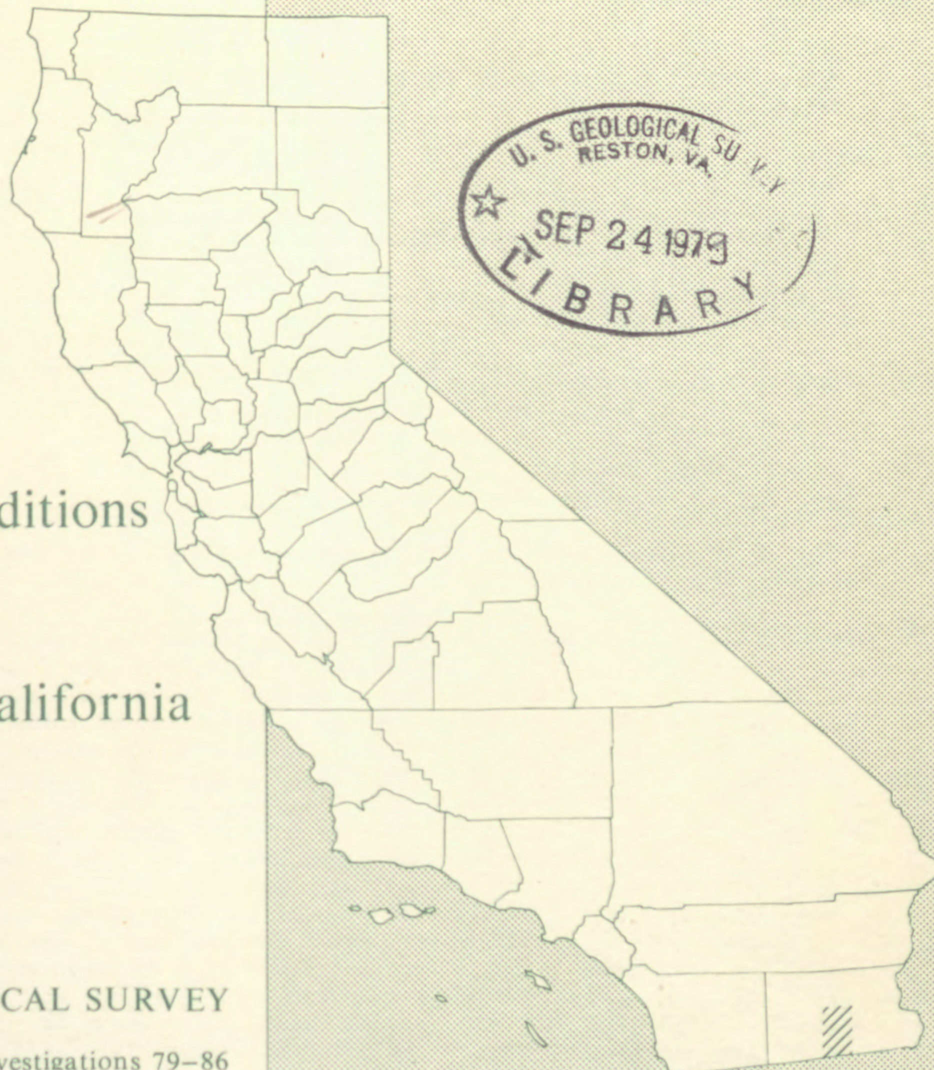

Water-Quality Conditions in the New River, Imperial County, California

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations 79–86

Prepared in cooperation with the
California Regional Water Quality Control Board
Colorado River Basin Region

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16. Abstract (Limit: 200 words) The New River, when entering the United States at Calexico, Calif., often contains materials which have the appearance of industrial and domestic wastes. Passage of some of these materials is recognized by a sudden increase in turbidity over background levels and the presence of white particulate matter. Water samples taken during these events are usually extremely high in organic content. During a 4-day reconnaissance of water quality in May 1977, white-to-brown extremely turbid water crossed the border on three occasions. On one of these occasions, the water was intensively sampled. The total organic-carbon concentration ranged from 80 to 161 milligrams per liter; dissolved organic carbon ranged from 34 to 42 milligrams per liter, and the chemical oxygen demand was as high as 510 milligrams per liter. River profiles showed a dissolved-oxygen sag, with the length of the zone of depressed dissolved-oxygen concentrations varying seasonally. During the summer months, dissolved-oxygen concentrations in the river were lower and the zone of depressed dissolved-oxygen concentrations was longer. The largest increases in dissolved-oxygen concentration from reaeration occurred at the three drop structures and the rock weir near Seeley. The effects of oxygen demanding materials crossing the border extended as far as Highway 80, 19.5 miles downstream from the international boundary at Calexico. Fish kills and anaerobic conditions were also detected as far as Highway 80. Standard bacteria indicator tests for fecal contamination showed a very high health-hazard potential near the border. Insufficient bacteria samples were collected to determine how far downstream this condition persists.

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WATER-QUALITY CONDITIONS IN THE NEW RIVER, IMPERIAL COUNTY, CALIFORNIA

By James G. Setmire

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Prepared in cooperation with the
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July 1979

UNITED STATES DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS

The inch-pound system is used in this report. For readers who prefer metric units, the conversion factors for the terms used in this report are listed below.

Multiply inch-pound unit	By	To obtain metric unit
acre	0.4047	ha (hectare)
acre-ft/yr (acre-foot per year)	0.001233	hm^3/yr (cubic hectometer per year)
ft (foot)	0.3048	m (meter)
ft/mi (foot per mile)	0.1894	m/km (meter per kilometer)
ft/s (foot per second)	0.3048	m/s (meter per second)
ft^3/s (cubic foot per second)	0.02832	m^3/s (cubic meter per second)
lb (pound)	0.45	kg (kilogram)
mi (mile)	1.609	km (kilometer)

Abreviations used:
- °C (Degree Celsius)
- JTU (Jackson turbidity unit)
- μmho (micromho)
- μg/L or UG/L (microgram per liter)
- mg/L or MG/L (milligram per liter)
- mL (milliliter)
- pCi/L or PC/L (picocurie per liter)

WATER-QUALITY CONDITIONS IN THE NEW RIVER,

IMPERIAL COUNTY, CALIFORNIA

By James G. Setmire

ABSTRACT

The New River, when entering the United States at Calexico, Calif., often contains materials which have the appearance of industrial and domestic wastes. Passage of some of these materials is recognized by a sudden increase in turbidity over background levels and the presence of white particulate matter. Water samples taken during these events are usually extremely high in organic content. During a 4-day reconnaissance of water quality in May 1977, white-to-brown extremely turbid water crossed the border on three occasions. On one of these occasions, the water was intensively sampled. The total organic-carbon concentration ranged from 80 to 161 milligrams per liter; dissolved organic carbon ranged from 34 to 42 milligrams per liter, and the chemical oxygen demand was as high as 510 milligrams per liter. River profiles showed a dissolved-oxygen sag, with the length of the zone of depressed dissolved-oxygen concentrations varying seasonally. During the summer months, dissolved-oxygen concentrations in the river were lower and the zone of depressed dissolved-oxygen concentrations was longer. The largest increases in dissolved-oxygen concentration from reaeration occurred at the three drop structures and the rock weir near Seeley.

The effects of oxygen demanding materials crossing the border extended as far as Highway 80, 19.5 miles downstream from the international boundary at Calexico. Fish kills and anaerobic conditions were also detected as far as Highway 80. Standard bacteria indicator tests for fecal contamination showed a very high health-hazard potential near the border. Insufficient bacteria samples were collected to determine how far downstream this condition persists.

INTRODUCTION

The New River flows north from the Colorado River Delta in the Mexicali Valley of Mexico, across the international boundary at Calexico, through the Imperial Valley, and into the Salton Sea (fig. 1). The Imperial Valley is bordered on the northwest by the Salton Sea, on the northeast by the Chocolate Mountains, and on the southwest by the Peninsular Range of southern California and Baja California. On the southeast it is contiguous with the Mexicali Valley of Mexico.

The New River was formed in the 1840's when the Colorado River abandoned its normal course and flowed north. According to Blake (1857), "The New River and its lagoons cannot be relied upon as an unfailing source of water; it depends upon the Colorado being filled during the season of floods, and not then unless the river attains unusual height." At that time, 1857, the New River did not flow across today's international boundary, and the Salton Sea had not been formed. Four times in the middle 1800's, water flowed into the the Salton Sink: 1840; 1842-52; 1859; and 1867. In 1891, water from the Colorado River flowed in the New River and formed a lake of 100,000 acres in the Salton Sink. This water evaporated, leaving a salt marsh. The marsh was inundated in 1906 as a result of a break in a diversion of the Colorado River, at which time the entire discharge of the river was into the Salton Sink for 4 months, thereby forming the current Salton Sea.

Water crossing the border creates a major water-quality problem in the New River through much of its course to the Salton Sea. Water quality in the New River is also influenced by numerous point and nonpoint discharges along the 60 mi in the United States from Calexico to Westmorland. According to 1975 discharge records, the river had a flow of 100,000 acre-ft/yr at the international boundary and received more than 300,000 acre-ft/yr of irrigation return flow in the United States. Irrigation return water contains lower concentrations of dissolved solids than does the water crossing the international boundary. As a result, this irrigation return improves the water quality as measured by the dissolved-solids concentration. Also, irrigation return apparently contains lower organic concentrations than water crossing the international boundary, so that water quality as measured by organic concentrations also improves. Nevertheless, some problems associated with high organic concentrations are:

1. Sudden shifts to anaerobic conditions, which result in numerous fish kills in the first 20 miles below the boundary;
2. An overall lowering of the dissolved-oxygen concentration of the entire river, especially in its upper reaches, rendering it unfit for most fish populations and changing the environment of the river to favor a less desirable biota and a poorer esthetic quality; and
3. Eutrophication, algae blooms, and fish kills in the Salton Sea, reducing its desirability as a recreation area.

In addition, the organic concentrations in the New River represent a potential threat to the fish, birds, and other wildlife in the area.

The New River and the Salton Sea are major feeding areas for migratory birds and the Salton Sea is also a spawning and rearing area for game fish. In 1965-67, 357,000 fisherman days per year were spent on the Salton Sea. (U.S. Department of the Interior and the Resources Agency of California, 1974). The three main game fish in the sea are the orangemouth corvina (Cynoscion xanthulus), the gulf croaker (Bairdiella icistia), and the sargo (Anisotremus davidsoni). Migratory birds, such as snow geese and Canadian geese, use Salton Sea areas during their annual journeys, while the delta areas of the New and Alamo Rivers afford a habitat for the Yuma clapper rail and the California brown pelican, both of which have been placed on the endangered species list. The tip of the New River Delta is the only nesting area in the western United States for the gull-billed tern. An egret rookery is also present in the south end of the Salton Sea, as are food plots to induce waterfowl away from the agricultural areas. The food plots are in the 2,200-acre Salton Sea National Wildlife Refuge (U.S. Department of the Interior and the Resources Agency of California, 1974).

The purposes of this study were (1) to identify the major constituents degrading the quality of the water in the New River at Calexico, (2) to document existing water-quality conditions in the New River from Calexico to the Salton Sea, and (3) to describe the effects of the water crossing the international boundary at Calexico on the river quality as it flows to the Salton Sea.

The following action phases and subjects are covered or will be covered in this study: reconnaissance trip, river profile study, diel study, time-of-travel investigation, effects of pollutant discharges on water quality, and water quality of the south end of the Salton Sea. The first four phases were completed during 1977 and 1978 in cooperation with the California Regional Water Quality Control Board, Colorado River Basin Region (Regional Board). The study of effects of pollutant discharges on water quality was started in 1979. The Salton Sea study is awaiting funding. Major topics covered in this report are dissolved-oxygen concentration, organic concentration, and reaeration.

COLLECTION OF DATA

Reconnaissance Study

The New River reconnaissance involved a single intensive sampling trip to the New River at the Calexico gaging station (fig. 2) designed to characterize the water entering the United States from Mexico. The trip was made the week of May 9, 1977, in order to sample during a period fairly representative of the year, recognizing, of course, that monthly and seasonal variations occur and that important variations in flow and water quality could be missed.

To develop a comprehensive list of deleterous materials that might be detected in the New River at Calexico, constituents generally associated with industrial, commercial, and agricultural practices were selected. The potential toxicity of the suspected constituents to wildlife in particular and to degradation of the river in general was considered in order to reduce the list to a workable size, in terms of economics and logistics of sampling and analysis.

During the reconnaissance, field tests and measurements for selected constituents (table 1 and figs. 3-7) were made on water samples collected at about 45-minute intervals. Together with the appearance of the river, these tests were used to signal the passage of polluted water. Samples for laboratory analysis (table 2) were collected whenever the appearance and the field tests indicated an increase in pollution. Background water-quality information was also collected during periods of little or no visible pollution. In addition, a set of control samples (table3) was collected from the Alamo River at Drop 9 near Holtville (fig. 2), where the discharge is about equal to that of the New River at Calexico but consists primarily of agricultural return water.

Water samples were analyzed for the following properties and chemical constituents. Only part of the field data for the New River are reported in table 1. In addition to the results given in table 1, a summary of the field data is given in table 4.

Field measurements and tests

Specific conductance
pH
Water temperature
Turbidity
Dissolved oxygen
Chlorine, free
Chlorine, total
Total phosphate
Orthophosphate
Hexavalent chromium
Copper
Iron
Lead
Manganese
Zinc
Cyanide
Methylene blue active substances
Tannin and lignin

Laboratory determinations

Chemical oxygen demand	Gross beta radiation
Total filtrable residue	Total organic carbon
Total nonfiltrable residue	Dissolved organic carbon
Antimony	Cyanide
Barium	Phenol
Chromium	Methylene blue active substances
Copper	Oil and grease
Lead	Tannin and lignin
Mercury	Total chlorinated hydrocarbons
Nickel	Total organic phosphates
Gross alpha radiation	

Sample collection.--Water samples for field measurement and the laboratory analysis were collected from a walkway about 30 ft upstream from the Calexico gage, a quarter of a mile downstream from the international boundary. Initially, samples were collected with a D74 quart-size sampler suspended from a three-wheeled base crane anchored to the walkway at the midpoint of the channel. Because stream velocities remained less than 2.0 ft/s, the sampling device was later changed to an open-mouth glass bottle. A cross-sectional specific conductance profile of the river at the walkway showed a range of less than 1.5 percent at 7,000 μmho, indicating well-mixed water. For this reason a single depth-integrated sample collected at midstream was deemed representative of the flow at the gage during the passage of turbid and highly colored water indicating increased pollution.

Field and laboratory methods.--Samples for laboratory determination were sent to the U.S. Geological Survey's Central Laboratory at Arvada, Colo. Methods for analysis of most constituents are as specified in Brown, Skougstad, and Fishman (1970), pesticides were determined by gas chromatography, organic carbon was determined by wet oxidation, oil and grease were determined by ether extraction, and radioactivity was determined by U.S. Geological Survey standard methods (Goerlitz and Brown, 1972; Thatcher and others, 1977).

Field determinations (specific conductance, temperature, dissolved oxygen, pH, and turbidity) were made in accordance with standard Survey procedures (Brown and others, 1970). With the exception of zinc and lead, which were determined by a modification of the Huff (1948) field test for heavy metals, the field tests were done using standard commerical field-test kits.

Field tests not performed according to U.S. Geological Survey standard methods are subject to unknown interferences, owing to the imprecise nature of the tests, and should not be considered to be of the same precision as those analyses performed by the U.S. Geological Survey laboratory. Field tests using color-wheel comparison have detection limits of 0.1 mg/L for chromium, copper, and manganese. These constituents, when determined by the Survey's central laboratory, have a detection limit of 0.01 mg/L or less.

River Profile

A river profile, measuring several physical and chemical characteristics at 67 sites along the New River, was made during the week of September 26-30, 1977. The profile was designed to determine the degree and the effects of organic loading and the rate of recovery of the river from that loading. Dissolved-oxygen concentration, which is an indicator of the major reactions that are constantly occurring in the aqueous environment, was the primary indicator used (table 5 and figs. 8-10).

Samples were also collected to measure the organic concentrations--chemical oxygen demand, total and dissolved organic carbon, and biochemical oxygen demand (table 6). By coupling the organic-concentration information with dissolved-oxygen concentration and percent saturation, the mechanisms at work in the river can be further understood.

Counts of fecal coliform and fecal streptococcus bacteria, both indicative of waste contamination, were also determined. The results of these determinations indicate the dieoff of these organisms with time and with distance downstream from the international boundary and identify any additional sources of contamination.

Water samples were analyzed for the following properties and chemical constituents:

Field measurements

Specific conductance	Biochemical oxygen demand
pH	Fecal coliform
Water temperature	Fecal streptococcus
Dissolved oxygen	

Laboratory determinations:

Chemical oxygen demand	Dissolved organic carbon
Total organic carbon	

Sample collection.--Field measurements of dissolved oxygen, water temperature, specific conductance, and pH were made at 67 sites from a boat during its upstream traverse from the Westmorland gage to Calexico. The other field measurements were made within 6 hours of collection at the El Centro sewage-treatment plant laboratory or in a mobile laboratory. Water samples for chemical analysis at the Survey's central laboratory and for determination of biochemical oxygen demand, fecal coliform, and fecal streptococcus were collected at 20 of the 67 sites. Sites were selected on the basis of distance and amount of tributary inflow and were located on U.S. Geological Survey quadrangle maps, with river morphology, bridge crossings, and contour lines as reference points. From this information, river miles were determined. All samples were collected with a wide-mouth glass bottle at midpoint in the channel. Additional dissolved-oxygen data were collected at bridge crossings on the river.

Field and laboratory methods.--Methods were the same as for the reconnaissance trip, except for biochemical oxygen demand which was performed in accordance with standards established by the American Public Health Association, American Water Works Association, and Water Pollution Control Federation (1976).

Diel Study

During the week of October 17, 1977, a diel (spanning a 24-hour period) measurement at five sites was made to determine the downstream effects of organic loading on the intensity of biological activities, as indicated by dissolved-oxygen concentration. Measurements of dissolved-oxygen concentration, water temperature, pH, and specific conductance were made hourly (tables 7-11) at each of the following sites on the New River (fig. 2):

at international boundary at Calexico (site 0)
at Highway 80 (site 19.5)
at Keystone Road (site 36.1)
below Drop 4 near Brawley (site 43.6)
near Westmorland (site 61.2)

Samples were collected at 6-hour intervals for determination of the following constituents:

Chemical oxygen demand	Dissolved organic carbon
Total organic carbon	Biochemical oxygen demand

Graphs in figures 11-15 show dissolved-oxygen fluctuations with time and include data on chemical oxygen demand and organic carbon. For some sites biochemical oxygen demand data are included also.

Sample collection.--Water samples for field measurements and the determination of chemical constituents were collected by dip sampling, using wide-mouth glass bottles at the centroid of flow.

Field and laboratory methods.--Methods were the same as for the river profiles.

Time-of-Travel Investigation

The time-of-travel study was made February 6-9, 1978, to evaluate the rate of flow in the reach of the New River between the international boundary and the Salton Sea. Seventy-five pounds of a 20-percent solution of Rhodamine WT[1] fluorescent dye was injected in the river at the Calexico gaging site. Approximate traveltimes were estimated on the basis of streamflow measurements at Calexico and Westmorland for the first site, which was at Clark Road, 5.5 mi downstream from the dye injection point. Sampling was begun 2 hours before the projected arrival of the leading edge of the dye at Clark Road, both to insure that the dye was not missed and to gather background fluorescent readings. At the first site the color was pronounced, and the leading edge and peak dye concentration were close together (40 minutes apart). Based upon the traveltime to the Clark site, arrival time of the dye at the downstream sites was calculated and a sampling schedule devised.

Figure 16 graphically presents the time-of-travel and discharge data.

Sample collection.--Samples were collected in 30-mL vials from midpoint in the channel. The frequency of collection varied with the time to peak dye concentration, duration of the dye cloud, and the ratio of the width to the depth at each of the sites.

Laboratory methods.--Relative fluorescence was determined by a fluorometer.

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

BACTERIAL CONTAMINATION

Samples to determine the presence of fecal coliform and fecal streptococcus were collected at 16 sites on the New River during the profile of September 26-30, 1977 (table 6). These two groups of enteric bacteria are used to indicate the existence and degree of fecal pollution of a body of water. Their presence in an aquatic system means that fecal contamination has occurred and that the potential exists for a public health problem--the higher the number of indicator bacteria the greater the health risk. Correlations between the density of indicator organisms and the occurrence of specific pathogens are not available except for the Salmonella group. Geldriech's study (1970) of the occurrence of Salmonella in freshwater indicated almost 32 percent positive detection of Salmonella when fecal coliform concentrations were between 1 and 200 colonies per 100 mL. Detection of Salmonella increased to 83 percent for samples having fecal coliform concentrations of 201 to 1,000 colonies per 100 mL. For fecal coliform concentrations of 1,001-2,000 colonies per 100 mL, over 88 percent positive detection was found, and for concentrations above 2,000, positive detection increased to nearly 98 percent. Salmonella causes diseases such as typhoid and paratyphoid fever and a variety of types of food poisoning. Other diseases possibly resulting from fecal contamination are dysentery, cholera, and a wide range of parasitic infections.

The highest observed fecal coliform concentration, 2,800,000/100 mL, during the river profile occurred at Brockman Road, 11.4 mi downstream of the boundary. The corresponding fecal streptococcal concentration was 180,000/100 mL. The lowest fecal coliform concentration, 1,000/100 mL (a non-ideal count), was observed at Lack Road, 60.2 mi downstream from the boundary. The corresponding fecal streptococcal concentration was also 1,000/100 mL and a non-ideal count. There was no discernible pattern from sample to sample, although the concentrations near the mouth of the New River were lower than at the boundary, as expected with the die-off of organisms with time in the aquatic system. The absence of a pattern resulted from the compounding of variables, the distance and time from the source of contamination, the cyclic nature of domestic sewage discharge, and the time and direction of sample collection.

ORGANIC LOADING AND DISSOLVED-OXYGEN CONCENTRATION

Organic loading and its effect on dissolved-oxygen concentration are major fisheries and esthetics problems in the New River. Large quantities of organic matter in the river at the Calexico gaging site are rapidly decomposed (oxidized) by bacteria and other organisms. The dissolved oxygen is quickly used and is exhausted first in the oxidation process. Oxidation continues under anaerobic conditions with nitrates, sulfates, and finally carbon dioxide acting as oxidizing agents. During aerobic oxidation, the dissolved oxygen acts as the oxidizing agent and, in turn, is reduced while the organic matter goes from a reduced state to an oxidized state. During anaerobic oxidation of organic matter, the nitrates are preferentially reduced to ammonia; then sulfates are reduced to hydrogen sulfide; then carbon dioxide is reduced to methane.

In the New River, the effects of both the aerobic and anaerobic oxidation of organic compounds are clearly evidenced in the reach from the Calexico gage (site 0) to Highway 80 (site 19.5), where dissolved-oxygen concentrations are the lowest of any reach of the river. Dissolved-oxygen profiles for the summer of 1977 (fig. 10) show anaerobic conditions from Calexico to at least Worthington Road (site 26.4) in the July 28 sampling, to at least Highway 80 (site 19.5) in the August 30 sampling, and to at least Brockman Road (site 11.4) in the June 13 sampling.

The biochemical oxygen demand reflects the amount of oxygen required by bacteria to biochemically oxidize organic matter. The two main factors affecting the degradation rate of the biochemical oxygen demand are temperature and the amount of unoxidized organic material in the water. Phelp's law states that "the rate of biochemical oxidation of chemical organic matter is proportional to the remaining concentration of unoxidized substance measured in terms of its oxidizability" (Velz, 1970). This law applies only when there is excess oxygen and a constant temperature.

Summer water temperatures in the Imperial Valley exceed 30°C. Temperature has two effects on the dissolved-oxygen concentration. First, the amount of oxygen that water can hold decreases as water temperature increases. For example, at 20°C and 50-percent saturation, the dissolved-oxygen concentration is 4.5 mg/L, and at 34°C and 50-percent saturation, it is 3.5 mg/L. Although 1.0 mg/L seems small, it represents nevertheless a 20-percent difference in the amount of oxygen available for aerobic oxidation of the organic matter.

Second, the metabolic rate of bacteria is temperature dependent. For 5-day biochemical oxygen demands (BOD_5), the reaction rates change in the following manner: At 29°C, the BOD_5 half-life is 2 days with a reaction rate of 82 percent per day; at 20°C, BOD_5 half-life is 3 days with a reaction rate of 68 percent per day; and at 14°C, BOD_5 half-life is 4 days with a reaction rate of 58 percent per day (Klein, 1962). Because the reaction rate is much faster at high temperatures when the dissolved oxygen is correspondingly lower, high organic loading during the summer months leads to deoxygenation and possible anaerobic conditions in the river.

Reconnaissance Study

The reconnaissance of May 9-13, 1977, was instrumental in characterizing the pollution observed at the Calexico gaging site. Background samples revealed turbidities ranging from 17 to 45 JTU, pH's ranging from 7.4 to 7.8, and concentrations of total and dissolved organic carbon ranging from about 10 to 20 mg/L. On May 12, 1977, at 0905 hours, the first major slug of pollution during the reconnaissance was detected. It was immediately identifiable by an increase in turbidity caused by white particulate matter in the water. Turbidity rose to a maximum of 115 JTU and pH increased to 8.8. Concentrations of total and dissolved organic carbon in samples collected during the pollutant discharge ranged from 30 to 161 mg/L and 23 to 42 mg/L respectively. Other maximum concentrations measured during this period included chemical oxygen demand at 510 mg/L, oil and grease at 56 mg/L, and tannin-lignin at 10 mg/L. These concentrations were maximum values for the reconnaissance.

Relative to the high turbidities, total nonfiltrable residues had correspondingly higher values during the pollutant discharge, with concentrations of 110 and 170 mg/L compared with background values of 30 to 50 mg/L. As the slug of pollution passed the Calexico gaging station, turbidity and pH gradually decreased to background levels.

The pollutant slug placed a very large demand on the oxidative processes of the river. Although no downstream samples were collected during this phase of the study, dissolved-oxygen concentrations were probably depressed for many miles.

Concentrations of oil and grease also increased in the pollutant slug. A black, tar-like substance was observed at 0922 hours, and concentrations of oil and grease increased from 0 mg/L at 0850 hours to 31 mg/L at 0905 and 56 mg/L at 0930.

Turbidity and concentrations of total organic carbon indicated that additional pollutant slugs passed on May 12. Additional samples were collected May 12 when turbidites rose above background levels. Slightly higher than background total organic carbon concentrations of 28 and 37 mg/L were detected at 1545 and 1715 hours. A white discharge was observed at 1715 hours and again at 2130 hours. Unfortunately, the total organic carbon sample taken at 2130 hours was broken during shipment. The sample collected at 1545 hours had the highest observed phenol concentration, 27 mg/L, observed during the reconnaissance trip. Other than a small rise in dissolved and total organic carbon concentrations of 3-4 mg/L, no increases were noted for the sample collected at 1545.

With the industry present upstream of the Calexico gage, it was anticipated that trace elements would be found in the New River. None, however, were observed in concentrations indicative of industrial sources (table 2). Methylene-blue active substances (generally detergents) were detected both in the laboratory analyses and in the field test. Concentrations of these substances generally reached a daily maximum between 0700 and 1200 hours.

Of the trace elements, barium had the highest concentration, 0.2 mg/L. With a limit of 1 mg/L for domestic water supplies, and with the wide industrial use that barium receives, 0.2 mg/L does not represent a health hazard nor is it indicative of major industrial pollution. Orthophosphate and total phosphorous were determined by field tests. Concentrations, in the elemental form, ranged from 0.01 to 0.07 mg/L and from 0.02 to 0.11 mg/L, respectively. The upper limits of these phosphorous concentrations are high enough to cause enrichment of the receiving water, the Salton Sea. Phosphorous concentrations near the mouth of the New River, however, are significantly higher than those at the Calexico gage, indicating inflow of water having higher concentrations of phosphorous as the river flows to the Salton Sea.

Small amounts of various pesticides were detected, with the highest concentration being 1.6 μg/L of malathion at 1415 hours on May 10. DDT concentrations ranging from 0.00 to 0.25 μg/L were detected in the New River at Calexico along with its breakdown products DDD and DDE. Even though use of DDT is banned in the United States, trace amounts are still being found because of its persistence in the environment. It is not surprising, therefore, that minor concentrations of these pesticides were detected in the New River at Calexico.

A control sample was collected from the Alamo River at Drop 9 near Holtville. The discharge at that site is about the same as that of the New River at Calexico, but sources are solely agricultural. Specific conductance for this sample was 3,560 μmho, compared with a mean of 8,300 μmho for the New River at Calexico. Chemical oxygen demand for the control site was 72 mg/L as compared to a mean chemical oxygen demand of 322 mg/L for the New River at Calexico. The total and dissolved organic carbon was 11 and 15 mg/L (discrepancy of results within analytical precision) as compared to means of 30 and 15 mg/L for total and dissolved organic carbon, respectively, in the New River at Calexico (during selected slug periods).

The higher (450 percent) chemical oxygen demand at the Calexico site indicates greater concentration of oxidizable material than at the Alamo River site. The organic carbon concentrations do not show as great a difference as do the chemical oxygen demand concentrations. The high concentrations of organic carbon, such as detected in the slug flows, stress the dissolved-oxygen concentrations and the biota in the river. Although no detailed water-quality studies involving chemical oxygen demand, total organic carbon, and dissolved organic carbon have been made of the Alamo River, no such extremes in organic concentration have been observed on casual inspection by the Survey or its cooperators.

Filtrable residues for the New River at Calexico are about twice that of the control site on the Alamo River, which is consistent with the difference in specific conductance of the two rivers. Nonfiltrable residues are higher on the Alamo at the control site than the background levels for the New River at Calexico. Values obtained during the passage of pollutant slugs however, are comparable with control-site values.

River Profile

Dissolved-oxygen profiles constructed from river profile data in 1977 (fig. 10) indicate that during the summer months the New River is frequently depleted of dissolved oxygen at the international boundary and that concentrations are very low for many miles downstream.

At high summertime temperatures, the combined effects of low dissolved-oxygen capacity, high rates of oxidation (due to increased bacterial metabolism), and high concentrations of organics in the river at Calexico place a generally continual and severe demand on the oxygen supply. The supply is further stressed by periodic slugs of pollution.

In contrast to the summer profiles, which begin at the border with anaerobic conditions, the profiles for the winter months (fig. 9) show a gradual decrease in dissolved-oxygen concentration downstream from Calexico. This pattern probably results from an increase in the dissolved-oxygen holding capacity of the water and slower reaction rates than those of the summer months. Because of the slower biochemical oxidation rates in winter, the organic load in the river does not exert as great an immediate oxygen demand as in the summer. Consequently, the profiles of December 28, 1976, and January 11, 1977, show that sufficient oxygen is present to aerobically oxidize the organic matter and to maintain aerobic conditions throughout the reach to the Salton Sea.

Figures 8-10 show the seasonal variation of dissolved oxygen in the New River. For the profile of September 26-30, 1977, (fig. 8) a classical dissolved-oxygen sag curve is portrayed. Dissolved-oxygen concentration at the Calexico gage was 3.7 mg/L, 45 percent saturation. Water temperature was 24.5°C, somewhat low for late summer. Chemical oxygen demand was higher at Calexico (170 mg/L) than at any other site on the profile. The biochemical oxygen demand, total organic carbon, and dissolved organic carbon were 20, 17, and 15 mg/L, respectively. The amount of oxygen that would be required to break down the carbonaceous matter, ultimate first stage oxygen demand, is 2.67 times the concentration of organic matter. For 1 mg/L of ammonial or organic nitrogen, 4.57 mg/L of oxygen will ultimately be used.

Based on these facts, the organic matter at the Calexico gage is sufficient to deplete the dissolved oxygen in the water at that point. With a biochemical oxygen demand reaction rate of about 25 percent per day, it would take 2½ days to reduce the demand to one-half its original value. At Kemp Road, 1.5 mi downstream, the dissolved oxygen was 2.6 mg/L, while at Highway 98, 3.5 mi downstream, the dissolved oxygen was approaching 0 at 0.3 mg/L. Because the water observed at Highway 98 and Kemp Road did not necessarily cross the international boundary with the same quality as water sampled at the Calexico gage for this profile (due to time of travel), the lower chemical and biochemical oxygen demands cannot be attributed entirely to aerobic oxidation. Also, the lower demands may be due in part to dilution and the settling out of particulate matter.

During the summer months the first 19.5 mi of river, from the international boundary to Highway 80, are generally anaerobic. Because Phelps law applies only in the presence of excess dissolved oxygen, the rate of aerobic oxidation would decrease as the dissolved oxygen drops below about 2 mg/L. Although aerobic oxidation continues at a rate equal to reaeration, the conditions are set for anaerobic oxidation, in which the nitrates and sulfates are reduced as the organic matter is oxidized. Even though no measurements for hydrogen sulfide or ammonia were made, U.S. Geological Survey and State Regional Board personnel observed conditions that are indicative of anaerobic decomposition, such as the odor of hydrogen sulfide and black discoloration of water.

In general, however, the principal reason for the reduced dissolved-oxygen concentrations in the profiles is aerobic oxidation. Biochemical oxygen demands downstream at the Westmorland gage reflect what remains of the organic load from the boundary after approximately 55 hours of aerobic and anaerobic oxidation plus what remains of the organic load from agricultural returns north of the boundary.

The reduction in chemical oxygen demand, biochemical oxygen demand, total organic carbon, and dissolved organic carbon with distance downstream from Calexico (table 6) indicates the degree of oxidation that has occurred. The time that the water has been exposed to the oxidative processes can be determined from the time-of-travel data listed in table 12 and in figure 16. These traveltimes apply only for flow conditions the same as those for the time-of-travel study.

Diel Study

The effects of organic loading on the intensity of biological activity as indicated by dissolved-oxygen concentration was assessed by a diel study during the week of October 17, 1977. Dissolved-oxygen concentration was measured hourly, and samples for confirmation of organic material concentrations were collected three or four times during the 24-hour period.

At the Calexico gage and at Highway 80, significant variation in dissolved-oxygen concentrations was observed. At 1300 hours October 17, the dissolved-oxygen concentrations at the Calexico gage were about 3 mg/L, 35 to 45 percent saturation. Seven hours later at 2000 hours, anaerobic conditions were prevalent and continued for 9 hours. During the 9-hour period, the concentration of total organic carbon increased appreciably and the concentration of the dissolved organic carbon fraction increased by 5.6 mg/L. Also, chemical oxygen demand increased from 120 mg/L to 480 mg/L as the dissolved-oxygen concentration decreased from 3.0 mg/L to 0.1 mg/L. Apparently a pollutant slug containing high concentrations of organic matter was present. After the slug had passed the Calexico gage, the dissolved organic carbon concentration and the chemical oxygen demand returned to their earlier levels.

At the Highway 80 crossing from 1600 hours on the 17th to 0700 hours the following morning, the dissolved-oxygen concentration and percent saturation gradually decreased. At that time, the dissolved-oxygen concentration fell to 0.5 mg/L and 5 percent saturation. Chemical oxygen demand increased from 77 mg/L at about 0330 that morning to 120 mg/L at about 0900. During that time, dissolved organic carbon concentrations increased from 7.4 to 8.5 mg/L. The dissolved-oxygen concentration then increased to 2.2 mg/L at 1200, remained stable for an hour, then decreased to 0.1 mg/L. The biochemical oxygen demand increased from 5.1 mg/L at 2200 hours on the 17th to a high of 18.4 mg/L at 1410 hours on the following day. These depressed oxygen levels correspond to the occurrence of the pollutant slug 18-22 hours earlier at the Calexico gage. The 18-22 hours agrees with a computed traveltime from the time-of-travel study.

The effects of the pollutant slug were detected at least 20 mi downstream from the international boundary. Because the diel studies at Highway 80 and Keystone were made at the same time and because the low dissolved-oxygen concentrations at Highway 80 were observed at the end of the 24-hour period, it is not known whether the low dissolved-oxygen and high organic concentrations reached the site at the Keystone bridge. Samples collected at Highway 80 at 1600 hours had a chemical oxygen demand of 93 mg/L, total organic carbon concentration of 11.2 mg/L, and a dissolved organic carbon concentration of 7.5 mg/L. Sixteen hours later, the approximate traveltime between Highway 80 and Keystone, the chemical oxygen demand at the Keystone site had decreased to 77 mg/L and the total and dissolved organic carbon concentrations had decreased to 9.8 mg/L and 6.8 mg/L, respectively.

For the reach between Calexico and Highway 80, the gain in discharge from agricultural drains is small. Downstream from Highway 80, however, the discharge increases from agricultural drainage, and dilution occurs with respect to dissolved-solids concentration and, possibly to organic loads. Because the agricultural drainage exerts an oxygen demand, the dissolved oxygen concentrations observed at downstream sites are not due entirely to the organic loads at the international boundary and the subsequent anaerobic or aerobic oxidation of these loads.

The dissolved-oxygen concentration pattern over the diel period at the Keystone site was like that seen often in other streams with the highest concentrations in the late afternoon as a result of the photosynthetic activity of the algae and the lowest concentrations in the early morning hours as a result of respiration by the river's biota. Dissolved-oxygen concentrations measured downstream of Drop 4 near Brawley showed very little variation. This was expected, however, because readings were taken below the drop structure. At the Westmorland site, like the Keystone site, diel variations in dissolved-oxygen concentrations were fairly normal.

In the reach from Keystone to Westmorland, dissolved-oxygen concentrations were above 5 mg/L and the water was more than 50 percent saturated with respect to oxygen. This is in sharp contrast to the anaerobic conditions in the upper reaches of the river.

Reaeration

Dissolved-oxygen concentrations in water are replenished by photosynthesis, and by reaeration. According to Velz (1970, p. 189), oxygen enters the water at the air-water interface as an infinitely thin film that is instantly saturated. Subsurface diffusion is then responsible for spreading the dissolved oxygen. Turbulence greatly increases the rate at which saturated surface layers are mixed with the unsaturated water, which decreases the depth through which the oxygen must diffuse. In general, the rate of reaeration is proportional to the difference between the observed dissolved-oxygen concentration and the dissolved-oxygen concentration at saturation, although the actual amount received depends upon the physical and hydrologic characteristics such as temperature, water depth, occupied channel volume, and stream turbulence of each stretch of river (Velz, 1970, p. 184). If the dissolved-oxygen concentration in the river is 0, then the rate of reaeration is at its maximum.

The effects of photosynthesis and reaeration on the dissolved-oxygen concentration in the New River can be seen in the dissolved-oxygen profile from Calexico to the Westmorland gage shown in figure 8. The effects of reaeration are most apparent at the three drop structures and the rock weir just downstream from Highway 80 where turbulence mixes the water and results in sharp increases in the dissolved-oxygen concentration. The largest increase, 2.0 mg/L, was at Drop 4, the farthest upstream drop structure, and the lowest increase, 0.6 mg/L was at Drop 2. The size of these increases was consistent with the concept that the oxygen deficit regulates the rate of reaeration. The dissolved-oxygen profiles of June 13, July 28, and August 30, 1977 (fig. 10), also show reaeration occurring at the three drop structures and the rock weir about 0.25 mi downstream from Highway 80. The increase in dissolved-oxygen concentration for these summer profiles was greater than the increase of the September 26-30 dissolved-oxygen profiles. A greater dissolved-oxygen deficit was present for the summer profiles, resulting in a more sizeable increase in dissolved-oxygen concentration.

The sharp increases in dissolved-oxygen concentration at Salt Creek and Keystone Road (fig. 8) represent diel variations due to photosynthetic activity. The measurements immediately downstream of these sites were made in the afternoon when photosynthetic activity and dissolved-oxygen concentrations were high. The lower concentrations at or just upstream of those sites were measured early on the following morning when photosynthetic activity was low.

Statistical Analysis

Distribution graphs of chemical oxygen demand and biochemical oxygen demand are presented in figure 17. These graphs are a composite of data collected by the Survey and Regional Board at the Calexico gage during the period July 1976-March 1978. Both distributions are skewed to the right and are best represented by the geometric means, 133 mg/L for chemical oxygen demand and 44 mg/L for biochemical oxygen demand. The correlation coefficient between biochemical oxygen demand and chemical oxygen demand was 0.9 (a coefficient of ±1.0 indicates a perfect relation between variables). There was no correlation between dissolved-oxygen concentration and biochemical oxygen demand, as indicated by a correlation coefficient of -0.20. For the reconnaissance trip of May 9-13, 1977, the correlation coefficient between chemical oxygen demand and total organic carbon was 0.57. The geometric mean for chemical oxygen demand was 322 mg/L, with a range for one standard deviation unit about the mean of 240 mg/L to 417 mg/L. For total organic carbon the geometric mean was 29.8 mg/L, with a range of 14 mg/L to 60 mg/L for one standard deviation unit, indicating much more variation in the total organic carbon concentration than in chemical oxygen demand. The correlation between chemical oxygen demand and dissolved organic carbon concentration was higher, with a coefficient of 0.67. The geometric mean concentration of dissolved organic carbon was 15.4 mg/L, and the range for one standard deviation unit was 9.55 mg/L to 25.1 mg/L.

Environmental Effects

One of the major environmental problems resulting from pollution in the New River is low dissolved-oxygen concentration. As discussed previously, many miles of the river exhibit anaerobic conditions where the dissolved oxygen has been completely exhausted. Associated with these low or zero dissolved-oxygen levels are numerous accounts of fish kills. The U.S. Environmental Protection Agency (1976) has recommended that a lower limit of 5.0 mg/L dissolved-oxygen concentration be maintained for freshwater aquatic life. It further recommends that for esthetic enjoyment the water should contain sufficient dissolved oxygen to maintain aerobic conditions in the water column and, except as affected by natural phenomenon, at the sediment-water interface. It is the extremes, not the average conditions, that are largely responsible for deleterious effects.

In reaches of the river from Calexico to Highway 80, dissolved-oxygen concentrations are constantly less than 5.0 mg/L and often less than 1.0 mg/L. Dissolved-oxygen profiles during the summer of 1977 indicate that occasionally dissolved-oxygen concentrations less than 5.0 mg/L occur in the lower reaches of the river. For the lower reaches, including Gentry and Lack Roads, the profiles of June 13, July 28, and August 30, 1977, have dissolved-oxygen concentrations less than 5.0 mg/L and therefore violate the criterion previously mentioned.

At the Calexico gage, the Regional Board has a monthly 12-hour sampling program. The following are remarks from a written communication from the Regional Board concerning some of these samplings: "(1) July 28, 1976, 1550 to 1700 hours, slug flow of white discharge; white particulate matter on surface; thousands of dead and dying minnows observed; dissolved oxygen zero; (2) June 1, 1977, 1105 hours, slug flow of white discharge; dead and dying minnows on surface; strong sewage odor." These are just two of many observations of fish kills in the New River at Calexico. Conditions downstream are similar. At La Brucherie Road, May 10, 1977, at 1800 hours, the dissolved oxygen was 0, the river color was black, a sulfide odor was present, and dead fish were observed. Similar observations have been made at Drew, Brockman, Lyons, and Clark Roads throughout the last few years.

As this richly organic water enters the Salton Sea, it provides a nutrient source for the algae. As the algae multiply, the photosynthesis-respiration cycle of the sea may be stressed. The result can be large and sometimes rapid change in dissolved-oxygen concentration as high daytime production of oxygen is followed by high respiration use and oxygen depletion during the night. When the population of algae and other aquatic plants becomes very large, all the available oxygen can be utilized and a fish kill can result. As the algae die, the anerobic bacteria break down the detritus, producing an esthetically unpleasing environment. This process varies seasonally, with the worst conditions prevalent in the summer.

SUMMARY AND CONCLUSIONS

Environmental Effects

The New River, as it enters the United States at Calexico, frequently contains materials that are like industrial and untreated domestic wastes in appearance and response to laboratory analysis. Some of these occurrences of pollution are recognized by an immediate increase in turbidity and the presence of white particulate matter and there is a high organic content. During a reconnaissance May 9-13, 1977, three occurrences of pollutant slugs were detected and one of them was intensively sampled. The total organic carbon concentration in this slug ranged from 80 to 161 mg/L, concentrations of dissolved organic carbon ranged from 34 to 42 mg/L, and the chemical oxygen demand was as high as 510 mg/L. The pH increased from 7.6 prior to the arrival of the pollutant slug to a maximum of 8.8 and then decreased to 7.7 as the slug passed.

In comparison, concentrations of chemical oxygen demand, total organic carbon, and dissolved organic carbon at the control site, Alamo River at Drop 9 near Holtville, were 72, 11, and 15 mg/L respectively.

Dissolved-oxygen profiles along the reach of the New River from Calexico to the Salton Sea showed a dissolved-oxygen sag downstream of Calexico, with the length of the zone of depressed dissolved oxygen varying seasonally. During the summer, dissolved oxygen was depleted in the upper end of the reach and zero concentration was occasionally observed at Worthington Road, 26.4 mi downstream. Reaeration occurred at the drop structures and rock weir near Seeley, with dissolved-oxygen increases as large as 4 mg/L at Drop 4. Concentrations were occasionally below the 5.0 mg/L recommended minimum of the U.S. Environmental Protection Agency (1976, p. 224) as far downstream as Gentry and Lack Roads, sites 57.3 and 60.2, respectively. In winter the dissolved-oxygen sag was still present, but concentrations were higher and the length of the depressed zone shorter. The decrease per river mile in dissolved-oxygen concentration was much more gradual. Dissolved-oxygen concentration levels, for the most part, did not reach zero, and major reaeration occurred between Highway 80 and Worthington Road, largely due to the turbulence at the rock weir near Seeley. Downstream reaches, below Drop 4, had dissolved-oxygen concentrations well in excess of the 5.0 mg/L criterion, with reaeration occurring at the three drop structures.

The diel study, coupled with the time-of-travel data, showed the downstream effects of a pollutant slug. The discharge of white particulate matter was observed at the Calexico gage at 1800 hours October 17, 1977. This discharge was characterized by a chemical oxygen demand of 480 mg/L and a dissolved organic carbon concentration of 15 mg/L, as compared with a chemical oxygen demand of 120 mg/L and dissolved organic carbon concentration of 9.4 mg/L 5 hours earlier. This slug reduced the dissolved-oxygen concentration to zero, where it remained for about 9 hours. Twenty hours later, at 1400 October 18, 1977, the dissolved-oxygen concentration decreased sharply at Highway 80. The 20 hours corresponds to the measured traveltime between the Calexico gage and Highway 80, confirming the downstream effects of the pollutant slug. As the slug passed the site at Highway 80, biochemical oxygen demand rose from 5.1 mg/L to 18.4 mg/L and the dissolved-oxygen concentration decreased from 2.1 to 0.1 mg/L. The other downstream sites, Keystone, Drop 4, and Westmorland, exhibited fairly normal diel variations in dissolved-oxygen concentration, with highs in the afternoon and lows in the early morning. Effects of the slug at these three sites are difficult to discern because of dilution by the agricultural drainage and the quality of that return. In general, however, chemical oxygen demand and concentrations of total and dissolved organic carbon all decreased downstream as the dissolved-oxygen concentration increased.

In the upper reaches of the New River from Calexico to Highway 80, the quality of the water is poor and detrimental to aquatic life and the esthetic character of the river. Numerous fish kills have been documented in this reach, as have anaerobic conditions where the river had a blackish discoloration and the odor of hydrogen sulfide was present. In the lower reaches, summertime dissolved-oxygen concentrations are often below the recommended criterion of 5 mg/L, which may have a detrimental effect on the fish population in the river and the southern end of the Salton Sea. The richly organic water flowing into the Salton Sea may also increase the rate of eutrophication.

FUTURE STUDIES

The New River study will continue in 1979 with a monitoring program at the international boundary at Calexico that involves monthly collection and analysis of 12-hour composite samples. A 24-hour and 96-hour sampling consisting of 12-hour composites will also be incorporated into this program. Additionally, a river-effects phase of the study will be started and center around trice-yearly sampling of four sites on the New River and one control site on the Alamo River. Samples of whole water and bottom sediments will be analyzed for selected trace elements and pesticides. A major part of this phase will be devoted to the biological sampling of benthic invertebrates, periphyton, and phytoplankton.

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Velz, C. J., 1970, Applied stream sanitation: Wiley-Interscience, 619 p.

ILLUSTRATIONS

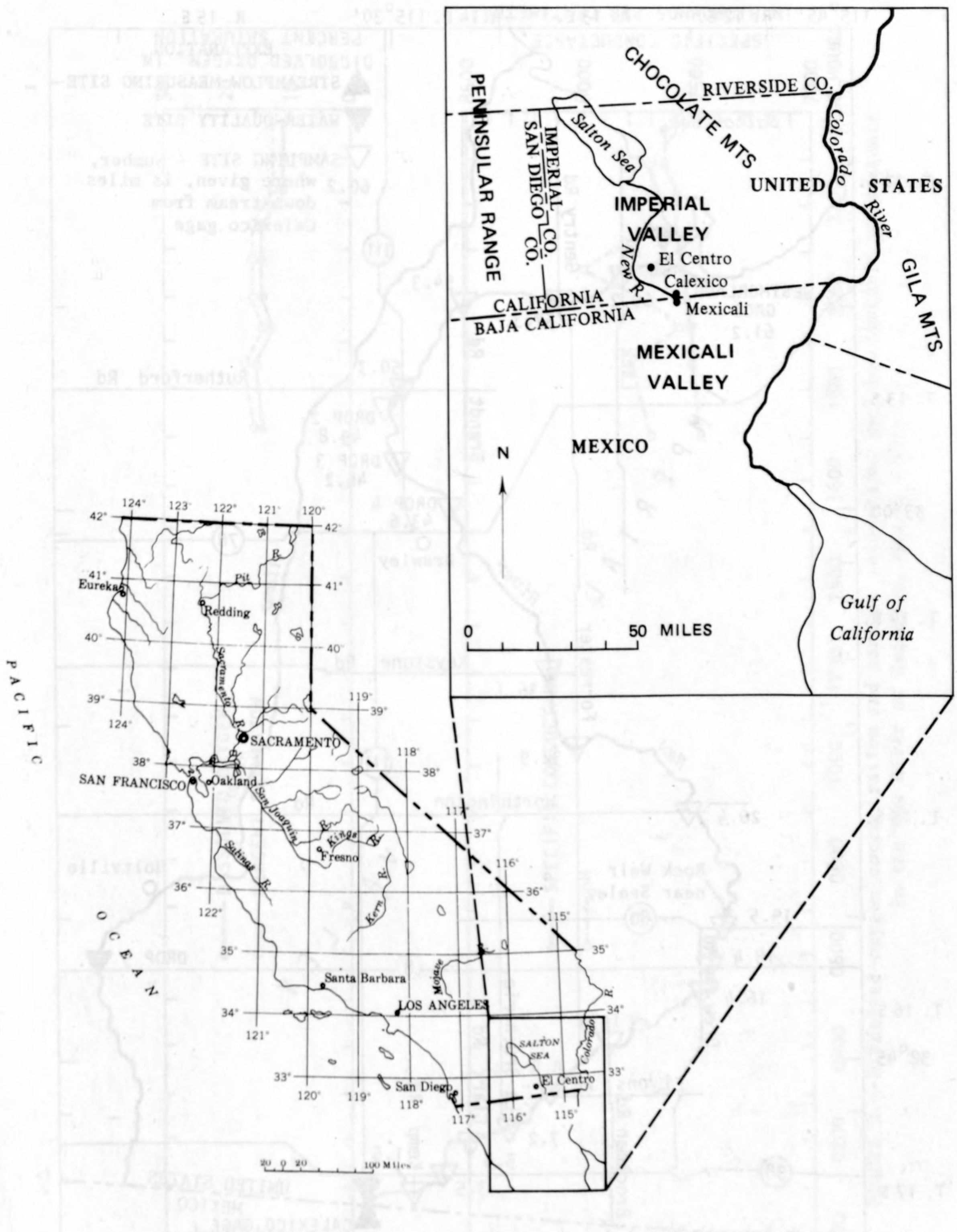


FIGURE 1.--Location of study area.

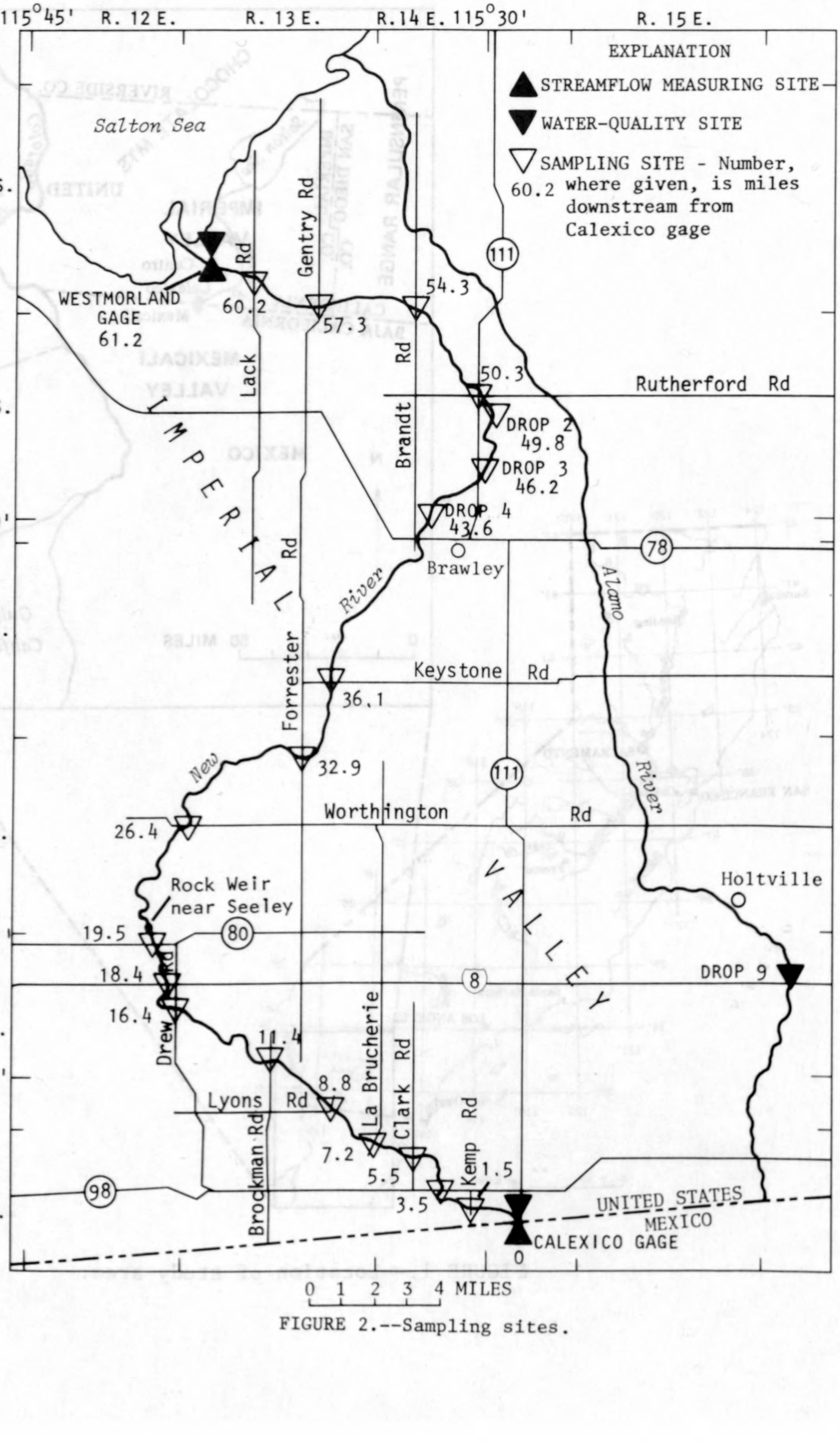


FIGURE 2.--Sampling sites.

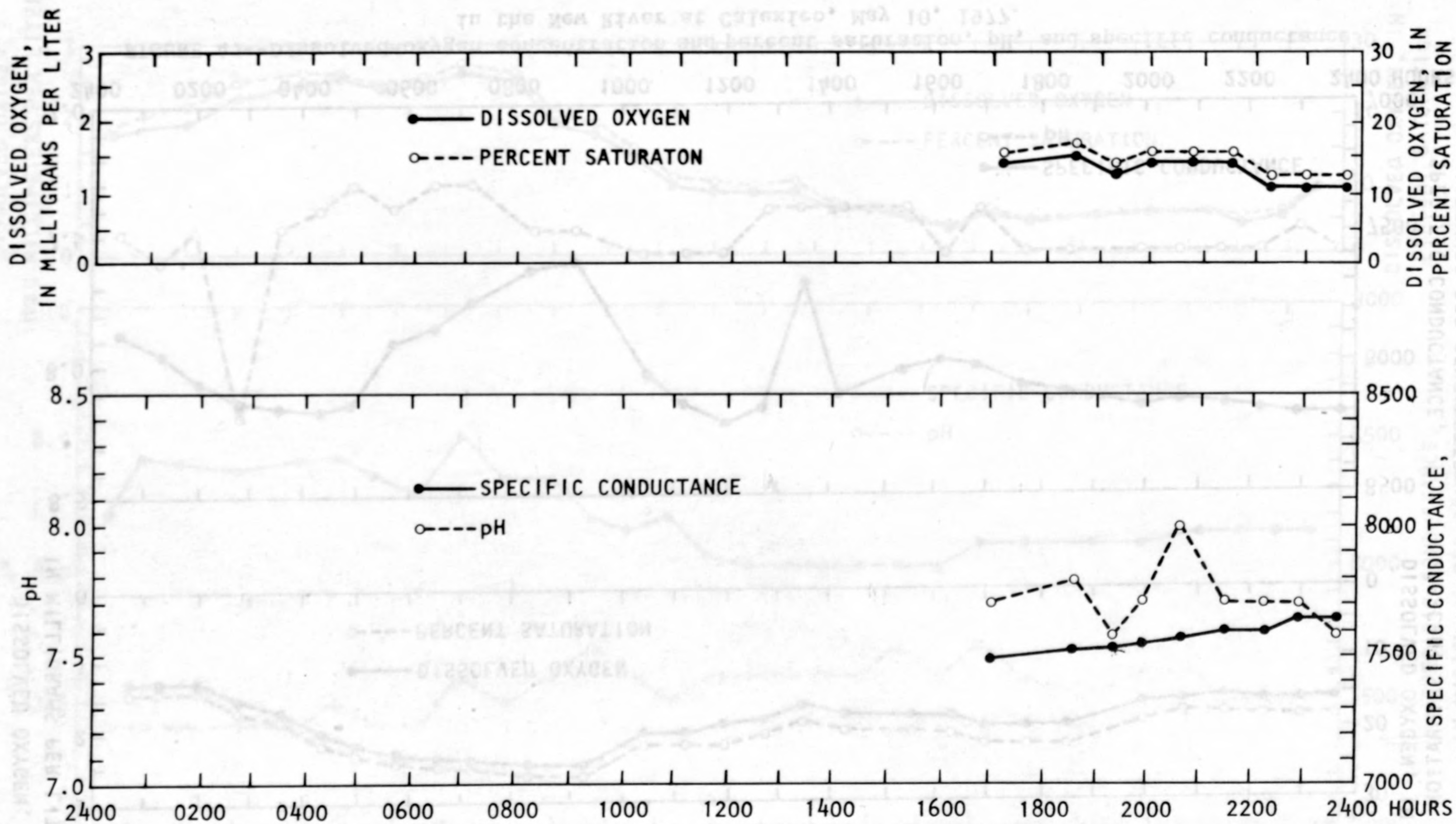


FIGURE 3.--Dissolved-oxygen concentration and percent saturation, pH, and specific conductance in the New River at Calexico, May 9, 1977.

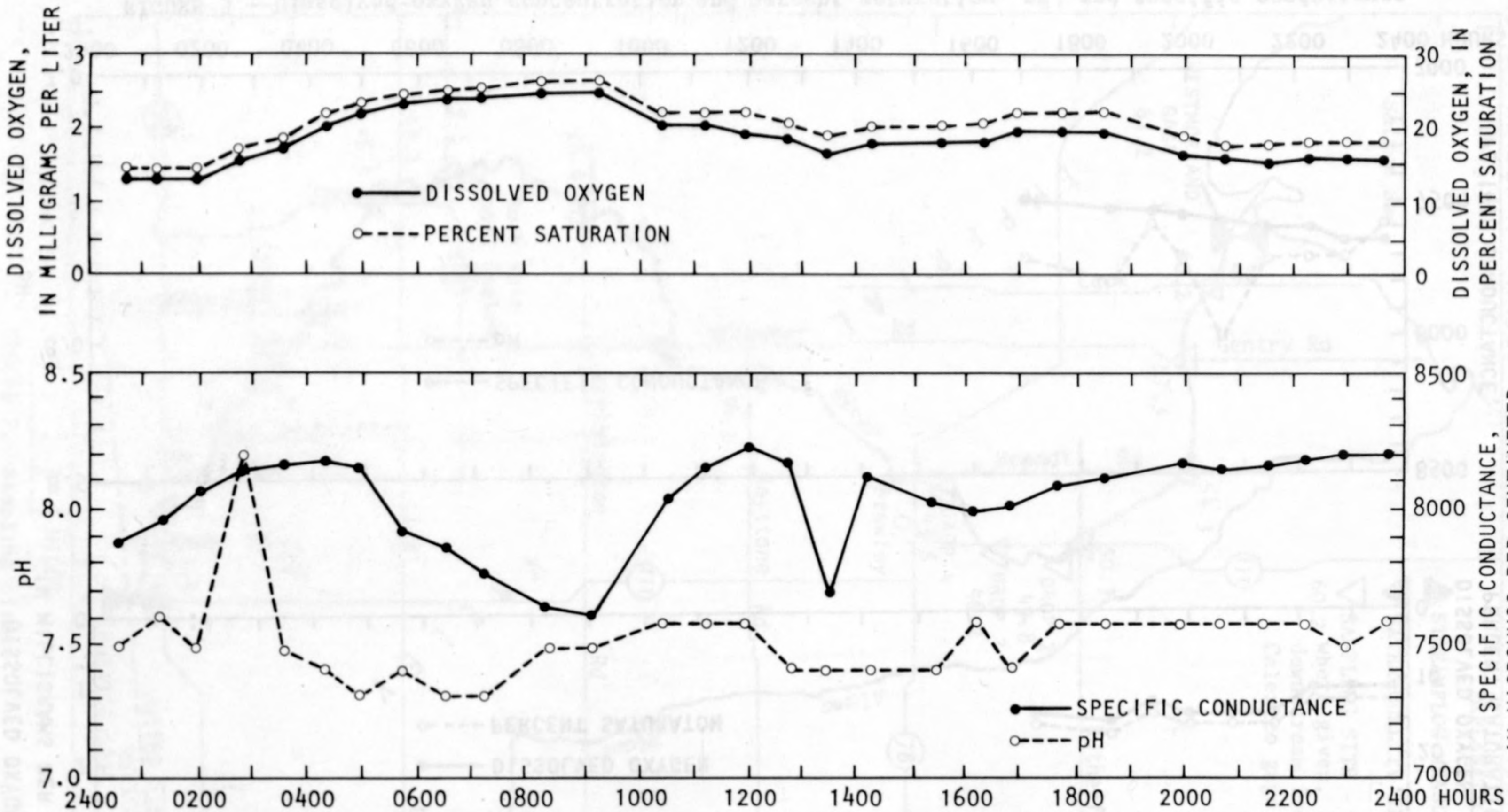


FIGURE 4.--Dissolved-oxygen concentration and percent saturation, pH, and specific conductance in the New River at Calexico, May 10, 1977.

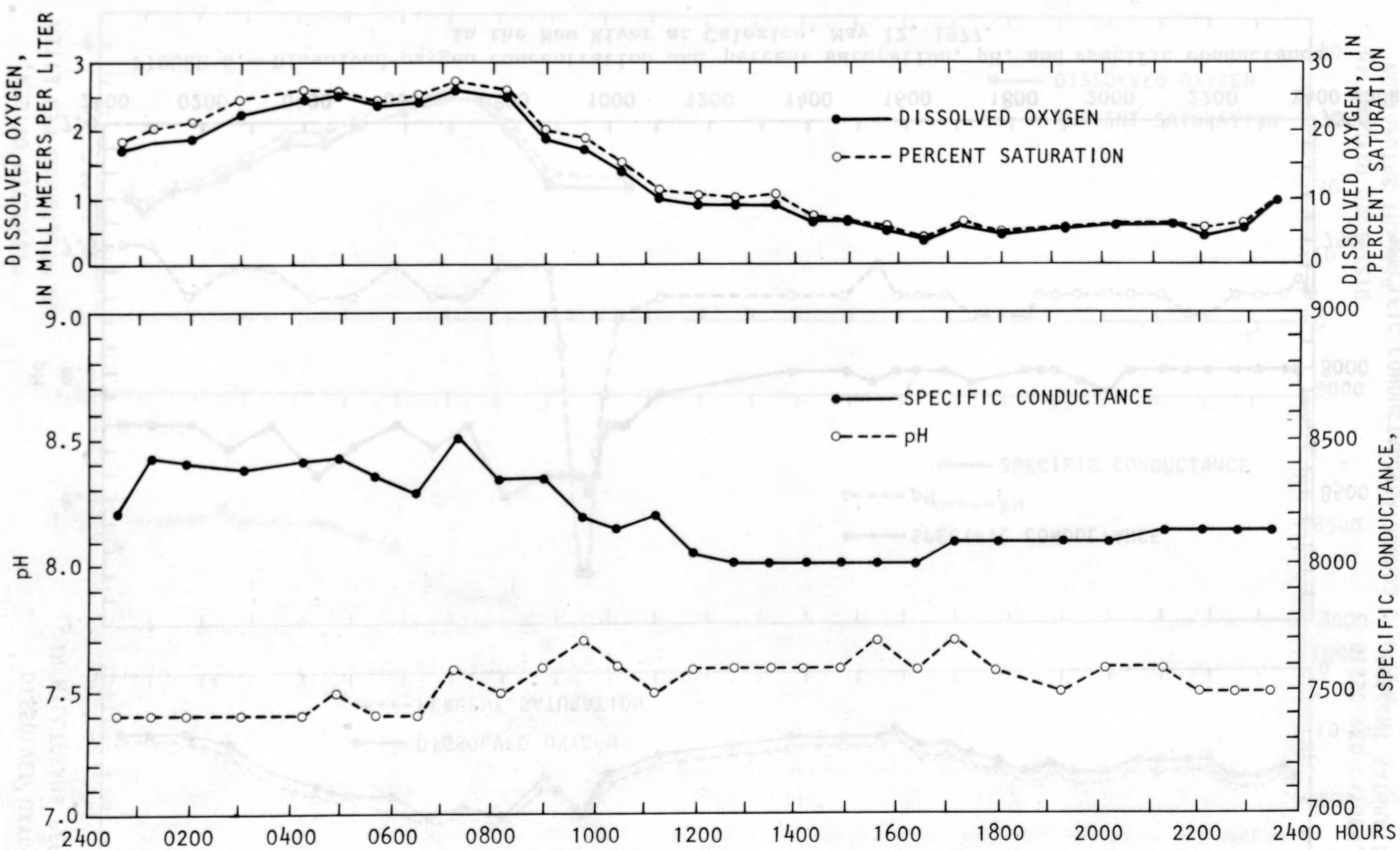


FIGURE 5.--Dissolved-oxygen concentration and percent saturation, pH, and specific conductance in the New River at Calexico, May 11, 1977.

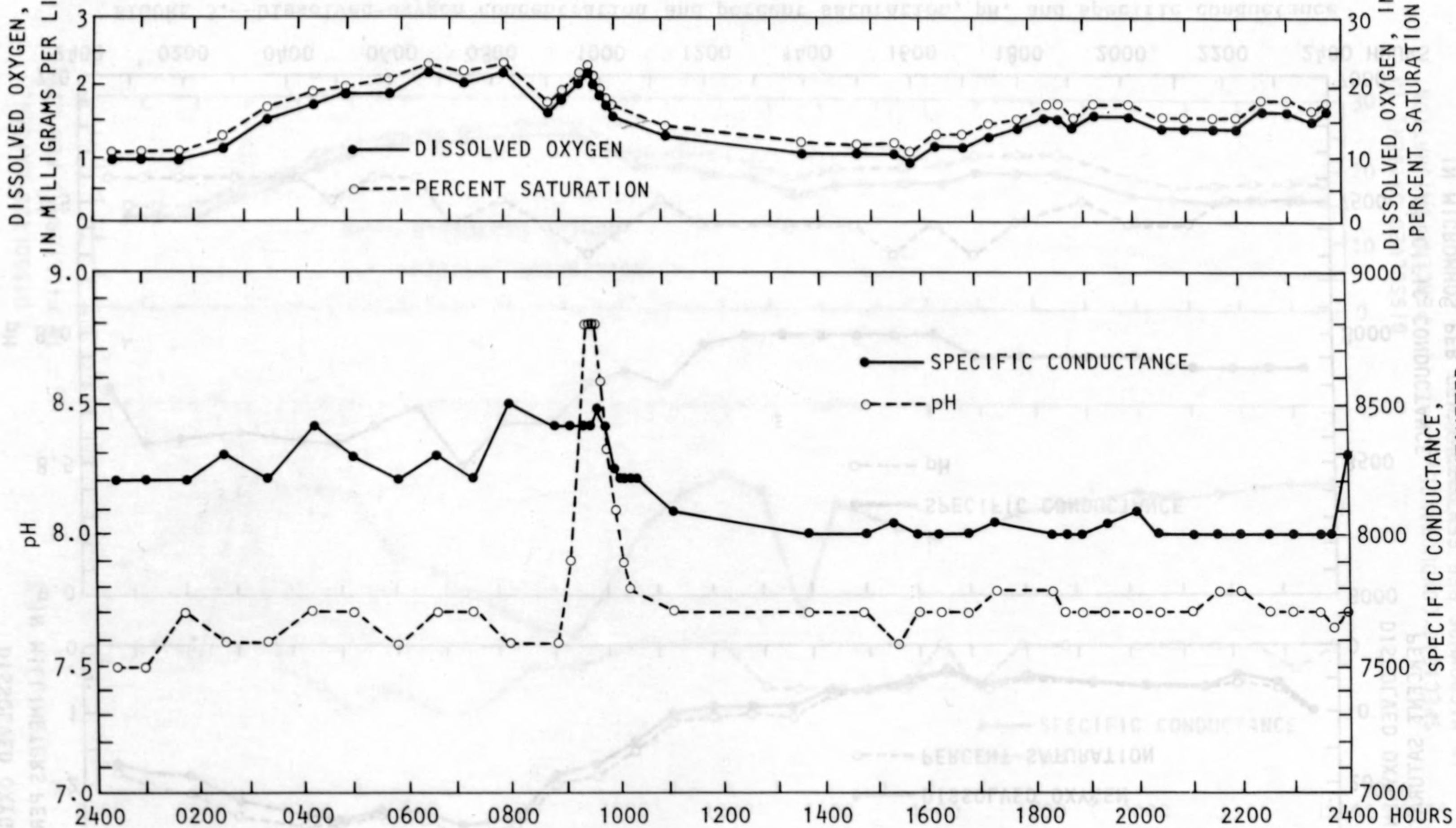


FIGURE 6.--Dissolved-oxygen concentration and percent saturation, pH, and specific conductance in the New River at Calexico, May 12, 1977.

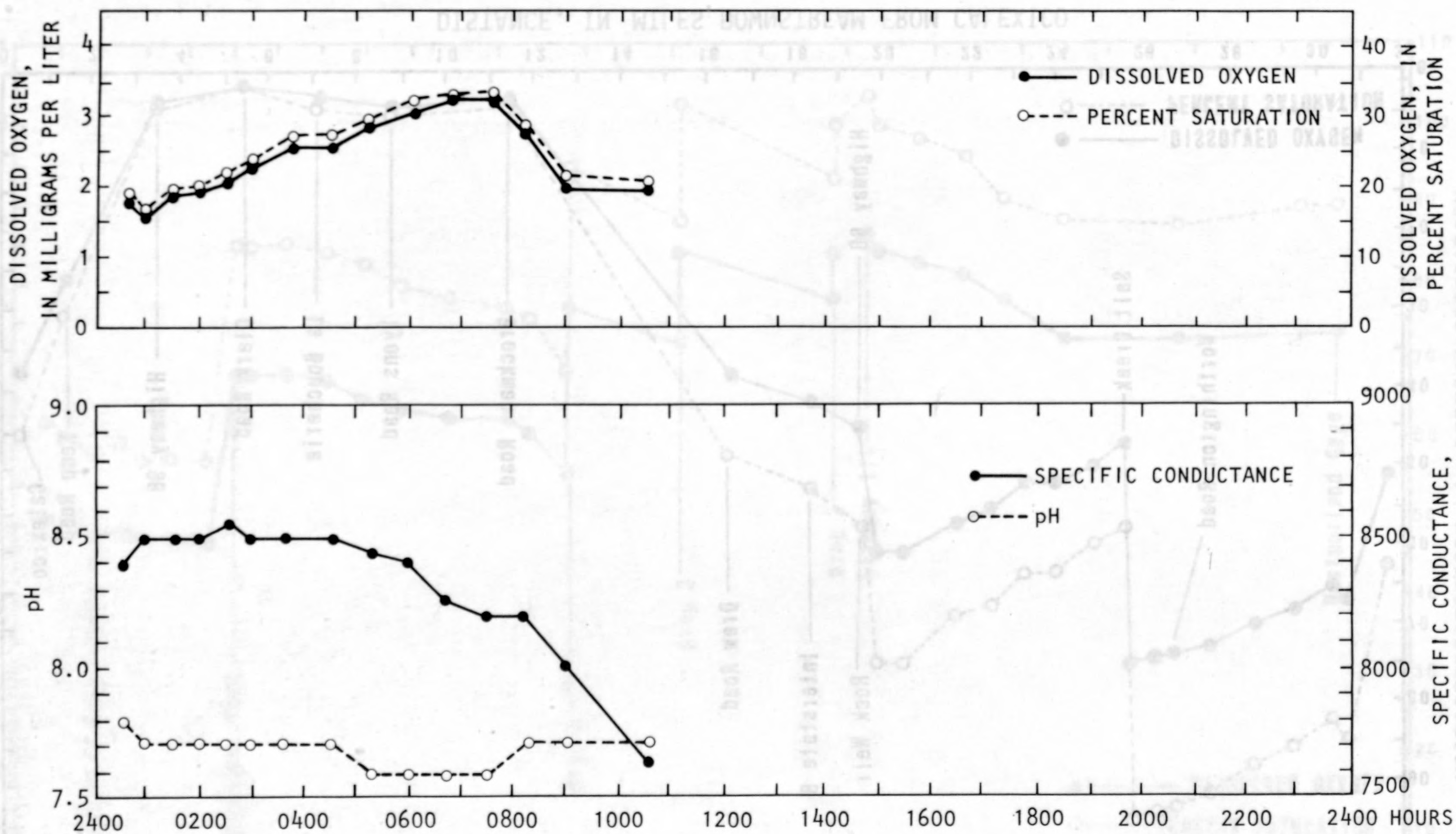


FIGURE 7.--Dissolved-oxygen concentration and percent saturation, pH, and specific conductance in the New River at Calexico, May 13, 1977.

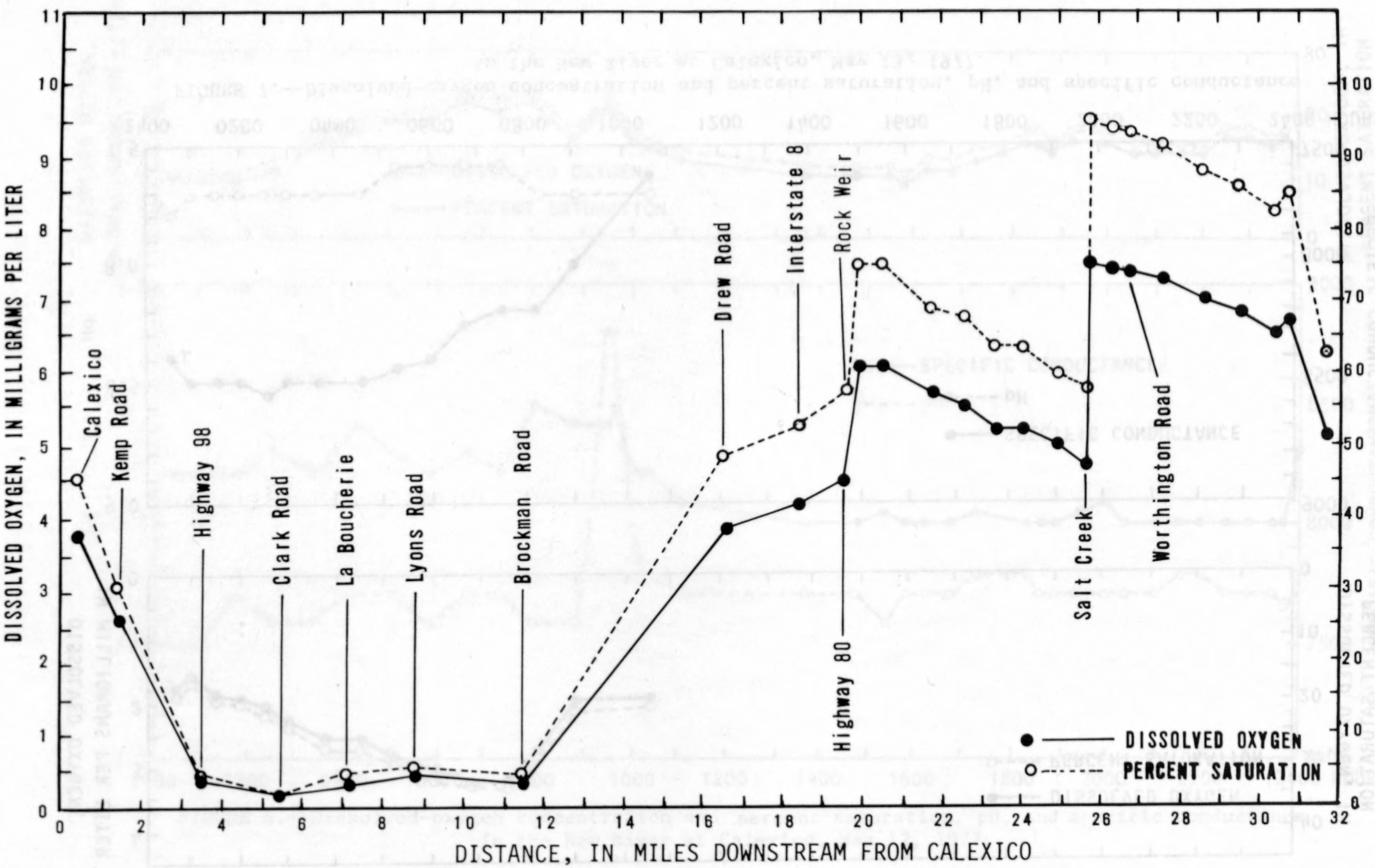


FIGURE 8.--Dissolved-oxygen concentration and percent saturation in the New River from Calexico to the Westmorland gage, September 26-30, 1977.

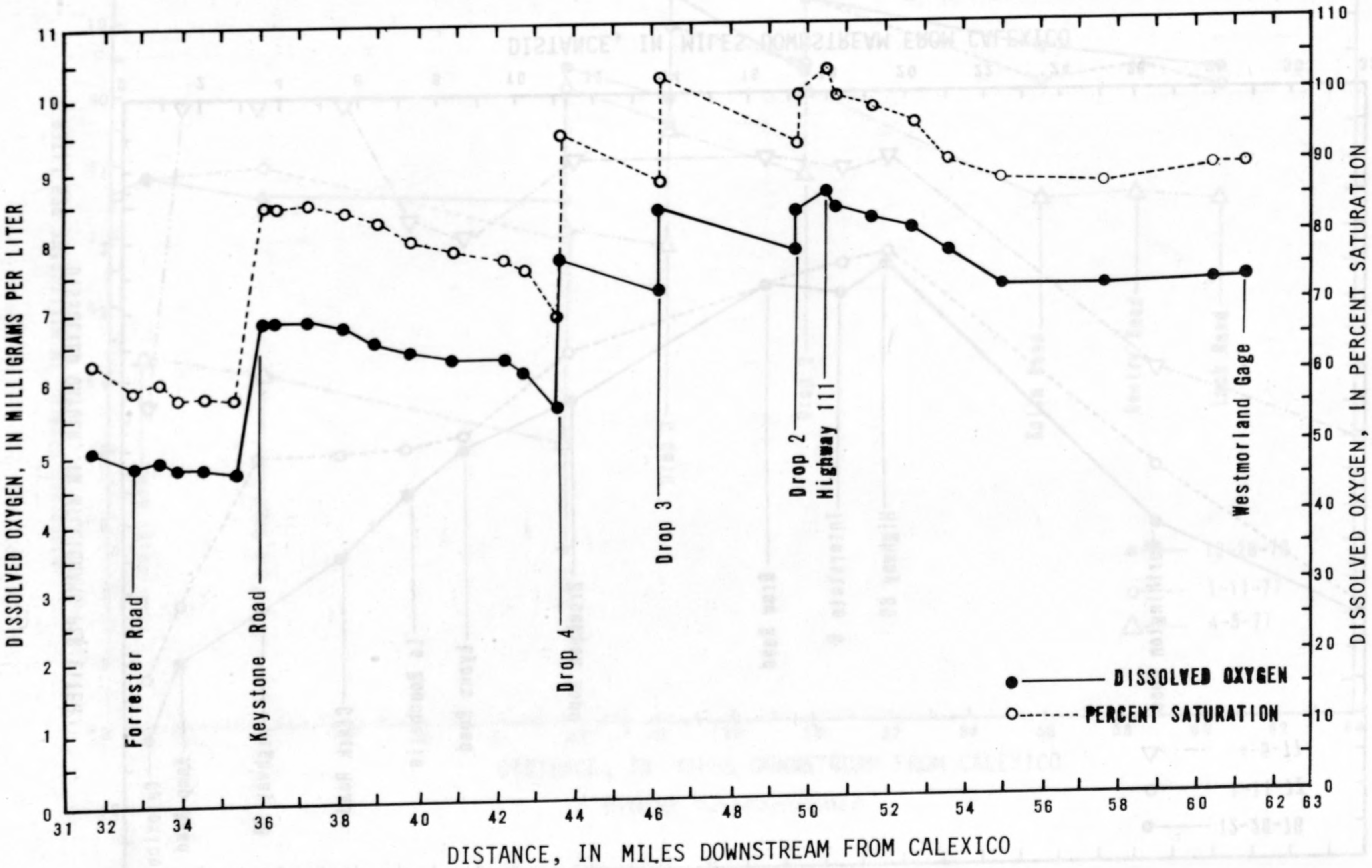
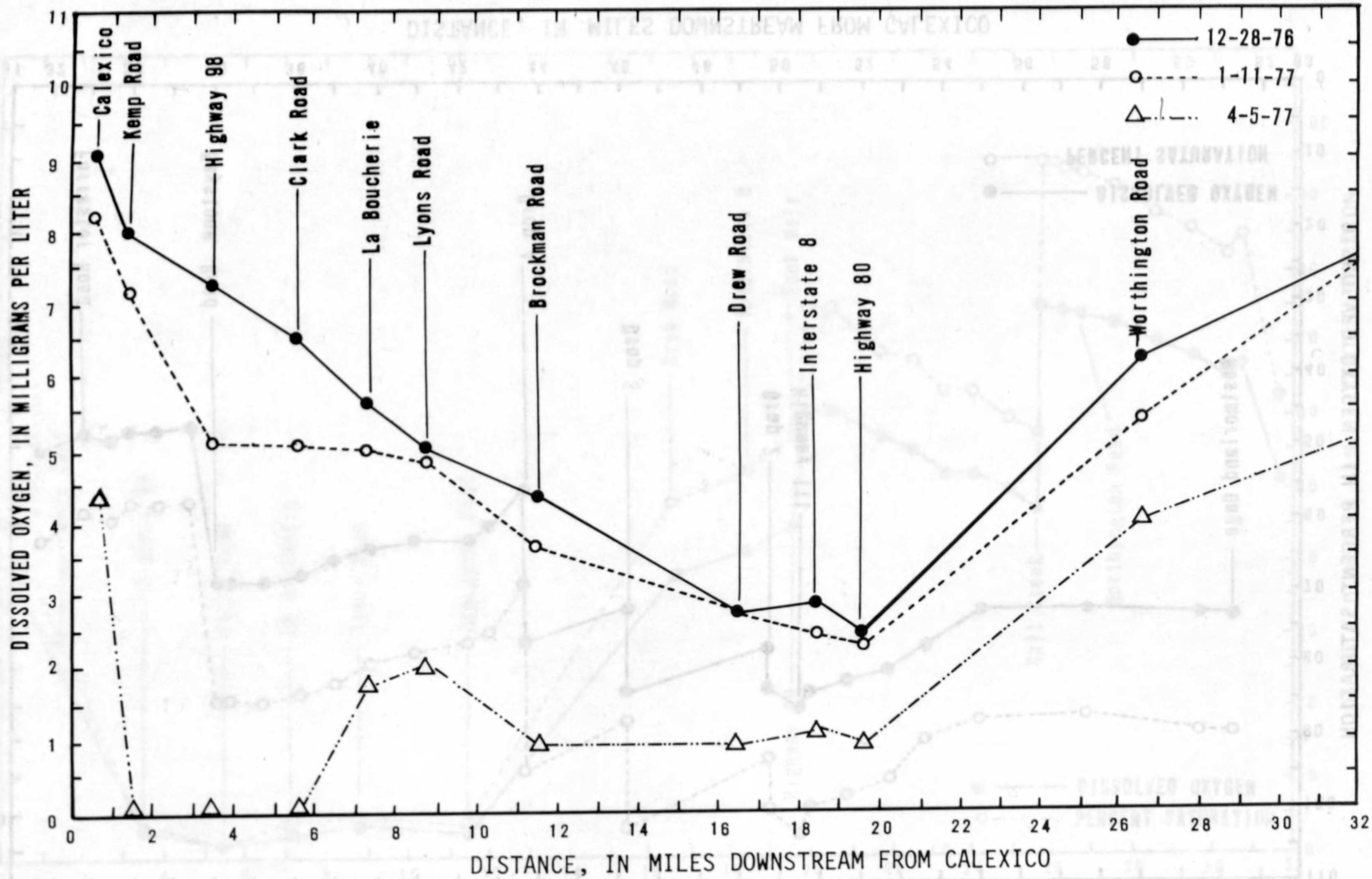


FIGURE 8.--Continued



Data from California Regional Water Quality Control Board, Colorado River Basin Region (written commun., 1978)

FIGURE 9.--Dissolved-oxygen concentration at selected sites on the New River, December 28, 1976, January 1, and April 5, 1977.

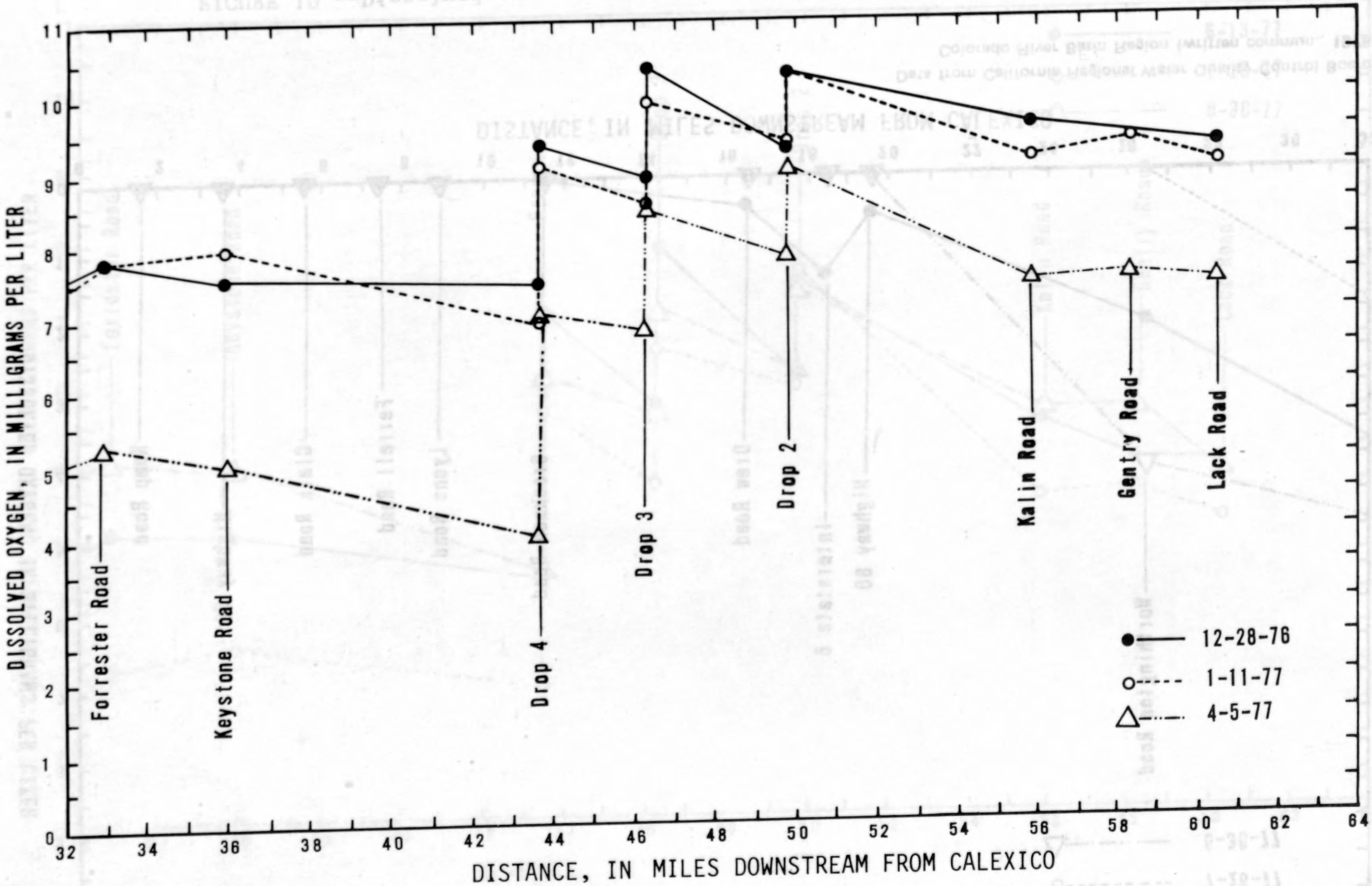
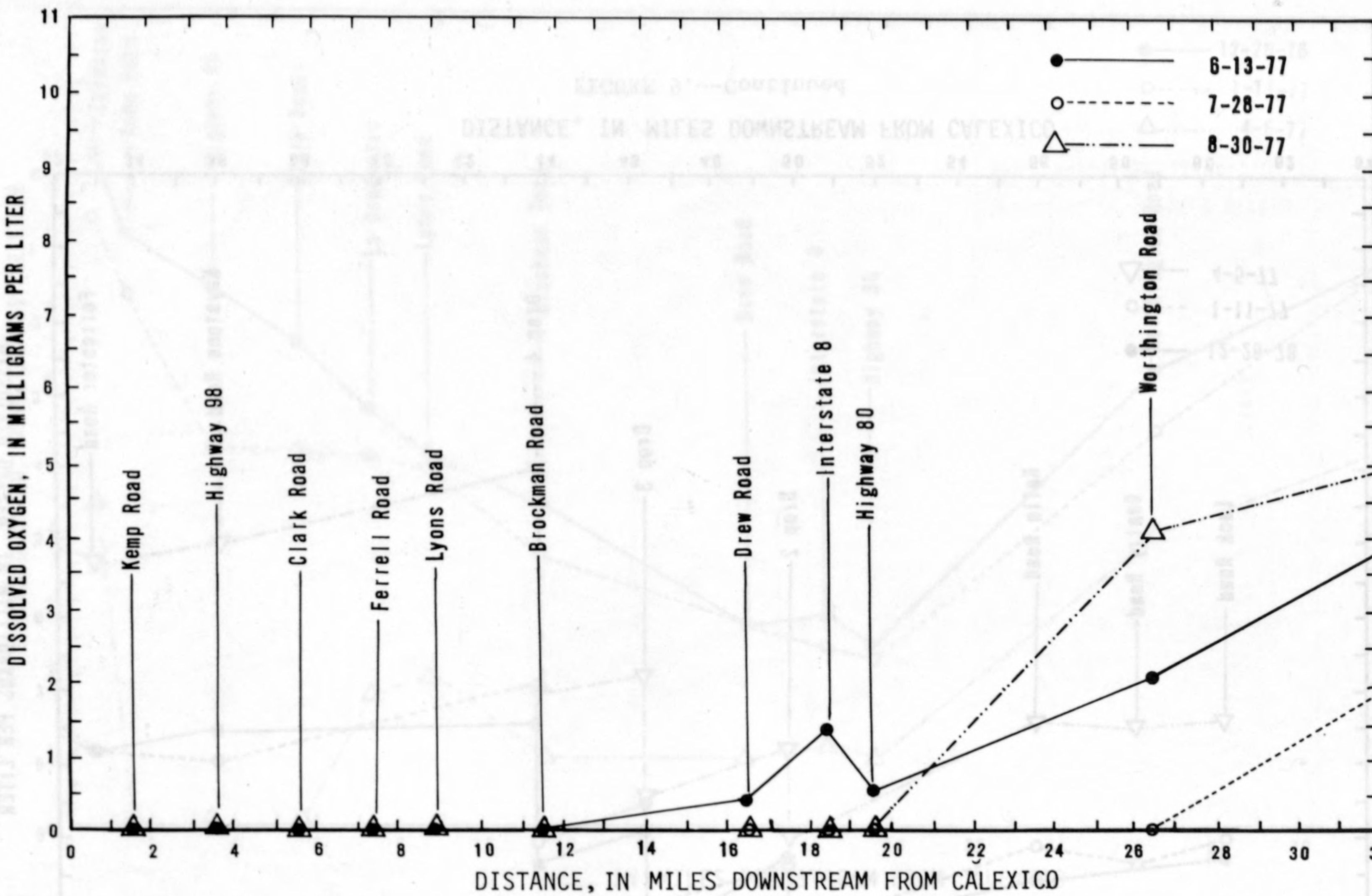


FIGURE 9.--Continued



Data from California Regional Water Quality Control Board, Colorado River Basin Region (written commun., 1978)

FIGURE 10.--Dissolved-oxygen concentration at selected sites on the New River, June 13, July 28, and August 30, 1977.

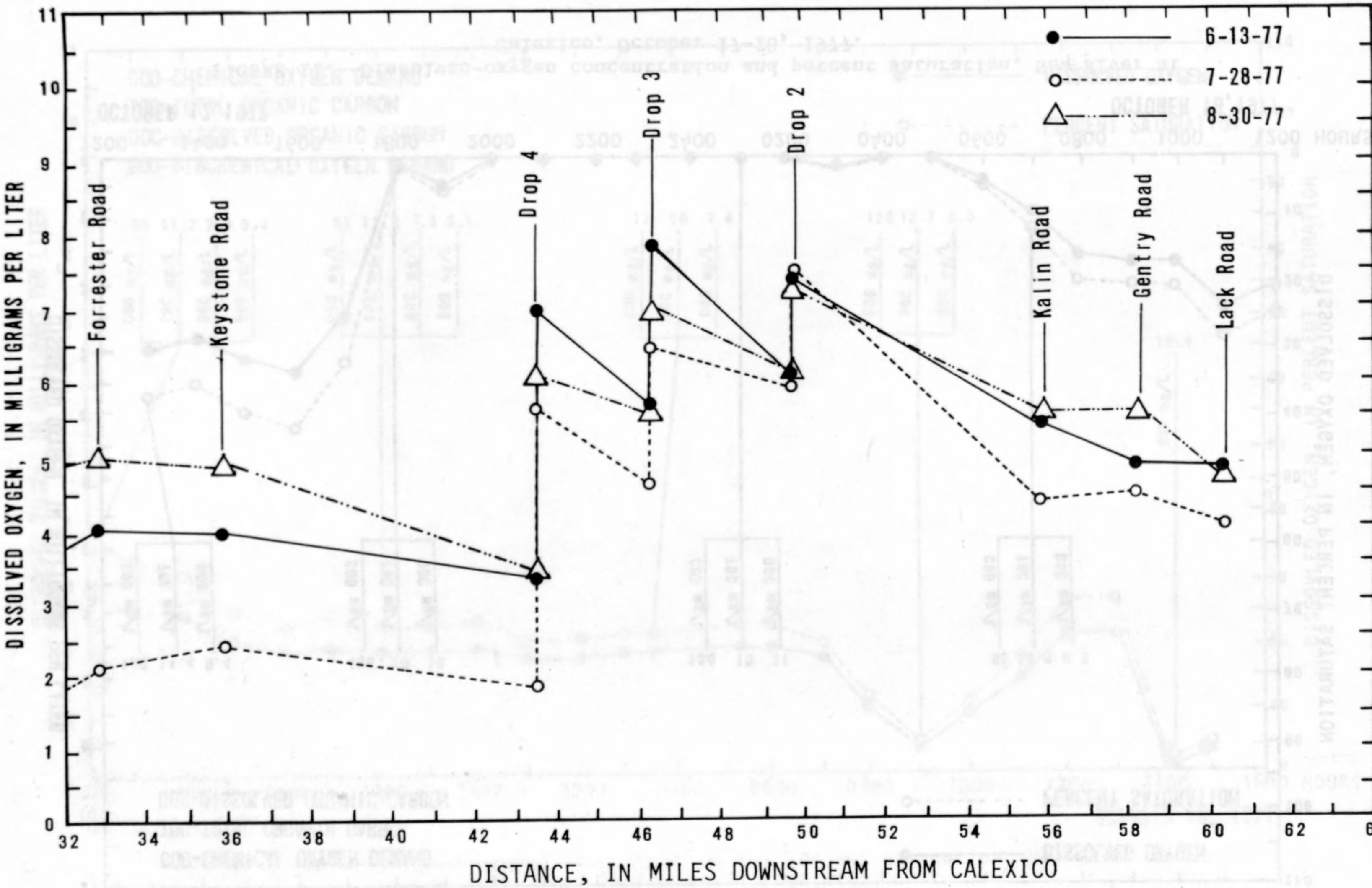


FIGURE 10.--Continued

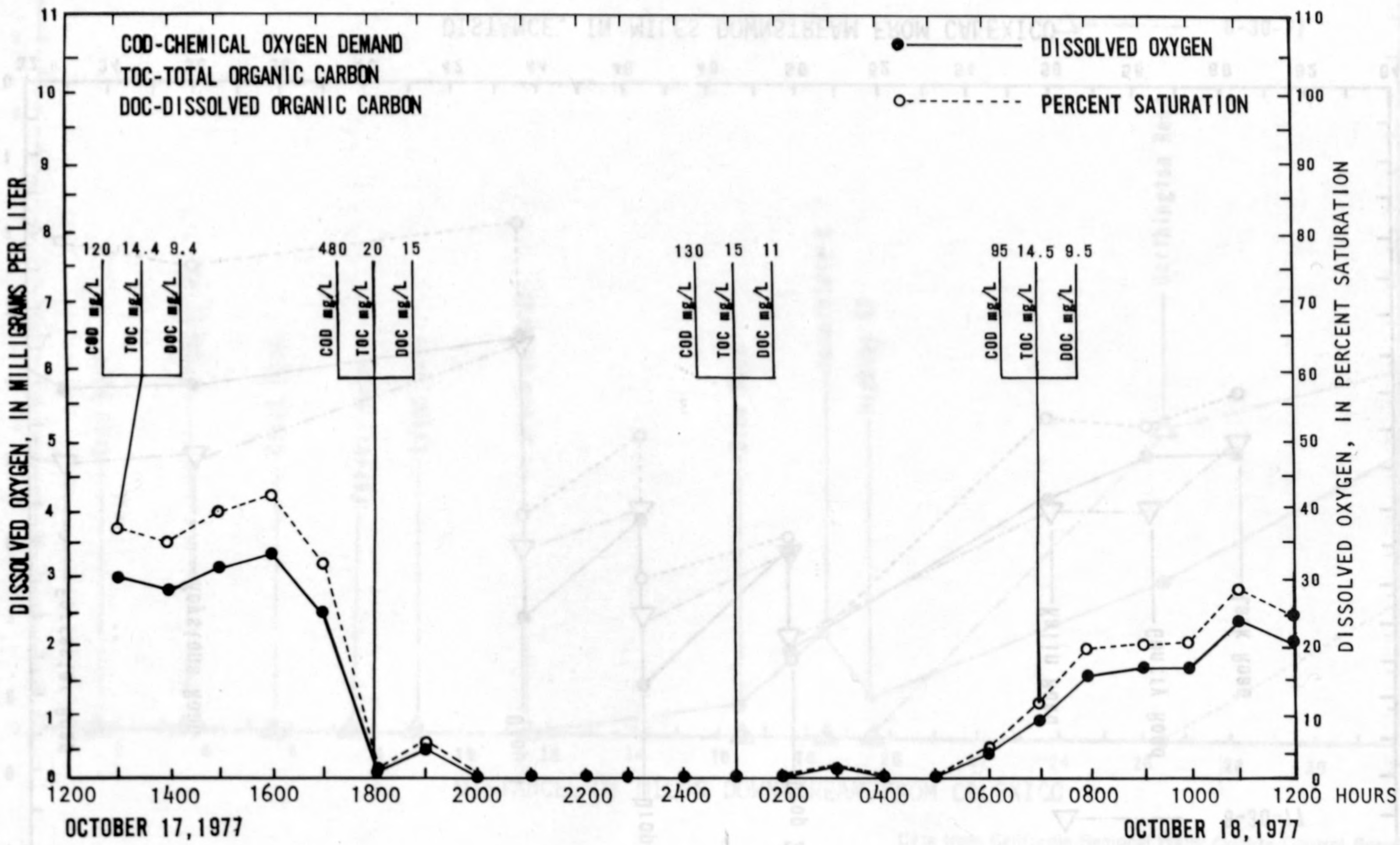


FIGURE 11.--Dissolved-oxygen concentration and percent saturation, New River at Calexico, October 17-18, 1977.

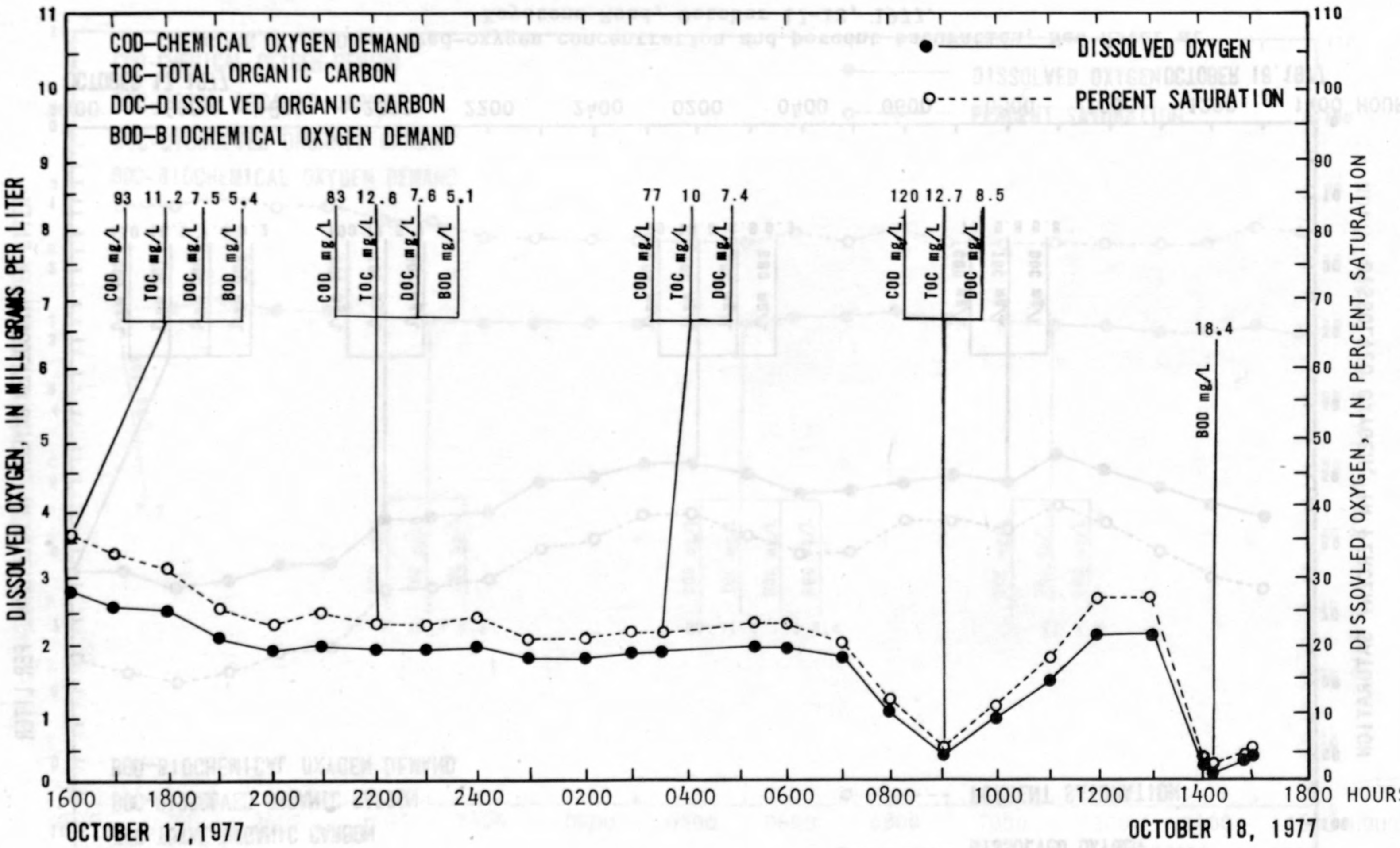


FIGURE 12.--Dissolved-oxygen concentration and percent saturation, New River at Highway 80, October 17-18, 1977.

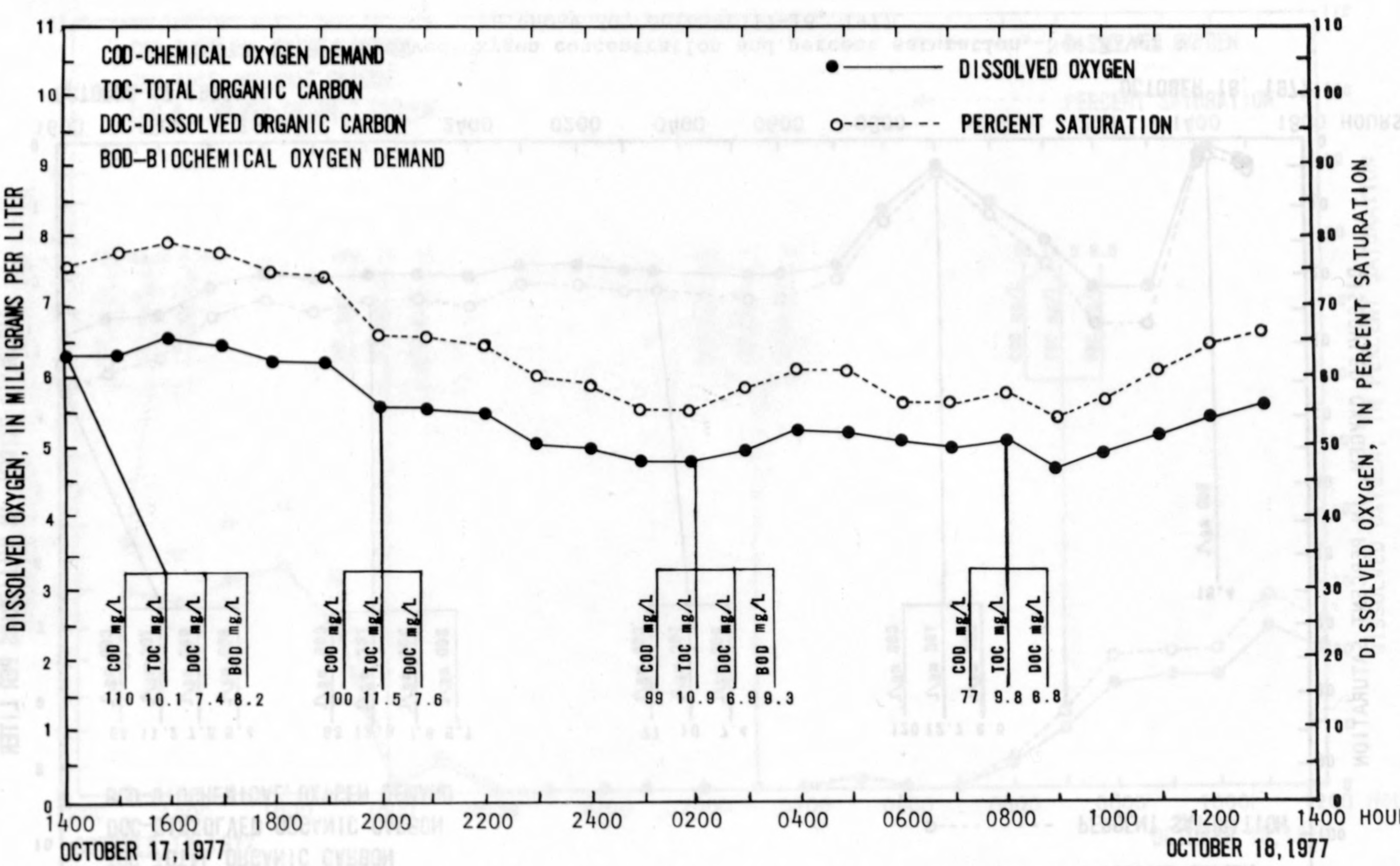


FIGURE 13.--Dissolved-oxygen concentration and percent saturation, New River at Keystone Road, October 17-18, 1977.

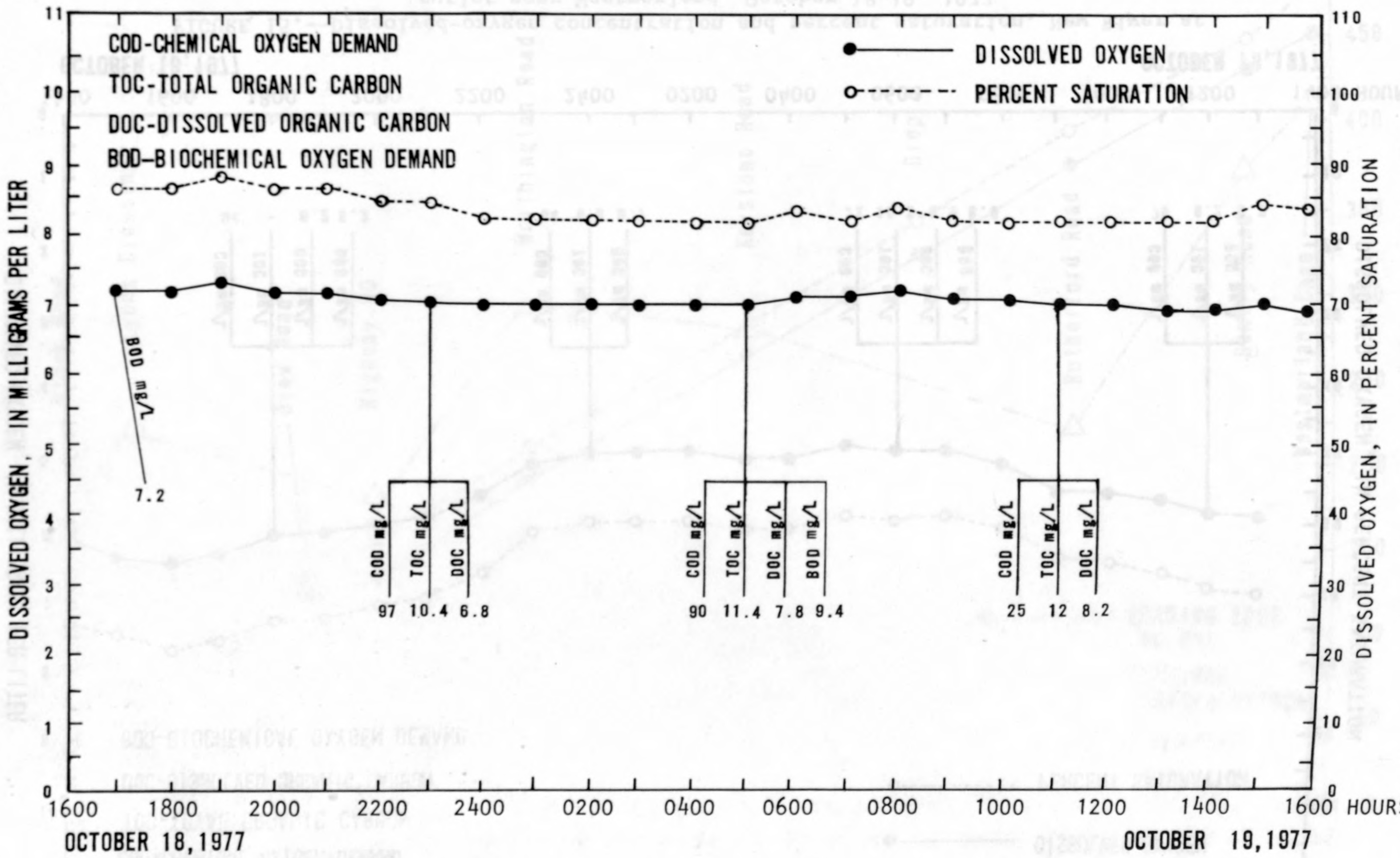


FIGURE 14.--Dissolved-oxygen concentration and percent saturation, New River below Drop 4 near Brawley, October 18-19, 1977.

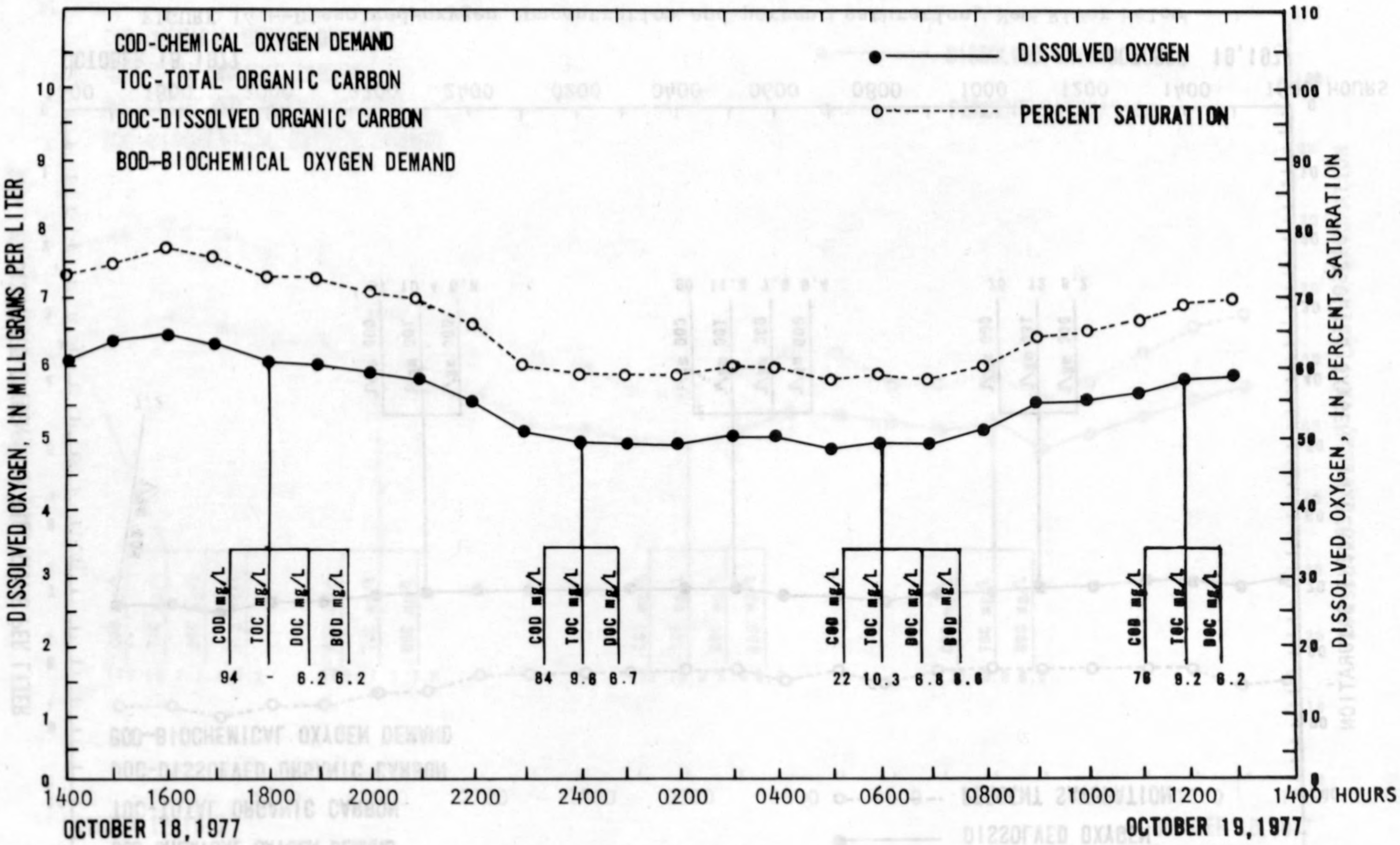


FIGURE 15.--Dissolved-oxygen concentration and percent saturation, New River at outlet near Westmorland, October 18-19, 1977.

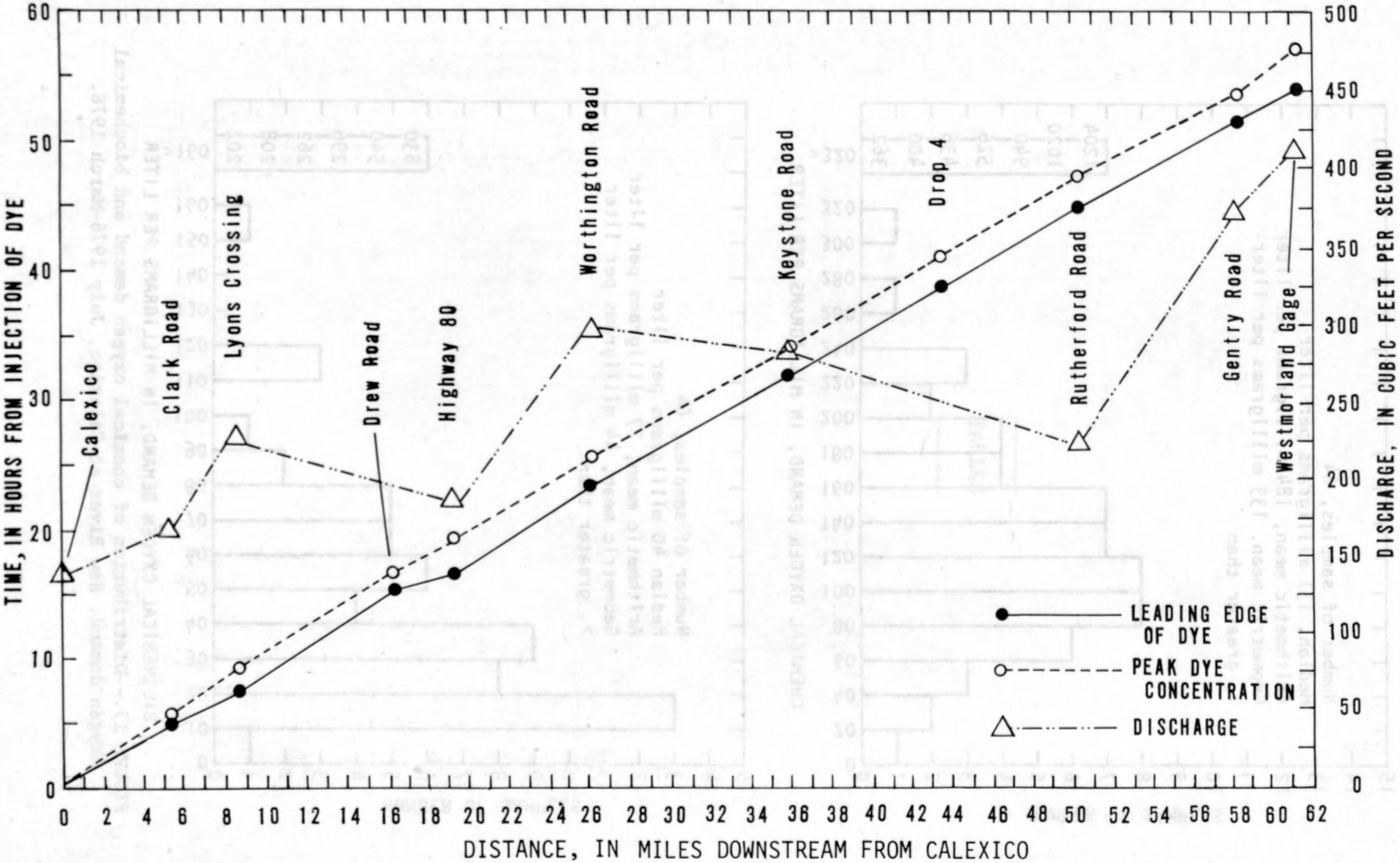


FIGURE 16.--Time of travel of dye and discharge in the New River from Calexico to Westmorland gage, February 6-9, 1978.

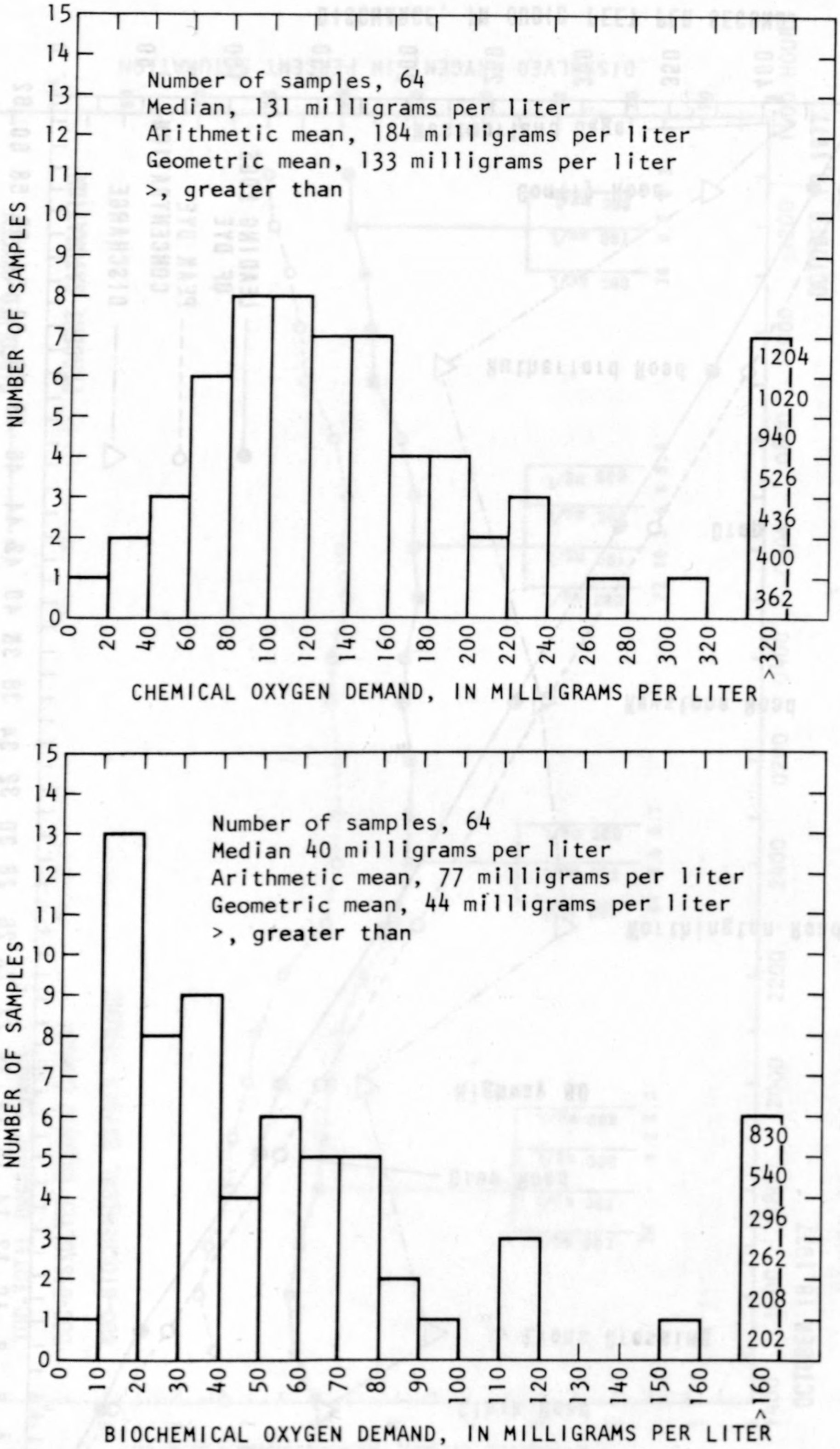


FIGURE 17.--Distribution of chemical oxygen demand and biochemical oxygen demand, New River at Calexico, July 1976-March 1978.

TABLES

TABLE 1.--Field measurements of selected physical and chemical characteristics, New River at Calexico, May 9-13, 1977

DATE	TIME (HOURS)	INSTANTANEOUS DISCHARGE (FT^3/S)	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	TEMPERATURE (DEG C)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)
MAY							
09...	1710	156	7500	7.7	23.0	35	1.4
09...	1830	153	7510	7.8	22.6	35	1.5
09...	1915	153	7540	7.6	22.3	36	1.3
09...	2000	159	7560	7.7	22.0	34	1.4
09...	2045	159	7580	8.0	21.7	35	1.4
09...	2130	159	7600	7.7	21.5	36	1.4
09...	2215	159	7600	7.7	21.3	37	1.2
09...	2300	159	7670	7.7	21.1	30	1.2
09...	2345	158	7670	7.6	21.0	26	1.2
10...	0030	158	7890	7.5	20.8	30	1.3
10...	0115	157	7960	7.6	20.4	30	1.3
10...	0200	155	8080	7.5	20.0	26	1.3
10...	0245	155	8130	8.2	19.6	28	1.6
10...	0330	155	8150	7.5	19.4	26	1.7
10...	0420	159	8170	7.4	19.0	26	2.1
10...	0500	159	8140	7.3	18.9	28	2.2
10...	0545	159	7940	7.4	18.6	31	2.3
10...	0630	159	7860	7.3	18.4	32	2.4
10...	0715	151	7780	7.3	18.3	27	2.4
10...	0820	151	7650	7.5	18.4	22	2.5
10...	0910	158	7620	7.5	18.7	25	2.5
10...	1030	156	8040	7.6	19.5	32	2.1
10...	1115	155	8160	7.6	20.0	32	2.1
10...	1200	155	8230	7.6	20.5	30	2.0
10...	1245	155	8180	7.4	21.0	30	1.9
10...	1330	161	7700	7.4	21.6	30	1.7
10...	1415	167	8130	7.4	21.9	28	1.6
10...	1530	158	8040	7.4	22.4	32	1.8
10...	1615	156	8010	7.6	22.5	36	1.8
10...	1700	153	8030	7.4	22.5	31	2.0
10...	1745	153	8080	7.6	22.5	39	2.0
10...	1830	161	8100	7.6	22.5	32	2.0
10...	2000	159	8190	7.6	22.2	30	1.7
10...	2045	159	8140	7.6	22.0	30	1.6
10...	2130	157	8160	7.6	21.9	25	1.5
10...	2215	154	8180	7.6	21.7	25	1.6
10...	2300	153	8200	7.5	21.5	26	1.6
10...	2345	152	8200	7.6	21.4	29	1.6
11...	0030	152	8220	7.4	21.1	24	1.7

TABLE 1.--Field measurements of selected physical and chemical characteristics, New River at Calexico, May 9-13, 1977--Continued

DATE	TIME (HOURS)	INSTANTANEOUS DISCHARGE (FT^3/S)	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	TEMPERATURE (DEG C)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)
MAY							
11...	0115	151	8440	7.4	20.9	22	1.8
11...	0200	150	8410	7.4	20.7	20	1.9
11...	0300	148	8380	7.4	20.4	25	1.7
11...	0415	149	8400	7.4	20.0	30	2.4
11...	0500	150	8400	7.5	19.6	28	2.5
11...	0545	150	8350	7.4	19.4	21	2.3
11...	0630	149	8300	7.4	19.1	24	2.4
11...	0715	145	8500	7.6	19.0	17	2.6
11...	0815	144	8350	7.5	18.2	30	2.5
11...	0900	144	8350	7.6	19.5	40	1.9
11...	0945	144	8200	7.7	19.9	40	1.7
11...	1030	144	8150	7.6	20.4	36	1.4
11...	1115	144	8200	7.5	20.8	42	1.1
11...	1200	144	8050	7.6	21.4	43	1.0
11...	1245	144	8000	7.6	21.8	45	1.0
11...	1330	157	8000	7.6	22.2	45	1.0
11...	1415	147	8000	7.6	22.6	44	.7
11...	1500	144	8000	7.6	22.9	43	.7
11...	1545	144	8000	7.7	23.1	39	.5
11...	1630	151	8000	7.6	23.2	37	.3
11...	1715	154	8100	7.7	23.2	33	.6
11...	1800	141	8100	7.6	23.2	32	.4
11...	1915	140	8100	7.5	23.0	32	.5
11...	2015	144	8100	7.6	22.8	24	.6
11...	2120	144	8150	7.6	22.6	27	.6
11...	2205	144	8150	7.5	22.4	27	.5
11...	2250	155	8150	7.5	22.1	24	.6
11...	2335	155	8150	7.5	22.0	23	.9
12...	0015	146	8200	7.5	21.8	36	1.0
12...	0100	146	8200	7.5	21.8	32	1.0
12...	0145	146	8200	7.7	21.6	30	1.0
12...	0230	144	8300	7.6	21.6	27	1.2
12...	0315	144	8200	7.6	21.1	30	1.5
12...	0415	144	8400	7.7	20.7	36	1.7
12...	0500	144	8300	7.7	20.3	32	1.9
12...	0545	144	8200	7.6	20.0	36	1.9
12...	0630	144	8300	7.7	19.8	33	2.2
12...	0715	140	8200	7.7	19.7	33	2.1
12...	0800	137	8500	7.6	19.6	23	2.2

TABLE 1.--Field measurements of selected physical and chemical characteristics, New River at Calexico, May 9-13, 1977--Continued

DATE	TIME (HOURS)	INSTANTANEOUS DISCHARGE (FT^3/S)	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	TEMPERATURE (DEG C)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)
MAY							
12...	0850	137	8400	7.6	19.7	28	1.6
12...	0905	137	8400	7.9	19.7	40	1.8
12...	0920	137	8400	8.8	19.8	78	2.1
12...	0922	137	8400	8.8	19.8	78	2.1
12...	0927	136	8450	8.8	19.8	93	2.2
12...	0930	136	8450	8.8	19.8	93	2.2
12...	0932	136	8450	8.8	19.8	115	2.1
12...	0937	136	8450	8.6	19.8	115	2.0
12...	0942	136	8400	8.6	19.8	105	2.0
12...	0950	136	8250	8.3	19.8	85	1.8
12...	0955	136	8200	8.1	19.8	65	1.7
12...	1000	136	8200	7.9	19.8	60	1.6
12...	1002	136	8200	7.9	19.8	60	1.6
12...	1008	135	8200	7.8	19.9	45	1.5
12...	1105	136	8100	7.7	21.0	40	1.3
12...	1340	146	8000	7.7	20.8	36	1.1
12...	1445	146	8000	7.7	20.8	45	1.1
12...	1515	150	8050	7.6	20.7	45	1.1
12...	1545	143	8000	7.7	20.7	55	1.0
12...	1615	143	8000	7.7	20.6	50	1.2
12...	1645	145	8000	7.7	20.5	38	1.2
12...	1715	145	8050	7.8	20.3	58	1.3
12...	1815	146	8000	7.8	20.2	33	1.5
12...	1830	146	8000	7.7	20.2	30	1.5
12...	1845	146	8000	7.7	20.2	45	1.4
12...	1915	146	8050	7.7	20.2	36	1.5
12...	2000	147	8100	7.7	20.1	32	1.5
12...	2030	147	8000	7.7	20.0	35	1.4
12...	2100	143	8000	7.7	20.0	38	1.4
12...	2130	143	8000	7.8	19.9	80	1.4
12...	2200	143	8000	7.8	19.9	55	1.4
12...	2230	143	8000	7.7	19.8	30	1.6
12...	2300	143	8000	7.7	19.5	30	1.6
12...	2330	143	8000	7.7	19.3	36	1.5
12...	2345	141	8000	7.6	19.1	30	1.6
12...	2400	141	8300	7.7	19.1	27	1.6
13...	0030	141	8400	7.8	18.8	32	1.8
13...	0100	147	8500	7.7	18.8	30	1.6
13...	0130	147	8500	7.7	18.5	40	1.9
13...	0200	146	8500	7.7	18.4	39	2.0
13...	0230	146	8550	7.7	18.3	34	2.1
13...	0300	145	8500	7.7	18.3	31	2.3
13...	0345	146	8500	7.7	18.1	32	2.6
13...	0430	146	8500	7.7	18.1	32	2.6
13...	0515	147	8450	7.6	17.9	30	2.9
13...	0600	148	8400	7.6	17.8	35	3.1
13...	0645	145	8250	7.6	17.9	32	3.2
13...	0730	145	8200	7.6	17.9	34	3.2
13...	0815	135	8200	7.7	18.0	29	2.8
13...	0900	132	8000	7.7	18.3	32	2.6
13...	1030	132	7650	7.7	19.3	35	2.0

TABLE 2.--Chemical analyses of water, New River at Calexico May 10-12, 1977

DATE	TIME	CHEM-ICAL OXYGEN DEMAND (HIGH LEVEL) (MG/L)	TOTAL FILT-RABLE RESIDUE (MG/L)	TOTAL NON-FILT-RABLE RESIDUE (MG/L)	TOTAL ANTI-MONY (SB) (UG/L)	TOTAL BARIUM (BA) (UG/L)
MAY						
10...	0910	330	5600	32	2	200
10...	1415	340	5700	48	2	200
11...	0300	390	6100	35	0	200
11...	1800	370	--	--	2	200
12...	0800	190	6100	110	0	200
12...	0850	190	--	--	2	200
12...	0905	400	--	--	1	200
12...	0920	510	5900	170	2	200
12...	0930	--	--	--	2	200
12...	0950	290	5800	72	0	200
12...	1000	300	6000	50	--	200
12...	1545	330	5700	38	0	200
12...	1715	350	6000	52	--	200
12...	2130	370	6100	50	1	200

TABLE 2.--Chemical analyses of water, New River at Calexico May 10-12, 1977--Continued

DATE	TOTAL CHRO-MIUM (CR) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL NICKEL (NI) (UG/L)
MAY					
10...	10	20	100	.0	<50
10...	10	80	100	.0	50
11...	10	20	100	.1	50
11...	0	30	100	.0	50
12...	10	20	100	.0	<50
12...	0	20	<100	.0	50
12...	10	20	100	.0	100
12...	10	20	<100	.0	50
12...	20	30	100	.0	50
12...	10	20	100	.0	50
12...	10	20	100	.0	<50
12...	10	20	100	.2	50
12...	10	40	100	.0	50
12...	10	30	100	.0	50

DATE	DIS-SOLVED GROSS ALPHA AS U-NAT. (UG/L)	SUS-PENDED GROSS ALPHA AS U-NAT. (UG/L)	DIS-SOLVED GROSS BETA AS CS-137 (PC/L)	SUS-PENDED GROSS BETA AS CS-137 (PC/L)	DIS-SOLVED GROSS BETA AS SR90 /Y90 (PC/L)	SUS-PENDED GROSS BETA AS SR90 /Y90 (PC/L)	TOTAL ORGANIC CARBON (C) (MG/L)
MAY							
10...	<69	1.8	83	2.6	66	2.2	14
10...	71	1.9	87	3.1	69	2.6	20
11...	90	1.4	86	2.2	69	1.8	13
11...	--	--	--	--	--	--	22
12...	<71	4.1	84	3.8	67	3.0	19
12...	--	--	--	--	--	--	17
12...	--	--	--	--	--	--	30
12...	<37	5.7	100	3.9	82	3.1	80
12...	--	--	--	--	--	--	161
12...	<81	2.5	120	3.4	94	2.8	48
12...	<73	2.0	92	3.6	74	3.1	29
12...	65	1.2	92	2.3	73	2.0	28
12...	<36	2.3	100	3.0	82	2.5	37
12...	73	2.2	100	3.0	82	2.5	--

TABLE 2.--Chemical analyses of water, New River at Calexico May 10-12, 1977--Continued

DATE	DIS-SOL-VED ORGANIC CARBON (C) (MG/L)	CYANIDE (CN) (MG/L)	PHENOLS (UG/L)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)	OIL AND GREASE (MG/L)	TANNIN AND LIGNIN (MG/L)
MAY						
10...	11	.00	14	.70	0	.7
10...	12	.01	18	2.1	0	.7
11...	9.1	.00	10	.80	0	.4
11...	14	.01	10	2.7	0	1.0
12...	9.3	.00	6	.60	0	.5
12...	11	.01	8	.80	0	3.0
12...	23	.01	8	.80	31	4.0
12...	42	.01	18	--	--	3.0
12...	34	.01	8	.90	56	10
12...	17	.01	16	.90	0	2.0
12...	14	.01	10	1.1	0	2.0
12...	17	.01	27	2.6	0	3.0
12...	12	.01	2	2.5	0	2.0
12...	--	.00	13	1.7	0	.9

DATE	TOTAL ALDRIN (UG/L)	TOTAL CHLOR-DANE (UG/L)	TOTAL DDD (UG/L)	TOTAL DDE (UG/L)	TOTAL DDT (UG/L)	TOTAL DI-AZINON (UG/L)
MAY						
10...	.00	.0	.01	.00	.01	.02
10...	--	--	--	--	--	.20
11...	.00	.0	.01	.00	.01	.01
11...	.00	.0	.04	.01	.08	.12
12...	.00	.0	.00	.00	.00	.02
12...	.00	.0	.02	.00	.02	.08
12...	.00	.0	.06	.05	.15	.05
12...	.00	.0	.05	.04	.06	.03
12...	.00	.0	.06	.06	.11	.03
12...	.00	.0	.02	.01	.06	.03
12...	.00	.0	.04	.01	.25	.05
12...	.00	.0	.05	.02	.14	.11
12...	.00	.0	.09	.03	.13	.14
12...	.00	.0	.04	.02	.05	.14

TABLE 2.--Chemical analyses of water, New River at Calexico May 10-12, 1977--Continued

DATE	TOTAL DI-ELDRIN (UG/L)	TOTAL ENDO-SULFAN (UG/L)	TOTAL ENDRIN (UG/L)	TOTAL ETHION (UG/L)	TOTAL HEPTA-CHLOR (UG/L)	TOTAL HEPTA-CHLOR EPOXIDE (UG/L)
MAY						
10...	.01	.00	.00	.00	.00	.01
10...	--	--	--	.00	--	--
11...	.00	.00	.00	.00	.00	.00
11...	.02	.00	.00	.00	.00	.00
12...	.00	.00	.00	.00	.00	.00
12...	.01	.00	.00	.00	.00	.00
12...	.02	.00	.00	.00	.00	.00
12...	.01	.00	.00	.00	.00	.00
12...	.00	.00	.00	.00	.00	.00
12...	.01	.00	.00	.00	.00	.00
12...	.01	.00	.00	.00	.00	.00
12...	.02	.00	.00	.00	.00	.00
12...	.02	.00	.00	.00	.00	.01
12...	.01	.00	.00	.00	.00	.00

DATE	TOTAL LINDANE (UG/L)	TOTAL MALA-THION (UG/L)	TOTAL PARA-THION (UG/L)	TOTAL TOX-APHENE (UG/L)	TOTAL TRI-THION (UG/L)	POLY-CHLO-RINATED NAPH-THA-LENES (UG/L)
MAY						
10...	.01	.02	.00	0	.00	.00
10...	--	1.6	.00	--	.00	--
11...	.00	.04	.00	0	.00	--
11...	.00	.36	.00	0	.00	.00
12...	.00	.04	.00	0	.00	.00
12...	.00	.05	.00	0	.00	.00
12...	.06	.00	.00	0	.00	.00
12...	.02	.00	.00	0	.00	.00
12...	.00	.00	.00	0	.00	--
12...	.00	.09	.00	0	.00	.00
12...	.00	.09	.00	0	.00	.00
12...	.00	.29	.00	0	.00	--
12...	.00	.32	.00	0	.00	.00
12...	.00	.90	.00	0	.00	--

TABLE 3.--Chemical analyses of water at control site, Alamo River at Drop 9 near Holtville, May 12,1977 (time, 1000 hours)

Constituent	
Specific conductance------------------µmho--	3,560
pH---------------------------------units--	7.4
Chemical oxygen demand-------------mg/L--	72
Total filtrable residue------------mg/L--	2,700
Total nonfiltrable residue---------mg/L--	170
Total antimony---------------------µg/L--	0
Total barium-----------------------µg/L--	100
Total chromium---------------------µg/L--	10
Total copper-----------------------µg/L--	10
Total lead-------------------------µg/L--	100
Total mercury----------------------µg/L--	0.0
Total nickel-----------------------µg/L--	50
Dissolved gross alpha as U-nat------µg/L--	60
Suspended gross alpha as U-nat------µg/L--	12
Dissolved gross beta as CS-137-----pCi/L--	17
Suspended gross beta as CS-137-----pCi/L--	8.4
Dissolved gross beta as SR90/Y90---pCi/L--	13
Suspended gross beta as SR90/Y90---pCi/L--	6.9
Total organic carbon----------------mg/L--	11
Dissolved organic carbon------------mg/L--	15
Cyanide-----------------------------mg/L--	0.00
Phenols-----------------------------µg/L--	2
Methylene blue active substances----mg/L--	0.20
Oil and grease----------------------mg/L--	0
Tannin and lignin-------------------mg/L--	0.9
Total aldrin------------------------µg/L--	0.00
Total chlordane---------------------µg/L--	0.0
Total DDD---------------------------µg/L--	0.00
Total DDE---------------------------µg/L--	0.02
Total DDT---------------------------µg/L--	0.01
Total diazinon----------------------µg/L--	0.33
Total dieldrin----------------------µg/L--	0.01
Total endosulfan--------------------µg/L--	0.00
Total endrin------------------------µg/L--	0.00
Total ethion------------------------µg/L--	0.00
Total heptachlor--------------------µg/L--	0.00
Total heptachlor epoxide------------µg/L--	0.00
Total lindane-----------------------µg/L--	0.00
Total malathion---------------------µg/L--	0.00
Total parathion---------------------µg/L--	0.00
Total toxaphene---------------------µg/L--	0
Total trithion----------------------µg/L--	0.00
Polychlorinated naphthalenes--------µg/L--	0.00

TABLE 4.--Summary of water-quality field data for New River at Calexico May 9-13, 1977

Constituent	Range in concentration	Mean	Standard deviation
Specific conductance---------μmho--	7,500-8,550	8,300	243
pH-------------------units--	7.3-8.8		
Water temperature------°C--	17.8-23.2	20.4	1.4
Turbidity--------------JTU--	20-115	37	17.0
Dissolved oxygen------mg/L--	0.3-3.2	1.7	0.6
Chlorine, free--------mg/L--	0-0.2	0.05	0.06
Chlorine, total-------mg/L--	0-0.4	0.06	0.1
Total phosphate as P--mg/L--	0.5-3.3	1.34	0.8
Orthophosphate as P---mg/L--	0.4-2.3	0.78	0.4
Hexavalent chromium------------μg/L--	00	--	--
Copper----------------μg/L--	00	--	--
Iron------------------mg/L--	0.3-1.0	0.6	0.1
Lead------------------μg/L--	0-20	--	--
Manganese-------------μg/L--	0	--	--
Zinc------------------μg/L--	<10-20	--	--
Cyanide---------------mg/L--	--	--	--
Methylene blue active substances-----------mg/L--	0.2-4.6	2.0	1.2
Tannin and lignin-----mg/L--	2.5-7.2	5.0	0.8

TABLE 5.--Field measurements of selected physical and chemical characteristics at sites on New River, September 26-30, 1977

[Site number is miles downstream from the international boundary at Calexico]

Date, time	Site number	Specific conductance (µmho/cm at 25°C)	pH	Water temperature (°C)	Dissolved oxygen (mg/L)	Remarks
9-30 at 1020	0	7280	8.0	24.5	3.7	At Calexico
9-30 at 0955	1.5	6890	8.0	24.1	2.6	At Kemp Road
9-30 at 0945	3.5	6660	8.0	24.8	0.3	At Highway 98
9-30 at 0930	5.5	6300	8.0	24.6	0.2	At Clark Road
9-30 at 0905	7.2	6050	8.0	24.7	0.3	At La Boucherie
9-30 at 0840	8.8	6470	7.9	24.8	0.4	At Lyons Road
9-30 at 0820	11.4	6620	7.8	24.8	0.3	At Bockman Road
9-29 at 1610	16.4	6490	8.2	27.2	3.8	At Drew Road
9-29 at 1555	18.4	6470	8.0	27.0	4.2	At Interstate 8
9-29 at 1520	19.5	6440	8.0	26.7	4.5	At Highway 80
9-29 at 1120	19.8	6710	7.9	25.5	6.1	
9-29 at 1110	20.4	6570	7.8	25.7	6.1	
9-29 at 1045	21.7	6440	7.8	25.2	5.7	
9-29 at 1035	22.5	6630	7.8	25.2	5.5	
9-29 at 1020	23.2	6660	7.8	25.0	5.2	
9-29 at 1000	24.0	6710	7.8	24.8	5.2	
9-29 at 0945	24.9	6680	7.8	24.7	5.0	
9-29 at 0930	25.6	6610	7.8	24.8	4.7	
9-28 at 1655	25.6	6930	8.0	27.5	7.5	
9-28 at 1632	26.4	6830	8.0	27.2	7.5	At Worthington Road
9-28 at 1626	26.7	6850	8.0	27.2	7.4	
9-28 at 1610	27.6	6850	7.9	27.2	7.3	
9-28 at 1552	28.6	6840	7.9	27.2	7.0	
9-28 at 1540	29.4	6750	7.9	27.2	6.8	
9-28 at 1526	30.2	6700	7.9	27.1	6.5	
9-28 at 1518	30.7	6760	7.9	27.3	6.7	

TABLE 5.--Field measurements of selected physical and chemical characteristics at sites on New River, September 26-30, 1977--Continued

Date, time	Site number	Specific conductance (μmho/cm at 25°C)	pH	Water temperature (°C)	Dissolved oxygen (mg/L)	Remarks
9-28 at 1045	31.7	6240	7.8	25.1	5.1	
9-28 at 1010	32.9	6290	7.8	25.0	4.9	At Forrester Road
9-28 at 0928	33.4	6320	7.8	24.9	5.0	
9-28 at 0914	34.0	6290	7.8	24.8	4.8	
9-28 at 0903	34.6	6390	7.8	24.9	4.8	
9-28 at 0853	35.2	6400	7.8	24.9	4.7	
9-27 at 1615	36.1	6620	7.8	26.5	6.8	At Keystone Road
9-27 at 1610	36.4	6540	7.8	26.8	6.8	
9-27 at 1600	37.2	6590	7.8	26.9	6.8	
9-27 at 1543	38.1	6590	7.8	27.0	6.7	
9-27 at 1521	39.0	6340	7.8	26.9	6.5	
9-27 at 1510	39.8	6340	7.8	26.9	6.4	
9-27 at 1455	41.0	6340	7.8	26.8	6.2	
9-27 at 1443	42.2	6410	7.8	26.5	6.2	
9-27 at 1435	42.9	6480	7.8	26.3	6.1	At Highway 78 and 99
9-27 at 1345	43.6	6250	7.8	26.1	5.6	Above Drop 4
9-27 at 1345	43.6	6240	7.9	26.1	7.7	Below Drop 4
9-27 at 1155	46.2	6300	7.8	25.3	7.2	Above Drop 3
9-27 at 1155	46.2	6330	7.9	25.3	8.4	Below Drop 3
9-27 at 1130	49.8	6530	7.9	25.0	7.7	Above Drop 2
9-27 at 1130	49.8	6570	7.9	25.0	8.3	Below Drop 2
9-27 at 1042	50.3	6510	7.9	24.8	8.6	At Highway 111
9-27 at 1034	50.6	6490	7.9	24.6	8.4	
9-27 at 1017	51.8	6470	7.9	24.8	8.2	
9-27 at 1000	52.7	6230	7.9	24.3	8.1	
9-27 at 0945	53.6	6290	7.9	24.2	7.7	
9-26 at 1700	55.0	6020	8.0	26.0	7.2	
9-26 at 1600	57.3	5700	8.0	26.0	7.2	At Gentry Road
9-26 at 1500	60.2	5620	8.1	26.0	7.3	At Lack Road
9-26 at 1430	61.2	5600	8.1	26.0	7.3	At Westmorland gage

TABLE 6.--Determinations of selected physical, chemical, and biological characteristics at sites on New River, September 26-30, 1977

[Site number is miles downstream from international boundary at Calexico. BOD, biochemical oxygen demand; COD, chemical oxygen demand; DOC, dissolved organic carbon; Ec, specific conductance; FC, fecal coliform; FS, fecal streptococci; TOC, total organic carbon]

Site number	Ec (µmho/cm at 25°C)	COD (mg/L)	TOC (mg/L)	DOC (mg/L)	BOD (mg/L)	FC (col/ (100 mL)	FS (col/ (100 mL)
0	7280	170	17	15	20	460,000	240,000
1.5	6890	130	12	9.6	6.4	620,000	120,000
7.2	6050	79	13	8.6	15	--	--
8.8	6470	79	12	7.9	7.6	780,000	62,000
11.4	6620	92	14	9	12	2,800,000	180,000
16.4	6490	120	12	7.6	8.4	--	--
19.8	6710	110	7.3	7.3	6.0	180,000	5,000
24.0	6710	100	10	13	8.0	250,000	30,000
26.7	6850	100	11	8.4	6.8	--	--
27.6	6850	69	10	12	8.7	--	--
32.9	6290	68	--	--	14	980,000	--
36.1	6620	81	--	7.4	--	3,700	[1]3,000
39.0	6340	83	9.2	12	7.6	3,000	<1,000
43.6	6240	110	9.4	8.0	6.4	8,000	<1,000
50.3	6510	--	--	--	--	110,000	5,300
52.7	6230	100	9.1	7.3	5.6	17,000	6,000
55.0	6020	99	11	9.4	10	24,000	[1]2,000
57.5	5700	84	9.5	12	8.0	[1]3,300	[1]1,200
60.2	5620	77	9.2	8.1	7.6	[1]1,000	[1]1,000
61.2	5600	73	8.6	6.9	8.4	[1]4,700	[1]400

[1]Non-ideal count.

TABLE 7.--Diel variations in selected physical and chemical characteristics of the New River at Calexico, October 17-18, 1977

Time (hour)	Specific conductance (μmho/cm at 25°C)	pH (units)	Water temperature (°C)	Dissolved oxygen (mg/L)
		October 17, 1977		
1300	7470	7.6	25.6	3.0
1400	7460	7.5	26.0	2.8
1500	7450	7.7	26.4	3.2
1600	7400	7.7	26.7	3.3
1700	7380	7.7	27.4	2.5
1800	7460	7.6	26.7	.1
1900	7440	7.5	26.5	.5
2000	7390	7.4	26.4	.0
2100	7340	7.6	26.1	.0
2200	7240	7.6	25.7	.0
2300	7170	7.7	25.4	.0
2400	8100	7.6	24.8	.0
		October 18, 1977		
0100	7200	7.4	24.8	0.0
0200	7210	7.6	24.5	.0
0300	7240	7.6	24.2	.2
0400	6990	7.5	24.0	.0
0500	6840	7.4	23.7	.0
0600	6760	7.7	23.5	.5
0700	6900	7.6	23.3	1.0
0800	6910	7.6	23.0	1.6
0900	7200	7.7	23.0	1.7
1000	7180	7.5	23.3	1.7
1100	7150	7.5	23.7	2.4
1200	7150	7.6	24.5	2.1

TABLE 8.--Diel variations in selected physical and chemical characteristics of the New River at Highway 80, October 17-18, 1977

Time (hour)	Specific conductance (μmho/cm at 25°C)	pH (units)	Water temperature (°C)	Dissolved oxygen (mg/L)
		October 17, 1977		
1600	5650	7.8	28.0	2.8
1700	5800	7.8	27.0	2.6
1800	5800	7.7	26.0	2.5
1900	5800	7.5	25.2	2.1
2000	5800	7.5	25.5	1.9
2100	5900	7.4	24.5	2.0
2200	5950	7.4	25.0	1.9
2300	6000	7.4	24.5	1.9
2400	6200	7.5	24.0	2.0
		October 18, 1977		
0100	6100	7.5	23.5	1.8
0200	6100	7.5	23.5	1.8
0300	6200	7.5	23.0	1.9
0330	6200	7.4	23.0	1.9
0525	6200	7.4	22.5	2.0
0600	6000	7.4	22.0	2.0
0700	6200	7.4	22.7	1.8
0800	6450	7.4	22.5	1.1
0900	6750	7.3	23.8	.4
1000	6700	7.4	24.5	1.0
1100	6700	7.4	25.0	1.5
1200	6800	7.4	25.2	2.2
1300	7000	7.5	25.0	2.2
1400	7000	7.5	25.0	.2
1410	7000	7.4	25.0	.1
1450	7000	7.4	25.0	.3
1500	7000	7.4	25.0	.5

TABLE 9.--Diel variations in selected physical and chemical characteristics of the New River at Keystone Road, October 17-18, 1977

Time (hour)	Specific conductance (μmho/cm at 25°C)	pH (units)	Water temper-ature (°C)	Dis-solved oxygen (mg/L)
		October 17, 1977		
1400	6560	7.6	25.0	6.3
1500	6580	7.6	25.5	6.3
1600	6530	7.7	25.0	6.5
1700	6490	7.8	25.0	6.4
1800	6520	7.7	25.0	6.2
1900	6470	7.8	24.0	6.2
2000	6520	7.7	24.0	5.6
2100	6580	7.8	24.0	5.6
2200	6580	7.8	23.0	5.5
2300	6740	7.8	23.0	5.1
2400	6710	7.7	23.0	5.0
		October 18, 1977		
0100	6730	7.7	23.0	4.8
0200	6800	7.4	23.0	4.8
0300	6800	7.4	22.3	5.0
0400	6690	7.6	22.3	5.3
0500	6710	7.6	22.3	5.3
0600	6490	7.6	22.1	5.1
0700	6420	7.6	22.0	5.0
0800	6420	7.5	22.0	5.1
0900	6320	7.4	22.1	4.7
1000	6400	7.5	23.0	4.9
1100	6540	7.6	23.2	5.2
1200	6570	7.8	23.5	5.4
1300	6620	7.7	23.8	5.0

TABLE 10.--Diel variations in selected physical and chemical characteristics of the New River below Drop 4 near Brawley, October 18-19, 1977

Time (hour)	Specific conductance (µmho/cm at 25°C)	pH (units)	Water temper-ature (°C)	Dis-solved oxygen (mg/L)
		October 18, 1977		
1700	6000	7.8	24.5	7.0
1800	6300	7.8	24.5	7.2
1900	6300	7.8	24.5	7.3
2000	6300	7.8	24.5	7.2
2100	6300	7.7	24.5	7.2
2200	5750	7.7	24.0	7.1
2300	6200	7.7	24.0	7.1
2400	6000	7.7	23.5	7.0
		October 19, 1977		
0100	6000	7.8	23.5	7.0
0200	6500	7.7	23.5	7.0
0300	6500	7.7	23.0	7.0
0400	6500	7.8	23.0	7.0
0500	6350	7.7	23.0	7.0
0600	6250	7.8	22.8	7.1
0700	6200	7.7	22.5	7.1
0800	6100	7.7	22.3	7.2
0900	6100	7.7	22.5	7.1
1000	7000	7.8	22.6	7.1
1100	7000	7.7	23.0	7.0
1200	7050	7.9	23.2	7.0
1300	7000	7.8	23.8	6.9
1400	6800	7.8	24.0	6.9
1500	6700	7.8	24.5	7.0
1545	6700	7.8	24.8	6.9

TABLE 11.--Diel variations in selected physical and chemical characteristics of the New River at outlet near Westmorland, October 18-19, 1977

Time (hour)	Specific conductance (μmho/cm at 25°C)	pH (units)	Water temperature (°C)	Dissolved oxygen (mg/L)
		October 18, 1977		
1400	5720	7.7	24.3	6.1
1500	5680	7.7	24.5	6.3
1600	5710	7.8	25.0	6.4
1700	5770	7.7	25.1	6.3
1800	5720	7.6	25.0	6.1
1900		7.6	24.6	6.1
2000	5840	7.6	25.2	5.9
2100	5900	7.6	24.9	5.8
2200	5950	7.6	24.6	5.5
2300	6000	7.7	24.4	5.2
2400	5980	7.8	24.1	5.0
		October 19, 1977		
0100	5960	7.8	24.1	5.0
0200	6030	7.5	24.0	5.0
0300	5890	7.7	24.0	5.1
0400	5720	7.7	23.6	5.1
0500	5690	7.7	23.5	4.9
0600		7.7	23.5	5.0
0700	5660	7.7	23.2	5.0
0800	5640	7.8	23.3	5.2
0900	5590	7.7	23.5	5.5
1000	5640	7.7	23.8	5.5
1100	5700	7.6	24.3	5.6
1200	5720	7.7	24.4	5.8
1300		7.7	24.5	5.9

TABLE 12.--Time-of-travel data for selected sites on the New River, February 6-9, 1978

Site	Cumulative miles	Arrival of leading edge of dye: Time, date	Arrival of leading edge of dye: Cumulative hours	Arrival of leading edge of dye: Cumulative minutes	Arrival of peak concentration of dye: Time, date	Arrival of peak concentration of dye: Cumulative hours	Arrival of peak concentration of dye: Cumulative minutes	Time and date of indicated percentage of peak dye concentration on recession
Calexico	0	1200, 2-6 (dye injected)	-	-	- -	-	-	
Clark Road	5.5	1700, 2-6	5	0	1740, 2-6	5	40	5 percent of peak 1840, 2-6
Lyons Crossing	8.8	2010, 2-6	8	10	2120, 2-6	9	20	5 percent of peak 2250, 2-6
Drew Road	16.4	0315, 2-7	15	15	0435, 2-7	16	35	
Highway 80	19.5	05--, 2-7	17	0	0730, 2-7	19	30	5 percent of peak 0945, 2-7
Worthington Road	26.4	1130, 2-7	23	30	1325, 2-7	25	25	10 percent of peak 1540, 2-7
Keystone Road	36.1	2000, 2-7	32	00	2210, 2-7	34	10	10 percent of peak 0200, 2-8
Drop 4	43.6	0300, 2-8	39	00	0530, 2-8	41	30	15 percent of peak 0930, 2-8
Rutherford Road	50.3	0900, 2-8	45	00	1130, 2-8	47	30	10 percent of peak 1600, 2-8
Gentry Road	57.5	1530, 2-8	51	30	1750, 2-8	53	50	10 percent of peak 2200, 2-8
Westmorland Gage	61.2	1830, 2-8	54	30	2115, 2-8	57	15	10 percent of peak 0230, 2-9