water year	
February 22	127	220	641	151
June 15	—	—	—	407
August 14	—	—	—	198
			1982 water year	
October 17	—	—	—	395
February 22	36	57	166	—
March 12	225	376	1,050	524
March 13	167	320	757	327
March 16	118	288	654	216
March 20	82	167	413	123
July 10	1,070	319	3,000	—
July 15	46	—	225	—
August 4	158	200	393	133
August 7	—	—	—	105

— peak discharge at this site did not reach discharge base.

Maximum and Minimum Flow Characteristics

Streamflow extremes for the study period occurred in different years; the minimum discharges occurred in the 1981 water year and the maximum discharges in 1982. The minimum 7-day low flows were not critically low. Based on the recorded discharge for the Galena River near Buncombe, the minimum flows were greater than the average 7-day low flow that occurs on the average once every 2 years.

The annual maximum instantaneous stream discharges varied considerably from station to station and from year to year. To evaluate these peak discharges, flood-recurrence intervals up to 50 years were estimated using equations presented by Conger (1971). These estimates are shown in table 6.

It should be noted that at the index station, Galena River at Buncombe, the peak discharge for both water years was less than could be expected for any 2-year recurrence interval based on Conger's equation. This is because the large size of the basin (125 mi^2) is not indicative of flood peaks for smaller basins when intense but very local storms occurred in the study area.

All of the stations had peak discharges significantly less than that predicted for the 2-year recurrence interval during the 1981 water year. The peak discharges for the year occurred on February 22, 1981, for all stations except the Apple River. The peak discharges were caused by a fairly intense rain falling on snow and frozen ground. It appeared that the rainfall was unevenly distributed with a lesser amount falling in the Apple River basin, which is the reason for the Apple River not having a comparable discharge.

In the Apple River basin, the largest peak discharge occurred on June 15, 1981, when 3.26 in. of rain fell in the basin. The peak discharge of 407 ft^3 was still less than the 2-year peak discharge recurrence interval estimated for this station.

In the 1982 water year spring peak discharges at all stations were near the estimated 2-year peak discharge recurrence interval as a result of the melting snowpack. The largest peak discharges during the study period occurred on July 10, 1982. Slightly more than 4 in. of rain fell in the Madden Branch tributary and Madden Branch basins. This intense rain caused unusually high flood discharges at both stations. The peak discharge of 1,070 ft^3 at Madden Branch tributary was between the 25- and 50-year recurrence flood and the peak discharge of 3,000 ft^3 at Madden Branch was between the 10- and 25-year recurrence flood. On July 10, 1982, only 1.01 and 0.90 in. were recorded at Pats Creek and the Apple River, respectively, causing discharge peaks of a lesser magnitude.

STREAM WATER QUALITY

The water-quality data collected at the subbasin gaging stations were used to determine the water-quality characteristics of the four streams. The water-quality data collected include suspended solids, volatile solids, dissolved solids, phosphorus, dissolved phosphorus, nitrite plus nitrate

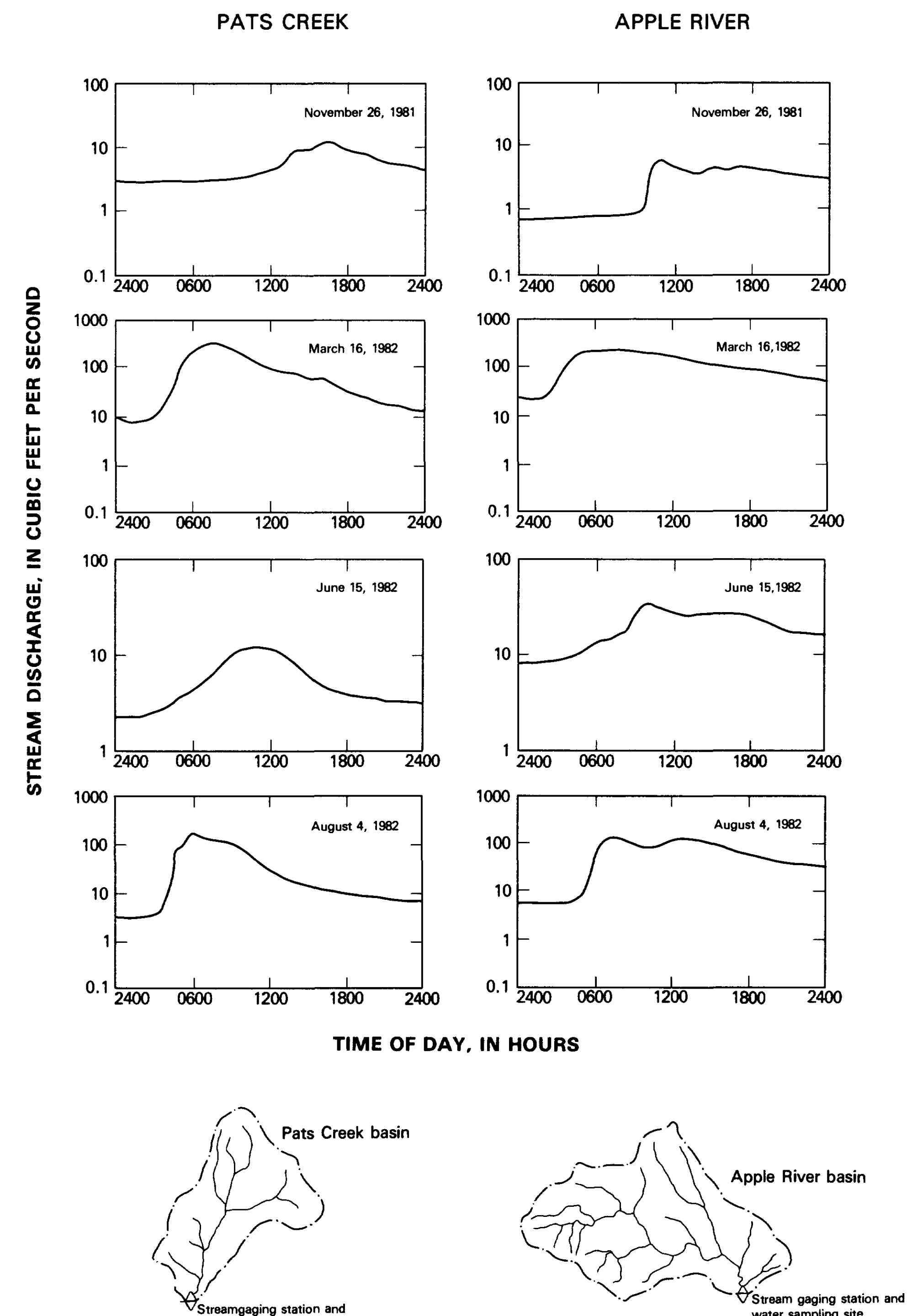


Figure 6. Stream discharges for seasonal runoff from the Pats Creek and Apple River basins.

nitrogen, ammonia nitrogen, Kjeldahl nitrogen, water temperature, dissolved oxygen, specific conductance, pH, biochemical-oxygen demand, trace metals, and pesticides. A statistical summary of concentrations of solids and nutrients are shown in table 7. Chemical data and particle-size distribution of suspended sediment were published in "Water Resources Data for Wisconsin, Water Year 1982".

Loads of Suspended and Volatile Solids and Nutrients

Suspended and volatile solids[6] and nutrient (nitrogen and phosphorus) loads, computed by streamflow and

[6] Suspended solids differ from volatile solids in that suspended solids are a measure of the total amount of material suspended in the stream. Volatile solids are a measure of the amount of volatile material (ignitable material at 550°C) present in the suspended solids. The suspended-solid and suspended-sediment concentrations are

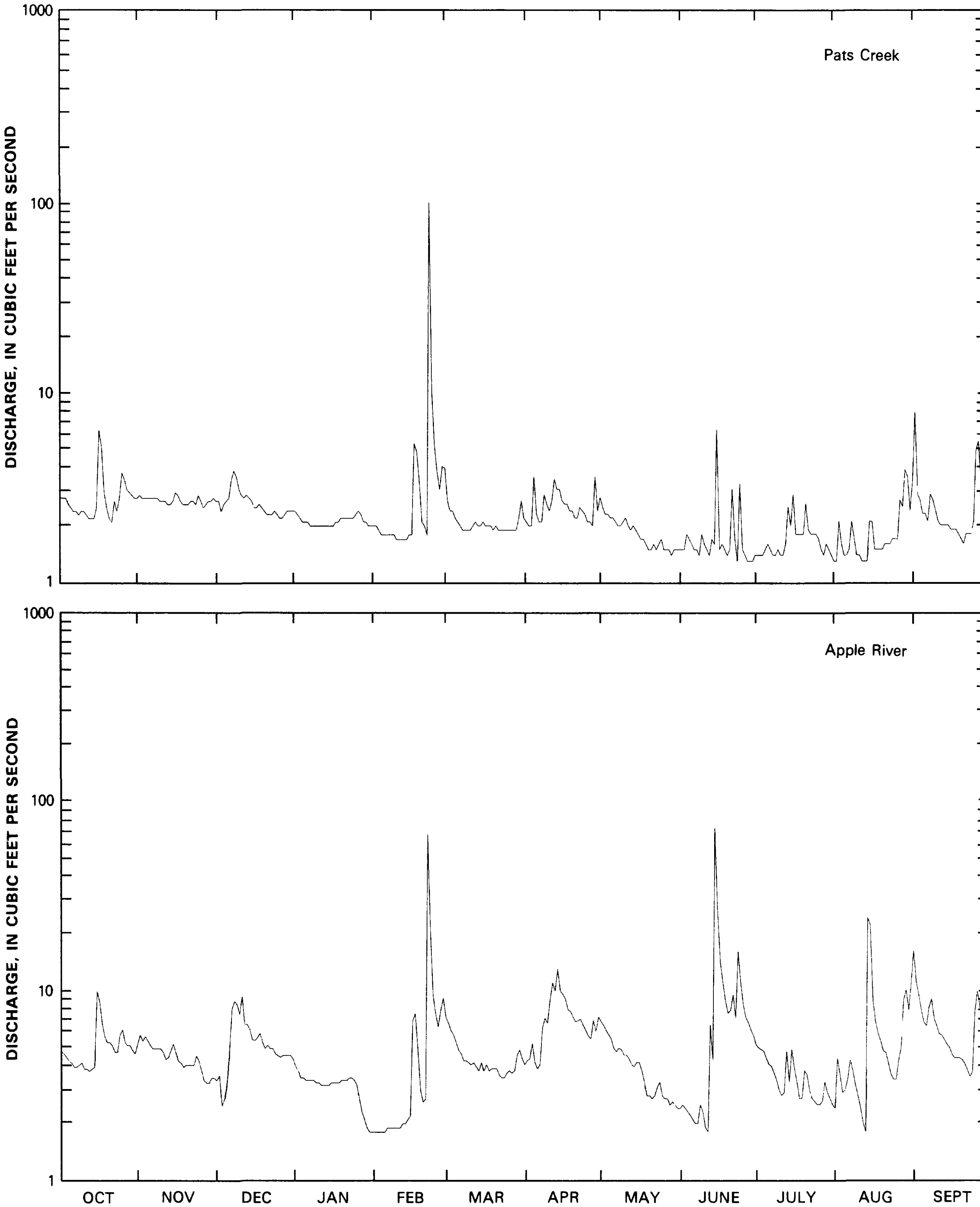


Figure 7. Total runoff for Pats Creek and Apple River, 1981 water year.

considered equivalent because the suspended sediment was predominantly silt-clay size material (U.S. Geological Survey, 1983) with little volatile solids. Analyses of duplicate samples by the Wisconsin State Laboratory of Hygiene for suspended solids, and the U.S. Geological Survey for suspended sediment, agreed within 4 percent.

concentration-integration techniques described by Porterfield (1972), are given in tables 8–23. Load and yield data are summarized in table 24.

Much of the chemical constituent load was transported from the basin in only a few days. Constituent loads and percentage of annual loads for selected storms are shown in tables 25 to 28. During the 1981 water year most of the constituent loads at all stations (except the Apple River) were transported during the February 22–23 storm. The greatest storm load was at the Pats Creek station where 91 percent of the annual suspended-solids load was transported during this 2-day period. Although the February 22–23 storm transported a significant amount of the annual constituent load (25 to 31 percent) from the Apple River basin, the June 15–16 storm transported the largest annual percentage, ranging from 28 percent for Kjeldahl nitrogen to 50 percent for suspended solids.

During the 1982 water year at all stations except the Apple River, 71 percent or more of the annual constituent load was transported as a result of three storms in March and one on July 10. At Madden Branch tributary 55 percent of the annual suspended solids and 56 percent of the annual volatile solids loads were transported on July 10. At the Apple River station, 37 to 64 percent of the annual constituent load was transported during 5 days—October 17 and 18 and March 12, 13, and 14.

Figure 8 illustrates how concentrations of suspended solids and total phosphorus change with changes in streamflow. At Madden Branch tributary, the increase in streamflow was the result of the intense rainstorm of July 10, 1982. The July 10 storm caused the stream discharge to peak at 1,070 ft^3/s—a recurrence interval of 25 to 50 years. Fifty-four percent of the suspended-solids load and 52 percent of the total phosphorus load were transported on this one day. The close relationship of phosphorus concentration with that of suspended sediment (equivalent to suspended solids as discussed above) has been demonstrated in the Steiner Branch basin (Field and Lidwin, 1982) as well as in other basins (Ward and Eckardt, 1979; McElroy and others, 1976; Verhoff and others, 1979).

Suspended solids and nutrient yields in water year 1982 were significantly higher than in water year 1981. This was due, in part, to the increased streamflow, as discussed in the section "Comparison of Streamflow for 1981 and 1982 Water Years". Madden Branch tributary and Madden Branch had a greater increase in loading in 1982 than did Apple River and Pats Creek. This was primarily due to the intense storm of July 10, 1982, that fell in the Madden Branch tributary and Madden Branch basins but not in the others. Figure 9 illustrates how the suspended solids and nutrient loads of the Galena River stations compare to those predicted by Hindall and to other streams monitored previously under the Nonpoint Source Pollution project. Although the suspended-sediment loads in the Galena River basin are among some of the highest in the State of Wisconsin, the phosphorus yields for the 1982 water year are the highest monitored to date.

The differences in runoff between basins may cause misinterpretations of comparisons of suspended solids and nutrient yields. The use of double mass-accumulation curves (figs. 10–14) helps eliminate this bias by providing a comparison of loadings and temporal changes in loadings between stations. Double mass-accumulation curves (fig. 10) were constructed by plotting the cumulative monthly constituent yield against cumulative inches of total runoff. In figure 10 the suspended-solids curves show that there are several sharp increases combined with several flat areas. This shape is characteristic of streams in Wisconsin receiving high base flow. During periods of base-flow runoff, the curves tend to be very flat and show almost no suspended solids or nutrient loading, and steady discharge. In contrast, during surface runoff, loading increases much more rapidly than discharge, resulting in a sharp increase in the slope of these curves.

As mentioned previously, base flow is made up of ground water that is discharged to the stream. For illustrative purposes, ground water was assumed to contain little or no suspended solids, volatile solids, total phosphorus, or Kjeldahl nitrogen. To eliminate the irregular shape of the double-mass curves, the base-flow component of total runoff was subtracted out.

Table 6. Estimated peak discharges, in cubic feet per second, for the Galena River basin gaging stations

Peak discharge recurrence interval	Madden Branch tributary[1]	Pats Creek[1]	Apple River[1]	Madden Branch[1]	Galena River[2]
2 year	223	379	549	995	5,390
5 year	398	675	973	1,780	8,330
10 year	551	929	1,320	2,460	10,400
25 year	921	1,500	2,080	3,770	13,100
50 year	1,230	2,100	3,040	5,510	15,200

[1] Estimates based on Conger's equation (Conger, 1971).
[2] Conger, 1981.

The double-mass curves for suspended solids, volatile solids, total phosphorus, and Kjeldahl nitrogen for all four stations, with the base-flow contribution subtracted out, are shown in figures 11–14. In general, the curves for Madden Branch exhibited the highest loading of the four streams monitored and the Apple River basin showed the least. (With the exception of the plots for suspended solids, each stream exhibited similar loading for volatile solids, total phosphorus, and Kjeldahl nitrogen.)

Most of the solids and nutrient loads observed during the 1981 water year were transported in February during spring runoff that resulted from rain on frozen ground. Apparently there was less rain in the Apple River basin because less runoff was measured. June was a significant month for loading in the Apple River basin, however, the rains that caused this high loading did not occur in the other basins.

In the 1982 water year, October was a significant month for loading in the Apple River basin; the rains causing this loading did not occur in the other basins. Runoff in March showed significant loading at all stations. The severe loading in July at Madden Branch and Madden Branch tributary as a result of the intense storm of July 10 is of particular interest; this month showed the greatest loading for most of the constituents during the 2-year study. As discussed previously the rainstorm causing this high loading did not occur in the Pats Creek or the Apple River basin. August showed moderate to high loading at all stations.

Loads of volatile solids, total phosphorus, and Kjeldahl nitrogen were proportional to animal density units. The high loading at Pats Creek can probably be explained by the high density whereas the low loading at the Apple River is probably due to the low density. However, the high loading at Madden Branch is difficult to explain except that feedlots upstream of the Madden Branch station may be contributing an unusually high concentration of nutrients to the stream.

The greater suspended-solid yields at Madden Branch can be explained in part by the greater number of steep soil

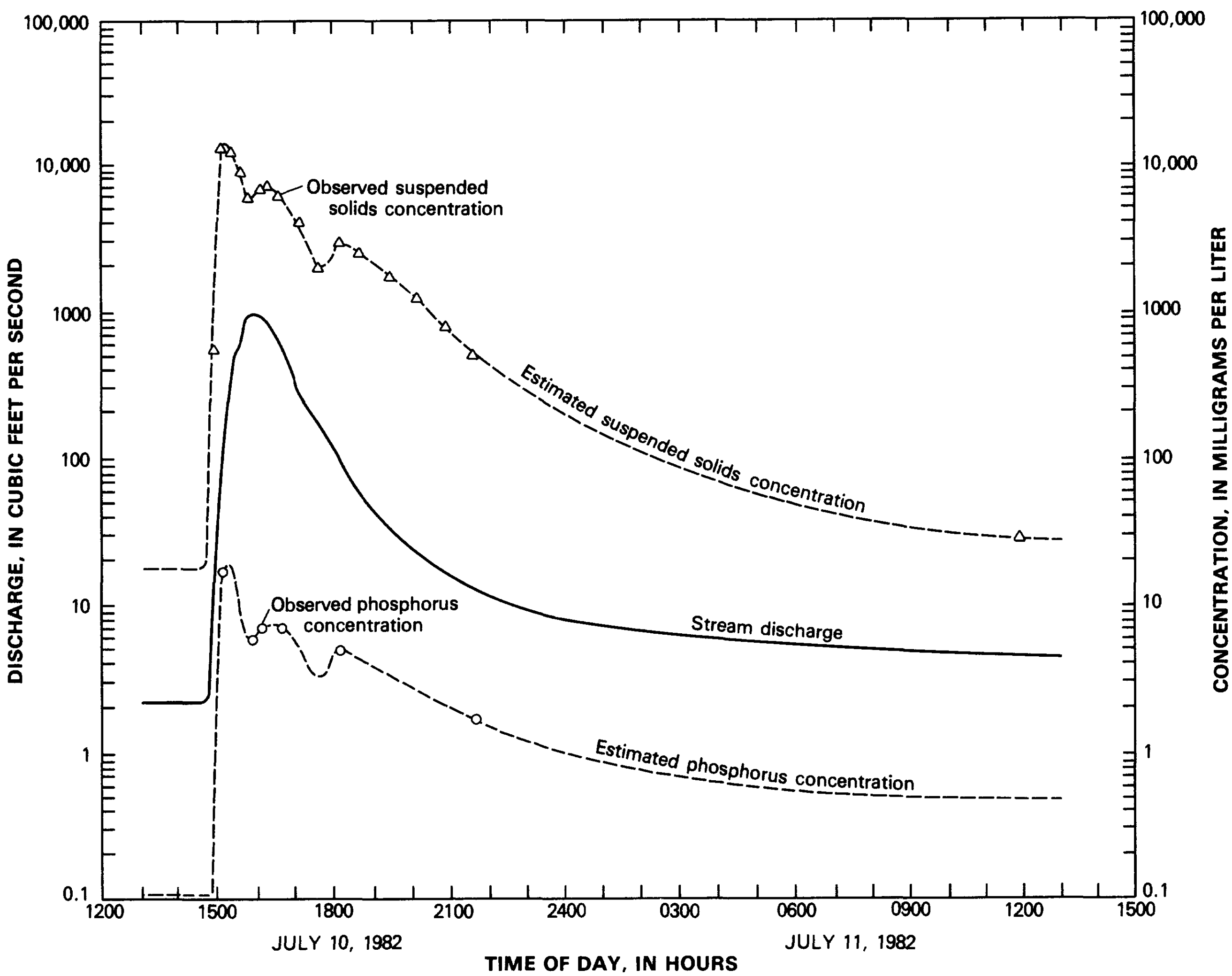
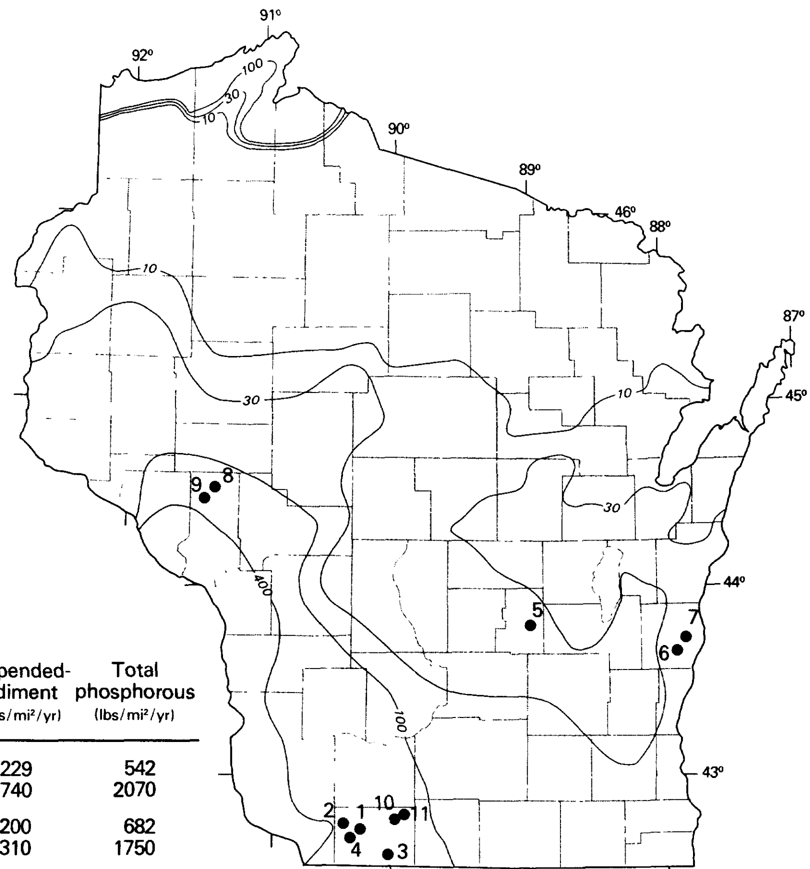


Figure 8. Stream discharge, suspended solids, and total phosphorus for storm of July 10–11, 1982, at Madden Branch tributary near Belmont, Wisconsin.

slopes that have greater soil loss than gentler shallow soil slopes.

The Apple River basin showed the lowest suspended solid yield despite the fact that the Apple River basin had the most of its basin in row crops. This may be due in part to the flatter soil slopes and the flatter channel slope (10 to 85 percent). Previous studies have shown that the channel slope between the 10 and 85 percent points is more closely related to flood peaks than the channel slope for the entire stream length. Flood peaks, of course, affect sediment loads.

Loads for dissolved phosphorus were not computed for any of the gaging stations. This was because sample analysis required immediate filtration which was not possible with an automatic sampler. Instead regression analyses of dissolved phosphorus versus total phosphorus were made for each station to evaluate the percent of the dissolved fraction of total phosphorus.



	Non-point source monitoring station names	Water year	Drainage area (mi²)	Suspended-sediment (tons/mi²/yr)	Total phosphorous (lbs/mi²/yr)
1*	Madden Branch tributary	1981	2.83	229	542
		1982		740	2070
2*	Pats Creek	1981	5.4	200	682
		1982		310	1750
3*	Apple River	1981	9.3	137	463
		1982		284	1400
4*	Madden Branch	1981	15.1	239	749
		1982		684	2290
5	White Creek	1982	3.05	983	711
		1983		316	458
6	Onion River-Hingham	1979	37.2	79	331
		1980		64	317
7	Onion River-Sheboygan Falls	1979	94.1	88	528
		1980		76	517
8	Bruce Valley	1980	10.1	215	1600
9	Elk Creek	1980	99.7	184	1350
10	Steiner Branch	1978	5.9	369	707
		1979		85	231
11	Yellowstone River	1978	28.5	220	
		1979		54	

* Study Basin

Figure 9. Regionalized suspended-sediment yields of Wisconsin streams, and locations of the nonpoint-source monitoring stations and suspended-sediment and total-phosphorus yields.

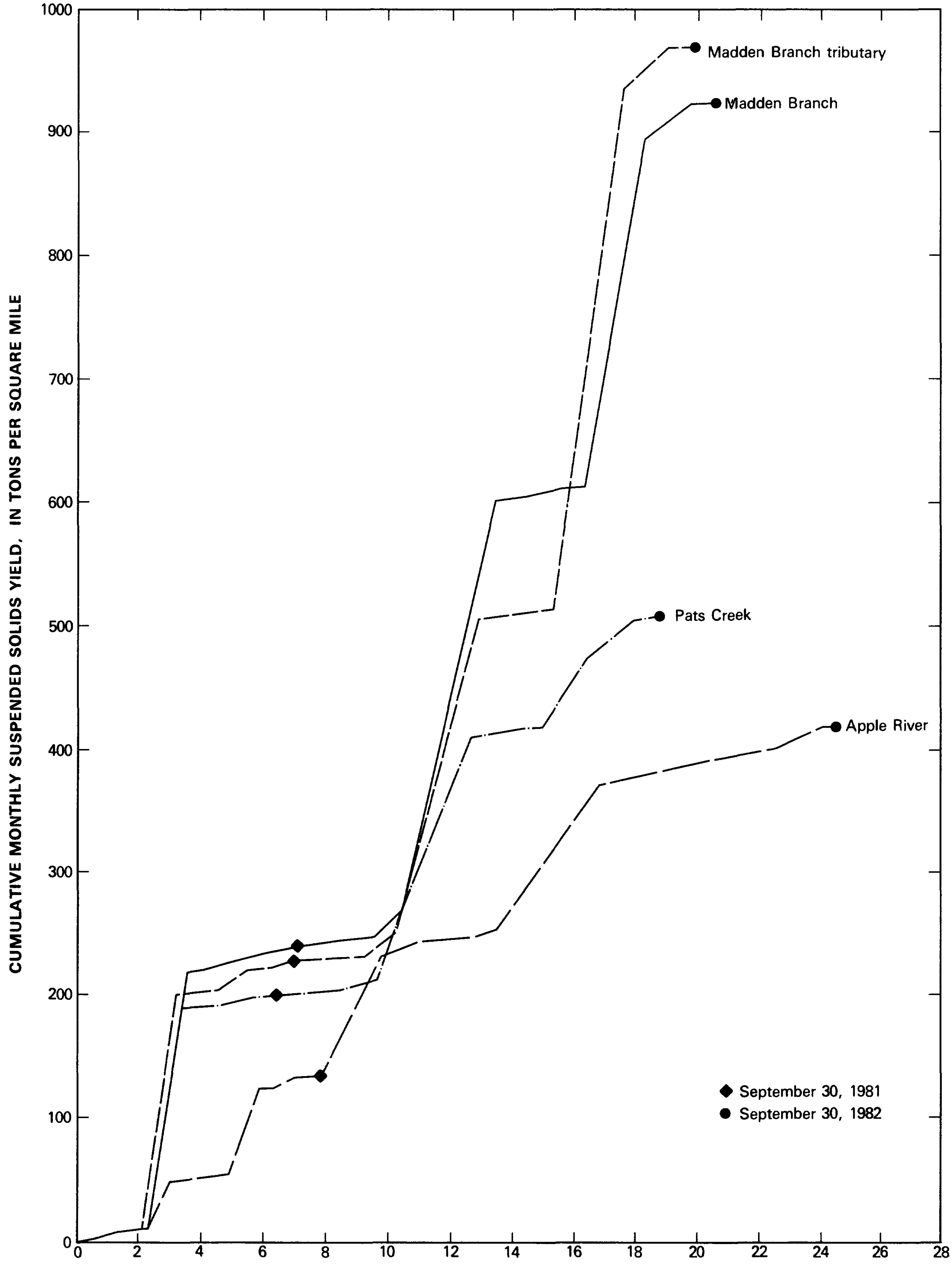


Figure 10. Double-mass-accumulation curves for suspended solids as a function of total monthly runoff at the Galena River gaging stations.

Dissolved phosphorus was plotted as the dependent variable and total phosphorus as the independent variable. The plots are shown in figure 15. Comparison of the regression lines of the four stations is shown in figure 16. The regression lines are sufficiently close and therefore probably indicate similar relationships at all stations. Using the relations shown in figure 15, these data could be used to arrive at the annual load of dissolved phosphorus.

Water Temperatures

During winter, water temperatures approach 0°C and all streams become ice covered. During summer the water temperatures become very warm and have maximum temperatures commonly in excess of 25°C and, on many occasions, reach 30°C.

Water temperature has a significant affect on the streams' dissolved-oxygen concentration. All other factors being equal, warmer water holds less oxygen than colder water. For example, at an atmospheric pressure of 730 millimeters of mercury and a water temperature of 0°C, the maximum saturation solubility of oxygen in water is 14.1 mg/L; at 30°C it is only about one-half that amount, or 7.3 mg/L.

Dissolved Oxygen

Dissolved-oxygen-concentration data were collected intermittently at all stations. The Apple River was monitored from June 19 through October 7, 1981; Madden Branch from May 20 through September 29, 1982; Madden Branch tributary from May 9 through July 20, 1981; and Pats Creek from May 13 through September 15, 1982. Many equipment problems were encountered during the study. However, the data are reliable during periods after probe calibration.[7] The records showed dissolved-oxygen sags that are probably associated with agricultural runoff, which helps to explain the degradation of the water quality in the area. Dissolved-oxygen sags are defined as those where the diurnal flux is disrupted and the dissolved oxygen drops in response to surface runoff. Numerous dissolved-oxygen sags associated with surface runoff were noted on all streams except at Madden Branch tributary. However, most dissolved-oxygen

[7] The dissolved-oxygen probes were calibrated on the following dates:
Madden Branch tributary: May 8, 12; June 4, 16, 19; July 16, 1981.
Pats Creek: May 13, 19, 27; June 3, 11, 15; July 2, 7, 12, 29; Aug. 3, 4, 6, 18, 26; Sept. 8, 15, 1982.
Apple River: June 19, 25; July 17, 29; Aug. 11, 24, 29; Sept. 9, 22, 30; Oct. 7, 1981.
Madden Branch: Aug. 24, 29; Sept. 1, 9, 17, 1981; May 19; July 2, 12; Aug. 6, 18, 26; Sept. 8, 15, 30, 1982.

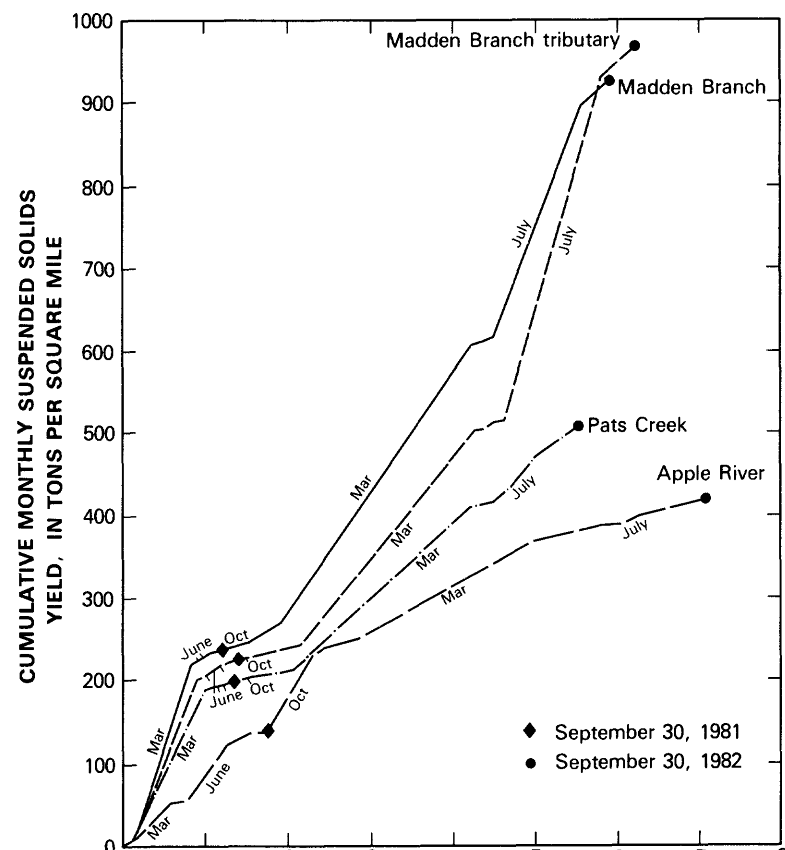


Figure 11. Double-mass-accumulation curves for suspended solids as a function of monthly surface runoff at the Galena River gaging stations.

minimums were not at critical levels. Most sags either coincide with peak stream discharges or within 3 hours following the peak. Dissolved-oxygen sags were recorded at the stations listed below on the following dates:

Pats Creek: July 10, 15, 16; 1982.
Apple River: July 13, 20; August 14, 28, 31; September 1, 25, 26, 29; October 4, 6, 1981.
Madden Branch: August 26, 28, 1981; May 26, 27; June 15, 1982.

The dissolved-oxygen concentration needed to maintain a warm-water fishery in a stream should not be less than 5.0 mg/L at any time (Wisconsin Department of Natural Resources, 1973). Dissolved-oxygen concentrations were below 5.0 mg/L on 16 occasions at Pats Creek and on two occasions at Madden Branch. The daily minimum dissolved-oxygen levels at the Apple River were less than 5.0 mg/L on 28 occasions; most of these minimums were due to consumption of oxygen by plant respiration at night.

A fishkill occurred at Madden Branch on July 13, 1981, after streamflow at the gage increased from 4.3 ft^3/s to a minor discharge peak of 15 ft^3/s. The dissolved-oxygen recorder was not in operation on this date, but a dissolved-oxygen sag was noted on the Apple River. A similar sag may have occurred at Madden Branch. The DNR investigated the fishkill (Van Dyke, 1981) and found numerous dead rough fish and game fish, including 12 smallmouth bass, 11 green sunfish, 1 bluegill, and 20 stone catfish.

Upstream from the Madden Branch gage, Van Dyke (1981) reported finding a feedlot near the stream covered with up to 1 ft of cow manure. The feedlot showed evidence o. severe erosion from the July 13 rainstorm. Downstream from the feedlot, the stream bottom was "covered with a considerable amount of highly volatile organic silt." This was likely from the manure in the feedlot. Van Dyke suspected this "highly volatile organic silt" may have caused an oxygen depletion, which resulted in the fishkill. He noted that the pattern of this fishkill was very similar to fishkill patterns in other smallmouth-bass streams in the area.

Plots of stream discharge and dissolved-oxygen concentrations for Madden Branch, Pats Creek, and Apple River are shown in figure 17 for various periods. The recorders in each period illustrated were calibrated prior to the dissolved-oxygen sags. The previous day is shown to illustrate the normal instream dissolved-oxygen flux.

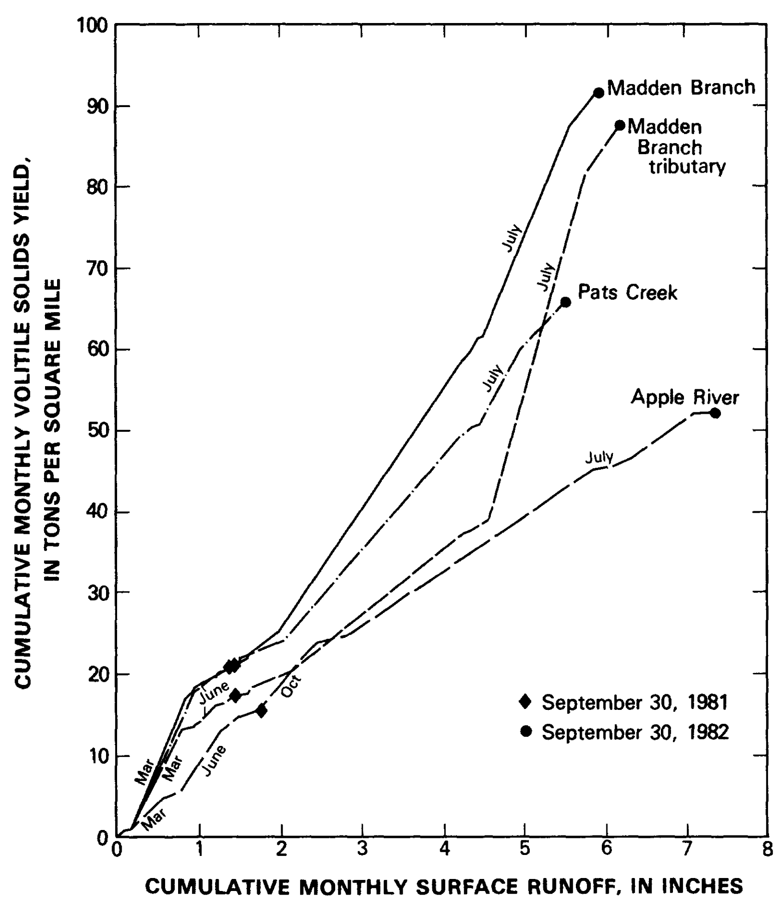


Figure 12. Double-mass-accumulation curves for volatile solids as a function of monthly surface runoff at the Galena River gaging stations.

On August 24, 1981, following the fishkill at Madden Branch, a dissolved-oxygen recorder was installed on that stream. On August 25–26, 1981, a minor storm increased streamflow from 5 to 12 ft^3/s (fig. 17). Within 2 hours following the peak discharge, dissolved oxygen fell from 5.5 to 3.2 mg/L. Although the dissolved-oxygen sag did not cause a fishkill, it indicated what may have caused the fishkill of July 13, 1981. One of the most significant aspects of this dissolved-oxygen sag is the timing. The increase in streamflow and the subsequent dissolved-oxygen sag occurred at a time of day when stream dissolved-oxygen levels are normally at a minimum—during early morning hours. This indicates that even minor rises could reduce oxygen levels sufficiently to cause fishkills if sufficient oxidizable material is flushed into the stream at night when plants are respiring and oxygen levels are near their diurnal minimums.

In the illustration for Pats Creek (fig. 17), the dissolved-oxygen sag to 1.2 mg/L on July 7, 1982, occurred prior to the discovery of a fishkill. During an inspection of the station on July 8 by the U.S. Geological Survey, dead fish were noticed, and the Wisconsin Department of Natural Resources was contacted. The DNR estimated the kill at 1,000 fish and also noted that the benthic community was affected (Schlesser, 1982).

Whether this fishkill can be directly linked to the dissolved-oxygen sag observed on that date is difficult to determine. It is known that, on or about July 5, a herbicide containing 2-4-D was sprayed close to Pats Creek. It is not known what the concentration of this herbicide was during the period July 6–7 or its effect on fish life in the stream. A discrete sample for biochemical oxygen demand (BOD) near the peak discharge had a concentration of 27 mg/L. It should be noted that the dissolved-oxygen sag to 1.2 mg/L occurred much later after the discharge peak than other sags.

The dissolved-oxygen sag to 1.2 mg/L could not have directly caused the fishkill. Smallmouth bass have been found to exist, under laboratory conditions, at dissolved-oxygen

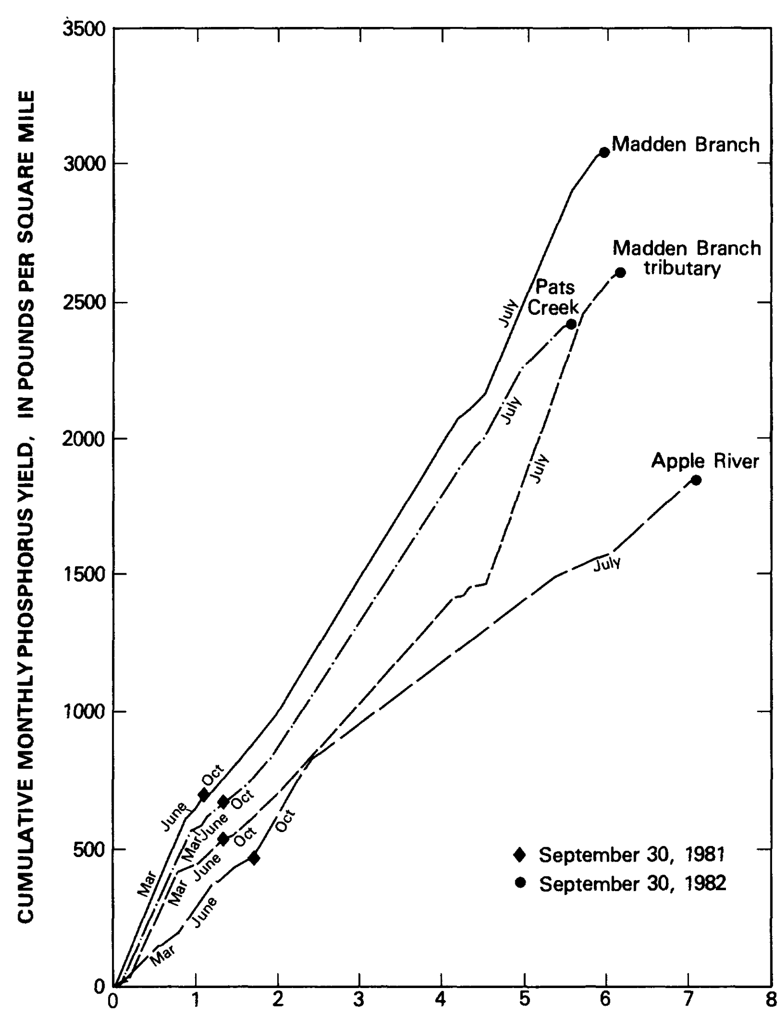


Figure 13. Double-mass-accumulation curves for total phosphorus as a function of monthly surface runoff at the Galena River gaging stations.

concentrations as low as 0.63 to 0.98 mg/L; carp can exist at concentrations as low as 1.1 mg/L (U.S. Environmental Protection Agency, 1971). Therefore, the low dissolved-oxygen level probably did not cause the fishkill directly. However, Downing and Merkins (1955) have found that low dissolved-oxygen levels can cause an increase in the toxicity levels of un-ionized ammonia on rainbow trout (*Salmo gairdnerii Richardson*). It is therefore theorized that the synergistic effect of the low dissolved-oxygen level and the moderately high concentrations of other critical factors, such as un-ionized ammonia, suspended solids, and pesticides, caused the fishkill.

The discharge runoff of July 10, 1982, at Pats Creek (fig. 17) also was associated with a significant drop in the stream dissolved-oxygen level. This drop in dissolved oxygen was probably the result of sediment-oxygen demand. The dissolved-oxygen sag to 3.2 mg/L was almost coincident with the stream discharge peak and the suspended-solids peak. Although the sag was not low enough to cause an outright fishkill, it nevertheless was significant. It is theorized that the particulate organic material from the July 6–7 storm, which had a high biochemical oxygen demand, settled in the bed of the stream and began to decompose. As the stream velocities on July 10 increased, this decomposing material in the stream sediments became resuspended and created an immediate oxygen demand (IOD).

Immediate oxygen demand (IOD) has been documented by various researchers. Qasim and others (1980), in sampling the Trinity River of eastern Texas, found that resuspended bottom sediments dropped oxygen levels to low or zero levels in as little as 15 minutes. Grant (Southeastern Wisconsin Regional Planning Commission, oral commun., 1984) also found an IOD created by the bottom sediments in Milwaukee Harbor, Milwaukee, Wis., as they became resuspended with increased stream discharge.

Although no fishkills were documented on the Apple River, it does appear that the runoff waters do contain highly oxidizable materials that affect the stream's dissoved-oxygen levels (fig. 17) and that the potential probably exists for fishkills in that basin as well as at Pats Creek and Madden Branch. The Apple River station did show the greatest fluctuations of stream dissolved-oxygen levels of the four stations monitored. Dissolved-oxygen fluctuations from 4.5 to 12 mg/L were not uncommon and were likely due to the greater number of macrophytes growing in this stream compared to limited numbers in the other streams. (This was not a quantitative determination but observations by the author at the time of visits to the sites.)

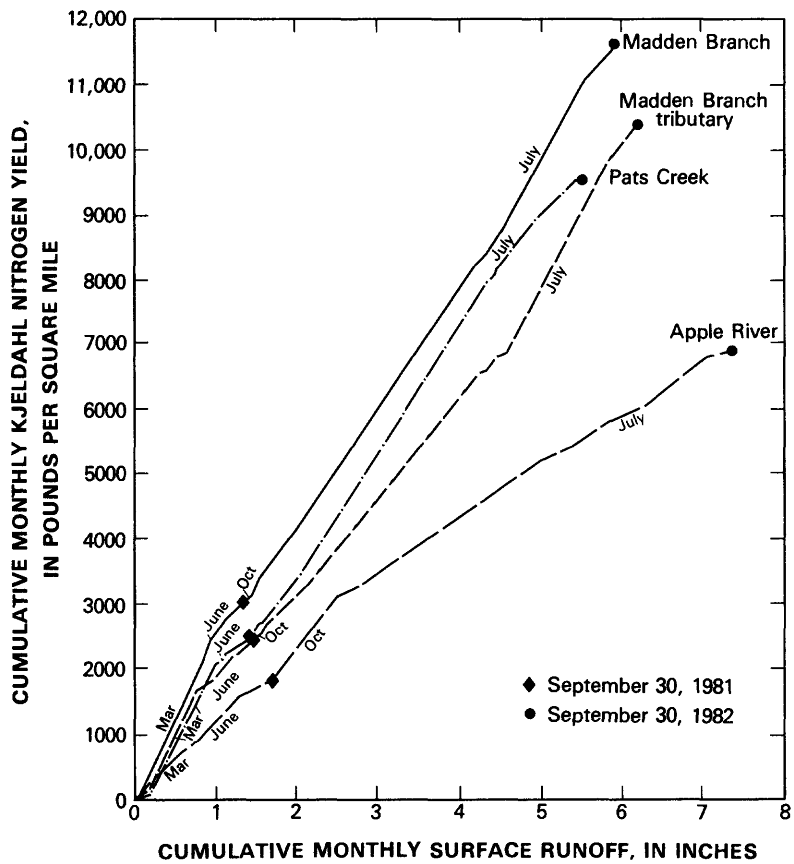


Figure 14. Double-mass-accumulation curves for Kjeldahl nitrogen as a function of monthly surface runoff at the Galena River gaging stations.

No dissolved-oxygen sags were noticed at the Madden Branch tributary station. However, the dissolved-oxygen recorder was removed from that station on July 20, 1981; most dissolved-oxygen sags at the other stations were recorded during July and August. Had the dissolved-oxygen recorder been operational during these months at Madden Branch tributary, dissolved-oxygen sags may have been noticed in that stream also.

Biochemical Oxygen Demand

Values for 5-day BOD indicate that high levels of oxidizable organic material occur in all the streams. The 5-day BOD value at Pats Creek ranged from 1.2 to 27 mg/L; at Madden Branch tributary the range was from <1 to 33 mg/L; at Apple River the range was from 1.2 to 12 mg/L; and at Madden Branch the 5-day BOD ranged from 12 to 25 mg/L (U.S. Geological Survey, 1983). The minimum values occurred during low flows, whereas the maximum values occurred during high flows.

Although the BOD of the organic material in the streams is high, the sharp declines in the dissolved-oxygen levels of the study streams (fig. 17) are not characteristic of dissolved-oxygen sags described in the scientific literature. High BOD characteristically causes gradual declines, measured over days, in the dissolved-oxygen levels in a stream. It is theorized that this highly oxidizable material

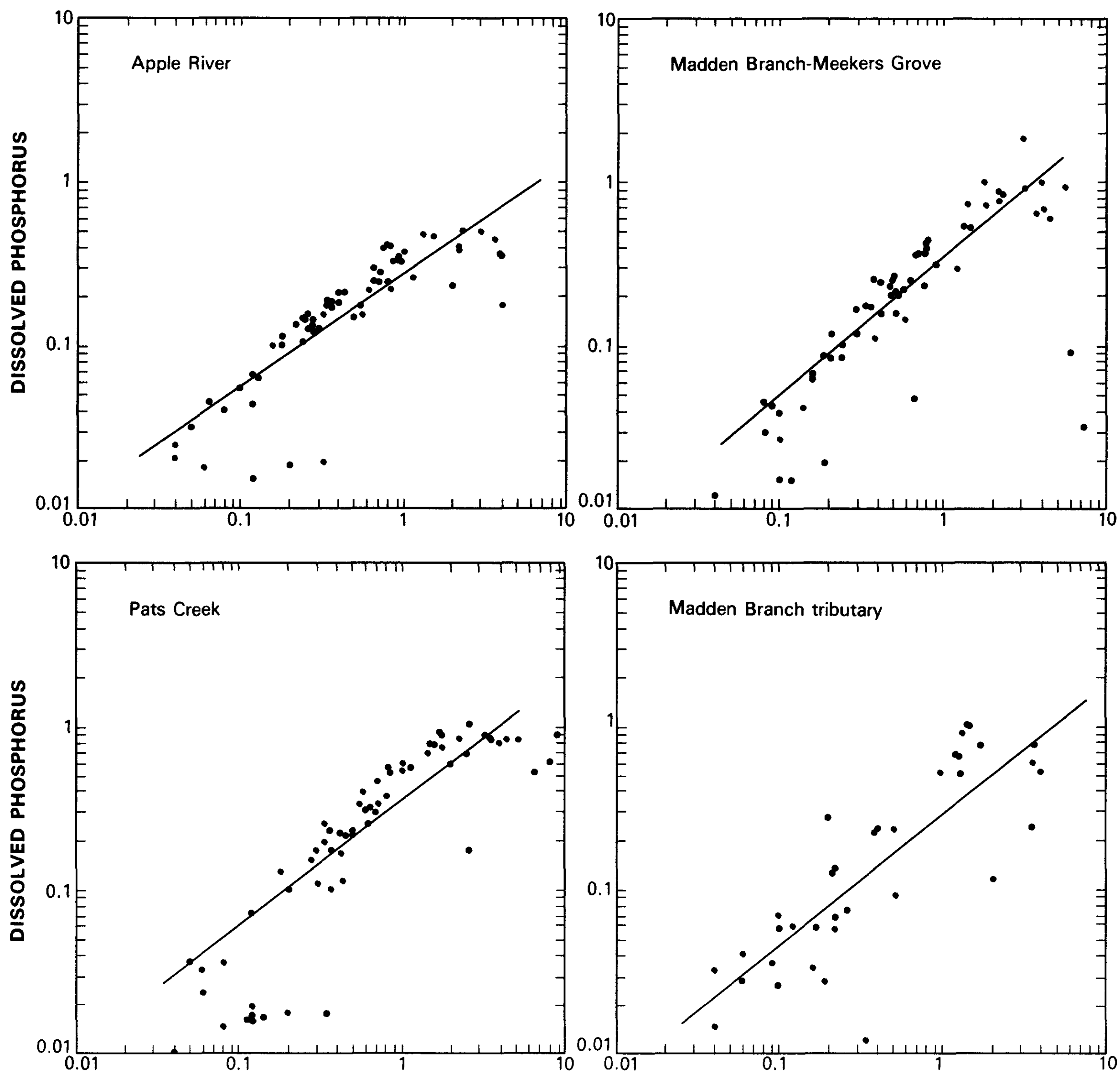


Figure 15. Graphs showing relation of dissolved phosphorus to total phosphorus for the Galena River basin gaging stations, 1981 and 1982 water years.

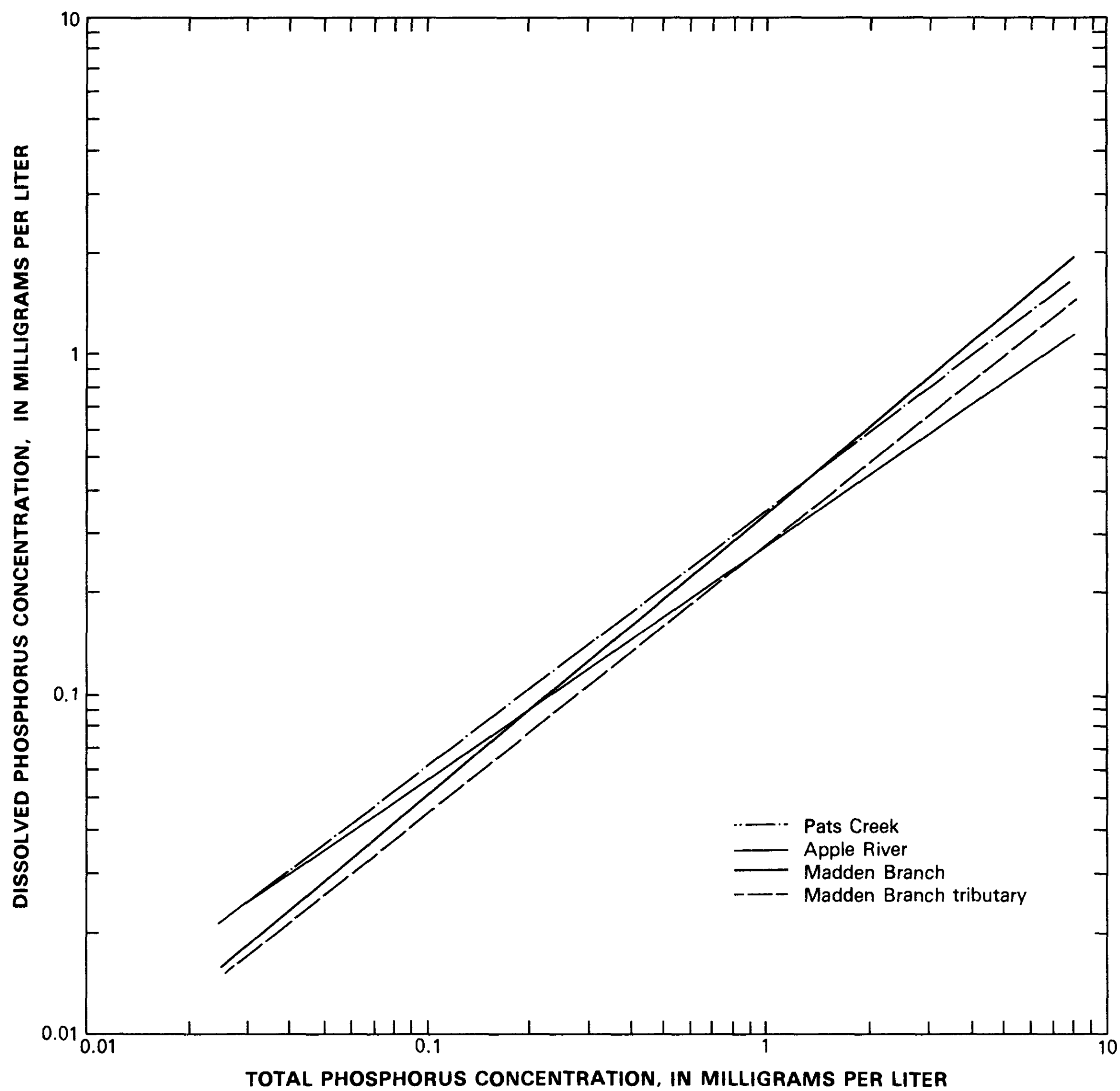


Figure 16. Graph showing relation of regression lines of dissolved phosphorus to total phosphorus for the Galena River gaging stations.

in the study streams is deposited in the streambed in areas of low velocities. Once deposited, the organic material decays and becomes part of the sediment-oxygen demand. As stream velocities increase during the next rainstorm, this decayed organic material is scoured from the streambed, creates an immediate oxygen demand on the water column, and depreses the dissolved-oxygen levels. This scenerio is illustrated in figure 17 at Pats Creek for July 6–10, 1982.

pH

Continuous records of pH were collected by the U.S. Geological Survey at Madden Branch from May 20 to July 1 and from August 12 to September 30, 1981. At Madden Branch, the pH ranged from 7.4 to 8.4. Miscellaneous measurements of pH at low and high flows also were made by U.S. Geological Survey and Wisconsin Department of Natural Resources personnel at various times throughout the study period. The ranges of miscellaneous measurements of pH were almost the same at all four stations—from 7.3 during high flow to 8.2 during low flow.

Total Phosphorus

The U.S. Environmental Protection Agency (1977) has suggested that the following concentrations of total phosphorus should not be exceeded to prevent biological nuisance growths:

0.1 mg/L for streams not discharging into lakes or impoundments,

0.05 mg/L in any stream at the point where it enters a lake or reservoir,

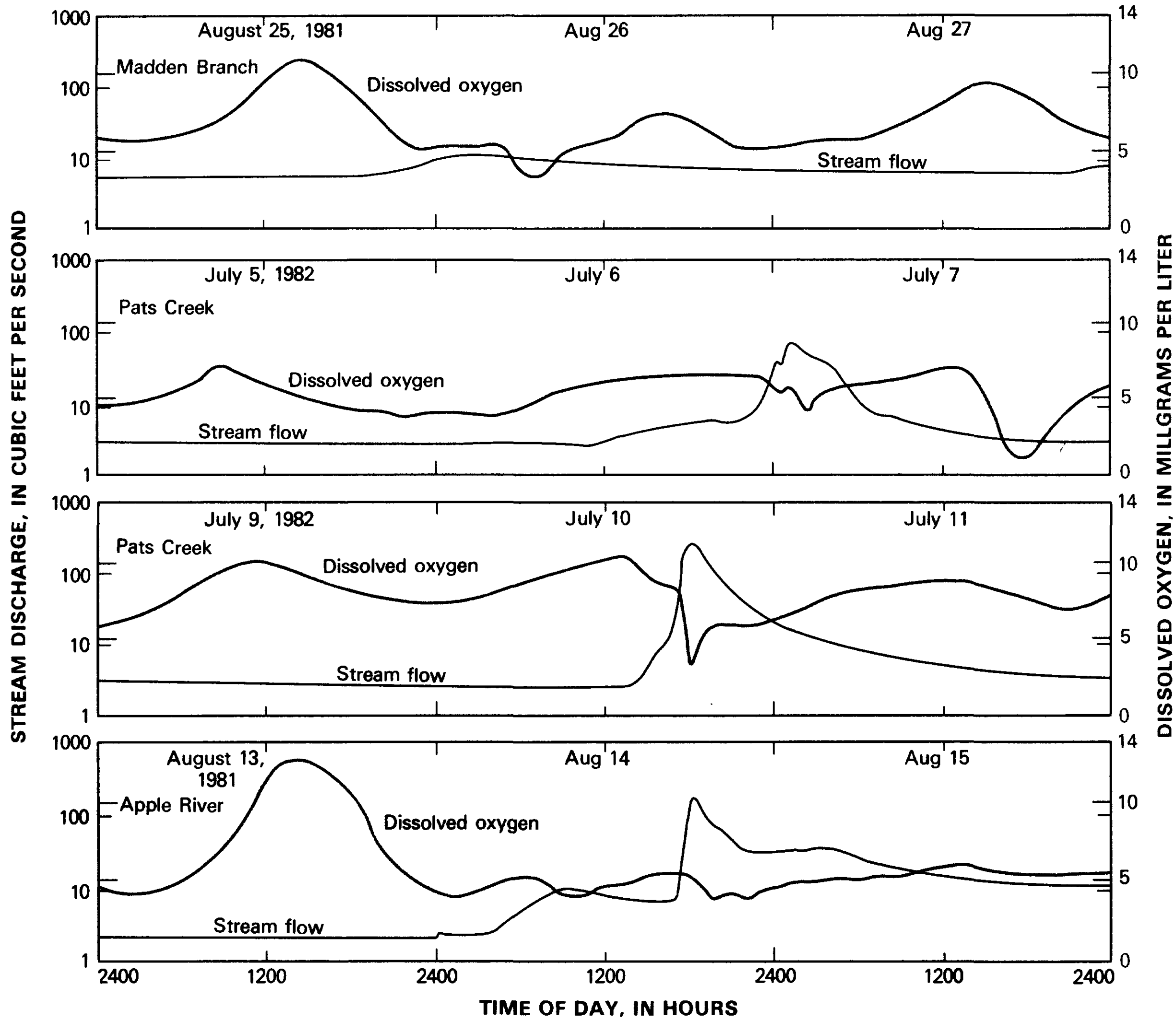


Figure 17. Graphs showing stream discharge and dissolved-oxygen concentration at Madden Branch, Pats Creek, and Apple River.

0.025 mg/L within a lake or reservoir.

During low flow, only Madden Branch had samples (four) that exceeded the U.S. Environmental Protection Agency criteria. During surface runoff, most samples at all stations exceeded the criteria.

Un-ionized Ammonia

Ammonia-nitrogen concentrations during low flow at all stations did not exceed the DNR criterion of 0.05 mg/L of un-ionized ammonia (NH_3-N) (Schuettpelz and Harpt, Department of Natural Resources, written common., 1980). Only one sample at Pats Creek may have exceeded this criterion during surface runoff. There were no significant streamflow rises during these periods to indicate how pH responds to increases in streamflow. However, miscellaneous grab samples for pH were obtained during surface runoff and pH values ranged from 7.0 to 8.2, with a median of 7.7. Based on the median pH of 7.7, the observed concentration of dissolved ammonia, and the water temperature, the dissolved-ammonia concentration of 12.0 mg/L on February 21, 1982, at Pats Creek and concentrations of 3.0, 2.2, and 2.2 mg/L on June 15, 1982, at Madden Branch exceeded the DNR criterion of 0.05 mg/L for un-ionized ammonia.

Concentrations of un-ionized ammonia can be determined from analyses of ammonia nitrogen (NH_3+NH_4) if the pH and water temperature of the samples are known. Although water temperatures were recorded continuously, pH was only recorded at Madden Branch from May 20 to July 1 and August 12 to September 30, 1982. Miscellaneous grab samples for pH were also obtained. None of the ammonia-nitrogen concentrations during low flow at all stations exceeded this criterion.

During high flow only the dissolved-ammonia concentration of 12.0 mg/L on February 21, 1982, at Pats Creek exceeded the criterion. This evaluation was based on a median pH of 7.7 from miscellaneous grab samples of surface runoff where pH values ranged from 7.0 to 8.2.

Fecal-Coliform Bacteria

Concentrations of fecal-coliform bacteria suggest fecal contamination and the possible presence of pathogenic organisms. Wisconsin water-quality standards for recreational waters with respect to fecal coliform bacteria are the same as those of the U.S. Environmental Protection Agency, 1976: "The geometric mean of not less than 5 samples within a 30-day period shall not exceed 200 per ml nor shall more than 10 percent of total samples during any 30-day period exceed 400 per 100 ml."

Fecal-coliform samples were collected seasonally and at low flows and are shown below:

	Madden Branch Tributary	Pats Creek	Madden Branch	Apple River
Number of samples	13	13	14	14
Maximum	600,000	300,000	200,000	2,000,000
Minimum	10	<10	<10	<10
Geometric mean	2,250	1,064	3,819	2,393

Although the sample frequencies were not as specified for the above standards, the geometric means of the data set all indicate they are well above those standards at all stations.

Pesticides

Samples of the water column and the bed material were analyzed for pesticides commonly used in the basins. The major reason for the pesticide analyses is that the use of pesticides had been believed to have caused a decline in fish populations. In 1981, the Illinois Department of Conservation and the U.S. Fish and Wildlife Service reported an exceptionally high number of fishkills in Illinois streams and impoundments (U.S. Geological Survey, 1981). It was not possible to determine the specific chemicals responsible for these fishkills. However, the chemicals suspected were insecticides of the organo-phosphate and carbamate groups.

The bed material was analyzed for pesticides in the first year of study and in the water column during the second year. The bed material was analyzed the first year because pesticides transported in the water column will eventually become deposited in the bed material of the stream. It is difficult to determine when the pesticide will reach its peak concentration in the discharge hydrograph in the water column; many costly analyses would be required to define the peak concentration accurately. However, after the analyses of the bed material in 1981 showed that most concentrations were less than the detection limit, analyses of the water column during surface runoff were conducted in June 1982. June was selected because this month had the greatest potential of pesticide runoff. The results of these analyses are shown in table 29.

Although there are no toxicity criteria for pesticide concentrations in bed material, it is available for pesticide concentration data in the water column (U.S. Environmental Protection Agency, 1975). Concentration data from the water column (table 29) were well below the LC 50[8] for blue gills. Despite this, the concentration data of the bed material and water column do indicate the presence of some pesticides and their transport in the water column. Therefore, the possibility exists that pesticides may occur at concentrations higher than the samples indicate.

SUMMARY AND CONCLUSIONS

A study in the Galena River basin in southwestern Wisconsin by the U.S. Geological Survey, in cooperation with the Wisconsin Department of Natural Resources, found that nonpoint-source discharges significantly degrade water quality. Four small tributaries—Madden Branch tributary, Pats Creek, Apple River, and Madden Branch—that drain agricultural lands and that contain no significant point sources, were monitored to define their water quality. Drainage areas of the streams' basins range from 2.8 to 15.1 mi^2

Streamflow during the 1981 water year was about 25 percent below normal and, during the 1982 water year, was about 38 percent above normal. Precipitation in the basins was near the 30-year normal for both years of study except in the Apple River basin, which had precipitation 5 in. above normal during the 1982 water year. The greater streamflow during the 1982 water year was caused by storms of increased intensity that occurred during periods of low evapotranspiration and higher base flow. A significant storm on July 10, 1982, in Madden Branch tributary basin and Madden Branch basin exceeded a recurrence interval of 100 years for a 1-hour storm-intensity for the area.

The yields of suspended solids, volatile solids, total phosphorus, and ammonia plus organic nitrogen during the 1982 water year were at least twice those of the 1981 water year. The higher yields correlate with the greater streamflow in 1982. The greatest yields were 740 tons of suspended solids per square mile from Madden Branch tributary; and 71 tons of volatile solids per square mile, 2,290 lb of total phosphorus per square mile, and 8,530 lb of ammonia plus organic nitrogen per square mile from Madden Branch. The lowest annual yields of all constituents for both years were from the Apple River.

Double mass-accumulation curves indicate that Madden Branch has the greatest loading of all constituents and the Apple River has the least.

Concentrations of many constituents were very high during periods of runoff. The maximum dissolved-ammonia concentration—12 mg/L during the study period—was measured during spring runoff February 21, 1982, in Pats Creek. The maximum total phosphorus concentration—17 mg/L—was measured during the July 10, 1982, storm at

[8] LC 50 is the lethal concentration when 50 percent of the population dies.

Madden Branch tributary. The maximum suspended-solids concentration, 13,500 mg/L, was measured during spring runoff February 22, 1981, at Madden Branch tributary.

Concentrations of many constituents exceeded State and Federal standards. Concentrations of ammonia nitrogen exceeded the Wisconsin standard at Pats Creek and at Madden Branch. Most phosphorus concentrations during runoff at all sites exceeded U.S. Environmental Protection Agency standards. Concentrations of pesticides of the bed material and water column were well below toxicity levels. Dissolved-oxygen concentrations were less than the minimum State standard on numerous occasions at all sites except Madden Branch tributary.

The most significant finding of the study was that instream dissolved-oxygen sags are associated with storm runoff. Twenty-three dissolved-oxygen sags in Pats Creek, Apple River, and Madden Branch were documented, but most did not reach critical levels. The dissolved-oxygen sags are the result of either sediment or biochemical-oxygen demand. Although the instream dissolved-oxygen levels did not actually get low enough for a long-enough period to kill the fish, the synergistic effects of low dissolved oxygen and moderately high concentrations of other constituents (suspended solids, un-ionized ammonia, pesticides) may be the cause of fishkills.

On July 7, 1982, the dissolved oxygen at Pats Creek dropped to 1.2 mg/L 16 hours after the stream discharge peaked at 84 ft^3/s. Dead fish were found the next day. Biochemical oxygen demand of the water near the peak discharge was 27 mg/L.

Another fishkill was noted at Madden Branch on July 13, 1981. The kill was attributed possibly to low instream dissolved-oxygen levels resulting from manure coming from a feedlot. Subsequent dissolved-oxygen data at this site did show dissolved-oxygen sags occurred during storm runoff.

Both fishkills occurred during July—a month when kills in recent years in other basins have been reported. The cause of these kills seems to be related to dissolved-oxygen sags occurring at a time when stream temperatures are near their maximums.

The data collected in this study suggest that the Madden Branch basin requires the greatest use of best-management practices and the Apple River the least to reduce total solids and nutrient loadings to the streams. However, unless the above practices include a concentrated effort to rid the stream of loadings of highly oxidizable material, specifically manure, the practices may not improve the low instream dissolved-oxygen levels that appear to be a major factor contributing to the degradation of the streams' water quality, and the fishery may not be improved.

A data base that defines the water quality in relation to nonpoint-source discharges has been established in the Galena River basin. The fishkills in this basin appear to be linked to the high oxygen demand of the organics, probably manure. As best-management practices are installed in the basin the streams' water quality is expected to improve. Future streamflow and water-quality monitoring is recommended. Monitoring can show which management practices are most effective in improving the streams' water quality. It may well be that proper management of feedlots and barnyards, which can help prevent manure from entering the stream, may be more effective in improving the streams' water quality than implementation of other best-management practices.

REFERENCES CITED

Conger, D. H., 1971, Estimating magnitude and frequency of floods in Wisconsin: U.S. Geological Survey Open-File Report, 200 p.

____ 1981, Techniques for estimating magnitude and frequency of floods for Wisconsin streams: U.S. Geological Survey Water-Resources Investigations Open-File Report 80-1214, 116 p.

Donigon, A. S., Jr., and Crawford, N. H., 1976, Modeling nonpoint pollution from the land surface: U.S. Environmental Protection Agency, EPA-6003-76-083, 279 p.

Downing, K. M., and Merkens, J. C., 1955, The influence of dissolved oxygen concentrations on the toxicity of unionized ammonia to rainbow trout (*Salmo gairdnerii Richardson*): Ann. Applied Biology 43(2), p. 243-246.

Field, S. J., and Lidwin, R. A., 1982, Water quality assessment of Steiner Branch basin, Lafayette County, Wisconsin: U.S. Geological Survey Water-Resources Investigations 81-52, 58 p.

Guy, H. P., and Norman, V. W., 1970, Field methods for measurement of fluvial sediment: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter C2, 50 p.

Hindall, S. M., 1975, Measurement and prediction of sediment yields in Linsley, R. K. Jr., Kohler, M. A., Paulhus, J. L. H., 1975, Hydrology for engineers (2d ed.): New York, McGraw-Hill Book Company, 482 p.

McElroy, A. D., Chiu, S. Y., Nebgen, J. W., Aleti, A., and Bennett, F. W., 1976, Loading functions for assessment of water pollution from nonpoint sources: Midwest Research Institute, Kansas City, Mo., U.S. Environmental Protection Agency Report EPA-600-2-76-151, 444 p.

Mudrey, M. G., Jr., Brown, B. A., and Greenberg, J. K., 1982, Bedrock geologic map of Wisconsin: Wisconsin Geological and Natural History Survey map, scale 1:1,000,000.

Porterfield, George, 1972, Computation of fluvial-sediment discharge: U.S. Geological Survey Techniques of Water Resources Investigations, Book 3, Chapter C3, 66 p.

Qasim, S. R., Armstrong, A. T., Corn, J., Jordan, B. L., 1980, Quality of water and bottom sediments in the

Trinity River: Water Resources Bulletin, American Water Resources Association, June 1980, v. 16, no. 3.
Schlesser, R., 1982, Wisconsin Department of Natural Resources Fishkill Report—Pats Creek: Wisconsin Department of Natural Resources, July 8, 1982.
Thwaites, F. T., 1958, Outline of glacial geology: Ann Arbor, Michigan, Edward Bros., Inc., 129 p.
U.S. Department of Agriculture, 1981, Estimating your soil-erosion losses with the universal soil loss equation: Madison, Wisconsin, Soil Conservation Service, 17 p.
U.S. Department of Commerce, 1963, Rainfall frequency atlas of the United State: U.S. Department of Commerce, Technical Paper No. 40, 61 p.
_____1979, Climatological data, Wisconsin: U.S. Department of Commerce, v. 84, no. 3, 18 p.
_____1980, Climatological data, Wisconsin: U.S. Department of Commerce, v. 85, no. 13, 14 p.
_____1981, Climatological data, Wisconsin, February: U.S. Department of Commerce, v. 86, no. 2, 18 p.
_____1982, Climatological data, Wisconsin, February: U.S. Department of Commerce, v. 87, no. 2, 30 p.
U.S. Congress, 1972, Federal water pollution control act amendments of 1972, Public Law 92-500, section 208: U.S. 92d Congress, 2d session, p. 25-26.
U.S. Environmental Protection Agency, 1971, Effects of chemicals on aquatic life: Water-quality criteria data book, 100 p.
_____1977 [1978], Quality criteria for water, 1976: U.S. Environmental Protection Agency, Washington, D.C., 256 p.
_____1981, Interdepartmental memorandum, reports and statistics: DNR monthly report of activities, August 1981.
_____1983, Water resources data for Wisconsin, water year 1982: U.S. Geological Survey Water-Data Report WI-82-1, 426 p.
Van Dyke, E. J., 1981, Fishkill, July 13, 1981: Wisconsin Department of Natural Resources memorandum.
Verhoff, F. G., Melfi, D. A., and Yalesick, S. M., 1979, Storm travel distance calculations for total phosphorus and suspended material in rivers: Water Resources Research, v. 15, no. 6, p. 1,354–1,360.
Ward, J. R., and Eckhardt, D. A., 1979, Nonpoint-source discharges in Pequea Creek basin, Pennsylvania, 1977: U.S. Geological Survey Water-Resources Investigations Report 79-88, 110 p.
Watson, B. G., 1966, Soil survey of Lafayette County, Wisconsin: Soil Conservation Service, series 160, no. 27, 137 p.
Wisconsin Department of Agriculture, 1961, Wisconsin climatological data: Madison, Wisconsin Crop Reporting Service Publication, 168 p.
Wisconsin Department of Natural Resources, 1972, Wisconsin lakes: Madison, Wisconsin Department of Natural Resources Publication 218–72, 79 p.
_____1973, Wisconsin administrative code, section DNR 102.02(3)(a): Register, September 1973, no. 213, Environmental Protection.
_____1976, DNR information paper on nonpoint-source pollution: Madison, Wisconsin Department of Natural Resources, 5 p.
_____1979a, Galena River watershed, Grant and Lafayette Counties—Application for rural clean water program: Madison, Wisconsin Department of Natural Resources, 28 p.
_____1979b, The Galena River priority watershed plan: Madison, Wisconsin Department of Natural Resources, 17 p.

Table 7. Statistical summaries of solids and nutrients at the Galena River basin gaging stations

[Concentrations given in milligrams per liter]

Constituent		Madden Branch tributary		Pats Creek		Apple River		Madden Branch	
		Low flow	High flow	Low flow	High flow	Low flow	High flow	Low flow	High flow
Suspended solids	n	72	428	65	587	47	487	44	528
	P_{50}	20	436	17	180	12	184	28.5	214
	x	51.4	1,360	27.2	556	21.8	506	32	769
	S_d	183	2,230	31.9	1,060	26.1	910	18	1,380
	Min	2	2	4	2	2	4	4	8
	Max	1,570	18,000	192	7,230	152	9,580	8,560	98
Volatile solids	n	10	152	9	198	9	161	8	184
	P_{50}	5.0	51	3.0	28	2	34	2.5	36
	x	4.8	129	3.7	70	3	74	3	85
	S_d	1.7	198	1.6	109	2	114	3	123
	Min	2.00	0	2.00	0	1.00	0	0	0
	Max	8.00	1,460	6.00	650	7.00	825	9.00	660
$NO_2 + NO_3$ nitrogen	n	11	153	10	200	11	159	10	189
	P_{50}	6.70	4.2	7.4	4.1	11	6.0	7.4	4.6
	x	6.17	47	7.2	4.3	10	6.3	7.4	4.9
	S_d	2.05	2.4	1.0	2.10	1.2	2.6	1.0	2.2
	Min	.90	1.20	5.50	1.00	8.20	1.10	5.90	.50
	Max	8.10	15.0	8.80	16.0	12.0	16.0	8.90	15.0
Ammonia nitrogen	n	10	164	10	209	11	163	10	193
	P_{50}	.04	.32	.04	.34	.05	.2	.1	.52
	x	.06	.75	.08	1.1	.13	.38	.10	.90
	S_d	.05	.87	.09	1.6	.23	.42	.06	.89
	Min	.02	.02	.02	.02	.02	.02	.02	.02
	Max	.17	3.50	.31	12.0	.80	2.10	.20	3.70
Ammonia plus organic nitrogen	n	7	165	9	208	8	164	6	194
	P_{50}	.60	4.6	.4	3.35	.4	2.90	.65	4.2
	x	.64	6.9	.42	5.8	.53	4.3	.68	6.0
	S_d	.20	7.3	.15	5.8	.18	4.3	.98	5.5
	Min	.30	.36	.038	.35	.30	.30	.20	.42
	Max	.78	47.8	.58	27.0	1.60	25.0	.70	26.0
Total phosphorus	n	10	166	10	209	11	163	10	194
	P_{50}	.06	1.1	.06	.86	.06	.7	.10	.95
	x	.07	1.8	.07	1.4	.07	1.18	.10	1.6
	S_d	.02	2.3	.02	1.5	.03	1.4	.03	1.7
	Min	.04	.05	.04	.10	.03	.04	.04	.09
	Max	.10	17.0	.10	9.00	.12	8.70	.16	8.50
Dissolved phosphorus	n	6	33	6	61	7	58	8	59
	P_{50}	.03	1.36	.03	.35	.02	.02	.04	.26
	x	.01	.33	.03	.42	.03	.24	.04	.40
	S_d	.03	.33	.01	.29	.01	.14	.02	.34
	Min	.015	.012	.010	.023	.009	.021	.120	.027
	Max	.041	1.02	.047	1.02	.044	.69	.067	1.81

n = number of samples used
P_{50} = median
x = mean
S_d = standard deviation

Table 8. Suspended-solids loads for Madden Branch tributary near Belmont, 1981 and 1982 water years

SOLIDS, RESIDUE AT 105 DEG. C, SUSPENDED (TONS PER DAY), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.32	.47	.20	.18	.06	.05	.06	.05	.22	.20	.07	8.20
2	.28	.42	.19	.18	.08	.05	.08	.04	.21	.20	.08	.16
3	.28	.47	.18	.18	.06	.04	.06	.04	.21	.20	.07	.11
4	.24	.40	.19	.14	.05	.04	.07	.05	.21	.20	.07	.09
5	.24	.35	.20	.13	.06	.04	.04	.05	.20	.20	.07	.07
6	.24	.28	.52	.12	.06	.04	.04	.08	.20	.19	.08	.08
7	.21	.28	.63	.10	.06	.04	.04	.07	.20	.17	.60	.07
8	.21	.28	.50	.10	.06	.03	.18	.07	.28	.17	.25	.06
9	.21	.28	.36	.09	.05	.03	.11	.07	.38	.16	.12	.05
10	.24	.27	.30	.07	.05	.03	.09	.10	.46	.15	.09	.04
11	.21	.27	.28	.07	.05	.03	.08	.13	.47	.14	.08	.04
12	.21	.26	.28	.06	.05	.03	.72	.17	.42	.14	.06	.04
13	.21	.27	.25	.06	.05	.03	1.50	.18	1.40	.52	.05	.04
14	.24	.28	.24	.09	.05	.03	2.50	.13	.90	.15	.08	.04
15	.76	.28	.22	.09	.08	.04	.53	.10	21.00	.45	.05	.04
16	.47	.26	.21	.09	1.20	.05	.11	.08	.30	.24	.04	.04
17	.32	.28	.19	.07	.13	.07	.09	.07	.14	.20	.04	.04
18	.24	.25	.18	.07	.09	.08	.07	.07	.13	.13	.05	.04
19	.21	.30	.17	.06	.07	.07	.06	.11	.12	.10	.05	.04
20	.18	.24	.15	.05	.08	.07	.05	.13	.11	.10	.05	.04
21	.28	.24	.14	.06	.08	.06	.04	.16	11.00	.08	.08	.06
22	.24	.24	.18	.06	534	.06	.05	.20	.92	.08	.07	.08
23	.52	.25	.17	.05	2.80	.05	.04	.24	.21	.08	.08	.11
24	.58	.23	.18	.05	.22	.05	.03	.25	1.80	.08	.06	.15
25	.63	.21	.17	.08	.12	.05	.04	.25	.23	.09	.32	1.10
28	.52	.22	.17	.05	.07	.04	.05	.25	.19	.10	.96	2.20
27	.47	.22	.17	.08	.15	.04	.08	.24	.19	.10	.45	.88
28	.42	.22	.19	.08	.11	.04	.16	.24	.19	.11	.23	.22
29	.37	.22	.19	.08	---	.12	.10	.23	.19	.11	.23	.49
30	.32	.21	.19	.06	---	.23	.08	.23	.19	.08	.20	.18
31	.37	---	.18	.06	---	.09	---	.22	---	.07	.88	---
TOTAL	10.24	8.43	7.35	2.83	539.95	1.72	7.13	4.26	42.45	4.99	5.37	14.58

WATER YEAR 1981 TOTAL 849.10

SOLIDS, RESIDUE AT 105 DEG. C, SUSPENDED (TONS PER DAY), WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.08	.04	.13	.03	.02	.08	.05	.02	.40	.15	.14	.08
2	.08	.04	.11	.04	.03	.07	.05	.02	.29	.15	.15	.07
3	.05	.04	.08	.04	.03	.06	1.80	.02	.18	.24	.13	.07
4	.05	.04	.07	.04	.03	.05	.05	.02	.17	.12	93.00	.07
5	.17	.04	.06	.04	.03	.05	.03	.42	.17	.08	.27	.06
6	.47	.04	.08	.03	.03	.04	.03	.03	.17	3.40	.16	.06
7	.04	.04	.05	.03	.03	.04	.03	.02	.17	5.80	.11	.08
8	.03	.05	.05	.03	.03	.06	.04	.08	.17	.20	.11	.12
9	.02	.04	.05	.03	.03	.11	.05	.15	.17	.14	.10	.11
10	.02	.04	.04	.03	.03	.18	.06	.13	.17	1140	.09	.10
11	.02	.04	.04	.03	.03	.40	.07	.10	.18	.82	.09	.08
12	.02	.04	.04	.03	.03	117	.10	.08	.18	.27	.09	.08
13	.02	.04	.04	.03	.03	246	.11	.06	.17	.24	.09	.08
14	.29	.04	.04	.03	.03	17.00	.10	.08	.17	.17	.09	.08
15	.10	.04	.04	.03	.03	.53	.12	.08	1.20	31.00	.09	.07
16	.05	.13	.04	.03	.04	190	.14	.07	.10	1.60	.08	.07
17	.63	.11	.04	.03	.04	.23	.13	.07	.13	.31	.08	.06
18	.16	.09	.04	.03	.04	.15	.12	.08	.18	.21	.07	.05
19	.09	.08	.05	.03	.06	.37	.09	.10	.17	.21	.07	.05
20	.09	.07	.05	.03	.09	157	.06	.08	.17	.20	.07	.05
21	.10	.06	.05	.03	1.20	1.10	.04	.10	.17	.20	.07	.05
22	.09	.05	.05	.03	30.00	.49	.03	.47	.17	.21	.07	.05
23	.08	.05	.05	.03	11.00	.27	.02	.11	.17	.21	.08	.05
24	.06	.08	.04	.02	1.30	.16	.02	.12	.17	.20	.08	.05
25	.06	.07	.04	.02	.20	.09	.01	.14	.18	.20	.08	.05
28	.05	1.40	.03	.02	.14	.11	.01	2.80	.18	.20	.07	.05
27	.05	.33	.03	.03	.09	.18	.01	1.80	.17	.23	.08	.05
28	.05	.15	.03	.03	.09	.24	.01	.82	.17	.23	.05	.05
29	.04	.14	.03	.03	---	.36	.02	3.90	.17	.21	.04	.05
30	.04	.13	.03	.02	---	.56	.02	.37	.16	.21	.04	.05
31	.04	---	.03	.02	---	.08	---	.26	---	.17	.07	---
TOTAL	3.10	3.53	1.53	0.92	44.73	733.04	3.42	12.56	6.40	1187.58	95.79	1.97

WATER YEAR 1982 TOTAL 2094.57

Table 9. Volatile solids loads for Madden Branch tributary near Belmont, 1981 and 1982 water years

RESIDUE, VOLATILE NONFILTERABLE (TONS/DAY), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.03	.05	.03	.02	.01	.01	.01	.03	.02	.03	.01	.99
2	.03	.05	.02	.02	.01	.01	.01	.02	.02	.03	.02	.10
3	.03	.05	.02	.02	.01	.01	.01	.02	.02	.03	.02	.04
4	.02	.05	.03	.02	.01	.01	.01	.02	.02	.02	.01	.03
5	.02	.05	.03	.02	.01	.01	.01	.02	.02	.02	.01	.03
6	.02	.04	.03	.02	.01	.01	.01	.03	.02	.02	.01	.03
7	.02	.04	.04	.02	.01	.01	.01	.03	.02	.02	.10	.03
8	.02	.04	.03	.02	.01	.01	.05	.03	.02	.02	.03	.03
9	.02	.04	.03	.02	.01	.01	.03	.03	.03	.02	.03	.02
10	.02	.04	.02	.02	.01	.01	.03	.03	.03	.02	.02	.02
11	.02	.03	.02	.02	.01	.01	.03	.03	.03	.02	.02	.02
12	.02	.03	.02	.01	.01	.01	.08	.03	.03	.01	.02	.02
13	.02	.03	.02	.01	.01	.01	.12	.03	.03	.21	.02	.02
14	.02	.03	.02	.01	.01	.01	.16	.03	.03	.04	.03	.02
15	.07	.03	.02	.01	.01	.01	.08	.03	2.30	.07	.03	.02
16	.04	.03	.02	.01	.13	.01	.02	.03	.03	.04	.02	.02
17	.03	.03	.02	.01	.04	.01	.01	.03	.02	.04	.02	.01
18	.03	.03	.02	.01	.03	.01	.01	.02	.02	.03	.02	.01
19	.02	.03	.02	.01	.02	.01	.01	.03	.02	.03	.02	.01
20	.02	.03	.02	.01	.01	.01	.01	.03	.02	.03	.02	.01
21	.02	.03	.02	.01	.01	.01	.01	.03	1.20	.02	.02	.01
22	.02	.03	.02	.01	34.00	.01	.01	.03	.15	.02	.01	.01
23	.04	.03	.02	.01	.31	.01	.01	.03	.03	.02	.01	.01
24	.04	.03	.02	.01	.03	.01	.01	.03	.24	.02	.01	.01
25	.04	.03	.02	.01	.02	.01	.01	.03	.04	.02	.05	.16
26	.04	.03	.02	.01	.01	.01	.01	.03	.03	.02	.15	.30
27	.04	.03	.02	.01	.02	.01	.01	.03	.03	.02	.08	.11
28	.04	.03	.02	.01	.02	.01	.02	.03	.03	.02	.05	.09
29	.04	.03	.02	.01	---	.03	.03	.02	.03	.02	.05	.19
30	.04	.03	.02	.01	---	.04	.03	.02	.03	.01	.04	.02
31	.04	---	.02	.01	---	.02	---	.02	---	.01	.11	---
TOTAL	0.92	1.05	0.70	0.42	34.80	0.37	0.84	0.85	4.56	0.95	1.06	2.39

WATER YEAR 1981 TOTAL 48.91

RESIDUE, VOLATILE NONFILTERABLE (TONS/DAY), WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.01	.03	.03	.01	.01	.08	.01	.01	.10	.01	.06	.03
2	.01	.03	.03	.01	.01	.07	.01	.01	.09	.01	.05	.03
3	.01	.03	.02	.01	.01	.06	.31	.01	.08	.04	.05	.03
4	.01	.03	.02	.01	.01	.06	.02	.01	.07	.03	14.00	.03
5	.02	.03	.02	.01	.01	.05	.02	.06	.07	.03	.11	.02
6	.06	.03	.02	.01	.01	.04	.02	.01	.06	.46	.09	.02
7	.02	.03	.02	.01	.01	.04	.01	.01	.06	1.10	.08	.02
8	.02	.03	.02	.01	.01	.04	.01	.01	.05	.08	.07	.02
9	.01	.04	.02	.01	.01	.04	.01	.01	.05	.04	.06	.02
10	.01	.04	.02	.01	.01	.04	.01	.01	.05	112	.05	.02
11	.01	.04	.01	.01	.01	.05	.02	.01	.05	.25	.05	.02
12	.01	.04	.01	.01	.01	8.40	.02	.01	.05	.04	.05	.02
13	.01	.04	.01	.01	.01	13.00	.02	.01	.05	.04	.04	.02
14	.03	.04	.01	.01	.01	1.40	.02	.01	.04	.10	.04	.02
15	.01	.04	.01	.01	.01	.06	.02	.01	.04	5.60	.04	.02
16	.01	.04	.01	.01	.01	18.00	.02	.01	.24	.47	.04	.02
17	.08	.04	.01	.01	.01	.05	.01	.01	.02	.08	.03	.02
18	.05	.04	.01	.01	.01	.04	.01	.01	.02	.06	.03	.02
19	.03	.04	.01	.01	.01	.19	.01	.01	.02	.06	.03	.02
20	.02	.04	.01	.01	.01	8.90	.01	.01	.02	.06	.02	.01
21	.02	.03	.01	.01	.34	.20	.01	.01	.01	.06	.02	.01
22	.02	.02	.01	.01	3.00	.12	.01	.01	.01	.06	.02	.01
23	.02	.02	.01	.01	1.50	.02	.01	.01	.01	.08	.02	.01
24	.02	.03	.01	.01	.36	.03	.01	.01	.01	.05	.02	.01
25	.02	.03	.01	.01	.12	.03	.01	.01	.01	.05	.02	.01
26	.02	.12	.01	.01	.11	.03	.01	.46	.01	.05	.01	.01
27	.02	.05	.01	.01	.09	.04	.01	.32	.01	.06	.01	.01
28	.02	.03	.01	.01	.10	.04	.01	.14	.01	.06	.01	.01
29	.02	.03	.01	.01	---	.05	.01	.72	.01	.06	.01	.01
30	.02	.03	.01	.01	---	.07	.01	.11	.01	.08	.01	.01
31	.02	---	.01	.01	---	.02	---	.08	---	.05	.02	---
TOTAL	0.66	1.11	0.43	0.31	5.92	49.26	0.69	2.13	1.33	121.18	15.16	0.53

WATER YEAR 1982 TOTAL 198.71

Table 10. Kjeldahl nitrogen loads for Madden Branch tributary near Belmont, 1981 and 1982 water years

NITROGEN, AMMONIA PLUS ORGANIC, TOTAL (POUNDS/DAY), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	4.9	4.9	3.2	2.3	1.6	4.6	4.4	6.4	6.2	6.4	3.1	274
2	4.5	4.6	2.8	2.3	1.5	4.3	4.3	5.9	6.1	6.2	4.4	14.0
3	4.5	4.9	3.0	2.3	1.5	4.1	4.3	5.6	6.0	6.0	4.1	8.6
4	4.2	4.9	3.3	2.1	1.5	4.0	5.5	6.0	5.9	5.8	4.4	7.0
5	4.2	4.9	3.3	2.1	1.5	4.1	3.9	5.9	5.8	5.7	4.6	6.7
6	4.2	4.6	4.3	2.1	1.5	3.8	3.6	7.0	5.7	5.0	5.2	6.1
7	3.9	4.6	4.8	2.1	1.4	3.7	3.6	7.0	5.7	4.6	14.0	10.0
8	3.9	4.6	4.3	2.0	1.4	3.7	10.0	6.7	5.9	4.4	8.8	10.0
9	4.2	4.6	3.5	2.0	1.3	3.6	5.6	6.8	10.0	4.3	4.6	5.7
10	3.9	4.3	3.1	1.9	1.3	3.7	4.7	6.7	15.0	3.8	4.5	5.2
11	3.9	4.3	3.0	1.9	1.3	3.9	4.7	6.6	15.0	3.7	4.4	5.1
12	3.9	4.1	3.1	1.9	1.3	3.7	19.0	6.6	10.0	3.6	4.4	5.1
13	3.9	4.3	2.9	1.9	1.4	3.8	33.0	6.8	17.0	12.0	4.3	5.0
14	4.2	4.3	2.9	1.9	1.4	3.9	50.0	6.9	12.0	7.3	10.0	4.9
15	17.0	4.3	2.8	1.6	1.9	4.1	15.0	6.6	262	10.0	10.0	4.8
16	9.0	4.1	2.9	2.0	36.0	4.1	7.0	6.6	16.0	13.0	5.9	4.6
17	4.9	4.1	2.7	1.9	9.0	4.4	6.7	6.5	9.2	12.0	4.4	3.8
18	4.2	3.8	2.7	1.8	4.7	3.9	6.1	6.0	6.5	9.6	4.0	3.7
19	3.9	3.4	2.7	1.8	1.4	3.7	6.0	6.7	7.8	6.9	3.6	3.7
20	3.6	3.1	2.5	1.8	1.4	3.9	5.4	6.8	7.1	10.0	3.1	3.6
21	4.5	3.2	2.3	2.1	1.4	4.2	4.5	6.7	110	7.3	3.0	3.5
22	4.2	3.2	2.4	2.1	4100	4.2	5.1	6.6	28.0	6.5	3.0	3.5
23	10.0	3.4	2.5	2.1	80.0	4.3	4.9	6.6	12.0	6.2	2.9	3.4
24	12.0	3.1	2.5	2.1	8.7	4.2	4.0	6.9	23.0	5.5	2.9	3.4
25	13.0	2.9	2.3	2.3	5.9	4.1	4.2	6.8	11.0	5.4	5.9	28.0
26	5.1	3.0	2.2	2.0	4.3	4.0	4.0	6.7	7.2	5.1	25.0	61.0
27	4.9	3.2	2.0	2.0	8.2	4.0	3.7	6.6	7.1	4.7	10.0	17.0
28	4.6	3.2	2.4	2.0	8.3	3.9	11.0	6.5	7.0	4.4	8.9	12.0
29	4.3	3.2	2.3	1.8	---	5.3	6.5	6.4	6.8	4.6	9.4	35.0
30	4.1	3.2	2.4	1.8	---	6.4	7.6	6.3	6.6	3.5	6.2	19.0
31	4.3	---	2.3	1.6	---	4.9	---	6.3	---	3.3	17.0	---
TOTAL	171.9	118.3	69.4	61.8	4291.1	126.5	256.5	202.9	655.6	199.0	206.0	577.6

WATER YEAR 1981 TOTAL 6962.6

NITROGEN, AMMONIA PLUS ORGANIC, TOTAL (POUNDS/DAY), WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	4.1	3.8	5.5	3.1	1.9	17.0	7.3	3.2	14.0	6.3	11.0	10.0
2	3.7	3.8	5.4	3.1	1.9	15.0	6.2	3.1	12.0	7.3	13.0	9.4
3	3.5	3.8	4.4	3.2	1.9	13.0	63.0	2.9	10.0	9.6	13.0	10.0
4	3.5	3.8	4.1	3.1	1.9	12.0	6.7	3.0	6.9	5.7	926	11.0
5	8.5	4.0	3.9	3.4	1.9	12.0	3.4	34.0	8.3	6.3	58.0	9.8
6	14.0	4.0	4.0	3.2	1.9	9.6	3.1	14.0	7.6	30.0	49.0	11.0
7	3.4	4.0	4.0	3.1	1.9	9.0	2.9	9.4	7.1	161	39.0	12.0
8	2.1	3.9	4.0	3.1	1.9	8.6	3.1	9.2	6.5	51.0	33.0	12.0
9	1.9	3.9	3.9	3.1	1.9	7.7	3.3	9.3	6.0	35.0	27.0	11.0
10	1.9	3.9	3.9	2.9	1.9	7.2	3.5	9.3	5.6	7550	23.0	11.0
11	1.9	3.9	3.7	2.9	1.9	7.5	7.0	9.7	6.7	53.0	19.0	10.0
12	1.9	3.8	3.6	2.9	1.9	1930	19.0	9.6	10.0	17.0	17.0	10.0
13	2.1	3.8	3.5	2.9	2.0	2920	23.0	9.5	8.8	13.0	15.0	10.0
14	16.0	3.8	3.4	2.7	2.1	364	13.0	9.2	7.8	6.8	14.0	9.1
15	7.9	3.9	3.3	2.6	2.1	40.0	19.0	9.1	45.0	430	12.0	8.7
16	5.6	5.8	3.4	2.5	2.3	2110	27.0	8.7	4.7	85.0	10.0	8.7
17	25.0	8.5	3.1	2.4	2.6	31.0	16.0	8.8	4.7	15.0	8.5	8.7
18	15.0	9.7	3.2	2.3	2.7	20.0	11.0	9.1	4.7	8.9	7.6	6.3
19	7.4	9.8	3.2	2.3	3.4	48.0	4.1	10.0	4.7	8.5	7.4	7.1
20	5.0	9.9	3.5	2.3	4.9	1400	4.0	6.8	4.7	7.8	7.4	7.1
21	5.1	8.5	3.5	2.3	85.0	23.0	3.6	9.7	4.7	7.4	8.0	7.1
22	5.1	7.8	3.6	2.4	783	17.0	3.8	16.0	4.7	7.2	9.5	6.8
23	4.9	8.4	3.6	2.2	618	15.0	3.6	9.4	4.7	6.7	15.0	6.6
24	4.1	11.0	3.7	2.3	133	13.0	3.7	9.0	4.7	6.2	14.0	5.7
25	4.0	12.0	3.7	2.1	44.0	11.0	3.7	9.1	5.1	5.8	18.0	5.7
26	4.0	47.0	3.5	2.0	28.0	8.5	3.7	47.0	5.6	5.5	8.7	5.1
27	4.0	14.0	3.5	2.0	20.0	7.2	3.4	40.0	5.6	14.0	8.5	5.1
28	4.0	5.4	3.1	2.0	18.0	7.2	3.2	30.0	5.9	14.0	8.0	5.1
29	3.9	4.6	3.3	2.0	---	7.2	3.2	69.0	6.3	12.0	16.0	5.1
30	3.9	4.6	3.3	2.0	---	19.0	3.2	25.0	6.3	15.0	34.0	4.5
31	3.9	---	3.0	2.0	---	9.2	---	19.0	---	12.0	8.9	---
TOTAL	181.3	225.5	114.8	80.4	1773.9	9118.9	281.1	473.1	241.4	6635.0	1460.5	251.9

WATER YEAR 1982 TOTAL 22,837.8

Table 11. Total phosphorus loads for Madden Branch tributary near Belmont, 1981 and 1982 water years

PHOSPHORUS, TOTAL, POUNDS PER DAY, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.81	.97	.54	.52	.28	.63	.28	.99	.76	1.05	.50	22.00
2	.76	.83	.49	.52	.27	.56	.28	.87	.78	1.02	.88	1.40
3	.76	.87	.51	.52	.27	.50	.29	.81	.78	.98	.58	1.08
4	.70	.87	.53	.47	.27	.47	2.20	.81	.76	.95	.58	.99
5	.70	.87	.58	.47	.28	.46	1.10	.77	.76	.92	.54	.94
6	.70	.83	.75	.47	.28	.41	.27	.88	.76	.82	.55	.86
7	.85	.83	.85	.47	.23	.34	.28	.83	.76	.74	2.10	1.08
8	.65	.83	.76	.46	.22	.36	3.10	.77	.81	.71	1.90	1.01
9	.70	.83	.63	.46	.22	.33	2.00	.75	.96	.89	1.47	.80
10	.65	.89	.56	.48	.22	.32	.72	.71	1.25	.61	1.32	.73
11	.85	.69	.54	.46	.22	.30	.72	.68	1.41	.59	1.20	.72
12	.65	.85	.56	.46	.22	.30	4.70	.84	1.39	.57	1.09	.70
13	.85	.69	.53	.46	.23	.29	7.00	.64	1.87	9.20	.99	.69
14	.70	.89	.54	.45	.24	.28	9.30	.66	1.83	1.45	1.24	.88
15	3.90	.69	.53	.43	.95	.29	4.00	.68	69.00	1.36	1.08	.67
16	2.40	.85	.54	.48	7.40	.27	1.50	.65	3.58	1.35	.82	.83
17	.81	.65	.51	.46	2.80	.27	.81	.65	1.77	1.24	.73	.52
18	.70	.80	.52	.45	1.80	.23	.81	.81	1.38	1.03	.81	.51
19	.65	.54	.52	.40	1.04	.21	.85	.89	1.07	.96	.52	.50
20	.59	.50	.49	.39	.71	.21	.82	.71	.83	1.16	.41	.49
21	.78	.51	.49	.48	.89	.22	.74	.71	30.00	.84	.37	.48
22	.70	.52	.48	.48	1050	.21	.91	.71	3.40	.77	.33	.47
23	1.03	.55	.51	.48	16.00	.20	.95	.71	.97	.75	.30	.46
24	3.00	.52	.50	.48	2.55	.20	.84	.76	10.00	.69	.27	.46
25	3.30	.48	.49	.52	1.63	.21	.94	.78	1.67	.70	1.00	3.60
28	1.03	.50	.46	.42	1.11	.21	.98	.78	1.22	.68	3.30	6.80
27	.97	.53	.46	.42	1.13	.21	.96	.76	1.19	.65	1.24	2.40
28	.92	.53	.50	.42	.91	.22	1.32	.76	1.16	.62	1.40	1.90
29	.86	.54	.50	.38	---	1.80	1.08	.78	1.12	.87	1.39	4.30
30	.81	.54	.52	.36	---	2.50	1.24	.76	1.09	.53	.61	2.70
31	.88	---	.51	.35	---	1.50	---	.78	---	.52	2.40	---
TOTAL	33.02	19.99	18.90	14.05	1092.17	14.51	50.97	22.99	144.27	34.82	31.50	60.57

WATER YEAR 1981 TOTAL 1535.78

PHOSPHORUS, TOTAL, POUNDS PER DAY, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.77	.92	1.32	.40	.27	1.01	1.17	1.05	2.06	.77	1.27	1.56
2	.71	.94	1.25	.39	.26	.94	.99	1.02	1.82	.85	1.27	1.41
3	.67	.97	1.00	.39	.28	.90	16.00	.95	1.87	1.75	1.28	1.31
4	.86	.99	.92	.38	.25	.85	2.70	.94	1.53	1.13	312	1.41
5	1.89	1.09	.86	.41	.25	.89	1.62	4.21	1.46	.89	13.00	1.12
6	3.61	1.11	.85	.37	.23	.81	1.44	2.11	1.40	55.00	10.00	1.12
7	.95	1.14	.84	.36	.23	.82	1.33	1.62	1.34	60.00	7.51	1.17
8	.71	1.17	.84	.37	.23	.84	1.40	1.47	1.28	14.00	5.89	1.17
9	.84	1.19	.80	.37	.22	.81	1.47	1.43	1.23	5.96	4.46	1.12
10	.63	1.22	.78	.38	.22	.82	1.56	1.40	1.18	2470	3.64	1.12
11	.82	1.25	.72	.37	.22	4.08	1.78	1.42	1.18	19.00	2.96	1.04
12	.62	1.28	.68	.36	.21	381	2.16	1.36	1.19	3.21	2.48	.91
13	.88	1.31	.66	.36	.21	689	2.15	1.30	1.18	2.27	2.08	.91
14	4.72	1.34	.63	.34	.22	97.00	1.85	1.22	1.14	1.81	1.75	.91
15	1.26	1.40	.80	.33	.22	15.00	5.80	1.18	9.28	130	1.47	.87
16	.98	1.85	.58	.32	.22	450	2.09	1.09	1.21	27.00	1.15	.87
17	5.77	1.75	.54	.32	.24	5.24	1.83	1.07	1.09	3.69	.91	.87
18	2.20	1.89	.54	.32	.24	4.90	1.63	1.08	1.04	2.63	.77	.83
19	1.21	1.95	.53	.31	.27	18.00	1.60	1.20	1.00	2.47	.76	.71
20	.96	2.00	.57	.31	1.30	246	1.52	.98	.98	2.23	.77	.71
21	.88	1.74	.56	.32	21.00	14.00	1.48	.99	.91	2.10	.85	.71
22	.90	1.64	.56	.33	158	3.77	1.42	1.31	.88	2.00	.93	.68
23	.91	1.79	.56	.32	127	3.52	1.39	.96	.84	1.80	1.03	.68
24	.77	2.36	.55	.32	22.00	3.47	1.36	.89	.80	1.89	1.04	.68
25	.79	2.55	.55	.30	3.02	2.98	1.33	.87	.83	1.49	1.10	.68
26	.81	4.52	.50	.30	1.07	2.56	1.30	20.00	.87	1.45	1.00	.82
27	.82	2.81	.50	.30	.97	2.40	1.18	11.00	.83	1.54	1.01	.51
28	.84	1.34	.44	.31	.99	2.43	1.12	5.61	.83	1.46	.96	.51
29	.86	1.18	.45	.30	---	2.43	1.10	15.00	.85	1.44	5.33	.51
30	.88	1.17	.44	.29	---	3.26	1.07	5.77	.81	1.53	6.71	.57
31	.90	---	.39	.28	---	1.51	---	2.31	---	1.31	1.40	---
TOTAL	39.38	47.86	21.02	10.51	339.62	1961.24	64.60	92.81	42.65	2822.47	396.78	27.29

WATER YEAR 1982 TOTAL 5866.43

Table 12. Suspended-solids loads for Pats Creek near Belmont, 1981 and 1982 water years

SOLIDS, RESIDUE AT 105 DEG. C, SUSPENDED (TONS PER DAY), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.35	.36	.40	.20	.06	.15	.07	.06	.19	.09	.18	5.40
2	.35	.36	.35	.19	.07	.12	.07	.05	.16	.06	.34	.40
3	.30	.35	.37	.17	.09	.11	.08	.06	.20	.07	.23	.33
4	.28	.34	.37	.16	.12	.09	.14	.06	.18	.06	.14	.27
5	.26	.33	.39	.14	.13	.08	.10	.06	.16	.12	.13	.24
6	.26	.33	.46	.13	.13	.07	.09	.06	.15	.16	.12	.20
7	.24	.34	.53	.12	.14	.06	.10	.06	.14	.15	.76	.21
8	.26	.34	.49	.11	.15	.06	.58	.07	.13	.13	.42	.20
9	.26	.35	.44	.10	.14	.05	.40	.06	.15	.14	.11	.15
10	.24	.35	.41	.09	.15	.05	.12	.09	.13	.12	.07	.12
11	.22	.35	.40	.06	.16	.05	.24	.09	.12	.12	.07	.10
12	.22	.36	.41	.06	.17	.05	.59	.09	.10	.12	.06	.09
13	.22	.38	.41	.07	.16	.05	.74	.09	.22	.43	.06	.06
14	.26	.45	.40	.04	.20	.05	.74	.09	.19	.16	.09	.07
15	1.70	.42	.39	.04	.20	.06	.16	.08	9.70	.70	.08	.07
16	1.20	.40	.40	.05	2.40	.06	.12	.07	.44	.16	.06	.06
17	.40	.41	.42	.05	1.60	.12	.09	.07	.30	.11	.06	.08
18	.28	.42	.41	.05	.60	.15	.06	.07	.26	.11	.06	.08
19	.22	.42	.42	.04	.26	.13	.06	.07	.22	.11	.06	.09
20	.20	.43	.40	.03	.19	.11	.05	.07	.22	.16	.06	.09
21	.32	.43	.37	.02	.14	.09	.04	.07	3.23	.13	.06	.12
22	.26	.43	.35	.02	974	.07	.05	.07	.75	.12	.06	.14
23	.35	.47	.34	.02	6.60	.06	.04	.08	.17	.12	.07	.17
24	.63	.44	.29	.01	.49	.06	.04	.10	1.37	.13	.10	.25
25	.54	.41	.26	.02	.21	.06	.03	.10	.27	.13	.15	.77
26	.42	.42	.24	.02	.10	.06	.03	.12	.15	.12	.50	1.20
27	.40	.43	.23	.02	.97	.06	.03	.13	.12	.12	.37	.28
28	.37	.43	.24	.02	.92	.06	.71	.14	.12	.14	1.20	.23
29	.38	.42	.23	.03	---	.07	.14	.17	.11	.14	1.00	.51
30	.36	.41	.22	.04	---	.09	.11	.20	.10	.15	.39	.22
31	.38	---	.21	.04	---	.07	---	.20	---	.15	---	---
TOTAL	12.17	11.78	11.27	2.20	990.57	2.44	5.82	2.82	19.77	4.77	7.06	12.24

WATER YEAR 1981 TOTAL 1062.93

SOLIDS, RESIDUE AT 105 DEG. C, SUSPENDED (TONS PER DAY), WATER YEAR OCTOBER 1961 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.21	.07	.16	.05	.02	.10	.10	.05	.56	.32	.06	.36
2	.18	.06	.11	.06	.02	.09	.29	.05	.53	.43	.06	.29
3	.17	.06	.09	.07	.02	.08	11.00	.05	.50	.84	.05	.28
4	.14	.09	.06	.10	.02	.06	2.50	.04	.43	.13	161	.31
5	.12	.09	.07	.14	.02	.06	1.10	.79	.35	.11	4.80	.27
6	.22	.10	.07	.13	.02	.05	.80	.22	.30	3.10	.62	.23
7	.08	.11	.06	.14	.03	.05	.70	.10	.26	24.00	.54	.21
8	.08	.11	.06	.13	.03	.04	.09	.06	.23	.45	.52	.16
9	.07	.11	.06	.12	.03	.04	.09	.07	.19	.23	.53	.18
10	.07	.10	.06	.12	.03	.04	.09	.09	.16	221	.52	.24
11	.06	.10	.05	.11	.04	.13	.10	.12	.14	2.00	.52	.28
12	.06	.09	.07	.11	.04	236	.14	.16	.13	.36	.50	.30
13	.05	.09	.29	.11	.04	353	.13	.21	.11	.79	.52	.31
14	.66	.09	.30	.11	.05	23.00	.13	.25	.09	1.50	.52	.30
15	.18	.09	.26	.10	.05	2.50	.16	.29	1.10	27.00	.54	.30
16	.10	.10	.22	.11	.06	340	.23	.23	.17	9.00	.53	.26
17	5.90	.09	.20	.10	.06	.58	.18	.17	.14	.71	.54	.29
18	.69	.06	.17	.10	.05	.51	.17	.20	.29	.54	.51	.27
19	.32	.08	.17	.10	.05	1.70	.15	1.30	.33	.42	.45	.25
20	.24	.07	.16	.09	.09	110	.13	.21	.34	.35	.44	.23
21	.20	.06	.14	.09	2.20	1.20	.10	.66	.34	.30	.39	.21
22	.18	.05	.11	.09	18.00	.58	.09	.22	.34	.28	.42	.19
23	.16	.05	.08	.08	26.00	.55	.08	.19	.35	.23	.48	.18
24	.14	.05	.05	.08	2.10	.60	.07	.16	.36	.21	.44	.17
25	.13	.05	.04	.07	.56	.10	.06	.15	.39	.18	.42	.16
26	.11	2.50	.03	.07	.21	.08	.06	.70	.42	.15	.33	.14
27	.10	.22	.02	.07	.13	.06	.06	1.70	.39	.15	.31	.13
28	.09	.13	.03	.06	.11	.06	.06	1.30	.37	.12	.26	.11
29	.08	.12	.03	.03	---	.05	.05	1.10	.37	.10	1.10	.10
30	.07	.11	.04	.02	---	2.20	.06	.75	.36	.10	4.00	.08
31	.07	---	.04	.02	---	.13	---	.62	---	.07	.34	---
TOTAL	10.93	5.16	3.32	2.78	50.08	1075.64	16.97	12.23	10.04	295.17	182.26	6.61

WATER YEAR 1982 TOTAL 1673.39

Table 13. Volatile solids loads for Pats Creek near Belmont, 1981 and 1982 water years

RESIDUE, VOLATILE NONFILTERABLE (TONS/DAY), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.08	.08	.07	.03	.02	.05	.02	.05	.04	.03	.05	1.30
2	.08	.08	.06	.03	.02	.04	.02	.05	.04	.03	.10	.09
3	.06	.08	.07	.03	.02	.04	.02	.05	.04	.02	.09	.06
4	.06	.08	.07	.03	.03	.04	.04	.05	.04	.02	.09	.05
5	.05	.08	.08	.03	.03	.03	.03	.05	.04	.02	.10	.05
6	.05	.08	.09	.02	.03	.03	.03	.04	.04	.02	.12	.05
7	.04	.08	.11	.02	.03	.03	.03	.04	.04	.02	.20	.07
8	.05	.07	.10	.02	.04	.03	.07	.04	.04	.02	.16	.06
9	.04	.07	.08	.02	.04	.03	.06	.04	.05	.02	.12	.06
10	.04	.07	.08	.02	.04	.03	.05	.05	.04	.01	.11	.05
11	.03	.07	.08	.02	.05	.03	.06	.04	.04	.01	.12	.05
12	.03	.07	.08	.02	.05	.03	.12	.04	.04	.01	.11	.05
13	.03	.07	.08	.02	.06	.02	.08	.04	.05	.10	.11	.05
14	.03	.08	.07	.02	.06	.02	.08	.04	.04	.03	.17	.05
15	.60	.08	.07	.02	.07	.02	.07	.04	1.46	.15	.16	.05
16	.28	.07	.07	.02	.31	.02	.06	.04	.08	.02	.12	.05
17	.08	.07	.07	.02	.24	.02	.06	.04	.03	.01	.12	.05
18	.07	.07	.06	.02	.09	.02	.05	.04	.03	.01	.11	.05
19	.06	.07	.06	.02	.02	.02	.05	.03	.03	.01	.10	.04
20	.06	.07	.05	.02	.01	.02	.04	.03	.03	.02	.11	.04
21	.07	.07	.05	.01	.01	.02	.04	.03	.51	.02	.10	.05
22	.06	.07	.05	.01	89.00	.02	.04	.03	.16	.02	.11	.05
23	.08	.08	.05	.01	1.00	.02	.04	.04	.03	.02	.11	.05
24	.10	.07	.05	.01	.10	.02	.04	.04	.29	.02	.10	.06
25	.09	.07	.04	.01	.07	.02	.03	.04	.06	.02	.10	.14
26	.08	.07	.04	.01	.06	.02	.03	.04	.04	.02	.14	.22
27	.08	.07	.04	.01	.15	.02	.03	.04	.03	.03	.12	.09
28	.08	.07	.04	.02	.14	.02	.15	.03	.03	.04	.29	.04
29	.08	.08	.04	.02	---	.02	.05	.04	.03	.04	.24	.06
30	.08	.07	.04	.02	---	.03	.07	.04	.03	.04	.08	.02
31	.08	---	.04	.02	---	.02	---	.04	---	.04	.21	---
TOTAL	2.70	2.21	1.98	0.60	91.79	0.80	1.56	1.25	3.45	0.89	3.97	3.10

WATER YEAR 1981 TOTAL 114.30

RESIDUE, VOLATILE NONFILTERABLE (TONS/DAY), WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.02	.04	.06	.03	.03	.10	.01	.03	.10	.07	.02	.10
2	.02	.04	.05	.03	.03	.09	.08	.03	.09	.08	.03	.07
3	.02	.04	.04	.03	.03	.08	3.00	.03	.08	.16	.02	.06
4	.01	.04	.04	.04	.03	.06	.67	.03	.07	.06	25.00	.06
5	.01	.04	.04	.05	.02	.06	.20	.16	.07	.05	.29	.05
6	.07	.04	.04	.04	.02	.05	.12	.10	.06	.70	.32	.03
7	.06	.04	.04	.05	.02	.05	.10	.07	.06	4.70	.29	.03
8	.06	.04	.04	.04	.02	.05	.05	.06	.05	.13	.26	.02
9	.05	.04	.04	.04	.02	.05	.05	.05	.05	.07	.25	.02
10	.04	.04	.04	.04	.02	.04	.05	.05	.05	32.00	.23	.02
11	.04	.04	.03	.04	.02	.19	.05	.04	.04	.52	.22	.02
12	.03	.04	.03	.04	.02	32.00	.07	.04	.04	.04	.21	.02
13	.03	.04	.03	.03	.02	46.00	.06	.04	.04	.07	.20	.02
14	.10	.04	.03	.03	.02	3.70	.05	.03	.03	.33	.19	.02
15	.06	.04	.03	.03	.02	.52	.06	.03	.26	5.60	.19	.02
16	.04	.04	.03	.03	.02	38.00	.08	.03	.06	2.00	.16	.02
17	1.00	.04	.03	.03	.02	.48	.06	.03	.05	.14	.17	.02
18	.28	.04	.03	.03	.02	.43	.05	.05	.05	.11	.15	.02
19	.12	.03	.03	.03	.02	.79	.05	.19	.05	.09	.13	.02
20	.06	.03	.04	.03	.05	13.00	.05	.06	.05	.08	.12	.02
21	.05	.03	.04	.03	.67	.70	.04	.09	.05	.07	.11	.02
22	.05	.03	.04	.03	3.30	.02	.04	.06	.04	.07	.11	.02
23	.05	.03	.04	.03	4.30	.02	.04	.06	.04	.06	.12	.02
24	.05	.03	.04	.03	.59	.02	.04	.05	.04	.06	.11	.02
25	.05	.02	.03	.03	.23	.01	.04	.04	.04	.05	.10	.01
26	.05	.75	.04	.03	.12	.01	.03	.11	.05	.04	.07	.01
27	.05	.08	.04	.03	.11	.02	.03	.41	.05	.04	.07	.01
28	.04	.04	.03	.03	.11	.03	.03	.33	.06	.04	.06	.01
29	.04	.04	.03	.03	---	.04	.03	.20	.06	.03	.22	.01
30	.04	.04	.03	.03	---	.54	.03	.16	.07	.04	1.00	.01
31	.04	---	.03	.03	---	.03	---	.12	---	.03	.11	---
TOTAL	2.63	1.87	1.13	1.04	9.90	137.18	5.26	2.78	1.65	47.53	30.55	0.80

WATER YEAR 1982 TOTAL 242.52

Table 14. Kjeldahl nitrogen loads for Pats Creek near Belmont, 1981 and 1982 water years

NITROGEN, AMMONIA PLUS ORGANIC, TOTAL (POUNDS/DAY), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	7.6	5.4	3.8	2.3	1.40	12.0	5.7	11.0	6.7	4.8	3.9	204
2	7.6	5.3	3.4	2.2	1.30	10.0	5.4	9.7	6.8	4.8	7.8	29.0
3	8.9	5.3	3.6	2.1	1.20	10.0	5.4	9.4	8.1	4.7	5.2	25.0
4	6.6	5.2	3.7	2.1	1.20	9.2	30.0	8.8	7.9	4.9	4.3	22.0
5	6.2	5.1	3.9	2.0	1.20	8.7	9.8	8.6	7.4	5.2	4.1	21.0
6	6.1	5.1	9.4	1.9	1.20	8.1	5.7	7.9	7.1	4.8	4.1	19.0
7	5.7	5.1	13.0	1.9	1.20	7.7	5.6	7.3	7.3	4.4	7.8	25.0
8	5.8	4.9	10.0	1.8	1.10	7.4	17.0	7.1	7.0	4.3	4.6	23.0
9	5.7	4.8	4.1	1.9	1.00	7.4	13.0	7.3	8.9	4.5	4.5	19.0
10	5.3	4.6	3.8	1.8	1.00	7.4	11.0	7.4	8.5	4.2	4.4	17.0
11	5.0	4.5	3.6	1.8	1.00	7.5	15.0	6.5	7.8	3.9	3.9	18.0
12	4.9	4.5	3.7	1.8	1.00	7.9	28.0	6.2	7.4	4.3	3.7	15.0
13	4.8	4.7	3.5	1.8	.92	7.5	21.0	6.4	9.4	27.0	3.5	15.0
14	5.4	5.3	3.3	1.8	.97	7.4	20.0	6.4	8.6	16.0	7.8	14.0
15	70.0	4.7	3.1	1.8	.97	7.6	15.0	6.1	233	33.0	7.7	13.0
16	32.0	4.4	3.1	1.8	39.00	7.0	13.0	5.9	18.0	9.7	5.2	13.0
17	7.3	4.3	3.1	1.8	28.00	7.0	13.0	6.0	8.4	7.0	4.7	13.0
18	5.9	4.2	2.9	1.9	8.50	6.8	8.5	5.9	8.1	6.8	4.5	12.0
19	6.1	4.2	2.9	1.8	1.80	6.6	8.0	5.5	7.7	8.7	4.4	11.0
20	4.8	4.2	2.6	1.8	1.50	6.6	5.2	5.5	8.3	28.0	4.5	10.0
21	8.0	4.1	2.8	1.8	1.00	6.4	4.8	5.8	80.0	6.9	4.3	11.0
22	5.2	4.1	2.7	1.8	9780	6.2	11.0	5.7	34.0	6.4	4.3	11.0
23	5.9	4.4	2.7	1.8	311	6.2	6.5	6.2	7.9	6.3	4.6	10.0
24	7.9	4.1	2.5	1.7	35.00	6.0	6.0	6.6	41.0	6.2	4.6	11.0
25	7.1	3.8	2.4	1.8	12.00	5.8	5.2	6.0	8.9	5.8	4.6	50.0
26	6.3	3.8	2.3	1.7	6.30	5.5	5.0	6.1	5.3	5.0	15.0	71.0
27	6.1	3.9	2.4	1.6	16.00	5.3	4.3	6.2	4.8	4.6	22.0	30.0
28	5.9	4.0	2.6	1.6	15.00	5.1	37.0	5.9	4.7	5.2	47.0	10.0
29	5.6	4.0	2.5	1.4	---	8.7	11.0	6.2	4.6	4.7	30.0	5.7
30	5.5	3.9	2.5	1.4	---	15.0	16.0	6.5	4.9	4.4	11.0	2.1
31	5.7	---	2.4	1.4	---	8.7	---	6.6	---	4.0	28.0	---
TOTAL	275.9	135.9	118.1	56.1	10271.76	238.7	356.1	212.7	568.5	248.5	274.0	747.8

WATER YEAR 1981 TOTAL 13,506.06

NITROGEN, AMMONIA PLUS ORGANIC, TOTAL (POUNDS/DAY), WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	8.2	7.7	35.0	5.5	5.0	19.0	25.0	7.7	16.0	20.0	7.1	25.0
2	7.5	7.6	17.0	5.4	4.6	18.0	58.0	7.6	14.0	21.0	7.4	19.0
3	7.3	7.5	7.7	5.7	4.6	15.0	373	7.4	13.0	39.0	6.5	17.0
4	6.7	7.7	7.5	6.0	4.6	11.0	37.0	7.0	12.0	14.0	2050	18.0
5	6.2	7.5	7.2	7.5	4.3	9.5	13.0	67.0	11.0	9.3	59.0	15.0
8	13.0	7.4	7.2	7.4	4.2	8.8	11.0	42.0	10.0	85.0	54.0	12.0
7	7.0	7.4	6.9	8.0	4.2	8.1	11.0	19.0	10.0	605	40.0	11.0
8	6.0	7.0	6.9	7.3	4.2	8.0	10.0	15.0	9.7	15.0	37.0	9.0
9	5.6	6.9	6.8	6.6	4.1	9.5	10.0	13.0	9.2	11.0	38.0	8.6
10	5.4	6.6	8.9	6.3	4.1	8.6	10.0	12.0	8.6	2430	34.0	9.1
11	5.2	6.6	6.4	6.0	4.1	15.0	52.0	12.0	8.1	91.0	32.0	8.8
12	4.9	8.4	6.2	6.0	4.0	4760	90.0	12.0	8.0	20.0	30.0	8.2
13	4.7	6.2	6.0	5.6	4.0	6540	71.0	11.0	7.2	15.0	30.0	8.5
14	42.0	6.4	5.7	5.7	4.0	789	52.0	10.0	6.5	42.0	29.0	8.6
15	26.0	6.6	5.5	5.3	4.1	188	78.0	9.4	80.0	590	29.0	9.0
16	12.0	7.2	5.3	5.2	4.3	5280	174	9.0	21.0	243	27.0	8.6
17	132	6.4	5.5	5.1	4.3	111	90.0	9.4	16.0	30.0	27.0	9.3
18	39.0	6.0	5.5	5.2	4.0	58.0	61.0	22.0	17.0	25.0	24.0	9.1
19	18.0	6.1	6.0	5.1	4.1	134	64.0	36.0	18.0	21.0	21.0	8.9
20	12.0	6.2	6.5	5.2	6.8	4280	11.0	19.0	18.0	19.0	20.0	8.7
21	10.0	5.7	7.1	5.2	67.0	114	9.9	36.0	18.0	17.0	18.0	8.4
22	10.0	5.3	6.8	5.3	1730	47.0	9.5	19.0	17.0	17.0	19.0	8.1
23	9.4	5.7	6.5	5.1	1630	45.0	9.1	17.0	17.0	15.0	22.0	8.3
24	9.3	6.0	6.4	5.2	313	45.0	8.7	15.0	17.0	14.0	20.0	8.2
25	9.1	5.8	6.1	5.0	44.0	32.0	8.6	15.0	19.0	12.0	19.0	7.8
26	8.7	145	8.4	5.1	21.0	27.0	6.4	38.0	21.0	11.0	14.0	7.7
27	6.5	31.0	6.1	5.5	22.0	24.0	8.2	96.0	20.0	11.0	14.0	7.2
28	8.3	8.5	5.6	5.4	22.0	23.0	7.9	77.0	20.0	9.4	12.0	6.6
29	8.0	7.2	5.4	5.1	---	25.0	7.7	39.0	21.0	8.9	43.0	6.2
30	7.9	7.3	5.5	5.3	---	170	7.8	30.0	21.0	9.6	51.0	5.4
31	8.1	---	5.4	5.0	---	40.0	---	22.0	---	7.4	26.0	---
TOTAL	466.0	364.9	235.0	177.3	3936.6	22862.7	1386.8	751.5	504.3	4477.6	2858.0	305.3

WATER YEAR 1982 TOTAL 38,326.0

Table 15. Total phosphorus loads for Pats Creek near Belmont, 1981 and 1982 water years

PHOSPHORUS, TOTAL, POUNDS PER DAY, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.76	.61	.68	.75	.54	1.51	.91	1.33	1.13	1.22	.70	74.00
2	.76	.61	.62	.71	.51	1.31	.93	1.25	1.17	1.21	1.50	4.91
3	.70	.61	.67	.68	.49	1.24	1.00	1.18	1.41	1.16	.90	4.36
4	.68	.62	.69	.68	.49	1.10	1.96	1.13	1.40	1.15	.80	3.96
5	.65	.61	.74	.68	.49	1.00	1.39	1.11	1.33	1.22	.80	3.77
6	.65	.61	.92	.65	.49	.91	1.35	1.00	1.30	1.10	.80	3.42
7	.62	.63	3.50	.65	.49	.84	1.46	.93	1.35	.98	1.30	4.65
8	.65	.61	2.90	.65	.49	.78	3.90	.98	1.30	.90	.80	4.34
9	.65	.61	.84	.65	.46	.76	2.85	.98	1.69	.95	.70	3.70
10	.62	.60	.78	.65	.46	.73	1.56	1.00	1.62	.89	.70	3.31
11	.59	.59	.76	.65	.46	.73	1.57	.88	1.52	.86	.70	3.13
12	.48	.60	.78	.65	.46	.74	11.00	.84	1.46	.94	.60	3.10
13	.48	.61	.76	.65	.46	.68	4.70	.84	1.87	4.75	.60	3.08
14	.54	.72	.72	.65	.49	.65	4.70	.85	1.74	2.45	1.50	3.05
15	39.00	.66	.69	.65	.49	.65	2.19	.81	60.00	8.35	1.50	2.88
16	21.00	.62	.69	.68	7.25	.58	2.11	.80	4.37	2.50	.60	2.85
17	4.30	.61	.72	.68	5.80	.56	2.10	.83	1.59	2.30	.60	2.83
18	.54	.62	.69	.71	2.55	.53	1.81	.83	1.28	2.20	.60	2.66
19	.48	.62	.65	.71	.85	.50	1.80	.77	1.02	2.10	.60	2.49
20	.45	.63	.62	.71	10.00	.48	1.66	.80	.91	2.80	.60	2.41
21	.58	.63	.62	.71	9.93	.45	1.54	.85	15.00	2.00	.50	2.62
22	.52	.63	.62	.71	2820	.43	1.76	.84	12.00	1.80	.50	2.58
23	.58	.70	.65	.71	58.00	.42	1.68	.93	1.55	1.70	.60	2.56
24	8.50	.65	.62	.75	5.47	.45	1.49	1.01	11.00	1.60	.50	2.91
25	6.73	.62	.59	.78	3.46	.48	1.36	.92	2.25	1.50	.50	15.00
26	.65	.63	.59	.75	2.44	.52	1.25	.95	1.41	1.20	3.20	29.00
27	.63	.66	.62	.68	3.90	.56	1.24	.98	1.27	1.10	5.92	7.68
28	.62	.66	.65	.68	3.70	.61	5.34	.94	1.31	1.10	13.00	2.91
29	.60	.69	.78	.65	---	.78	1.35	1.00	1.27	1.00	7.30	8.63
30	.60	.69	.78	.65	---	1.00	1.52	1.07	1.30	.80	2.30	3.43
31	.63	---	.76	.54	---	.91	---	1.10	---	.70	6.20	---
TOTAL	95.24	18.98	26.72	21.10	2940.64	22.89	69.48	29.73	137.82	54.53	57.42	214.22

WATER YEAR 1981 TOTAL 3688.77

PHOSPHORUS, TOTAL, POUNDS PER DAY, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1.42	1.35	2.92	.94	.68	2.92	4.26	1.91	3.86	2.36	2.13	4.24
2	1.35	1.32	2.15	.92	.63	3.09	5.13	1.69	3.49	2.80	2.33	3.44
3	1.35	1.29	1.84	.94	.62	3.20	101	1.85	3.14	7.75	2.15	3.27
4	1.29	1.30	1.79	.98	.62	3.16	26.00	1.77	2.90	3.44	657	3.64
5	1.24	1.27	1.88	1.22	.57	3.93	7.95	11.00	2.59	2.81	26.00	3.18
6	3.14	1.24	1.66	1.19	.56	3.69	2.30	6.53	2.38	18.00	13.00	2.70
7	1.69	1.22	1.56	1.27	.55	3.91	2.20	3.89	2.31	182	7.99	2.53
8	1.46	1.14	1.56	1.16	.54	4.42	2.17	3.25	2.16	4.40	7.26	2.22
9	1.36	1.11	1.52	1.05	.53	5.20	2.16	2.61	2.02	2.65	6.90	2.12
10	1.33	1.04	1.52	1.00	.53	5.62	2.23	2.29	1.87	814	6.27	2.20
11	1.30	1.03	1.41	.93	.52	6.30	6.27	2.04	1.73	30.00	5.88	2.08
12	1.22	.99	1.33	.92	.51	1120	14.00	1.86	1.68	4.70	5.37	1.91
13	1.19	.95	1.27	.87	.50	1670	9.93	1.61	1.49	7.40	5.13	1.95
14	10.00	.98	1.20	.87	.50	196	6.27	1.35	1.32	15.00	4.82	1.93
15	2.51	.99	1.15	.81	.51	39.00	11.00	1.15	18.00	180	4.69	1.99
16	1.57	1.06	1.10	.82	.54	1450	37.00	1.02	4.49	95.00	4.31	1.86
17	37.00	.94	1.11	.76	.53	21.00	14.00	.89	2.82	10.00	4.12	1.98
18	8.05	.93	1.11	.78	.51	19.00	7.95	.95	3.05	8.14	3.68	1.92
19	3.54	1.01	1.20	.75	.58	37.00	8.57	5.80	2.99	6.61	3.16	1.84
20	2.40	1.09	1.27	.76	1.50	850	6.27	3.10	2.93	5.69	3.03	1.78
21	2.05	1.07	1.37	.75	13.00	32.00	2.28	5.80	2.82	5.07	2.70	1.68
22	1.97	1.06	1.30	.76	337	19.00	2.21	4.50	2.64	4.87	2.93	1.80
23	1.83	1.22	1.23	.73	389	5.64	2.13	1.44	2.59	4.16	3.43	1.60
24	1.78	1.35	1.19	.75	68.00	5.80	2.06	1.43	2.54	3.87	3.29	1.56
25	1.72	1.40	1.12	.71	8.65	4.18	2.04	1.50	2.65	3.32	3.18	1.46
26	1.62	37.00	1.17	.73	6.33	3.49	2.02	6.20	2.86	2.95	2.58	1.41
27	1.58	6.57	1.10	.77	2.91	3.06	1.98	11.00	2.71	2.86	2.52	1.30
28	1.53	2.11	1.00	.75	2.75	2.90	1.91	9.60	2.60	2.36	2.30	1.18
29	1.46	1.80	.95	.71	---	2.81	1.89	9.10	2.63	2.33	9.36	1.08
30	1.42	1.81	.95	.73	---	29.00	1.91	5.78	2.59	2.64	8.03	.93
31	1.43	---	.93	.68	---	6.96	---	4.27	---	2.12	4.02	---
TOTAL	102.80	77.64	42.66	27.01	839.87	5562.48	297.09	117.38	93.85	1419.30	819.56	62.60

WATER YEAR 1982 TOTAL 9462.24

Table 16. Suspended-solids loads for Apple River near Shullsburg, 1981 and 1982 water years

SOLIDS, RESIDUE AT 105 DEG. C, SUSPENDED (TONS PER DAY), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.75	1.20	.34	.29	.02	.57	.14	.26	.10	.34	.05	4.60
2	.71	1.00	.39	.28	.02	.47	.17	.25	.11	.31	.16	1.80
3	.65	1.10	.17	.25	.01	.39	.18	.22	.10	.29	.07	.90
4	.58	1.00	.20	.20	.01	.34	.35	.21	.10	.26	.06	.57
5	.55	.89	.32	.15	.01	.28	.15	.20	.10	.23	.07	.40
6	.49	.82	.75	.11	.01	.23	.12	.17	.09	.20	.08	.30
7	.49	.82	1.60	.08	.01	.20	.14	.16	.09	.20	.15	1.20
8	.52	.82	2.50	.06	.01	.15	.80	.16	.09	.19	.10	1.40
9	.55	.82	2.00	.04	.01	.12	.57	.17	.24	.18	.11	.56
10	.47	.75	1.30	.04	.01	.10	1.80	.19	.22	.15	.11	.33
11	.47	.61	2.90	.02	.01	.08	2.90	.23	.19	.15	.08	.27
12	.44	.61	.80	.02	.01	.07	4.00	.28	.18	.16	.06	.23
13	.47	.78	.70	.02	.01	.05	2.30	.29	.57	.26	.05	.19
14	.49	.93	.85	.05	.01	.04	4.30	.21	.24	.11	61.00	.16
15	3.90	.71	.42	.06	.05	.07	1.20	.16	627	.27	8.70	.15
16	2.90	.58	.40	.05	1.00	.09	.74	.12	8.70	.14	.56	.14
17	1.60	.55	.45	.05	.99	.15	.47	.09	2.30	.12	.33	.13
18	1.10	.49	.55	.05	.39	.21	.29	.10	1.30	.11	.25	.13
19	.97	.52	.38	.06	.12	.29	.26	.11	.72	.11	.21	.13
20	.97	.52	.25	.06	.07	.25	.24	.13	.44	.15	.16	.13
21	.89	.52	.26	.05	.08	.19	.22	.17	.81	.14	.14	.12
22	.74	.52	.27	.05	379	.14	.21	.23	1.20	.11	.11	.11
23	.75	.68	.28	.05	12.00	.11	.21	.31	.88	.10	.10	.10
24	1.20	.58	.27	.05	.66	.09	.18	.30	5.40	.09	.16	.17
25	1.40	.44	.28	.11	.37	.08	.17	.22	1.20	.08	.17	.65
26	.97	.22	.29	.17	.23	.08	.17	.19	.72	.07	.83	1.80
27	.89	.32	.31	.14	.96	.07	.17	.17	.59	.08	.55	.85
28	.89	.32	.31	.08	1.40	.06	.25	.14	.52	.09	4.00	.40
29	.78	.37	.31	.05	---	.21	.15	.13	.45	.07	1.90	8.50
30	.71	.37	.31	.04	---	.26	.30	.11	.40	.07	.53	1.50
31	.93	---	.31	.03	---	.18	---	.10	---	.05	2.10	---
TOTAL	29.22	19.86	20.27	2.76	397.48	5.62	23.15	5.78	654.85	4.88	82.95	27.92

WATER YEAR 1981 TOTAL 1274.74

SOLIDS, RESIDUE AT 105 DEG. C, SUSPENDED (TONS PER DAY), WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.47	.28	3.50	.16	.07	.30	.35	.19	1.60	.35	.46	.10
2	.37	.28	2.00	.18	.06	.26	.87	.19	1.40	.95	.29	.09
3	.31	.30	.60	.20	.06	.22	48.00	.19	1.40	.82	.18	.08
4	.30	.32	.54	.23	.06	.19	4.60	.19	1.20	.53	3.00	.08
5	.36	.34	.51	.22	.05	.18	1.70	3.30	1.00	.33	6.40	.08
6	3.00	.35	.49	.10	.05	.16	.87	10.00	1.00	17.00	7.10	.08
7	.81	.36	.49	.09	.05	.13	.68	2.00	1.00	2.00	40.00	.08
8	.47	.39	.47	.09	.05	.13	.52	8.80	.79	.63	90.00	.09
9	.40	.37	.39	.09	.05	.13	.52	.50	.73	.49	1.90	.09
10	.34	.37	.36	.09	.06	.12	.39	.29	.64	.91	.92	.11
11	.28	.36	.33	.10	.06	.20	.87	1.80	.57	.54	.61	.12
12	.24	.34	.32	.10	.07	397	5.30	.88	1.20	.34	.51	.14
13	.21	.35	.32	.11	.07	374	11.00	.64	.95	.28	.44	.14
14	4.90	.34	.32	.12	.10	18.00	2.90	.64	.86	.21	.40	.15
15	2.10	.34	.31	.12	.12	4.80	2.00	.81	9.30	.17	.34	.16
16	1.70	1.20	.27	.12	.15	253	2.00	.66	.84	.14	.29	.16
17	700	.94	.26	.13	.11	3.40	1.10	.82	.49	.13	.26	.20
18	200	.82	.29	.14	.09	1.40	.55	.58	.48	.55	.23	.20
19	10.00	.68	.27	.14	.07	4.20	.52	.52	.46	.42	.22	.20
20	5.00	.57	.28	.12	1.60	45.00	.39	.47	.44	.31	.20	.21
21	1.30	.45	.24	.12	2.30	5.50	.28	.43	.41	.29	.18	.22
22	1.10	.35	.21	.12	26.00	2.00	.26	1.20	.38	.80	.18	.24
23	.85	.27	.19	.11	23.00	2.50	.24	.88	.35	.53	.17	.26
24	.71	.28	.18	.10	3.10	3.20	.23	.68	.34	.36	.90	.27
25	.61	.31	.16	.10	3.40	1.40	.25	.82	.34	.30	1.20	.28
26	.53	46.20	.15	.09	1.30	.68	.17	.35	.34	.25	.79	.31
27	.44	2.90	.14	.08	.49	.61	.16	4.00	.36	.22	.45	.33
28	.39	.97	.13	.08	.34	.56	.16	3.20	.36	.18	.12	.36
29	.34	.77	.14	.07	---	.53	.16	22.00	.37	5.50	.11	.38
30	.30	.70	.14	.07	---	6.40	.16	7.20	.36	35.00	.12	.40
31	.26	---	.15	.07	---	.93	---	3.00	---	.82	.09	---
TOTAL	937.89	62.50	14.15	3.66	62.93	1127.13	87.20	76.41	29.76	71.35	158.06	5.61

WATER YEAR 1982 TOTAL 2636.65

Table 17. Volatile solids loads for Apple River near Shullsburg, 1981 and 1982 water years

RESIDUE, VOLATILE NONFILTERABLE (TONS/DAY), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.08	.12	.02	.02	.01	.09	.01	.04	.01	.03	.02	.87
2	.07	.10	.02	.02	.01	.05	.01	.03	.01	.03	.03	.27
3	.07	.12	.01	.02	.01	.04	.01	.03	.01	.03	.03	.13
4	.06	.11	.01	.02	.01	.03	.01	.03	.01	.02	.02	.10
5	.06	.09	.02	.02	.01	.02	.01	.03	.01	.02	.02	.08
6	.05	.08	.04	.02	.01	.02	.01	.02	.01	.02	.02	.08
7	.05	.08	.12	.02	.01	.01	.01	.02	.01	.02	.03	.09
8	.05	.08	.15	.02	.01	.01	.22	.02	.01	.01	.02	.10
9	.06	.08	.14	.02	.01	.01	.12	.02	.01	.01	.02	.08
10	.05	.08	.10	.02	.01	.01	.30	.02	.01	.01	.02	.07
11	.05	.06	.17	.01	.01	.01	.76	.02	.01	.01	.01	.06
12	.04	.07	.08	.01	.01	.01	.82	.02	.01	.01	.01	.06
13	.05	.08	.08	.02	.01	.01	.50	.02	.16	.19	.01	.05
14	.05	.10	.07	.02	.01	.01	1.40	.02	.01	.01	11.00	.05
15	.40	.07	.05	.02	.01	.01	.51	.02	64.00	.08	1.90	.04
16	.30	.06	.05	.02	.43	.01	.24	.02	1.40	.05	.34	.04
17	.17	.06	.05	.03	.43	.01	.20	.02	.17	.04	.25	.04
18	.12	.05	.06	.02	.14	.01	.15	.01	.09	.03	.20	.03
19	.10	.05	.19	.02	.03	.01	.13	.01	.05	.03	.17	.03
20	.10	.05	.04	.02	.02	.01	.11	.01	.03	.04	.14	.03
21	.09	.05	.04	.02	.02	.01	.09	.01	.31	.04	.13	.03
22	.08	.05	.04	.02	35.00	.01	.08	.01	.42	.03	.11	.03
23	.08	.07	.04	.02	1.80	.01	.07	.01	.09	.03	.09	.02
24	.12	.06	.03	.02	.13	.01	.06	.01	1.10	.02	.07	.04
25	.14	.05	.03	.02	.09	.01	.04	.01	.23	.02	.06	.21
26	.10	.03	.03	.01	.06	.01	.04	.01	.09	.02	.21	.39
27	.09	.03	.03	.01	.11	.01	.03	.01	.06	.02	.20	.26
28	.09	.03	.03	.01	.16	.01	.04	.01	.05	.03	.78	.15
29	.08	.04	.03	.01	---	.01	.03	.01	.04	.02	.49	1.60
30	.07	.04	.03	.01	---	.01	.04	.01	.04	.02	.20	.17
31	.09	---	.03	.01	---	.01	---	.01	---	.02	.50	---
TOTAL	3.01	2.04	1.83	0.55	36.37	0.50	6.05	0.54	68.46	0.96	17.10	5.20

WATER YEAR 1981 TOTAL 144.61

RESIDUE, VOLATILE NONFILTERABLE (TONS/DAY), WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.11	.10	.21	.03	.01	.08	.07	.13	.01	.22	.09	.02
2	.09	.09	.19	.03	.01	.07	.20	.12	.01	.24	.08	.02
3	.08	.08	.15	.03	.01	.06	8.70	.12	.01	.27	.07	.02
4	.09	.08	.14	.03	.01	.06	2.70	.12	.01	.22	22.00	.02
5	.18	.08	.13	.04	.01	.05	1.30	1.30	.01	.18	3.50	.02
6	.69	.07	.13	.04	.01	.05	.68	2.70	.01	3.10	4.80	.02
7	.22	.07	.13	.03	.01	.05	.73	1.00	.01	.53	5.60	.02
8	.19	.07	.13	.03	.01	.04	.61	.16	.01	.18	9.80	.03
9	.17	.06	.11	.03	.01	.04	.61	.15	.01	.13	1.70	.03
10	.16	.06	.10	.03	.01	.04	.61	.11	.01	.12	.26	.03
11	.14	.08	.10	.02	.01	.06	.86	.86	.01	.10	.18	.03
12	.13	.06	.09	.02	.01	31.00	2.90	.61	.01	.08	.16	.03
13	.12	.06	.09	.02	.01	40.00	4.80	.50	.01	.08	.14	.03
14	.62	.05	.09	.02	.01	5.50	1.90	.50	.02	.07	.13	.03
15	.21	.05	.08	.02	.01	.20	1.50	.61	2.90	.07	.12	.03
16	.10	.06	.07	.02	.01	34.00	.38	.50	.30	.07	.11	.03
17	42.00	.05	.07	.02	.01	.53	.31	.40	.22	.07	.10	.04
18	12.00	.05	.06	.02	.01	.64	.27	.13	.21	.07	.09	.04
19	3.80	.05	.06	.02	.01	1.50	.24	.12	.22	.07	.08	.04
20	2.40	.04	.06	.02	.12	12.00	.22	.09	.22	.06	.07	.04
21	.20	.04	.06	.02	.35	2.00	.20	.09	.21	.40	.06	.04
22	.18	.04	.06	.02	3.20	.83	.18	.73	.21	.31	.05	.04
23	.15	.04	.05	.02	3.80	1.00	.16	.61	.20	.07	.05	.04
24	.14	.04	.05	.02	1.00	1.30	.17	.50	.21	.06	.05	.05
25	.13	.04	.05	.02	.48	.64	.16	.40	.22	.08	.05	.05
26	.12	7.50	.05	.02	.24	.35	.15	.35	.22	.06	.03	.06
27	.11	.50	.04	.02	.16	.24	.14	1.50	.23	.06	.03	.06
28	.11	.20	.04	.01	.09	.24	.14	1.30	.23	.05	.02	.06
29	.10	.17	.04	.01	---	.24	.13	3.60	.24	.13	.02	.07
30	.10	.16	.03	.01	---	.77	.13	2.90	.23	2.80	.02	.07
31	.09	---	.03	.01	---	.13	---	1.50	---	.11	.02	---
TOTAL	64.93	10.02	2.69	0.70	9.63	133.71	31.35	23.71	6.42	9.64	49.48	1.11

WATER YEAR 1982 TOTAL 343.59

Table 18. Kjeldahl nitrogen loads for Apple River near Shullsburg, 1981 and 1982 water years

NITROGEN, AMMONIA PLUS ORGANIC, TOTAL (POUNDS/DAY), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	19.0	13.0	6.4	20.0	13.0	35.0	7.5	21.0	8.7	19.0	7.8	141
2	19.0	12.0	6.7	20.0	12.0	29.0	7.7	19.0	9.0	18.0	24.0	86.0
3	17.0	12.0	4.7	19.0	12.0	27.0	7.8	17.0	9.0	19.0	14.0	51.0
4	16.0	12.0	5.0	20.0	12.0	22.0	9.2	16.0	9.1	18.0	9.4	40.0
5	15.0	11.0	6.1	20.0	12.0	20.0	7.2	15.0	9.0	17.0	9.7	34.0
6	14.0	10.0	8.9	22.0	11.0	16.0	6.6	13.0	8.7	16.0	11.0	31.0
7	14.0	10.0	15.0	22.0	11.0	15.0	6.7	12.0	8.2	17.0	23.0	37.0
8	14.0	10.0	16.0	24.0	11.0	12.0	68.0	12.0	6.6	16.0	10.0	41.0
9	15.0	10.0	15.0	23.0	11.0	11.0	57.0	12.0	11.0	14.0	8.6	31.0
10	13.0	9.8	14.0	25.0	11.0	11.0	65.0	11.0	10.0	13.0	7.6	27.0
11	13.0	9.0	17.0	26.0	11.0	11.0	120	10.0	8.9	12.0	6.5	24.0
12	13.0	9.1	13.0	26.0	11.0	11.0	123	9.7	8.8	13.0	5.1	23.0
13	13.0	9.9	13.0	28.0	11.0	11.0	48.0	9.0	23.0	19.0	4.9	21.0
14	14.0	11.0	13.0	28.0	11.0	10.0	60.0	8.9	8.8	15.0	406	20.0
15	57.0	9.4	12.0	29.0	11.0	11.0	46.0	9.5	4600	20.0	334	18.0
16	43.0	8.4	13.0	29.0	26.0	10.0	42.0	9.7	250	19.0	88.0	16.0
17	24.0	8.4	14.0	27.0	31.0	8.8	39.0	9.2	66.0	16.0	61.0	15.0
18	13.0	7.9	15.0	27.0	12.0	8.4	33.0	8.2	49.0	13.0	47.0	14.0
19	12.0	8.1	26.0	28.0	4.0	8.4	32.0	7.2	37.0	13.0	37.0	14.0
20	12.0	8.1	14.0	28.0	2.9	8.6	29.0	7.3	30.0	16.0	30.0	13.0
21	12.0	8.1	15.0	28.0	2.9	8.4	27.0	7.4	32.0	16.0	25.0	12.0
22	11.0	8.1	15.0	28.0	4220	7.8	26.0	7.7	42.0	13.0	20.0	11.0
23	11.0	9.0	16.0	26.0	332	7.6	26.0	8.9	37.0	12.0	15.0	9.9
24	13.0	8.3	16.0	26.0	50.0	7.4	23.0	9.6	143	11.0	13.0	12.0
25	14.0	7.4	16.0	26.0	31.0	7.6	21.0	8.2	41.0	9.4	13.0	45.0
26	12.0	6.5	16.0	20.0	22.0	7.9	20.0	8.3	27.0	9.4	30.0	74.0
27	11.0	6.3	18.0	17.0	33.0	7.4	19.0	8.4	24.0	9.8	30.0	35.0
28	11.0	6.3	19.0	15.0	46.0	7.5	23.0	8.1	23.0	16.0	107	32.0
29	11.0	6.6	20.0	13.0	---	9.0	19.0	8.7	21.0	11.0	64.0	244
30	10.0	6.6	21.0	13.0	---	9.4	22.0	8.4	21.0	10.0	37.0	50.0
31	11.0	---	21.0	13.0	---	8.1	---	8.5	---	9.4	71.0	---
TOTAL	497.0	272.3	440.6	716.0	4983.8	384.3	1040.7	328.9	5583.8	450.0	1569.6	1221.9

WATER YEAR 1981 TOTAL 17,489.1

NITROGEN, AMMONIA PLUS ORGANIC, TOTAL (POUNDS/DAY), WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	26.0	41.0	34.0	12.0	6.2	18.0	34.0	18.0	53.0	26.0	26.0	16.0
2	22.0	38.0	31.0	12.0	5.9	17.0	94.0	18.0	43.0	28.0	19.0	14.0
3	19.0	38.0	26.0	12.0	5.7	16.0	808	18.0	39.0	29.0	14.0	13.0
4	21.0	37.0	24.0	13.0	5.4	14.0	184	18.0	35.0	22.0	2920	12.0
5	32.0	37.0	23.0	14.0	5.0	13.0	105	185	31.0	18.0	475	12.0
6	77.0	36.0	23.0	15.0	4.8	12.0	73.0	362	30.0	295	653	12.0
7	22.0	35.0	24.0	13.0	4.7	11.0	63.0	140	29.0	116	753	11.0
8	19.0	35.0	24.0	12.0	4.5	11.0	55.0	86.0	26.0	54.0	1300	11.0
9	19.0	34.0	21.0	11.0	4.2	11.0	28.0	71.0	25.0	42.0	237	11.0
10	18.0	35.0	20.0	11.0	4.2	11.0	27.0	57.0	22.0	42.0	140	12.0
11	18.0	35.0	20.0	11.0	4.4	17.0	73.0	121	20.0	43.0	46.0	12.0
12	17.0	34.0	19.0	11.0	4.4	3940	200	86.0	21.0	29.0	39.0	11.0
13	17.0	35.0	19.0	11.0	4.4	5280	303	71.0	19.0	28.0	34.0	11.0
14	156	35.0	19.0	10.0	4.5	910	142	71.0	17.0	25.0	31.0	11.0
15	78.0	36.0	18.0	9.6	4.5	323	117	86.0	214	24.0	26.0	11.0
16	41.0	41.0	17.0	9.2	4.7	3750	117	71.0	48.0	23.0	23.0	11.0
17	5430	36.0	16.0	9.0	4.2	191	83.0	57.0	34.0	22.0	21.0	13.0
18	1600	36.0	16.0	8.8	3.9	52.0	64.0	35.0	33.0	24.0	19.0	13.0
19	516	34.0	15.0	8.4	4.5	215	55.0	32.0	33.0	21.0	18.0	13.0
20	328	34.0	15.0	6.2	35.0	1170	47.0	28.0	32.0	19.0	17.0	12.0
21	60.0	33.0	16.0	8.2	102	266	22.0	24.0	31.0	71.0	16.0	12.0
22	55.0	32.0	16.0	8.4	398	129	21.0	102	29.0	44.0	16.0	13.0
23	50.0	34.0	15.0	8.1	875	156	21.0	86.0	28.0	22.0	16.0	13.0
24	47.0	35.0	15.0	7.7	274	184	20.0	71.0	29.0	20.0	18.0	14.0
25	45.0	34.0	14.0	7.6	140	37.0	20.0	57.0	29.0	18.0	20.0	13.0
26	44.0	761	14.0	7.2	71.0	28.0	19.0	50.0	29.0	17.0	16.0	14.0
27	42.0	96.0	14.0	6.8	24.0	18.0	18.0	210	29.0	17.0	14.0	15.0
28	41.0	32.0	12.0	6.6	20.0	18.0	18.0	137	29.0	16.0	14.0	15.0
29	40.0	26.0	13.0	6.6	---	16.0	18.0	406	29.0	19.0	14.0	15.0
30	40.0	26.0	11.0	6.6	---	203	18.0	188	28.0	362	17.0	16.0
31	38.0	---	11.0	6.2	---	69.0	---	83.0	---	37.0	14.0	---
TOTAL	6976.0	1831.0	575.0	301.4	2029.1	17108.0	2867.0	3045.0	1094.0	1573.0	6986.0	382.0

WATER YEAR 1982 TOTAL 46,769.5

Table 19. Total phosphorus loads for Apple River near Shullsburg, 1981 and 1982 water years

PHOSPHORUS, TOTAL, POUNDS PER DAY, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1.30	2.20	.53	1.30	.58	11.00	1.80	8.20	.20	1.40	.84	34.00
2	1.20	1.80	.61	1.20	.58	9.10	2.10	7.00	.22	1.30	3.00	21.00
3	1.10	2.10	.24	1.10	.58	7.50	2.20	5.30	.20	1.20	2.00	16.00
4	.97	1.90	.29	1.10	.58	6.40	3.70	4.40	.18	1.20	1.30	11.00
5	.91	1.60	.49	1.00	.58	5.40	1.90	3.80	.18	.92	1.40	7.70
6	.80	1.40	1.40	1.00	.62	4.40	1.70	2.40	.14	.77	1.80	7.00
7	.80	1.40	4.80	1.00	.62	3.80	1.80	2.10	.11	.77	2.90	11.00
8	.85	1.40	8.30	1.00	.62	3.10	6.10	2.40	.12	.64	2.20	14.00
9	.91	1.40	5.70	1.10	.62	2.80	8.50	2.30	.22	.48	1.60	8.40
10	.75	1.30	4.20	1.10	.62	2.50	11.00	1.80	.18	.34	1.20	7.00
11	.75	1.00	3.00	1.00	.62	2.20	25.00	1.80	.11	.29	.84	5.70
12	.70	1.10	2.20	1.00	.65	2.00	28.00	1.50	.09	.32	.51	5.50
13	.75	1.40	2.20	1.00	.85	1.80	30.00	.90	2.60	3.70	.46	4.90
14	.80	1.70	2.00	1.00	.68	1.50	76.00	.72	.87	1.60	239	4.30
15	8.50	1.20	1.80	1.10	.71	1.50	30.00	.82	1500	3.80	73.00	4.00
16	6.10	.91	1.60	1.10	7.80	1.20	25.00	.82	49.00	2.80	12.00	3.30
17	3.10	.91	1.80	1.10	9.80	1.20	21.00	.84	18.00	1.70	5.40	3.00
18	2.10	.80	1.90	1.10	3.00	1.00	13.00	.44	9.50	1.10	3.10	3.00
19	1.70	.85	1.70	1.10	.78	.92	12.00	.29	5.40	1.10	2.70	3.00
20	1.70	.85	1.60	1.10	.53	.85	9.50	.29	3.70	2.20	2.20	2.80
21	1.60	.85	1.70	1.10	.53	.75	7.70	.29	4.10	2.00	2.00	2.60
22	1.30	.85	1.60	1.10	1020	.63	8.10	.29	6.40	1.40	1.70	2.40
23	1.30	1.10	1.60	1.10	83.00	.57	8.60	.38	3.20	1.10	1.40	1.90
24	2.20	1.00	1.50	1.10	12.00	.63	6.60	.44	32.00	1.10	1.30	2.10
25	2.60	.75	1.50	1.00	5.90	1.40	5.30	.29	8.20	.92	1.30	9.70
26	1.70	.53	1.50	.87	3.50	1.60	4.10	.27	4.80	.92	4.50	17.00
27	1.80	.49	1.50	.74	6.80	1.40	3.60	.27	3.30	1.00	8.90	12.00
28	1.60	.49	1.50	.88	16.00	1.50	8.60	.22	2.80	1.80	30.00	7.00
29	1.40	.57	1.50	.82	---	2.50	5.00	.24	2.10	1.20	17.00	65.00
30	1.20	.57	1.50	.58	---	3.00	9.50	.22	1.90	1.10	6.30	11.00
31	1.70	---	1.40	.58	---	2.10	---	.20	---	.92	15.00	---
TOTAL	53.99	34.42	81.36	30.97	1160.95	86.25	377.40	50.83	1659.82	40.89	444.85	307.30

WATER YEAR 1981 TOTAL 4309.03

PHOSPHORUS, TOTAL, POUND8 PER DAY, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	7.76	4.72	24.00	1.30	1.18	12.00	7.10	6.80	11.00	3.31	2.26	3.20
2	5.25	4.14	17.00	1.28	1.12	9.71	21.00	6.80	8.74	3.53	1.90	2.78
3	3.87	3.97	9.00	1.29	1.12	8.23	224	6.80	8.00	4.09	1.61	2.52
4	3.47	3.71	5.14	1.36	1.09	6.80	15.00	8.80	7.41	3.51	1020	2.36
5	3.11	3.52	4.91	1.45	1.04	5.88	9.18	25.00	6.89	3.20	88.00	2.33
8	20.00	3.22	4.80	1.47	1.03	4.94	7.73	81.00	6.59	75.00	135	2.32
7	5.48	3.01	4.88	1.37	1.00	4.07	7.85	17.00	8.38	22.00	184	2.25
8	4.88	2.88	4.78	1.25	1.00	3.60	7.22	8.70	5.78	7.67	344	2.25
9	4.31	2.65	4.03	1.23	.98	3.22	7.77	6.70	5.65	6.14	35.00	2.18
10	4.10	2.59	3.82	1.21	.99	2.94	8.36	5.10	5.19	6.24	17.00	2.24
11	3.81	2.48	3.64	1.15	1.03	4.25	14.00	20.00	4.82	5.81	6.59	2.22
12	3.58	2.31	3.46	1.20	1.08	1120	70.00	17.00	4.97	4.45	5.50	2.15
13	3.47	2.25	3.38	1.18	1.10	1500	135	15.00	4.70	4.38	4.63	2.15
14	43.00	2.15	3.30	1.22	1.18	153	40.00	15.00	4.32	3.89	4.15	2.10
15	18.00	2.09	3.08	1.21	1.20	51.00	30.00	17.00	52.00	3.80	3.50	2.07
18	12.00	2.40	2.81	1.17	1.21	1070	30.00	16.00	8.82	3.63	3.01	2.08
17	2360	2.23	2.60	1.18	.96	38.00	17.00	14.00	5.77	3.53	2.65	2.33
18	455	2.37	2.47	1.17	.80	16.00	13.00	13.00	5.41	3.92	2.33	2.27
19	99.00	2.39	2.33	1.16	1.00	37.00	12.00	13.00	5.26	3.62	2.32	2.17
20	14.00	2.51	2.28	1.15	42.00	258	12.00	12.00	5.06	3.15	2.28	2.12
21	12.00	2.57	2.29	1.17	50.00	47.00	11.00	11.00	4.76	25.00	2.20	2.10
22	10.00	2.64	2.18	1.22	184	21.00	11.00	11.00	4.48	12.00	2.38	2.13
23	8.80	2.94	2.08	1.20	263	26.00	11.00	11.00	4.21	3.25	2.45	2.19
24	7.68	3.21	1.98	1.20	79.00	31.00	9.64	11.00	4.21	2.92	2.81	2.22
25	7.24	3.49	1.90	1.18	74.00	16.00	9.34	11.00	4.16	2.74	3.17	2.13
28	6.77	211	1.82	1.15	33.00	9.30	8.36	11.00	4.05	2.60	2.63	2.21
27	6.10	29.00	1.72	1.17	18.00	7.80	7.71	29.00	4.03	2.55	2.51	2.28
28	5.68	8.15	1.50	1.17	14.00	6.50	7.71	25.00	3.93	2.38	2.43	2.32
29	5.30	6.28	1.51	1.15	---	6.40	7.26	101	3.87	3.20	2.66	2.32
30	5.05	6.12	1.31	1.17	---	38.00	7.26	41.00	3.59	320	3.22	2.31
31	4.61	---	1.29	1.16	---	12.00	---	17.00	---	8.90	2.80	---
TOTAL	3153.30	332.99	131.27	37.94	777.07	4529.44	778.29	581.70	213.85	560.29	1874.97	68.26

WATER YEAR 1962 TOTAL 13,039.39

Table 20. Suspended-solids loads for Madden Branch near Meekers Grove, 1981 and 1982 water years

SOLIDS, RESIDUE AT 105 DEG. C, SUSPENDED (TONS PER DAY), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1.60	2.60	.66	.65	.12	1.20	.36	.97	.62	.30	.25	19.00
2	1.50	2.00	.64	.59	.13	.89	.31	.86	.60	.28	.75	2.30
3	1.30	2.60	.75	.54	.13	.68	.30	.84	.61	.26	.65	1.30
4	1.20	2.00	.80	.50	.12	.55	2.00	.85	.55	.25	.60	.91
5	1.10	1.90	.92	.47	.13	.40	.45	.88	.53	.22	.54	.77
6	1.00	2.30	1.80	.47	.12	.30	.36	.63	.49	.20	.50	.65
7	.98	2.20	2.60	.42	.12	.24	.30	.82	.46	.21	1.70	1.40
8	1.10	2.10	2.00	.39	.12	.23	4.50	.86	.46	.21	1.00	1.60
9	1.00	1.90	1.20	.35	.12	.23	1.90	.91	.55	.20	.43	.66
10	.91	1.70	1.00	.33	.12	.23	1.70	1.10	.51	.17	.35	.67
11	.62	1.50	1.00	.30	.12	.24	7.50	1.20	.44	.17	.32	.67
12	.85	1.40	1.00	.28	.12	.24	3.70	1.30	.40	.19	.29	.67
13	.88	1.30	.92	.26	.13	.24	7.20	1.20	.66	1.00	.28	.51
14	1.00	1.20	.91	.15	.13	.23	26.00	.97	.52	.63	2.20	.40
15	4.90	1.00	.81	.08	.14	.28	3.90	.82	43.00	.69	2.70	.40
16	2.00	.93	.76	.11	9.20	.33	2.00	.70	2.60	.56	.62	.37
17	1.40	.86	.71	.16	3.20	.40	1.60	.62	1.30	.55	.45	.36
18	1.10	.81	.67	.16	1.40	.49	1.20	.67	.97	.52	.39	.37
19	.82	.75	.60	.16	.90	.64	.90	.76	.81	.46	.35	.36
20	.70	.72	.55	.16	.62	.62	.80	.86	.74	.80	.35	.36
21	1.30	.67	.57	.18	.44	.46	.74	.98	14.00	.44	.33	.39
22	1.10	.64	.62	.18	3130	.35	.93	1.10	5.50	.38	.31	.54
23	3.30	.67	.65	.18	31.00	.28	.80	1.40	.93	.34	.32	.96
24	3.30	.59	.64	.20	3.80	.28	.71	1.40	6.40	.33	.63	1.20
25	4.00	.53	.67	.30	2.30	.29	.60	1.10	1.40	.33	.69	3.40
26	3.20	.49	.71	.42	1.60	.32	.76	1.00	.88	.33	1.80	4.30
27	2.10	.51	.83	.55	2.60	.34	.68	.91	.69	.33	.82	1.10
28	2.10	.54	.80	.40	2.60	.35	1.70	.82	.52	.53	1.40	.56
29	1.90	.57	.77	.28	---	.48	.65	.66	.41	.44	1.50	2.90
30	1.60	.61	.74	.18	---	.80	1.60	.78	.35	.33	.92	1.40
31	1.60	---	.70	.12	---	.45	---	.67	---	.30	1.80	---
TOTAL	51.86	37.59	28.00	9.52	3191.73	13.06	78.17	29.06	88.32	11.95	25.24	50.70

WATER YEAR 1981 TOTAL 3615.20

SOLIDS, RESIDUE AT 105 DEG. C, SUSPENDED (TONS PER DAY), WATER YEAR OCTOBER 1961 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.58	.66	3.40	.48	.47	.78	.80	.37	2.60	2.10	1.10	1.50
2	.61	.61	2.30	.53	.43	.77	.60	.35	2.40	1.30	.77	1.20
3	.63	.64	1.50	.57	.37	.77	18.00	.35	3.00	2.00	.63	1.00
4	.71	.66	.59	.64	.33	.76	1.60	.35	2.90	1.50	399	.90
5	.65	.70	.51	.69	.29	.79	.89	4.00	2.40	1.10	7.60	.90
6	3.50	.67	.52	.59	.26	.80	.65	1.30	2.20	2.00	3.60	.90
7	1.10	.66	.59	.56	.27	.60	.52	.94	2.00	30.00	2.30	.80
8	.98	.69	.66	.56	.27	.80	.42	.88	1.90	1.50	2.10	.80
9	1.60	.69	.64	.56	.29	.80	.30	.84	1.70	1.10	1.70	.80
10	1.70	.75	.63	.55	.29	.79	.29	.87	1.60	3820	1.60	.80
11	.94	.79	.59	.55	.32	.97	.60	.92	1.30	23.00	1.50	.80
12	1.70	.66	.60	.57	.32	1720	1.50	.93	1.30	4.50	1.30	.80
13	1.30	.84	.54	.58	.35	1320	2.00	.92	1.20	2.40	1.30	.60
14	3.60	.84	.48	.60	.36	165	.90	.96	1.00	1.60	1.20	.80
15	2.10	1.10	.43	.58	.39	8.40	1.50	1.00	6.70	232	1.10	.90
16	.73	1.50	.38	.57	.42	1150	3.00	1.10	1.60	29.00	1.00	.90
17	5.20	1.10	.34	.59	.46	4.10	1.50	1.10	1.40	3.60	.90	1.00
18	3.60	.97	.32	.60	.50	2.50	.70	1.50	2.40	1.90	.68	1.10
19	1.90	.86	.26	.55	.56	16.00	.66	1.50	2.30	1.70	.86	1.10
20	1.40	.74	.26	.54	1.20	600	.64	1.50	2.20	1.40	.64	1.10
21	1.30	.62	.24	.54	19.00	16.00	.59	1.50	2.30	1.30	.84	.94
22	1.20	.54	.27	.53	184	3.00	.56	2.00	2.30	1.20	.84	.91
23	1.20	.52	.29	.53	137	2.20	.51	1.50	2.30	1.10	.67	.89
24	1.00	1.20	.31	.50	13.00	2.00	.48	1.50	2.30	1.10	1.00	.83
25	.95	1.00	.33	.48	1.60	.60	.46	1.50	2.20	1.10	.91	.61
26	.68	8.00	.35	.52	.91	.52	.41	3.50	2.30	1.20	.66	.78
27	1.60	2.20	.36	.63	.74	.52	.41	6.10	2.30	1.30	.60	.75
28	1.40	1.30	.39	.72	.76	.63	.36	6.60	2.30	1.40	1.20	.72
29	1.00	.90	.40	.68	---	.63	.38	6.90	2.30	1.60	1.20	.70
30	1.10	1.00	.43	.64	---	6.00	.35	5.60	2.20	2.20	4.50	.67
31	.65	---	.46	.55	---	1.90	---	3.70	---	1.50	1.20	---
TOTAL	47.21	33.43	19.41	17.60	365.16	5026.83	41.64	62.08	66.90	4178.90	445.10	26.90

WATER YEAR 1982 TOTAL 10,333.36

Table 21. Volatile solids loads for Madden Branch near Meekers Grove, 1981 and 1982 water years

RESIDUE, VOLATILE NONFILTERABLE (TONS/DAY), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.28	.44	.17	.15	.10	.18	.08	.29	.10	.08	.05	3.00
2	.27	.35	.13	.13	.09	.16	.08	.26	.10	.08	.08	.36
3	.24	.44	.16	.13	.09	.14	.09	.24	.10	.08	.08	.29
4	.22	.35	.16	.12	.07	.14	.14	.23	.09	.07	.07	.26
5	.20	.34	.19	.12	.07	.12	.11	.23	.09	.06	.07	.24
6	.19	.32	.32	.12	.06	.10	.11	.21	.09	.06	.07	.22
7	.19	.32	.44	.12	.06	.10	.11	.19	.08	.05	.32	.44
8	.20	.32	.35	.11	.06	.10	.31	.19	.08	.05	.18	.48
9	.19	.31	.29	.11	.06	.09	.31	.19	.10	.05	.09	.23
10	.18	.27	.22	.10	.06	.09	.33	.19	.10	.04	.08	.20
11	.16	.24	.22	.10	.08	.08	.94	.18	.09	.04	.07	.20
12	.16	.24	.22	.10	.06	.07	.63	.17	.08	.04	.06	.20
13	.17	.25	.19	.10	.07	.07	.54	.17	.10	.16	.05	.18
14	.19	.25	.20	.10	.07	.06	.70	.18	.08	.16	.47	.18
15	.75	.22	.18	.10	.09	.08	.52	.15	6.14	.32	.44	.15
16	.35	.20	.18	.10	.52	.05	.48	.15	.68	.06	.15	.15
17	.25	.19	.18	.10	.44	.04	.45	.14	.17	.06	.13	.14
18	.20	.19	.18	.11	.27	.04	.39	.13	.11	.06	.11	.14
19	.16	.18	.16	.11	.17	.03	.38	.13	.09	.05	.10	.14
20	.14	.19	.15	.11	.15	.04	.35	.12	.07	.30	.10	.13
21	.24	.18	.15	.11	.14	.03	.33	.12	2.21	.06	.09	.13
22	.20	.18	.18	.12	227	.02	.35	.12	1.48	.05	.09	.15
23	.53	.22	.16	.11	3.13	.02	.34	.13	.40	.05	.09	.19
24	.53	.19	.14	.12	.57	.02	.31	.14	1.43	.05	.12	.19
25	.83	.17	.14	.13	.32	.03	.29	.12	.27	.05	.13	.66
26	.53	.17	.14	.12	.19	.04	.28	.17	.14	.05	.53	.74
27	.35	.18	.15	.11	.52	.05	.26	.11	.13	.05	.35	.15
28	.35	.18	.16	.10	.52	.05	.34	.11	.12	.07	.46	.07
29	.34	.17	.16	.09	---	.07	.28	.12	.11	.06	.46	.56
30	.28	.17	.16	.09	---	.09	.33	.12	.10	.06	.24	.28
31	.32	---	.16	.09	---	.08	---	.10	---	.05	.18	---
TOTAL	8.99	7.42	5.97	3.43	235.01	2.26	10.16	5.08	14.93	2.47	5.51	10.43

WATER YEAR 1981 TOTAL 311.66

RESIDUE, VOLATILE NONFILTERABLE (TONS/DAY), WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.20	.00	.60	.11	.17	.43	.00	.40	.53	.05	.35	.24
2	.19	.00	.45	.11	.17	.41	.00	.31	.45	.05	.34	.22
3	.18	.00	.30	.11	.17	.39	3.30	.31	.45	.10	.31	.20
4	.19	.00	.20	.12	.16	.35	1.10	.31	.45	.07	51.00	.18
5	.21	.00	.15	.13	.16	.65	.83	.77	.39	.06	1.10	.17
6	.76	.00	.15	.13	.16	.53	.51	.77	.39	.10	.94	.17
7	.35	.00	.20	.14	.16	.41	.51	.83	.36	.80	.62	.15
8	.29	.00	.30	.14	.16	.51	.51	.51	.36	.10	.51	.15
9	.39	.00	.13	.14	.16	.41	.51	.40	.33	.07	.41	.15
10	.24	.00	.12	.13	.16	.32	.63	.40	.33	333	.34	.15
11	.17	.00	.07	.14	.17	.51	.77	.40	.40	3.60	.31	.14
12	.22	.00	.07	.14	.17	165	1.10	.40	.59	.47	.26	.14
13	.19	.00	.07	.14	.17	136	1.30	.31	.29	.89	.23	.14
14	.45	.00	.07	.15	.17	23.00	.93	.31	.26	.51	.20	.14
15	.34	.00	.07	.14	.17	.90	1.10	.31	1.20	35.00	.17	.14
16	.31	.00	.07	.14	.16	101	1.50	.31	.33	5.10	.15	.13
17	.80	.21	.07	.14	.19	.76	1.10	.31	.14	.85	.13	.13
18	.80	.15	.07	.15	.19	.90	.93	.40	.13	.51	.12	.13
19	.39	.12	.08	.14	.20	1.50	.77	.40	.11	.49	.12	.13
20	.33	.09	.08	.15	.30	60.00	.77	.40	.10	.48	.11	.13
21	.21	.07	.08	.16	2.50	2.00	.63	.40	.10	.45	.11	.11
22	.14	.05	.09	.16	19.00	1.00	.63	.51	.09	.46	.11	.11
23	.09	.11	.09	.18	17.00	.90	.51	.40	.09	.43	.37	.11
24	.05	.17	.09	.17	2.80	.90	.51	.40	.08	.41	.25	.11
25	.03	.12	.09	.17	.72	.60	.51	.40	.08	.42	.16	.11
26	.02	1.20	.10	.17	.49	.40	.40	.67	.07	.42	.07	.11
27	.01	.45	.10	.19	.46	.40	.40	1.00	.07	.42	.04	.11
28	.01	.09	.10	.19	.49	.40	.40	1.70	.07	.42	.20	.11
29	.01	.05	.10	.19	---	.40	.40	1.60	.06	.61	.20	.11
30	.00	.05	.10	.18	---	.97	.40	1.10	.06	.86	.70	.11
31	.00	---	.10	.17	---	---	---	.72	---	.57	.21	---
TOTAL	7.59	2.93	4.36	4.62	47.00	501.95	22.76	17.26	8.36	387.77	60.14	4.23

WATER YEAR 1982 TOTAL 1068.97

Table 22. Kjeldahl nitrogen loads for Madden Branch near Meekers Grove, 1981 and 1982 water years

NITROGEN, AMMONIA PLUS ORGANIC, TOTAL (POUNDS/DAY), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	61.0	115	30.0	11.0	7.6	64.0	37.0	62.0	28.0	29.0	23.0	844
2	57.0	85.0	21.0	11.0	7.4	58.0	35.0	53.0	26.0	29.0	70.0	115
3	49.0	115	28.0	10.0	7.3	56.0	34.0	49.0	27.0	29.0	65.0	76.0
4	42.0	85.0	28.0	10.0	6.5	56.0	74.0	46.0	26.0	27.0	50.0	62.0
5	39.0	80.0	34.0	10.0	6.3	51.0	37.0	44.0	28.0	26.0	55.0	57.0
6	38.0	75.0	73.0	10.0	6.2	44.0	37.0	39.0	25.0	23.0	55.0	50.0
7	34.0	75.0	116	10.0	6.1	42.0	27.0	35.0	25.0	23.0	65.0	84.0
8	39.0	75.0	85.0	10.0	6.1	43.0	180	35.0	26.0	22.0	71.0	91.0
9	36.0	70.0	49.0	10.0	6.1	43.0	180	34.0	49.0	21.0	48.0	57.0
10	31.0	57.0	22.0	9.4	6.1	43.0	160	33.0	45.0	16.0	41.0	47.0
11	28.0	49.0	17.0	8.8	6.1	39.0	235	30.0	37.0	18.0	36.0	47.0
12	29.0	49.0	16.0	8.6	6.2	39.0	206	27.0	26.0	19.0	32.0	47.0
13	30.0	51.0	15.0	8.0	6.3	39.0	310	27.0	53.0	71.0	30.0	38.0
14	36.0	53.0	15.0	7.7	6.6	38.0	400	26.0	42.0	42.0	125	31.0
15	249	44.0	15.0	7.7	14.0	38.0	220	25.0	973	70.0	90.0	31.0
16	86.0	37.0	14.0	7.8	130	32.0	140	25.0	163	38.0	60.0	29.0
17	51.0	34.0	14.0	7.6	110	31.0	106	25.0	53.0	36.0	55.0	27.0
18	39.0	34.0	14.0	8.0	65.0	31.0	71.0	24.0	40.0	34.0	43.0	29.0
19	28.0	33.0	13.0	8.0	40.0	31.0	46.0	24.0	37.0	30.0	39.0	29.0
20	23.0	34.0	12.0	8.1	35.0	91.0	39.0	24.0	36.0	70.0	38.0	29.0
21	49.0	33.0	12.0	8.2	35.0	62.0	34.0	24.0	307	50.0	35.0	29.0
22	39.0	33.0	13.0	8.4	24800	54.0	70.0	24.0	218	35.0	32.0	39.0
23	152	44.0	12.0	8.4	815	48.0	64.0	30.0	49.0	33.0	29.0	62.0
24	152	36.0	12.0	8.5	150	43.0	43.0	49.0	319	32.0	44.0	72.0
25	196	30.0	11.0	8.9	90.0	34.0	37.0	42.0	89.0	30.0	39.0	262
26	152	30.0	11.0	8.5	70.0	32.0	32.0	38.0	47.0	29.0	98.0	339
27	85.0	33.0	12.0	8.1	130	32.0	27.0	29.0	42.0	29.0	55.0	116
28	85.0	31.0	12.0	7.6	92.0	28.0	78.0	25.0	41.0	55.0	84.0	60.0
29	80.0	30.0	12.0	7.4	---	36.0	83.0	49.0	36.0	50.0	85.0	150
30	61.0	29.0	12.0	7.3	---	95.0	105	45.0	34.0	26.0	62.0	68.0
31	75.0	---	12.0	7.4	---	59.0	---	37.0	---	24.0	111	---
TOTAL	2149.0	1579.0	762.0	270.6	26666.9	1430.0	3127.0	1079.0	2945.0	1068.0	1765.0	2817.0

WATER YEAR 1981 TOTAL 45,658.5

NITROGEN, AMMONIA PLUS ORGANIC, TOTAL (POUNDS/DAY), WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	41.0	42.0	200	22.0	20.0	51.0	50.0	42.0	73.0	35.0	50.0	65.0
2	40.0	37.0	150	22.0	20.0	44.0	39.0	38.0	59.0	36.0	48.0	65.0
3	38.0	37.0	100.0	22.0	20.0	36.0	531	38.0	59.0	84.0	48.0	45.0
4	43.0	42.0	90.0	22.0	19.0	35.0	90.0	38.0	58.0	53.0	3980	41.0
5	53.0	42.0	80.0	23.0	19.0	30.0	77.0	160	53.0	45.0	208	39.0
6	175	38.0	55.0	23.0	19.0	30.0	65.0	148	52.0	64.0	132	37.0
7	58.0	35.0	54.0	23.0	19.0	25.0	65.0	118	52.0	1200	109	32.0
8	59.0	35.0	53.0	23.0	19.0	25.0	65.0	105	51.0	170	97.0	30.0
9	63.0	33.0	43.0	22.0	19.0	25.0	65.0	95.0	51.0	69.0	86.0	30.0
10	56.0	33.0	37.0	21.0	19.0	25.0	77.0	91.0	49.0	28500	78.0	30.0
11	41.0	33.0	34.0	21.0	20.0	55.0	83.0	87.0	47.0	541	74.0	30.0
12	52.0	33.0	32.0	22.0	20.0	18400	90.0	82.0	50.0	115	68.0	30.0
13	48.0	38.0	32.0	22.0	20.0	15100	110	73.0	47.0	120	65.0	30.0
14	188	38.0	30.0	22.0	20.0	2030	65.0	70.0	44.0	100.0	62.0	30.0
15	117	36.0	29.0	21.0	20.0	340	90.0	68.0	287	3260	56.0	31.0
16	85.0	42.0	28.0	21.0	21.0	13200	150	65.0	100.0	648	54.0	32.0
17	177	38.0	28.0	20.0	22.0	328	90.0	63.0	60.0	133	48.0	32.0
18	108	38.0	28.0	20.0	22.0	198	65.0	66.0	58.0	89.0	47.0	32.0
19	58.0	39.0	28.0	20.0	30.0	440	61.0	66.0	52.0	82.0	47.0	33.0
20	49.0	40.0	28.0	20.0	49.0	9500	61.0	59.0	50.0	75.0	45.0	33.0
21	48.0	39.0	27.0	21.0	480	580	56.0	60.0	49.0	71.0	46.0	30.0
22	48.0	39.0	28.0	21.0	3670	280	56.0	63.0	48.0	69.0	46.0	30.0
23	46.0	44.0	28.0	22.0	4410	200	52.0	54.0	46.0	64.0	49.0	31.0
24	43.0	48.0	28.0	21.0	952	142	52.0	52.0	44.0	80.0	81.0	31.0
25	42.0	49.0	27.0	21.0	294	115	52.0	49.0	43.0	55.0	63.0	31.0
26	41.0	307	27.0	21.0	162	98.0	48.0	123	43.0	54.0	41.0	31.0
27	54.0	83.0	28.0	22.0	102	88.0	48.0	213	42.0	55.0	35.0	32.0
28	49.0	51.0	25.0	22.0	54.0	78.0	48.0	253	41.0	54.0	55.0	32.0
29	43.0	43.0	24.0	22.0	---	74.0	48.0	243	40.0	55.0	55.0	32.0
30	54.0	54.0	24.0	22.0	---	329	48.0	249	38.0	62.0	150	32.0
31	45.0	---	23.0	20.0	---	162	---	130	---	52.0	50.0	---
TOTAL	2060.0	1506.0	1448.0	867.0	10561.0	62039.0	2497.0	3061.0	1786.0	36050.0	6071.0	1039.0

WATER YEAR 1982 TOTAL 128,783.0

Table 23. Total phosphorus loads for Madden Branch near Meekers Grove, 1981 and 1982 water years

PHOSPHORUS, TOTAL, POUNDS PER DAY, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	14.00	36.00	4.30	3.00	2.70	7.20	3.70	10.00	3.30	2.60	2.40	195
2	12.00	23.00	2.60	2.80	2.70	5.40	3.50	9.00	3.30	2.60	7.30	24.00
3	9.70	36.00	4.00	2.80	2.70	4.40	2.70	8.40	3.40	2.70	5.20	10.00
4	7.70	23.00	4.00	2.70	2.40	4.00	15.00	8.00	3.20	2.70	3.00	6.50
5	6.80	20.00	5.60	2.70	2.30	3.30	7.50	7.90	3.10	2.60	3.20	4.40
6	6.00	18.00	18.00	2.70	2.50	2.80	5.40	7.00	3.00	2.50	3.20	3.50
7	6.20	18.00	36.00	2.70	2.40	2.40	3.40	6.50	2.90	2.80	22.00	13.00
8	6.80	18.00	23.00	2.60	2.40	2.30	31.00	6.40	2.90	2.60	12.00	11.00
9	6.00	17.00	14.00	2.50	2.40	2.20	33.00	6.30	6.60	2.50	8.00	9.20
10	5.00	12.00	8.60	2.50	2.40	2.20	19.00	6.30	4.90	2.30	4.40	8.40
11	4.00	9.70	4.40	2.50	2.40	2.20	182	5.80	3.00	2.30	2.90	8.40
12	4.30	9.70	4.30	2.50	2.50	2.10	49.00	5.40	2.80	2.50	2.80	6.70
13	4.60	10.00	4.00	2.50	2.50	2.00	40.00	5.40	7.00	14.00	2.80	6.00
14	6.00	11.00	4.10	2.50	2.00	1.90	163	5.10	4.40	11.00	28.00	5.50
15	114	8.20	3.90	2.50	1.60	1.90	39.00	4.80	234	13.00	30.00	5.30
16	23.00	6.40	3.80	2.50	47.00	1.70	19.00	4.70	37.00	10.00	8.30	4.00
17	10.00	5.60	3.80	2.50	41.00	1.60	13.00	4.60	29.00	7.30	6.20	3.90
18	6.80	5.60	3.80	2.50	4.80	1.60	6.90	4.30	17.00	4.90	5.60	4.00
19	4.00	5.30	3.40	2.50	2.10	1.50	4.90	4.20	2.50	3.10	5.40	4.00
20	3.00	5.60	3.30	2.60	1.60	9.10	5.00	4.00	2.60	7.30	5.70	4.00
21	2.60	5.30	3.30	2.80	1.50	4.10	5.40	4.00	110	4.40	5.70	4.00
22	6.80	5.30	3.40	2.90	6970	2.00	6.40	4.00	47.00	3.60	5.60	6.20
23	54.00	8.20	3.50	2.90	156	1.40	7.00	6.00	8.50	2.60	5.60	14.00
24	54.00	6.00	3.20	2.90	25.00	1.50	7.20	8.20	66.00	2.60	5.70	16.00
25	80.00	4.60	3.20	3.10	14.00	1.60	7.50	6.00	13.00	2.60	4.30	68.00
26	54.00	4.60	3.20	3.00	7.00	1.70	8.00	3.90	6.40	2.60	18.00	87.00
27	23.00	5.30	3.30	2.90	15.00	1.80	8.60	3.70	3.90	2.60	8.80	32.00
28	23.00	5.00	3.40	2.70	17.00	1.90	12.00	3.60	3.00	6.30	15.00	19.00
29	20.00	4.30	3.40	2.70	---	4.00	10.00	6.60	3.00	3.60	18.00	43.00
30	14.00	4.30	3.40	2.80	---	9.50	16.00	4.00	2.90	2.60	12.00	20.00
31	19.00	---	3.40	2.70	---	5.90	---	3.50	---	2.50	28.00	---
TOTAL	610.30	351.00	195.60	83.50	7337.90	97.20	734.10	177.60	639.60	137.10	295.10	646.00

WATER YEAR 1981 TOTAL 11,305.00

PHOSPHORUS, TOTAL, POUNDS PER DAY, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	12.00	7.10	40.00	3.90	3.40	8.60	9.30	2.90	17.00	6.20	8.10	14.00
2	7.90	6.40	30.00	3.90	3.40	7.60	7.90	1.80	10.00	5.90	7.40	11.00
3	5.50	6.30	15.00	3.60	3.40	6.80	109	1.80	9.50	12.00	6.80	9.00
4	5.80	6.30	8.10	3.70	3.00	6.10	15.00	1.80	9.10	8.00	1390	7.00
5	8.80	6.10	7.60	3.80	2.90	6.00	6.20	29.00	8.20	7.10	52.00	7.00
6	49.00	5.80	7.40	3.80	2.90	5.50	4.30	28.00	7.90	12.00	37.00	6.00
7	18.00	5.30	8.10	3.90	2.60	4.90	4.30	15.00	7.70	400	29.00	6.00
8	18.00	5.20	8.20	3.80	2.60	4.90	4.30	12.00	7.40	17.00	25.00	6.00
9	22.00	4.80	7.50	3.70	2.60	4.50	4.30	11.00	7.20	14.00	21.00	6.00
10	20.00	4.70	7.00	3.80	2.70	4.50	6.20	11.00	6.70	9220	18.00	6.00
11	6.00	4.60	6.50	3.80	2.50	9.40	8.80	10.00	8.30	144	16.00	6.00
12	11.00	4.60	6.20	3.80	2.50	4620	16.00	9.70	6.50	28.00	14.00	6.00
13	11.00	4.60	5.60	3.80	2.60	4270	22.00	8.80	6.10	19.00	13.00	6.00
14	46.00	4.50	5.50	3.80	2.60	682	12.00	8.50	5.50	13.00	12.00	6.00
15	29.00	4.40	5.30	3.70	2.30	60.00	16.00	8.20	61.00	969	11.00	6.30
16	16.00	13.00	5.20	3.90	2.40	3330	28.00	7.90	22.00	183	9.70	6.30
17	39.00	6.00	5.20	3.80	2.50	55.00	16.00	7.70	15.00	32.00	8.30	6.40
18	29.00	6.20	5.20	3.80	2.50	34.00	12.00	8.00	14.00	24.00	7.70	6.40
19	17.00	5.90	4.80	3.60	2.70	80.00	8.80	8.00	12.00	22.00	7.80	6.50
20	12.00	5.70	4.80	3.60	6.50	2600	8.80	7.20	12.00	19.00	7.50	6.60
21	11.00	5.20	4.80	4.10	90.00	105	6.20	7.40	11.00	18.00	7.70	6.00
22	11.00	4.90	4.90	4.10	1010	47.00	6.20	13.00	10.00	17.00	7.70	6.10
23	10.00	9.00	4.90	4.20	1140	40.00	4.30	8.90	9.80	15.00	8.20	6.10
24	9.20	11.00	4.90	4.10	230	25.00	4.30	8.30	9.20	13.00	9.80	6.20
25	8.90	11.00	4.90	3.90	30.00	14.00	4.30	7.70	8.80	12.00	8.20	6.20
26	8.50	82.00	4.50	4.20	11.00	16.00	2.90	24.00	11.00	12.00	6.40	6.30
27	8.70	42.00	4.40	4.40	11.00	21.00	2.90	54.00	11.00	11.00	6.00	6.30
28	8.70	11.00	4.30	4.40	11.00	28.00	2.90	63.00	11.00	11.00	11.00	6.40
29	7.80	8.60	4.20	4.40	---	38.00	2.90	61.00	8.40	16.00	11.00	6.40
30	8.10	8.50	4.20	3.90	---	71.00	2.90	66.00	7.70	13.00	38.00	6.40
31	7.30	---	4.00	3.80	---	28.00	---	33.00	---	8.90	9.00	---
TOTAL	480.20	310.70	243.20	121.00	2591.60	16233.00	359.00	544.60	349.00	11302.10	1824.30	202.90

WATER YEAR 1982 TOTAL 34,561.80

Table 24. Suspended and volatile solids and nutrient loads and yields for the Galena River gaging stations, 1981 and 1982 water years

Station name	Suspended solids		Volatile solids		Kjeldahl nitrogen		Total phosphorus	
	Annual load (tons)	Annual yield (tons per mi^2)	Annual load (tons)	Annual yield (tons per mi^2)	Annual load (tons)	Annual yield (tons per mi^2)	Annual load (tons)	Annual yield (tons per mi^2)
				1981 water year				
Madden Branch tributary	649	229	49	17.3	6,962	2,460	1,540	542
Pats Creek	1,080	200	114	21.2	13,500	2,500	3,690	682
Apple River	1,280	137	145	15.5	17,500	1,880	4,310	463
Madden Branch	3,610	239	312	20.7	45,700	3,020	11,300	749
				1982 water year				
Madden Branch tributary	2,090	740	199	70.2	22,800	8,070	5,870	2,070
Pats Creek	1,670	310	242	44.9	38,300	7,100	9,460	1,750
Apple River	2,640	284	344	36.9	46,800	5,030	13,000	1,400
Madden Branch	10,300	684	1,070	70.8	129,000	8,530	34,600	2,290

Table 25. Constituent loads and percentage of annual load for Madden Branch tributary for selected storms

Dates of storms	Suspended solids		Volatile solids		Kjeldahl nitrogen		Total phosphorus	
	Load (tons)	Percentage of annual load	Load (tons)	Percentage of annual load	Load (tons)	Percentage of annual load	Load (tons)	Percentage of annual load
				1981 water year				
Feb. 22-23	537	83	34	69	4,180	60	1,070	70
Apr. 11-15	5	<1	.5	<1	122	2	26	1
June 15-16	21	3	2	5	278	4	73	5
June 21-22	12	2	1	2	138	2	33	2
Aug. 14-15	.1	<1	.1	<1	20	<1	2	<1
				1982 water year				
Oct. 17-18	1	<1	.1	<1	40	<1	8	<1
Mar. 12-14	380	18	21	10	5,210	23	1,170	20
Mar. 16	190	9	18	9	2,110	9	450	8
Mar. 20	157	8	9	5	1,400	6	246	4
July 10	1,140	55	112	56	7,550	33	2,470	42
Aug. 4	93	4	14	7	926	4	312	5
Aug. 7-8	.2	<1	.2	<1	72	<1	13	<1

Table 26. Constituent loads and percentage of annual load for Pats Creek for selected storms

Dates of storms	Suspended solids		Volatile solids		Kjeldahl nitrogen		Total phosphorus	
	Load (tons)	Percentage of annual load	Load (tons)	Percentage of annual load	Load (tons)	Percentage of annual load	Load (tons)	Percentage of annual load
				1981 Water Year				
Feb. 22-23	981	91	90	79	10,100	75	2,880	78
Apr. 11-15	2.5	<1.0	.4	<1	99	1	24	1
June 15-16	10	<1.0	1.5	1	251	2	64	2
June 21-22	4	<1.0	.7	<1	94	<1	27	<1
Aug. 14-15	.2	<1.0	.4	<1	16	<1	3	<1
				1982 Water Year				
Oct. 17-18	7	<1.0	1	<1	171	<1	45	<1
Mar. 12-14	614	37	82	34	12,100	32	2,990	32
Mar. 16	340	20	38	16	5,280	14	1,450	15
July 10	221	13	32	13	2,430	6	814	9
Aug. 4	161	10	25	10	2,050	5	657	7
Aug. 7-8	1	<1	.6	<1	77	<1	15	<1

Table 27. Constituent loads and percentage of annual load for Apple River for selected storms

Dates of storms	Suspended solids		Volatile solids		Kjeldahl nitrogen		Total phosphorus	
	Load (tons)	Percentage of annual load	Load (tons)	Percentage of annual load	Load (tons)	Percentage of annual load	Load (tons)	Percentage of annual load
				1981 Water Year				
Feb. 22-23	391	31	37	26	4,550	26	1,080	25
Apr. 11-15	15	1	4	3	397	2	189	4
June 15-16	636	50	65	45	4,850	28	1,580	36
June 21-22	2	<1	1	<1	74	<1	11	<1
Aug. 14-15	70	5	13	9	780	4	312	7
				1982 Water Year				
Oct. 17-18	900	34	54	16	7,030	15	2,820	22
Mar. 12-14	789	30	77	22	10,100	22	2,770	21
Mar. 16	253	10	34	10	3,750	8	1,070	8
July 10	1	<1	.1	<1	42	<1	6	<1
Aug. 4	3	<1	22	6	2,920	6	1,020	8
Aug. 7-8	130	5	15	4	1,540	3	508	4

Table 28. **Constituent loads and percentage of annual load for Madden Branch for selected storms**

Dates of storms	Suspended solids		Volatile solids		Kjeldahl nitrogen		Total phosphorus	
	Load (tons)	Percentage of annual load	Load (tons)	Percentage of annual load	Load (tons)	Percentage of annual load	Load (tons)	Percentage of annual load
				1981 Water Year				
Feb. 22-23	3,160	88	230	74	25,600	56	7,130	63
Apr. 11-15	50	1	3	1	1,370	3	473	4
June 15-16	46	1	7	2	1,140	2	271	2
June 21-22	20	<1	4	1	525	1	157	1
Aug. 14-15	5	<1	1	<1	215	<1	58	<1
				1982 Water Year				
Oct. 17-18	9	<1	2	<1	285	<1	68	<1
Mar. 12-14	3,200	31	324	30	35,500	28	9,570	28
Mar. 16	1,150	11	101	9	13,200	10	3,330	10
Mar. 20	600	6	60	6	9,500	7	2,600	8
July 10	3,820	37	333	31	28,500	22	9,220	27
Aug. 4	399	4	51	5	3,980	3	1,390	4
Aug. 7-8	4	<1	1	<1	206	<1	54	<1

Table 29. **Pesticide analyses of bed material and water column for the Galena River gaging stations**

Station name	Discharge (ft^3/s)	Alachlor	Foutofos	Turbofos	Carbofuran	Atrazine
			Bed material assay in ppm, June 19, 1981 1/			
Madden Branch tributary	1.2	<0.05	<0.02	<0.02	<0.1	<0.01
Pats Creek	1.4	<.05	<.02	<.02	<.1	<.01
Apple River	8.8	<.05	<.02	<.02	<.1	.03
Madden Branch	10	<.05	<.02	<.02	<.1	<.01
			Water column assay in ug/L, June 15, 1982 2/			
Madden Branch tributary	4.4	3.2	.17	<.3	<.5	5.5
Pats Creek	9.5	5.5	<.1	<.2	<.1	6.6
Apple River	28	9	<.1	<.2	<.2	11
Madden Branch	26	16	<.1	<.7	<.2	9.9

1/ Analyses by Raltech Scientific Services, P.O. Box 7545, Madison, Wis.
2/ Analyses by Wisconsin State Laboratory of Hygiene, Madison, Wis.

☆U.S. GOVERNMENT PRINTING OFFICE 1986—644-36S/1063