STATE OF LOUISIANA
DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT
OFFICE OF PUBLIC WORKS

WATER RESOURCES
TECHNICAL REPORT
NO. 30

WATER QUALITY OF THE UPPER VERMILION RIVER, LOUISIANA, APRIL-AUGUST 1980

Prepared by
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
In cooperation with
LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT
OFFICE OF PUBLIC WORKS

1983

STATE OF LOUISIANA

DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

OFFICE OF PUBLIC WORKS

Water Resources

TECHNICAL REPORT NO. 30

WATER QUALITY OF THE UPPER VERMILION RIVER, LOUISIANA, APRIL-AUGUST 1980

By

Dennis K. Demcheck and Harold L. Leone, Jr.
U.S. Geological Survey

Prepared by

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

In cooperation with

LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

OFFICE OF PUBLIC WORKS

1983

STATE OF LOUISIANA

DAVID C. TREEN, Governor

DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

PAUL J. HARDY, Secretary

OFFICE OF PUBLIC WORKS

DARRELL WILLIAMSON, Assistant Secretary

Cooperative projects with

UNITED STATES DEPARTMENT OF THE INTERIOR

JAMES G. WATT, Secretary

GEOLOGICAL SURVEY

DALLAS L. PECK, Director

CONTENTS

ILLUSTRATIONS

[Plate is at back]

TABLES

CONVERSION FACTORS

For use of readers who prefer to use metric units, conversion factors for terms used in this report are listed below:

Multiply	By	To obtain
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
foot (ft)	0.3048	meter (m)
foot per second (ft/s)	0.3048	meter per second (m/s)
micromho per centimeter at 25° Celsius (μmho/cm at 25°C)	1	microsiemens per centimeter at 25° Celsius (μmho/cm at 25°C)
mile (mi)	1.609	kilometer (km)
million gallons per day (Mgal/d)	3.785×10^3	cubic meter per day (m^3/d)
	1.548	cubic foot per second (ft^3/s)
pound (lb)	0.4536	kilogram (kg)
square mile (mi^2)	2.590	square kilometer (km^2)
ton per day (ton/d)	0.9072	megagram per day (Mg/d)

To convert temperature in degree Celsius (°C) to degree Fahrenheit (°F), multiply by 9/5 and add 32.

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, called NGVD of 1929.

diverted into Bayou Fusilier (the headwaters of the Vermilion River), to Milton, La., 6 mi downstream from Lafayette. (See pl. 1.) The area of greatest concern was the 23-mi reach of the Vermilion River from the State Highway 726 bridge (site 5) to the State Highway 3073 bridge (site 8). Three tributaries to the upper Vermilion River, Bayou Fusilier, Bayou Carencro, and Bayou Bourbeaux, were also included in the study.

Basin Description

Bayou Teche and the Vermilion River are in the West Gulf Coastal Plain section of the Coastal Plain physiographic province (Fenneman, 1946). The Vermilion River drains a 652 mi^2 area lying between the Mermentau River watershed on the west and the Bayou Teche ridge on the east. The river can be separated into two distinct sections, the upper and lower Vermilion River. The upper Vermilion River, as used in this report, begins at the confluence of Bayou Bourbeaux and Bayou Fusilier, is about 28 mi long, and extends to the southern part of the City of Lafayette. It has a broad valley, and its banks are only slightly higher than the adjacent lands. The lower Vermilion River, about 33 mi long, begins downstream from Lafayette and flows into Vermilion Bay. It has high banks and a well-defined stream valley. The flow of the Vermilion River, from Lafayette downstream, is affected by tidal fluctuations at all stages and the flow direction can reverse, depending on the tide and discharge (Calandro, 1981).

Bayou Fusilier, a small alluvial stream about 6 mi in length, connects the Vermilion River with Bayou Teche at Arnaudville; thus, the Vermilion River functions as a distributary of Bayou Teche. An average of about 25 percent of the flow of Bayou Teche is normally diverted through this channel into the Vermilion River, although a small earthen dam prevents flow at stages below about 10 ft above NGVD of 1929 (National Geodetic Vertical Datum of 1929). The mean gage reading at Bayou Teche at Arnaudville, 1965-72, was 10.70 ft, and the mean discharge was 707 ft^3/s (U.S. Army Corps of Engineers, 1976).

The Ruth (also known locally as Evangeline) Canal, about 4 mi long, connects Bayou Teche with the Vermilion River just upstream from Lafayette. It was built by private interests for diverting water from Bayou Teche into the Vermilion River for rice irrigation. Water may be diverted only when the flow in Bayou Teche at Keystone Dam (about 16 mi downstream from Ruth Canal) exceeds 100 ft^3/s.

Data Collection and Analyses

This study was designed to determine the water-quality characteristics of the upper Vermilion River during varying hydrologic conditions. High-flow rates during the spring and low-flow rates during the summer were, therefore, of particular interest. Initial samples were collected at sites 5 through 9, April 10, 1980, during the early heavy spring rains.

Degraded water quality upstream of the City of Lafayette (site 5) led to the selection of four additional sampling sites (sites 1-4). The major sampling during high flow was in two phases. Samples were collected on May 12 to represent the quality of the river during sustained downstream flow, and again on May 17 to represent the quality of the river immediately following a heavy basin-wide rainstorm. Low-flow samples were collected once on August 8 when streamflow was near zero at most sites.

The four sites selected to better define water quality in the headwaters were Bayou Teche (site 1), Bayou Fusilier (site 2), Bayou Bourbeaux (site 3), and Bayou Carencro (site 4). Bayou Bourbeaux (site 3) is generally about 2 ft in depth and flows slowly (less than 0.5 ft/s). Bayou Carencro (site 4) is often completely dry. Bayou Fusilier (site 2) is a distributary of Bayou Teche (site 1), which is the main source of water to the Vermilion River. These sites were sampled for biochemical oxygen demand (BOD) and fecal bacteria. Measurements of conductance, dissolved oxygen, pH, and temperature were made in the field using a four-parameter Hydrolab[1] Model 4041 field monitor.

Water quality was monitored at five sites on the main stem of the Vermilion River. Of these five sites, two were major water-quality sampling sites. One site was located about 2 mi downstream from the confluence of the Vermilion River and Bayou Carencro (site 5). It was chosen to represent the water entering the Lafayette urban area. The other major water-quality site (site 8) was located just downstream from the city. Site 8 has been operated since 1970 as a monthly sampling site for chemical constituents. Analyses of samples collected during the 1980 water year are listed in table 8. A four-parameter monitor (installed at this site in water year 1970) continuously measured dissolved oxygen (DO), specific conductance, pH, and temperature during the study period. (See table 9.) Data collected at site 8 since 1970 has been published annually by the U.S. Geological Survey in Water Resources Data for Louisiana. (See Selected References.) Data from the two major sites were analyzed to determine the influences of Lafayette and the upper basin on the water quality of the Vermilion River. Two other sites (6 upstream of the city at Highway 353 and 7 at Highway 90) were selected to better define local changes as the river passed through the urban area. The fifth Vermilion River site (site 9 at Highway 92) was selected 6 mi downstream from Lafayette, at Milton, La., to detect any potential recovery zone.

Water samples collected at sites 5 and 8 were analyzed for inorganics, nutrients, metals, pesticides, and phytoplankton. Bed material was collected for determination of metals and pesticides. Benthic invertebrates and fecal bacteria were collected at all five Vermilion River sites. Measurements of temperature, pH, DO, and specific conductance were also made in the field at the five sites on the main stem of the Vermilion River.

---

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

Within the Lafayette metropolitan area are four wastewater treatment plants. Average monthly BOD in effluent from these plants is given in table 2 for April, May, and August.

Samples of water and bed material were analyzed for chemical constituents using methods approved by the U.S. Geological Survey (Skougstad and others, 1979). The samples were prepared for analysis onsite in a mobile laboratory and stored, according to recommended procedures, until they could be shipped to the laboratory for analysis. Analyses for fecal bacteria and BOD were performed onsite in the mobile laboratory. Benthic-invertebrate samples were sieved and preserved onsite, organisms were identified in the District laboratory, and identifications were confirmed at the U.S. Geological Survey Central Laboratory in Doraville, Ga. Grain-size analyses were performed in the District sediment laboratory, according to methods outlined by Guy (1969).

WATER QUALITY

Streamflow Considerations

The Vermilion River is a sluggish, slow-flowing river. The upper Vermilion River generally maintains downstream flow, but sustained downstream flow diminishes as the river approaches Lafayette. The entire river has sustained downstream flow only during periods of frequent rainfall. The contributions of Bayou Bourbeaux and Bayou Carencro to the flow of the Vermilion River are slight, except during periods of heavy rainfall. As a large percentage of the flow in the upper Vermilion River originates from Bayou Teche, water upstream from Lafayette reflects water-quality conditions not only in the Vermilion River basin but in the upper Bayou Teche basin as well.

During periods of high flow, generally in the spring, runoff from heavy local storms in the upper Vermilion watershed can cause a reversal of flow in Bayou Fusilier toward Bayou Teche. If substantial rainfall occurs immediately west of Lafayette, Coulee Ile des Cannes can create a backwater effect in the Vermilion River just downstream from Lafayette. Both of these conditions occurred during the May 17, 1980 sampling trip. During periods of extreme low flow, which usually occur in the summer and early fall, the river virtually stagnates throughout the study reach. Flow is sluggish or nil and can move in either the upstream or downstream direction, dependent upon the tides. This stagnation and reversal of flow is especially apparent downstream from Lafayette.

Because of the variability of the Vermilion River streamflow during both high- and low-flow periods, a rigorous definition of streamflow was not attempted. Rather, a single site (site 6) was chosen at which to measure discharge in order to give an indication of the streamflow conditions prevalent at the time of sampling.

The Vermilion River is often limited in its ability to dilute and assimilate wastes. The least desirable water-quality conditions would be expected to occur during extreme low flow, when tidal effects are most pronounced. The river can best handle waste loads during periods of heavy and frequent rainfall.

Specific Conductance

Specific conductance is a measure of the ability of water to conduct an electric current. The presence of charged ionic species in solution makes the solution conductive. As ion concentrations increase, conductance of the solution increases; therefore, the specific conductance provides an indication of ion concentration. The relation between specific conductance and dissolved solids can be expressed by $KA = S$, where K is conductance in micromhos per centimeter at 25° Celsius, S is dissolved solids in milligrams per liter, and A is a conversion factor, which generally ranges between about 0.55 and 0.75 (Hem, 1970, p. 99). Based on the limited data on major ions in Vermilion River water (tables 4 and 8), the approximate concentration of dissolved solids can be estimated by multiplying specific conductance by 0.63. Specific conductance measurements, thus, are a useful first step in the investigation of the quality of natural waters.

As a result of tidal movement and other factors, such as ground-water inflow during base flow and withdrawal of water for irrigation, conductance can vary throughout the study reach and may not be solely ascribable to a specific influence. For example, during low flow downstream from Lafayette, tidal influences create a temporary backwater, effectively storing the water until low tides enable the river to slowly flush out the stagnant water. This storage of water is one factor that contributes to increased specific conductance, as any inputs tend to remain localized until the tides permit downstream flow. Upstream from Lafayette (above site 5) there is some continuous downstream flow. This prevents any inputs from remaining localized and generally results in lower conductance values.

On April 10, 1980, discharge was 3,300 ft^3/s at site 6. Conductance in the main stem of the Vermilion River ranged from 90 μmhos/cm (micromhos per centimeter) at site 5 to 101 μmhos/cm at site 9 (fig. 1).

On May 12, flow had decreased to 477 ft^3/s at site 6. The conductance at sites 1 and 2 was 85 and 86 μmhos/cm, respectively (table 1), while site 3 had a conductance of 1,140. The inflow from Bayou Bourbeaux (site 3) apparently was one factor in increasing the conductance of the main stem of the upper Vermilion River, where values ranged from 124 μmhos/cm at site 5 to 158 at site 8. At site 9 the conductance increased to 252 μmhos/cm, probably due to input from Coulee Ile des Cannes, which drains areas to the west.

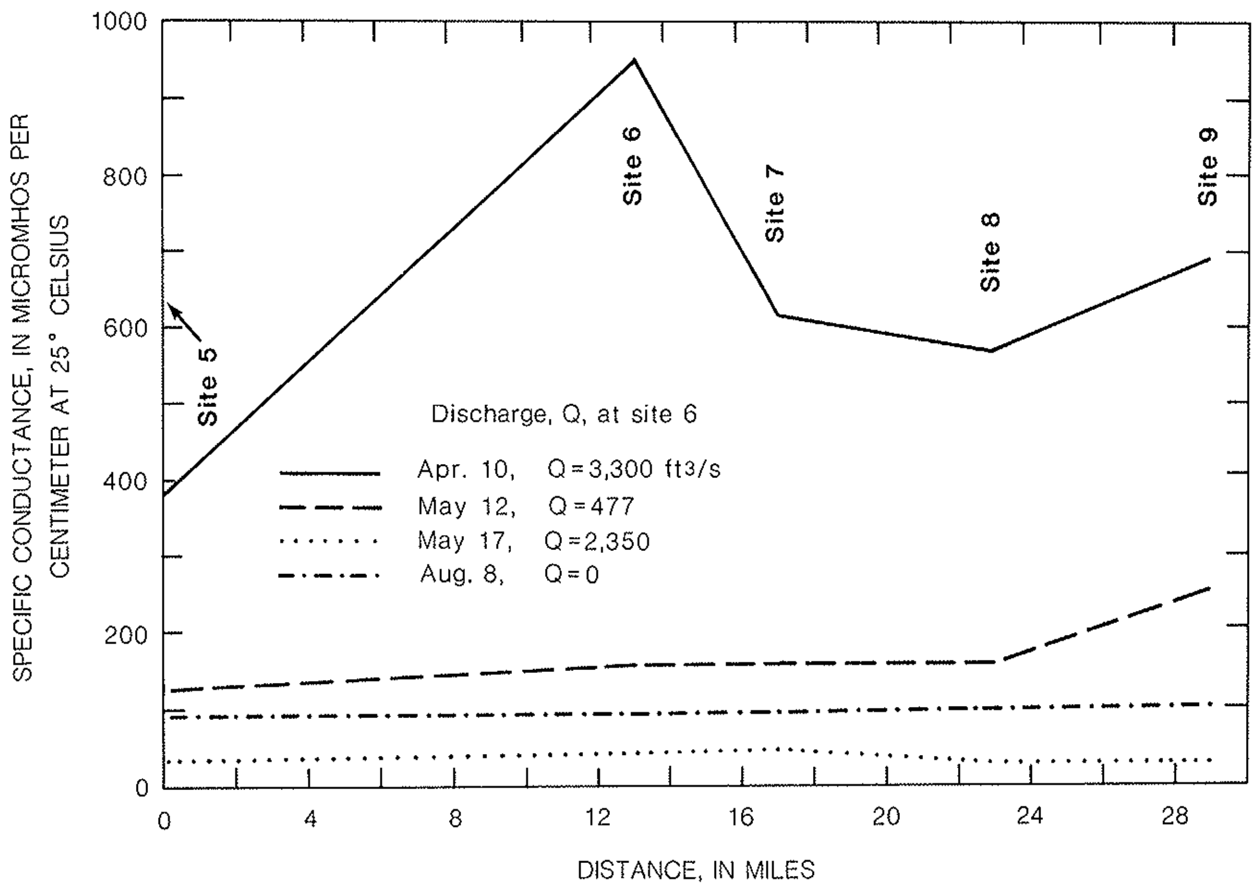

Figure 1.--Specific-conductance values at five sites (5-9) on the Vermilion River during four different discharge conditions.

The heavy rains of May 15-16 increased the discharge to 2,350 ft^3/s at site 6 on May 17. The conductance at site 3 decreased dramatically, from 1,140 to 17 μmhos/cm in 5 days. The conductance of the Vermilion main stem also decreased and ranged from 28 to 46 μmhos/cm. The lowest conductance levels measured during the study period were for the storm-event of May 17, although the discharge at site 6 was not as great as on April 10.

When discharge decreased to zero at site 6 on August 8, conductance levels increased greatly. Conductance levels in the headwaters were quite uniform. Sites 1 and 2 had identical conductances of 390 μmhos/cm, while site 3 had a conductance of 389 μmhos/cm. Conductances on the main stem of the upper Vermilion River, however, were much more variable, ranging from 380 to 945 μmhos/cm. At site 6, just upstream from Lafayette, the river was stagnant. When flow is near zero any input from the area just upstream from site 6 tends to remain localized in that area and, thus, could be responsible for the increase in conductance that was noted there. The major ions that contributed to the difference in specific conductance between sites 5 and 8 were sodium and chloride. During times of stagnant conditions in the river, it is difficult to determine whether the increase originated upstream or downstream from site 8.

Table 1.--Biochemical oxygen demand, fecal bacteria, and parameters measured onsite for nine sites on the Vermilion River and its tributaries

[BOD, biochemical oxygen demand; FC, fecal coliform; FS, fecal streptococci; DO, dissolved oxygen]

Site No.	BOD (mg/L)	FC colonies/ 100 mL	FS colonies/ 100 mL	FC/FS ratio	Temperature (°C)	DO (mg/L)	pH	Specific conductance (µmho/cm)
				April 10, 1980				
5	3.4	260	400	0.65	20.1	4.3	6.0	90
6	5.0	50	120	.42	19.2	3.0	5.8	94
7	3.1	100	200	.5	19.1	2.8	5.8	95
8	1.8	750	300	2.5	19.4	3.3	5.9	99
9	7.0	400	300	1.3	19.8	3.4	5.9	101
				May 12, 1980				
1	2.9	150	200	0.75	23.7	4.9	6.3	85
2	3.1	300	300	1.0	24.6	5.6	6.3	86
3	4.3	250	450	.56	28.0	4.6	7.2	1,140
[a]4	---	------	------	----	----	---	---	-----
5	2.7	250	300	.83	23.8	5.4	6.4	124
6	2.1	300	360	.83	24.7	4.5	6.4	157
7	2.5	100	180	.56	24.9	4.0	6.3	158
8	2.8	450	340	1.32	25.3	3.3	6.4	158
9	2.8	250	140	1.79	25.5	3.0	6.5	252
				May 17, 1980				
1	1.8	30,000	56,000	0.54	22.2	6.1	6.4	44
2	2.4	17,500	47,000	.37	21.4	6.6	6.0	27
3	2.0	13,500	23,000	.59	20.8	7.6	5.5	17
4	1.8	20,500	31,000	.66	20.0	6.9	5.5	24
5	2.0	10,000	11,500	.87	20.6	6.2	5.7	33
6	1.6	7,000	10,500	.67	21.1	6.2	5.9	43
7	2.0	22,500	75,500	.30	20.7	6.0	6.0	46
8	1.8	11,500	12,500	.92	20.5	6.2	5.7	29
9	1.5	10,500	6,500	1.62	20.9	6.3	5.7	28
				August 8, 1980				
1	0.9	205	390	0.53	30.3	3.5	7.0	390
2	2.6	290	670	.43	29.8	4.3	7.0	390
3	3.6	4,200	10,450	.40	28.1	2.1	7.0	389
[b]4	---	------	------	----	----	---	---	-----
5	1.6	275	6,150	.04	31.5	3.2	6.8	379
6	6.6	65	185	.35	31.9	5.2	7.1	944
7	2.1	215	250	.86	30.7	4.6	7.0	612
8	6.1	220	250	.88	31.2	7.8	7.2	565
9	5.1	190	170	1.12	30.8	5.8	6.9	685

[a] Shallow, stagnant. [b] Dry.

The data on specific conductance collected by the continuous monitor at site 8 are listed in table 9. In spring, downstream flow occurred for much of the time, and the conductance was about 200 micromhos or less. As flow decreased through the summer and the river began to stagnate, dissolved solids increased, and the conductance increased dramatically. Maximum conductance during the 1980 water year occurred in August and September 1980.

Dissolved-Oxygen and Biochemical Oxygen Demand

The solubility of oxygen in water is a temperature dependent variable that influences many aspects of water quality. The health of a river is contingent upon the differential rates of oxygen depletion and replenishment by various physical, chemical, and biological means. At least 5.0 mg/L of DO is considered necessary to maintain a healthy and diverse fish population, and 4.0 mg/L is cited as the minimum concentration necessary to maintain a sizeable population of pollution-tolerant species (U.S. Environmental Protection Agency, 1976). The Louisiana State criteria are similar (Louisiana Stream Control Commission, 1977). On April 10 the discharge at site 6 was 3,300 ft^3/s. A DO of 4.3 mg/L (fig. 2) was recorded at site 5. There was a sag to 2.9 mg/L at site 7, and a slight recovery to 3.4 mg/L at site 9.

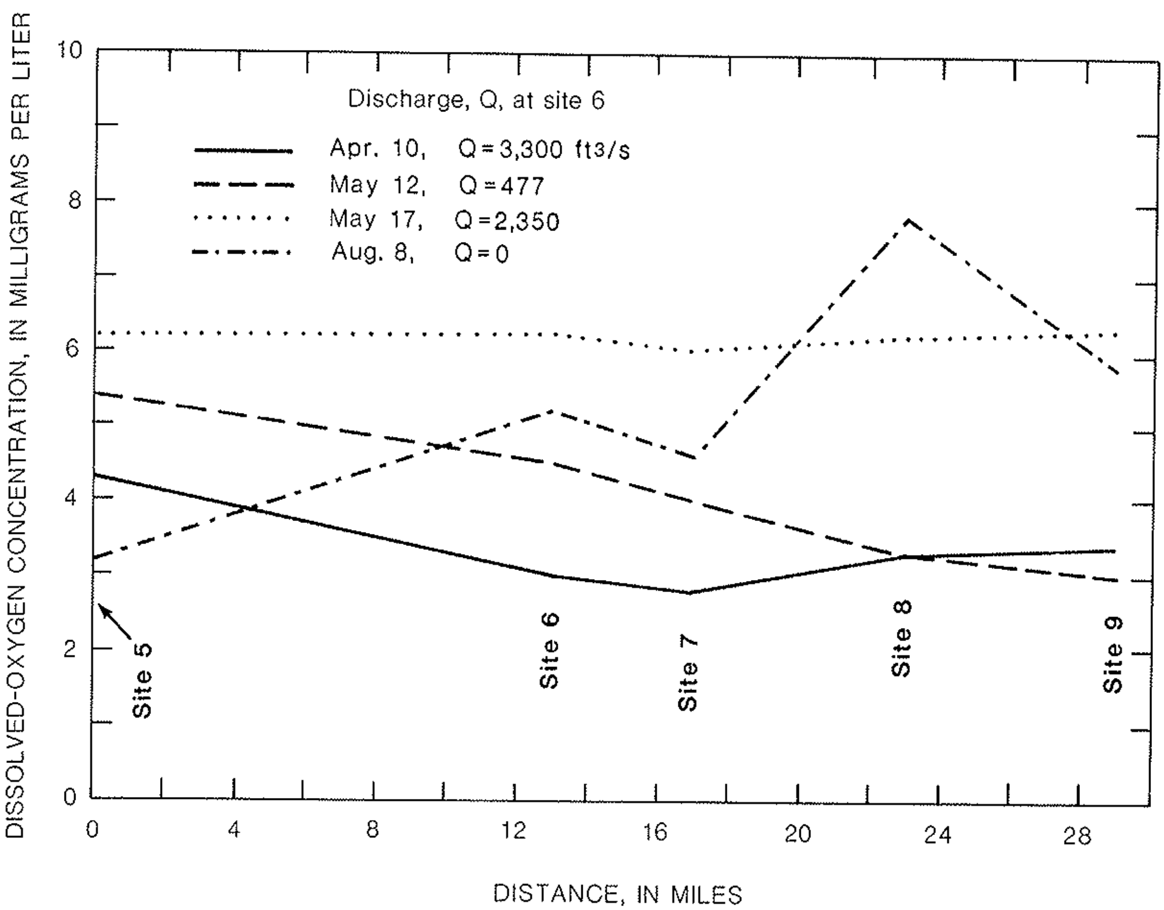

Figure 2.--Dissolved-oxygen concentrations at five sites (5-9) on the Vermilion River during four different discharge conditions.

Table 2.--BOD concentration, discharge, and BOD load at site 6 and average BOD concentration, discharge, and BOD load from the City of Lafayette wastewater treatment plants, 1980

Date (1980)	BOD concentration (mg/L)	Discharge (ft^3/s)	BOD load (tons/d)
SITE 6			
April 10------	5.0	3,300	44.6
May 12--------	2.1	477	2.70
May 17--------	1.6	2,350	10.2
August 8------	6.6	0	0
CITY OF LAFAYETTE WASTEWATER TREATMENT PLANTS (AVERAGES)[1]			
South Plant			
April---------	3	11.1	0.090
May-----------	4	11.1	.120
August--------	5	11.1	.150
East Plant			
April---------	22	4.8	0.285
May-----------	19	4.8	.246
August--------	15	4.8	.194
Broadmoor			
April---------	9	0.37	0.009
May-----------	9	.37	.009
August--------	6	.37	.006
Oxidation Pond			
April---------	7	0.23	0.004
May-----------	5	.23	.003
August--------	7	.23	.004

[1] Based on data from City of Lafayette, Department of Wastewater Treatment.

As the discharge decreased, the BOD contribution from the urban area, including the City of Lafayette wastewater treatment plants (table 2) became more apparent. Discharge decreased to 477 ft^3/s on May 12. Dissolved-oxygen concentrations increased from 4.9 mg/L at site 1 to 5.6 mg/L at site 2. There was a slight decrease to 5.4 mg/L at site 5, probably due to the inflow of water with a DO of 4.6 mg/L from Bayou Bourbeaux (site 3). However, there was a steady decrease in DO through the city and beyond to a concentration of 3.0 mg/L at site 9, with no noticeable recovery.

After heavy rains May 15-16, the discharge at site 6 increased to 2,350 ft^3/s on May 17. Dissolved-oxygen concentrations on the main stem of the Vermilion River were uniform, varying only from 6.0-6.3 mg/L. At this discharge, influences of the BOD contribution of the urban area on DO in the Vermilion River were virtually negligible.

Although the April 10 and May 17 studies were conducted during periods of relatively high, sustained discharge, differences in DO and BOD concentrations are evident between the two investigations. On April 10, the BOD load from Lafayette was masked because of the large BOD load from the upper basin (above site 5, table 2). This large BOD load created a DO sag in the urban area, which recovered slightly at sites 8 and 9 (fig. 2). Figure 3 shows that the BOD concentrations decreased through the urban area, further confirming that the urban BOD contributions were not great.

On May 17 the BOD concentrations were much lower than on April 10, even with a lesser discharge, indicating that much of the biodegradable waste was flushed from the basin with the earlier rains. The fact that the DO concentrations downstream from Lafayette increased slightly during the April 10 and May 17 investigations showed that during high-discharge periods the Vermilion River could assimilate the BOD inputs from the Lafayette area without any noticeable affect on DO.

The DO profiles based on data collected on August 8-9 show the influence of high phytoplankton concentrations in the Lafayette area, especially at site 8. Very slight downstream flow, about 0.2 ft/s, probably helped to inhibit the buildup of algae at site 5, but the water was stagnant throughout the rest of the study reach. The DO graph (fig. 2) shows what appears to be improving conditions downstream from Lafayette, but the high DO values probably were due to photosynthetic activity of algae. Site 6 (located at the upstream end of the urban area) showed an increase of BOD concentrations, and downstream from Lafayette at sites 8 and 9 the increase in BOD concentrations was evident. Without substantial flow to carry the BOD loads downstream, algal concentrations increased, BOD concentrations accumulated in stagnant reaches, and large diel (24-hour) fluctuations in DO occurred.

During much of the study, the river was stagnant and often behaved as a lake, storing nutrients and other wastes. For this reason, a study was conducted on August 8-9 to determine diel oxygen fluctuations at sites 5, 6, and 8 (fig. 4). Dissolved-oxygen concentrations on August 9 did not increase to the levels recorded on August 8 because of the

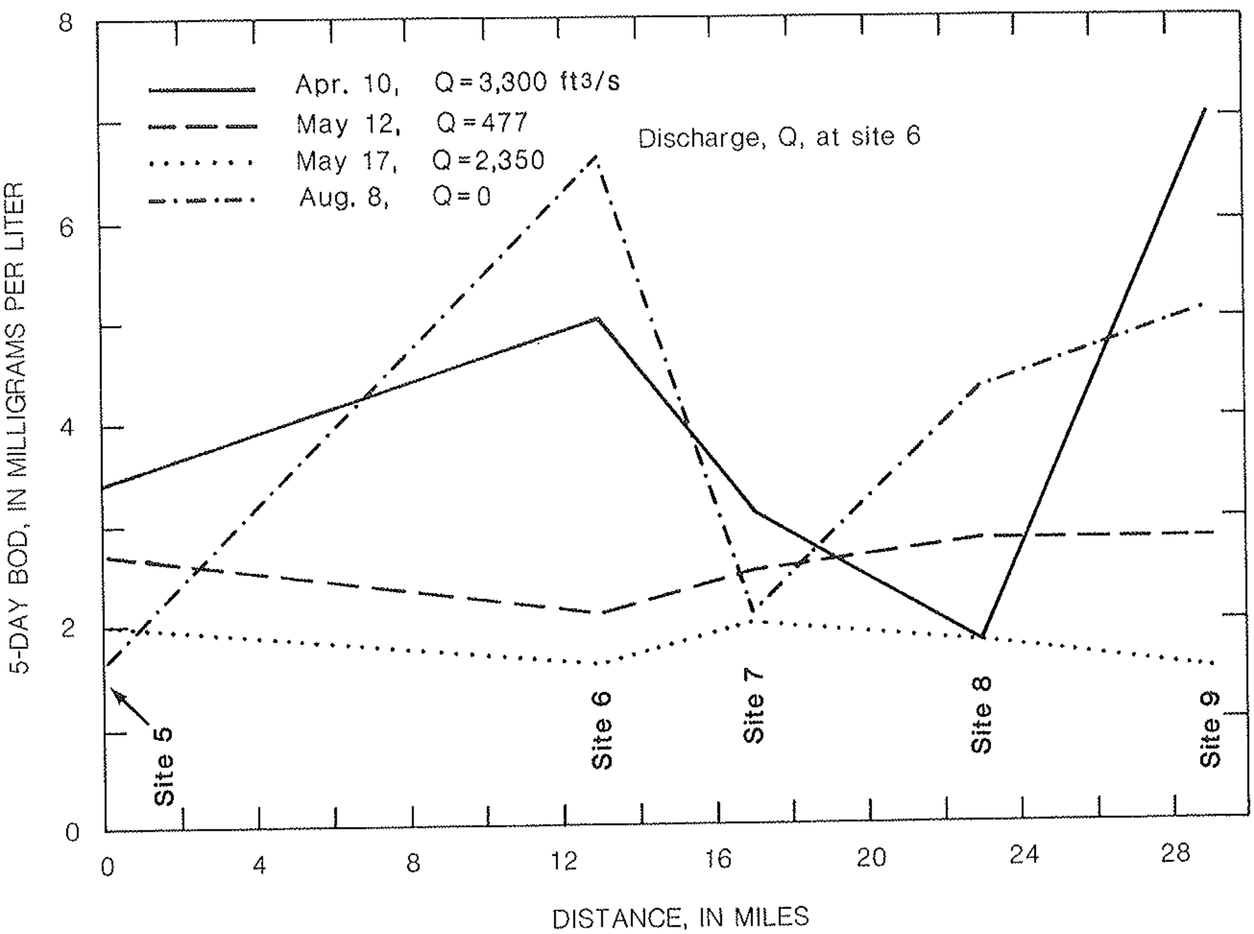

Figure 3.--Five-day biochemical oxygen demand at five sites (5-9) on the Vermilion River during four different discharge conditions.

occurrence of afternoon thundershowers. At site 5 the diel variations in DO ranged from 3.2 mg/L to 2.9 mg/L. However, at site 6 the diel variations ranged from 5.2 mg/L to 2.7 mg/L, indicating a substantial amount of photosynthetic activity. At site 8 the diel variations ranged from 7.8 mg/L to 3.5 mg/L, and algae in the water were apparent to even the casual observer. (See section, "Productivity and Eutrophication".)

The daily maximums and minimums of the DO data recorded by the monitor at site 8 are presented in table 9. The concentrations reflect the depressed oxygen levels that prevailed in the Vermilion River except during very short periods of heavy rainfall, such as April 13. In general, the DO at site 8 ranged between 2.5 and 5.0 mg/L during April and May, when downstream flow prevailed, and then fell below 2.0 mg/L for June and the first week in July as flow decreased and the river stagnated. Data for the last three weeks in July show the effects of the stagnation at site 8, which occurred when streamflow was zero. The large, daily

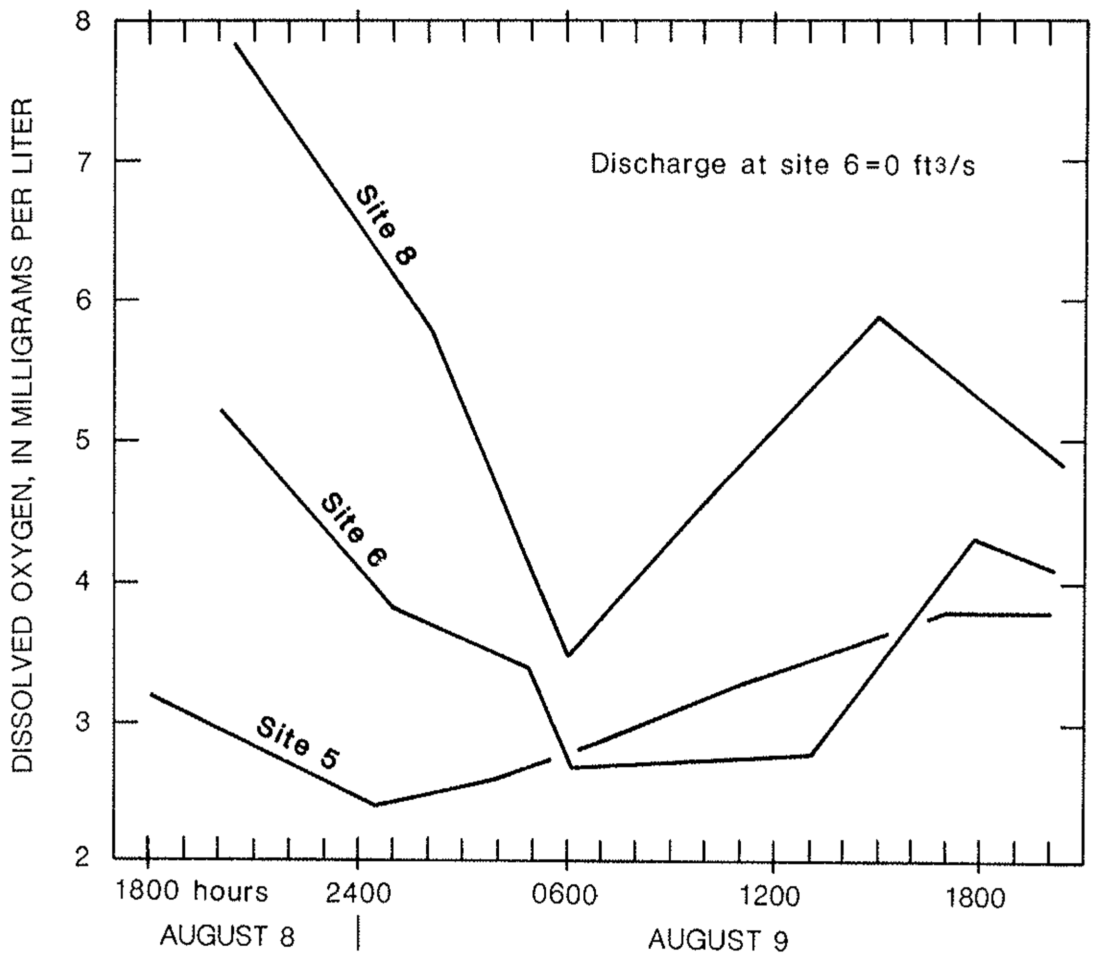

Figure 4.--Variation in dissolved oxygen in the Vermilion River during a 24-hour period, August 8-9, 1980.

fluctuations in oxygen reflect variations in photosynthetic activity, superimposed on the BOD load. Biochemical oxidation of the BOD load during the night depresses the DO concentrations, which has the effect of increasing the magnitude of the diel fluctuations.

Temperature and pH

Determinations of temperature and pH at sites 5 through 9 (table 3) show negligible differences upstream and downstream from Lafayette. In general, temperature and pH were lowest following heavy rains, as on May 17. Temperature and pH were highest during the period of stagnant conditions and increased photosynthetic activity on August 8.

Table 3.--Temperature and pH for five sites on the Vermilion River on four different dates

	Date (1980)	Sites				
		5	6	7	8	9
Temperature (°C)-----	Apr. 10	20.0	19.5	19.0	19.5	20.0
	May 12	24.0	24.5	25.0	25.0	25.5
	May 17	20.5	21.0	21.0	20.5	21.0
	Aug. 8	31.5	32.0	31.0	31.0	31.0
pH------------------	Apr. 10	6.0	5.8	5.8	5.9	5.9
	May 12	6.4	6.4	6.3	6.4	6.5
	May 17	5.7	5.9	6.0	5.7	5.7
	Aug. 8	6.8	7.1	7.0	7.2	6.9

The temperature and pH data collected at site 8, which are typical of conditions on the main stem of the upper Vermilion River, are included in table 9. The pH data show that the water was generally slightly acidic (<7.0) during periods of runoff and downstream flow, and became slightly alkaline when flow decreased and photosynthetic uptake of CO_2 by algae increased. Temperature followed the general pattern of increasing gradually throughout the summer months to maxima in August, the hottest month of the year in southern Louisiana. Some temporary decreases were noted following increased storm runoff due to large inputs of cooler rainwater.

Inorganic Constituents

Major Ions

Inorganic constituents were determined for samples collected on April 10 at site 8. The predominant cations were sodium and calcium, and chloride and bicarbonate were the predominant anions. During sustained downstream flow on May 12, the predominant cations at sites 5 and 8 were sodium and calcium, and bicarbonate, chloride, and sulfate were the predominant anions. Increases in all major ions except potassium were noted between sites 5 and 8. The greatest increases between these locations were in chloride and sulfate. (See table 4.) It can be inferred from the conductance graph (fig. 1) that most of the increase in dissolved constituents occurred between sites 5 and 6, just upstream from the city. There was no significant increase in specific conductance through the City of Lafayette. On May 17, the greatly increased discharge (2,300 ft^3/s at site 6) resulted in lower concentrations of major ions. Potassium concentrations, however, remained at approximately the same levels as on May 12. Conductance was low and uniform throughout the study reach, and there was little difference between the ion concentrations at sites 5 and 8.

Table 4.--Concentrations of major ions at two sites on the Vermilion River on four different dates

Site No.	Date (1980)	Specific conductance (µmhos/cm)	Dissolved constituents, in milligrams per liter: Sodium (Na)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)	Chloride (Cl)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Fluoride (F)	Silica (SIO_2)	Sum of determined constituents
[a]8	Apr. 10	95	6.4	2.9	8.0	1.9	10	33	3.7	0.0	6.0	55
5	May 12	124	11	2.5	7.7	3.2	9.3	42	12	---	----	67
8	May 12	158	14	2.1	10	3.7	19	46	19	---	----	91
5	May 17	33	3.0	2.2	2.2	.7	4.6	10	1.7	---	----	19
8	May 17	29	1.8	2.0	3.0	.5	2.5	12	1.5	---	----	17
5	Aug. 8	370	29	3.7	28	11	36	135	18	---	----	193
8	Aug. 8	556	64	5.1	30	11	92	141	24	.2	16	313

[a] See table 8 for analyses of routine monthly samples collected at site 8.

During the period of stagnant conditions on August 8, conductance increased at all sites, probably due to evaporation, lack of inflow, and a greater effect from ground-water contributions (G. T. Cardwell, oral commun.). From figure 1 it can be inferred that the concentration of dissolved solids at site 5 was much less than at site 6 and at other sites further downstream. This is partially due to the approximately 0.2 ft/s downstream flow at site 5 at this time. At all other sites flow was at or near zero, and dissolved inorganics were greatly increased compared to concentrations at site 5. The greatest increase was seen at site 6. The differences between the major-ion compositions at sites 5 and 8 were due to increases in sodium and chloride. The origin of these increases is unclear. It appears from the conductance graph (fig. 1) that most of the increase occurred upstream from site 6. At sites 7 and 8, the conductance values decreased considerably. Another increase appeared at site 9. It is difficult to say whether the increases in sodium and chloride concentrations at site 8 originated from the influences upstream from site 6 or from the downstream, possibly tidal, influence noted at site 9.

Trace Metals

Trace metals are elements that occur naturally in streams in very low concentrations. Some act as essential nutrients in these very low concentrations and are necessary for certain biochemical processes. However, these elements can also be associated with industrial and municipal wastes, and high concentrations of metals can have harmful physiological effects on aquatic organisms. High concentrations of metals can also adversely effect a stream's potential as a public-water supply, or even as a source of agricultural irrigation.

During both high flow and low flow, water samples were collected at sites 5 and 8 and analyzed for the trace-metal constituents listed in table 5 for both filtered and whole-water samples. Only filtered samples were analyzed for iron and vanadium. No sample contained concentrations of trace metals that exceeded recommended limits for either dissolved or total metals (U.S. Environmental Protection Agency, 1976). Slight differences occurred between concentrations in the high-flow (May 17) and the low-flow (Aug. 8) samples, but the data for samples collected during time of high flow and steady downstream flow (May 12) were almost identical. Most of the constituents increased slightly during low flow, but were still well below recommended limits. Only dissolved iron showed significantly increased concentrations at high flow, as compared to low flow. This may have been due to the increased suspended-solids concentrations and decreased pH values at high flow, allowing for greater desorption of iron from the sediments to the dissolved phase. No significant differences were noted between sites upstream and downstream from Lafayette during any of the three flow regimes.

Bed-material samples were also collected at sites 5 and 8 during high flow and low flow for analysis for trace metals (table 5). No significant differences in concentrations between high-flow and low-flow samples were apparent. Most of the constituents showed slightly higher concentrations downstream from Lafayette than upstream. However, the differences were very small, and even the samples collected downstream from the urban area showed very little trace-metal accumulation on the bed sediments. Since bed-material analyses reflect cumulative and longer-term water-quality conditions compared to water analyses, it is apparent from these bed-material data that trace-metal contamination was not a problem in the Vermilion River during the study.

Pesticides and Organic Compounds

Water samples and bed material were collected at sites 5 and 8 and analyzed for some organic constituents--organophosphorus and organochlorine insecticides, chlorophenoxy-acid herbicides, polychlorinated biphenyls (PCBs), phenolic compounds, and oil and grease--and residue, loss on ignition, and cyanides. Table 6 presents the data for those compounds that were detected in water or bed material. The aqueous phase was relatively free of all determined constituents except for trace levels of 2,4,D and 2,4,5-T (herbicides), aldrin and diazinon (organic phosphorus insecticides), and phenolic compounds at site 8 during low

PCB concentrations in the bed material increased from zero and one at site 5 to 11 μg/kg and 16 μg/kg at site 8 during high water and low water, respectively. This seems to indicate that there was some PCB input from the urban area. No PCB residues were detected in the aqueous phase, however, upstream or downstream from the urban area during high- or low-flow conditions.

Oil and grease in the bed material showed major increases at both sites during near-zero flow. The source of the increases is uncertain, as they were found both upstream and downstream from Lafayette.

The large amount of organic matter that was in the stream in the spring was evident from analyses of bed material for residue, loss on ignition (table 6). This property indicates the percentage of potentially decomposable organic matter in the bed material. On May 12, large amounts of solid organic matter were found at sites 5 and 8. Its source was probably in the upper basin, as it was found in similar quantities both upstream and downstream from Lafayette. During the low-flow sampling of August 8, the concentrations at both sites decreased by a factor of ten, indicating that most of the organic matter had probably been flushed out.

Bacteria

Fecal-coliform bacteria are useful indicators of the sanitary condition of water. In addition, FC/FS (fecal-coliform/fecal-streptococci) ratios can be used to suggest whether the wastes are of human or nonhuman origin. A FC/FS ratio less than 0.7 is evidence that wastes are of nonhuman origin; a ratio between 2.0 and 4.0 suggests predominance of human wastes; and a ratio greater than 4.0 can be considered as strong evidence that wastes are of human origin (Geldreich and Kenner, 1969). However, considering the difficulty involved in producing reliable quantitative results in a river system such as the Vermilion River, FC/FS ratios should be used only to suggest overall patterns.

On April 10, the Vermilion River had downstream flow at all sites. Fecal bacteria at sites 5, 6, and 7 were indicative of mainly nonhuman sources (fig. 5), and downstream from the urban area (site 8) the bacterial concentrations and rise in FC/FS ratios (fig. 5) suggested a substantial contribution of human waste. The FC concentrations downstream from the urban area were greater than upstream, and the FC/FS ratios increased. The greatest FC concentration was determined at site 8, and some die off and (or) dilution was apparent at site 9. In general, waste input in the upper basin (indicated by sampling at sites 5 and 6) was mostly nonhuman in origin; whereas some wastes in the urban area were of human origin. The total numbers of fecal bacteria at the various sites did not vary dramatically, but there was a definite increase in FC concentrations downstream from the Lafayette area.

The same general pattern prevailed on the May 12 and 17 sampling trips for sites 1-9. Fecal-coliform concentrations on May 12 during steady downstream flow ranged from 100-500 colonies/100 mL throughout the study reach, with ratios suggesting predominantly animal wastes. After the heavy rains of May 15-16, FC concentrations increased dramatically to

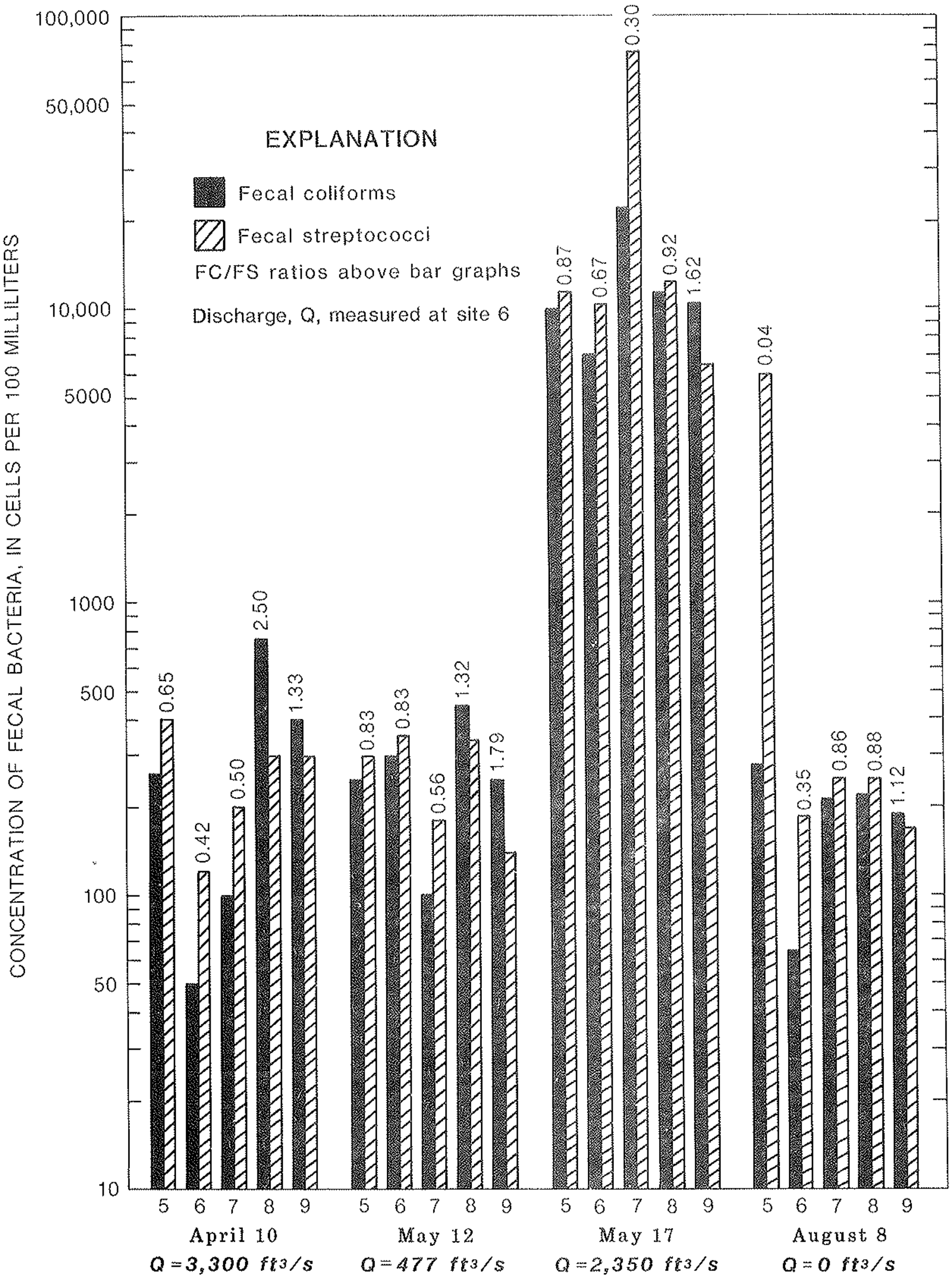

Figure 5.--Concentrations of fecal bacteria at five sites (5-9) on the Vermilion River during four different discharge conditions.

the range of 7,000-30,000 colonies/100 mL on May 17, with decreased FC/FS ratios, suggesting that runoff provided most of the bacterial load. For both of the high-water sampling trips, the highest FC/FS ratios were found downstream from the urban area at sites 8 and 9. These higher ratios show that urban inputs did affect the bacterial load, but during heavy runoff conditions, such as May 17, the human component of the waste load was less prominent than during conditions of decreased overland runoff.

On August 8 flow was near zero. Fecal-coliform concentrations at sites 1 and 2 were low, 205 colonies/100 mL and 290 colonies/100 mL, respectively. Site 3 had an exceptionally high concentration of 4,200 colonies/100 mL, but the FC/FS ratio was consistent with the bacterial ratios at other headwater sites (table 1). Fecal-coliform concentrations on the main stem of the Vermilion River were consistently low (about 200 colonies/100 mL) and FC/FS ratios were greatest at sites 7, 8, and 9. During this stagnant condition there was not a dramatic increase in total fecal-bacteria concentrations downstream from the urban area, because flow was not sufficient to carry the bacteria downstream.

The bacteria data indicate that the Vermilion River headwaters contain considerable numbers of fecal bacteria, mostly nonhuman in origin. The City of Lafayette contributes mainly human wastes to the river, as inferred from increased FC/FS ratios at site 8. The small recovery zone between sites 5 and 7 (midtown Lafayette) may be due to bacterial die off in the reach upstream of the urban area. When the Vermilion River ceases to flow in the study area, bacterial input tends to remain restricted to localized reaches of the river.

Productivity and Eutrophication

Algae are simple phytosynthetic organisms ubiquitous in surface water. Their presence, numbers, and relative occurrence can reflect important aspects of, or changes in, the water quality of a lake or stream. The algae analyzed are phytoplankton, that is, algae suspended in the water column rather than attached to a substrate. The four divisions of algae shown in figure 6 are the blue-green algae (Cyanophyta), green algae (Chlorophyta), diatoms (Chrysophyta), and euglenoids (Euglenophyta).

The algal populations of the Vermilion River differed upstream and downstream from Lafayette. On May 12 during steady downstream flow, site 5 had an algal population dominated by green algae and diatoms and completely devoid of blue-green algae, whereas the algal population at site 8 had 71 percent blue greens. This suggested less organic-enrichment in water upstream from Lafayette, because the diatom/green algal population at site 5 was characteristic of less-eutrophic conditions than the blue-green/green algal population at site 8. Therefore, during steady downstream flow not accompanied by storm runoff, the organic and nutrient loads from the urban area did create conditions that were slightly more eutrophic downstream from Lafayette than in the upper reach. This is reflected in the increase in algal concentrations at site 8, the higher percentage of blue-green algae, the very slight increases in organic

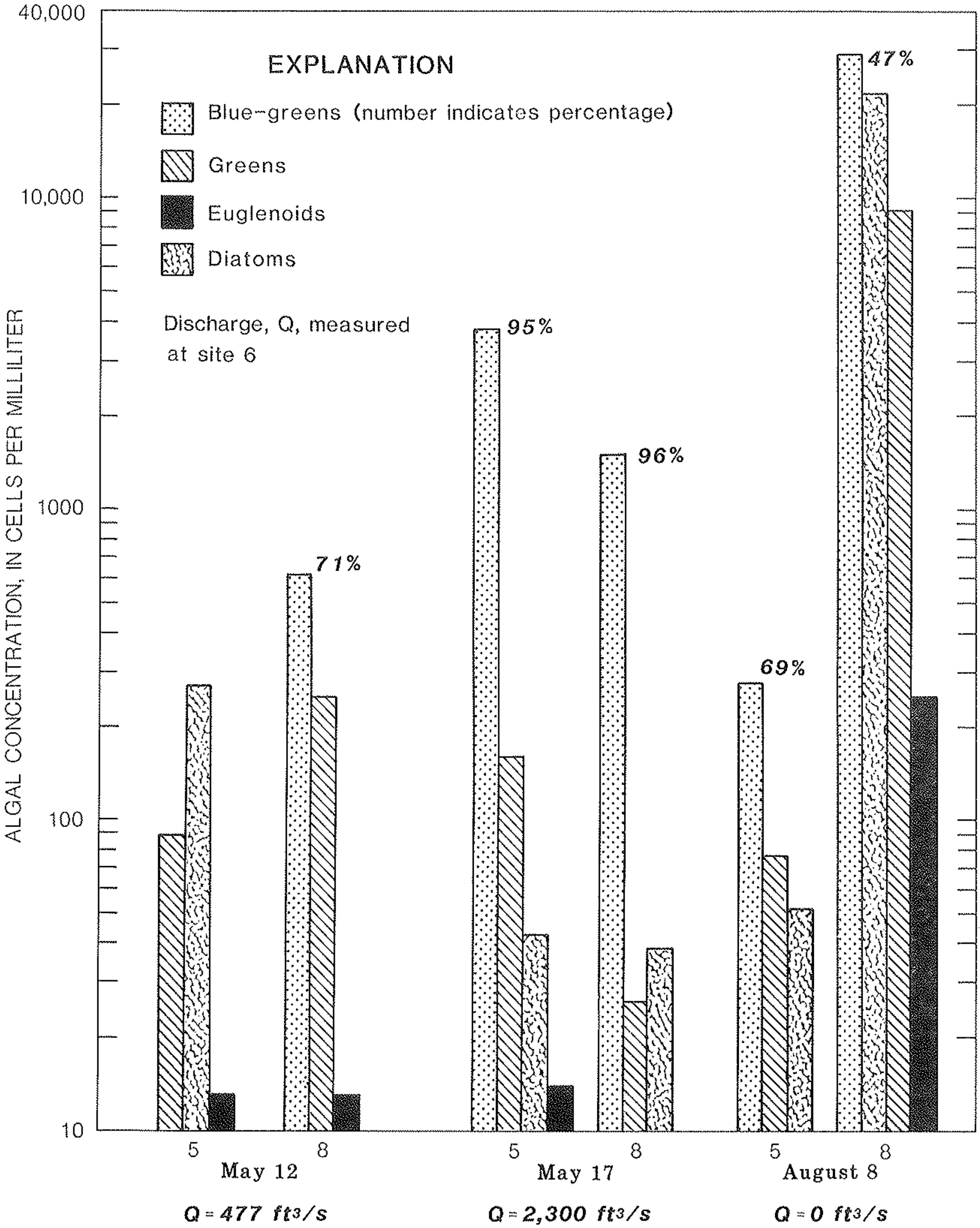

Figure 6.--Concentrations and composition of phytoplankton communities in the Vermilion River upstream (site 5) and downstream (site 8) from Lafayette during three different discharge conditions.

carbon and 5-day BOD, and the decrease in DO--all of which were noted downstream from Lafayette (fig. 7). It can be stated from these data that there was a slight degradation of the quality of the Vermilion River downstream from the urban area during conditions of steady, downstream flow.

However, when a heavy rainstorm occurred in the basin, a very different phenomenon occurred. On May 17, after heavy rainstorms, the algal concentration at site 5 had increased tenfold, 95 percent of the algal population being blue-green algae. This probably was due to flushing of the many stagnant ditches and small bayous in the upper basin. Bayou Bourbeaux, for example, contributed very little flow to the Vermilion River except during storms, and its shallow (2 ft), stagnant waters generally abounded with algae, as evidenced by its green color and odor. In stagnant pools, as observed in the ditches throughout the upper basin, blue-green algae can become dominant. Nitrogen depletion, particularly depletion of dissolved nitrates, is a limiting factor for most algae other than the blue-green algae, which are able to utilize atmospheric nitrogen when dissolved forms are not available. When heavy storms occurred, such as those on May 16, fresh loads of nutrients and organic debris were introduced to the upper Vermilion River from agricultural runoff, and algae from ditches throughout the upper basin were flushed into the stream where they flourished with the increased availability of dissolved nutrients. During these conditions, algal (fig. 6), nitrate, BOD, and organic-carbon concentrations (fig. 7) at the upstream water-quality site indicated that the most of the organic, nutrient, and oxygen-consuming loads originated in the upper basin and not from urban-associated wastes (fig. 7). In fact, there was no noticeable oxygen sag downstream from the urban area, and the nitrate, algal, and organic-carbon concentrations indicated improved water quality downstream from Lafayette.

During low-flow conditions, the effects of urban wastes and lack of continuous flow on phytoplankton in the Vermilion River were very noticeable. On August 8 there was a much larger algal population at site 8 than at site 5. Part of this increase could be explained by the stagnant conditions at and near site 8. This would enable phytoplankton from upstream to drift into the downstream areas, where they could remain localized longer and reproduce. However, the lower percentage of blue-green algae at the downstream site (47 percent at site 8) suggests that nitrate was an available nutrient downstream from Lafayette at low flow. At the upstream site, nitrate was more limiting, and 69 percent of the algae were blue-greens. The predominance of blue-greens (with significant numbers of green algae and diatoms) at site 5 is indicative of eutrophic water, but the additional euglenoids at site 8 support chemical evidence that there was an even richer organic mixture downstream. As euglenoids were found at sites 5 and 8 during moderate flow on May 12, their presence at site 8 on August 8 cannot be attributed solely to a preference for low-flow conditions. At site 8, there was a 150-fold increase in algal concentrations compared to site 5, 50-percent increases in total-nitrate, total-phosphorus, and organic-carbon concentrations, and a threefold increase in BOD concentrations compared with values for the upstream site. The DO concentration was supersaturated (105 percent) downstream from Lafayette, reflecting the large amount of photosynthetic activity occurring there.

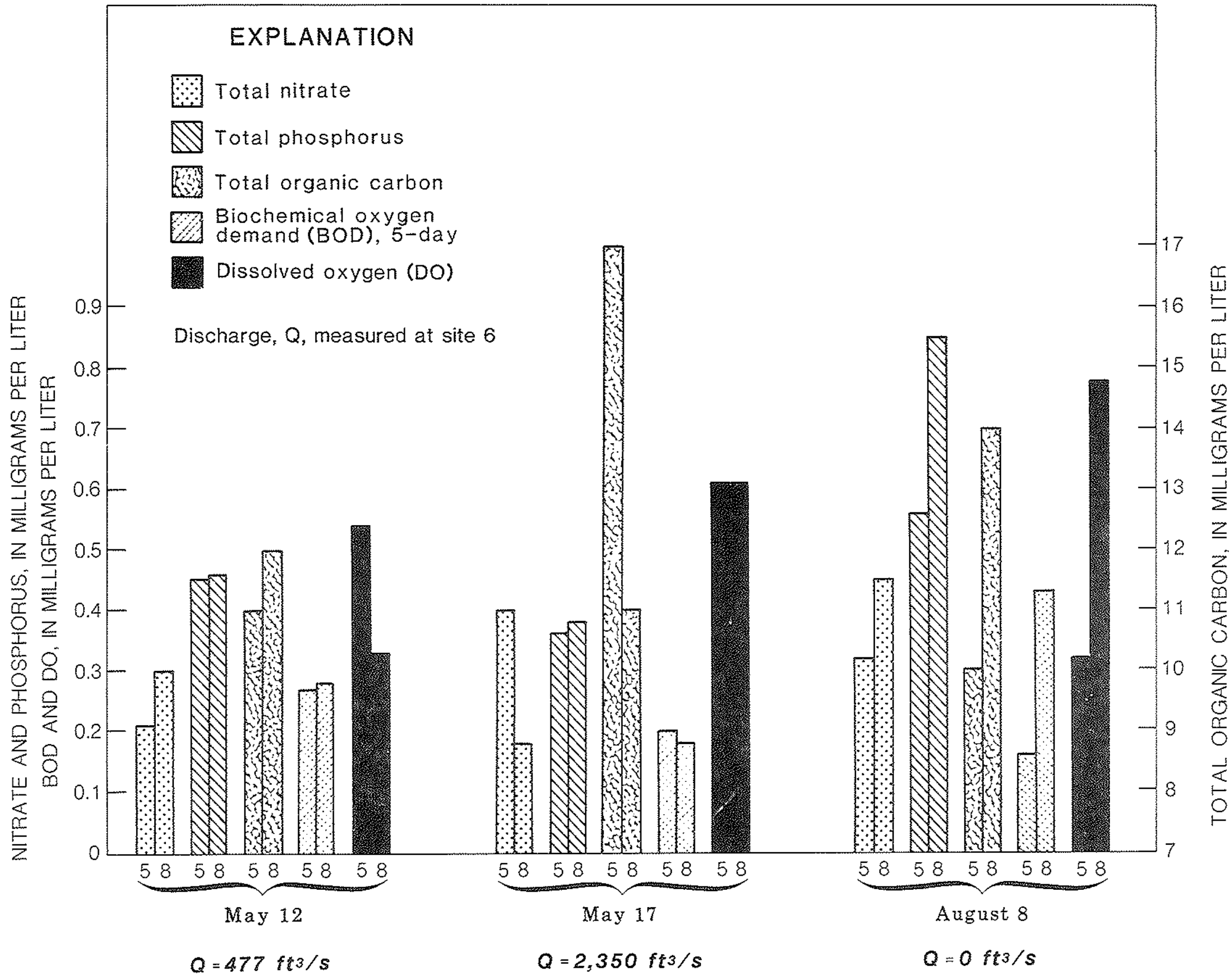

Figure 7.--Comparisons of nutrients, organic carbon, dissolved-oxygen, and biochemical oxygen demand in the Vermilion River upstream (site 5) and downstream (site 8) from Lafayette during three different discharge conditions.

It should be noted that during the low-flow conditions of August 8, stagnant areas in the study reach were sinks for nutrient and organic accumulation. Inputs into the upper reach were not sufficient to produce the eutrophic conditions that occurred downstream from the urban area. It was during this stagnant, low-flow situation that discharges in the Lafayette area had the greatest affect on the phytoplankton communities.

Benthic Macroinvertebrates

Benthic macroinvertebrates are animals that are large enough to be seen by the unaided eye, can be retained by a U.S. Standard No. 30 sieve (28 meshes/in., 0.595-mm openings), and live at least part of their life cycle within or upon available substrates in an aqueous environment (Weber, 1973). Benthic invertebrates form resident communities of individuals that move very little within a particular reach of a stream or lake throughout their lifetime in the water. The composition of these communities can be indicative of the hydrologic and water-quality conditions where the organisms live (Mackenthum and Ingram, 1966).

Benthic invertebrates were sampled May 12, 1980, and August 8 at five sites; upstream, within, and downstream from Lafayette. A Petite Ponar sampler was used for benthic invertebrate collection. The Petite Ponar is designed to take a sample 232.3 cm^2 in surface area. Samples were collected at three cross-sectional points per site (left bank, center, and right bank). Each cross-sectional point consisted of two Ponar samples, which were composited. Thus for each site a total of six bed samples were collected. U.S. Standard No. 30 sieves were used to separate the organisms from the bed-material substrate. Sieved organisms were preserved in 70-percent ethyl alcohol (denatured) for later study and identification in the laboratory. The study was designed to define the benthic-invertebrate communities and to determine discontinuities (if any) due to the influence of the City of Lafayette. However, a direct comparison of benthic populations upstream and downstream from Lafayette would be contingent upon similar flow and substrate at all sites. Berg (1943, 1948) felt that substrate type and velocity are the two most important ecological factors in classifying streams. This is supported by the findings of Wells and Demas (1979) for benthic populations in the lower Mississippi River. Velocities in the upper Vermilion River can vary between sites, especially during periods of low flow. But more importantly, in the Vermilion River the substrate changes downstream from Lafayette, becoming a much finer silty clay.

At sites 5 and 6, approximately 37 percent of the bed material is finer than 0.062 mm (silt), and 15 percent is finer than 0.004 mm (clay). Site 7 has a slightly coarser substrate, with about 20 percent finer than 0.062 mm and 8 percent finer than 0.004 mm. At sites 8 and 9, 80 to 90 percent of the bed material was finer than 0.062 mm and about 30 percent was finer than 0.004 mm. Thus, any changes in the benthic-invertebrate populations downstream from Lafayette cannot be solely attributed to urban effects. The coarser substrates upstream from Lafayette favor increased colonization by a more diverse population. The fine silty clay substrate downstream from Lafayette favors burrowing forms such as chironomids and tubificids. Table 7 lists all organisms collected during the study. Tubificid worms and chironomid (midge) larvae were the most abundant organisms during both sustained and low flow. Both of these groups are generally considered to be highly pollution-tolerant.

The data for May showed a general decrease in numbers of species and increase in pollution tolerance (based on Weber, 1973) downstream. Chaoborid larvae found at site 9 are lentic water species similar to mosquito larvae. These are not typical of rivers (Merritt and Cummins, 1978). Their presence illustrates the low velocities of the Vermilion River downstream from Lafayette.

The August sampling showed a sharp drop in species abundance and diversity at all sites. The low or zero discharge, with resultant depressed DO values, apparently eliminated even many pollution-tolerant species, such as leeches. The predominance of chironomid larvae was to be expected, as these are highly pollution-tolerant organisms and are capable of surviving periods of low-oxygen concentration. The sharp decline in tubificid populations on August 8 can probably be attributed to prolonged periods of oxygen depletion and elevated levels of oil and grease in the bed material (table 6), greatly reducing the abundance of even these extremely pollution-tolerant organisms. However, as viable tubificid eggs were found, tubificid populations probably could recover quickly.

SUMMARY

The major water-quality problems in the Vermilion River are related to the slow-flowing nature of the river that results in depressed DO concentrations and elevated BOD concentrations and fecal-bacteria densities.

The upper basin contributed most of the BOD load during spring rains, as investigated April 10, when the urban inputs had little effect on DO and BOD. During moderate downstream flow on May 12, after the basin washout in April, the effects of discharges in the Lafayette area were apparent from increased BOD and decreased DO concentrations through and downstream from the urban area. Much of that BOD load originated from the upper basin. Following heavy rains May 15-16, the urban effects on DO and BOD concentrations were negligible. During conditions of stagnant flow on August 8, the urban effects were obvious with increased BOD and large algal populations in the stagnant reach just downstream from Lafayette.

Table 7.--Composition of benthic-invertebrate populations at five sites on the Vermilion River on two different dates

Taxa	May 12					August 8				
Site No---	5	6	7	8	9	5	6	7	8	9
Cladocera----------------	--	--	--	--	--	--	-	-	1	-
Oligochaeta										
Plesiopora										
Tubificidae										
Limnodrilus--------	5	3	7	9	23	--	-	-	2	-
Branchiura---------	--	--	1	--	1	--	-	-	-	-
Unidentified-------	12	5	17	22	25	1	2	1	2	3
Hirudinea										
Pharyngobdella										
Erpobdellidae										
Erpobdella---------	--	2	--	4	--	--	-	-	-	-
Unidentified-------	--	--	4	--	--	--	-	-	-	-
Apharyngobdella										
Glossiphoniidae										
Unidentified-------	--	1	3	9	7	--	-	-	-	-
Gastropoda										
Mesogastropoda										
Bythiniidae										
Amnicola-----------	--	--	--	2	--	--	-	-	-	-
Planorbidae										
Gyraulus-----------	--	--	--	1	--	--	-	-	-	-
Ancylidae										
Laevipex-----------	2	2	--	--	--	--	-	-	-	-
Bivalvia										
Heterodonta										
Corbiculidae										
Corbicula----------	11	28	21	1	--	11	-	-	-	-
Sphaeriidae										
Sphaerium----------	1	1	--	12	1	--	-	-	-	-
Musculium----------	--	--	--	10	3	--	-	-	-	-
Crustacea										
Isopoda										
Asellidae										
Asellus------------	1	2	--	4	--	--	-	-	-	-
Amphipoda										
Gammaridae										
Gammarus-----------	8	4	--	--	--	--	-	-	-	-

Table 7.--Composition of benthic-invertebrate populations at five sites on the Vermilion River on two different dates--Continued

Taxa	Date of collection									
	May 12					August 8				
Site No-----	5	6	7	8	9	5	6	7	8	9
Insecta										
Diptera										
Chironomidae										
Ablabesmyia----------	--	1	2	1	3	1	-	-	-	-
Chironomus-----------	--	--	1	--	--	--	-	-	-	-
Cladotanytarsus------	1	--	--	--	--	2	-	-	-	-
Coelotanypus---------	--	--	--	--	1	--	-	-	-	-
Cryptochironomus-----	--	4	5	--	1	--	2	-	-	-
Dicrotendipes--------	--	--	--	--	--	3	-	-	-	-
Glyptotendipes-------	--	1	--	--	--	--	-	-	-	-
Harnischia-----------	--	--	1	--	--	--	-	-	-	-
Nanocladius----------	--	--	2	--	--	--	-	-	-	-
Phaenopsectra--------	--	--	--	--	--	6	-	-	-	-
Polypedilum----------	5	4	2	--	1	3	-	-	-	-
Procladius-----------	--	--	--	1	1	--	1	-	2	4
Stenochironomus------	1	1	--	--	--	1	-	-	-	-
Chaoboridae										
Chaoborus------------	--	--	--	--	4	--	2	-	-	1
Ceratopogonidae										
Bezzia/Probezzia group---------------	--	--	--	--	--	--	-	-	-	1
Psychodidae										
Unidentified---------	--	--	--	--	1	--	-	-	-	-
Coleoptera										
Elmidae										
Stenelmis------------	--	2	--	--	--	4	-	-	-	-
Ephemeroptera										
Baetidae										
Caenis---------------	3	--	--	--	--	--	-	-	-	-
Heptageniidae										
Unidentified---------	--	--	--	--	--	1	-	-	-	-
Trichoptera										
Hydropsychidae										
Hydropsyche----------	5	2	--	--	--	--	-	-	-	-
Odonata										
Corduliidae										
Neurocordulia--------	--	--	--	--	--	1	-	-	-	-

A substantial fecal-bacteria population was present during each flow condition. The FC/FS ratios increased downstream from the urban area, indicating introduction of human wastes, but most of the bacterial load originated from a mixture of human and animal sources upstream from Lafayette. The urban bacterial contributions were most noticeable during early spring runoff on April 10 and moderate downstream flow on May 12. The greatest total fecal-bacteria densities encountered during the study followed the rainstorm of May 15-16 and seemed to originate mainly from a mixture of human and nonhuman sources upstream from the city.

Analyses for inorganic constituents, including trace metals, showed negligible influence from urban sources, and all concentrations were within recommended limits for freshwater aquatic life.

Evidence of inputs in the upper basin were noted from analyses of pesticides in bottom material. A slight accumulation of PCBs in the bed material was noted downstream from the urban area. Accumulation of substantial levels of oil and grease in the bed material was noted upstream and downstream from Lafayette during low flow in August.

Urban sources of nutrients and organic carbon served to dramatically elevate the concentrations at site 8 only during stagnant conditions as investigated August 8. High concentrations of algae were present at site 8 at the time, and the diel DO fluctuation was much greater than at site 5.

Changes in benthic-macroinvertebrate populations downstream from the city indicated generally poorer water-quality conditions there.

SELECTED REFERENCES

Berg, K., 1943, Physiographical studies on the River Susaa: Folia Limnology Scandinavia, v. 1, 174 p.

----- 1948, Biological studies on the River Susaa: Folia Limnology Scandinavia, v. 4, 318 p.

Calandro, A. J., 1981, Time of travel of solutes in the Vermilion River, Louisiana: Louisiana Department of Transportation and Development, Office of Public Works, U.S. Geological Survey Open-File Report 81-1065, 19 p.

Fenneman, N. M., 1946, Physical divisions of the United States [map]: U.S. Geological Survey.

Geldreich, E. E., and Kenner, B. A., 1969, Concepts of fecal streptococci in stream pollution: Journal of Water Pollution Control Federation, v. 41, no. 8, pt. 2, p. 336-352.

Guy, H. P., 1969, Laboratory theory and methods for sediment analysis: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 5, Chapter C1, 58 p.

Hem, J. D., 1970, Study and interpretation of the chemical characteristics of natural water (2d ed.): U.S. Geological Survey Water-Supply Paper 1473, p. 96-103.

Louisiana Stream Control Commission, 1977, State of Louisiana water quality criteria, 49 p.

Mackenthum, K. M., and Ingram, W. M., 1966, Pollution and the life in water, in Cummins, Tyron, and Hartman, eds., Organism-substrate relationships in streams: University of Pittsburg, Pa., Pymatuning Laboratory of Ecology Special Publications 4:136-145.

Merritt, R. W., and Cummins, K. W., eds., 1978, An introduction to the aquatic insects of North America: Dubuque, Iowa, Kendall/Hunt Publishing Co., p. 274.

Palmer, C. M., 1962, Algae in water supplies: U.S. Department of Health, Education, and Welfare, Public Health Service, 88 p.

Skougstad, M. W., Fishman, M. J., Friedman, L. C., Erdmann, D. E., and Duncan, S. S., eds., 1979, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 5, Chapter A1, 626 p.

U.S. Army Corps of Engineers, 1976, Draft composite environmental impact statement for operation and maintenance of three projects in the Teche-Vermilion basin: 502 p.

U.S. Environmental Protection Agency, 1976 [1977], Quality criteria for water: U.S. Environmental Protection Agency, 256 p.

U.S. Geological Survey, 1970-74, Water resources data for Louisiana--part 2, Water quality records [released annually]: Baton Rouge, La., U.S. Geological Survey, Water Resources Division.

----- 1975-80, Water resources data for Louisiana, [released annually]: U.S. Geological Survey Water-Data Reports LA-75-1, LA-76-2, LA-77-2, LA-78-2, LA-79-2, LA-81-2.

Weber, C. I., ed., 1973, Biological field and laboratory methods for measuring the quality of surface water and effluents: U.S. Environmental Protection Agency, Cincinnati, Ohio, 186 p.

Wells, F. C., and Demas, C. R., 1979, Benthic invertebrates of the lower Mississippi River: Water Resources Bulletin, v. 15, no. 6, December 1979, p. 1565-1577.

TABLE 8.--MONTHLY WATER-QUALITY DATA FOR THE VERMILION RIVER AT LAFAYETTE, LA. (SITE 8)

[WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980]

DATE	TIME	SPECIFIC CONDUCTANCE (UMHOS)	PH (UNITS)	TEMPERATURE (DEG C)	COLOR (PLATINUM-COBALT UNITS)	TURBIDITY (JTU)	OXYGEN, DISSOLVED (MG/L)	OXYGEN DEMAND, CHEMICAL (HIGH LEVEL) (MG/L)	C.O.D. TOTAL IN BOTTOM MATERIAL (MG/KG)	OXYGEN DEMAND, BIOCHEMICAL, 5 DAY (MG/L)	COLIFORM, FECAL, 0.7 UM-MF (COLS./100 ML)	STREPTOCOCCI FECAL, KF AGAR (COLS. PER 100 ML)
OCT 24...	1430	375	6.1	23.0	100	60	4.0	--	--	1.4	54000	2400
NOV 27...	1330	121	6.7	--	100	70	7.3	--	--	3.7	<20	18000
DEC 11...	1000	269	6.6	13.0	100	35	6.9	--	--	2.6	K3800	1100
JAN 18...	1245	142	5.9	16.0	120	100	6.1	--	--	3.7	11000	15000
FEB 13...	1145	161	6.8	9.0	100	120	8.8	--	--	--	--	K21000
MAR 06...	1245	260	6.7	13.0	100	85	7.1	--	--	5.5	29000	1000
APR 10...	1145	95	6.5	19.5	80	40	3.3	--	--	1.6	K750	K300
MAY 12...	1600	158	6.4	25.0	--	--	3.3	38	17000	2.8	K450	K340
17...	1700	29	5.7	20.5	--	--	6.2	38	--	1.8	12000	12000
JUN 10...	1045	124	6.2	26.0	60	20	2.1	--	--	1.9	K50	K140
JUL 11...	1045	390	7.4	32.0	20	3	1.8	--	--	4.0	--	370
AUG 08...	1345	595	7.6	30.0	15	6	5.8	--	--	3.0	K40	280
08...	2030	556	7.3	31.0	15	10	7.8	37	21000	4.3	K140	310
SEP 04...	1200	618	7.3	29.0	20	10	8.2	--	--	5.1	K80	100

DATE	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	POTASSIUM, DISSOLVED (MG/L AS K)	BICARBONATE FET-FLD (MG/L AS HCO3)	CARBONATE FET-FLD (MG/L AS CO3)	ALKALINITY FIELD (MG/L AS CACO3)	SULFATE DISSOLVED (MG/L AS SO4)	CHLORIDE, DISSOLVED (MG/L AS CL)	FLUORIDE, DISSOLVED (MG/L AS F)
OCT 24...	47	4	13	3.6	47	3.7	53	0	43	16	72	0.1
NOV 27...	30	3	7.5	2.7	7.9	5.2	33	0	27	6.4	11	.1
DEC 11...	54	8	14	4.6	29	3.9	56	0	46	14	42	.1
JAN 18...	39	3	11	2.7	11	3.5	44	0	36	8.0	14	.1
FEB 13...	38	6	9.5	3.4	16	2.8	39	0	32	5.7	21	.1
MAR 06...	47	6	12	4.1	29	3.2	50	0	41	5.2	46	.1
APR 10...	28	1	8.0	1.9	6.4	2.9	33	0	27	3.7	10	.0
MAY 12...	40	2	10	3.7	14	2.1	46	0	38	19	19	--
17...	10	1	3.0	.5	1.8	2.0	12	0	10	1.5	2.5	--
JUN 10...	33	4	8.6	2.7	9.4	3.0	35	0	29	5.6	11	.0
JUL 11...	120	9	30	11	30	4.4	135	0	111	25	38	.3
AUG 08...	120	0	29	11	61	4.3	132	0	108	21	93	.2
08...	120	5	30	11	64	5.1	141	0	116	24	92	--
SEP 04...	130	7	33	12	75	4.2	152	0	130	25	110	.2

DATE	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	SOLIDS, RESIDUE AT 105 DEG. C, SUS- PENDED (MG/L)	SOLIDS, VOLA- TILE IN BOTTOM MATERI- AL (MG/KG)	NITRO- GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO- GEN, AMMONIA TOTAL (MG/L AS N)	NITRO- GEN, AMMONIA DIS- SOLVED (MG/L AS N)	NITRO- GEN,NH4 TOTAL IN BOT. MAT. (MG/KG AS N)	NITRO- GEN,AM- MONIA + ORGANIC TOTAL (MG/L AS N)	NITRO- GEN,AM- MONIA + ORGANIC DIS. (MG/L AS N)	NITRO- GEN,NH4 + ORG. TOT. IN BOT MAT (MG/KG AS N)	PHOS- PHORUS, TOTAL (MG/L AS P)
OCT 24...	8.3	199	--	--	0.49	--	--	--	1.40	--	--	0.610
NOV 27...	7.0	78	--	--	1.2	--	--	--	1.60	--	--	.630
DEC 11...	12	157	--	--	.35	--	--	--	2.00	--	--	.700
JAN 18...	8.6	107	--	--	.27	--	--	--	1.70	--	--	.390
FEB 13...	6.7	116	--	--	.41	--	--	--	1.60	--	--	.490
MAR 06...	7.2	150	--	--	.40	--	--	--	2.40	--	--	.660
APR 10...	6.0	76	--	--	.12	--	--	--	1.50	--	--	.360
MAY 12...	--	--	71	40600	.34	.440	.450	66	1.10	1.0	789	.460
17...	--	--	184	--	.22	.250	.210	--	1.30	.91	--	.380
JUN 10...	6.0	78	--	--	.10	--	--	--	1.40	--	--	.260
JUL 11...	17	235	--	--	.36	--	--	--	1.70	--	--	.660
AUG 08...	16	326	--	--	.43	--	--	--	1.60	--	--	.720
08...	--	--	--	5000	.54	.900	.790	40	2.40	2.0	940	.850
SEP 04...	21	341	--	--	.39	--	--	--	2.60	--	--	1.30

DATE	PHOS- PHORUS, DIS- SOLVED (MG/L AS P)	ARSENIC TOTAL (UG/L AS AS)	ARSENIC DIS- SOLVED (UG/L AS AS)	ARSENIC TOTAL IN BOT- TOM MA- TERIAL (UG/G AS AS)	BERYL- LIUM, TOTAL RECOV- ERABLE (UG/L AS BE)	BERYL- LIUM, DIS- SOLVED (UG/L AS BE)	BERYL- LIUM, RECOV. FM BOT- TOM MA- TERIAL (UG/G)	CADMIUM TOTAL RECOV- ERABLE (UG/L AS CD)	CADMIUM DIS- SOLVED (UG/L AS CD)	CADMIUM RECOV. FM BOT- TOM MA- TERIAL (UG/G AS CD)	CHRO- MIUM, TOTAL RECOV- ERABLE (UG/L AS CR)	CHRO- MIUM, RECOV. FM BOT- TOM MA- TERIAL (UG/G)
OCT 24...	--	--	2	3	--	--	--	--	2	0	--	10
JAN 18...	--	--	2	--	--	--	--	--	<1	--	--	--
APR 10...	--	--	2	--	--	--	--	--	<1	--	--	--
MAY 12...	.220	3	2	23	0	<1	1	1	<1	1	10	17
17...	.160	3	1	--	0	<1	--	1	<1	--	10	--
JUL 11...	--	--	4	--	--	--	--	--	<1	--	--	--
AUG 08...	.720	7	6	8	0	<1	0	1	<1	1	0	17

DATE	CHRO- MIUM, HEXA- VALENT, DIS. (UG/L AS CR)	COPPER, TOTAL RECOV- ERABLE (UG/L AS CU)	COPPER, DIS- SOLVED (UG/L AS CU)	COPPER, RECOV. FM BOT- TOM MA- TERIAL (UG/G AS CU)	IRON, DIS- SOLVED (UG/L AS FE)	IRON, RECOV. FM BOT- TOM MA- TERIAL (UG/G AS FE)	LEAD, TOTAL RECOV- ERABLE (UG/L AS PB)	LEAD, DIS- SOLVED (UG/L AS PB)	LEAD, RECOV. FM BOT- TOM MA- TERIAL (UG/G AS PB)	MANGA- NESE, DIS- SOLVED (UG/L AS MN)	MANGA- NESE, RECOV. FM BOT- TOM MA- TERIAL (UG/G)
OCT 24...	0	--	9	10	220	6000	--	0	330	210	460
JAN 18...	0	--	11	--	100	--	--	3	--	10	--
APR 10...	2	--	6	--	250	--	--	0	--	90	--
MAY 12...	0	7	6	19	450	--	12	3	40	--	690
17...	0	8	8	--	200	--	8	2	--	--	--
JUL 11...	0	--	--	--	10	--	--	--	--	320	--
AUG 08...	0	6	4	18	10	--	4	1	50	--	420

TABLE 8.--MONTHLY WATER-QUALITY DATA FOR THE VERMILION RIVER AT LAFAYETTE, LA. (SITE 8)--CONTINUED

[WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980]

DATE	MERCURY TOTAL RECOV-ERABLE (UG/L AS HG)	MERCURY DIS-SOLVED (UG/L AS HG)	MERCURY RECOV. FM BOT-TOM MA-TERIAL (UG/G AS HG)	NICKEL, TOTAL RECOV-ERABLE (UG/L AS NI)	NICKEL, DIS-SOLVED (UG/L AS NI)	NICKEL, RECOV. FM BOT-TOM MA-TERIAL (UG/G AS NI)	SELE-NIUM, TOTAL (UG/L AS SE)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	SELE-NIUM, TOTAL IN BOT-TOM MA-TERIAL (UG/G)	VANA-DIUM, DIS-SOLVED (UG/L AS V)	ZINC, TOTAL RECOV-ERABLE (UG/L AS ZN)
OCT 24...	0.1	--	0.05	--	--	--	--	--	--	--	--
JAN 18...	.1	--	--	--	--	--	--	--	--	--	--
APR 10...	.0	--	--	--	--	--	--	--	--	--	--
MAY 12...	--	.0	.09	3	2	10	--	0	0	3.0	40
17...	.1	.0	--	3	2	--	0	0	--	1.0	30
JUL 11...	.0	--	--	--	--	--	--	--	--	--	--
AUG 08...	.2	.1	.09	3	2	20	0	0	0	5.0	20

DATE	ZINC, DIS-SOLVED (UG/L AS ZN)	ZINC, RECOV. FM BOT-TOM MA-TERIAL (UG/G AS ZN)	CARBON, ORGANIC TOTAL (MG/L AS C)	CYANIDE TOTAL (MG/L AS CN)	CYANIDE TOTAL IN BOT-TOM MA-TERIAL (UG/G AS CN)	PHENOLS (UG/L)	OIL AND GREASE, TOTAL RECOV. GRAVI-METRIC (MG/L)	OIL AND GREASE, TOT. IN BOT MAT GRAVI-METRIC (MG/KG)	PCB, TOTAL (UG/L)	PCB, TOTAL IN BOT-TOM MA-TERIAL (UG/KG)	NAPH-THA-LENES, POLY-CHLOR. TOTAL (UG/L)
OCT 24...	20	30	13	0.00	--	2	--	--	0.00	9	0.00
JAN 18...	40	--	16	--	--	--	--	--	--	--	--
APR 10...	10	--	11	--	--	--	--	--	.10	--	.00
MAY 12...	<3	60	12	.00	0	--	--	0	.00	11	.00
17...	20	--	11	--	--	--	--	--	.00	--	.00
JUL 11...	20	--	1.0	--	--	--	--	--	--	--	--
AUG 08...	10	75	14	.00	0	3	0	1000	.00	16	.00

DATE	ALDRIN, TOTAL (UG/L)	ALDRIN, TOTAL IN BOT-TOM MA-TERIAL (UG/KG)	CHLOR-DANE, TOTAL (UG/L)	CHLOR-DANE, TOTAL IN BOT-TOM MA-TERIAL (UG/KG)	DDD, TOTAL (UG/L)	DDD, TOTAL IN BOT-TOM MA-TERIAL (UG/KG)	DDE, TOTAL (UG/L)	DDE, TOTAL IN BOT-TOM MA-TERIAL (UG/KG)	DDT, TOTAL (UG/L)	DDT, TOTAL IN BOT-TOM MA-TERIAL (UG/KG)
OCT 24...	0.00	0.0	0.00	20	0.01	8.3	0.00	7.0	0.01	0.8
APR 10...	.00	--	.00	--	.00	--	.00	--	.01	--
MAY 12...	.00	.0	.00	30	.00	7.0	.00	7.0	.00	3.4
17...	.00	--	.00	--	.00	--	.00	--	.00	--
AUG 08...	.09	.0	.00	39	.00	16	.00	6.1	.00	12

DATE	DI-AZINON, TOTAL (UG/L)	DI-AZINON, TOTAL IN BOT-TOM MA-TERIAL (UG/KG)	DI-ELDRIN TOTAL (UG/L)	DI-ELDRIN, TOTAL IN BOT-TOM MA-TERIAL (UG/KG)	ENDO-SULFAN, TOTAL (UG/L)	ENDO-SULFAN, TOTAL IN BOT-TOM MA-TERIAL (UG/KG)	ENDRIN, TOTAL (UG/L)	ENDRIN, TOTAL IN BOT-TOM MA-TERIAL (UG/KG)	ETHION, TOTAL (UG/L)	ETHION, TOTAL IN BOT-TOM MA-TERIAL (UG/KG)
OCT 24...	0.02	0.0	0.02	1.0	0.00	0.0	0.00	0.0	0.00	0.0
APR 10...	.01	--	.00	--	.00	--	.00	--	.00	--
MAY 12...	.02	.0	.00	.2	.00	.0	.00	.0	.00	.0
17...	.02	--	.00	--	.00	--	.00	--	.00	--
AUG 08...	.10	.0	.00	.9	.00	--	.00	.0	.00	.0

DATE	HEPTA-CHLOR, TOTAL (UG/L)	HEPTA-CHLOR, TOTAL IN BOT-TOM MA-TERIAL (UG/KG)	HEPTA-CHLOR EPOXIDE TOTAL (UG/L)	HEPTA-CHLOR EPOXIDE TOT. IN BOTTOM MATERIAL (UG/KG)	LINDANE TOTAL (UG/L)	LINDANE TOTAL IN BOT-TOM MA-TERIAL (UG/KG)	MALA-THION, TOTAL (UG/L)	MALA-THION, TOTAL IN BOT-TOM MA-TERIAL (UG/KG)	METH-OXY-CHLOR, TOTAL (UG/L)	METH-OXY-CHLOR, TOTAL IN BOTTOM MATERIAL (UG/KG)
OCT 24...	0.00	0.0	0.00	0.2	0.00	0.0	0.00	0.0	0.00	0.0
APR 10...	.00	--	.00	--	.00	--	.00	--	.00	--
MAY 12...	.00	.0	.00	.1	.00	.0	.00	.0	.00	.0
17...	.00	--	.00	--	.00	--	.00	--	.00	--
AUG 08...	.00	.0	.00	.0	.00	.0	.00	.0	.00	.0

DATE	METHYL PARA-THION, TOTAL (UG/L)	METHYL PARA-THION, TOT. IN BOTTOM MATERIAL (UG/KG)	METHYL TRI-THION, TOTAL (UG/L)	METHYL TRI-THION, TOT. IN BOTTOM MATERIAL (UG/KG)	MIREX, TOTAL (UG/L)	PARA-THION, TOTAL (UG/L)	PARA-THION, TOTAL IN BOT-TOM MA-TERIAL (UG/KG)	PER-THANE TOTAL (UG/L)	PER-THANE IN BOTTOM MATERIAL (UG/KG)	TOX-APHENE, TOTAL (UG/L)
OCT 24...	0.00	0.0	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0
APR 10...	.00	--	.00	--	.00	.00	--	.00	--	0
MAY 12...	.00	.0	.00	.0	.00	.00	.0	.00	.00	0
17...	.00	--	.00	--	.00	.00	--	.00	--	0
AUG 08...	.00	.0	.00	.0	.00	.00	.0	.00	--	0

DATE	TOXA-PHENE, TOTAL IN BOT-TOM MA-TERIAL (UG/KG)	TOTAL TRI-THION (UG/L)	TRI-THION, TOTAL IN BOT-TOM MA-TERIAL (UG/KG)	2, 4-DP TOTAL (UG/L)	2,4,5-T TOTAL (UG/L)	SILVEX, TOTAL (UG/L)	PHYTO-PLANK-TON, TOTAL (CELLS PER ML)	CHLOR-A PHYTO-PLANK-TON CHROMO FLUOROM (UG/L)	CHLOR-B PHYTO-PLANK-TON CHROMO FLUOROM (UG/L)	ALGAL GROWTH POTEN-TIAL, BOTTLE TEST (MG/L)
OCT 24...	0.0	0.00	0.0	0.05	0.15	0.05	--	--	--	--
APR 10...	--	.00	--	.00	.00	.00	--	--	--	--
MAY 12...	.0	.00	.0	.00	.01	.00	880	1.11	.000	39
17...	--	.00	--	--	--	--	1500	.800	.020	36
AUG 08...	.0	.00	.0	--	.00	.00	62000	32.0	3.40	--

TABLE 9.--SPECIFIC-CONDUCTANCE, DISSOLVED-OXYGEN, TEMPERATURE, AND PH DATA COLLECTED DOWNSTREAM FROM LAFAYETTE (SITE 8) USING A CONTINUOUS WATER-QUALITY MONITOR

07386935 - VERMILION RIVER AT STATE HIGHWAY 3073, NEAR LAFAYETTE, LA.

SPECIFIC CONDUCTANCE (MICROMHOS/CM AT 25 DEG. C), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980

DAY	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
	OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH	
1	265	172	457	396	138	121	197	179	249	151	303	205
2	353	236	651	445	142	133	227	178	164	149	454	133
3	323	256	612	343	143	134	242	196	199	158	153	132
4	291	257	491	337	180	138	281	193	---	---	144	125
5	292	254	524	405	180	150	297	241	---	---	156	136
6	309	265	405	298	191	160	312	248	---	---	---	---
7	326	281	348	307	195	175	287	227	---	---	227	199
8	367	283	345	329	242	176	255	223	---	---	229	211
9	377	330	368	332	255	218	266	209	---	---	397	227
10	382	315	409	331	240	223	356	158	---	---	416	303
11	345	313	392	358	261	228	205	67	---	---	361	281
12	379	340	484	360	299	258	151	74	---	---	391	337
13	466	361	368	314	284	94	95	86	---	---	489	339
14	478	363	344	322	318	140	87	80	158	136	421	296
15	386	351	322	293	231	139	99	83	164	141	297	265
16	400	368	307	272	157	133	120	99	360	141	271	234
17	483	357	330	287	349	153	154	120	519	146	287	205
18	377	336	355	304	367	192	259	118	164	142	332	161
19	355	278	361	342	241	161	136	120	201	153	242	174
20	334	284	386	335	226	138	132	128	229	188	185	175
21	349	295	374	330	165	145	138	126	212	181	238	170
22	503	317	360	310	170	154	174	134	255	201	258	170
23	626	315	344	191	155	132	372	108	255	228	231	186
24	563	328	477	158	207	134	149	98	262	241	190	149
25	381	321	187	121	309	134	118	108	504	242	280	164
26	500	346	126	93	154	142	168	112	261	234	---	---
27	497	418	118	92	149	137	129	107	280	250	---	---
28	455	415	126	112	169	137	141	121	323	241	---	---
29	430	401	126	117	179	150	161	127	351	240	---	---
30	449	393	130	123	191	138	162	132	---	---	---	---
31	457	408	---	---	226	161	187	152	---	---	---	---
MONTH	626	172	651	92	367	94	372	67	519	136	489	125

DAY	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
	APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER	
1	---	---	141	126	91	86	441	400	894	736	523	461
2	---	---	153	138	83	78	528	431	774	701	635	508
3	---	---	324	144	80	76	472	360	760	627	648	614
4	---	---	232	164	83	73	409	322	707	623	625	614
5	---	---	205	181	81	76	376	262	655	606	638	585
6	---	---	234	179	86	73	414	276	626	588	604	483
7	---	---	212	167	101	76	407	319	618	581	617	517
8	---	---	239	164	97	84	378	309	608	579	715	612
9	---	---	210	151	139	90	381	336	597	426	614	492
10	---	---	214	150	140	106	415	350	521	431	561	499
11	---	---	170	151	127	113	435	332	614	512	782	531
12	96	83	297	152	152	120	411	340	630	591	880	729
13	95	43	181	155	173	146	440	354	796	579	875	768
14	72	26	180	161	183	162	462	384	797	758	878	662
15	69	58	291	165	356	178	572	464	789	607	658	599
16	69	61	---	---	355	237	660	533	774	604	644	591
17	73	66	---	---	329	240	625	532	---	---	601	563
18	94	72	---	---	337	299	631	556	---	---	557	498
19	88	84	40	24	---	---	620	579	---	---	574	314
20	84	80	48	42	---	---	616	560	939	846	353	119
21	86	79	55	47	---	---	571	538	931	848	343	281
22	91	83	66	53	---	---	636	563	945	907	455	340
23	111	89	65	58	---	---	566	425	965	890	591	414
24	113	100	69	66	---	---	526	403	957	883	618	539
25	197	98	82	69	328	223	591	515	942	---	681	536
26	---	---	84	77	280	241	597	539	919	870	667	431
27	100	94	---	---	353	280	716	580	916	849	435	414
28	161	99	102	81	387	349	781	532	844	731	485	415
29	124	108	108	94	392	372	550	484	775	740	522	446
30	135	120	114	98	465	390	689	523	765	536	523	170
31	---	---	98	91	---	---	938	637	627	470	---	---
MONTH	197	26	324	24	465	73	938	262	965	426	880	119
YEAR	965	24										

TABLE 9.--SPECIFIC-CONDUCTANCE, DISSOLVED-OXYGEN, TEMPERATURE, AND PH DATA COLLECTED DOWNSTREAM FROM LAFAYETTE (SITE 8) USING A CONTINUOUS WATER-QUALITY MONITOR--CONTINUED

07386935 - VERMILION RIVER AT STATE HIGHWAY 3073, NEAR LAFAYETTE, LA.--CONTINUED

PH (STANDARD UNITS), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980

DAY	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
	OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH	
1	6.8	6.6	7.0	6.8	6.3	6.2	6.3	6.2	6.4	6.3	6.7	6.4
2	6.8	6.7	7.0	6.9	6.4	6.3	6.3	6.2	6.4	6.3	6.8	6.4
3	6.9	6.8	6.9	6.8	6.5	6.4	6.4	6.3	6.5	6.3	6.4	6.3
4	6.9	6.8	7.0	6.8	6.6	6.4	6.3	6.2	---	---	6.3	6.2
5	6.9	6.8	7.0	6.9	6.7	6.5	6.3	6.2	---	---	6.3	6.2
6	6.9	6.8	6.9	6.9	6.7	6.6	6.4	6.2	---	---	6.3	6.1
7	6.9	6.8	7.0	6.8	6.7	6.5	6.5	6.3	---	---	6.3	6.2
8	6.9	6.8	7.0	6.9	6.7	6.5	6.4	6.3	---	---	6.2	6.2
9	7.0	6.8	7.0	6.9	6.8	6.6	6.8	6.3	---	---	6.3	6.2
10	6.9	6.8	7.0	6.9	6.8	6.7	6.8	6.5	---	---	6.3	6.2
11	6.9	6.8	7.0	6.9	6.9	6.7	7.5	6.1	---	---	6.2	5.9
12	7.0	6.8	6.9	6.9	7.0	6.8	6.8	6.1	---	---	6.1	6.0
13	6.9	6.8	6.9	6.8	7.5	6.8	6.7	6.2	---	---	6.2	6.0
14	6.9	6.8	6.9	6.8	6.9	6.7	6.2	6.1	7.0	6.1	6.1	6.0
15	6.9	6.8	6.8	6.7	6.7	6.4	6.0	6.0	6.5	6.4	6.1	6.1
16	7.0	6.8	6.7	6.7	6.4	6.4	6.1	6.0	6.4	6.4	6.2	6.1
17	6.9	6.8	6.7	6.6	6.4	6.3	6.5	6.0	6.5	6.3	6.2	5.8
18	6.9	6.8	6.8	6.7	6.4	6.2	6.4	6.1	6.4	6.3	6.0	5.7
19	6.9	6.8	6.8	6.7	6.3	6.2	6.3	6.1	6.6	6.4	5.9	5.8
20	6.9	6.8	6.8	6.7	6.4	6.2	6.0	6.0	6.7	6.6	5.9	5.9
21	6.9	6.8	7.1	6.7	6.5	6.3	6.0	5.9	6.6	6.5	6.0	5.9
22	7.0	6.8	7.0	6.9	6.6	6.4	6.9	5.8	6.6	6.6	6.1	6.0
23	7.0	6.8	7.1	6.9	6.6	6.5	6.3	5.9	6.6	6.5	6.2	6.1
24	6.9	6.6	6.9	6.7	6.7	6.4	6.2	6.0	6.6	6.5	6.6	6.2
25	6.8	6.7	7.1	6.6	6.5	6.4	6.1	6.0	6.6	6.5	6.4	6.3
26	6.9	6.7	6.6	6.4	6.4	6.2	6.3	6.1	6.5	6.4	---	---
27	6.9	6.7	6.5	6.3	6.2	6.2	6.3	6.2	6.7	6.5	---	---
28	7.0	6.8	6.4	6.3	6.3	6.2	6.3	6.2	6.7	6.5	---	---
29	7.0	6.9	6.3	6.2	6.3	6.2	6.3	6.3	6.7	6.5	---	---
30	7.0	6.9	6.3	6.3	6.2	6.2	6.5	6.4	---	---	---	---
31	7.0	6.9	---	---	6.3	6.2	6.5	6.4	---	---	---	---
MONTH	7.0	6.6	7.1	6.2	7.5	6.2	7.5	5.8	7.0	6.1	6.8	5.7
	APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER	
1	---	---	6.1	6.0	5.8	5.8	7.0	6.8	7.9	6.8	7.0	6.8
2	---	---	6.2	6.1	5.8	5.8	6.9	6.8	7.5	6.9	7.1	6.8
3	---	---	6.2	6.1	5.8	5.7	6.9	6.7	7.7	6.9	7.8	6.8
4	---	---	6.2	6.1	5.8	5.7	6.9	6.7	7.5	6.8	7.3	6.9
5	---	---	6.3	6.2	5.8	5.7	6.8	6.7	7.8	6.9	7.1	6.9
6	---	---	6.3	6.2	5.8	5.7	6.8	6.7	7.2	6.8	7.1	6.8
7	---	---	6.3	6.2	5.9	5.7	6.8	6.7	7.2	6.9	6.9	6.8
8	---	---	6.4	6.2	5.9	5.8	7.1	6.7	7.2	6.8	7.1	6.8
9	---	---	6.2	6.2	5.9	5.8	7.2	6.7	7.1	6.7	7.2	6.8
10	6.0	5.9	6.3	6.2	6.0	5.9	7.2	6.8	6.9	6.7	7.7	6.8
11	6.0	5.9	6.3	6.2	6.0	5.9	7.0	6.7	7.1	6.8	7.8	7.0
12	6.0	5.9	6.3	6.2	6.0	5.9	7.1	6.8	7.3	6.8	7.7	7.0
13	6.6	6.0	6.3	6.2	6.1	6.0	7.1	6.8	7.2	6.9	7.4	7.1
14	6.2	5.8	6.3	6.2	6.1	6.1	6.9	6.8	7.1	6.9	7.3	7.0
15	6.0	5.9	---	---	6.2	6.1	---	---	7.4	6.8	7.5	7.0
16	6.0	5.9	---	---	6.2	6.2	7.7	6.8	7.2	6.9	7.4	7.0
17	5.9	5.8	6.4	5.5	6.4	6.2	7.6	6.9	7.2	6.9	7.0	7.0
18	5.9	5.9	5.7	5.5	6.4	6.3	7.6	7.0	7.1	6.9	7.0	6.9
19	5.9	5.8	5.8	5.7	---	---	7.3	7.0	7.6	6.9	7.2	6.8
20	5.9	5.9	5.8	5.8	---	---	7.1	6.9	7.6	6.9	7.5	6.9
21	5.9	5.9	5.8	5.8	---	---	6.9	6.8	7.6	7.0	7.0	6.9
22	5.9	5.9	5.8	5.8	---	---	7.0	6.8	7.7	7.0	7.1	6.8
23	5.9	5.9	5.8	5.8	---	---	7.1	6.7	7.1	6.9	7.3	6.9
24	6.0	5.9	5.8	5.8	---	---	7.5	6.7	7.3	6.9	7.2	6.9
25	6.6	5.9	5.8	5.8	6.6	6.5	7.9	6.8	7.5	6.9	7.4	7.0
26	6.6	6.0	5.8	5.8	6.6	6.5	7.7	6.9	7.2	6.9	7.2	6.9
27	6.0	5.9	6.3	5.8	6.8	6.6	7.3	6.9	7.6	6.9	7.0	6.9
28	6.0	5.9	6.2	5.7	6.8	6.7	7.1	6.7	7.3	6.8	7.1	6.9
29	6.0	5.9	5.9	5.8	6.9	6.7	7.8	6.7	6.9	6.9	7.1	6.9
30	6.1	6.0	5.9	5.8	7.0	6.8	8.1	6.8	7.1	6.8	7.0	6.9
31	---	---	5.8	5.8	---	---	7.6	6.8	7.0	6.8	---	---
MONTH	6.6	5.8	6.4	5.5	7.0	5.7	8.1	6.7	7.9	6.7	7.8	6.8
YEAR	8.1	5.5										

TABLE 9.--SPECIFIC-CONDUCTANCE, DISSOLVED-OXYGEN, TEMPERATURE, AND PH DATA COLLECTED DOWNSTREAM FROM LAFAYETTE (SITE 8) USING A CONTINUOUS WATER-QUALITY MONITOR--CONTINUED

07386935 - VERMILION RIVER AT STATE HIGHWAY 3073, NEAR LAFAYETTE, LA.--CONTINUED

TEMPERATURE, WATER (DEG. C), WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980

DAY	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
	OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH	
1	25.5	24.0	21.5	20.0	10.0	9.0	12.0	10.5	10.0	9.0	16.5	13.0
2	26.0	24.5	20.0	19.0	10.0	9.0	11.5	10.5	9.0	8.0	12.5	11.0
3	27.0	24.5	19.5	18.0	9.5	9.0	11.5	11.0	9.0	8.0	11.5	10.0
4	25.5	24.5	18.5	17.5	10.0	8.5	11.0	10.5	---	---	12.0	11.0
5	25.5	23.0	18.0	17.0	10.0	8.5	11.5	10.0	---	---	13.5	12.0
6	24.5	23.0	18.5	17.0	10.5	9.5	11.5	10.0	---	---	14.5	12.0
7	25.5	23.0	18.0	17.5	10.5	9.5	12.5	11.0	---	---	15.5	13.5
8	26.0	23.5	19.0	17.0	11.0	9.5	12.0	11.5	---	---	16.5	14.5
9	26.0	24.0	19.0	18.0	11.5	10.0	11.5	11.0	---	---	17.5	16.0
10	24.5	23.0	19.0	17.5	11.5	10.5	12.0	10.5	---	---	19.5	17.0
11	24.5	22.0	17.5	16.5	13.5	11.5	17.5	12.0	---	---	20.0	18.5
12	24.5	22.0	17.0	15.5	14.5	12.5	17.0	14.0	---	---	20.5	19.5
13	23.5	22.5	16.5	15.5	14.5	13.0	15.5	14.0	---	---	20.5	19.5
14	22.5	21.5	15.0	14.0	13.0	12.5	14.0	13.5	10.0	9.0	20.0	18.5
15	23.0	21.0	15.5	14.0	12.5	11.0	14.5	13.5	11.5	10.0	19.5	18.5
16	22.5	21.5	15.5	14.0	12.0	11.0	15.0	14.0	11.0	10.0	19.5	19.5
17	23.5	21.5	15.5	14.5	11.5	9.5	16.5	15.0	10.0	9.0	19.5	18.5
18	23.5	22.5	15.5	14.5	9.5	8.5	16.5	15.5	10.5	9.0	18.5	17.5
19	23.5	22.5	16.5	15.0	9.0	8.0	16.5	16.0	11.5	9.5	17.5	17.0
20	25.0	23.0	17.5	15.5	10.0	8.5	16.5	16.0	13.5	12.0	18.0	17.5
21	25.0	23.5	17.5	17.0	11.5	10.0	16.5	16.0	14.5	13.5	18.5	17.0
22	24.5	23.5	17.5	15.5	12.5	11.5	17.0	15.5	16.0	14.0	18.0	16.5
23	23.0	21.5	15.0	12.0	13.5	12.5	15.0	12.5	16.0	15.5	17.5	17.0
24	21.5	20.0	13.0	10.5	14.5	13.0	12.5	11.5	17.0	15.5	19.0	17.5
25	20.5	19.5	11.0	10.5	14.5	12.5	12.5	12.0	16.5	16.0	18.0	---
26	20.5	19.0	11.0	10.0	13.5	12.5	13.0	12.5	16.0	14.5	18.0	17.0
27	21.0	19.0	12.5	11.0	13.0	12.0	13.0	12.0	16.0	14.0	17.0	15.5
28	21.5	19.5	12.5	12.0	12.5	12.0	12.5	12.0	17.0	15.0	16.5	15.5
29	21.5	20.5	12.0	10.5	12.5	12.0	12.5	12.0	17.0	16.0	18.0	---
30	22.0	21.0	10.5	9.5	12.0	11.5	13.5	12.0	---	---	18.5	17.5
31	22.0	21.5	---	---	12.0	11.5	13.0	10.5	---	---	18.0	17.0
MONTH	27.0	19.0	21.5	9.5	14.5	8.0	17.5	10.0	17.0	8.0	20.5	10.0

DAY	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
	APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER	
1	18.0	17.0	22.0	20.0	25.0	24.0	33.5	30.0	33.0	30.0	31.5	28.5
2	18.0	17.5	22.5	21.0	25.0	24.0	33.0	31.0	32.0	30.5	31.5	29.5
3	19.0	18.5	23.5	21.5	25.5	24.5	33.0	31.0	32.5	30.5	32.0	29.5
4	19.0	18.5	24.0	22.0	25.5	24.5	32.5	30.5	32.0	30.5	30.5	29.5
5	20.5	18.0	24.5	22.5	26.0	24.5	32.0	31.5	33.0	30.5	29.5	28.0
6	23.0	17.5	26.0	23.0	26.5	25.5	33.0	31.0	32.5	30.5	28.5	27.5
7	22.5	18.0	25.0	24.0	27.0	26.0	33.5	31.5	32.0	30.0	29.5	27.5
8	25.0	16.5	24.5	23.5	28.0	26.5	35.0	31.0	31.5	30.5	30.5	28.0
9	20.0	14.0	25.0	23.0	27.5	26.5	33.5	31.0	31.0	29.5	31.0	29.0
10	19.5	19.0	25.0	23.0	27.0	26.0	33.0	31.0	31.0	29.5	31.0	29.0
11	20.0	19.0	25.0	24.0	27.0	25.5	33.0	31.0	32.0	30.5	31.0	29.0
12	20.0	19.5	26.5	24.5	27.0	25.5	33.5	31.5	33.5	30.5	31.5	29.5
13	19.5	14.5	25.5	25.0	28.0	26.0	34.0	31.5	32.5	30.5	31.5	29.5
14	16.0	14.0	26.0	24.5	29.5	26.5	32.5	31.5	32.0	30.5	31.5	30.0
15	16.5	15.5	24.5	24.0	29.0	27.0	34.5	32.0	32.5	30.5	32.0	30.0
16	18.0	16.0	24.0	20.0	29.5	28.0	35.0	32.0	31.5	30.5	32.0	30.0
17	17.5	16.5	20.5	19.5	30.5	28.0	34.5	32.0	31.5	30.0	30.5	29.5
18	18.0	17.0	21.5	20.5	29.5	29.0	33.5	32.5	31.5	30.0	29.5	29.0
19	18.5	17.5	22.5	21.5	---	---	33.5	32.0	33.5	30.0	30.0	27.0
20	18.5	17.5	23.0	22.0	---	---	32.5	31.5	33.0	30.5	28.0	26.5
21	19.0	18.0	23.0	22.5	---	---	31.5	30.5	33.0	30.5	29.0	27.0
22	19.5	18.5	23.0	22.0	---	---	31.0	30.0	33.5	31.0	30.5	28.0
23	20.0	19.0	23.5	22.5	---	---	31.5	29.5	32.5	30.5	31.0	28.5
24	20.5	19.5	23.5	22.5	---	---	32.5	29.5	32.0	30.0	30.0	29.0
25	21.0	20.5	24.0	23.0	31.0	29.0	33.0	30.5	32.0	30.5	30.5	28.5
26	21.5	20.5	25.0	23.5	31.0	28.5	32.5	30.5	31.5	30.5	29.5	28.5
27	20.5	19.0	25.0	24.0	32.0	29.5	31.5	30.5	31.0	29.5	29.0	28.0
28	20.0	19.0	25.0	24.0	31.0	29.5	30.5	28.5	30.5	29.0	29.5	28.0
29	20.5	19.0	25.0	24.5	32.0	30.0	31.5	28.0	29.5	29.0	30.0	28.5
30	21.0	20.0	25.0	24.5	34.0	30.0	33.0	29.0	30.5	28.0	28.5	25.0
31	---	---	25.0	24.5	---	---	32.5	30.0	30.5	27.5	---	---
MONTH	25.0	14.0	26.5	19.5	34.0	24.0	35.0	28.0	33.5	27.5	32.0	25.0
YEAR	35.0	8.0										

TABLE 9.--SPECIFIC-CONDUCTANCE, DISSOLVED-OXYGEN, TEMPERATURE, AND PH DATA COLLECTED DOWNSTREAM FROM LAFAYETTE (SITE 8) USING A CONTINUOUS WATER-QUALITY MONITOR--CONTINUED

07386935 - VERMILION RIVER AT STATE HIGHWAY 3073, NEAR LAFAYETTE, LA.--CONTINUED

OXYGEN, DISSOLVED (DO), MG/L, WATER YEAR OCTOBER 1979 TO SEPTEMBER 1980

DAY	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
	OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH	
1									---	---		
2									---	---		
3									---	---		
4									---	---		
5									---	---		
6									---	---		
7									---	---		
8									---	---		
9									---	---		
10									---	---		
11									---	---		
12									---	---		
13									---	---		
14									9.2	8.8		
15									8.9	7.9		
16									---	---		
17									---	---		
18									---	---		
19									---	---		
20									---	---		
21									---	---		
22									---	---		
23									---	---		
24									---	---		
25									---	---		
26									---	---		
27									---	---		
28									---	---		
29									---	---		
30									---	---		
31									---	---		
MONTH									9.2	7.9		

DAY	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
	APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER	
1	---	---	2.9	2.5	1.6	1.4	1.6	.8	7.1	1.2		
2	---	---	2.8	2.5	1.5	1.4	1.3	.9	5.6	1.8		
3	---	---	2.6	2.2	1.4	1.2	1.9	.7	6.2	1.4		
4	---	---	2.8	2.6	1.3	1.1	1.5	.6	---	---		
5	---	---	2.7	2.3	1.2	.9	1.5	.9	---	---		
6	---	---	2.4	1.8	1.1	.8	1.4	.8	---	---		
7	---	---	2.9	2.1	1.0	.8	1.7	1.0	---	---		
8	---	---	3.0	2.3	1.2	.8	2.8	.6	---	---		
9	---	---	3.2	2.8	1.3	.9	2.9	.6	---	---		
10	3.4	3.3	3.3	2.8	1.9	1.1	3.0	.6	---	---		
11	3.4	3.2	3.4	3.0	2.0	1.3	3.9	.3	---	---		
12	3.2	2.7	3.7	3.0	1.8	1.3	4.4	1.4	---	---		
13	8.2	3.1	3.2	2.9	1.6	1.1	4.0	1.3	---	---		
14	8.3	5.9	3.5	3.0	2.2	.8	3.7	1.5	---	---		
15	5.9	5.3	4.3	1.2	1.7	.6	10.5	1.8	---	---		
16	5.2	4.2	8.0	4.1	1.6	.3	7.6	1.5	---	---		
17	4.5	4.2	7.1	6.3	.8	.1	7.3	2.0	---	---		
18	4.1	4.0	6.2	4.9	.3	.1	6.4	3.1	---	---		
19	4.0	3.8	4.5	3.6	---	---	4.6	2.3	---	---		
20	3.8	3.5	3.7	3.3	---	---	4.0	2.1	---	---		
21	3.4	3.1	3.4	3.2	---	---	2.5	1.2	---	---		
22	3.0	2.6	3.3	3.1	---	---	3.4	.4	---	---		
23	2.6	2.4	3.1	2.8	---	---	4.2	.3	---	---		
24	2.4	1.9	2.8	2.6	---	---	6.7	.5	---	---		
25	3.5	2.1	2.6	2.4	2.7	1.3	9.3	.9	---	---		
26	3.8	2.4	2.3	2.0	2.2	1.5	8.3	2.4	---	---		
27	2.4	2.1	3.3	1.7	1.9	1.2	5.8	2.2	---	---		
28	2.4	2.1	3.3	2.0	1.5	.8	3.7	1.2	---	---		
29	2.6	2.3	2.1	1.8	1.7	.9	6.5	.2	---	---		
30	2.7	2.4	2.0	1.8	2.0	1.0	8.2	1.6	---	---		
31	---	---	1.8	1.6	---	---	6.0	1.4	---	---		
MONTH	8.3	1.9	8.0	1.2	2.7	.1	10.5	.2	7.1	1.2		
YEAR	10.5	.1										