Limerick Generating Station
Units 1 & 2

License Renewal Project

Environmental Report

Response to Request for Additional Information (RAI) for the Review of LGS LRA ER, Dated February 28, 2012

Enclosure 2

Book 6 of 11

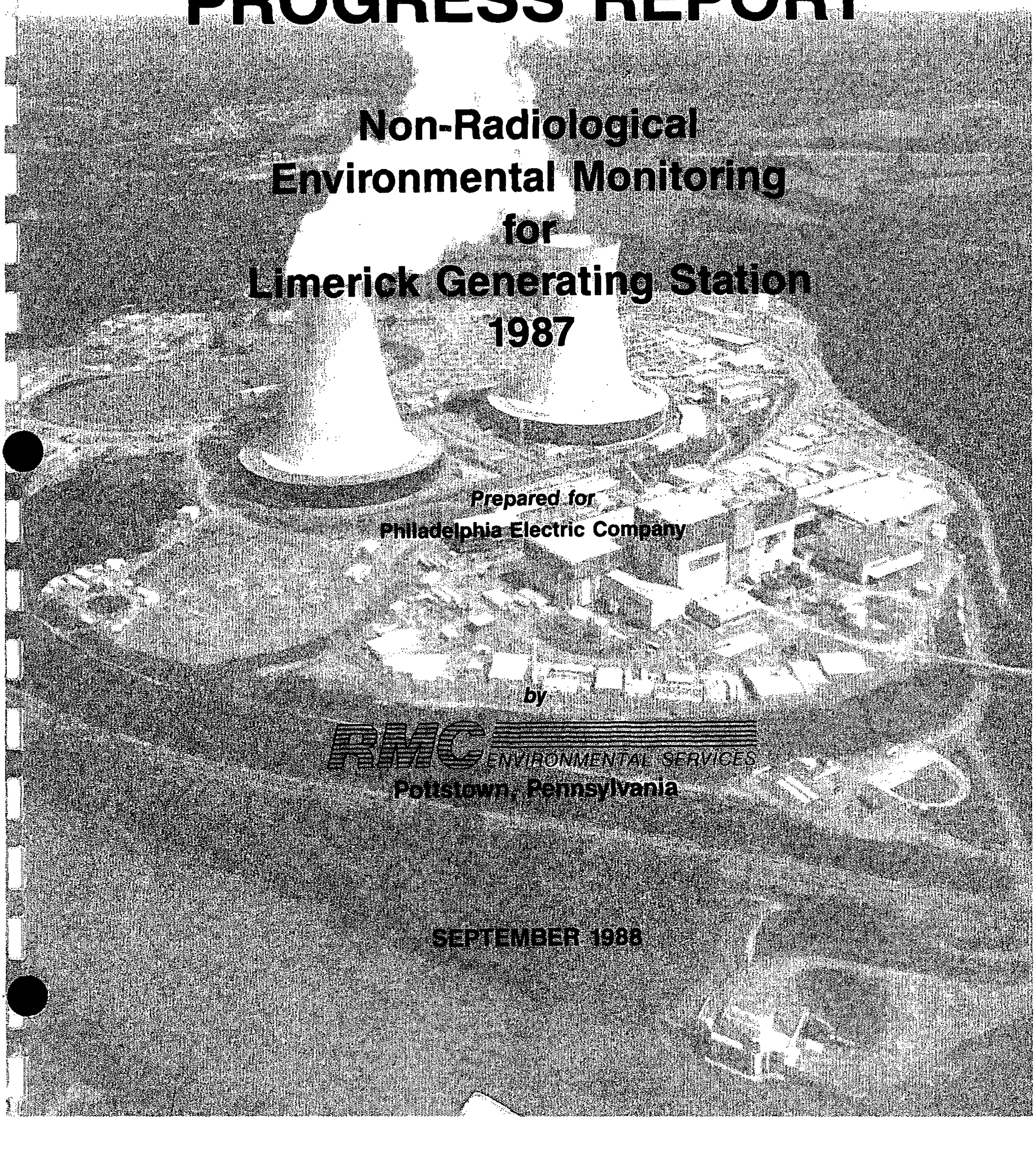
E2-11: <u>Enclosure 2: Aquatic Ecology, item I</u>

RMC (RMC Environmental Services). 1988. Progress Report, Non-Radiological Environmental Monitoring for Limerick Generating Station 1987. Prepared for Philadelphia Electric Company. September.

<u>Exelon Response</u>

The requested document is provided.

PROGRESS REPORT



Non-Radiological Environmental Monitoring for Limerick Generating Station 1987

Prepared for

Philadelphia Electric Company

by

RMC ENVIRONMENTAL SERVICES

Pottstown, Pennsylvania

SEPTEMBER 1988

CA 15

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TABLE OF CONTENTS

LIST OF TABLES

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

LIST OF FIGURES

List of Figures (cont.)

List of Figures (cont.)

1.0 Executive Summary

This report summarizes non-radiological environmental monitoring related to Philadelphia Electric Company's Limerick Generating Station (LGS) conducted in 1987, the third year of plant operation and the second complete year with a full power license. LGS Unit 1 was shut down for maintenance between 16 May and 30 August 1987, during which time only a minimal amount of service water was withdrawn from and discharged to the Schuylkill River. The Point Pleasant Water Diversion Project, designed to supply cooling water to LGS during late spring-early autumn, is under construction and did not operate in 1987. Results of the monitoring programs are summarized in the following paragraphs, including an assessment of the effects of LGS operation on the aquatic ecology of the Schuylkill River, the only stream monitored that is currently subjected to LGS operational influences.

Delaware River

Water quality in the Delaware River in 1987 was similar to that reported in the EROL and subsequent progress reports. Most new extremes slightly extended the observed range of values. In the fall quarter, fourteen new maxima were observed which coincided with the first period of high flow following an approximate four month period of generally low flows.

Pennsylvania DER issued a permit for the Bradshaw Reservoir discharge on 14 July 1988. Comparison of the water quality data for the Delaware River (which will be the only source of water to the reservoir other than direct rainfall) with the proposed effluent limits indicated several permit limit exceedances. The permit limit exceedances for aluminum, zinc, cadmium, and iron were associated with two periods of high flow in the Delaware River. The exceedance for mercury and pH occurred as a single observation during 1987 while the temperature and fecal coliform exceedances were more common during the period June through August.

The asiatic clam, a potential biofouling organism capable of damaging water intakes, was present in the Delaware River between Washington Crossing State Park (river mile 146.0) and the Betsy Ross Bridge in Philadelphia (river mile 104.8). The species is believed to exist even further downstream. Upstream, the limit of distribution is presently 11 miles below Point Pleasant. Although this limit did not extend the observed range of the species upstream, population density at Washington Crossing State Park increased since the 1986 survey.

East Branch Perkiomen Creek

Extensions of previously observed ranges of a number of water quality parameters were routinely associated with periods of high or very low flows. Mean monthly flows were generally less than the period of record with no observations of zero flow at the gaging station. The influence of nutrient loading is evident in the water quality of the two downstream stations.

Taxonomic composition of the benthic macroinvertebrate community varied by station but included ubiquitous organisms and taxa unique to smaller stream reaches. Standing crop (number of organisms/m^2) generally increased with distance from the headwaters and varied by season, but seasonal differences were not consistent among stations. Density of many taxa varied considerably among stations. The considerable spatial and temporal variation in community structure is common for benthic macroinvertebrates in biologically complex warmwater streams. Although presence of asiatic clam was not directly assessed, none was found in the East Branch Perkiomen Creek during sampling.

Seine and electrofishing surveys of fishes agreed with past descriptions of the abundance and distribution of fishes in this stream. A pattern of longitudinal zonation from the headwaters to stream mouth was evident. Collectively, the results indicated a fish community exhibiting patterns of annual variability superimposed on one of long-term stability, which is typical of warmwater stream fish communities not exposed to severe environmental degradation.

Perkiomen Creek

The flow of Perkiomen Creek was generally near or below previous observations except for the month of April during which the monthly mean flow was twice the mean for the period. Significant extensions for total dissolved solids were established at both stations on the stream during the year.

The large fish community of Perkiomen Creek, comprised of species sampled by electrofishing, showed no evidence of any increase in anthropogenic stress as species composition, abundance, and distribution of fishes were consistent with past observations. Collectively, Perkiomen Creek fish data displayed typical spatial, seasonal, and annual variability resulting from the complex interplay of the physical and biological factors that regulate fish community structure in warmwater streams.

Although asiatic clams are present in the Schuylkill River where it is joined by Perkiomen Creek, they were not collected anywhere in this major Schuylkill River tributary in 1987.

Schuylkill River

Water quality in the Schuylkill River in 1987 was similar to the period of record. New minima and maxima were observed during the year with most associated with the flow regime. A new maximum flow value was observed in early September that was in excess of 4000 cfs over the previous record for the month. The operational year was characterized by an extended shutdown of LGS from mid-May to late August. Some extensions of the range of water quality concentrations were established that were generally related to the flow regime. A comparison of downstream water quality with water quality upstream of LGS indicated no sustained impacts on Schuylkill River water quality attributable to LGS operation.

Benthic macroinvertebrate samples downstream of LGS were subjected to sedimentation which influenced taxonomic composition and density of colonizing organisms. Any effects of LGS discharge, if present, were therefore confounded with effects of sedimentation. However, since community characteristics observed downstream of LGS were within the range observed during preoperational sampling, any such real but undetected effects were probably small and unimportant to the total ecological community of the Schuylkill River near LGS.

Population surveys, aspects of the biology of important species, redbreast sunfish age and growth characteristics, and impingement and creel surveys were all programs conducted in 1987 to assess possible station-related effects on resident fish populations near LGS. Collectively these programs revealed many interesting and ecologically significant relationships between fishes and their environment, but found no evidence of a significant impact of LGS operation to date.

Although asiatic clams have been collected in past years from the tidal Schuylkill River, none was found downstream of the Strawberry Mansion Bridge (river mile 11.0) in 1987. However, in 1987 the species extended its range upstream by at least 1.4 miles, from Black Rock Dam (the 1986 upstream limit) to the Pennsylvania Route 113 bridge over Black Rock pool between the dam and Cromby Generating Station. At present, the species has penetrated the system to within 10 river miles of LGS, and has shown consistent upstream expansion since monitoring was initiated in 1982.

2.0 Introduction

The aquatic ecology of the Delaware River, Schuylkill River, Perkiomen Creek, and East Branch Perkiomen Creek has been studied since 1970 for Philadelphia Electric Company (PECo) by RMC Environmental Services (formerly Ichthyological Associates) to assess possible environmental impacts of Limerick Generating Station (LGS) and its water supply system which includes the proposed Point Pleasant Water Diversion Project. Along with certain terrestrial ecological studies, these assessments are collectively referred to as the LGS Non-radiological Environmental Monitoring Program. Prior to initial LGS operation in 1985, this program's objective was to document natural variation in the ecological variables under study, thereby developing an environmental baseline against which the magnitude and significance of LGS-related impacts could be assessed. These studies have continued for a sufficient period of time after LGS operation to permit detailed environmental impact evaluations of certain components of the station on the environment.

The various study components of the Non-radiological Environmental Monitoring Program and the duration of each are listed in Table 2.0-1. Previous progress reports based on these studies are listed in Table 2.0-2. The results of studies conducted in 1970-1977 were used in preparation of the Environmental Report: Operating License Stage (EROL) for LGS, submitted to the Nuclear Regulatory Commission (NRC) by PECo in 1981.

This report summarizes non-radiological environmental monitoring studies conducted for PECo in 1987. The report sections for Schuylkill River studies focus where appropriate on evaluation of possible LGS operational impacts. It is important to note that any potential LGS operational effects are confined to the effects of water withdrawal from and discharge to the Schuylkill River, since the Point Pleasant Water Diversion Project (which impacts the Delaware River, Perkiomen Creek, and East Branch Perkiomen Creek) is not operational. Studies in 1987 of the Delaware River, Perkiomen Creek, and East Branch Perkiomen Creek, therefore, are not reported in the same detail as Schuylkill River studies.

Throughout this report, sample station locations are designated by a letter ('A' for Delaware River, 'S' for Schuylkill River, 'P' for Perkiomen Creek, and 'E' for East Branch Perkiomen Creek) followed by a number indicating the distance in meters upstream from a reference point. Except for the Delaware River, where the reference point was river mile 150, the reference point was the stream mouth. If a station was comprised of an area of stream instead of a transect or single point location, the distance in meters from the reference point to the downstream edge of the area was used as the station designation.

Table 2.0-1. Ecological and water quality studies conducted in relation to Limerick Generating Station by RMC Environmental Services.

Program	1970	1971	1972	1973	1974	1975	1976	1977	1978
<u>Delaware River</u>									
Water quality					X	X	X	X	X
Fisheries survey			X	X					
Macroinvertebrate drift			X	X					
Larval fish									
Asiatic clam									
<u>East Branch Perkiomen Creek</u>									
Water quality					X	X	X	X	X
Periphyton				X	X				
Benthic macroinvertebrates	X		X	X	X		X		
Larval fish				X	X				
Seine	X					X	X	X	
Electrofishing					X	X	X	X	X
Age and Growth				X		X		X	
Creel Survey									
<u>Perkiomen Creek</u>									
Water quality					X	X	X	X	X
Phytoplankton					X				
Periphyton				X					
Benthic macroinvertebrates	X		X	X	X		X		
Larval fish				X	X	X	X		
Seine	X					X	X	X	X
Electrofishing					X	X	X	X	X
Age and growth				X			X		X
Creel survey									
Asiatic clam									
<u>Schuylkill River</u>									
Water quality					X	X	X	X	X
Phytoplankton				X	X				
Periphyton				X	X				
Macrophytes								X	
Benthic macroinvertebrates	X		X	X	X	X	X	X	X
Larval fish				X	X	X	X		
Seine	X					X	X	X	X
Electrofishing				X	X	X	X	X	X
Trap net		X	X	X	X	X	X		
Age and growth				X		X		X	
Creel survey									
Asiatic clam									
Cooling tower bird mortality									
Impingement									
Entrainment									

Table 2.0-1. (continued)

Program	1979	1980	1981	1982	1983	1984	1985	1986	1987
Delaware River									
Water quality	X	X	X	X	X	X	X	X	X
Fisheries survey				X					
Macroinvertebrate drift									
Larval fish				X	X	X	X	X	
Asiatic clam				X	X	X	X	X	X
East Branch Perkiomen Creek									
Water quality					X	X	X	X	X
Periphyton									
Benthic macroinvertebrates					X	X	X	X	X
Larval fish									
Seine			X	X	X	X	X	X	X
Electrofishing			X	X	X	X	X	X	X
Age and Growth			X		X	X	X	X	
Creel Survey		X	X		X		X	X	X
Perkiomen Creek									
Water quality	X	X	X	X	X	X	X	X	X
Phytoplankton									
Periphyton									
Benthic macroinvertebrates									
Larval fish									
Seine								X	
Electrofishing			X	X	X	X	X	X	X
Age and growth									
Creel survey		X	X	X	X		X		
Asiatic clam					X	X	X	X	X
Schuylkill River									
Water quality	X	X	X	X	X	X	X	X	X
Phytoplankton									
Periphyton									
Macrophytes									
Benthic macroinvertebrates					X	X	X	X	X
Larval fish									
Seine			X	X	X	X	X	X	X
Electrofishing			X	X	X	X	X	X	X
Trap net									
Age and growth			X		X	X	X	X	X
Creel survey		X	X	X	X	X	X		X
Asiatic clam				X	X	X	X	X	X
Cooling tower bird mortality			X	X	X	X	X	X	X
Impingement							X	X	X
Entrainment								X	

Table 2.0-2. List of progress reports which pertain to non-radiological environmental monitoring for Limerick Generating Station, 1970-1986.

Denoncourt, R. F., and C. H. Hocutt. 1971. An ecological study of the Schuylkill River in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Schuylkill Progress Report No. 1. (Part One).

Brett, J. J., and R. F. Denoncourt. 1971. An ecological study of the Schuylkill River in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Schuylkill Progress Report No. 1. (Part Two).

Denoncourt, R. F., C. H. Hocutt, and C. B. Milstein. 1971. An ecological study of the East Branch of the Perkiomen Creek system near Pottstown, Pennsylvania. Ichthyological Associates, Perkiomen Progress Report No. 1. (Part One - Fishes).

Brett, J. J., R. F. Denoncourt, and R. J. Stira. 1971. An ecological study of the East Branch of the Perkiomen Creek system near Pottstown, Pennsylvania. Ichthyological Associates, Perkiomen Progress Report No. 1. (Part Two - Macroinvertebrates).

Harmon, P. L., W. A. Potter, K. W. Knopf, and R. H. Ellis. 1971. An ecological study of the Schuylkill River in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Schuylkill Progress Report No. 2.

Molzahn, R. F. 1971. An ecological study of the East Branch of the Perkiomen Creek system near Pottstown, Pennsylvania. Ichthyological Associates, Perkiomen Progress Report No. 2. (Part One - Fishes).

Knopf, K. W. 1971. An ecological study of the East Branch of the Perkiomen Creek system near Pottstown, Pennsylvania. Ichthyological Associates, Perkiomen Progress Report No. 2. (Part Two - Macroinvertebrates).

Ellis, R. H., T. P. Poe, and D. C. Stefan. 1973. An ecological study of the Schuylkill River in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Schuylkill Progress Report No. 3. (Volume I).

Harmon, P. L., R. F. Molzahn, T. M. Kincaid, A. K. Megay, R. J. Stira, and R. W. Blye. 1973. An ecological study of the Schuylkill River in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Schuylkill Progress Report No. 3. (Volume II).

Molzahn, R. F., and R. P. Rutter. 1973. An ecological study of the East Branch Perkiomen Creek system near Pottstown, Pennsylvania. Ichthyological Associates, Perkiomen Progress Report No. 3.

Harmon, P. L., and Associates. 1974. An ecological study in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Inc., Schuylkill Progress Report No. 4.

Harmon, P. L., and Associates, 1974. An ecological study of the East Branch of the Perkiomen Creek system near Graterford, Pennsylvania. Ichthyological Associates, Inc., Perkiomen Progress Report No. 4.

Harmon, P. L., V. M. Douglass, K. R. Fite, T. P. Poe, and Associates. 1976. An ecological study in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Inc., Schuylkill Progress Report No. 5.

Harmon, P. L., V. M. Douglass, K. R. Fite, T. P. Poe, and Associates. 1976. An ecological study of the East Branch of the Perkiomen Creek system near Graterford, Pennsylvania. Ichthyological Associates, Inc., Perkiomen Progress Report No. 5.

Edinger, J. E., E. M. Buchak, and H. J. Reisinger. 1976. Limerick Water Chemistry Program. 1974 Annual Report. J. E. Edinger Associates, Inc., and Ichthyological Associates, Inc.

Harmon, P. L, V. M. Douglass, K. R. Fite, T. P. Poe, H. J. Reisinger, and Associates. 1978. An ecological study in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Radiation Management Corporation, Schuylkill Progress Report No. 6.

Harmon, P. L., V. M. Douglass, K. R. Fite, T. P. Poe, H. J. Reisinger, and Associates. 1978. An ecological study of the East Branch of the Perkiomen Creek system near Graterford, Pennsylvania. Radiation Management Corporation, Perkiomen Progress Report No. 6.

RMC Environmental Services. 1984. Progress Report: Non-radiological Environmental Monitoring for Limerick Generating Station 1979-1983. Prepared for Philadelphia Electric Company.

RMC Environmental Services. 1985. Progress Report: Non-radiological Environmental Monitoring for Limerick Generating Station 1984. Prepared for Philadelphia Electric Company.

RMC Environmental Services. 1986. Progress Report: Non-radiological Environmental Monitoring for Limerick Generating Station 1985. Prepared for Philadelphia Electric Company.

RMC Environmental Services. 1987. Progress Report: Non-radiological Environmental Monitoring for Limerick Generating Station 1986. Prepared for Philadelphia Electric Company.

3.0 Delaware River

The Delaware River near Point Pleasant and the Point Pleasant Pumping Station and Water Diversion Project were described in Section 3.0 of the 1986 progress report to PECo (RMC Environmental Services 1987a). Although construction of several project components continued in 1987, no instream work was necessary since the intake screens and pipes leading to the pumphouse are in place.

In 1987 ecological studies of the Delaware River near Point Pleasant were confined to a water quality study initiated in 1974, which is summarized in the following report section.

3.1 Water Quality

Introduction and Methods

Water quality of the Delaware River at Point Pleasant was investigated from 1974 through 1987 to chemically characterize the river and to permit comparisons of Delaware River water quality with the water quality of the streams that will receive water from the diversion. Results of water quality analyses conducted from 1975 through 1978 were reported in the EROL. Results of water quality sampling on the Delaware River near Point Pleasant in 1987 are reported herein.

Subsurface grab samples were collected biweekly beginning 14 January 1987 approximately 15 m from the Pennsylvania shore at the Point Pleasant Canoe Outfitters' boat ramp, station A11760 (Fig. 3.1-1). Samples were analyzed using analytical procedures approved or accepted by state and federal regulatory agencies.

Results and Discussion

River discharge measured at the U.S.G.S. gage at Trenton, New Jersey was low to moderate during most of 1987 (Table 3.1-1, Fig. 3.1-2). The period of January to March was characterized by mean monthly flows below the mean monthly flows calculated for the period 1971-1987 (Table 3.1-2, Fig. 3.1-3). The mean daily discharges for 1-20 April 1987 exceeded 20,000 cfs with a maximum discharge of 83,600 cfs on 6

April 1987. The April 1987 mean monthly discharge exceeded the April mean monthly discharge for the period 1971-1987 by more than 7,000 cfs. A period of low flow occurred from May through early September with the exception of a short period of slightly enhanced flow in mid-July. From 7 September to 8 September 1987, flow increased more than seven-fold. A period of high flow persisted until early December. The December 1987 mean monthly flow was less than the mean monthly for the period of record. Mean monthly flows in 1987 were less than mean flows in 1986 except for April, July, September, and October. Median monthly flows in 1987 were less than the median monthly flows for the overall 1971-1987 period in six months (February, March, May, June, August, and November). No new minimum or maximum flows were established during 1987 as compared to the overall record at Trenton.

Tables 3.1-3 and 3.1-4 provide seasonal summaries of Delaware River water quality data for the period 1979 through 1987 and for 1987 alone, respectively. New seasonal minimum and maximum values observed in 1987 are presented in Tables 3.1-5 and 3.1-6, respectively. Three additional parameters were monitored during 1987. Turbidity values were monitored beginning on 25 February 1987. In addition, dissolved iron and dissolved aluminum were monitored beginning on 11 November 1987. Quarterly minimum and maximum values for turbidity were established during the year, while minima and maxima for dissolved iron and dissolved aluminum were established during the winter and fall quarters. Nickel, aluminum, sulfide, mercury, and cadmium analyses began in late 1986. As such, several of the new seasonal minima and maxima for these parameters reflect the limited database established in 1986 as well as the fact that cadmium and mercury were not detected in any of the 1986 surveys.

With the exception of the parameters discussed above nearly all new minima established in 1987 were related to flow. The major cations (sodium, potassium, calcium, magnesium) and alkalinity vary inversely with flow and the dates on which any of these parameters established a new minimum coincided with high flow.

New maximum values were established in all quarters and several were likely flow related. In the winter quarter new maximum values for pH, potassium, and trichloroethylene (TCE) were observed. The TCE observation was the first time the compound had been detected in the winter quarter in Delaware River water. The new potassium maximum value (6.2 mg/l) exceeded the previous maximum by 0.9 mg/l.

In the spring quarter new maxima for biochemical oxygen demand (BOD), total alkalinity, total hardness, specific conductance, nitrite nitrogen, ortho phospate phosphorus, iron, and manganese were established. With the exception of BOD and iron, the remaining maxima were observed on 20 May during period of low flow. The BOD maximum was double the previous maximum.

The summer quarter was characterized by low flow with a brief period of elevated flow from 15-18 July. Maxima for total suspended solids and manganese were observed on 15 July during high flow. Nitrite nitrogen and total hardness maxima were observed on 17 June while new maxima for total dissolved solids, potassium, and ammonia nitogren were observed on various days.

The fall quarter sampling was initiated on 9 September which coincided with the first major high flow since late April. Fourteen of the 18 new maximum values were observed on 9 September. The new maximum for total suspended solids (548 mg/l) represents a thirty-fold increase over the previous fall maximum (18 mg/l). A significantly elevated suspended solids load on 9 September may well account for the establishment of the 14 new maximum values in the 9 September sample.

Pennsylvania DER issued a permit for the discharge of Bradshaw Reservoir water (Delaware River water) to the East Branch Perkiomen Creek on 14 July 1988. The effluent limits are:

	Time Period	Value
Temperature	2-15 to 7-31	74 F, 23.3 C
	8-1 to 2-14	87 F, 30.5 C
Fecal coliform	5-1 to 9-30	200 colonies/100 ml geometric average
	10-1 to 4-30	2000 colonies/100 ml geometric average
pH	All year	6-9 units

	Average monthly mg/l	Maximum daily mg/l
Aluminum, Total	0.4	2.0
Cadmium	0.00076	0.0022
Iron, Dissolved	--	0.3
Iron, Total	1.5	7.5
Mercury	Nondetectable	Nondetectable
Nickel, Total	0.052	0.26
Phenolics, Total	0.005	0.010
Zinc, Total	0.10	0.5

Several of the proposed effluent limits were exceeded during the 1987 monitoring of the Delaware River. The parameters included:

Temperature	June-July
pH	Single exceedance in late February
Fecal coliforms	July-August
Aluminum, Total	Maximum daily exceedance in April and September
Mercury	Single detection in May
Zinc	Single maximum daily exceedance
Iron, Total	Maximum daily and monthly average exceedance in April and September
Cadmium	Maximum daily and monthly average in September

Of these proposed permit limits the exceedances for aluminum, zinc, cadmium, and total iron were associated with periods of very high flow in early May and September. High flow rates were associated with high suspended solids. Acidification of the samples for total metal analyses resulted in the digestion of the elevated suspended solids which in turn resulted in elevated concentrations of total metals. The dissolved metal concentrations (not the acid digested total metal concentrations) are the important metal forms that are readily available for biological uptake. The single proposed dissolved metal limit for iron of 0.3 mg/l (daily maximum) was not exceeded during the limited period of monitoring (18 November to 31 December 1987).

Table 3.1-1. Mean daily Delaware River discharge (ft^3/sec) measured at the Trenton US Geological Survey gage in 1987.

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	14300	8190	10200	21800	9840	5340	3850	4290	6580	10100	14800	30600
02	14200	7850	20300	26700	9280	4850	6090	3950	6120	10000	12500	29300
03	14100	7920	19200	22800	8580	5410	7790	3850	5820	9850	11100	23100
04	13100	8690	19500	37400	9450	6460	5310	3510	5440	11800	10800	19700
05	12100	8820	17700	67100	11500	7120	5500	3700	4620	12100	9450	17400
06	10600	7980	15200	83600	12200	6030	5300	5430	3850	11500	9000	15400
07	10400	7440	14000	65700	11200	5790	4630	5300	3670	10900	8610	13800
08	10100	7540	15200	57300	9980	5080	4540	4820	5490	10200	8370	12700
09	9960	7240	19200	48900	9220	4550	5850	4440	40600	10000	7470	12300
10	9550	6630	29400	42300	8470	4450	8480	7250	44400	9750	7050	11800
11	9870	6500	27800	33600	7680	4650	7220	6400	33100	8850	11300	11300
12	9480	7190	23100	27900	7290	4660	6620	4800	22500	9020	10600	10600
13	9070	6820	20400	25900	7020	4460	5730	4640	20900	9040	9910	10100
14	9600	6240	18100	29800	6460	4190	6490	4030	57500	8430	10300	9100
15	9560	5940	16000	32500	6230	4660	14200	3640	51100	7670	10000	9000
16	9880	5370	13600	27600	6230	4410	15500	3400	38900	7200	9260	11900
17	10400	4420	12500	25200	5880	4560	15300	3320	31100	6800	8940	11500
18	10700	5050	12200	24000	5610	4340	11000	3300	26600	6520	9810	10800
19	10600	5500	11600	22300	5540	4090	8400	3530	28600	6010	13200	10100
20	11100	5660	11300	20600	6270	3990	6810	3890	35600	5530	13600	9300
21	11000	5590	11500	18800	6490	4010	5830	3090	29300	5940	12800	9160
22	10600	5540	11400	15900	6540	4500	5640	3080	25400	5470	11500	9440
23	9660	5420	10100	14300	6260	4810	5730	3150	22200	5560	10400	10400
24	9030	5200	9830	13600	6170	4220	5390	3010	18900	5850	8880	9880
25	7550	4940	11400	16500	6780	4010	5220	2940	17000	5660	9200	9220
26	7500	4930	12300	14800	7010	4680	5290	3020	14900	5190	9520	8590
27	7580	5080	13400	13000	6820	4630	6070	3320	13400	4940	9190	8500
28	7200	5110	15200	12000	6340	4450	4980	4280	12800	9690	8090	9070
29	7870		15400	11500	6010	4340	4900	5700	11900	16900	8280	8830
30	8540		14200	10500	5800	4120	4630	7210	10700	23100	19000	8990
31	8580		15900		5890		4510	7140		17600		7840
Minimum	7200	4420	9830	10500	5540	3990	3850	2940	3670	4940	7050	7840
Mean	10122	6386	15714	29463	7550	4762	6865	4304	21633	9264	10431	12572
Median	9880	6090	15200	24600	6780	4555	5730	3890	19900	9020	9860	10400
Maximum	14300	8820	29400	83600	12200	7120	15500	7250	57500	23100	19000	30600

Table 3.1-2. Mean monthly Delaware River discharge (ft^3/sec) measured at the Trenton US Geological Survey gage, 1971 - 1987.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1971										7639	9936	19719
1972	13032	10602	25448	23560	18699	33460	15396	4866	4055	4152	24992	25010
1973	20006	19376	15878	26680	23626	17852	18497	9157	5544	5111	6306	31066
1974	19442	16362	19255	26380	14616	7594	4826	5729	11695	8570	9254	19699
1975	18638	21507	23461	18120	16841	14764	13753	6694	12170	17679	16611	10473
1976	19774	26831	16448	13415	12665	7490	8610	8007	4800	18019	10800	7476
1977	3755	7511	38406	26528	11277	4454	3723	3515	8275	19926	17242	25552
1978	29116	12350	25049	23202	20596	9669	4818	6141	4289	4045	4127	8821
1979	34946	15170	30235	18343	19916	10538	5330	4366	9062	15490	14054	11310
1980	7532	4176	20283	26610	11920	4874	4008	3198	2981	3512	3986	3784
1981	2539	22787	7715	8100	18721	6836	5158	3524	3565	4500	6301	6695
1982	10321	13616	16599	25023	9298	13759	7424	5390	4430	4188	5129	6842
1983	8681	15607	23232	45187	18687	12404	5459	3879	3310	4030	8171	27813
1984	8081	20886	14741	34900	26758	18427	15937	5891	3667	3702	3620	7369
1985	6250	6861	9824	6757	7889	6223	4830	3696	9005	9708	17727	16376
1986	11007	15642	29653	17734	11420	12798	5661	7569	3639	4065	13653	17284
1987	10122	6386	15714	29463	7550	4762	6865	4304	21633	9264	10431	12572
Minimum	1900	2200	3370	4410	3760	3230	2440	2490	2100	2630	2570	2370
Mean	13569	14278	20104	22162	15212	11619	8143	5370	7007	8183	10331	14735
Median	9590	10350	16100	18450	12300	8205	5580	4525	4055	5175	7275	11000
Maximum	106000	88000	128000	129000	130000	109000	108000	23900	65400	58200	63100	107000

Table 3.1-3. Summary of Delaware River water quality at Station A11760, 20 March 1979 through 30 December 1987.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	0.0	2.0	8.0	2.0	10.0	24.0	14.0	24.0	30.0	5.0	14.5	26.0	271
Dissolved Oxygen (mg/l)	8.2	12.5	15.3	7.5	11.0	17.2	5.0	8.6	14.0	7.2	10.3	14.4	244
Biochemical Oxygen Demand (mg/l)	0.3	1.7	7.8	0.0	1.6	9.2	0.1	2.0	7.7	0.0	1.6	35.0	248
Chemical Oxygen Demand (mg/l)	0.0	9.8	68.3	0.0	10.3	55.1	0.0	12.3	88.6	0.0	11.3	39.5	244
Total Organic Carbon (mg/l)	0.0	2.7	15.0	0.0	2.2	12.1	0.0	3.5	40.6	0.0	3.0	20.3	241
pH	7.03	7.57	9.09	6.55	7.51	8.79	6.78	7.96	9.02	7.15	7.83	9.48	248
Total Alkalinity (mg/l)	8.7	35.6	72.3	9.3	29.9	56.2	9.0	46.4	71.6	0.0	48.3	82.7	247
Total Hardness (mg/l)	25.4	56.6	128.5	18.5	46.5	87.7	29.8	67.1	121.2	27.8	67.2	134.7	247
Specific Conductance (usm/cm)	81	148	309	76	124	310	93	171	225	94	178	373	248
Turbidity (ntu)	1.5	2.2	10.4	2.8	6.2	25.5	3.4	5.5	108.0	1.5	3.9	355.0	44
Total Suspended Solids (mg/l)	0	3	145	0	8	35	0	8	214	0	3	548	248
Total Dissolved Solids (mg/l)	16	106	224	37	94	158	43	137	380	50	125	260	248
Dissolved Silica (mg/l)	1.24	2.13	4.71	0.19	1.84	3.40	1.39	2.07	3.23	0.28	1.38	2.74	95
Total Inorganic Carbon (mg/l)	10.1	39.0	75.1	10.6	30.5	47.0	20.6	48.9	73.5	22.9	51.4	82.1	142
Chloride (mg/l)	0.0	12.5	32.8	0.0	9.8	25.3	0.0	11.9	19.0	0.0	14.2	49.4	248
Sulfate (mg/l)	2.7	23.2	87.8	6.5	21.4	33.2	5.1	22.8	41.0	8.7	27.4	56.9	248
Sodium (mg/l)	3.72	7.93	19.70	0.00	6.15	13.70	4.45	8.18	15.40	4.45	9.40	36.10	248
Potassium (mg/l)	0.9	1.4	6.2	0.1	1.1	2.5	0.6	1.5	6.6	0.4	1.8	9.2	248
Calcium (mg/l)	7.0	14.0	29.7	0.0	9.9	25.3	0.0	14.6	27.1	8.0	14.2	41.0	248
Magnesium (mg/l)	0.00	6.25	13.60	0.00	4.60	8.80	3.42	7.20	12.05	2.47	8.10	14.10	248
Ammonia Nitrogen (mg/l)	0.000	0.140	0.700	0.000	0.085	0.270	0.000	0.050	0.400	0.000	0.074	0.570	248
Nitrite Nitrogen (mg/l)	0.000	0.017	0.085	0.000	0.018	0.090	0.000	0.038	1.180	0.000	0.045	0.101	248
Nitrate Nitrogen (mg/l)	0.29	1.15	3.48	0.16	0.78	5.90	0.00	0.96	6.11	0.00	1.16	12.57	248
Total Phosphate Phosphorus (mg/l)	0.00	0.08	0.27	0.00	0.06	0.20	0.00	0.10	1.09	0.00	0.10	0.76	236
Ortho Phosphate Phosphorus (mg/l)	0.00	0.05	0.16	0.00	0.03	0.12	0.00	0.06	0.13	0.00	0.07	0.26	246
Cadmium (mg/l)	0.000	0.000	0.002	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.004	74
Chromium (mg/l)	0.000	0.004	0.032	0.000	0.006	0.060	0.000	0.004	0.076	0.000	0.004	0.046	247
Copper (mg/l)	0.000	0.002	0.048	0.000	0.003	0.056	0.000	0.003	0.121	0.000	0.002	0.058	248
Iron (mg/l)	0.00	0.17	3.64	0.00	0.29	4.52	0.00	0.20	5.42	0.00	0.15	12.90	288
Lead (mg/l)	0.000	0.000	0.148	0.000	0.000	0.032	0.000	0.000	0.029	0.000	0.000	0.193	248
Manganese (mg/l)	0.00	0.00	0.46	0.00	0.05	0.44	0.00	0.05	0.42	0.00	0.00	0.99	248
Nickel (mg/l)	0.000	0.000	0.003	0.000	0.002	0.011	0.000	0.001	0.004	0.000	0.000	0.023	73
Zinc (mg/l)	0.00	0.03	0.48	0.00	0.03	0.44	0.00	0.02	0.39	0.00	0.02	0.57	290
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.3	0.0	0.0	0.0	74
Cyanide, Total (mg/l)	0.000	0.000	0.012	0.000	0.000	0.008	0.000	0.000	0.013	0.000	0.000	0.006	246
Phenols (mg/l)	0.000	0.000	0.021	0.000	0.000	0.012	0.000	0.000	0.088	0.000	0.000	0.051	247
Trichloroethylene (ug/l)	0.0	0.0	3.0	0.0	0.0	3.1	0.0	0.0	6.4	0.0	0.0	7.7	219
Total Coliforms (MF) (c/.1l)	0	788	21500	6	480	32000	30	1100	154000	10	1100	54000	264
Fecal Coliforms (MF) (c/.1l)	0	84	10000	0	70	870	3	170	40000	1	80	7000	262
Aluminum (mg/l)	0.00	0.16	0.34	0.07	0.24	2.20	0.00	0.10	0.57	0.00	0.00	4.27	74
Dissolved Aluminum (mg/l)	0.00	0.00	0.16							0.00	0.00	0.00	8
Dissolved Iron (mg/l)	0.00	0.00	0.30							0.00	0.00	0.10	8
Fecal Coliforms (MPN) (c/.1l)	46	220	2400	2	120	920	11	95	1600	7	240	2400	42
Sulfide (mg/l)	0.00	0.00	6.40	0.00	0.00	2.94	0.00	0.00	0.20	0.00	0.25	4.56	56
Total Coliforms (MPN) (c/.1l)	1600	2400	2400	79	2050	16000	49	730	2400	350	2400	5800	42

Table 3.1-4. Summary of Delaware River water quality at Station A11760, 14 January 1987 through 30 December 1987.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	0.0	4.0	7.0	2.5	11.5	17.5	25.0	26.3	28.0	10.0	12.0	20.0	24
Dissolved Oxygen (mg/l)	10.7	13.0	14.6	9.7	10.8	12.0	6.5	9.2	12.9	7.6	10.7	11.7	24
Biochemical Oxygen Demand (mg/l)	0.6	0.9	4.0	1.6	3.6	9.2	1.2	2.2	4.6	1.4	1.8	35.0	26
Chemical Oxygen Demand (mg/l)	0.0	0.0	17.2	0.0	5.6	15.8	0.0	0.0	14.4	0.0	11.7	30.6	26
Total Organic Carbon (mg/l)	2.0	2.5	3.2	1.6	2.4	3.0	2.4	3.1	3.5	2.6	3.1	5.2	26
pH	7.51	7.73	9.09	7.17	7.63	8.58	7.48	8.21	8.94	7.21	7.44	8.04	26
Total Alkalinity (mg/l)	19.7	37.5	50.6	21.4	33.0	56.2	9.0	47.5	54.8	0.0	37.2	67.6	26
Total Hardness (mg/l)	36.8	65.5	85.9	18.9	47.3	87.7	72.8	83.0	121.2	39.0	63.5	83.2	26
Specific Conductance (usm/cm)	102	162	214	84	135	206	177	189	221	106	138	163	26
Turbidity (ntu)	1.6	4.5	10.4	2.8	7.0	25.5	3.9	5.8	108.0	1.5	3.7	355.0	22
Total Suspended Solids (mg/l)	1	2	9	0	7	31	1	3	140	1	2	548	26
Total Dissolved Solids (mg/l)	78	88	133	63	103	157	115	137	380	89	102	128	26
Chloride (mg/l)	0.0	13.3	18.6	0.0	7.0	11.9	13.8	14.4	18.3	0.0	13.0	17.1	26
Sulfate (mg/l)	13.4	19.8	22.0	13.6	15.9	18.8	16.7	20.0	24.9	14.1	17.4	21.5	26
Sodium (mg/l)	4.40	8.58	11.00	0.00	5.70	7.70	6.90	8.40	11.40	4.96	7.32	17.70	26
Potassium (mg/l)	1.2	1.4	6.2	0.1	1.2	1.8	1.1	1.5	6.6	0.8	1.3	4.0	26
Calcium (mg/l)	7.9	17.0	22.2	0.0	9.3	14.7	11.2	17.3	23.5	8.0	12.4	41.0	26
Magnesium (mg/l)	2.90	6.40	8.86	0.00	3.99	5.77	5.61	6.26	9.00	3.50	5.41	8.06	26
Ammonia Nitrogen (mg/l)	0.000	0.177	0.330	0.000	0.076	0.121	0.000	0.080	0.400	0.067	0.091	0.140	26
Nitrite Nitrogen (mg/l)	0.000	0.021	0.041	0.011	0.045	0.090	0.030	0.060	1.180	0.013	0.043	0.094	26
Nitrate Nitrogen (mg/l)	0.61	1.03	1.51	0.63	0.77	1.50	0.94	1.20	1.70	0.41	0.80	1.48	26
Total Phosphate Phosphorus (mg/l)	0.00	0.06	0.11	0.00	0.05	0.07	0.08	0.11	0.27	0.05	0.07	0.32	26
Ortho Phosphate Phosphorus (mg/l)	0.00	0.04	0.05	0.00	0.00	0.12	0.00	0.06	0.08	0.04	0.06	0.26	26
Cadmium (mg/l)	0.000	0.000	0.002	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.004	26
Chromium (mg/l)	0.000	0.002	0.004	0.000	0.001	0.007	0.000	0.000	0.003	0.000	0.003	0.046	26
Copper (mg/l)	0.000	0.002	0.003	0.000	0.004	0.010	0.000	0.004	0.012	0.002	0.003	0.058	26
Iron (mg/l)	0.00	0.10	0.40	0.00	0.24	4.52	0.00	0.10	0.58	0.00	0.16	12.90	26
Lead (mg/l)	0.000	0.000	0.004	0.000	0.000	0.019	0.000	0.000	0.012	0.000	0.000	0.193	26
Manganese (mg/l)	0.00	0.00	0.11	0.00	0.07	0.44	0.00	0.00	0.31	0.00	0.00	0.99	26
Nickel (mg/l)	0.000	0.000	0.001	0.000	0.004	0.010	0.000	0.002	0.003	0.000	0.001	0.003	26
Zinc (mg/l)	0.00	0.02	0.04	0.01	0.03	0.13	0.01	0.02	0.07	0.02	0.03	0.57	26
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.3	0.0	0.0	0.0	26
Cyanide, Total (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000	26
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Trichloroethylene (ug/l)	0.0	0.0	3.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	26
Total Coliforms (MF) (c/.1l)	5	2500	6500	160	1100	2300	30	220	2500	600	5550	9900	26
Fecal Coliforms (MF) (c/.1l)	1	22	400	0	46	90	9	110	600	20	140	3360	26
Aluminum (mg/l)	0.00	0.18	0.22	0.10	0.22	2.20	0.00	0.07	0.57	0.00	0.11	4.27	26
Dissolved Aluminum (mg/l)	0.00	0.00	0.00							0.00	0.00	0.00	4
Dissolved Iron (mg/l)	0.00	0.00	0.10							0.00	0.00	0.00	4
Fecal Coliforms (MPN) (c/.1l)	46	350	2400	2	125	540	17	79	1600	43	240	2400	22
Sulfide (mg/l)	0.00	0.28	0.70	0.00	0.00	0.30	0.00	0.10	0.20	0.00	0.25	0.70	26
Total Coliforms (MPN) (c/.1l)	2400	2400	2400	79	1660	5400	49	1200	2400	540	4100	5800	22

Table 3.1-5. New minimum values observed for water quality parameters measured in 1987 at station A11760 on the Delaware River.

Season	Parameter	Value	Date
Dec, Jan, Feb	Turbidity (ntu)	1.5	12/09/87
	Aluminum (mg/l)	0.00	02/11/87
	Dissolved Aluminum (mg/l)	0.00	12/02/87
	Dissolved Iron (mg/l)	0.00	12/02/87
	Fecal Coliforms (MPN) (c/.1l)	46	12/30/87
	Total Coliforms (MPN) (c/.1l)	1600	12/09/87
Mar, Apr, May	Turbidity (ntu)	2.8	03/24/87
	Chloride (mg/l)	0.0	04/08/87
	Sodium (mg/l)	0.00	05/20/87
	Potassium (mg/l)	0.1	05/20/87
	Calcium (mg/l)	0.0	05/20/87
	Magnesium (mg/l)	0.00	05/20/87
	Cadmium (mg/l)	0.000	03/24/87
	Iron (mg/l)	0.00	03/24/87
	Nickel (mg/l)	0.000	03/11/87
	Mercury (ug/l)	0.0	03/11/87
	Aluminum (mg/l)	0.07	04/29/87
	Fecal Coliforms (MF) (c/.1l)	0	03/24/87
	Fecal Coliforms (MPN) (c/.1l)	2	03/24/87
	Total Coliforms (MPN) (c/.1l)	79	03/24/87
Jun, Jul, Aug	Total Alkalinity (mg/l)	9.0	07/15/87
	Turbidity (ntu)	3.4	07/08/87
	Cadmium (mg/l)	0.000	06/03/87
	Iron (mg/l)	0.00	06/03/87
	Nickel (mg/l)	0.000	08/12/87
	Mercury (ug/l)	0.0	06/03/87
	Aluminum (mg/l)	0.00	06/17/87
	Fecal Coliforms (MPN) (c/.1l)	11	08/19/87
	Total Coliforms (MF) (c/.1l)	30	07/01/87
	Total Coliforms (MPN) (c/.1l)	49	07/29/87
Sep, Oct, Nov	Total Alkalinity (mg/l)	0.0	09/09/87
	Turbidity (ntu)	1.5	11/18/87
	Calcium (mg/l)	8.0	09/23/87
	Dissolved Aluminum (mg/l)	0.00	11/18/87
	Dissolved Iron (mg/l)	0.00	11/18/87
	Fecal Coliforms (MPN) (c/.1l)	7	10/14/87
	Total Coliforms (MPN) (c/.1l)	350	11/24/87

Table 3.1-6. New maximum values observed for water quality parameters measured in 1987 at station A11760 on the Delaware River.

Season	Parameter	Value	Date
Dec, Jan, Feb	pH	9.09	02/25/87
	Turbidity (ntu)	10.4	12/02/87
	Potassium (mg/l)	6.2	01/28/87
	Cadmium (mg/l)	0.002	12/02/87
	Nickel (mg/l)	0.003	01/07/87
	Dissolved Aluminum (mg/l)	0.16	12/09/87
	Dissolved Iron (mg/l)	0.30	12/22/87
	Fecal Coliforms (MPN) (c/.1l)	2400	12/02/87
	Total Coliforms (MPN) (c/.1l)	2400	12/02/87
	Trichloroethylene (ug/l)	3.0	02/25/87
Mar, Apr, May	Biochemical Oxygen Demand (mg/l)	9.2	04/22/87
	Total Alkalinity (mg/l)	56.2	05/20/87
	Total Hardness (mg/l)	87.7	05/20/87
	Turbidity (ntu)	25.5	04/08/87
	Nitrite Nitrogen (mg/l)	0.090	05/20/87
	Ortho Phosphate Phosphorus (mg/l)	0.12	05/20/87
	Cadmium (mg/l)	0.001	04/08/87
	Iron (mg/l)	4.52	04/08/87
	Manganese (mg/l)	0.44	04/08/87
	Nickel (mg/l)	0.011	05/27/87
	Mercury (ug/l)	0.4	05/06/87
	Aluminum (mg/l)	2.20	04/08/87
	Fecal Coliforms (MPN) (c/.1l)	920	04/01/87
	Total Coliforms (MPN) (c/.1l)	16000	04/29/87
Jun, Jul, Aug	Total Hardness (mg/l)	121.2	06/17/87
	Turbidity (ntu)	108.0	07/15/87
	Total Dissolved Solids (mg/l)	380	07/01/87
	Potassium (mg/l)	6.6	08/26/87
	Ammonia Nitrogen (mg/l)	0.400	08/12/87
	Nitrite Nitrogen (mg/l)	1.180	06/17/87
	Cadmium (mg/l)	0.001	07/15/87
	Nickel (mg/l)	0.004	06/24/87
	Mercury (ug/l)	0.3	07/15/87
	Aluminum (mg/l)	0.57	07/15/87
	Fecal Coliforms (MPN) (c/.1l)	1600	07/15/87
	Sulfide (mg/l)	0.20	06/03/87
	Total Coliforms (MPN) (c/.1l)	2400	07/15/87
Sep, Oct, Nov	Biochemical Oxygen Demand (mg/l)	35.0	09/09/87
	Turbidity (ntu)	355.0	09/09/87
	Total Suspended Solids (mg/l)	548	09/09/87
	Calcium (mg/l)	41.0	10/21/87
	Ortho Phosphate Phosphorus (mg/l)	0.26	09/09/87
	Cadmium (mg/l)	0.004	09/09/87
	Chromium (mg/l)	0.046	09/09/87
	Copper (mg/l)	0.058	09/09/87
	Iron (mg/l)	12.90	09/09/87
	Lead (mg/l)	0.193	09/09/87
	Manganese (mg/l)	0.99	09/09/87
	Nickel (mg/l)	0.023	09/30/87
	Zinc (mg/l)	0.57	09/09/87
	Aluminum (mg/l)	4.27	09/09/87
	Dissolved Aluminum (mg/l)	0.08	11/18/87
	Dissolved Iron (mg/l)	0.10	11/11/87
	Fecal Coliforms (MPN) (c/.1l)	2400	09/09/87
	Total Coliforms (MPN) (c/.1l)	5800	09/09/87

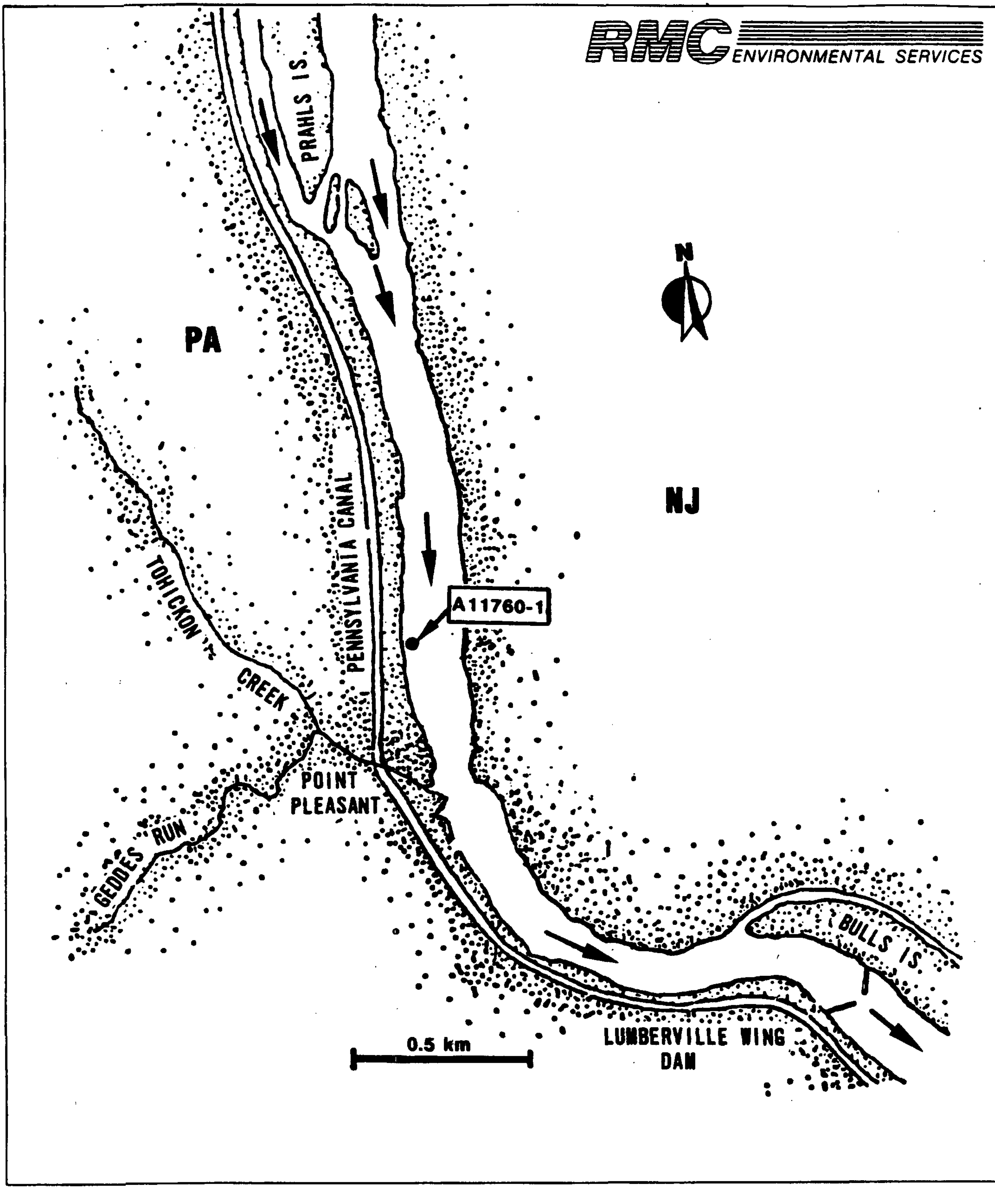

FIGURE 3.1-1 LOCATION OF WATER QUALITY SAMPLE STATIONS ON THE DELAWARE RIVER NEAR POINT PLEASANT, 1987.

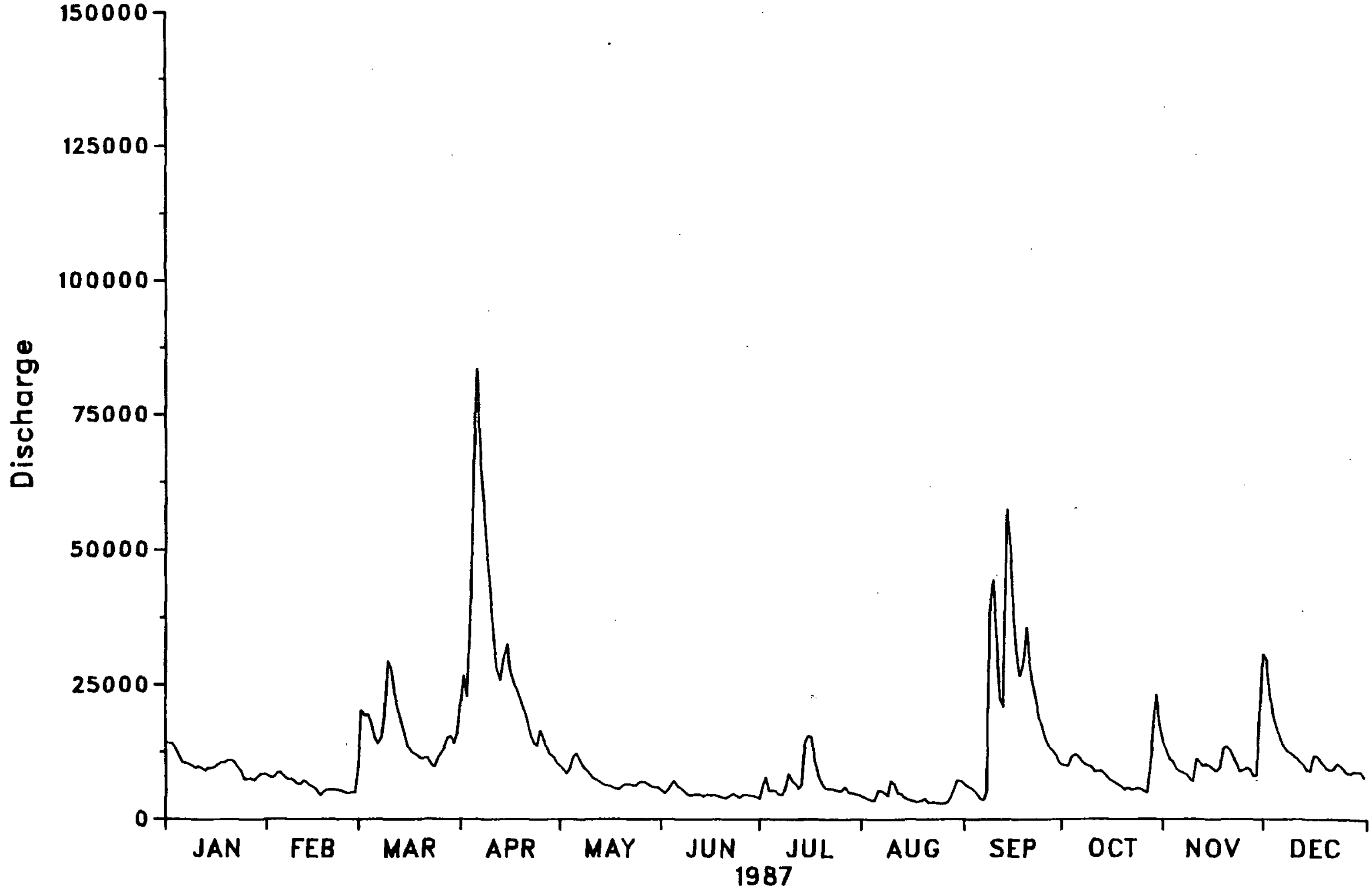

Figure 3.1–2. Delaware River mean daily discharge (cfs) during 1987 (Trenton gage).

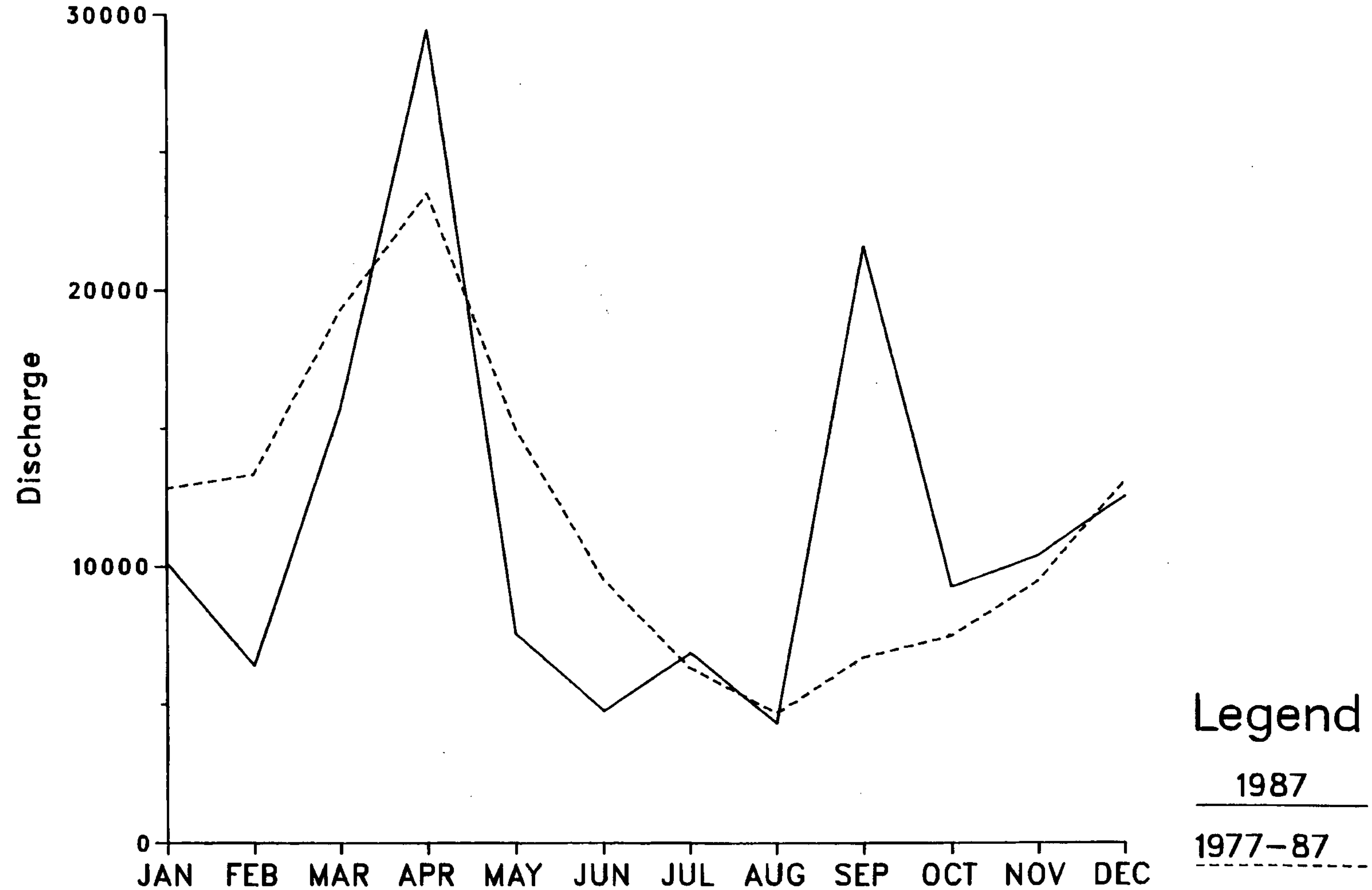

Figure 3.1-3. Delaware River mean monthly discharge (cfs) during 1977-1987 and 1987 (Trenton gage).

4.0 East Branch Perkiomen Creek

East Branch Perkiomen Creek (EBPC) was described in section 4.0 of the 1986 progress report to PECo (RMC Environmental Services 1987a). Upon completion of the Point Pleasant Water Diversion Project, the EBPC will carry 10-65 cfs of Delaware River water over a distance of 37 km from its headwaters northeast of Sellersville, Pennsylvania, to its junction with Perkiomen Creek near Schwenksville.

Studies of water quality, benthic macroinvertebrates, and fish continued in 1987 and are summarized in the following three report sections (4.1 to 4.3, respectively). These studies add to the preoperational baseline of information reported on in earlier progress reports and the EROL. Effects of diversion on the ecology of the EBPC will be assessed by comparing preoperational and postoperational information.

Although the EBPC has not been affected by LGS operation, the discharge structure to the stream was built in 1987. This activity disturbed a small area in the extreme headwaters. Construction activities probably added temporarily to the stream's sediment load. However, much more extensive development in the watershed is presently occurring from Sellersville upstream. In one instance, a landowner near Bucks Road channelized approximately 100 feet of stream, built a gabion dam to partially impound it, and diverted flow into a nearby pond. Increased construction activity through the upper watershed has added noticeably to the amount of sediment accumulating in the upper EBPC.

In 1987 the Pennsylvania Fish Commission stocked the EBPC with trout for the first time in many years. This activity resulted in greatly increased fishing pressure between Sellersville and Branch Road (RMC Environmental Services 1987b). Results of a trout creel survey and evaluation of the potential effects of water diversion on stocked trout were presented to PECo in 1987 as separate reports and are not considered here. However, increased construction activities and trout stocking were noteworthy events that distinguished 1987 from earlier preoperational years. Despite these differences, preliminary evaluations indicated that ecological conditions described in earlier progress reports remained generally similar in 1987. Therefore, the objective of the following three report sections is to briefly summarize the results of 1987 sampling activities.

4.1 Water Quality

Introduction and Methods

East Branch Perkiomen Creek (EBPC) water quality was studied from May 1974 through December 1978 and again from January 1983 through the present. The results of samples collected in 1987 are summarized below. The objectives of this program were to monitor existing water quality conditions on EBPC in order to provide a more extensive database with which to predict and assess changes associated with diversion of water from the Delaware River to this stream for LGS operation, and to provide water quality information for concurrent aquatic ecological studies.

As in previous years, three sample stations were located within the study area which extended from the upper reach near Branch Road bridge to near the confluence with Perkiomen Creek (Fig. 4.1-1). Station E32300 is immediately downstream of Branch Road and about 4.7 km downstream from the proposed diversion outfall location. Station E22880 is downstream of Cathill Road and 3.2 km downstream of the Pennridge Wastewater Treatment Plant. E2800 is upstream of Garges Road.

Sampling began on 14 January and all stations were sampled once every 2 weeks. All samples were collected as subsurface grab samples and were analyzed according to standard, widely accepted methods.

In 1986, sampling was initiated for aluminum and resumed for cadmium, nickel, mercury, and total dissolved solids. In 1987 sampling was initiated for dissolved aluminum and dissolved iron at Station E32300.

Results and Discussion

Low steady flows interrupted by a few high flow events characterized the period of January through early May 1987 (Table 4.1-1 and Fig. 4.1-2). Flow was extremely low, but steady from mid-May through late October. Steady flows and several high flow events occurred from late October through December. Since the U.S.G.S. began monitoring EBPC discharge at Bucks Road in October 1983, the period of record (October 1983-December 1987) is short, and daily as well as monthly minimum and maximum flows were established in 1987 for the month of March.

Mean monthly flows in 1987 were greater than mean monthly flows for the period of record only in January, March, and April (Table 4.1-2 and Fig. 4.1-3). Median monthly flows in 1987 were greater than median monthly flow for the period of record in January, April, September, and October. Comparison of mean monthly flow to the 1986 flow data indicates that the mean monthly flow in 1987 exceeded the 1986 values for the months of March-May, July, September, and October.

Stream flow measured at Bucks Road is only reflective of headwater conditions above Sellersville. Flow downstream of Sellersville is augmented by discharge from the Pennridge Wastewater Treatment Plant, below which permanent flow exists. However, the pattern of flow in the lower EBPC followed that exhibited in the headwaters.

Almost all of the parameters measured in this study are conservative with respect to flow. The majority of the new minimum values were observed during periods of high flow while many new maximum values were observed during periods of low flow.

E32300

Seasonal summaries of water quality data for this headwater station for 1983-1987 are presented in Table 4.1-3 and for the year 1987 in Table 4.1-4. New minimum and maximum values are presented in Tables 4.1-5 and 4.1-6, respectively. Some of the new minimum and maximum values reflect in part the beginning of analysis for dissolved iron and dissolved aluminum in 1987 as well as the short period of analysis for aluminum (1986-1987), nickel, cadmium, and mercury.

In the winter quarter new maxima were observed for fourteen parameters. The maxima for cadmium, nickel, aluminum, dissolved iron, dissolved aluminum, sulfide, and trichloroethylene represent the first detection of these compounds during the quarter. The rest of the maxima for which the record is greater than one year did not display significant departures from the previous maximum values.

Five first detections (cadmium, nickel, mercury, aluminum, and trichloroethylene) accounted for half of the spring quarter maxima. The remaining new maxima did not represent any significant departures from previous maxima.

The summer quarter was characterized by extended periods of low to very low flow which is reflected in seventeen new maximum values. Of these, cadmium, nickel, mercury, and aluminum represent first detection values. Seven of the new maximum values (chloride, cadmium, chromium, copper, iron, lead, and manganese) were observed in a single sample on 26 August. Although not a new maximum value, the total suspended solids in the 26 August sample was the maximum value for the quarter as well as the year of 1987. This indicates a very turbid sample and may account for the elevated total metal concentrations. High turbidity was apparently due to a recent channel modification performed by a landowner a short distance upstream which resulted in a large increase in sediment load. The chloride maximum on the same day may be explained by very low flow conditions. Of the new metal maxima the values for copper, lead, manganese, and zinc depart by at least one order of magnitude from previous maximum values. The new temperature maximum was 3 C higher than the previous value which could be a function of sustained very low flow conditions.

Seventeen new maximum values were established in the fall quarter. Four of the new values (cadmium, nickel, dissolved iron, and dissolved aluminum) represent first detections. Three sample dates accounted for fourteen of the new values, 9 September (five maxima), 7 October (four maxima), and 21 October (five maxima). Three of the new maxima, biochemical oxygen demand (BOD), total suspended solids, and total dissolved solids represented significant change from the previous values. BOD increased by a factor of 6, total suspended solids by 4, and total dissolved solids by a factor of 0.5. The new maximum for BOD was associated with high flow on 9 September. The maxima for total suspended solids observed on 26 August and total dissolved solids observed on 1 July were not associated with high flow conditions. The results could reflect possible stream disturbances upstream of the sampling point.

E22880

Seasonal summaries of water quality data obtained for this station for 1983-1987 are shown in Table 4.1-7 and the 1987 data are shown in Table 4.1-8. New minima and new maxima are presented in Tables 4.1-9 and 4.1-10, respectively.

Five new maximum values were established in the winter quarter with sulfide detected for the first time. The remaining parameters (cadmium, nickel, chemical oxygen demand, and trichloroethylene) did not increase to any significant extent.

Four of the eleven new maxima in the spring quarter represent the first detection of cadmium, nickel, mercury, and aluminum. Five of the maxima (potassium, total phosphate phosphorus, ortho phosphate phosphorus, nickel, and trichloroethylene) were detected in the 24 March sample which was collected during a period of low flow. None of the maxima represent any significant increases from the previous value.

The summer quarter maxima included the first detection of aluminum, cadmium, mercury, and nickel. Total dissolved solids and chloride maxima were both more than double the previous maxima. Both samples were collected at extremely low flow. The remaining new maxima did not represent a significant increase above previous maximum values.

Three new maxima were established in the fall representing minor increases to the previous values. The parameters having new maximum values were total suspended solids, manganese, and chemical oxygen demand.

E2800

Seasonal summaries of water quality data obtained for the most downstream station for 1983 through 1987 are presented in Table 4.1-11 while the 1987 data are presented in Table 4.1-12. New minima and maxima are presented in Tables 4.1-13 and 4.1-14, respectively. The new maximum pH values in the spring and summer quarters exceeded the state water quality standard of 9.0 units.

Two first detections for cadmium and trichloroethylene and a slightly increased value for the total dissolved solids were the three new maxima established in the winter quarter.

The spring quarter established fourteen new maxima. Eleven of the new values were observed on two days (24 March and 20 May) when flow was reduced. Five first detections in the quarter established new maxima for aluminum, cadmium, mercury, nickel, and trichloroethylene. None of the remaining maxima represent any significant increase over the previous values.

First detection of the metals aluminum, cadmium, mercury, and nickel were among the new maxima established during the summer quarter. Eight maxima in addition to the previously mentioned metals were established. Two of the eight maxima represent significant increases in concentration. These were an approximate doubling of the chloride maximum and an increase of nitrite nitrogen by a factor of 15. The new nitrite maximum represents the highest concentration of nitrite observed on the East Branch for any station in any season.

All new maxima in the fall quarter were observed on 9 September. The new nickel maximum of 9.4 mg/l may be the result of a procedural error, since the next highest concentration measured at that station was only 0.01 mg/l. For this reason, the value of 9.4 mg/l is reported here but will subsequently be deleted from the database. In addition, new maxima were established for ammonia and nitrite nitrogen as well as total and ortho phosphate phosphorus. Both total and ortho phospate maxima increased by a factor of 2. The nitrite nitrogen had a minimal increase while the ammonia nitrogen maximum increased approximately nine times. The increased nitrogen and phosphate concentrations observed on 9 September suggests the possibility of some localized input.

Table 4.1-1. Mean daily East Branch Perkiomen Creek discharge (ft^3/sec) measured at the Bucks Road US Geological Survey gage in 1987.

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	2.40	2.90	118.00	6.60	2.20	0.52	0.08	0.08	N/A	0.14	1.10	13.00
02	9.70	4.00	46.00	3.40	1.90	0.61	0.10	0.11	N/A	0.17	1.00	6.30
03	10.00	13.00	22.00	2.60	2.10	0.31	0.24	0.10	0.06	0.98	0.96	4.30
04	6.60	18.00	12.00	142.00	11.00	0.27	0.10	0.07	0.05	2.80	0.93	4.10
05	4.20	10.00	8.00	22.00	9.10	0.43	0.12	0.08	0.04	0.97	0.85	3.10
06	3.20	7.30	7.30	58.00	6.30	0.25	0.13	0.12	0.06	0.61	0.69	2.50
07	3.10	10.00	7.90	19.00	3.50	0.19	0.15	0.10	0.10	1.90	0.63	2.10
08	3.20	9.60	6.80	9.70	2.50	0.17	0.19	0.10	0.16	2.10	0.57	1.90
09	2.90	6.70	5.30	5.70	1.90	0.25	4.80	0.10	0.26	1.30	0.59	1.90
10	5.70	4.20	3.30	4.10	1.50	0.15	1.40	0.10	0.20	0.51	16.00	1.80
11	14.00	3.80	2.50	3.20	1.20	0.11	0.46	0.09	0.13	0.54	31.00	1.80
12	7.50	4.00	2.50	3.00	1.00	0.10	0.32	0.08	0.09	0.57	15.00	1.70
13	9.30	3.00	2.40	4.70	0.79	0.10	0.28	0.07	0.59	0.47	12.00	1.40
14	11.00	2.60	2.00	3.00	0.68	0.05	0.40	0.07	0.41	0.41	6.30	1.20
15	18.00	2.00	1.80	2.50	1.10	0.06	0.64	0.07	0.17	0.43	3.90	13.00
16	8.30	2.10	1.60	2.20	0.87	0.06	0.26	0.07	0.18	0.40	3.00	11.00
17	4.30	1.70	1.40	9.60	0.63	0.05	0.26	0.07	0.33	0.36	2.70	4.50
18	12.00	1.70	1.30	8.00	0.54	0.05	0.23	0.06	1.90	0.38	2.80	3.00
19	33.00	1.60	1.20	4.90	0.53	0.05	0.16	N/A	0.81	0.30	2.20	2.50
20	17.00	1.50	1.30	3.50	1.00	0.05	0.10	N/A	0.54	0.33	2.00	7.00
21	9.90	1.60	1.40	2.90	0.98	0.06	0.06	N/A	0.39	0.54	1.60	5.70
22	6.00	2.10	1.10	2.20	0.63	0.51	0.08	N/A	0.34	0.44	1.30	3.60
23	7.80	3.10	0.92	1.90	0.61	0.92	0.09	N/A	0.30	0.43	1.20	3.20
24	8.10	3.20	0.86	12.00	0.58	0.29	0.09	N/A	0.26	0.43	1.30	2.50
25	11.00	3.20	0.82	31.00	0.44	0.18	0.08	N/A	0.21	0.52	1.20	2.60
26	7.80	3.70	0.82	7.00	0.42	0.15	0.09	N/A	0.20	0.54	1.20	4.20
27	6.20	3.90	0.76	4.20	0.38	0.12	0.09	0.07	0.18	1.00	1.10	3.10
28	5.30	6.50	0.97	4.50	0.39	0.15	0.07	0.11	0.20	11.00	1.10	2.90
29	4.50		0.92	5.70	0.33	0.06	0.08	N/A	0.20	2.50	19.00	2.50
30	3.90		1.10	3.20	0.46	0.07	0.09	N/A	0.19	1.70	86.00	1.70
31	3.60		15.00		0.58		0.09	N/A		1.30		1.40
Minimum	2.40	1.50	0.76	1.90	0.33	0.05	0.06	0.06	0.04	0.14	0.57	1.20
Mean	8.37	4.89	9.01	13.08	1.81	0.21	0.37	0.09	0.31	1.16	7.31	3.92
Median	7.50	3.45	1.80	4.60	0.87	0.15	0.12	0.08	0.20	0.54	1.30	2.90
Maximum	33.00	18.00	118.00	142.00	11.00	0.92	4.80	0.12	1.90	11.00	86.00	13.00

Table 4.1-2. Mean monthly East Branch Perkiomen Creek discharge (ft^3/sec) measured at the Bucks Road US Geological Survey gage, 1983 - 1987.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1983										6.48	13.29	20.91
1984	4.45	19.08	15.73	17.25	20.97	4.72	20.89	0.87	0.19	1.01	1.92	5.81
1985	2.61	11.77	2.21	0.91	3.40	1.24	0.13	0.09	12.95	3.02	14.53	5.01
1986	9.92	15.40	8.83	8.97	0.40	0.25	0.22	0.38	0.03	0.14	10.80	15.33
1987	8.37	4.89	9.01	13.08	1.81	0.21	0.37	0.09	0.31	1.16	7.31	3.92
Minimum	0.42	0.34	0.76	0.36	0.07	0.00	0.00	0.00	0.00	0.06	0.10	0.41
Mean	6.35	12.84	8.94	10.05	6.65	1.61	5.40	0.38	3.42	2.05	9.57	10.20
Median	2.30	4.60	2.50	2.80	0.96	0.29	0.11	0.13	0.06	0.43	1.70	3.60
Maximum	143.00	177.00	118.00	278.00	172.00	70.00	313.00	7.30	372.00	61.00	100.00	169.00

Table 4.1-3, Summary of East Branch Perkiomen Creek water quality at Station E32300, 30 March 1983 through 30 December 1987.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	-1.0	1.0	8.5	1.0	9.5	22.0	17.0	22.0	29.0	3.0	12.3	22.0	149
Dissolved Oxygen (mg/l)	10.6	11.8	17.4	6.1	12.0	15.1	3.8	7.7	9.9	3.4	9.4	11.6	112
Biochemical Oxygen Demand (mg/l)	0.0	1.5	7.2	0.2	1.4	4.6	0.2	1.9	4.8	0.0	1.4	34.0	116
Chemical Oxygen Demand (mg/l)	0.0	10.9	65.7	0.0	10.6	41.1	0.0	16.1	223.0	0.0	17.4	36.6	117
Total Organic Carbon (mg/l)	0.0	2.5	25.8	0.0	3.2	13.3	0.9	4.4	111.8	1.7	4.4	27.8	113
pH	6.86	7.28	7.82	6.33	7.57	8.58	7.04	7.71	8.43	7.12	7.62	8.08	117
Total Alkalinity (mg/l)	0.0	30.9	83.6	14.6	39.0	84.1	0.0	65.8	106.8	16.4	73.2	125.6	117
Total Hardness (mg/l)	32.0	69.4	110.0	12.7	67.0	114.6	47.1	88.0	188.7	61.5	100.9	166.9	117
Specific Conductance (usm/cm)	121	189	281	105	181	274	142	247	577	176	267	362	117
Total Suspended Solids (mg/l)	0	8	431	0	4	73	0	9	331	0	4	85	118
Total Dissolved Solids (mg/l)	26	122	204	94	136	252	111	192	2030	84	172	376	118
Dissolved Silica (mg/l)	2.44	3.39	4.21	0.67	3.18	3.92	0.87	2.37	4.41	0.48	0.93	4.24	40
Total Inorganic Carbon (mg/l)	23.1	29.1	35.1	27.2	31.1	59.0	0.0	51.2	75.4	20.9	51.2	77.2	20
Chloride (mg/l)	10.0	20.1	43.2	0.0	16.1	25.8	7.4	24.3	36.0	12.0	24.8	40.9	117
Sulfate (mg/l)	16.1	27.4	40.6	15.1	26.5	37.5	16.3	29.3	93.3	16.6	33.3	77.7	117
Sodium (mg/l)	6.25	11.20	18.00	6.58	11.50	14.40	5.74	13.31	20.60	8.80	14.09	22.60	117
Potassium (mg/l)	1.5	2.1	7.1	1.4	2.0	3.2	1.5	3.2	10.0	2.3	3.7	7.9	117
Calcium (mg/l)	5.8	14.8	28.5	5.7	14.7	25.0	7.0	18.9	31.6	8.2	23.5	38.7	117
Magnesium (mg/l)	5.25	8.63	15.51	4.46	9.11	14.19	7.20	12.30	17.00	8.26	13.43	21.80	117
Ammonia Nitrogen (mg/l)	0.000	0.000	0.246	0.000	0.033	0.068	0.000	0.043	0.175	0.000	0.000	0.061	117
Nitrite Nitrogen (mg/l)	0.000	0.006	0.030	0.000	0.012	0.076	0.000	0.000	0.135	0.000	0.000	0.033	117
Nitrate Nitrogen (mg/l)	0.00	2.30	3.31	0.00	1.35	2.46	0.00	0.00	2.06	0.00	0.31	3.88	117
Total Phosphate Phosphorus (mg/l)	0.00	0.05	0.35	0.00	0.03	0.07	0.00	0.04	0.26	0.00	0.04	0.19	114
Ortho Phosphate Phosphorus (mg/l)	0.00	0.02	0.12	0.00	0.01	0.08	0.00	0.01	0.26	0.00	0.00	0.07	115
Cadmium (mg/l)	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	74
Chromium (mg/l)	0.000	0.003	0.014	0.000	0.004	0.010	0.000	0.004	0.080	0.000	0.003	0.010	117
Copper (mg/l)	0.000	0.002	0.018	0.000	0.002	0.220	0.000	0.003	0.320	0.001	0.002	0.015	117
Iron (mg/l)	0.00	0.26	8.77	0.00	0.19	1.56	0.00	0.26	19.00	0.00	0.14	2.83	158
Lead (mg/l)	0.000	0.000	0.008	0.000	0.000	0.014	0.000	0.001	0.950	0.000	0.000	0.012	117
Manganese (mg/l)	0.00	0.00	0.38	0.00	0.00	0.10	0.00	0.07	0.44	0.00	0.00	0.36	117
Nickel (mg/l)	0.000	0.000	0.006	0.000	0.000	0.010	0.000	0.002	0.160	0.000	0.000	0.004	73
Zinc (mg/l)	0.00	0.01	0.25	0.00	0.00	0.06	0.00	0.01	4.15	0.00	0.01	0.05	159
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	74
Cyanide, Total (mg/l)	0.000	0.000	0.002	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.002	117
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.191	0.000	0.000	0.000	117
Trichloroethylene (ug/l)	0.0	0.0	2.6	0.0	0.0	13.9	0.0	0.0	6.5	0.0	0.0	4.8	115
Total Coliforms (MF) (c/.1l)	0	550	10500	10	480	9000	200	1750	60000	60	1000	16000	128
Fecal Coliforms (MF) (c/.1l)	0	84	3100	0	91	2900	20	305	17550	18	220	7200	127
Aluminum (mg/l)	0.00	0.24	1.82	0.09	0.21	0.55	0.00	0.13	3.90	0.00	0.00	1.64	74
Dissolved Aluminum (mg/l)	0.00	0.00	0.24							0.00	0.00	0.01	6
Dissolved Iron (mg/l)	0.00	0.00	0.36							0.00	0.00	0.00	5
Sulfide (mg/l)	0.00	0.00	1.00	0.00	0.00	0.82	0.00	0.25	0.70	0.00	0.40	1.10	57

Table 4.1-4. Summary of East Branch Perkiomen Creek water quality at Station E32300, 7 January 1987 through 30 December 1987.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	0.0	1.0	6.0	1.0	9.5	19.0	20.0	24.0	29.0	3.0	13.0	22.0	49
Dissolved Oxygen (mg/l)	10.6	13.0	17.4	8.8	11.6	13.3	4.5	8.1	9.2	6.3	10.1	11.5	23
Biochemical Oxygen Demand (mg/l)	0.7	1.3	3.6	0.2	2.2	3.1	1.0	2.5	4.8	1.3	2.2	34.0	26
Chemical Oxygen Demand (mg/l)	0.0	0.0	22.0	0.0	5.2	17.5	0.0	0.0	16.7	0.0	10.0	25.3	26
Total Organic Carbon (mg/l)	2.2	2.5	6.5	2.6	3.1	3.6	3.7	3.9	4.3	3.0	4.4	5.3	26
pH	7.10	7.44	7.77	7.40	7.70	8.58	7.63	7.80	8.29	7.29	7.63	7.90	26
Total Alkalinity (mg/l)	20.7	32.6	44.0	31.8	42.4	73.8	58.0	93.0	106.8	30.8	76.8	91.7	26
Total Hardness (mg/l)	63.0	79.7	110.0	57.1	70.8	114.6	108.2	138.2	154.0	107.0	134.0	151.0	26
Specific Conductance (usm/cm)	180	213	281	169	199	274	255	313	342	233	286	357	26
Total Suspended Solids (mg/l)	0	7	121	0	1	7	0	8	109	2	12	85	27
Total Dissolved Solids (mg/l)	51	131	204	126	146	198	186	225	2030	156	235	376	27
Chloride (mg/l)	16.9	20.1	43.2	0.0	16.2	23.2	24.5	28.1	36.0	27.8	37.1	40.9	26
Sulfate (mg/l)	22.7	26.2	40.6	15.7	26.1	27.8	19.1	29.2	38.8	26.4	31.8	33.9	26
Sodium (mg/l)	9.80	12.60	18.00	10.20	11.45	13.30	12.80	15.20	18.00	13.90	18.55	22.60	26
Potassium (mg/l)	1.5	3.0	4.8	1.5	2.0	2.9	1.5	3.6	10.0	2.6	4.6	6.5	26
Calcium (mg/l)	10.6	15.2	19.1	9.4	16.9	20.0	12.8	22.8	29.9	16.4	24.9	32.3	26
Magnesium (mg/l)	7.80	8.98	12.30	7.12	9.66	11.80	8.90	14.10	17.00	9.80	13.00	19.40	26
Ammonia Nitrogen (mg/l)	0.000	0.000	0.051	0.000	0.042	0.065	0.000	0.000	0.130	0.000	0.000	0.000	26
Nitrite Nitrogen (mg/l)	0.000	0.000	0.023	0.000	0.022	0.033	0.000	0.000	0.030	0.000	0.014	0.033	26
Nitrate Nitrogen (mg/l)	0.00	2.25	2.90	0.70	1.08	2.29	0.00	0.00	1.34	0.00	0.77	2.11	26
Total Phosphate Phosphorus (mg/l)	0.00	0.02	0.09	0.00	0.00	0.07	0.03	0.05	0.17	0.00	0.05	0.12	26
Ortho Phosphate Phosphorus (mg/l)	0.00	0.00	0.06	0.00	0.00	0.08	0.00	0.00	0.07	0.00	0.02	0.07	26
Cadmium (mg/l)	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	52
Chromium (mg/l)	0.000	0.002	0.003	0.000	0.000	0.008	0.000	0.002	0.080	0.000	0.003	0.010	26
Copper (mg/l)	0.000	0.001	0.003	0.000	0.003	0.008	0.001	0.004	0.320	0.002	0.003	0.015	26
Iron (mg/l)	0.00	0.20	2.87	0.00	0.15	0.37	0.00	0.20	19.00	0.00	0.17	2.83	53
Lead (mg/l)	0.000	0.000	0.004	0.000	0.000	0.002	0.001	0.003	0.950	0.000	0.002	0.012	26
Manganese (mg/l)	0.00	0.00	0.10	0.00	0.00	0.10	0.00	0.10	0.44	0.00	0.00	0.36	26
Nickel (mg/l)	0.000	0.000	0.006	0.000	0.000	0.010	0.000	0.002	0.160	0.000	0.000	0.004	51
Zinc (mg/l)	0.00	0.01	0.06	0.00	0.02	0.03	0.00	0.02	4.15	0.00	0.01	0.05	52
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	52
Cyanide, Total (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Trichloroethylene (ug/l)	0.0	0.0	2.6	0.0	0.0	13.9	0.0	0.0	0.0	0.0	0.0	-0.0	26
Total Coliforms (MF) (c/.1l)	100	800	4900	15	455	6200	200	1450	8000	70	1000	7100	40
Fecal Coliforms (MF) (c/.1l)	11	130	1150	0	131	600	20	190	6000	20	170	2010	39
Aluminum (mg/l)	0.00	0.20	1.82	0.09	0.21	0.55	0.00	0.13	3.90	0.00	0.10	1.33	52
Dissolved Aluminum (mg/l)	0.00	0.00	0.24							0.00	0.00	0.01	6
Dissolved Iron (mg/l)	0.00	0.00	0.36							0.00	0.00	0.00	5
Sulfide (mg/l)	0.00	0.38	1.00	0.00	0.00	0.10	0.00	0.40	0.70	0.20	0.40	1.00	26

Table 4.1-5. New minimum values observed for water quality parameters measured in 1987 at station E32300 on the East Branch Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Nitrate Nitrogen (mg/l)	0.00	02/11/87
	Chromium (mg/l)	0.000	02/25/87
	Dissolved Aluminum (mg/l)	0.00	12/09/87
	Dissolved Iron (mg/l)	0.00	12/09/87
Mar, Apr, May	Biochemical Oxygen Demand (mg/l)	0.2	04/08/87
	Chloride (mg/l)	0.0	04/22/87
	Cadmium (mg/l)	0.000	03/11/87
	Chromium (mg/l)	0.000	03/11/87
	Nickel (mg/l)	0.000	03/11/87
	Mercury (ug/l)	0.0	03/11/87
	Aluminum (mg/l)	0.09	04/22/87
	Fecal Coliforms (MF) (c/.1l)	0	03/24/87
Jun, Jul, Aug	Potassium (mg/l)	1.5	08/12/87
	Cadmium (mg/l)	0.000	06/03/87
	Iron (mg/l)	0.00	06/17/87
	Nickel (mg/l)	0.000	07/15/87
	Mercury (ug/l)	0.0	06/03/87
	Aluminum (mg/l)	0.00	06/17/87
	Fecal Coliforms (MF) (c/.1l)	20	08/05/87
	Total Coliforms (MF) (c/.1l)	200	06/03/87
Sep, Oct, Nov	Temperature (C)	3.0	11/11/87
	Dissolved Aluminum (mg/l)	0.00	11/11/87
	Dissolved Iron (mg/l)	0.00	11/11/87

Table 4.1-6. New maximum values observed for water quality parameters measured in 1987 at station E32300 on the East Branch Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Dissolved Oxygen (mg/l)	17.4	02/25/87
	Total Hardness (mg/l)	110.0	12/30/87
	Specific Conductance (usm/cm)	281	02/25/87
	Total Dissolved Solids (mg/l)	204	02/25/87
	Chloride (mg/l)	43.2	02/25/87
	Sulfate (mg/l)	40.6	12/30/87
	Sodium (mg/l)	18.00	02/25/87
	Cadmium (mg/l)	0.002	12/02/87
	Nickel (mg/l)	0.006	12/02/87
	Aluminum (mg/l)	1.82	01/19/87
	Dissolved Aluminum (mg/l)	0.24	01/19/87
	Dissolved Iron (mg/l)	0.36	01/19/87
	Sulfide (mg/l)	1.00	12/16/87
	Trichloroethylene (ug/l)	2.6	02/25/87
Mar, Apr, May	pH	8.58	03/24/87
	Total Hardness (mg/l)	114.6	05/20/87
	Specific Conductance (usm/cm)	274	05/20/87
	Ortho Phosphate Phosphorus (mg/l)	0.08	05/20/87
	Cadmium (mg/l)	0.000	05/20/87
	Manganese (mg/l)	0.10	04/22/87
	Nickel (mg/l)	0.010	05/20/87
	Mercury (ug/l)	0.3	05/06/87
	Aluminum (mg/l)	0.55	04/08/87
	Trichloroethylene (ug/l)	13.9	04/08/87
Jun, Jul, Aug	Temperature (C)	29.0	07/22/87
	Biochemical Oxygen Demand (mg/l)	4.8	06/03/87
	Total Alkalinity (mg/l)	106.8	08/12/87
	Total Dissolved Solids (mg/l)	2030	07/01/87
	Chloride (mg/l)	36.0	08/26/87
	Potassium (mg/l)	10.0	07/29/87
	Magnesium (mg/l)	17.00	06/17/87
	Cadmium (mg/l)	0.001	08/26/87
	Chromium (mg/l)	0.080	08/26/87
	Copper (mg/l)	0.320	08/26/87
	Iron (mg/l)	19.00	08/26/87
	Lead (mg/l)	0.950	08/26/87
	Manganese (mg/l)	0.44	08/26/87
	Nickel (mg/l)	0.160	08/26/87
	Zinc (mg/l)	4.15	08/05/87
	Mercury (ug/l)	0.0	06/03/87
	Aluminum (mg/l)	3.90	08/05/87
Sep, Oct, Nov	Biochemical Oxygen Demand (mg/l)	34.0	09/09/87
	Total Suspended Solids (mg/l)	85	10/21/87
	Total Dissolved Solids (mg/l)	376	10/21/87
	Chloride (mg/l)	40.9	09/09/87
	Sodium (mg/l)	22.60	09/09/87
	Nitrite Nitrogen (mg/l)	0.033	10/07/87
	Ortho Phosphate Phosphorus (mg/l)	0.07	10/07/87
	Cadmium (mg/l)	0.000	10/07/87
	Chromium (mg/l)	0.010	09/09/87
	Copper (mg/l)	0.015	09/09/87
	Iron (mg/l)	2.83	10/21/87
	Lead (mg/l)	0.012	09/23/87
	Manganese (mg/l)	0.36	10/21/87
	Nickel (mg/l)	0.004	10/07/87
	Zinc (mg/l)	0.05	10/21/87
	Dissolved Aluminum (mg/l)	0.01	10/14/87
	Dissolved Iron (mg/l)	0.00	11/11/87

Table 4.1-7. Summary of East Branch Perkiomen Creek water quality at Station E22880, 30 March 1983 through 30 December 1987.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	-1.0	2.0	8.5	1.0	10.0	20.0	18.0	21.0	25.0	3.0	13.0	22.0	118
Dissolved Oxygen (mg/l)	8.3	11.4	14.0	6.3	10.3	13.2	4.9	7.4	11.9	5.8	8.7	11.9	120
Biochemical Oxygen Demand (mg/l)	0.1	1.6	7.1	0.3	1.3	8.1	0.5	1.4	7.6	0.1	1.7	6.7	125
Chemical Oxygen Demand (mg/l)	0.0	13.0	35.0	0.0	14.4	31.7	0.0	15.0	39.3	0.0	17.5	50.7	125
Total Organic Carbon (mg/l)	0.0	3.7	19.1	0.0	3.6	14.7	0.0	4.9	18.5	0.0	5.7	24.3	121
pH	6.94	7.46	8.06	6.53	7.58	8.25	7.00	7.63	8.42	6.64	7.64	8.08	125
Total Alkalinity (mg/l)	12.6	49.1	99.6	14.6	47.0	83.2	40.1	73.8	101.2	22.0	74.8	126.5	125
Total Hardness (mg/l)	51.6	92.8	184.5	22.8	94.0	184.6	70.9	160.0	305.0	75.3	163.4	363.2	125
Specific Conductance (usm/cm)	157	283	576	148	292	696	174	620	1060	211	551	1158	125
Total Suspended Solids (mg/l)	0	8	429	0	7	99	0	7	55	0	4	45	125
Total Dissolved Solids (mg/l)	93	190	352	43	194	385	165	445	1650	154	394	754	125
Dissolved Silica (mg/l)	2.91	3.99	4.72	1.96	3.41	4.03	2.06	3.50	5.37	3.17	5.00	6.42	48
Total Inorganic Carbon (mg/l)	20.0	33.2	46.3	39.3	42.9	73.0	56.9	65.3	91.4	43.4	57.4	81.9	20
Chloride (mg/l)	13.7	38.6	110.4	10.1	38.4	117.4	9.9	102.2	440.7	21.3	87.5	226.1	125
Sulfate (mg/l)	16.6	37.1	80.9	18.1	38.0	97.6	19.1	66.5	132.0	22.9	71.2	298.2	125
Sodium (mg/l)	9.01	23.47	71.48	9.78	23.76	76.40	9.37	67.90	130.00	14.60	63.20	157.84	125
Potassium (mg/l)	1.9	4.0	9.9	1.8	3.3	8.7	2.4	7.1	18.1	3.3	7.5	31.7	125
Calcium (mg/l)	10.1	22.1	41.1	8.1	23.7	51.4	12.0	36.7	69.9	16.0	35.8	80.3	125
Magnesium (mg/l)	6.32	11.49	19.95	5.46	11.55	20.13	8.52	16.44	25.10	8.98	17.33	27.05	125
Ammonia Nitrogen (mg/l)	0.000	0.070	2.092	0.000	0.065	1.210	0.000	0.050	0.136	0.000	0.043	0.900	125
Nitrite Nitrogen (mg/l)	0.000	0.019	0.737	0.007	0.029	0.158	0.000	0.034	0.233	0.000	0.036	0.176	125
Nitrate Nitrogen (mg/l)	1.65	3.35	9.23	1.14	2.84	7.82	1.65	7.06	27.20	2.02	5.19	29.70	125
Total Phosphate Phosphorus (mg/l)	0.02	0.26	1.40	0.00	0.07	0.74	0.04	0.09	0.30	0.00	0.11	0.28	122
Ortho Phosphate Phosphorus (mg/l)	0.02	0.16	1.20	0.00	0.04	0.40	0.00	0.06	0.29	0.01	0.08	1.01	123
Cadmium (mg/l)	0.000	0.001	0.003	0.000	0.000	0.001	0.000	0.001	0.006	0.000	0.001	0.007	32
Chromium (mg/l)	0.003	0.010	0.100	0.002	0.008	0.035	0.001	0.008	0.193	0.000	0.009	0.120	125
Copper (mg/l)	0.004	0.006	0.038	0.003	0.010	0.030	0.000	0.018	0.110	0.003	0.013	0.059	125
Iron (mg/l)	0.00	0.23	9.54	0.00	0.24	2.50	0.00	0.24	0.86	0.00	0.21	2.83	125
Lead (mg/l)	0.000	0.000	0.015	0.000	0.000	0.007	0.000	0.000	0.010	0.000	0.001	0.004	125
Manganese (mg/l)	0.00	0.05	0.32	0.00	0.00	0.13	0.00	0.00	0.31	0.00	0.06	0.26	125
Nickel (mg/l)	0.001	0.002	0.014	0.000	0.007	0.010	0.004	0.012	0.024	0.002	0.009	0.038	32
Zinc (mg/l)	0.00	0.02	0.12	0.00	0.02	0.11	0.00	0.03	0.58	0.00	0.04	0.09	125
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	32
Cyanide, Total (mg/l)	0.000	0.000	0.016	0.000	0.000	0.007	0.000	0.000	0.003	0.000	0.001	0.011	125
Phenols (mg/l)	0.000	0.000	0.029	0.000	0.000	0.005	0.000	0.000	0.039	0.000	0.000	0.000	125
Trichloroethylene (ug/l)	0.0	0.0	4.3	0.0	0.0	12.9	0.0	0.0	8.3	0.0	0.0	5.2	124
Total Coliforms (MF) (c/.1l)	0	210	5100	21	435	10500	120	2600	97000	50	2300	27000	123
Fecal Coliforms (MF) (c/.1l)	0	12	1800	0	70	6100	70	495	15000	0	285	4700	124
Aluminum (mg/l)	0.13	0.22	1.60	0.03	0.17	0.63	0.00	0.05	0.87	0.00	0.00	2.12	32
Sulfide (mg/l)	0.00	0.00	1.20	0.00	0.00	0.98	0.00	0.00	0.70	0.00	0.25	1.40	57

Table 4.1-8. Summary of East Branch Perkiomen Creek water quality at Station E22880, 14 January 1987 through 30 December 1987.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	0.0	3.0	7.0	4.0	10.0	16.5	19.0	22.0	23.0	11.5	12.8	22.0	26
Dissolved Oxygen (mg/l)	10.0	11.2	13.2	9.1	11.3	12.1	6.4	8.6	11.9	7.9	8.6	9.8	24
Biochemical Oxygen Demand (mg/l)	0.4	2.1	4.4	0.7	2.3	2.8	0.9	2.1	4.2	1.0	2.2	5.0	26
Chemical Oxygen Demand (mg/l)	0.0	10.4	35.0	0.0	11.5	21.7	0.0	11.8	16.2	0.0	11.4	50.7	26
Total Organic Carbon (mg/l)	2.7	3.4	7.3	3.0	3.7	4.2	4.0	4.5	4.9	3.3	4.9	5.7	26
pH	7.28	7.50	8.06	7.33	7.67	8.03	7.51	7.63	7.90	7.03	7.64	7.70	26
Total Alkalinity (mg/l)	28.7	52.9	66.9	47.0	57.0	83.2	61.1	77.4	91.3	65.9	73.2	92.6	26
Total Hardness (mg/l)	84.7	104.7	150.0	77.1	100.4	139.9	118.1	176.3	305.0	134.0	149.0	175.0	26
Specific Conductance (usm/cm)	244	334	492	237	324	467	323	734	1060	349	390	609	26
Total Suspended Solids (mg/l)	1	5	18	0	5	8	1	5	30	0	11	45	26
Total Dissolved Solids (mg/l)	166	203	310	186	235	324	227	496	1650	162	269	403	26
Chloride (mg/l)	27.4	45.2	90.1	24.8	42.8	60.8	39.3	131.2	440.7	49.3	60.4	92.1	26
Sulfate (mg/l)	31.4	36.5	65.5	18.1	35.0	54.8	19.1	34.4	101.0	42.3	53.4	71.3	26
Sodium (mg/l)	16.80	25.30	61.00	18.30	25.25	76.40	24.80	78.62	104.00	28.30	35.45	64.00	26
Potassium (mg/l)	3.3	5.4	8.2	2.5	4.0	8.7	4.0	6.3	10.0	4.2	7.0	8.2	26
Calcium (mg/l)	13.6	21.1	32.3	14.8	24.9	35.4	19.4	36.2	66.0	23.8	32.9	40.2	26
Magnesium (mg/l)	8.70	9.97	14.10	8.59	11.50	15.20	10.60	14.14	18.70	11.20	14.55	16.20	26
Ammonia Nitrogen (mg/l)	0.000	0.035	1.424	0.000	0.092	0.154	0.000	0.050	0.100	0.000	0.000	0.031	26
Nitrite Nitrogen (mg/l)	0.000	0.019	0.177	0.020	0.034	0.090	0.000	0.040	0.233	0.000	0.023	0.051	26
Nitrate Nitrogen (mg/l)	1.99	2.96	4.19	1.30	2.44	4.54	1.78	7.69	13.10	2.02	2.72	5.13	26
Total Phosphate Phosphorus (mg/l)	0.24	0.34	0.54	0.00	0.12	0.74	0.07	0.11	0.26	0.08	0.12	0.14	26
Ortho Phosphate Phosphorus (mg/l)	0.07	0.30	0.54	0.00	0.10	0.40	0.00	0.07	0.11	0.06	0.10	0.12	26
Cadmium (mg/l)	0.000	0.001	0.003	0.000	0.000	0.001	0.000	0.001	0.006	0.000	0.001	0.003	26
Chromium (mg/l)	0.004	0.006	0.008	0.002	0.004	0.007	0.001	0.002	0.019	0.000	0.005	0.027	26
Copper (mg/l)	0.004	0.005	0.007	0.004	0.006	0.012	0.007	0.012	0.027	0.005	0.011	0.012	26
Iron (mg/l)	0.00	0.14	1.20	0.00	0.16	0.26	0.09	0.11	0.77	0.00	0.26	2.63	26
Lead (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.006	0.000	0.001	0.004	26
Manganese (mg/l)	0.00	0.00	0.10	0.00	0.00	0.13	0.00	0.10	0.31	0.00	0.00	0.26	26
Nickel (mg/l)	0.001	0.002	0.014	0.000	0.007	0.010	0.004	0.012	0.024	0.003	0.008	0.032	26
Zinc (mg/l)	0.00	0.02	0.04	0.02	0.04	0.06	0.03	0.06	0.08	0.02	0.04	0.05	26
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	26
Cyanide, Total (mg/l)	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.000	0.000	26
Trichloroethylene (ug/l)	0.0	0.0	4.3	0.0	0.0	12.9	0.0	0.0	3.1	0.0	0.0	0.0	26
Total Coliforms (MF) (c/.1l)	10	140	3800	21	95	1000	700	2500	8000	1200	4300	6100	26
Fecal Coliforms (MF) (c/.1l)	0	3	750	0	7	230	70	340	2500	10	550	3300	26
Aluminum (mg/l)	0.13	0.20	1.10	0.03	0.17	0.63	0.00	0.05	0.87	0.00	0.06	0.80	26
Sulfide (mg/l)	0.00	0.38	1.20	0.00	0.00	0.20	0.00	0.40	0.70	0.20	0.35	1.20	26

Table 4.1-9. New minimum values observed for water quality parameters measured in 1987 at station E22880 on the East Branch Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Aluminum (mg/l)	0.13	02/11/87
Mar, Apr, May	Sulfate (mg/l)	18.1	05/20/87
	Total Phosphate Phosphorus (mg/l)	0.00	05/06/87
	Cadmium (mg/l)	0.000	03/24/87
	Chromium (mg/l)	0.002	04/08/87
	Iron (mg/l)	0.00	03/11/87
	Nickel (mg/l)	0.000	03/11/87
	Mercury (ug/l)	0.0	03/11/87
	Aluminum (mg/l)	0.03	04/22/87
	Fecal Coliforms (MF) (c/.1l)	0	04/08/87
	Total Coliforms (MF) (c/.1l)	21	04/08/87
Jun, Jul, Aug	Sulfate (mg/l)	19.1	06/03/87
	Nitrite Nitrogen (mg/l)	0.000	06/17/87
	Cadmium (mg/l)	0.000	07/01/87
	Nickel (mg/l)	0.004	07/15/87
	Mercury (ug/l)	0.0	06/03/87
	Aluminum (mg/l)	0.00	06/17/87
	Fecal Coliforms (MF) (c/.1l)	70	06/17/87
Sep, Oct, Nov	Nitrate Nitrogen (mg/l)	2.02	09/09/87
	Cadmium (mg/l)	0.000	09/23/87
	Chromium (mg/l)	0.000	09/23/87

Table 4.1-10. New maximum values observed for water quality parameters measured in 1987 at station E22880 on the East Branch Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	pH	8.06	12/02/87
	Cadmium (mg/l)	0.003	12/02/87
	Nickel (mg/l)	0.014	12/30/87
	Chemical Oxygen Demand (mg/l)	35.0	12/16/87
	Sulfide (mg/l)	1.20	12/16/87
	Trichloroethylene (ug/l)	4.3	02/25/87
Mar, Apr, May	Total Alkalinity (mg/l)	83.2	05/20/87
	Sodium (mg/l)	76.40	05/20/87
	Potassium (mg/l)	8.7	03/24/87
	Total Phosphate Phosphorus (mg/l)	0.74	03/24/87
	Ortho Phosphate Phosphorus (mg/l)	0.40	03/24/87
	Cadmium (mg/l)	0.001	03/11/87
	Manganese (mg/l)	0.13	05/20/87
	Nickel (mg/l)	0.010	03/24/87
	Mercury (ug/l)	0.7	05/06/87
	Aluminum (mg/l)	0.63	04/08/87
	Trichloroethylene (ug/l)	12.9	03/24/87
Jun, Jul, Aug	Dissolved Oxygen (mg/l)	11.9	07/01/87
	Total Hardness (mg/l)	305.0	08/26/87
	Specific Conductance (usm/cm)	1060	08/26/87
	Total Dissolved Solids (mg/l)	1650	07/01/87
	Chloride (mg/l)	440.7	06/17/87
	Nitrite Nitrogen (mg/l)	0.233	08/26/87
	Cadmium (mg/l)	0.006	08/26/87
	Manganese (mg/l)	0.31	08/26/87
	Nickel (mg/l)	0.024	06/03/87
	Mercury (ug/l)	0.0	06/03/87
	Aluminum (mg/l)	0.87	07/15/87
	Sulfide (mg/l)	0.70	07/15/87
Sep, Oct, Nov	Total Suspended Solids (mg/l)	45	10/07/87
	Manganese (mg/l)	0.26	10/07/87
	Chemical Oxygen Demand (mg/l)	50.7	09/23/87

Table 4.1-11. Summary of East Branch Perkiomen Creek water quality at Station E2800, 5 January 1983 through 30 December 1987.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	-1.0	1.0	8.0	1.0	11.0	21.0	18.0	21.5	26.0	2.0	13.0	23.5	123
Dissolved Oxygen (mg/l)	8.1	12.2	15.2	6.1	11.4	14.7	3.9	7.7	13.3	5.4	9.5	13.7	128
Biochemical Oxygen Demand (mg/l)	0.3	1.4	7.5	0.1	1.5	5.3	0.4	1.2	5.2	0.0	1.3	5.7	131
Chemical Oxygen Demand (mg/l)	0.0	11.4	44.0	0.0	14.8	46.3	0.0	15.0	88.7	0.0	15.7	36.1	131
Total Organic Carbon (mg/l)	0.0	3.4	19.4	0.0	3.5	10.5	0.0	4.8	14.0	0.0	5.1	33.4	126
pH	6.89	7.65	8.27	6.69	7.91	9.40	6.97	8.01	9.33	7.20	7.98	8.97	130
Total Alkalinity (mg/l)	0.0	51.0	104.5	6.0	50.9	94.6	32.4	90.9	116.6	17.8	89.8	116.6	131
Total Hardness (mg/l)	45.1	100.1	182.2	27.3	97.1	168.6	65.3	149.5	192.1	64.3	146.6	238.4	130
Specific Conductance (usm/cm)	150	308	583	166	319	604	168	547	845	191	531	905	131
Total Suspended Solids (mg/l)	0	3	536	0	2	333	0	2	29	0	2	109	131
Total Dissolved Solids (mg/l)	96	207	319	125	220	420	144	404	664	153	370	583	131
Dissolved Silica (mg/l)	1.56	3.30	4.30	0.46	3.08	4.09	1.01	2.28	4.32	0.13	1.60	4.16	54
Total Inorganic Carbon (mg/l)	24.6	49.4	65.9	6.6	37.0	61.4	48.6	86.3	109.6	30.7	77.3	104.2	26
Chloride (mg/l)	13.7	45.3	130.7	14.3	43.7	130.6	9.0	87.7	366.3	20.0	99.6	221.1	131
Sulfate (mg/l)	14.9	36.5	73.4	12.2	36.8	75.3	10.3	50.0	90.7	19.5	57.1	126.6	130
Sodium (mg/l)	9.26	25.09	69.79	10.58	29.72	74.20	9.06	62.16	118.00	14.50	62.28	122.00	130
Potassium (mg/l)	2.1	4.0	6.7	2.1	3.4	8.0	2.2	5.8	13.6	0.0	6.5	11.9	131
Calcium (mg/l)	8.4	20.5	43.9	6.1	24.6	40.9	8.7	31.0	103.4	14.8	30.7	65.9	131
Magnesium (mg/l)	6.22	11.00	19.52	6.56	11.80	17.19	7.58	15.63	22.10	8.49	17.62	24.10	131
Ammonia Nitrogen (mg/l)	0.000	0.192	1.268	0.000	0.067	0.346	0.000	0.037	0.111	0.000	0.028	1.060	131
Nitrite Nitrogen (mg/l)	0.000	0.035	1.099	0.014	0.050	0.132	0.000	0.024	1.290	0.000	0.027	0.152	131
Nitrate Nitrogen (mg/l)	1.90	3.28	6.90	1.20	2.61	4.63	0.00	1.80	3.61	0.90	3.17	5.81	131
Total Phosphate Phosphorus (mg/l)	0.06	0.19	0.59	0.00	0.11	0.36	0.00	0.13	0.25	0.00	0.14	0.57	125
Ortho Phosphate Phosphorus (mg/l)	0.05	0.13	0.43	0.00	0.08	0.25	0.00	0.10	0.21	0.01	0.10	0.47	129
Cadmium (mg/l)	0.000	0.000	0.002	0.000	0.000	0.001	0.000	0.001	0.002	0.000	0.001	0.001	32
Chromium (mg/l)	0.000	0.006	0.051	0.000	0.007	0.020	0.000	0.004	0.185	0.000	0.005	0.014	131
Copper (mg/l)	0.000	0.005	0.022	0.001	0.006	0.029	0.000	0.004	0.015	0.002	0.006	0.016	131
Iron (mg/l)	0.00	0.14	10.70	0.00	0.13	6.46	0.00	0.03	0.98	0.00	0.10	4.77	131
Lead (mg/l)	0.000	0.000	0.019	0.000	0.000	0.016	0.000	0.000	0.015	0.000	0.001	0.008	131
Manganese (mg/l)	0.00	0.00	0.41	0.00	0.00	0.27	0.00	0.00	0.18	0.00	0.00	0.25	131
Nickel (mg/l)	0.000	0.002	0.006	0.000	0.003	0.005	0.002	0.004	0.010	0.000	0.004	9.410	32
Zinc (mg/l)	0.00	0.01	0.30	0.00	0.01	0.06	0.00	0.01	0.07	0.00	0.01	0.04	131
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	32
Cyanide, Total (mg/l)	0.000	0.000	0.004	0.000	0.000	0.004	0.000	0.000	0.001	0.000	0.000	0.002	131
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.010	0.000	0.000	0.000	131
Trichloroethylene (ug/l)	0.0	0.0	3.0	0.0	0.0	2.1	0.0	0.0	7.3	0.0	0.0	0.0	127
Total Coliforms (MF) (c/.1l)	0	300	17000	10	270	8300	60	900	14000	90	1100	22000	128
Fecal Coliforms (MF) (c/.1l)	0	51	8300	1	70	6800	34	350	9300	19	310	7400	129
Aluminum (mg/l)	0.14	0.26	4.20	0.03	0.13	0.63	0.00	0.03	0.33	0.00	0.02	3.64	32
Sulfide (mg/l)	0.00	0.00	1.10	0.00	0.00	0.57	0.00	0.00	0.60	0.00	0.25	1.30	57

Table 4.1-12. Summary of East Branch Perkiomen Creek water quality at Station E2800, 14 January 1987 through 30 December 1987.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	0.0	1.0	7.0	3.0	10.5	17.0	18.0	22.0	24.0	11.0	12.8	23.0	26
Dissolved Oxygen (mg/l)	10.6	11.8	14.5	10.2	13.3	14.0	7.4	9.7	13.3	8.1	9.2	12.1	24
Biochemical Oxygen Demand (mg/l)	0.5	1.7	4.4	0.5	2.8	4.5	0.7	1.5	4.6	0.8	1.9	2.5	26
Chemical Oxygen Demand (mg/l)	0.0	11.4	19.2	0.0	0.0	23.4	0.0	11.4	15.7	0.0	0.0	19.6	26
Total Organic Carbon (mg/l)	3.1	3.4	4.5	2.7	3.3	5.1	4.1	4.8	5.2	3.5	4.9	6.7	26
pH	7.48	7.78	8.00	7.53	7.99	9.40	7.96	8.57	9.33	7.74	7.95	8.08	26
Total Alkalinity (mg/l)	38.8	51.0	69.8	47.8	61.7	94.6	78.9	97.5	104.0	66.5	82.5	103.0	26
Total Hardness (mg/l)	92.2	106.0	137.3	69.6	108.0	157.0	136.7	170.9	181.5	128.0	143.5	187.0	26
Specific Conductance (usm/cm)	283	344	534	229	343	604	432	699	845	415	508	623	26
Total Suspended Solids (mg/l)	0	5	23	0	0	7	0	2	15	1	2	12	26
Total Dissolved Solids (mg/l)	152	206	319	178	243	420	278	475	664	257	320	437	26
Chloride (mg/l)	33.6	45.3	86.4	22.3	47.1	90.8	59.0	127.1	366.3	59.4	80.1	130.0	26
Sulfate (mg/l)	28.0	36.2	49.6	12.2	35.1	48.5	17.1	47.0	85.0	40.4	49.0	72.6	26
Sodium (mg/l)	18.70	27.35	47.70	17.50	38.05	74.20	46.30	85.87	100.00	31.00	53.65	94.40	25
Potassium (mg/l)	4.6	5.0	6.5	2.7	3.2	8.0	5.4	7.0	9.5	0.0	5.7	11.8	26
Calcium (mg/l)	16.6	25.5	35.5	15.9	26.9	32.7	24.3	31.0	47.0	25.4	29.7	50.4	26
Magnesium (mg/l)	8.00	11.00	14.60	7.47	11.90	15.30	10.30	15.66	18.00	10.60	14.80	19.50	26
Ammonia Nitrogen (mg/l)	0.031	0.142	1.016	0.000	0.079	0.204	0.000	0.000	0.100	0.000	0.000	1.060	26
Nitrite Nitrogen (mg/l)	0.000	0.040	0.137	0.030	0.056	0.132	0.020	0.030	1.290	0.014	0.030	0.152	26
Nitrate Nitrogen (mg/l)	2.31	2.77	4.27	1.20	2.15	3.10	1.03	1.81	2.39	2.62	2.95	3.50	26
Total Phosphate Phosphorus (mg/l)	0.16	0.24	0.50	0.04	0.13	0.36	0.03	0.20	0.24	0.00	0.15	0.57	26
Ortho Phosphate Phosphorus (mg/l)	0.05	0.18	0.38	0.03	0.13	0.25	0.00	0.10	0.19	0.07	0.17	0.47	26
Cadmium (mg/l)	0.000	0.000	0.002	0.000	0.000	0.001	0.000	0.001	0.002	0.000	0.001	0.001	26
Chromium (mg/l)	0.002	0.004	0.004	0.000	0.002	0.006	0.000	0.000	0.002	0.000	0.001	0.010	26
Copper (mg/l)	0.002	0.003	0.005	0.004	0.007	0.009	0.003	0.004	0.009	0.003	0.003	0.008	26
Iron (mg/l)	0.00	0.30	1.00	0.00	0.14	0.51	0.00	0.00	0.39	0.00	0.06	0.30	26
Lead (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.001	0.001	26
Manganese (mg/l)	0.00	0.00	0.11	0.00	0.00	0.10	0.00	0.00	0.13	0.00	0.00	0.00	26
Nickel (mg/l)	0.000	0.002	0.004	0.000	0.003	0.005	0.002	0.004	0.010	0.001	0.004	9.410	26
Zinc (mg/l)	0.00	0.00	0.03	0.00	0.03	0.05	0.01	0.02	0.07	0.01	0.02	0.03	26
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	26
Cyanide, Total (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Trichloroethylene (ug/l)	0.0	0.0	3.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	26
Total Coliforms (MF) (c/.1l)	150	400	12500	40	225	800	170	800	2000	90	1300	5200	25
Fecal Coliforms (MF) (c/.1l)	2	48	2100	1	90	340	66	280	970	19	600	1920	25
Aluminum (mg/l)	0.14	0.25	0.61	0.03	0.13	0.63	0.00	0.03	0.33	0.00	0.00	0.28	26
Sulfide (mg/l)	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.20	0.60	0.00	0.30	0.70	26

Table 4.1-13. New minimum values observed for water quality parameters measured in 1987 at station E2800 on the East Branch Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Nitrite Nitrogen (mg/l)	0.000	01/28/87
	Ortho Phosphate Phosphorus (mg/l)	0.05	01/14/87
	Cadmium (mg/l)	0.000	01/28/87
	Nickel (mg/l)	0.000	01/14/87
	Aluminum (mg/l)	0.14	01/28/87
Mar, Apr, May	Sulfate (mg/l)	12.2	05/20/87
	Nitrate Nitrogen (mg/l)	1.20	04/22/87
	Cadmium (mg/l)	0.000	03/11/87
	Chromium (mg/l)	0.000	05/20/87
	Nickel (mg/l)	0.000	03/11/87
	Mercury (ug/l)	0.0	03/24/87
	Aluminum (mg/l)	0.03	04/22/87
	Fecal Coliforms (MF) (c/.1l)	1	03/11/87
Jun, Jul, Aug	Cadmium (mg/l)	0.000	06/03/87
	Nickel (mg/l)	0.002	07/15/87
	Mercury (ug/l)	0.0	06/03/87
	Aluminum (mg/l)	0.00	06/17/87
Sep, Oct, Nov	Potassium (mg/l)	0.0	09/09/87
	Total Phosphate Phosphorus (mg/l)	0.00	11/18/87
	Cadmium (mg/l)	0.000	11/18/87
	Chromium (mg/l)	0.000	09/23/87
	Aluminum (mg/l)	0.00	09/23/87
	Fecal Coliforms (MF) (c/.1l)	19	11/04/87
	Total Coliforms (MF) (c/.1l)	90	11/04/87

Table 4.1-14. New maximum values observed for water quality parameters measured in 1987 at station E2800 on the East Branch Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Total Dissolved Solids (mg/l)	319	02/25/87
	Cadmium (mg/l)	0.002	12/02/87
	Trichloroethylene (ug/l)	3.0	02/25/87
Mar, Apr, May	pH	9.40	03/24/87
	Total Alkalinity (mg/l)	94.6	05/20/87
	Specific Conductance (usm/cm)	604	05/20/87
	Total Dissolved Solids (mg/l)	420	05/20/87
	Sodium (mg/l)	74.20	05/20/87
	Potassium (mg/l)	8.0	03/24/87
	Nitrite Nitrogen (mg/l)	0.132	03/24/87
	Total Phosphate Phosphorus (mg/l)	0.36	03/24/87
	Ortho Phosphate Phosphorus (mg/l)	0.25	03/24/87
	Cadmium (mg/l)	0.001	03/24/87
	Nickel (mg/l)	0.005	04/08/87
	Mercury (ug/l)	0.7	05/06/87
	Aluminum (mg/l)	0.63	04/08/87
	Trichloroethylene (ug/l)	2.1	03/24/87
Jun, Jul, Aug	Dissolved Oxygen (mg/l)	13.3	07/29/87
	pH	9.33	07/01/87
	Specific Conductance (usm/cm)	845	08/26/87
	Total Dissolved Solids (mg/l)	664	07/01/87
	Chloride (mg/l)	366.3	06/17/87
	Nitrite Nitrogen (mg/l)	1.290	06/17/87
	Cadmium (mg/l)	0.002	08/12/87
	Nickel (mg/l)	0.010	06/03/87
	Zinc (mg/l)	0.07	07/15/87
	Mercury (ug/l)	0.0	06/03/87
	Aluminum (mg/l)	0.33	07/15/87
	Sulfide (mg/l)	0.60	08/26/87
Sep, Oct, Nov	Ammonia Nitrogen (mg/l)	1.060	09/09/87
	Nitrite Nitrogen (mg/l)	0.152	09/09/87
	Total Phosphate Phosphorus (mg/l)	0.57	09/09/87
	Ortho Phosphate Phosphorus (mg/l)	0.47	09/09/87
	Nickel (mg/l)	9.410	09/09/87

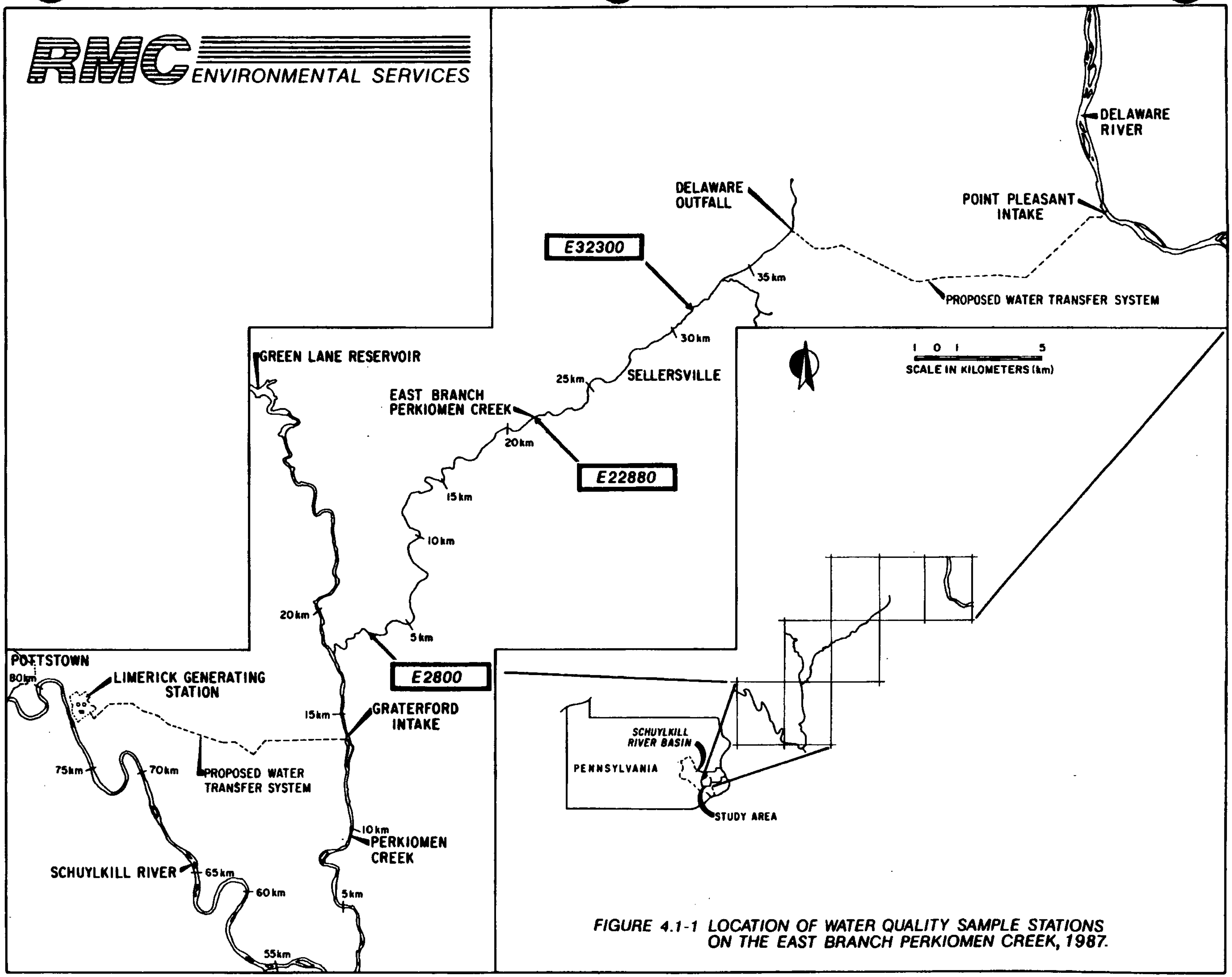

FIGURE 4.1-1 LOCATION OF WATER QUALITY SAMPLE STATIONS ON THE EAST BRANCH PERKIOMEN CREEK, 1987.

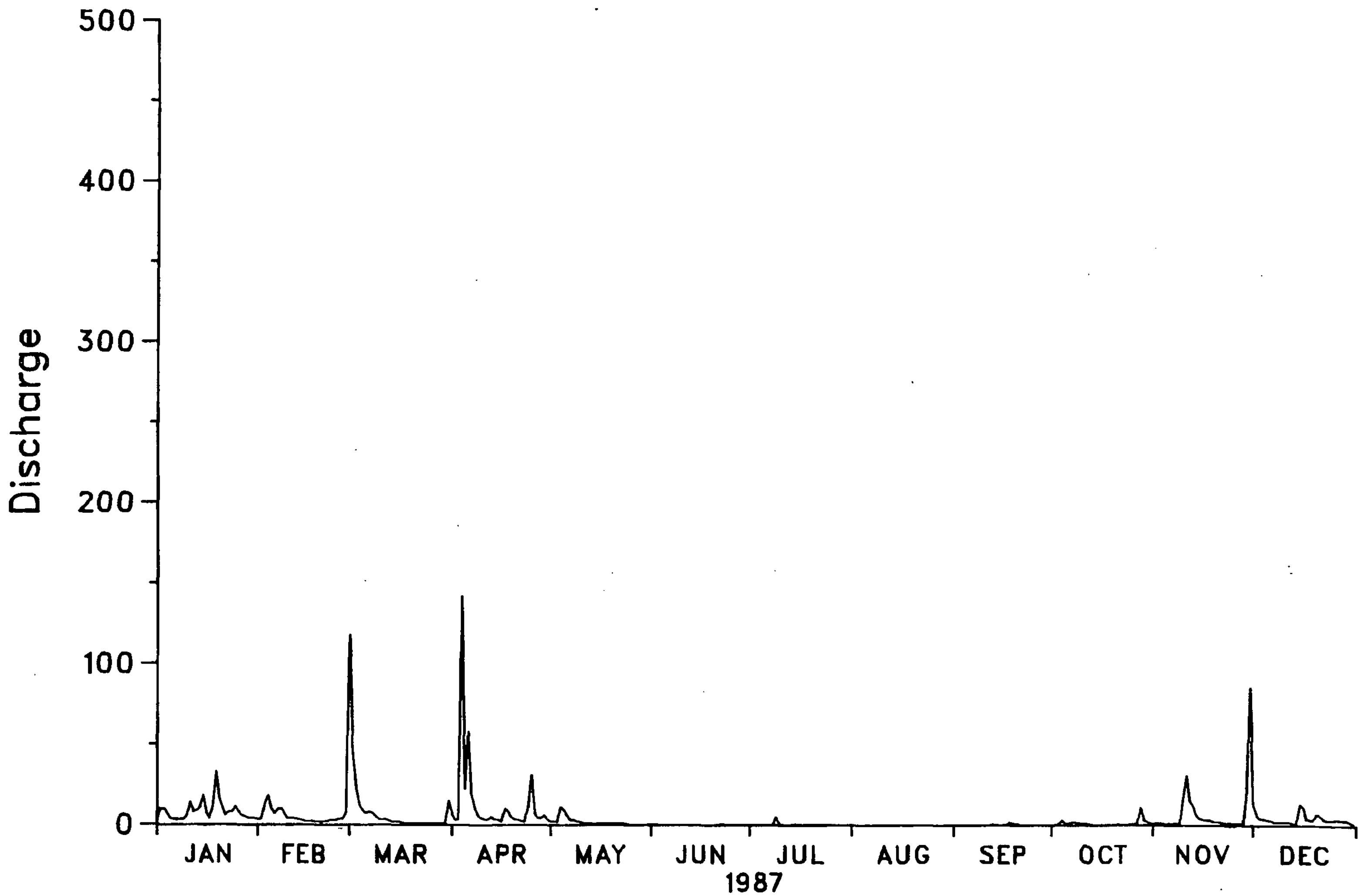

Figure 4.1–2. East Branch Perkiomen Creek mean daily discharge (cfs) during 1987 (Bucks Road gage).

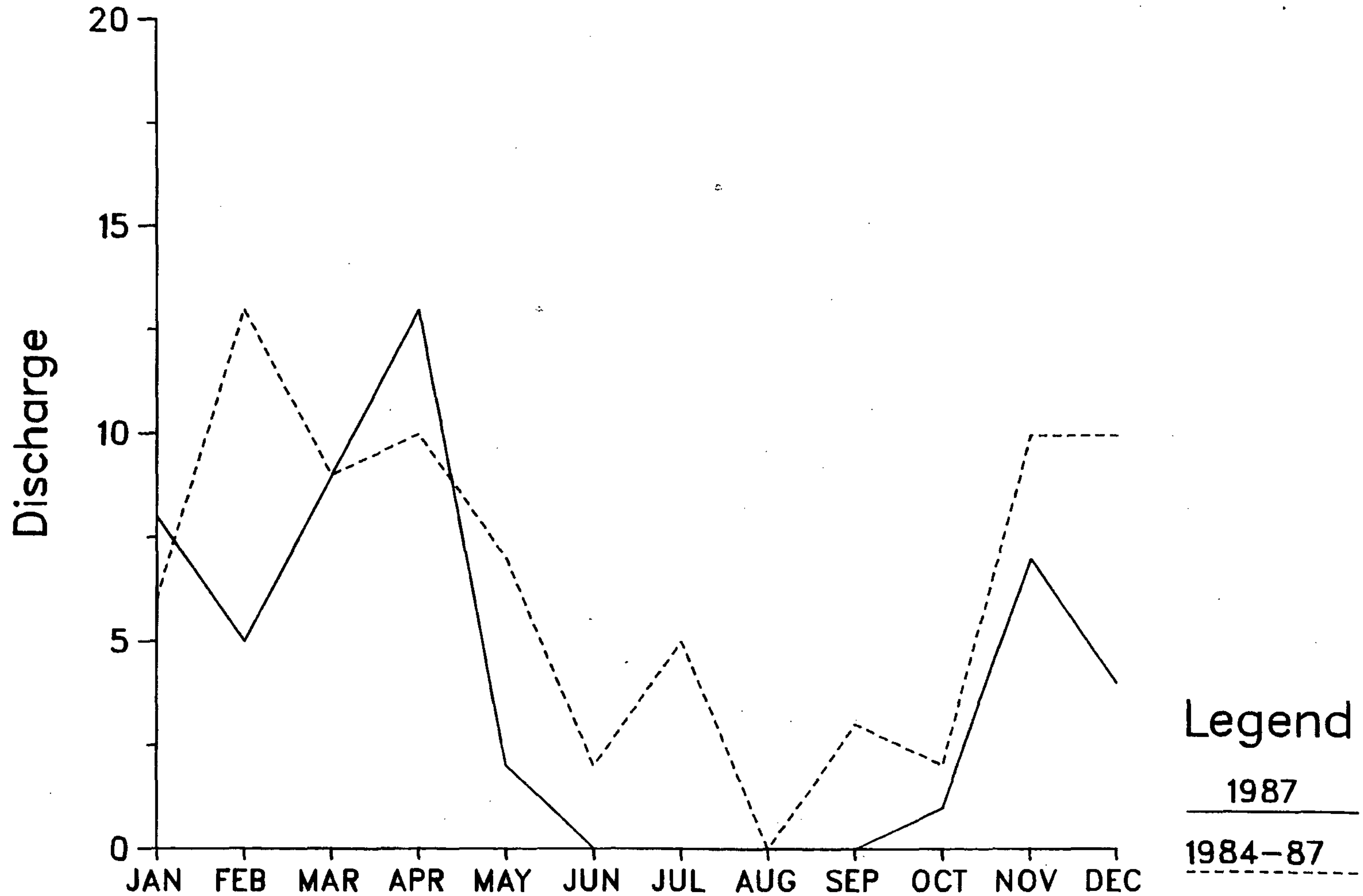

Figure 4.1–3. East Branch Perkiomen Creek mean monthly discharge (cfs) during 1984–1987 and 1987 (Bucks Road gage).

4.2 Benthic Macroinvertebrates

Introduction

The benthic macroinvertebrate community in East Branch Perkiomen Creek (EBPC) was studied in 1972-1974, 1976, and 1983-1987 to characterize spatial and temporal variation in taxonomic composition and density of organisms. The 1987 studies, conducted at six stations (Fig. 4.2-1), add to the preoperational baseline that will be compared to similar data collected after Delaware River water is transferred to the EBPC. Sampling stations, frequency, and methods to collect and summarize benthic macroinvertebrate data were the same as described in the 1986 progress report to PECo (RMC Environmental Services 1987a).

Studies of EBPC benthic macroinvertebrates reported in the 1970's (Table 2.0-2), the 1980's (RMC Environmental Services 1984, 1985, 1986, and 1987a), and the EROL showed that the community is relatively stable, diverse, and typical of small warmwater streams in southeast Pennsylvania. Rather than discuss in detail the similarities and differences with results from past years or further generalize ecological relationships discussed in earlier reports, the purpose of this report is to summarize 1987 results that will be incorporated into an evaluation of diversion effects once water is transferred to the EBPC.

Summary of 1987 Results

A total of 95 taxa was found in the 1987 EBPC benthic macroinvertebrate collections (Table 4.2-1). Taxonomic composition varied by station and included both ubiquitous organisms and taxa found only at a particular station or reach of stream. Number of taxa ranged from 41 at the extreme headwater station (E36985) to 63 taxa near Sellersville (E22910) and Moyer Road (E12500), the furthest downstream station.

Mean standing crop ranged from 8,196.7 organisms/m^2 at E36985 to 35,293.9 organisms/m^2 at E12500, and generally increased with distance from the headwaters (Table 4.2-2). Total density usually increased from winter to spring, declined somewhat in summer, and peaked again in autumn, but the magnitude and timing of changes were not consistent among stations.

Although seasonal trends in the density of individual taxa were not determined, density of many taxa varied considerably among stations (Table 4.2-3 and 4.2-4). At each station, important taxa were identified as those comprising more than 2% of the total number sampled. For these species, mean annual standing crop was computed for each year, 1983-1987 (Tables 4.2-5 to 4.2-10). Only 4 taxa (<u>Cheumatopsyche</u>, a caddisfly; Chironomidae, midges; Simuliidae, blackflies; and <u>Stenelmis</u>, a beetle) were important at all stations, while ten taxa were uniquely important to a single station.

Considerable spatial, seasonal, and annual variation in community structure was observed and is common for benthic macroinvertebrates in biologically complex warmwater streams. An understanding of the natural and anthropogenic factors related to such variation will be important when the effects of diversion on benthic macroinvertebrates are evaluated.

Table 4.2-1. Macroinvertebrate taxa collected in the East Branch Perkiomen Creek during 1987.

Taxon	E12500	E23000	E26700	E29910	E36725	E36985
Agabus					X	X
Allocapnia	X	X	X	X	X	X
Ameletus					X	X
Amnicola			X	X		
Amphinemura			X	X	X	X
Anodonta				X		
Argia	X	X	X	X		
Asellus	X		X			X
Baetis	X	X	X	X	X	
Berosus	X	X	X	X	X	X
Caenis	X	X	X	X	X	X
Cambarus		X	X		X	X
Campeloma				X		
Cecidomyiidae						X
Ceraclea	X		X	X		
Ceratopogonidae	X	X	X	X	X	X
Cheumatopsyche	X	X	X	X	X	X
Chimarra	X	X	X	X	X	X
Chironomidae	X	X	X	X	X	X
Choroterpes				X	X	
Climacia	X					
Corydalus	X	X				
Curculionidae				X		X
Dicranota			X		X	
Dubiraphia	X	X	X	X	X	X
Dugesia	X	X	X	X	X	
Dytiscidae				X		
Ectopria	X	X		X		
Empididae	X	X	X	X	X	X
Ephemera				X		
Ephemerella	X					X
Erioptera						X
Erpobdella	X	X	X	X	X	
Ferrissia	X	X	X	X	X	X
Gammarus			X			
Gomphidae	X	X	X	X		
Gomphus	X			X		
Gyraulus	X		X	X	X	X
Helichus					X	
Helisoma	X		X	X		
Helobdella			X	X		
Helophorus				X		
Hyalella	X		X	X	X	X
Hydroporus		X	X	X	X	X
Hydropsyche	X	X	X	X	X	X
Hydroptila	X	X	X	X		
Ironoquia						X
Ischnura	X	X	X	X	X	
Isonychia	X	X	X	X	X	
Isoperla					X	X
Lampyridae						X
Leucotrichia	X	X				
Libellula					X	
Lymnaea	X	X	X	X	X	
Macronemum	X	X				
Macronychus	X					
Microcylloepus	X					
Muscidae						X
Musculium	X	X	X	X		X
Mystacides	X		X			
Neureclipsis	X	X				
Neurocordulia	X					
Nigronia	X	X	X		X	
Odontomyia	X	X				
Oecetis	X	X	X			
Oligochaeta	X	X	X	X	X	X
Optioservus	X	X	X	X	X	
Orconectes		X	X	X		
Paraleptophlebia	X	X	X	X	X	X
Parargyractis	X	X	X	X	X	
Peltodytes			X	X	X	
Perlesta	X	X	X	X	X	X
Physa	X	X	X	X	X	X
Pilaria					X	
Pisidium	X	X	X	X	X	X

Table 4.2-1. (continued)

Taxon	E12500	E23000	E26700	E29910	E36725	E36985
Planorbdella	X		X	X		
Polycentropus				X		
Potamanthus	X					
Prostoia					X	X
Prostoma	X	X	X	X	X	X
Psephenus	X	X	X	X	X	
Sialis	X	X	X	X	X	X
Sigara					X	X
Simuliidae	X	X	X	X	X	X
Sphaerium	X		X	X	X	
Stenacron	X		X	X	X	
Stenelmis	X	X	X	X	X	X
Stenonema	X			X		
Tabanidae	X			X	X	X
Taeniopteryx	X			X		
Tipula	X	X	X	X	X	X
Tortricidae				X		
Triaenodes	X			X	X	
Tricorythodes	X	X	X	X		
Hormaldia					X	
Total Number of Taxa	63	46	55	63	52	41

Table 4.2-2. Total macroinvertebrate standing crop (mean number/m^2) measured in the East Branch Perkiomen Creek during 1987.

Date	E12500	E23000	E26700	E29910	E36725	E36985
Jan	-	-	12690.0	12610.0	5190.0	4716.7
Jan	21173.3	5306.7	-	-	-	-
Mar	41630.0	12206.7	16640.0	39463.3	5923.3	11316.7
May	63426.7	36136.7	64993.3	23233.3	6903.3	9496.7
Jul	25803.3	17403.3	18983.3	18093.3	9536.7	-
Sep	18116.7	28503.3	18933.3	12060.0	-	-
Nov	41613.3	8473.3	16433.3	30943.3	14510.0	7256.7
Mean	35293.9	18005.0	24778.9	22733.9	8412.7	8196.7

Table 4.2-3. Macroinvertebrate standing crop (mean number/m²) measured in the East Branch Perkiomen Creek during 1987.

Taxon	E12500	E23000	E26700	E29910	E36725	E36985
Agabus	-	-	-	-	2.7	25.8
Allocapnia	6.7	14.4	369.4	723.9	2172.0	1172.5
Ameletus	-	-	-	-	1.3	2.5
Amnicola	-	-	31.7	1180.6	-	-
Amphinemura	-	-	12.8	10.0	68.7	16.7
Anodonta	-	-	-	0.6	-	-
Argia	152.8	132.8	62.2	51.1	-	-
Asellus	7.8	-	100.0	-	-	1.7
Baetis	501.1	157.8	5.0	52.2	5.3	-
Berosus	177.8	38.9	146.1	757.2	39.3	2.5
Caenis	1010.0	92.2	484.4	1746.7	486.0	36.7
Cambarus	-	0.6	0.6	-	1.3	4.2
Campeloma	-	-	-	0.6	-	-
Cecidomyiidae	-	-	-	-	-	0.8
Ceraclea	1.7	-	1.7	2.2	-	-
Ceratopogonidae	31.1	12.8	17.2	40.6	118.7	28.3
Cheumatopsyche	4892.8	4247.8	660.6	535.6	154.0	1.7
Chimarra	1625.6	11.1	23.9	83.3	2.7	0.8
Chironomidae	8962.8	7501.7	6956.7	8333.9	3324.7	5847.5
Choroterpes	-	-	-	0.6	0.7	-
Climacia	0.6	-	-	-	-	-
Corydalus	53.9	3.9	-	-	-	-
Curculionidae	-	-	-	0.6	-	0.8
Dicranota	-	-	1.1	-	0.7	-
Dubiraphia	20.6	3.9	7.2	64.4	54.7	15.0
Dugesia	353.3	257.2	530.0	13.9	12.0	-
Dytiscidae	-	-	-	0.6	-	-
Ectopria	19.4	2.8	-	3.3	-	-
Empididae	62.2	21.7	177.8	185.0	36.7	33.3
Ephemera	-	-	-	1.1	-	-
Ephemerella	2.2	-	-	-	-	0.8
Erioptera	-	-	-	-	-	0.8
Erpobdella	5.6	1.7	48.3	102.8	2.0	-
Ferrissia	15.0	148.3	396.7	28.3	4.0	0.8
Gammarus	-	-	0.6	-	-	-
Gomphidae	0.6	0.6	1.1	3.9	-	-
Gomphus	0.6	-	-	3.9	-	-
Gyraulus	115.6	-	49.4	202.8	2.0	6.7
Helichus	-	-	-	-	2.0	-
Helisoma	2.8	-	4.4	22.8	-	-
Helobdella	-	-	2.8	31.1	-	-
Helophorus	-	-	-	1.1	-	-
Hyalella	61.7	-	87.8	180.0	136.7	1.7
Hydroporus	-	3.9	0.6	47.2	115.3	170.0
Hydropsyche	3281.1	1659.4	10.6	2.2	0.7	0.8
Hydroptila	91.7	1.7	128.9	12.2	-	-
Ironoquia	-	-	-	-	-	0.8
Ischnura	0.6	1.1	0.6	8.3	3.3	-
Isonychia	5.0	0.6	1.1	15.0	0.7	-
Isoperla	-	-	-	-	2.7	2.5
Lampyridae	-	-	-	-	-	0.8
Leucotrichia	52.8	10.0	-	-	-	-
Libellula	-	-	-	-	0.7	-
Lymnaea	3.3	0.6	6.7	13.3	0.7	-
Macronemum	135.6	0.6	-	-	-	-
Macronychus	22.2	-	-	-	-	-
Microcylloepus	40.0	-	-	-	-	-
Muscidae	-	-	-	-	-	1.7
Musculium	72.8	1.1	143.3	11.7	-	5.8
Mystacides	1.1	-	1.7	-	-	-
Neureclipsis	63.9	1.1	-	-	-	-
Neurocordulia	1.1	-	-	-	-	-
Nigronia	1.1	0.6	0.6	-	0.7	-
Odontomyia	0.6	0.6	-	-	-	-
Oecetis	5.0	0.6	0.6	-	-	-
Oligochaeta	120.0	306.7	3174.4	1778.3	566.7	297.5
Optioservus	38.9	13.9	5.6	37.2	1.3	-
Orconectes	-	1.1	3.3	0.6	-	-
Paraleptophlebia	0.6	0.6	4.4	15.6	24.0	30.0
Parargyractis	100.6	292.8	2.2	1.7	1.3	-
Peltodytes	-	-	0.6	2.2	16.0	-
Perlesta	2.2	0.6	28.9	75.6	128.0	97.5
Physa	151.7	2.2	15.0	211.1	74.7	177.5
Pilaria	-	-	-	-	4.7	-
Pisidium	476.7	13.3	228.3	534.4	209.3	20.8

Table 4.2-3. (continued)

Taxon	E12500	E23000	E26700	E29910	E36725	E36985
Planorbdella	1.7	-	1.1	1.1	-	-
Polycentropus	-	-	-	1.1	-	-
Potamanthus	0.6	-	-	-	-	-
Prostoia	-	-	-	-	3.3	8.3
Prostoma	12.8	127.2	25.6	1.1	3.3	5.8
Psephenus	694.4	30.6	877.8	1941.7	16.0	-
Sialis	22.8	5.0	25.0	112.8	43.3	0.8
Sigara	-	-	-	-	62.7	1.7
Simuliidae	5565.6	1497.2	6122.8	1293.3	45.3	144.2
Sphaerium	108.3	-	593.3	8.3	12.0	-
Stenacron	39.4	-	7.8	44.4	9.3	-
Stenelmis	5395.0	1372.2	3185.0	2151.1	423.3	16.7
Stenonema	47.2	-	-	31.7	-	-
Tabanidae	1.7	-	-	0.6	0.7	0.8
Taeniopteryx	0.6	-	-	0.6	-	-
Tipula	1.1	2.8	3.3	11.1	7.3	10.8
Tortricidae	-	-	-	0.6	-	-
Triaenodes	0.6	-	-	0.6	2.7	-
Tricorythodes	650.0	7.2	0.6	2.8	-	-
Wormaldia	-	-	-	-	4.7	-
*All Taxa	35293.9	18005.0	24778.9	22733.9	8412.7	8196.7

Table 4.2-4. Percent composition (by number) of macroinvertebrates collected in the East Branch Perkiomen Creek during 1987.

Taxon	E12500	E23000	E26700	E29910	E36725	E36985
Agabus	-	-	-	-	+	0.3
Allocapnia	+	+	1.5	3.2	25.8	14.3
Ameletus	-	-	-	-	+	+
Amnicola	-	-	0.1	5.2	-	-
Amphinemura	-	-	+	+	0.8	0.2
Anodonta	-	-	-	+	-	-
Argia	0.4	0.7	0.3	0.2	-	-
Asellus	+	-	0.4	-	-	+
Baetis	1.4	0.9	+	0.2	+	-
Berosus	0.5	0.2	0.6	3.3	0.5	+
Caenis	2.9	0.5	2.0	7.7	5.8	0.4
Cambarus	-	+	+	-	+	+
Campeloma	-	-	-	+	-	-
Cecidomyiidae	-	-	-	-	-	+
Ceraclea	+	-	+	+	-	-
Ceratopogonidae	+	+	+	0.2	1.4	0.3
Cheumatopsyche	13.9	23.6	2.7	2.4	1.8	+
Chimarra	4.6	+	+	0.4	+	+
Chironomidae	25.4	41.7	28.1	36.7	39.5	71.3
Choroterpes	-	-	-	+	+	-
Climacia	+	-	-	-	-	-
Corydalus	0.2	+	-	-	-	-
Curculionidae	-	-	-	+	-	+
Dicranota	-	-	+	-	+	-
Dubiraphia	+	+	+	0.3	0.6	0.2
Dugesia	1.0	1.4	2.1	+	0.1	-
Dytiscidae	-	-	-	+	-	-
Ectopria	+	+	-	+	-	-
Empididae	0.2	0.1	0.7	0.8	0.4	0.4
Ephemera	-	-	-	+	-	-
Ephemerella	+	-	-	-	-	+
Erioptera	-	-	-	-	-	+
Erpobdella	+	+	0.2	0.5	+	-
Ferrissia	+	0.8	1.6	0.1	+	+
Gammarus	-	-	+	-	-	-
Gomphidae	+	+	+	+	-	-
Gomphus	+	-	-	+	-	-
Gyraulus	0.3	-	0.2	0.9	+	+
Helichus	-	-	-	-	+	-
Helisoma	+	-	+	0.1	-	-
Helobdella	-	-	+	0.1	-	-
Helophorus	-	-	-	+	-	-
Hyalella	0.2	-	0.4	0.8	1.6	+
Hydroporus	-	+	+	0.2	1.4	2.1
Hydropsyche	9.3	9.2	+	+	+	+
Hydroptila	0.3	+	0.5	+	-	-
Ironoquia	-	-	-	-	-	+
Ischnura	+	+	+	+	+	-
Isonychia	+	+	+	+	+	-
Isoperla	-	-	-	-	+	+
Lampyridae	-	-	-	-	-	+
Leucotrichia	0.1	+	-	-	-	-
Libellula	-	-	-	-	+	-
Lymnaea	+	+	+	+	+	-
Macronemum	0.4	+	-	-	-	-
Macronychus	+	-	-	-	-	-
Microcylloepus	0.1	-	-	-	-	-
Muscidae	-	-	-	-	-	+
Musculium	0.2	+	0.6	+	-	+
Mystacides	+	-	+	-	-	-
Neureclipsis	0.2	+	-	-	-	-
Neurocordulia	+	-	-	-	-	-
Nigronia	+	+	+	-	+	-
Odontomyia	+	+	-	-	-	-
Oecetis	+	+	+	-	-	-
Oligochaeta	0.3	1.7	12.8	7.8	6.7	3.6
Optioservus	0.1	+	+	0.2	+	-
Orconectes	-	+	+	+	-	-
Paraleptophlebia	+	+	+	+	0.3	0.4
Parargyractis	0.3	1.6	+	+	+	-
Peltodytes	-	-	+	+	0.2	-
Perlesta	+	+	0.1	0.3	1.5	1.2
Physa	0.4	+	+	0.9	0.9	2.2
Pilaria	-	-	-	-	+	-
Pisidium	1.4	+	0.9	2.4	2.5	0.3

Table 4.2-4. (continued)

Taxon	E12500	E23000	E26700	E29910	E36725	E36985
Planorbdella	+	-	+	+	-	-
Polycentropus	-	-	-	+	-	-
Potamanthus	+	-	-	-	-	-
Prostoia	-	-	-	-	+	0.1
Prostoma	+	0.7	0.1	+	+	+
Psephenus	2.0	0.2	3.5	8.5	0.2	-
Sialis	+	+	0.1	0.5	0.5	+
Sigara	-	-	-	-	0.7	+
Simuliidae	15.8	8.3	24.7	5.7	0.5	1.8
Sphaerium	0.3	-	2.4	+	0.1	-
Stenacron	0.1	-	+	0.2	0.1	-
Stenelmis	15.3	7.6	12.9	9.5	5.0	0.2
Stenonema	0.1	-	-	0.1	-	-
Tabanidae	+	-	-	+	+	+
Taeniopteryx	+	-	-	+	-	-
Tipula	+	+	+	+	+	0.1
Tortricidae	-	-	-	+	-	-
Triaenodes	+	-	-	+	+	-
Tricorythodes	1.8	+	+	+	-	-
Wormaldia	-	-	-	-	+	-

+ = Less than 0.1%

Table 4.2-5. Macroinvertebrate standing crop (mean number/m^2) and percent composition of important taxa (>2%) at E12500 in the East Branch Perkiomen Creek, 1983 - 1987.

Taxon	1983 Mean	%	1984 Mean	%	1985 Mean	%	1986 Mean	%	1987 Mean	%
Baetis	724.0	3.0	1915.3	4.9	957.8	1.9	1130.0	2.8	501.1	1.4
Caenis	1121.3	4.7	520.7	1.3	666.7	1.3	1114.4	2.7	1010.0	2.9
Cheumatopsyche	3913.3	16.3	8084.0	20.9	9268.3	18.2	5822.2	14.2	4892.8	13.9
Chimarra	743.3	3.1	1454.7	3.8	2326.1	4.6	3152.2	7.7	1625.6	4.6
Chironomidae	5188.7	21.6	8304.0	21.4	12080.0	23.7	13371.7	32.7	8962.8	25.4
Hydropsyche	1404.0	5.9	4630.0	11.9	6525.0	12.8	3932.8	9.6	3281.1	9.3
Macronemum	475.3	2.0	862.7	2.2	482.2	0.9	258.9	0.6	135.6	0.4
Physa	2983.3	12.4	125.3	0.3	228.3	0.4	78.9	0.2	151.7	0.4
Psephenus	532.7	2.2	379.3	1.0	273.9	0.5	591.1	1.4	694.4	2.0
Simuliidae	430.7	1.8	5220.0	13.5	7308.9	14.4	2233.9	5.5	5565.6	15.8
Stenelmis	4157.3	17.3	5326.0	13.7	8013.9	15.7	5151.1	12.6	5395.0	15.3

Table 4.2-6. Macroinvertebrate standing crop (mean number/m^2) and percent composition of important taxa (>2%) at E23000 in the East Branch Perkiomen Creek, 1983 - 1987.

Taxon	1983 Mean	%	1984 Mean	%	1985 Mean	%	1986 Mean	%	1987 Mean	%
Cheumatopsyche	5609.3	47.1	2556.0	22.3	11124.4	24.3	1185.0	8.4	4247.8	23.6
Chironomidae	3036.0	25.5	3030.0	26.4	7023.3	15.3	5488.9	39.0	7501.7	41.7
Dugesia	56.0	0.5	52.7	0.5	293.9	0.6	380.0	2.7	257.2	1.4
Hydropsyche	1041.3	8.7	78.0	0.7	2874.4	6.3	1405.0	10.0	1659.4	9.2
Leucotrichia	52.0	0.4	2.7	0.0	132.2	0.3	295.6	2.1	10.0	0.1
Parargyractis	252.0	2.1	2.0	0.0	385.6	0.8	294.4	2.1	292.8	1.6
Simuliidae	62.0	0.5	4281.3	37.3	21572.8	47.0	2593.9	18.4	1497.2	8.3
Stenelmis	1024.0	8.6	1048.7	9.1	1256.1	2.7	1539.4	10.9	1372.2	7.6

Table 4.2-7. Macroinvertebrate standing crop (mean number/m^2) and percent composition of important taxa (>2%) at E26700 in the East Branch Perkiomen Creek, 1983 - 1987.

Taxon	1983 Mean	%	1984 Mean	%	1985 Mean	%	1986 Mean	%	1987 Mean	%
Allocapnia	55.3	0.4	1142.2	3.9	214.4	0.6	185.6	0.9	369.4	1.5
Amnicola	732.0	5.7	583.3	2.0	748.9	1.9	65.0	0.3	31.7	0.1
Caenis	485.3	3.8	418.3	1.4	686.1	1.8	686.7	3.2	484.4	2.0
Cheumatopsyche	140.0	1.1	1500.6	5.1	938.9	2.4	597.8	2.8	660.6	2.7
Chironomidae	4285.3	33.5	13308.9	45.6	8342.2	21.4	6252.8	29.0	6956.7	28.1
Dugesia	196.0	1.5	541.1	1.9	1291.1	3.3	399.4	1.9	530.0	2.1
Empididae	68.7	0.5	913.3	3.1	237.8	0.6	68.9	0.3	177.8	0.7
Hydroptila	22.0	0.2	18.3	0.1	11.1	0.0	477.8	2.2	128.9	0.5
Musculium	105.3	0.8	94.4	0.3	825.6	2.1	392.8	1.8	143.3	0.6
Oligochaeta	3032.7	23.7	760.6	2.6	997.8	2.6	1700.6	7.9	3174.4	12.8
Physa	321.3	2.5	57.8	0.2	44.4	0.1	103.3	0.5	15.0	0.1
Psephenus	305.3	2.4	132.8	0.5	375.6	1.0	1271.7	5.9	877.8	3.5
Simuliidae	320.0	2.5	3817.2	13.1	15957.8	41.0	3796.7	17.6	6122.8	24.7
Sphaerium	231.3	1.8	273.9	0.9	755.0	1.9	235.0	1.1	593.3	2.4
Stenelmis	1786.7	14.0	3348.3	11.5	5882.8	15.1	3916.1	18.1	3185.0	12.9

Table 4.2-8. Macroinvertebrate standing crop (mean number/m^2) and percent composition of important taxa (>2%) at E29910 in the East Branch Perkiomen Creek, 1983 - 1987.

Taxon	1983 Mean	%	1984 Mean	%	1985 Mean	%	1986 Mean	%	1987 Mean	%
Allocapnia	98.3	1.4	894.7	2.6	815.0	2.1	758.0	3.4	723.9	3.2
Amnicola	23.3	0.3	217.3	0.6	1161.7	3.0	187.3	0.8	1180.6	5.2
Baetis	40.8	0.6	2326.0	6.7	141.7	0.4	280.7	1.3	52.2	0.2
Berosus	26.7	0.4	31.3	0.1	167.5	0.4	637.3	2.8	757.2	3.3
Caenis	513.3	7.4	1634.7	4.7	3244.2	8.2	2935.3	13.1	1746.7	7.7
Cheumatopsyche	206.7	3.0	5734.7	16.5	2670.0	6.8	512.7	2.3	535.6	2.4
Chimarra	41.7	0.6	732.7	2.1	655.0	1.7	198.7	0.9	83.3	0.4
Chironomidae	3654.2	52.4	9398.7	27.0	14942.5	38.0	6506.0	29.0	8333.9	36.7
Hydropsyche	12.5	0.2	1265.3	3.6	130.8	0.3	22.7	0.1	2.2	0.0
Oligochaeta	747.5	10.7	1757.3	5.0	2050.8	5.2	1013.3	4.5	1778.3	7.8
Physa	49.2	0.7	58.7	0.2	35.0	0.1	738.7	3.3	211.1	0.9
Pisidium	45.8	0.7	139.3	0.4	830.0	2.1	190.0	0.8	534.4	2.4
Psephenus	321.7	4.6	123.3	0.4	1385.8	3.5	2167.3	9.7	1941.7	8.5
Simuliidae	82.5	1.2	1292.0	3.7	1160.8	3.0	2802.7	12.5	1293.3	5.7
Stenelmis	810.8	11.6	6496.7	18.7	7549.2	19.2	2336.0	10.4	2151.1	9.5

Table 4.2-9. Macroinvertebrate standing crop (mean number/m^2) and percent composition of important taxa (>2%) at E36725 in the East Branch Perkiomen Creek, 1983 - 1987.

Taxon	1983 Mean	%	1984 Mean	%	1985 Mean	%	1986 Mean	%	1987 Mean	%
Allocapnia	524.7	8.3	3750.0	29.5	4306.7	36.2	1583.3	19.4	2172.0	25.8
Amphinemura	485.3	7.7	415.3	3.3	122.5	1.0	129.2	1.6	68.7	0.8
Caenis	101.3	1.6	329.3	2.6	349.2	2.9	97.5	1.2	486.0	5.8
Cheumatopsyche	280.7	4.5	545.3	4.3	580.8	4.9	30.0	0.4	154.0	1.8
Chironomidae	2645.3	42.0	5302.7	41.7	3599.2	30.3	3110.8	38.1	3324.7	39.5
Oligochaeta	164.7	2.6	331.3	2.6	295.8	2.5	536.7	6.6	566.7	6.7
Paraleptophlebia	198.0	3.1	35.3	0.3	54.2	0.5	96.7	1.2	24.0	0.3
Perlesta	104.7	1.7	436.7	3.4	90.8	0.8	667.5	8.2	128.0	1.5
Pisidium	105.3	1.7	126.0	1.0	221.7	1.9	198.3	2.4	209.3	2.5
Simuliidae	84.7	1.3	349.3	2.7	703.3	5.9	547.5	6.7	45.3	0.5
Stenelmis	1300.7	20.7	529.3	4.2	625.8	5.3	711.7	8.7	423.3	5.0

Table 4.2-10. Macroinvertebrate standing crop (mean number/m^2) and percent composition of important taxa (>2%) at E36985 in the East Branch Perkiomen Creek, 1983 - 1987.

Taxon	1983 Mean	%	1984 Mean	%	1985 Mean	%	1986 Mean	%	1987 Mean	%
Allocapnia	2497.3	35.2	2942.7	26.1	3471.7	22.6	1262.5	26.2	1172.5	14.3
Amphinemura	660.7	9.3	620.0	5.5	280.0	1.8	95.8	2.0	16.7	0.2
Caenis	6.7	0.1	639.3	5.7	227.5	1.5	6.7	0.1	36.7	0.4
Cheumatopsyche	53.3	0.8	115.3	1.0	1302.5	8.5	15.8	0.3	1.7	0.0
Chironomidae	2739.3	38.7	4394.0	38.9	7196.7	46.8	1655.8	34.3	5847.5	71.3
Hydroporus	-	-	4.0	0.0	137.5	0.9	37.5	0.8	170.0	2.1
Oligochaeta	22.7	0.3	252.0	2.2	313.3	2.0	188.3	3.9	297.5	3.6
Paraleptophlebia	158.0	2.2	194.7	1.7	15.8	0.1	40.0	0.8	30.0	0.4
Perlesta	50.7	0.7	659.3	5.8	250.0	1.6	303.3	6.3	97.5	1.2
Physa	48.0	0.7	36.7	0.3	253.3	1.6	25.8	0.5	177.5	2.2
Simuliidae	284.7	4.0	746.7	6.6	670.8	4.4	920.8	19.1	144.2	1.8
Stenelmis	384.0	5.4	284.7	2.5	460.0	3.0	85.8	1.8	16.7	0.2

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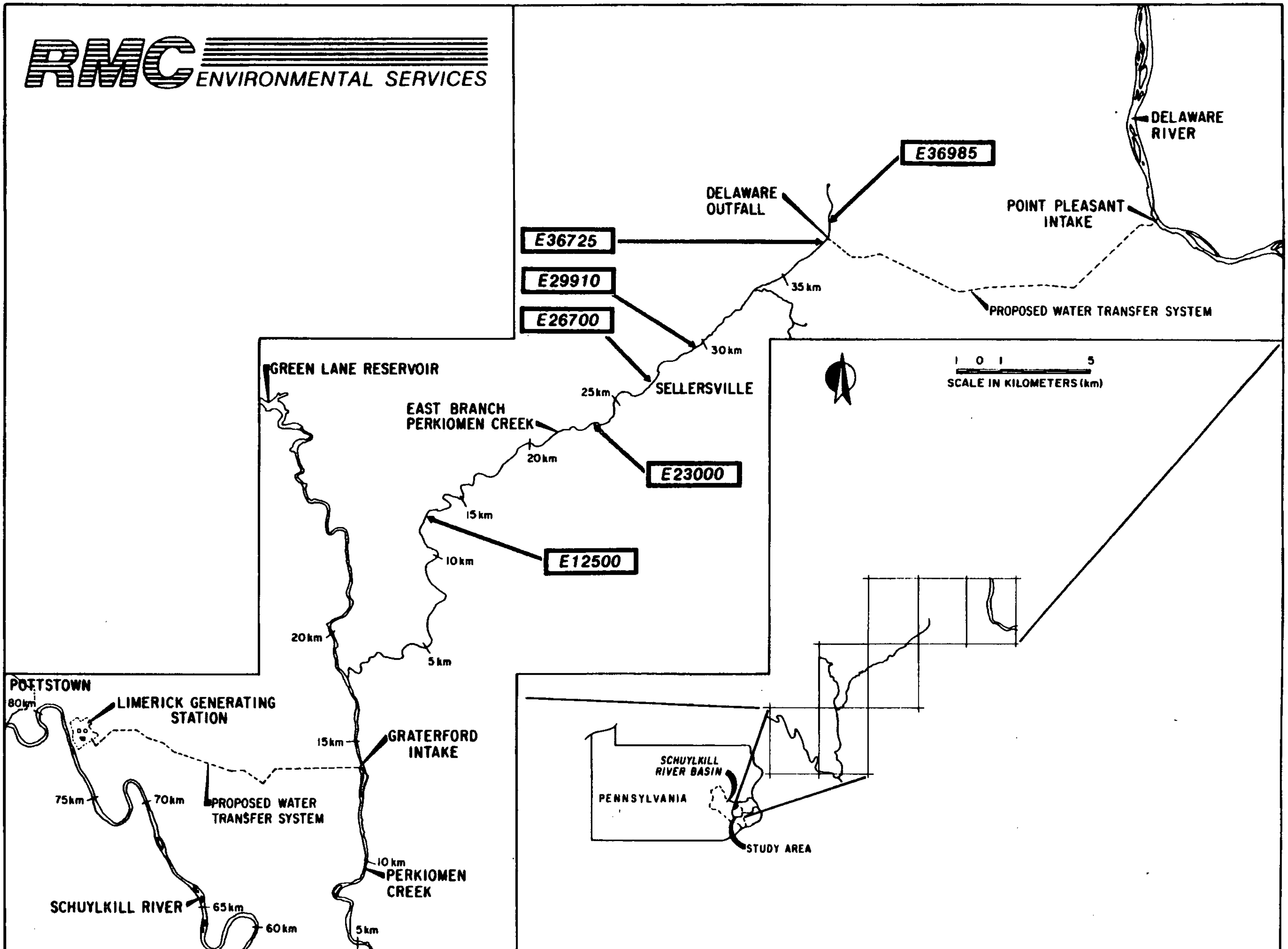


FIGURE 4.2-1 LOCATION OF BENTHIC MACROINVERTEBRATE SAMPLE STATIONS IN EAST BRANCH PERKIOMEN CREEK, 1987.

4.3 Fish

Introduction

Fishes inhabiting the EBPC were studied from 1970-1978 and from 1981-present, to establish a preoperational baseline that will be compared with data collected after diversion of Delaware River water to the EBPC via the Point Pleasant Water Diversion Project. Objectives of these fisheries investigations were outlined in previous progress reports (RMC Environmental Services 1984, 1985, 1986, and 1987a). Methods to collect, process, and analyze data in 1987 were unchanged from those reported in the 1986 progress report (RMC Environmental Services 1987a), except that age and growth of selected species was not studied in 1987. Station locations for seining and electrofishing surveys are shown in Figures 4.3-1 and 4.3-2, respectively.

Since the Point Pleasant Water Diversion Project (now under construction) has not been completed, the objective of this section is to briefly summarize the information collected in 1987. Less detail than has appeared in earlier progress reports is warranted because the primary purpose of the 1987 data collection effort is to add to the preoperational database that will ultimately be compared with postoperational data to assess the effects of water diversion. These data are available for analyses of long-term trends in fish community characteristics and biology of individual species, which in turn must be understood in order to assess the effects of water diversion on resident fishes in the EBPC.

Summary of 1987 Data Collections

Thirty three indigenous (native or established introductions) species of fish were seined or electrofished from the EBPC in 1987 (Table 4.3-1). Additionally, brown trout and rainbow trout were stocked between Sellersville and Branch Road. No new species was collected from the stream. Several less abundant species known to occur in the EBPC were not collected, including chain pickerel, bridle shiner, creek chub, white catfish, margined madtom, white crappie, yellow perch, and shield darter.

Sampling efforts did not overlap with the period of time when stocked trout were most abundant, and only two were collected. A trout creel survey indicated that most stocked trout were harvested (RMC Environmental Services 1987b). Species such as muskellunge, walleye, silvery minnow, and mummichog that have appeared in past collections are likely due to angler introductions.

In total, 6,615 fish of 29 species or hybrids were seined from seven EBPC stations in 1987 (Table 4.3-1). Catches from individual seine stations are given in Table 4.3-2. An additional 688 fish of 15 species were seined from Morris Run (an EBPC tributary), while 731 fish of 24 species were collected from Perkiomen Creek in Schwenksville (Table 4.3-3). These two streams were sampled to examine the status of minnow populations in streams near the EBPC that will not be directly affected by water diversion but that are subjected to similar climatological conditions.

In 1987, 13,105 fish of 20 species or hybrids were collected by electrofishing from seven stations distributed along the EBPC (Table 4.3-1). Data were used to make depletion or mark recapture population estimates (Van Deventer and Platts 1983, Ricker 1975) depending on station; results expressed as number of fish per hectare are given in Table 4.3-4. Population estimates can be converted to estimates of biomass (kilograms per hectare) but for the purpose of brevity these calculations are not presented at this time.

The seine and electrofishing results in 1987 agree with past descriptions of the abundance and distribution of fishes in the EBPC. Patterns of longitudinal zonation in community composition remained similar, as did studied aspects of the biology of important species. Collectively, results display a fish community exhibiting patterns of year-to-year variability superimposed on a pattern of long-term stability, which is typical of warmwater stream fish communities not exposed to severe environmental degradation. Such communities are regulated by both physical and biological factors (Schlosser 1987). The relative strength of each type varies from place to place and from year to year as hydrological, meteorological, and biological conditions change.

Table 4.3-1. Fishes collected from East Branch Perkiomen Creek since 1970, their status, and relative abundance by sampling method in 1987.

Species	Status	Electrofishing N	Electrofishing %	Seining N	Seining %
American eel	N	4	0.03	0	0
Brook trout	I	0	0	0	0
Brown trout	I	0	0	0	0
Rainbow trout	I	2	0.02	0	0
Redfin pickerel	N	8	0.06	3	0.04
Muskellunge	I	0	0	0	0
Hybrid *Esox*	I	0	0	0	0
Chain pickerel	N	0	0	0	0
Goldfish	I	30	0.23	0	0
Carp	I	87	0.66	0	0
Carp x goldfish hybrid	N	1	0.01	0	0
Cutlips minnow	N	X		9	0.14
Golden shiner	N	102	0.78	1,211	18.31
Comely shiner	N	X		521	7.88
Satinfin shiner	N	X		58	0.88
Bridle shiner	N	X		0	0
Common shiner	N	X		680	10.28
Silvery minnow	I	X		0	0
Spottail shiner	N	X		64	0.97
Swallowtail shiner	N	X		78	1.18
Spotfin shiner	N	X		1,679	25.38
Bluntnose minnow	N	X		267	4.04
Fathead minnow	I	X		2	0.03
Blacknose dace	N	X		27	0.41
Longnose dace	N	X		24	0.36
Creek chub	N	X		0	0
Fallfish	N	6	0.05	2	0.03
Minnow hybrids	N	X		0	0
White sucker	N	929	7.09	168	2.54
Creek chubsucker	N	1,991	15.19	272	4.11
White catfish	N	0	0	0	0
Yellow bullhead	N	525	4.01	5	0.08
Brown bullhead	N	72	0.55	4	0.06
Margined madtom	N	0	0	0	0
Banded killifish	N	X		927	14.01
Mummichog	I	X		0	0
Rock bass	I	1,270	9.69	12	0.18
Redbreast sunfish	I	3,300	25.18	156	2.36
Green sunfish	I	2,856	21.79	191	2.89
Pumpkinseed	N	1,049	8.00	42	0.63
Bluegill	I	77	0.59	26	0.39
Hybrid sunfish	N	135	1.03	3	0.04
Smallmouth bass	I	584	4.46	45	0.68
Largemouth bass	I	77	0.59	21	0.32

Table 4.3-1. (continued)

Species	Status	Electrofishing N	Electrofishing %	Seining N	Seining %
White crappie	I	0	0	0	0
Black crappie	I	0	0	3	0.04
Tessellated darted	N	X		151	2.28
Yellow perch	N	0	0	0	0
Walleye	I	0	0	0	0
Shield darter	N	X		0	0
Total		13,105		6,615	

Status:

N = Native
I = Introduced
X = Species excluded from electrofishing samples

Table 4.3-2. Total catch and relative abundance of fishes collected by seine from East Branch Perkiomen Creek by station in 1987.

Species	E 1890 Catch	%	E 5475 Catch	%	E12440 Catch	%	E22980 Catch	%	E26630 Catch	%	E29810 Catch	%	E36690 Catch	%
Redfin pickerel	-	-	-	-	-	-	-	-	-	-	-	-	3	0.2
Cutlips minnow	-	-	-	-	1	0.1	7	1.0	1	0.1	-	-	-	-
Golden shiner	-	-	-	-	5	0.5	50	7.5	10	1.4	69	3.3	1077	63.9
Comely shiner	-	-	-	-	242	22.5	43	6.4	2	0.3	233	11.1	1	0.1
Satinfin shiner	-	-	9	2.8	39	3.6	10	1.5	-	-	-	-	-	-
Common shiner	2	2.7	26	8.2	60	5.6	194	29.0	227	31.0	170	8.1	1	0.1
Spottail shiner	3	4.1	6	1.9	9	0.8	-	-	26	3.5	20	1.0	-	-
Swallowtail shiner	-	-	1	0.3	6	0.6	2	0.3	42	5.7	26	1.2	1	0.1
Spotfin shiner	21	28.4	147	46.2	506	47.1	198	29.6	98	13.4	704	33.6	5	0.3
Bluntnose minnow	-	-	-	-	10	0.9	44	6.6	5	0.7	96	4.6	112	6.6
Fathead minnow	-	-	-	-	-	-	-	-	1	0.1	1	+	-	-
Blacknose dace	6	8.1	1	0.3	1	0.1	6	0.9	13	1.8	-	-	-	-
Longnose dace	6	8.1	2	0.6	8	0.7	7	1.0	1	0.1	-	-	-	-
Fallfish	-	-	2	0.6	-	-	-	-	-	-	-	-	-	-
White sucker	2	2.7	8	2.5	1	0.1	9	1.3	17	2.3	69	3.3	62	3.7
Creek chubsucker	-	-	-	-	1	0.1	-	-	2	0.3	119	5.7	150	8.9
Yellow bullhead	-	-	1	0.3	-	-	1	0.1	2	0.3	1	+	-	-
Brown bullhead	-	-	-	-	-	-	-	-	4	0.5	-	-	-	-
Banded killifish	3	4.1	37	11.6	113	10.5	28	4.2	242	33.0	468	22.3	36	2.1
Rock bass	3	4.1	3	0.9	6	0.6	-	-	-	-	-	-	-	-
Redbreast sunfish	7	9.5	25	7.9	47	4.4	27	4.0	4	0.5	43	2.0	3	0.2
Green sunfish	-	-	14	4.4	8	0.7	4	0.6	2	0.3	28	1.3	135	8.0
Pumpkinseed	-	-	21	6.6	2	0.2	-	-	3	0.4	2	0.1	14	0.8
Bluegill	-	-	5	1.6	4	0.4	-	-	7	1.0	3	0.1	7	0.4
Lepomis hybrid	-	-	-	-	-	-	-	-	1	0.1	1	+	1	0.1
Smallmouth bass	21	28.4	8	2.5	3	0.3	9	1.3	2	0.3	2	0.1	-	-
Largemouth bass	-	-	2	0.6	2	0.2	3	0.4	11	1.5	1	+	2	0.1
Black crappie	-	-	-	-	-	-	3	0.4	-	-	-	-	-	-
Tessellated darter	-	-	-	-	-	-	23	3.4	10	1.4	42	2.0	76	4.5
Total Catch	74		318		1074		668		733		2098		1686	
Number of Species	10		18		21		19		23		19		16	
Number of Stations	1		1		1		1		1		1		1	

+ = Less than 0.1%

Table 4.3-3. Total catch and relative abundance of fishes collected by seine from Morris Run and Perkiomen Creek, and Perkiomen Creek in 1987.

Species	Morris Run Catch	%	Perkiomen Cr Catch	%
Cutlips minnow	-	-	1	0.1
Golden shiner	-	-	3	0.4
Comely shiner	19	2.8	16	2.2
Satinfin shiner	-	-	3	0.4
Common shiner	95	13.8	6	0.8
Spottail shiner	13	1.9	28	3.8
Swallowtail shiner	12	1.7	25	3.4
Spotfin shiner	124	18.0	539	73.7
Bluntnose minnow	96	14.0	21	2.9
Blacknose dace	33	4.8	6	0.8
Longnose dace	-	-	9	1.2
Fallfish	1	0.1	4	0.5
White sucker	-	-	2	0.3
Creek chubsucker	1	0.1	-	-
Brown bullhead	-	-	1	0.1
Banded killifish	189	27.5	12	1.6
Rock bass	-	-	7	1.0
Redbreast sunfish	26	3.8	9	1.2
Green sunfish	8	1.2	2	0.3
Pumpkinseed	-	-	2	0.3
Bluegill	2	0.3	2	0.3
Smallmouth bass	42	6.1	7	1.0
Largemouth bass	-	-	3	0.4
Tessellated darter	27	3.9	22	3.0
Shield darter	-	-	1	0.1
Total Catch	688		731	
Number of Species	15		24	
Number of Stations	1		1	

+ = Less than 0.1%

Table 4.3-4. Density (number/hectare) of fishes estimated in spring and fall at seven stations in East Branch Perkiomen Creek in 1987.

Station:	E1637		E5650		E12111		E22240		E30700		E36235		E36300	
Area(ha):	0.436		2.10		0.562		0.418		0.285		0.034		0.045	
Species / Season:	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
American eel	5	0	3	0	0	0	0	0	0	4	0	0	0	0
Rainbow trout	0	0	0	0	0	0	5	0	7	0	0	0	0	0
Redfin pickerel	0	0	0	0	0	0	0	0	0	7	0	118	44	0
Goldfish	0	0	3	2	48	5	0	0	0	0	0	0	0	0
Carp x Goldfish hybrid	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Carp	28	9	68	49	0	0	12	10	0	21	0	0	0	0
Golden shiner	0	0	10	1	0	0	0	0	35	0	735	588	600	511
Fall fish	5	14	0	0	0	0	0	0	0	0	0	0	0	0
White sucker	30	39	643	98	16	7	354	505	379	404	765	382	622	133
Creek chubsucker	0	101	0	8	7	5	7	77	4,340	3,642	1,794	147	1,378	622
Yellow bullhead	46	101	127	158	146	78	153	98	211	211	0	0	44	0
Brown bullhead	7	7	26	10	0	0	7	10	21	32	0	0	0	0
Rock bass	617	1,328	209	376	1,032	269	0	0	0	0	0	0	0	0
Redbreast sunfish	1,351	1,477	1,144	897	2,685	304	639	689	600	151	176	0	378	0
Green sunfish	447	573	1,352	1,020	528	130	514	797	2,740	4,347	1,118	294	2,911	2,600
Pumpkinseed	7	0	799	1,001	55	4	132	156	211	119	147	0	289	4
Bluegill	0	0	3	8	2	0	24	36	70	102	88	0	0	0
Hybrid sunfish	9	7	79	29	52	5	29	38	32	21	29	0	156	0
Smallmouth bass	622	647	20	56	149	219	96	110	14	14	0	0	0	0
Largemouth bass	14	96	7	101	4	7	5	0	4	14	29	0	44	22
Total	3,188	4,399	4,493	3,814	4,724	1,033	1,979	2,526	8,664	9,089	4,881	1,529	6,466	3,892

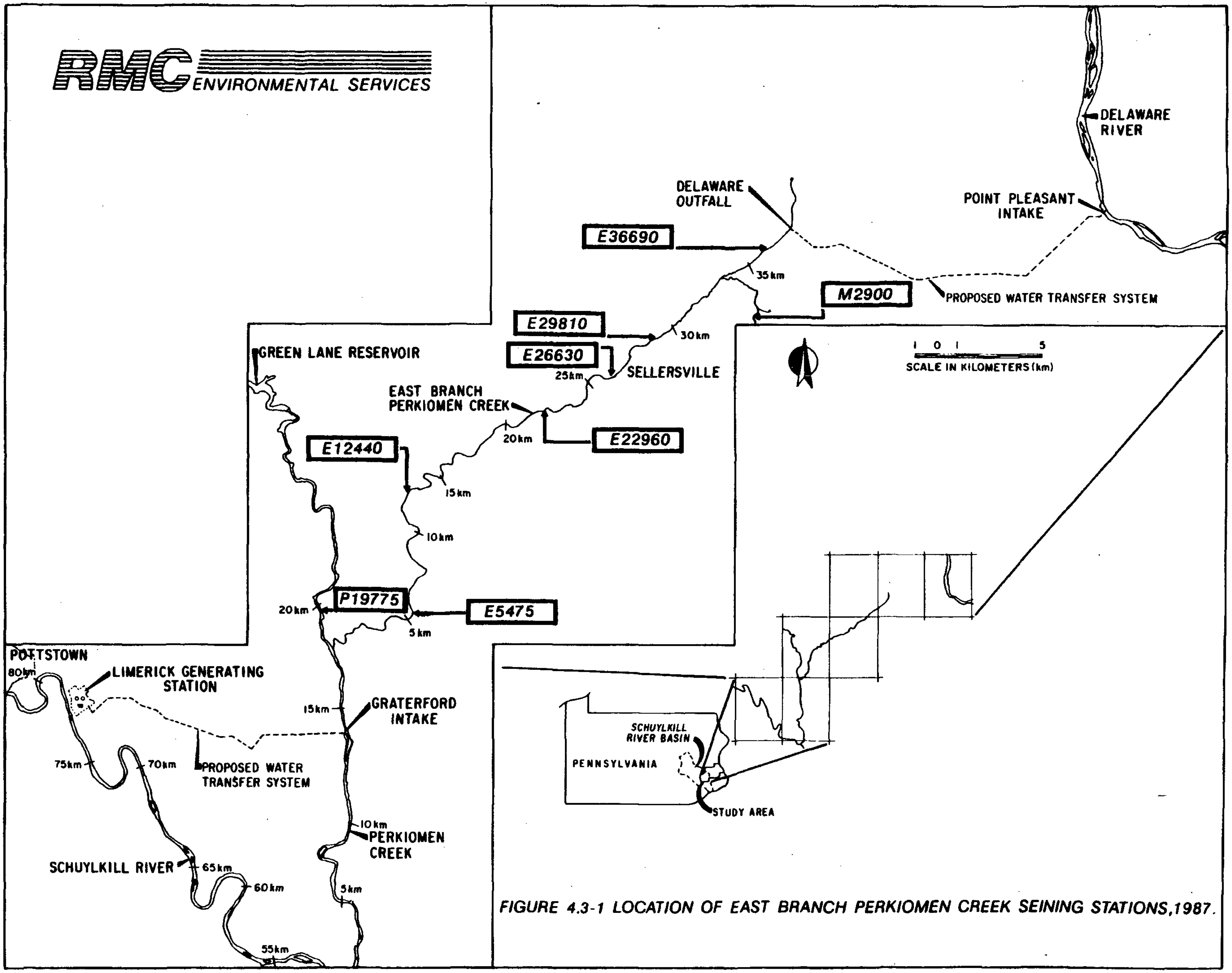


FIGURE 4.3-1 LOCATION OF EAST BRANCH PERKIOMEN CREEK SEINING STATIONS, 1987.

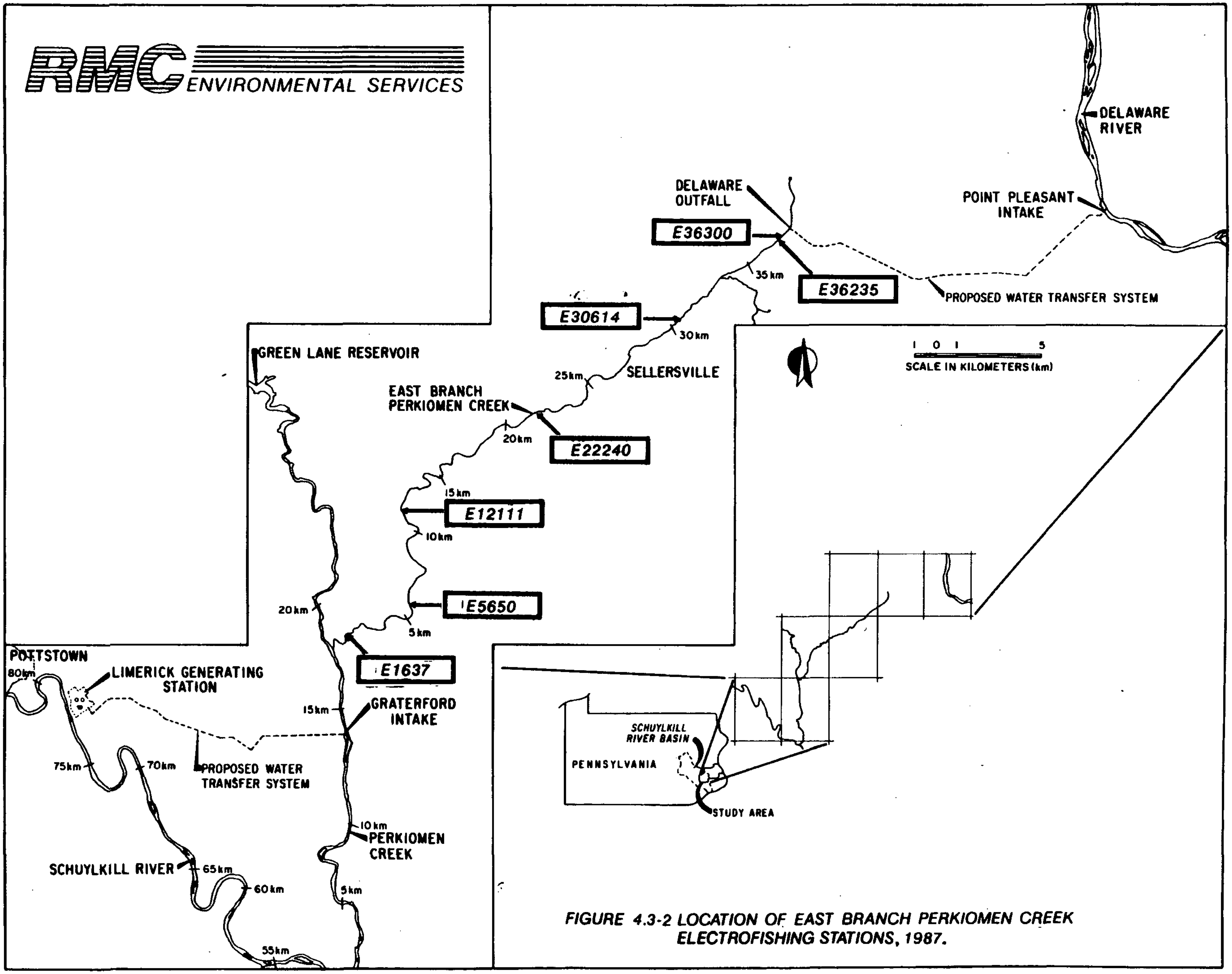


FIGURE 4.3-2 LOCATION OF EAST BRANCH PERKIOMEN CREEK ELECTROFISHING STATIONS, 1987.

5.0 Perkiomen Creek

The reach of Perkiomen Creek between Schwenksville and Graterford, Pennsylvania, that comprises a portion of the Point Pleasant Water Diversion Project was described in section 5.0 of the 1986 progress report to PECo (RMC Environmental Services 1987a). All construction of the Graterford intake, pumphouse, stabilizer bar, and pipeline was completed by the end of 1985. Operation of the intake station to date has been limited to infrequent test withdrawals and backflushing of the wedgewire screens located in midchannel. Therefore, 1987 data on water quality and fishes summarized in the following two sections (5.1 and 5.2, respectively) add to the preoperational baseline that will be compared with similar data collected after water is diverted to and withdrawn from Perkiomen Creek.

5.1 Water Quality

Introduction and Methods

Investigation of Perkiomen Creek water quality began in May 1974 and continued through 1987. The objectives of this program are to assess impacts of future diversion operation on water quality of the creek, provide water quality information regarding the consequences to LGS operation of Perkiomen Creek use as a cooling water source, and to complement concurrent aquatic ecological programs.

As in previous years, sampling was conducted at two stations on the mainstem Perkiomen Creek (Fig. 5.1-1). Station P18700 is located just upstream of the Pennsylvania Route 73 bridge and the confluence with East Branch Perkiomen Creek. This control station provides water quality information on a portion of Perkiomen Creek that will be unaffected by diversion. Station P14390 is situated downstream of the East Branch confluence in the immediate vicinity of the Graterford Intake. Sampling was conducted once every 2 weeks at both stations. All samples were subsurface grabs collected at mid-channel, and were analyzed according to standard, widely accepted methods.

Results and Discussion

Perkiomen Creek is a moderately hard warmwater stream which receives moderate amounts of nonindustrial pollution inputs as indicated by elevated concentrations of nutrients. The stream appears to fluctuate between a sulfate and carbonate ionic base and often contains high concentrations of major cations (calcium, magnesium, potassium, and sodium).

Discharge during 1987 as measured by the U.S.G.S. at Graterford, Pennsylvania was generally low, particularly in January-March, May-August, October, and December (Table 5.1-1 and Fig. 5.1-2).

Mean monthly flows exceeded 1970-1987 monthly means only in April, September, and November (Table 5.1-2 and Fig. 5.1-3). The September mean was 30 cfs above the record mean while the November mean was less than 10 cfs above the record mean. The April mean flow was approximately 860 cfs above the record mean. No new maximum or minimum flows were observed. Monthly median flows exceeded the record median flows in January, April-July, and September-October. The November median was the same as the record median.

Seasonal summaries of water quality data obtained from P18700 and P14390 for the 1979-1987 period are presented in Tables 5.1-3 and 5.1-4, respectively, and for 1987 alone in Tables 5.1-5 and 5.1-6, respectively. Some new minimum and maximum values were recorded for 1987 when compared to the 1983-1987 period of record at P18700 (Tables 5.1-7 and 5.1-8) and at P14390 (Tables 5.1-9 and 5.1-10).

Due to the limited period of analysis, the parameters cadmium, mercury, nickel, and aluminum appear often on both the new minimum and maximum tables for both stations. Unless the compound had been detected before, or was consistently detected during the course of the survey year, or exhibited extreme values, no mention will be made of these four metals in the following discussion.

During the winter quarter a first detection of trichloroethylene (TCE) at the downstream station was made. TCE was also detected for the first time at both stations on 24 March. Three additional new maxima were observed at the upstream station for pH, nitrite nitrogen and chemical oxygen demand. None of the new upstream maxima represented a significant increase in values. At the downstream station a new maximum for total phosphate phosphorus was observed. The new maximum does not represent a major change.

Several new maxima were established at both stations during the summer quarter. Higher nitrite nitrogen levels were detected at both stations on 17 June that were approximately 1 mg/l above previous maxima. At the upstream station, new maxima for total suspended solids, total dissolved solids, manganese, and cyanide were established but were not significant extensions of their range in concentration. New summer maxima at the downstream station included biochemical oxygen demand, total dissolved solids, ammonia nitrogen, ortho phosphate phosphorus, cyanide, and sulfide. Total dissolved solids increased by 669 mg/l and sulfide by 1 mg/l over previous maxima.

New maximum values for sulfide were observed at both stations on 21 October. Both new maxima increased by 5 mg/l. Maximum total dissolved solids at the upstream station increased by approximately 700 mg/l over the previous maximum. A slight increase in lead at the downstream station was observed along with a new maximum for fecal coliforms on 9 September, which coincided with the second highest flow of the year (3,070 cfs).

The high flow of 9 September corresponded with new minima at both stations. New minima were established at both stations for total alkalinity, sulfate, and magnesium. Also on 9 September, new minima for the season at the downstream station were established for specific conductance, sodium, and calcium.

Table 5.1-1. Mean daily Perkiomen Creek discharge (ft^3/sec) measured at the Graterford US US Geological Survey gage in 1987.

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	335	N/A	N/A	2090	1330	N/A	144	125	59	104	161	1200
02	579	280	N/A	N/A	1270	163	246	128	60	89	146	655
03	764	489	1970	N/A	N/A	N/A	734	N/A	57	109	137	442
04	605	917	1440	N/A	N/A	173	267	132	53	554	134	393
05	455	756	1000	N/A	N/A	220	N/A	N/A	52	275	126	338
06	375	534	840	N/A	N/A	192	149	240	53	184	119	281
07	352	530	767	3030	872	166	N/A	100	69	203	111	240
08	339	590	N/A	N/A	N/A	178	N/A	77	194	203	107	221
09	327	486	661	N/A	342	158	210	N/A	3070	142	105	209
10	373	350	545	N/A	N/A	165	N/A	111	N/A	119	399	204
11	898	338	N/A	1550	303	145	N/A	77	223	116	1900	194
12	691	317	N/A	1460	286	138	N/A	N/A	152	119	N/A	183
13	532	295	432	N/A	272	144	N/A	55	N/A	111	N/A	172
14	549	252	390	N/A	265	N/A	N/A	52	N/A	98	643	148
15	624	228	352	N/A	284	158	N/A	N/A	N/A	90	436	N/A
16	628	N/A	321	1270	320	140	336	N/A	N/A	85	330	N/A
17	439	237	305	1380	269	N/A	220	53	N/A	91	279	N/A
18	472	N/A	270	1750	247	131	170	52	N/A	76	362	N/A
19	1680	180	262	1470	269	131	149	53	N/A	78	331	N/A
20	1550	170	261	1370	341	N/A	137	N/A	N/A	78	259	N/A
21	921	164	252	N/A	376	156	141	N/A	N/A	121	234	N/A
22	669	172	246	1210	307	N/A	137	N/A	N/A	127	173	N/A
23	569	238	N/A	N/A	298	902	133	N/A	N/A	106	149	N/A
24	N/A	256	N/A	N/A	285	345	138	N/A	N/A	99	152	254
25	438	252	N/A	N/A	238	226	140	N/A	N/A	92	155	242
26	387	244	N/A	N/A	218	N/A	165	N/A	127	88	154	291
27	410	265	N/A	N/A	215	179	181	N/A	103	106	147	291
28	392	261	N/A	1560	208	176	N/A	101	91	950	141	246
29	N/A		223	1520	N/A	N/A	N/A	80	86	368	454	242
30	N/A		223	1400		140	302	75	92	244	5000	199
31	297		1010				124	60		190		226
Minimum	297	164	223	1210	208	131	124	52	52	76	105	148
Mean	595	352	589	1620	401	206	211	92	284	175	459	312
Median	502	265	371	1470	286	164	157	77	89	111	158	242
Maximum	1680	917	1970	3030	1330	902	734	240	3070	950	5000	1200

Table 5.1-2. Mean monthly Perkiomen Creek discharge (ft^3/sec) measured at the Graterford US Geological Survey gage, 1970 - 1987.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970	238	871	552	1123	167	240	83	89	64	183	727	395
1971	458	1241	770	467	361	162	116	493	1163	396	672	382
1972	468	691	984	482	601	1330	248	75	58	82	1182	1092
1973	719	731	521	1074	541	519	242	172	98	81	114	1311
1974	762	267	730	953	371	171	80	167	416	217	131	696
1975	895	903	836	471	466	790	1076	168	586	534	431	310
1976	1006	723	424	403	199	127	102	103	75	371	168	270
1977	134	710	1243	819	230	98	90	104	70	280	827	1307
1978	1344	278	1525	351	864	191	218	273	133	104	118	704
1979	2071	1186	752	527	733	298	186	143	648	657	661	398
1980	354	156	1043	816	379	112	93	74	80	99	137	83
1981	76	539	209	564	488	173	100	54	73	111	137	331
1982	542	973	387	933	290	946	143	84	58	54	128	217
1983	410	587	1112	1759	542	250	66	63	46	151	734	1491
1984	291	1106	946	1100	1259	557	1286	189	93	125	142	297
1985	195	515	186	128	276	100	68	84	544	217	814	478
1986	644	1025	707	616	183	85	97	193	77	103	601	1011
1987	595	352	589	1620	401	206	211	92	284	175	459	312
Minimum	58	58	83	77	74	48	31	38	28	35	35	58
Mean	622	716	754	762	465	355	251	147	253	219	450	622
Median	287	345	415	400	252	157	89	80	70	102	158	310
Maximum	14602	10000	9440	11399	8350	13300	14800	9000	11900	4430	8080	14300

Table 5.1-3. Summary of Perkiomen Creek water quality at Station P18700, 20 March 1979 through 30 December 1987.

Parameter	Dec, Jan, Feb Min	Dec, Jan, Feb Med	Dec, Jan, Feb Max	Mar, Apr, May Min	Mar, Apr, May Med	Mar, Apr, May Max	Jun, Jul, Aug Min	Jun, Jul, Aug Med	Jun, Jul, Aug Max	Sep, Oct, Nov Min	Sep, Oct, Nov Med	Sep, Oct, Nov Max	# of Samples
Temperature (C)	-1.0	1.5	8.0	1.0	9.9	21.0	14.0	22.0	27.0	3.5	14.0	23.5	219
Dissolved Oxygen (mg/l)	8.7	12.4	15.8	6.8	11.1	14.1	5.8	8.2	12.7	6.8	10.0	14.4	225
Biochemical Oxygen Demand (mg/l)	0.1	1.7	6.7	0.0	2.1	5.0	0.3	1.6	6.4	0.1	1.6	7.0	229
Chemical Oxygen Demand (mg/l)	0.0	11.5	123.9	0.0	13.3	43.6	0.0	11.1	76.6	0.0	14.5	42.1	228
Total Organic Carbon (mg/l)	0.0	3.7	20.2	0.0	3.4	15.7	0.0	4.4	16.0	0.0	4.8	21.4	222
pH	7.04	7.69	8.82	6.14	7.83	9.15	7.28	7.92	9.19	7.37	8.02	9.09	229
Total Alkalinity (mg/l)	11.4	48.8	99.6	4.7	44.7	67.2	20.5	60.9	77.8	26.4	66.7	83.8	229
Total Hardness (mg/l)	40.3	80.0	147.2	39.4	71.5	112.5	53.6	82.7	123.6	53.4	94.0	179.1	228
Specific Conductance (usm/cm)	126	207	381	109	190	239	106	218	452	145	243	585	229
Total Suspended Solids (mg/l)	0	3	471	0	7	63	0	8	40	0	2	83	229
Total Dissolved Solids (mg/l)	37	159	275	99	148	244	70	177	354	100	172	1190	229
Dissolved Silica (mg/l)	2.69	3.94	5.50	2.72	4.13	5.98	2.83	3.84	5.35	1.56	3.11	4.64	75
Total Inorganic Carbon (mg/l)	12.6	52.7	102.2	5.0	43.1	57.7	20.9	61.8	79.3	37.4	67.2	85.1	124
Chloride (mg/l)	12.1	21.8	49.3	9.2	17.3	30.8	4.6	18.1	81.0	11.0	22.3	67.1	229
Sulfate (mg/l)	15.4	30.8	70.4	12.0	27.1	40.1	0.0	26.8	76.7	14.0	32.3	96.6	229
Sodium (mg/l)	6.03	12.02	26.60	6.09	10.60	17.20	4.11	11.99	32.22	7.53	14.00	50.70	229
Potassium (mg/l)	1.7	3.3	12.2	1.5	2.8	6.7	1.6	3.9	14.8	2.3	5.0	30.5	229
Calcium (mg/l)	10.1	18.5	43.3	6.1	17.9	32.9	8.4	18.6	43.8	12.6	21.8	36.7	229
Magnesium (mg/l)	5.33	8.79	14.70	4.80	7.86	10.80	4.92	8.85	11.90	5.19	9.90	22.73	229
Ammonia Nitrogen (mg/l)	0.000	0.136	0.940	0.000	0.053	0.380	0.000	0.030	0.150	0.000	0.020	0.570	229
Nitrite Nitrogen (mg/l)	0.008	0.022	0.115	0.010	0.028	0.097	0.000	0.020	1.110	0.000	0.020	0.200	229
Nitrate Nitrogen (mg/l)	0.92	2.06	4.84	0.42	1.40	6.94	0.00	0.97	2.09	0.00	1.03	4.17	229
Total Phosphate Phosphorus (mg/l)	0.00	0.08	0.38	0.00	0.06	0.18	0.00	0.08	1.43	0.00	0.09	0.37	219
Ortho Phosphate Phosphorus (mg/l)	0.00	0.04	0.16	0.00	0.03	0.17	0.00	0.06	0.18	0.00	0.05	0.41	227
Cadmium (mg/l)	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	32
Chromium (mg/l)	0.000	0.004	0.026	0.000	0.005	0.050	0.000	0.003	0.056	0.000	0.003	0.043	228
Copper (mg/l)	0.000	0.002	0.082	0.000	0.003	0.020	0.000	0.003	0.036	0.000	0.001	0.017	229
Iron (mg/l)	0.00	0.25	10.70	0.00	0.27	1.41	0.00	0.28	1.74	0.00	0.21	4.26	229
Lead (mg/l)	0.000	0.000	0.020	0.000	0.000	0.015	0.000	0.000	0.049	0.000	0.000	0.013	229
Manganese (mg/l)	0.00	0.00	0.42	0.00	0.02	0.15	0.00	0.05	0.22	0.00	0.00	0.35	229
Nickel (mg/l)	0.000	0.000	0.002	0.000	0.002	0.005	0.000	0.000	0.002	0.000	0.000	0.002	32
Zinc (mg/l)	0.00	0.00	0.59	0.00	0.00	0.21	0.00	0.01	0.08	0.00	0.00	0.16	229
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.2	32
Cyanide, Total (mg/l)	0.000	0.000	0.005	0.000	0.000	0.004	0.000	0.000	0.005	0.000	0.000	0.004	227
Phenols (mg/l)	0.000	0.000	0.030	0.000	0.000	0.013	0.000	0.000	0.019	0.000	0.000	0.044	228
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	199
Total Coliforms (MF) (c/.1l)	0	445	18000	15	380	34000	120	980	37000	40	700	40000	224
Fecal Coliforms (MF) (c/.1l)	1	68	3400	0	85	8600	50	235	25000	22	155	4100	223
Aluminum (mg/l)	0.00	0.25	1.00	0.09	0.18	0.71	0.00	0.10	1.00	0.00	0.04	2.86	32
Sulfide (mg/l)	0.00	0.19	5.60	0.00	0.00	0.51	0.00	0.00	1.20	0.00	0.45	7.60	57

Table 5.1-4. Summary of Perkiomen Creek water quality at Station P14390, 20 March 1979 through 30 December 1987.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	-1.0	1.5	8.0	1.0	10.7	24.0	14.0	23.0	28.0	3.0	14.0	24.0	245
Dissolved Oxygen (mg/l)	7.6	12.3	15.0	5.5	11.0	16.5	4.6	7.8	13.4	4.5	9.7	14.2	225
Biochemical Oxygen Demand (mg/l)	0.0	1.8	7.4	0.0	2.1	5.0	0.5	2.0	8.5	0.3	1.7	7.0	229
Chemical Oxygen Demand (mg/l)	0.0	12.1	93.4	0.0	11.7	42.6	0.0	12.3	135.8	0.0	14.4	164.7	227
Total Organic Carbon (mg/l)	0.0	3.8	36.2	0.0	3.1	12.1	0.0	4.6	19.2	0.0	4.8	25.8	222
pH	6.73	7.65	9.95	6.24	7.79	9.08	7.01	7.92	9.23	7.24	7.99	9.34	229
Total Alkalinity (mg/l)	16.5	47.0	104.2	9.3	45.3	66.2	17.8	64.3	79.3	20.1	68.5	89.4	229
Total Hardness (mg/l)	45.0	81.9	507.7	42.2	73.2	102.0	52.5	88.1	133.0	61.5	100.0	183.2	228
Specific Conductance (usm/cm)	127	221	411	116	198	279	123	256	333	144	274	523	229
Total Suspended Solids (mg/l)	0	3	676	0	5	101	0	9	383	0	3	150	229
Total Dissolved Solids (mg/l)	62	156	402	112	160	225	85	190	953	103	182	327	255
Dissolved Silica (mg/l)	2.49	3.89	5.46	2.29	4.17	6.64	2.37	3.69	4.85	0.93	2.82	4.75	75
Total Inorganic Carbon (mg/l)	18.2	54.8	107.8	10.0	45.5	58.7	19.2	64.0	78.3	35.2	69.7	90.6	124
Chloride (mg/l)	11.4	22.8	56.1	9.2	18.5	38.7	5.8	24.4	52.2	0.0	29.0	102.4	229
Sulfate (mg/l)	10.5	32.7	72.6	16.1	29.5	44.3	0.0	29.9	101.0	14.5	34.7	76.3	229
Sodium (mg/l)	7.39	13.84	35.20	3.20	12.10	19.41	4.88	15.52	34.50	7.70	18.60	48.00	229
Potassium (mg/l)	1.9	3.6	7.6	1.0	2.9	5.9	1.7	3.9	11.0	2.5	5.0	15.5	229
Calcium (mg/l)	9.6	19.5	41.6	6.7	18.1	34.2	7.9	19.0	32.2	9.1	22.3	34.9	229
Magnesium (mg/l)	6.02	9.14	15.00	2.90	8.19	11.80	5.00	9.40	21.20	4.71	10.40	16.50	229
Ammonia Nitrogen (mg/l)	0.000	0.128	0.800	0.000	0.046	0.430	0.000	0.040	0.200	0.000	0.030	0.580	229
Nitrite Nitrogen (mg/l)	0.009	0.020	0.145	0.012	0.027	0.111	0.000	0.020	0.980	0.000	0.018	0.220	229
Nitrate Nitrogen (mg/l)	0.95	2.21	4.01	0.37	1.50	3.03	0.00	0.97	5.00	0.00	1.24	3.77	229
Total Phosphate Phosphorus (mg/l)	0.00	0.09	0.66	0.00	0.07	0.30	0.00	0.10	2.98	0.00	0.10	0.35	219
Ortho Phosphate Phosphorus (mg/l)	0.00	0.06	0.15	0.00	0.04	0.20	0.00	0.07	0.26	0.00	0.06	0.42	227
Cadmium (mg/l)	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	32
Chromium (mg/l)	0.000	0.004	0.032	0.000	0.004	0.020	0.000	0.002	2.523	0.000	0.002	0.029	254
Copper (mg/l)	0.000	0.002	0.053	0.000	0.003	0.031	0.000	0.003	0.053	0.000	0.002	0.015	255
Iron (mg/l)	0.00	0.22	16.49	0.00	0.24	2.43	0.00	0.27	3.88	0.00	0.25	3.96	229
Lead (mg/l)	0.000	0.000	0.034	0.000	0.000	0.027	0.000	0.000	5.368	0.000	0.000	0.015	255
Manganese (mg/l)	0.00	0.00	0.62	0.00	0.00	0.12	0.00	0.05	0.38	0.00	0.00	0.32	229
Nickel (mg/l)	0.000	0.000	0.002	0.000	0.000	0.006	0.000	0.000	0.006	0.000	0.000	0.003	58
Zinc (mg/l)	0.00	0.00	0.34	0.00	0.01	0.13	0.00	0.01	0.53	0.00	0.01	0.23	255
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	32
Cyanide, Total (mg/l)	0.000	0.000	0.005	0.000	0.000	0.004	0.000	0.000	0.005	0.000	0.000	0.003	227
Phenols (mg/l)	0.000	0.000	0.045	0.000	0.000	0.013	0.000	0.000	0.020	0.000	0.000	0.027	228
Trichloroethylene (ug/l)	0.0	0.0	3.3	0.0	0.0	8.7	0.0	0.0	5.5	0.0	0.0	5.3	198
Total Coliforms (MF) (c/.1l)	0	515	21000	4	340	37000	40	950	43000	70	1045	43000	223
Fecal Coliforms (MF) (c/.1l)	1	95	3100	0	70	12500	18	300	20000	13	190	7680	225
Aluminum (mg/l)	0.10	0.27	1.80	0.06	0.19	0.79	0.00	0.03	0.80	0.00	0.10	2.75	32
Sulfide (mg/l)	0.00	0.00	1.23	0.00	0.00	0.43	0.00	0.00	1.50	0.00	0.25	5.70	57

Table 5.1-5. Summary of Perkiomen Creek water quality at Station P18700, 14 January 1987 through 30 December 1987.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	0.0	1.5	7.0	3.0	10.0	15.5	18.0	22.0	24.0	11.0	12.5	22.0	26
Dissolved Oxygen (mg/l)	10.4	11.8	14.4	9.7	11.5	13.0	6.9	8.9	11.0	8.1	9.4	11.9	24
Biochemical Oxygen Demand (mg/l)	0.8	2.1	3.9	1.6	3.2	4.4	0.8	1.4	5.7	1.5	1.8	2.6	26
Chemical Oxygen Demand (mg/l)	0.0	10.6	50.0	0.0	8.0	43.6	0.0	13.2	30.6	0.0	10.8	26.6	26
Total Organic Carbon (mg/l)	2.8	3.4	5.4	2.6	3.4	4.0	3.2	4.3	5.1	4.1	5.1	6.2	26
pH	7.54	7.78	8.18	7.60	7.79	9.15	7.70	8.17	8.56	7.55	7.83	8.08	26
Total Alkalinity (mg/l)	41.0	48.6	59.0	40.9	50.7	62.5	35.4	66.6	75.6	26.4	60.7	73.0	26
Total Hardness (mg/l)	76.4	85.5	103.0	58.8	79.8	91.8	78.8	98.0	103.4	72.8	98.8	112.0	26
Specific Conductance (usm/cm)	189	232	260	174	210	225	182	223	238	151	222	244	26
Total Suspended Solids (mg/l)	1	4	12	2	7	16	1	4	40	2	4	61	26
Total Dissolved Solids (mg/l)	90	148	178	112	156	203	138	172	354	120	147	1190	26
Chloride (mg/l)	15.0	21.5	24.9	14.4	16.4	21.9	13.6	15.6	17.8	14.6	21.3	26.5	26
Sulfate (mg/l)	20.1	23.5	34.5	16.2	21.8	26.1	15.0	19.0	22.0	14.0	25.0	30.0	26
Sodium (mg/l)	8.70	13.40	14.00	8.30	10.35	12.40	9.31	10.40	13.80	8.20	11.95	13.60	26
Potassium (mg/l)	1.7	3.3	5.8	1.6	2.9	3.2	1.6	2.5	5.0	2.7	3.7	4.2	26
Calcium (mg/l)	15.2	20.4	24.8	12.4	19.1	24.6	11.2	23.4	25.4	13.6	19.4	27.8	26
Magnesium (mg/l)	6.20	8.78	9.79	5.66	7.98	9.70	6.40	8.00	10.10	5.19	8.30	10.10	26
Ammonia Nitrogen (mg/l)	0.059	0.179	0.224	0.031	0.052	0.060	0.000	0.000	0.150	0.000	0.000	0.288	26
Nitrite Nitrogen (mg/l)	0.021	0.027	0.044	0.010	0.042	0.097	0.000	0.024	1.110	0.020	0.029	0.050	26
Nitrate Nitrogen (mg/l)	1.22	1.88	2.54	0.75	1.34	2.04	0.27	0.85	1.10	0.69	0.96	1.67	26
Total Phosphate Phosphorus (mg/l)	0.00	0.06	0.12	0.00	0.06	0.07	0.09	0.16	0.28	0.07	0.10	0.26	26
Ortho Phosphate Phosphorus (mg/l)	0.00	0.02	0.05	0.00	0.00	0.06	0.00	0.07	0.15	0.00	0.07	0.22	26
Cadmium (mg/l)	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Chromium (mg/l)	0.002	0.003	0.004	0.000	0.000	0.002	0.000	0.000	0.002	0.000	0.001	0.043	26
Copper (mg/l)	0.000	0.001	0.004	0.001	0.004	0.006	0.000	0.002	0.004	0.001	0.003	0.016	26
Iron (mg/l)	0.14	0.24	0.60	0.00	0.19	1.12	0.00	0.25	1.20	0.11	0.19	0.70	26
Lead (mg/l)	0.000	0.000	0.013	0.000	0.000	0.000	0.000	0.001	0.005	0.000	0.001	0.002	26
Manganese (mg/l)	0.00	0.00	0.11	0.00	0.00	0.14	0.00	0.00	0.22	0.00	0.00	0.27	26
Nickel (mg/l)	0.000	0.000	0.002	0.000	0.002	0.005	0.000	0.000	0.002	0.000	0.000	0.001	26
Zinc (mg/l)	0.00	0.00	0.01	0.00	0.02	0.04	0.01	0.02	0.07	0.01	0.01	0.02	26
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.2	26
Cyanide, Total (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000	26
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	25
Total Coliforms (MF) (c/.1l)	280	750	5100	160	690	2800	280	1000	3100	600	1750	8000	26
Fecal Coliforms (MF) (c/.1l)	17	59	750	15	100	370	90	190	600	22	250	490	26
Aluminum (mg/l)	0.10	0.25	0.54	0.09	0.18	0.71	0.00	0.10	1.00	0.00	0.02	0.88	26
Sulfide (mg/l)	0.00	0.70	1.02	0.00	0.00	0.20	0.00	0.40	0.60	0.20	0.55	7.60	26

Table 5.1-6. Summary of Perkiomen Creek water quality at Station P14390, 14 January 1987 through 30 December 1987.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	0.0	1.0	7.0	3.0	10.0	16.5	20.0	23.5	26.0	11.0	13.0	22.0	25
Dissolved Oxygen (mg/l)	10.2	12.1	14.5	8.8	10.8	12.6	6.0	8.4	13.0	7.7	9.4	10.6	24
Biochemical Oxygen Demand (mg/l)	0.7	2.0	3.3	1.2	3.1	3.7	0.9	2.3	8.5	1.3	1.9	2.2	26
Chemical Oxygen Demand (mg/l)	0.0	0.0	25.2	0.0	0.0	11.7	0.0	11.8	29.3	0.0	11.9	27.0	26
Total Organic Carbon (mg/l)	2.8	3.2	5.2	2.9	3.5	4.2	3.9	4.4	5.5	3.7	5.0	5.7	26
pH	7.53	7.65	7.99	7.57	7.70	8.64	7.62	8.10	8.81	7.38	7.60	7.76	26
Total Alkalinity (mg/l)	38.2	47.1	58.5	41.7	51.3	55.3	22.2	71.7	74.7	20.1	60.2	77.2	26
Total Hardness (mg/l)	79.7	90.3	111.0	67.1	82.0	99.9	80.7	111.6	116.6	93.8	108.0	123.0	26
Specific Conductance (usm/cm)	197	240	275	195	217	261	185	289	309	144	230	268	26
Total Suspended Solids (mg/l)	0	3	22	2	5	10	1	4	73	2	7	80	26
Total Dissolved Solids (mg/l)	115	153	175	132	161	189	158	209	953	132	165	189	26
Chloride (mg/l)	15.8	22.3	27.7	11.3	18.6	28.9	15.8	28.2	34.5	16.6	21.3	32.6	26
Sulfate (mg/l)	19.7	26.2	38.6	16.1	24.8	28.7	18.0	23.7	34.0	14.5	26.1	33.0	26
Sodium (mg/l)	9.50	14.20	15.50	10.60	11.60	14.70	9.20	21.49	22.00	7.70	13.40	20.90	26
Potassium (mg/l)	3.2	4.4	7.5	1.8	3.0	3.9	2.4	4.2	5.4	2.6	3.3	5.6	26
Calcium (mg/l)	13.9	20.0	24.8	14.8	19.6	23.4	7.9	22.6	31.1	9.1	19.4	32.2	26
Magnesium (mg/l)	6.20	8.76	9.70	5.96	8.74	9.98	5.60	9.40	11.00	4.71	8.50	12.40	26
Ammonia Nitrogen (mg/l)	0.041	0.146	0.213	0.032	0.046	0.060	0.000	0.039	0.200	0.000	0.015	0.215	26
Nitrite Nitrogen (mg/l)	0.019	0.025	0.042	0.012	0.039	0.102	0.020	0.040	0.980	0.018	0.025	0.061	26
Nitrate Nitrogen (mg/l)	1.39	2.03	2.74	0.72	1.41	2.11	0.29	0.74	1.00	0.86	1.20	1.54	26
Total Phosphate Phosphorus (mg/l)	0.00	0.12	0.40	0.06	0.07	0.30	0.12	0.16	0.29	0.06	0.09	0.32	26
Ortho Phosphate Phosphorus (mg/l)	0.00	0.03	0.10	0.00	0.00	0.05	0.00	0.09	0.26	0.00	0.09	0.24	26
Cadmium (mg/l)	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Chromium (mg/l)	0.002	0.003	0.005	0.000	0.000	0.002	0.000	0.000	0.004	0.000	0.002	0.017	26
Copper (mg/l)	0.000	0.001	0.004	0.000	0.005	0.007	0.000	0.002	0.006	0.001	0.003	0.013	26
Iron (mg/l)	0.12	0.20	1.10	0.00	0.16	0.56	0.00	0.14	1.40	0.10	0.12	1.20	26
Lead (mg/l)	0.000	0.000	0.005	0.000	0.000	0.002	0.000	0.000	0.007	0.000	0.001	0.015	26
Manganese (mg/l)	0.00	0.00	0.10	0.00	0.00	0.12	0.00	0.10	0.21	0.00	0.00	0.26	26
Nickel (mg/l)	0.000	0.000	0.002	0.000	0.000	0.006	0.000	0.001	0.006	0.000	0.001	0.003	26
Zinc (mg/l)	0.00	0.00	0.02	0.00	0.01	0.03	0.01	0.02	0.04	0.00	0.02	0.02	26
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	26
Cyanide, Total (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000	26
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Trichloroethylene (ug/l)	0.0	0.0	3.3	0.0	0.0	8.7	0.0	0.0	0.0	0.0	0.0	0.0	26
Total Coliforms (MF) (c/.1l)	290	700	8100	130	1130	5000	190	700	2500	80	2600	8000	26
Fecal Coliforms (MF) (c/.1l)	40	100	820	17	205	460	52	150	600	14	675	7680	26
Aluminum (mg/l)	0.11	0.26	1.20	0.06	0.19	0.79	0.00	0.03	0.80	0.00	0.07	1.42	26
Sulfide (mg/l)	0.00	0.00	0.90	0.00	0.00	0.30	0.00	0.40	1.50	0.00	0.35	5.70	26

Table 5.1-7. New minimum values observed for water quality parameters measured in 1987 at station P18700 on the Perkiomen Creek.

Season	Parameter	Value	Date
Mar, Apr, May	Cadmium (mg/l)	0.000	03/11/87
	Nickel (mg/l)	0.000	03/11/87
	Mercury (ug/l)	0.0	03/11/87
	Aluminum (mg/l)	0.09	04/22/87
Jun, Jul, Aug	Potassium (mg/l)	1.6	07/29/87
	Cadmium (mg/l)	0.000	06/03/87
	Nickel (mg/l)	0.000	07/01/87
	Mercury (ug/l)	0.0	06/03/87
	Aluminum (mg/l)	0.00	06/17/87
Sep, Oct, Nov	Total Alkalinity (mg/l)	26.4	09/09/87
	Sulfate (mg/l)	14.0	09/09/87
	Magnesium (mg/l)	5.19	09/09/87
	Fecal Coliforms (MF) (c/.1l)	22	11/04/87

Table 5.1-8. New maximum values observed for water quality parameters measured in 1987 at station P18700 on the Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Cadmium (mg/l)	0.001	12/02/87
Mar, Apr, May	pH	9.15	03/24/87
	Nitrite Nitrogen (mg/l)	0.097	03/11/87
	Cadmium (mg/l)	0.000	03/11/87
	Nickel (mg/l)	0.005	05/20/87
	Mercury (ug/l)	0.6	05/06/87
	Aluminum (mg/l)	0.71	04/08/87
	Chemical Oxygen Demand (mg/l)	43.6	03/24/87
	Trichloroethylene (ug/l)	7.7	03/24/87
Jun, Jul, Aug	Total Suspended Solids (mg/l)	40	07/15/87
	Total Dissolved Solids (mg/l)	354	07/15/87
	Nitrite Nitrogen (mg/l)	1.110	06/17/87
	Cadmium (mg/l)	0.000	06/03/87
	Manganese (mg/l)	0.22	07/15/87
	Nickel (mg/l)	0.002	06/03/87
	Mercury (ug/l)	0.0	06/03/87
	Aluminum (mg/l)	1.00	08/12/87
	Cyanide, Total (mg/l)	0.005	08/26/87
Sep, Oct, Nov	Total Dissolved Solids (mg/l)	1190	09/23/87
	Cadmium (mg/l)	0.000	09/23/87
	Chromium (mg/l)	0.043	09/09/87
	Mercury (ug/l)	0.2	11/18/87
	Sulfide (mg/l)	7.60	10/21/87

Table 5.1-9. New minimum values observed for water quality parameters measured in 1987 at station P14390 on the Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Total Phosphate Phosphorus (mg/l)	0.00	01/14/87
Mar, Apr, May	Sulfate (mg/l)	16.1	05/20/87
	Cadmium (mg/l)	0.000	03/11/87
	Iron (mg/l)	0.00	03/11/87
	Nickel (mg/l)	0.000	03/11/87
	Mercury (ug/l)	0.0	03/11/87
	Aluminum (mg/l)	0.06	04/22/87
Jun, Jul, Aug	Calcium (mg/l)	7.9	07/15/87
	Cadmium (mg/l)	0.000	06/03/87
	Mercury (ug/l)	0.0	06/03/87
	Aluminum (mg/l)	0.00	06/17/87
Sep, Oct, Nov	Total Alkalinity (mg/l)	20.1	09/09/87
	Specific Conductance (usm/cm)	144	09/09/87
	Sulfate (mg/l)	14.5	09/09/87
	Sodium (mg/l)	7.70	09/09/87
	Calcium (mg/l)	9.1	09/09/87
	Magnesium (mg/l)	4.71	09/09/87

Table 5.1-10. New maximum values observed for water quality parameters measured in 1987 at station P14390 on the Perkiomen Creek.

Season	Parameter	Value	Date
Dec, Jan, Feb	Cadmium (mg/l)	0.001	12/02/87
	Nickel (mg/l)	0.002	12/16/87
	Trichloroethylene (ug/l)	3.3	02/25/87
Mar, Apr, May	Total Phosphate Phosphorus (mg/l)	0.30	05/06/87
	Cadmium (mg/l)	0.000	03/24/87
	Nickel (mg/l)	0.006	04/08/87
	Mercury (ug/l)	0.0	03/11/87
	Aluminum (mg/l)	0.79	04/08/87
	Trichloroethylene (ug/l)	8.7	03/24/87
Jun, Jul, Aug	Biochemical Oxygen Demand (mg/l)	8.5	06/03/87
	Total Dissolved Solids (mg/l)	953	06/03/87
	Ammonia Nitrogen (mg/l)	0.200	07/15/87
	Nitrite Nitrogen (mg/l)	0.980	06/17/87
	Ortho Phosphate Phosphorus (mg/l)	0.26	06/17/87
	Cadmium (mg/l)	0.000	07/29/87
	Nickel (mg/l)	0.006	06/03/87
	Mercury (ug/l)	0.5	07/15/87
	Aluminum (mg/l)	0.80	07/15/87
	Cyanide, Total (mg/l)	0.005	07/01/87
	Sulfide (mg/l)	1.50	07/01/87
Sep, Oct, Nov	Cadmium (mg/l)	0.000	09/09/87
	Lead (mg/l)	0.015	09/09/87
	Nickel (mg/l)	0.003	11/04/87
	Fecal Coliforms (MF) (c/.1l)	7680	09/09/87
	Sulfide (mg/l)	5.70	10/21/87

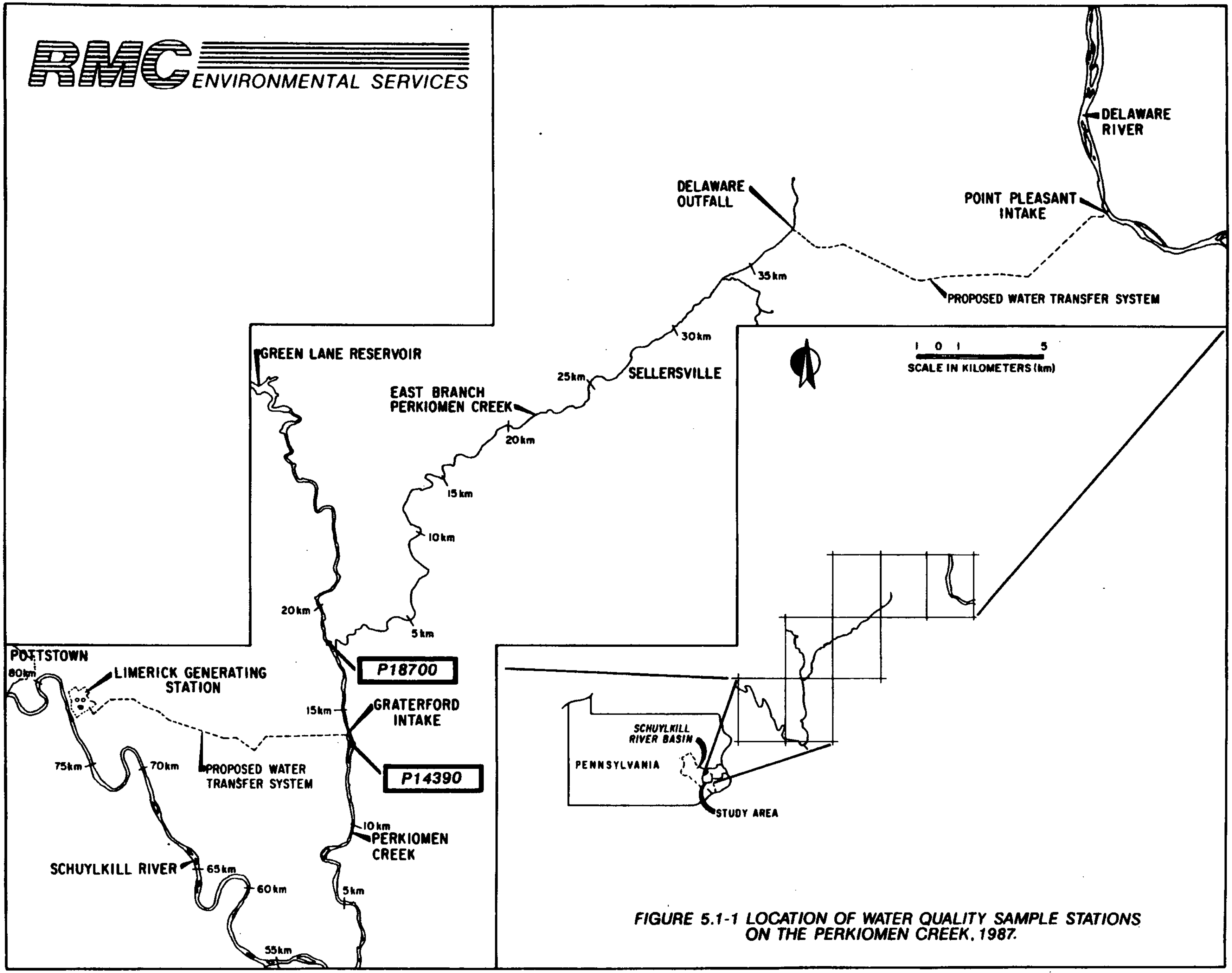


FIGURE 5.1-1 LOCATION OF WATER QUALITY SAMPLE STATIONS ON THE PERKIOMEN CREEK, 1987.

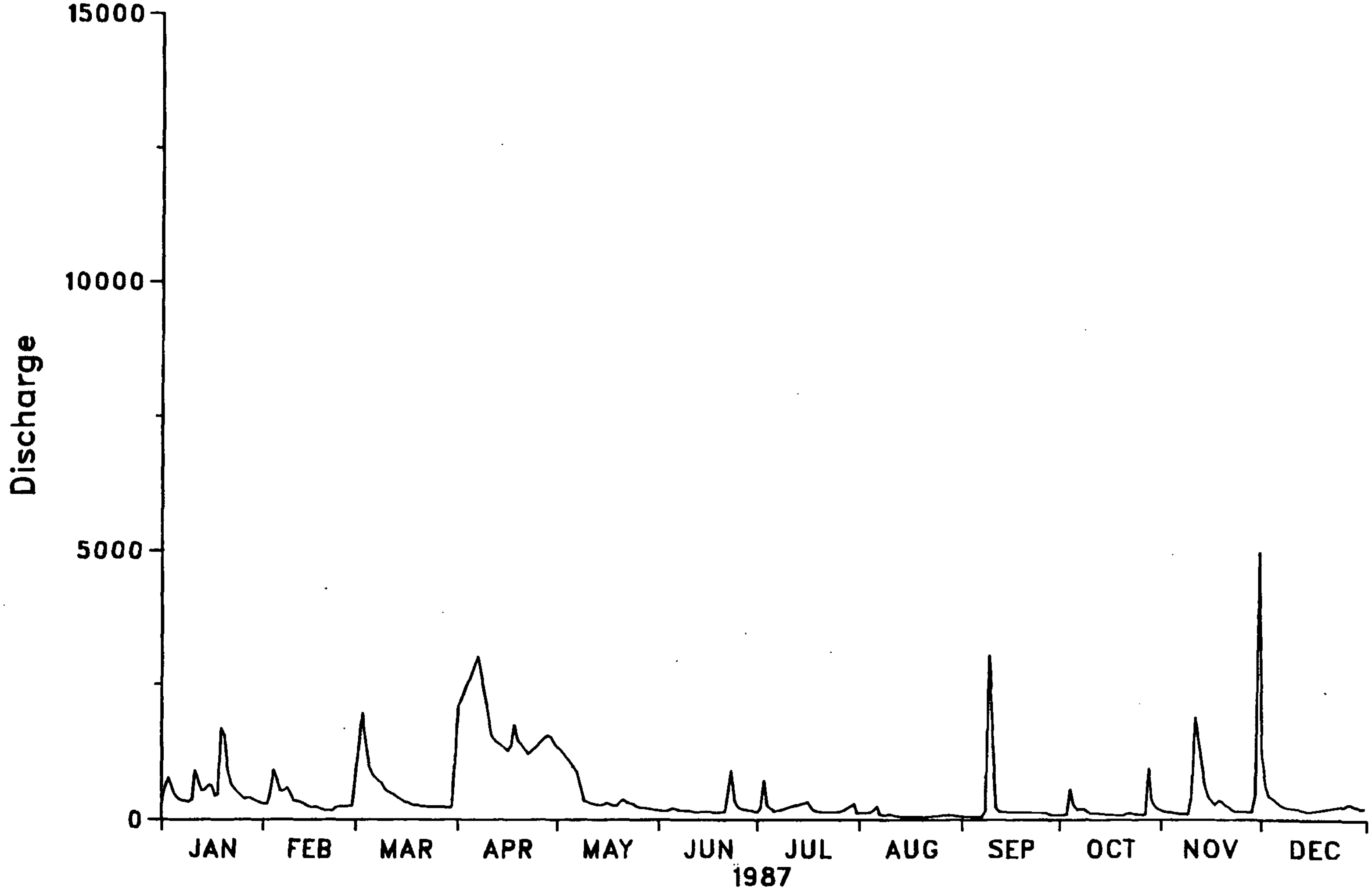


Figure 5.1–2. Perkiomen Creek mean daily discharge (cfs) during 1987 (Graterford gage).

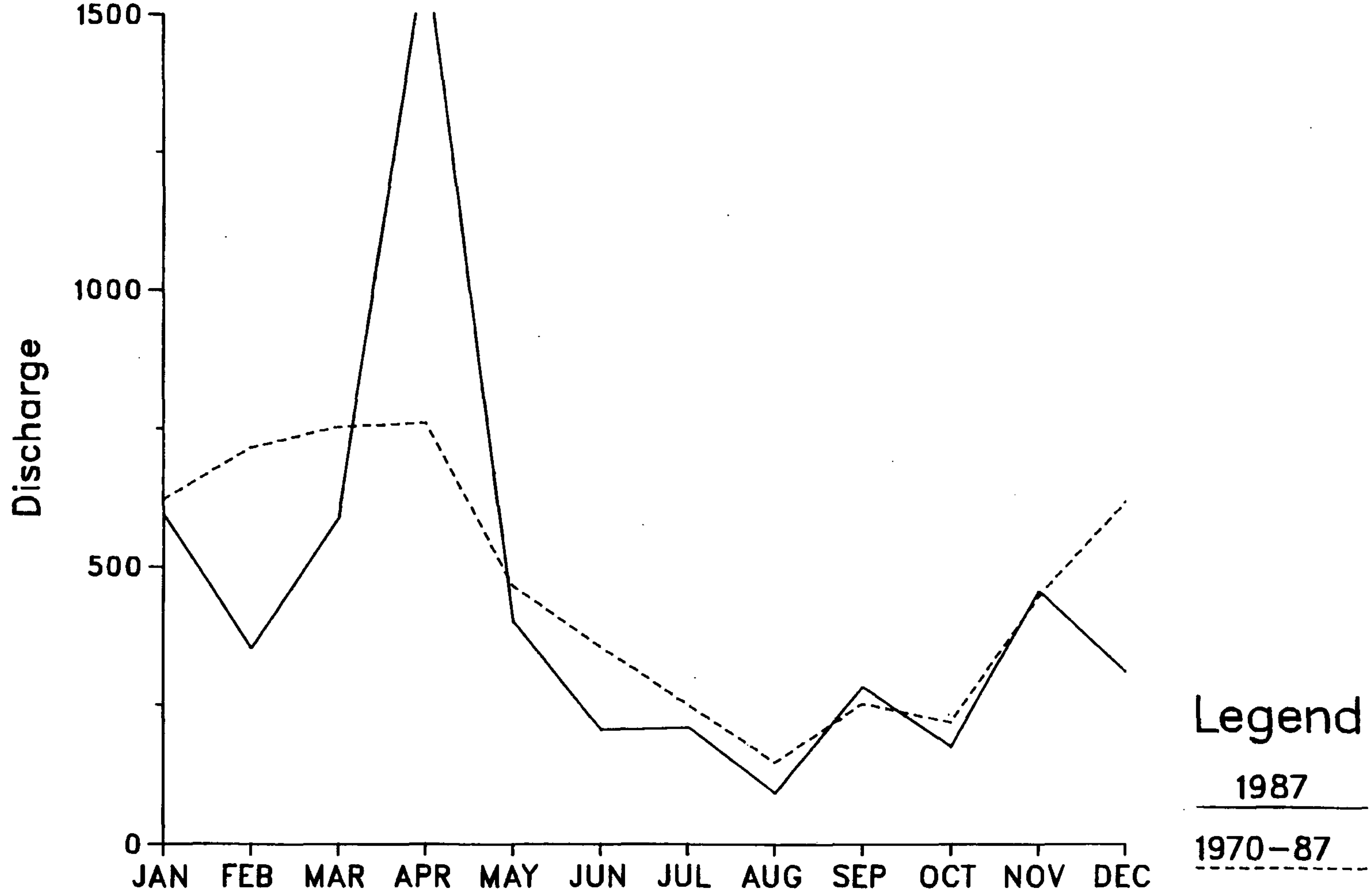


Figure 5.1-3. Perkiomen Creek mean monthly discharge (cfs) during 1970-1987 and 1987 (Graterford gage).

5.2 Fish

Introduction and Methods

Fishes inhabiting a 6-km reach of Perkiomen Creek between Schwenksville and Graterford, Pennsylvania, were studied from 1970-1978 and from 1981-present, to establish a preoperational baseline for comparison with data collected following start-up of the Point Pleasant Water Diversion Project. Studies since 1981 have consisted of monthly seine collections at a station in Schwenksville (reported on in Section 4.3) and periodic (monthly or bimonthly) electrofishing surveys at four stations (Table 5.2-1 and Fig. 5.2-1). Stations and methods were described in RMC Environmental Services (1984).

The objective of this report is to briefly summarize results of the 1987 electrofishing survey. A more detailed treatment of the data including that collected in 1987 is planned for the future after water is diverted to and withdrawn from Perkiomen Creek for consumptive use at LGS.

Summary of 1987 Results

In 1987, a total of 4,378 fish of 21 species and three hybrids was collected in 21.7 hours of electrofishing (Table 5.2-2). Annual CPUE, 202 fish/hour, declined for the first time in four years. Four species exceeded 10% of the annual catch; in decreasing order these were redbreast sunfish (30.6%), white sucker (14.7%), rock bass

(13.3%), and pumpkinseed (12.6%). Green sunfish and smallmouth bass comprised 6.5 and 5.9% of the total catch, respectively. Compared to 1986, relative density of white sucker, yellow bullhead, pumpkinseed, largemouth bass, and brown bullhead increased while relative densities of rock bass, redbreast sunfish, green sunfish, bluegill, carp, and smallmouth bass declined. Most differences were small; however, relative density of smallmouth bass declined from 9.7% in 1986 to 5.9% in 1987. Catches were distributed relatively evenly among the stations, except for a somewhat lower catch at P14030, which is consistent with previous data.

For the second year in a row a chain pickerel was collected at P20035. Although common in Pennsylvania, this species is rare in Perkiomen Creek. Six target species known or thought to occur in the stream were not collected in 1987; these were margined madtom, northern pike, muskellunge and its hybrid with northern pike, brook trout, rainbow trout, and brown trout. Hybrid northern pike x muskellunge have been collected in small numbers each year since 1981; several large individuals (> 5 kg) were caught in 1987. Salmonids are seasonally stocked upstream of the study area and in tributaries, but none was collected in 1986.

The large fish community at each station (Tables 5.2-3 to 5.2-6) appeared similar and composition at each station was similar to that observed in 1986 (RMC Environmental Services 1987a). Due to the proximity of stations to each other, station-to-station differences were probably due more to local differences in habitat rather than a shift in community structure due to longitudinal zonation.

Table 5.2-1. Summary of the Perkiomen Creek Creek electrofishing stations and months 1981 - 1987.

Station		A	M	J	J	A	S	O	N	Total
P20035	1981	X		X		X		X		4
	1982		X	X		X		X		4
	1983		X		X		X		X	4
	1984		X		X		X		X	4
	1985		X		X		X		X	4
	1986		X		X		X		X	4
	1987		X		X		X		X	4
										28
P14540	1981	X		X		X		X		4
	1982		X	X		X		X		4
	1983		X		X		X		X	4
	1984		X		X		X		X	4
	1985		X		X		X		X	4
	1986		X		X		X		X	4
	1987		X		X		X		X	4
										28
P14170	1981	X		X		X		X		4
	1982		X	X		X		X		4
	1983		X		X		X		X	4
	1984		X		X		X		X	4
	1985		X		X		X		X	4
	1986		X		X		X			3
	1987		X		X		X		X	4
										27
P14030	1981	X		X		X		X		4
	1982		X	X		X		X		4
	1983		X		X		X			3
	1984		X		X		X		X	4
	1985		X		X		X		X	4
	1986		X		X		X			3
	1987		X		X		X		X	4
										26
										109

Table 5.2-2. Annual relative abundance of target fishes from the Perkiomen Creek electrofished in 1987 (+ = Less than 0.1%, CPUE = fish per hour).

Species		P14030 3.00 Hr	P14170 4.25 Hr	P14540 7.98 Hr	P20035 6.47 Hr	Total 21.70 Hr
American eel	Catch	-	1	3	3	7
	%	-	0.1	0.3	0.3	0.2
	CPUE	-	0.24	0.38	0.46	0.32
Chain pickerel	Catch	-	-	-	1	1
	%	-	-	-	0.1	+
	CPUE	-	-	-	0.15	0.05
Esox hybrid	Catch	1	-	2	3	6
	%	0.1	-	0.2	0.3	0.1
	CPUE	0.33	-	0.25	0.46	0.28
Goldfish	Catch	-	1	1	-	2
	%	-	0.1	0.1	-	0.1
	CPUE	-	0.24	0.13	-	0.09
Carp	Catch	12	2	35	78	127
	%	1.7	0.1	2.9	7.8	2.9
	CPUE	4.00	0.47	4.39	12.06	5.85
Golden shiner	Catch	-	5	4	-	9
	%	-	0.3	0.3	-	0.2
	CPUE	-	1.18	0.50	-	0.41
Fallfish	Catch	-	-	3	4	7
	%	-	-	0.3	0.4	0.2
	CPUE	-	-	0.38	0.62	0.32
Minnow hybrid	Catch	-	-	4	-	4
	%	-	-	0.3	-	0.1
	CPUE	-	-	0.50	-	0.18
White sucker	Catch	97	88	223	235	643
	%	13.6	6.1	18.4	23.5	14.7
	CPUE	32.33	20.71	27.94	36.32	29.63
Creek chubsucker	Catch	2	9	4	2	17
	%	0.3	0.6	0.3	0.2	0.4
	CPUE	0.67	2.12	0.50	0.31	0.78
White catfish	Catch	-	-	2	2	4
	%	-	-	0.2	0.2	0.1
	CPUE	-	-	0.25	0.31	0.18
Yellow bullhead	Catch	20	70	47	5	142
	%	2.8	4.8	3.9	0.5	3.2
	CPUE	6.67	16.47	5.89	0.77	6.54
Brown bullhead	Catch	4	23	25	2	54
	%	0.6	1.6	2.1	0.2	1.2
	CPUE	1.33	5.41	3.13	0.31	2.49
Channel catfish	Catch	1	-	-	-	1
	%	0.1	-	-	-	+
	CPUE	0.33	-	-	-	0.05
Rock bass	Catch	165	198	133	84	580
	%	23.1	13.6	11.0	8.4	13.3
	CPUE	55.00	46.59	16.67	12.98	26.73
Redbreast sunfish	Catch	264	617	246	214	1341
	%	37.0	42.5	20.3	21.4	30.6
	CPUE	88.00	145.18	30.83	33.08	61.80
Green sunfish	Catch	22	96	85	81	284
	%	3.1	6.6	7.0	8.1	6.5
	CPUE	7.33	22.59	10.65	12.52	13.09
Pumpkinseed	Catch	64	198	204	86	552
	%	9.0	13.6	16.9	8.6	12.6
	CPUE	21.33	46.59	25.56	13.29	25.44

Table 5.2-2. (continued)

Species		P14030 3.00 Hr	P14170 4.25 Hr	P14540 7.98 Hr	P20035 6.47 Hr	Total 21.70 Hr
Bluegill	Catch	6	39	56	94	195
	%	0.8	2.7	4.6	9.4	4.5
	CPUE	2.00	9.18	7.02	14.53	8.99
Lepomis hybrid	Catch	3	12	28	22	65
	%	0.4	0.8	2.3	2.2	1.5
	CPUE	1.00	2.82	3.51	3.40	3.00
Smallmouth bass	Catch	45	69	86	56	256
	%	6.3	4.8	7.1	5.6	5.9
	CPUE	15.00	16.24	10.78	8.66	11.80
Largemouth bass	Catch	7	24	16	21	68
	%	1.0	1.7	1.3	2.1	1.6
	CPUE	2.33	5.65	2.01	3.25	3.13
White crappie	Catch	-	-	-	1	1
	%	-	-	-	0.1	+
	CPUE	-	-	-	0.15	0.05
Black crappie	Catch	-	1	3	8	12
	%	-	0.1	0.3	0.8	0.3
	CPUE	-	0.24	0.38	1.24	0.55
	Catch	713	1453	1210	1002	4378
	%					

Table 5.2-3. Monthly species composition and relative abundance of target fishes electrofished from the Perkiomen Creek at P14030 in 1987 (+ = Less than 0.1%).

Species		May 0.58 Hrs	Jul 1.08 Hrs	Sep 0.53 Hrs	Nov 0.80 Hrs
Esox hybrid	Catch	1	-	-	-
	%	0.9	-	-	-
	CPUE	1.7	-	-	-
Carp	Catch	2	-	1	9
	%	1.7	-	0.6	5.0
	CPUE	3.4	-	1.9	11.3
White sucker	Catch	8	20	29	40
	%	6.8	8.3	16.6	22.3
	CPUE	13.8	18.5	54.7	50.0
Creek chubsucker	Catch	-	-	-	2
	%	-	-	-	1.1
	CPUE	-	-	-	2.5
Yellow bullhead	Catch	3	3	6	8
	%	2.6	1.2	3.4	4.5
	CPUE	5.2	2.8	11.3	10.0
Brown bullhead	Catch	-	-	-	4
	%	-	-	-	2.2
	CPUE	-	-	-	5.0
Channel catfish	Catch	-	1	-	-
	%	-	0.4	-	-
	CPUE	-	0.9	-	-
Rock bass	Catch	53	50	31	31
	%	45.3	20.7	17.7	17.3
	CPUE	91.4	46.3	58.5	38.8
Redbreast sunfish	Catch	31	104	80	49
	%	26.5	43.0	45.7	27.4
	CPUE	53.4	96.3	150.9	61.3
Green sunfish	Catch	2	14	-	6
	%	1.7	5.8	-	3.4
	CPUE	3.4	13.0	-	7.5
Pumpkinseed	Catch	4	33	11	16
	%	3.4	13.6	6.3	8.9
	CPUE	6.9	30.6	20.8	20.0
Bluegill	Catch	-	5	1	-
	%	-	2.1	0.6	-
	CPUE	-	4.6	1.9	-

Table 5.2-3. (continued)

Species		May 0.58 Hrs	Jul 1.08 Hrs	Sep 0.53 Hrs	Nov 0.80 Hrs
Lepomis hybrid	Catch	1	1	-	1
	%	0.9	0.4	-	0.6
	CPUE	1.7	0.9	-	1.3
Smallmouth bass	Catch	12	11	16	6
	%	10.3	4.5	9.1	3.4
	CPUE	20.7	10.2	30.2	7.5
Largemouth bass	Catch	-	-	-	7
	%	-	-	-	3.9
	CPUE	-	-	-	8.8

CPUE = Number caught per hour of electrofishing.

Table 5.2-4. Monthly species composition and relative abundance of target fishes electrofished from the Perkiomen Creek at P14170 in 1987 (+ = Less than 0.1%).

Species		May 0.77 Hrs	Jul 1.02 Hrs	Sep 1.22 Hrs	Nov 1.25 Hrs
American eel	Catch	-	-	1	-
	%	-	-	0.2	-
	CPUE	-	-	0.8	-
Goldfish	Catch	-	-	-	1
	%	-	-	-	0.4
	CPUE	-	-	-	0.8
Carp	Catch	2	-	-	-
	%	0.5	-	-	-
	CPUE	2.6	-	-	-
Golden shiner	Catch	-	2	2	1
	%	-	0.6	0.5	0.4
	CPUE	-	2.0	1.6	0.8
White sucker	Catch	10	19	49	10
	%	2.3	5.7	12.0	3.5
	CPUE	13.0	18.6	40.2	8.0
Creek chubsucker	Catch	1	2	2	4
	%	0.2	0.6	0.5	1.4
	CPUE	1.3	2.0	1.6	3.2
Yellow bullhead	Catch	14	17	24	15
	%	3.3	5.1	5.9	5.3
	CPUE	18.2	16.7	19.7	12.0
Brown bullhead	Catch	4	3	6	10
	%	0.9	0.9	1.5	3.5
	CPUE	5.2	2.9	4.9	8.0
Rock bass	Catch	79	38	35	46
	%	18.5	11.4	8.6	16.1
	CPUE	102.6	37.3	28.7	36.8
Redbreast sunfish	Catch	161	163	182	111
	%	37.7	48.8	44.7	38.9
	CPUE	209.1	159.8	149.2	88.8
Green sunfish	Catch	39	26	28	3
	%	9.1	7.8	6.9	1.1
	CPUE	50.6	25.5	23.0	2.4
Pumpkinseed	Catch	58	45	44	51
	%	13.6	13.5	10.8	17.9
	CPUE	75.3	44.1	36.1	40.8

Table 5.2-4. (continued)

Species		May 0.77 Hrs	Jul 1.02 Hrs	Sep 1.22 Hrs	Nov 1.25 Hrs
Bluegill	Catch	22	3	12	2
	%	5.2	0.9	2.9	0.7
	CPUE	28.6	2.9	9.8	1.6
Lepomis hybrid	Catch	7	4	-	1
	%	1.6	1.2	-	0.4
	CPUE	9.1	3.9	-	0.8
Smallmouth bass	Catch	26	11	18	14
	%	6.1	3.3	4.4	4.9
	CPUE	33.8	10.8	14.8	11.2
Largemouth bass	Catch	4	1	4	15
	%	0.9	0.3	1.0	5.3
	CPUE	5.2	1.0	3.3	12.0
Black crappie	Catch	-	-	-	1
	%	-	-	-	0.4
	CPUE	-	-	-	0.8

CPUE = Number caught per hour of electrofishing.

Table 5.2-5. Monthly species composition and relative abundance of target fishes electrofished from the Perkiomen Creek at P14540 in 1987 (+ = Less than 0.1%).

Species		May 1.40 Hrs	Jul 1.98 Hrs	Sep 2.33 Hrs	Nov 2.27 Hrs
American eel	Catch	-	1	2	-
	%	-	0.5	0.7	-
	CPUE	-	0.5	0.9	-
Esox hybrid	Catch	1	-	-	1
	%	0.3	-	-	0.2
	CPUE	0.7	-	-	0.4
Goldfish	Catch	1	-	-	-
	%	0.3	-	-	-
	CPUE	0.7	-	-	-
Carp	Catch	9	11	9	6
	%	2.8	5.3	3.3	1.5
	CPUE	6.4	5.6	3.9	2.6
Golden shiner	Catch	2	-	2	-
	%	0.6	-	0.7	-
	CPUE	1.4	-	0.9	-
Fallfish	Catch	-	-	-	3
	%	-	-	-	0.7
	CPUE	-	-	-	1.3
Minnow hybrid	Catch	1	2	1	-
	%	0.3	1.0	0.4	-
	CPUE	0.7	1.0	0.4	-
White sucker	Catch	41	28	98	56
	%	12.7	13.4	36.3	13.7
	CPUE	29.3	14.1	42.1	24.7
Creek chubsucker	Catch	-	-	4	-
	%	-	-	1.5	-
	CPUE	-	-	1.7	-
White catfish	Catch	1	-	1	-
	%	0.3	-	0.4	-
	CPUE	0.7	-	0.4	-
Yellow bullhead	Catch	12	8	8	19
	%	3.7	3.8	3.0	4.6
	CPUE	8.6	4.0	3.4	8.4
Brown bullhead	Catch	6	5	5	9
	%	1.9	2.4	1.9	2.2
	CPUE	4.3	2.5	2.1	4.0

Table 5.2-5. (continued)

Species		May 1.40 Hrs	Jul 1.98 Hrs	Sep 2.33 Hrs	Nov 2.27 Hrs
Rock bass	Catch	40	30	18	45
	%	12.4	14.4	6.7	11.0
	CPUE	28.6	15.2	7.7	19.8
Redbreast sunfish	Catch	67	43	47	89
	%	20.8	20.6	17.4	21.8
	CPUE	47.9	21.7	20.2	39.2
Green sunfish	Catch	36	21	15	13
	%	11.2	10.0	5.6	3.2
	CPUE	25.7	10.6	6.4	5.7
Pumpkinseed	Catch	64	35	37	68
	%	19.9	16.7	13.7	16.6
	CPUE	45.7	17.7	15.9	30.0
Bluegill	Catch	10	5	4	37
	%	3.1	2.4	1.5	9.0
	CPUE	7.1	2.5	1.7	16.3
Lepomis hybrid	Catch	9	6	2	11
	%	2.8	2.9	0.7	2.7
	CPUE	6.4	3.0	0.9	4.8
Smallmouth bass	Catch	18	11	13	44
	%	5.6	5.3	4.8	10.8
	CPUE	12.9	5.6	5.6	19.4
Largemouth bass	Catch	4	3	4	5
	%	1.2	1.4	1.5	1.2
	CPUE	2.9	1.5	1.7	2.2
Black crappie	Catch	-	-	-	3
	%	-	-	-	0.7
	CPUE	-	-	-	1.3

CPUE = Number caught per hour of electrofishing.

Table 5.2-6. Monthly species composition and relative abundance of target fishes electrofished from the Perkiomen Creek at P20035 in 1987 (+ = Less than 0.1%).

Species		May 1.55 Hrs	Jul 1.95 Hrs	Sep 1.18 Hrs	Nov 1.78 Hrs
American eel	Catch	1	2	-	-
	%	0.2	0.8	-	-
	CPUE	0.6	1.0	-	-
Chain pickerel	Catch	-	-	-	1
	%	-	-	-	0.6
	CPUE	-	-	-	0.6
Esox hybrid	Catch	1	1	-	1
	%	0.2	0.4	-	0.6
	CPUE	0.6	0.5	-	0.6
Carp	Catch	24	17	2	35
	%	5.4	6.7	1.4	21.1
	CPUE	15.5	8.7	1.7	19.7
Fallfish	Catch	3	-	-	1
	%	0.7	-	-	0.6
	CPUE	1.9	-	-	0.6
White sucker	Catch	77	51	20	87
	%	17.4	20.1	14.3	52.4
	CPUE	49.7	26.2	16.9	48.9
Creek chubsucker	Catch	-	-	2	-
	%	-	-	1.4	-
	CPUE	-	-	1.7	-
White catfish	Catch	-	-	-	2
	%	-	-	-	1.2
	CPUE	-	-	-	1.1
Yellow bullhead	Catch	2	1	-	2
	%	0.5	0.4	-	1.2
	CPUE	1.3	0.5	-	1.1
Brown bullhead	Catch	-	-	-	2
	%	-	-	-	1.2
	CPUE	-	-	-	1.1
Rock bass	Catch	42	24	11	7
	%	9.5	9.4	7.9	4.2
	CPUE	27.1	12.3	9.3	3.9
Redbreast sunfish	Catch	80	85	43	6
	%	18.1	33.5	30.7	3.6
	CPUE	51.6	43.6	36.4	3.4

Table 5.2-6. (continued)

Species		May 1.55 Hrs	Jul 1.95 Hrs	Sep 1.18 Hrs	Nov 1.78 Hrs
Green sunfish	Catch	46	20	11	4
	%	10.4	7.9	7.9	2.4
	CPUE	29.7	10.3	9.3	2.2
Pumpkinseed	Catch	51	18	12	5
	%	11.5	7.1	8.6	3.0
	CPUE	32.9	9.2	10.2	2.8
Bluegill	Catch	59	15	18	2
	%	13.3	5.9	12.9	1.2
	CPUE	38.1	7.7	15.3	1.1
Lepomis hybrid	Catch	12	7	3	-
	%	2.7	2.8	2.1	-
	CPUE	7.7	3.6	2.5	-
Smallmouth bass	Catch	32	12	9	3
	%	7.2	4.7	6.4	1.8
	CPUE	20.6	6.2	7.6	1.7
Largemouth bass	Catch	7	-	8	6
	%	1.6	-	5.7	3.6
	CPUE	4.5	-	6.8	3.4
White crappie	Catch	1	-	-	-
	%	0.2	-	-	-
	CPUE	0.6	-	-	-
Black crappie	Catch	4	1	1	2
	%	0.9	0.4	0.7	1.2
	CPUE	2.6	0.5	0.8	1.1

CPUE = Number caught per hour of electrofishing.

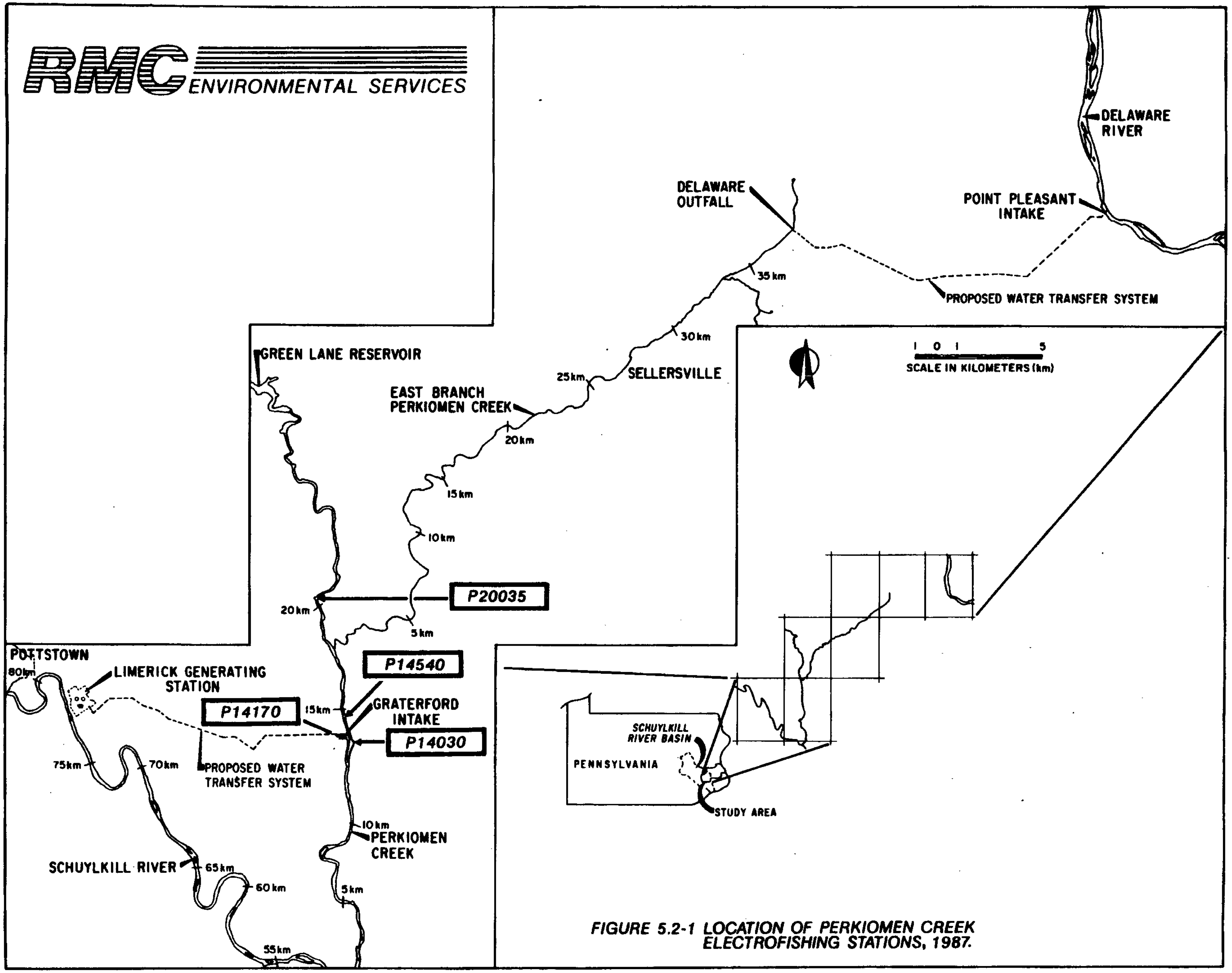


FIGURE 5.2-1 LOCATION OF PERKIOMEN CREEK ELECTROFISHING STATIONS, 1987.

6.0 Schuylkill River

The Schuylkill River flows 209 km from its source at Tuscarora Springs in Schuylkill County to its confluence with the Delaware River at Philadelphia. The river drains a 4,972 km^2 watershed that includes portions of the Appalachian Mountain, Great Valley, Reading Prong, Triassic Lowland, Piedmont Upland, and Coastal Plain physiographic regions in southeast Pennsylvania.

Typically, the river in the vicinity of LGS is 100 m wide, low gradient (0.5 m/km), and discharges 53 m^3/second. Except for a 3-km long pool above Vincent Dam, the study area is 95% run habitat over a gravel-rubble substrate. Riffle and shoal habitats comprise most of the remaining study area. Few backwaters are present and those that exist are small in size but can be important reproductive, nursery, and refuge areas for fish and other aquatic organisms. In most years, dense stands of aquatic vegetation develop during the warmer months. Between the blowdown discharge structure and the cooling water intake, the river is divided into two channels by Limerick Island, the only substantial, heavily wooded island in the study area.

Ecological studies were conducted from 1970 through 1978 and are summarized in Section 2.2.2.1 of the LGS EROL (Philadelphia Electric Company 1981). Additional studies of water quality (1979-1986), benthic macroinvertebrates (1983-1986) and fish (1980-1986) were reported in subsequent progress reports (RMC Environmental Services

1984, 1985, 1986, and 1987a). All non-radiological environmental monitoring programs conducted in 1986, except for entrainment, were continued in 1987. Additionally, a creel survey was again conducted during the 1987 recreational fishing season (April-September).

Ecological studies have focused on a 10-km reach extending upriver from Vincent Dam (S71960) to just above the Hooker Chemical Company plant (S82000) (Fig. 6.0-1). This reach includes an area upriver from and unaffected by LGS, and areas adjacent to and downriver from LGS that are potentially affected by the station. Sources of potential environmental impact include plant-site runoff from areas disturbed by the ongoing construction of LGS Unit 2, and the effects of water withdrawal from and discharge to the Schuylkill River. Discharge from LGS is comprised of cooling tower blowdown mixed with treated domestic wastewater, yard, and roof drainage.

An operational history of LGS reveals that 1987 was the third year of plant operation and the second year of operation in a full-power commercial mode (Fig. 6.0-2). Consequently, monitoring studies have provided varying quantities of postoperational data, depending on the environmental component studied and its potential exposure to impacts of LGS operation. The objectives of Section 6 are to summarize results of all 1987 non-radiological environmental monitoring programs on the Schuylkill River and to evaluate any environmental impacts from LGS operation that may be evident from comparisons of preoperational and postoperational data.

As in previous sections of this report, summaries of 1987 results are limited to tabular and graphical presentations of 1987 data, coupled with limited narratives that compare them with previously reported information. The identification and evaluation of LGS-related environmental impacts comprise the focus of this report section. Assessments incorporate appropriate statistical summaries and analyses of both preoperational and postoperational data. Emphasis has been placed on concise descriptions of the rationales, assumptions, methods, and interpretations of these preoperational-postoperational comparisons. Any potential environmental concerns are then identified and discussed.

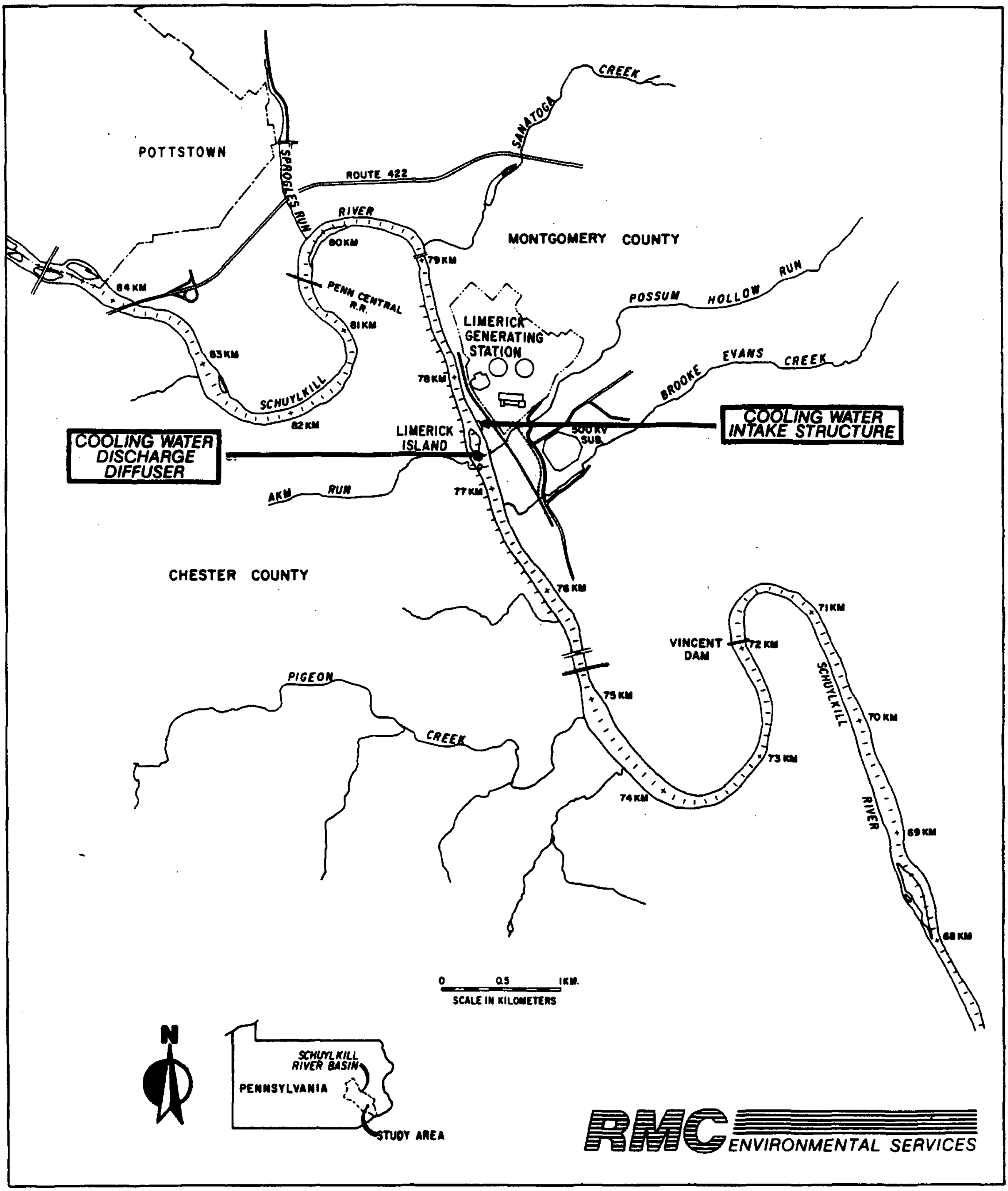


FIGURE 6.0-1 STUDY AREA FOR AQUATIC ECOLOGICAL AND WATER QUALITY STUDIES OF THE SCHUYLKILL RIVER NEAR LGS,1987.

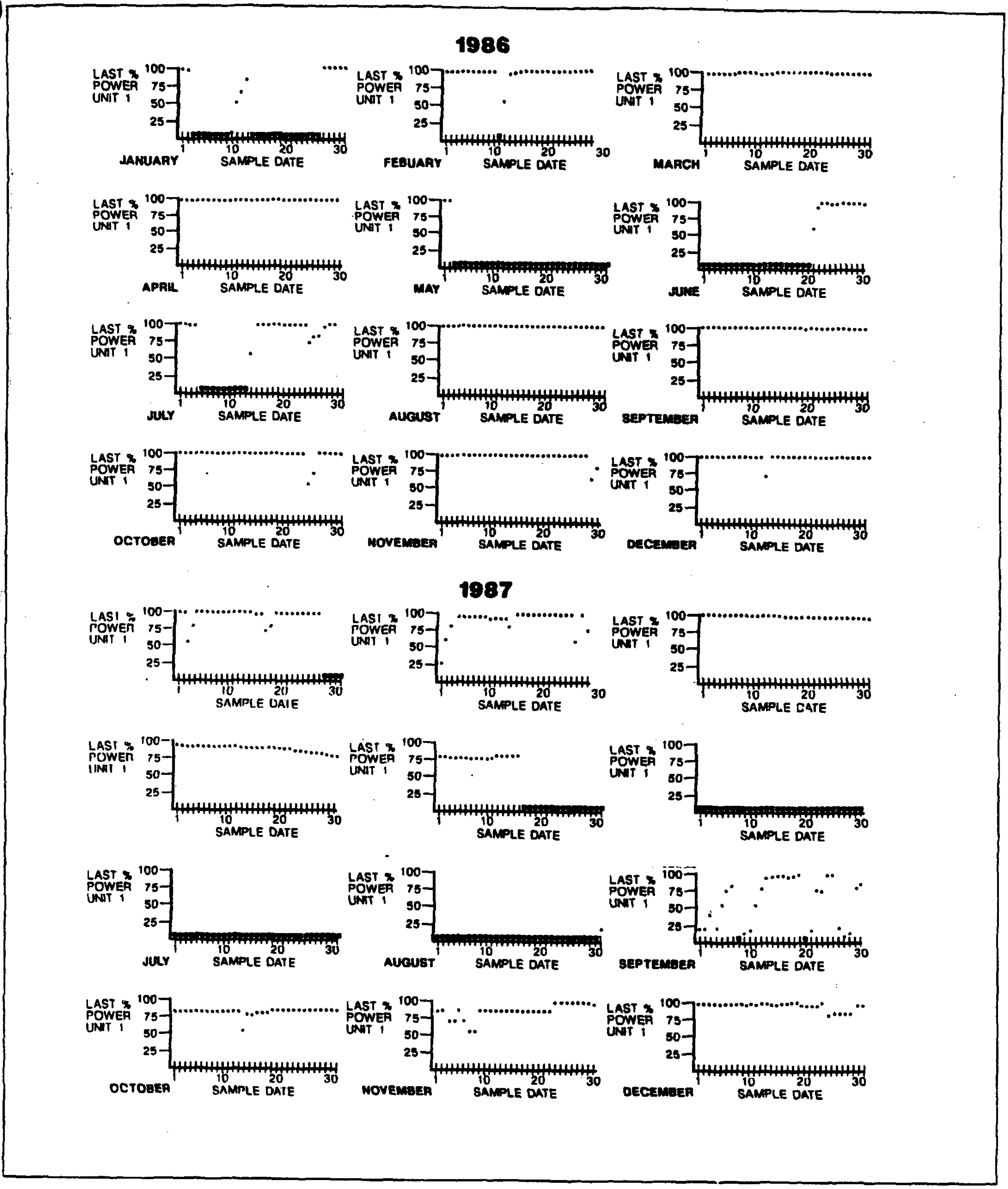


FIGURE 6.0-2 HISTORY OF COMMERCIAL OPERATION AT LGS (% POWER OUT).

6.1 Water Quality

Introduction and Methods

Water quality studies of the Schuylkill River near LGS were initiated in May 1974 and continued through 1987. Data obtained in 1987 are summarized in this progress report. Program objectives were to monitor ambient water quality, complement concurrent ecological studies, and evaluate water quality changes in relation to LGS operation.

Daily river discharge data were obtained from the U.S.G.S. gaging station in Pottstown, Pennsylvania. Water temperatures were obtained from daily measurements made at the Pottstown water treatment plant. Daily flow and temperature records were compiled for 1987 and used to determine minimum, maximum, mean, and median values for each month of the year. These values were then compared to similar values determined over the much longer period of record (1970-1987) for which data were available.

Schuylkill River water chemistry was monitored biweekly in 1987 at two stations (Fig. 6.1-1). Station S77660 was located 200 m upstream of the LGS intake where water quality was considered representative of ambient conditions as well as intake water withdrawn for use at LGS. Station S77140 was located 100 m downstream of the LGS discharge. Water at this location was assumed to be comprised of the combined effluent from all LGS-related sources (including plant-site runoff entering Possum Hollow Run) after mixing with one-third of Schuylkill River flow. It was estimated in the EROL that approximately one-third of the Schuylkill River is available for immediate mixing because of the island which splits the channel at the discharge location.

Monitoring for several chemical parameters was resumed or initiated in 1986. Monitoring for the heavy metals cadmium, nickel, and mercury, which were first monitored in 1975-1978 for the EROL, and aluminum were continued in 1987.

Field methods consisted of collecting subsurface grab samples near mid-channel or, in cases of high flow, near the Montgomery County shore. Samples were preserved and analyzed using standard, widely accepted methods.

Results and Discussion

Flow and Temperature

U.S.G.S. daily discharge records for the Schuylkill River in 1987 are presented in Table 6.1-1 and Figure 6.1-2; those for the period of record (1970-1987) are presented in Table 6.1-2 and Figure 6.1-3. Schuylkill River water temperature data obtained from the Pottstown water treatment plant are summarized for 1987 in Table 6.1-3 and Figure 6.1-4 and for the period of record 1970-1987 in Table 6.1-4 and Figure 6.1-5.

The period June to early September was characterized by low flow conditions. A new minimum monthly flow (487 cfs) was established on 20 June. On 9 September a new monthly maximum flow was observed with a peak flow of 22,900 cfs. The remainder of the year consisted of moderate flow alternating with periods of high flow.

Mean monthly flows in 1987 were below mean monthly flows for the period 1970-1987 except for the month of September. Except for the months of January and September, median monthly flows were below the median monthly flows for the period of record.

Mean monthly temperatures were warmer than average for the period of March-August, and December. The September average was one degree below the 1970-1987 average while January-February and October-November was the same as the period of record. No new maximum or minimum values were measured in 1987.

Water Chemistry

Seasonal summaries of water chemistry data for station S77660 for the period 1979-1987 are presented in Table 6.1-5 and for 1987 in Table 6.1-6. New maximum and minimum values established in 1987 are presented in Tables 6.1-7 and 6.1-8, respectively.

Seasonal summaries for station S77140 are presented in Table 6.1-9 for 1979-1987 and Table 6.1-10 for 1987. New maximum and minimum values are presented in Tables 6.1-11 and 6.1-12, respectively. In general, any differences between the upstream station (S77660) and the station below the LGS discharge (S77140) were within the normal range of variability for the parameter.

A number of new maximum values were established at both stations during the year. Some of the maxima were attributable to the short period of record for the metals aluminum, cadmium, mercury, and nickel. In the following discussion these metals will not be included due to their incorporation as new maxima as being first detected or slight extensions of the previous limited record.

During the winter quarter new maxima were observed at both stations for nitrate nitrogen, potassium, and sulfide. Nitrate nitrogen maxima were established 21 January at both stations. At the upstream station the new value represents a 0.2 mg/l increase while at the downstream station the increase was 1.4 mg/l. The potassium maxima represent an increase of 2 mg/l upstream and 0.3 mg/l downstream. The increase in the sulfide maximum was 3.8 mg/l upstream and 0.7 mg/l downstream. An additional maximum was established downstream for sodium that was 36 mg/l higher than the previous maximum value.

New maxima during the spring quarter common to both stations were potassium (22 April) and nitrite nitrogen (11 March). The increase for potassium was 2.9 mg/l upstream and 0.5 mg/l downstream. Nitrite nitrogen levels increased slightly at both stations with an increase of 0.04 mg/l upstream and 0.02 mg/l downstream. A slight increase in the total alkalinity maximum of 1.4 mg/l was also observed in the downstream station.

A number of new maxima were observed during the summer quarter at both stations, many of which occurred on 15 July. The daily flow record (Table 6.1-1) indicates a pulse of moderate flow for 14-16 July following a period of low flow. The summer quarter also coincides with a period of zero generation at LGS (16 May-30 August).

New maxima for total dissolved solids were established at both stations on 1 July which was preceeded by a week of low flow. The increase in the new maximum concentrations was 368 mg/l upstream and 1,500 mg/l downstream. Four new maxima were common to both stations on 15 July. These included total suspended solids, iron, manganese, and sulfide. Both the iron and sulfide maxima changed by less than 0.5 mg/l. The iron values increased by approximately 6 mg/l upstream and downstream. Both stations also had an approximate 60 mg/l increase in total suspended solids. Additional new maxima at the upstream station for the quarter included specific conductance and total alkalinity on 26 August, nitrate nitrogen, cyanide, and sulfide. The additional upstream maxima were not significantly greater than previous maxima.

Additional maxima observed at the downstream station include lead, sulfide, and trichloroethylene on 15 July. The increase in lead and sulfide was less than 0.2 mg/l while the trichloroethylene maximum represented a first detection for the quarter.

All the maxima observed during the fall quarter were associated with the record maximum flow recorded for the date of sampling, 9 September. Maxima common to both stations included total suspended solids, copper, iron, and manganese. The copper and manganese maxima were not appreciably different than the previous values. The total suspended solids increased 183 mg/l upstream and 275 mg/l downstream. Changes in the iron maxima were 5 mg/l upstream and 10 mg/l downstream. Additonally, a new maximum slightly higher than the previous value was established upstream for total phosphate phosphorus. At the downstream station new maxima for lead and phenol were observed with less than 0.1 mg/l increase. The chemical oxygen demand maximum doubled at the downstream station.

Schuylkill River Water Quality Trends and Limerick Generating Station Operational Effects: Preoperational-Postoperational Comparisons

Monitoring of Schuylkill River water quality commenced in 1974 and continued through 1987. Seasonal water quality data for the period 1975-1978 was presented in the EROL. Seasonal water quality data for the period 1979-1986 were presented in the four previous LGS progress reports.

Parameters that were monitored during the preoperational period included several major cations and anions. These included the cations sodium, potassium, calcium, and magnesium and the anions chloride, sulfate, and bicarbonate (based on alkalinity determinations). Conversion of the reported seasonal median data (mg/l) to the appropriate milli-equivalents per liter (meq/l) allows for a stoichiometric presentation of the data (i.e., one milli-equivalent of a cation will react with one milli-equivalent of a corresponding anion). Conversion of the concentrations of major anions and cations and the corresponding plots are called Stiff diagrams. The diagrams are a graphic presentation of the laboratory reported concentrations. The utility of the Stiff diagram is that any major differences in water quality become readily apparent. Stiff diagrams for station S77660 for the period 1975-1978 and 1979-1985 are shown in Figure 6.1-6. Slight variations of the calcium and bicarbonate equivalent values especially in the summer and fall quarters account for the differences in the figures. Seasonal Stiff diagrams for the upstream and downstream stations for the year 1987 are presented in Figure 6.1-7. Slight variations in the observed ionic concentrations were responsible for the differences depicted.

Comparison of Figure 6.1-6 with 6.1-7 indicated no significant differences between the preoperational period and the 1987 operational year, since normal water quality variability could account for the differences depicted. Note the subtle differences in the June through

August 1987 diagram which represented conditions observed during a period of zero generation (16 May-30 August 1987). The remaining quarterly diagrams for 1987 indicated no major change in water quality between the upstream and downstream stations for the major ions including sulfate which is introduced at LGS as sulfuric acid for pH control.

Moving average plots of mean seasonal values for 32 parameters over the period of record for the upstream (C) and downstream (A) stations are presented in Figures 6.1-8 through 6.1-39. The moving average method and seasonal (three month intervals) data were employed to provide an indication of any trends over time in Schuylkill water quality as well as providing an indication of normal ranges of concentrations observed during pre- and postoperation of LGS.

A number of the parameters measured exhibited seasonal periodicity. They included:

Parameter	Figure
Ammonia nitrogen	6.1-8
Biochemical oxygen demand	6.1-9
Calcium	6.1-11
Chloride	6.1-13
Dissolved oxygen	6.1-16
Fecal coliform	6.1-17
Magnesium	6.1-20

Manganese	6.1-21
Nitrate nitrogen	6.1-24
Nitrite nitrogen	6.1-25
Ortho phosphate phosphorus	6.1-30
Sodium	6.1-32
Specific conductance	6.1-29
Sulfate	6.1-30
Temperature	6.1-31
Total alkalinity	6.1-32
Total dissolved solids	6.1-34
Total hardness	6.1-38
Total phosphate phosphorus	6.1-37

The seasonal periodicity observed can be attributed to biotic and abiotic influences. In Figures 6.1-8 to 6.1-39 note that the data are presented as either a C (Control Station, S77660) or as an A (Affected Station, S77140).

Several of the parameters exhibited a trend in concentrations over the period of record. Some of the parameters exhibited a continuous trend while several exhibited a variable trend. The following parameters exhibited various trends:

Parameter	Figure	Trend/Comment
Biochemical oxygen demand	6.1-9	Increase 1979-1984 Increase 1986-1987
Calcium	6.1-11	Decrease 1982-1983
Chloride	6.1-13	Increase 1980-1987
Manganese	6.1-21	Increase 1981-1987
Ortho phosphate phosphorus	6.1-26	Decrease 1980-1987
Sodium	6.1-28	Increase 1980-1987
Sulfate	6.1-30	Decrease 1979-1987
Total alkalinity	6.1-32	Increase 1975-1987

The trends indicated above were visually interpreted from the figures cited.

The mean seasonal differences in concentrations between the downstream station (S77140) and the upstream station (S77660) for both the pre- and postoperational time periods for the same 32 parameters is presented in Figures 6.1-40 through 6.1-71. As presented, a negative difference value represents an increase in concentration at the downstream station compared to the upstream value. The time from the beginning of the period of record to 1985 is considered preoperational with the years 1986 and 1987 representing a period of full operation. The differences observed during the pre-operational period provide an indication of the normal variability in water quality between the two stations. Differences during 1986-1987 provide an indication of operational impacts of LGS on Schuylkill River quality.

Seasonal parameters were observed to exceed the normal range of variability in 1986-1987. These included:

Parameter	Figure
Calcium	6.1-43
Chloride	6.1-45
Dissolved oxygen	6.1-48
Iron	6.1-50
Magnesium	6.1-52
Manganese	6.1-53
Sodium	6.1-60
Specific conductance	6.1-61
Sulfate	6.1-62
Total dissolved solids	6.1-66

Of these parameters the values for calcium, dissolved oxygen, iron, manganese, and magnesium were 1 mg/l or less above the normal range. Chloride and sodium differences were less than 10 mg/l above the normal range while the sulfate value was approximately 15 mg/l out of the normal range. Total dissolved solids and specific conductance values beyond the normal range were observed in 1986 with dissolved oxygen, iron, and manganese observed in 1987. New maximum values for iron and manganese were established in the summer and fall quarter of 1987 at both Schuylkill stations. The new maxima were associated with high flow conditions. Of interest is the fact that the new maximum iron and manganese values in the summer period were established on 15 July 1987 when LGS was not generating.

Based on the long-term (preoperational) period of record and the 1986-1987 data, LGS does not appear to have any sustained impact on Schuylkill River water quality.

Table 6.1-1. Mean daily Schuylkill River discharge (ft^3/sec) measured at the Pottstown US Geological Survey gage in 1987.

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	N/A	1460	N/A	2480	1440	N/A	810	394	432	1370	1090	6790
02	N/A	1470	N/A	N/A	1360	N/A	1450	415	497	1380	1020	5070
03	2400	1580	6350	N/A	N/A	N/A	1210	416	474	1360	985	4020
04	2160	1720	5310	N/A	N/A	882	811	454	421	1460	984	3140
05	1950	1700	3930	N/A	N/A	4540	666	480	439	1300	966	2680
06	1770	1610	3130	N/A	1820	817	594	593	494	1220	923	2350
07	1710	1600	2910	5280	1620	745	628	511	647	1330	844	2130
08	1940	1630	2950	N/A	1530	718	624	442	5590	1250	821	1980
09	2070	1620	3160	N/A	1430	669	761	N/A	22900	1170	826	1800
10	2100	1480	3400	N/A	1360	718	661	588	7590	1120	1270	1720
11	2320	1440	N/A	2980	1320	626	516	592	3670	1130	2110	1620
12	2200	1430	2410	2780	1270	563	N/A	484	2460	1190	N/A	1530
13	2090	1420	2360	N/A	1170	585	907	408	6520	1120	N/A	1460
14	2020	1350	2110	N/A	1120	627	1230	387	11400	1070	1490	1370
15	2080	1290	1970	N/A	1210	555	1650	381	6600	1070	1480	N/A
16	2320	N/A	1870	2070	1200	724	1090	N/A	4940	1010	1510	N/A
17	2260	1240	1840	2170	1070	574	793	365	3170	778	1720	N/A
18	2340	N/A	1660	2290	1040	513	588	360	4200	738	2090	N/A
19	3220	1130	1570	2080	1430	495	506	394	4260	719	2420	N/A
20	3360	1090	1520	1940	1660	487	485	N/A	3530	718	2060	N/A
21	3020	N/A	1440	1770	1740	521	513	N/A	3120	796	1950	N/A
22	2580	N/A	1390	1680	1460	637	486	N/A	2930	784	1730	N/A
23	2500	1200	N/A	N/A	1420	1520	410	N/A	2520	744	1630	N/A
24	2410	1320	N/A	N/A	1290	1340	389	N/A	2110	710	1490	1470
25	2320	1290	N/A	N/A	1200	802	409	N/A	1890	677	1480	1420
26	2210	N/A	N/A	N/A	N/A	647	805	N/A	1710	673	1410	1510
27	N/A	1110	N/A	N/A	N/A	699	655	N/A	1590	684	1360	1460
28	1950	1120	N/A	N/A	N/A	859	492	731	1490	2770	1330	1360
29	1620		1150	N/A	N/A	624	N/A	635	1410	2600	2070	1360
30	N/A		1130	N/A	N/A	546	453	537	1380	1370	7770	1320
31	N/A		1600		N/A		445	409		1210		1140
Minimum	1620	1090	1130	1680	1040	487	389	360	421	673	821	1140
Mean	2266	1404	2507	2502	1371	853	725	475	3679	1146	1672	2214
Median	2205	1430	2040	2170	1360	647	628	442	2490	1120	1480	1575
Maximum	3360	1720	6350	5280	1820	4540	1650	731	22900	2770	7770	6790

Table 6.1-2. Mean monthly Schuylkill River discharge (ft^3/sec) measured at the Pottstown US Geological Survey gage, 1970 - 1987.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970	982	3717	2217	4889	1613	1175	1459	1045	540	1147	3370	1815
1971	1743	5113	3927	1581	1891	1387	728	2256	1616	1017	2796	2992
1972	2429	2692	4253	2389	2952	7634	2721	825	609	768	3510	4872
1973	3928	3734	2386	4799	3181	3095	2141	1408	1609	1030	1006	4733
1974	3343	2315	2911	4030	1916	1143	843	697	1478	833	766	2660
1975	2962	3402	3718	3249	2645	2500	3189	1399	3433	3348	3263	2025
1976	4953	3619	2588	2556	2002	1686	1562	1124	1033	3870	1716	1428
1977	731	1513	5497	3534	1490	852	795	822	720	2206	3192	5213
1978	5418	1897	5451	2526	3822	1538	1012	1683	949	904	837	2158
1979	7383	4097	4144	2720	2621	1399	991	814	2112	3235	1960	1932
1980	1394	834	3029	3497	2412	1007	611	483	457	487	525	419
1981	316	2933	1101	1675	1687	1230	1080	450	452	505	666	881
1982	1907	2786	2154	3043	1550	4171	1480	993	619	631	936	1320
1983	1392	2807	3535	7820	2654	2169	894	514	357	852	2543	6805
1984	1728	4093	3078	5065	4952	3105	3940	1604	782	743	858	1788
1985	1076	1665	1179	875	1352	826	573	636	1085	856	2301	2511
1986	1747	3603	3763	2658	1356	786	715	973	606	742	2278	3229
1987	2266	1404	2507	2502	1371	853	725	475	3679	1146	1672	2214
Minimum	250	360	658	533	510	487	326	276	271	328	334	300
Mean	2541	2916	3202	3330	2319	2037	1417	1021	1230	1351	1899	2734
Median	1770	2150	2590	2640	1880	1300	937	812	673	836	1235	1960
Maximum	37800	30865	20600	27400	22600	71200	17100	10488	22900	13000	10400	30100

Table 6.1-3. Daily Schuylkill River temperature (C) measured at the Pottstown Water Treatment Plant in 1987.

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	7	5	7	19	18	24	27	29	24	20	13	16
02	7	5	7	13	16	24	26	29	23	18	13	11
03	7	5	6	14	18	25	26	29	24	19	12	11
04	8	5	6	13	17	23	27	29	23	19	12	11
05	8	5	6	14	16	23	27	29	24	18	12	11
06	7	4	11	13	15	23	26	28	23	18	13	10
07	8	5	11	12	17	23	27	27	23	19	11	9
08	5	6	12	12	16	23	27	27	23	18	10	10
09	8	7	12	13	18	24	27	27	23	17	13	8
10	6	7	11	13	17	22	28	28	22	18	13	8
11	6	7	10	14	18	22	28	27	23	18	15	9
12	7	6	7	14	17	23	28	26	22	17	10	11
13	8	7	8	13	20	22	28	27	22	17	13	11
14	6	7	12	13	19	23	28	27	22	17	9	9
15	9	9	10	13	20	25	27	27	22	18	9	11
16	8	6	9	14	19	25	26	28	22	17	14	10
17	7	6	9	14	19	26	25	29	22	16	14	8
18	7	6	11	15	20	26	26	29	22	18	14	8
19	7	9	11	15	21	26	27	29	22	18	13	8
20	7	7	12	16	19	27	28	28	23	17	13	9
21	7	7	11	16	17	28	29	28	20	17	15	9
22	7	6	10	15	18	27	29	27	21	15	12	9
23	6	6	10	18	19	26	29	26	20	16	8	8
24	6	6	11	16	20	25	29	25	20	16	10	7
25	4	6	12	16	20	25	30	25	20	17	12	7
26	3	6	12	16	20	26	30	24	20	17	12	7
27	3	6	12	16	19	26	29	24	19	16	11	9
28	4	7	15	15	19	25	29	23	20	15	11	10
29	5		15	17	21	25	28	23	20	17	10	10
30	6		13	17	22	26	28	27	21	16	12	8
31	5		14		24		28	24		13		10
Minimum	3	4	6	12	15	22	25	23	19	13	8	7
Mean	6	6	10	15	19	25	28	27	22	17	12	9
Median	7	6	11	14	19	25	28	27	22	17	12	9
Maximum	9	9	15	19	24	28	30	29	24	20	15	16

Table 6.1-4. Mean monthly Schuylkill River temperature (C) measured at the Pottstown Water Treatment Plant, 1970 - 1987.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970	4	5	7	11	19	23	25	26	25	19	14	8
1971	5	6	9	14	18	24	27	25	24	19	13	10
1972	8	6	9	13	18	22	24	26	24	17	12	9
1973	7	6	10	13	16	22	25	26	24	19	13	10
1974	7	6	9	13	19	23	26	27	23	17	13	8
1975	7	6	9	11	18	22	24	26	21	16	12	8
1976	5	6	10	15	19	24	25	25	22	16	9	6
1977	4	5	10	14	19	22	27	26	24	17	14	7
1978	6	5	7	13	15	23	26	26	24	19	15	9
1979	6	2	7	14	19	22	25	26	23	17	13	8
1980	5	5	7	12	17	21	25	27	24	16	10	5
1981	3	5	8	13	17	22	25	25	22	15	10	5
1982	5	8	9	12	18	20	24	24	22	17	13	9
1983	6	6	9	10	16	21	25	26	24	18	11	8
1984	5	7	8	12	15	21	23	24	21	17	12	9
1985	6	6	11	15	20	23	25	26	23	17	15	9
1986	9	7	10	14	20	24	26	25	21	18	12	8
1987	6	6	10	15	19	25	28	27	22	17	12	9
Minimum	1	0	0	7	11	15	19	20	16	10	6	3
Mean	6	6	9	13	18	22	25	26	23	17	12	8
Median	5	6	9	13	18	23	26	26	23	17	12	8
Maximum	13	18	15	22	25	28	30	29	29	23	19	16

Table 6.1-5. Summary of Schuylkill River water quality at Station 377660, 20 March 1979 through 30 December 1987.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	-1.0	2.0	9.0	3.0	11.0	21.5	14.0	23.0	30.0	3.0	15.0	24.0	242
Dissolved Oxygen (mg/l)	6.6	11.0	14.4	3.2	9.8	13.4	4.9	7.7	15.4	4.9	8.8	12.4	224
Biochemical Oxygen Demand (mg/l)	0.9	2.7	7.1	1.0	2.8	6.2	1.1	2.8	7.3	0.9	2.1	9.4	229
Chemical Oxygen Demand (mg/l)	0.0	11.3	197.5	0.0	11.2	53.9	0.0	11.1	46.9	0.0	13.2	39.5	228
Total Organic Carbon (mg/l)	0.0	3.2	20.9	0.0	2.4	15.3	0.0	3.4	19.0	0.0	3.8	30.6	222
pH	7.06	7.58	8.20	6.73	7.58	8.99	7.16	7.75	9.09	7.08	7.65	8.65	229
Total Alkalinity (mg/l)	14.2	64.3	130.6	28.9	54.6	77.9	2.7	76.3	111.0	0.0	86.6	126.9	229
Total Hardness (mg/l)	64.6	124.5	687.1	37.0	105.6	156.4	88.7	154.5	786.6	78.6	169.8	255.0	228
Specific Conductance (usm/cm)	159	315	537	181	283	386	215	369	551	157	424	581	229
Total Suspended Solids (mg/l)	0	6	238	0	13	38	0	9	329	0	4	265	229
Total Dissolved Solids (mg/l)	127	211	388	101	218	346	22	305	863	138	293	425	255
Dissolved Silica (mg/l)	2.17	3.57	4.40	1.74	3.41	4.30	1.70	3.44	4.21	1.10	2.53	4.00	75
Total Inorganic Carbon (mg/l)	16.7	65.1	142.1	31.5	57.3	76.8	2.9	74.3	108.2	15.3	86.9	132.7	124
Chloride (mg/l)	12.0	23.9	62.0	0.0	19.2	50.2	8.8	27.3	79.0	10.8	33.2	51.6	229
Sulfate (mg/l)	25.5	56.8	146.0	25.9	54.9	105.9	28.0	79.0	141.9	26.0	86.2	209.8	229
Sodium (mg/l)	8.70	16.63	46.90	7.15	14.27	29.30	6.43	21.26	38.20	8.90	26.20	40.40	229
Potassium (mg/l)	1.9	3.2	14.4	1.5	2.2	7.2	1.4	3.1	7.0	1.2	3.9	8.9	229
Calcium (mg/l)	13.7	29.3	63.6	10.8	25.9	41.7	7.9	32.1	47.0	17.2	33.9	60.4	229
Magnesium (mg/l)	7.30	14.36	29.00	6.30	12.70	19.30	9.10	16.75	25.90	6.75	19.22	28.60	229
Ammonia Nitrogen (mg/l)	0.030	0.390	2.680	0.000	0.234	1.200	0.000	0.109	0.560	0.000	0.174	0.580	229
Nitrite Nitrogen (mg/l)	0.009	0.040	0.480	0.000	0.065	0.228	0.000	0.072	2.980	0.030	0.086	0.420	229
Nitrate Nitrogen (mg/l)	1.37	3.07	4.43	1.71	2.54	3.59	0.00	2.33	3.46	0.00	2.77	9.96	229
Total Phosphate Phosphorus (mg/l)	0.00	0.18	0.67	0.04	0.12	2.45	0.04	0.23	3.48	0.00	0.25	0.52	220
Ortho Phosphate Phosphorus (mg/l)	0.00	0.12	1.60	0.00	0.07	0.33	0.00	0.15	0.33	0.00	0.19	0.35	227
Cadmium (mg/l)	0.000	0.000	0.003	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001	32
Chromium (mg/l)	0.001	0.007	0.075	0.000	0.008	0.139	0.000	0.005	0.194	0.000	0.006	0.104	255
Copper (mg/l)	0.000	0.006	0.048	0.001	0.007	0.052	0.000	0.007	0.295	0.000	0.006	0.032	256
Iron (mg/l)	0.00	0.31	6.83	0.10	0.40	1.32	0.00	0.26	9.90	0.00	0.20	8.10	229
Lead (mg/l)	0.000	0.001	0.028	0.000	0.003	0.041	0.000	0.001	0.171	0.000	0.001	0.028	256
Manganese (mg/l)	0.05	0.23	0.76	0.09	0.23	0.68	0.00	0.11	0.66	0.00	0.06	0.49	229
Nickel (mg/l)	0.002	0.004	0.030	0.003	0.008	0.009	0.000	0.000	0.010	0.000	0.003	0.018	59
Zinc (mg/l)	0.00	0.04	0.81	0.00	0.03	1.20	0.00	0.02	8.34	0.00	0.02	0.62	256
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	32
Cyanide, Total (mg/l)	0.000	0.000	0.008	0.000	0.000	0.009	0.000	0.000	0.008	0.000	0.000	0.012	226
Phenols (mg/l)	0.000	0.000	0.030	0.000	0.000	0.019	0.000	0.000	0.020	0.000	0.000	0.050	228
Trichloroethylene (ug/l)	0.0	0.0	3.9	0.0	0.0	6.2	0.0	0.0	8.2	0.0	0.0	9.5	200
Total Coliforms (MF) (c/.1l)	4	2700	140000	151	3550	116000	60	5800	82000	140	6300	138000	226
Fecal Coliforms (MF) (c/.1l)	0	220	61000	10	268	12100	3	585	43000	10	445	30500	224
Aluminum (mg/l)	0.00	0.22	1.80	0.14	0.23	0.97	0.00	0.10	6.30	0.00	0.08	3.63	32
Sulfide (mg/l)	0.00	0.00	5.37	0.00	0.00	1.72	0.00	0.00	0.70	0.00	0.00	1.80	57

Table 6.1-6. Summary of Schuylkill River water quality at Station 577660, 14 January 1987 through 30 December 1987.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	0.0	2.0	7.0	3.0	9.5	15.0	19.5	23.0	24.0	9.0	14.5	21.0	25
Dissolved Oxygen (mg/l)	9.5	11.6	13.0	7.1	9.0	11.0	4.9	6.0	6.8	4.9	7.5	11.1	24
Biochemical Oxygen Demand (mg/l)	2.0	2.6	4.8	2.1	4.3	5.5	2.2	2.8	5.4	2.5	3.1	7.0	26
Chemical Oxygen Demand (mg/l)	0.0	0.0	0.0	0.0	6.4	18.3	0.0	11.0	16.3	0.0	13.9	37.5	26
Total Organic Carbon (mg/l)	2.2	3.1	3.9	2.1	2.4	2.8	2.7	3.5	4.9	2.2	3.5	5.7	26
pH	7.33	7.69	7.85	7.42	7.57	7.89	7.25	7.56	7.87	7.08	7.35	7.67	26
Total Alkalinity (mg/l)	54.3	73.3	87.4	48.0	64.3	74.4	42.4	93.0	111.0	0.0	82.1	94.3	26
Total Hardness (mg/l)	110.0	142.0	164.2	87.1	133.5	143.2	108.4	175.0	196.0	78.6	154.0	170.0	26
Specific Conductance (usm/cm)	240	350	415	220	319	353	246	459	551	157	344	380	26
Total Suspended Solids (mg/l)	2	6	13	6	18	28	4	12	329	5	8	265	26
Total Dissolved Solids (mg/l)	150	210	305	166	225	281	22	343	863	141	230	259	26
Chloride (mg/l)	14.6	24.7	36.0	0.0	18.9	23.9	21.0	40.7	54.1	18.3	28.2	38.4	26
Sulfate (mg/l)	29.1	48.5	62.3	30.1	43.8	57.9	35.6	64.3	109.0	26.0	59.8	79.6	26
Sodium (mg/l)	9.20	18.20	37.50	12.20	14.55	16.80	13.20	29.60	32.00	8.90	16.95	27.00	26
Potassium (mg/l)	2.6	3.7	14.4	2.0	2.3	7.2	2.0	4.0	7.0	2.6	3.7	5.3	26
Calcium (mg/l)	21.9	32.8	39.5	21.0	26.7	35.4	7.9	34.1	46.0	19.2	32.1	43.1	26
Magnesium (mg/l)	7.60	14.50	15.10	8.34	13.00	15.40	9.10	15.60	17.10	6.75	12.60	17.00	26
Ammonia Nitrogen (mg/l)	0.154	0.360	0.470	0.000	0.225	0.370	0.100	0.180	0.260	0.128	0.184	0.342	26
Nitrite Nitrogen (mg/l)	0.037	0.040	0.480	0.000	0.055	0.228	0.070	0.100	2.980	0.075	0.088	0.134	26
Nitrate Nitrogen (mg/l)	2.57	3.11	4.43	1.95	2.66	3.04	1.84	2.82	3.46	1.46	2.73	3.02	26
Total Phosphate Phosphorus (mg/l)	0.09	0.13	0.24	0.06	0.10	0.14	0.23	0.33	0.39	0.07	0.17	0.52	26
Ortho Phosphate Phosphorus (mg/l)	0.00	0.07	0.14	0.00	0.06	0.13	0.13	0.21	0.27	0.09	0.12	0.30	26
Cadmium (mg/l)	0.000	0.000	0.003	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001	26
Chromium (mg/l)	0.001	0.004	0.006	0.000	0.003	0.010	0.000	0.002	0.011	0.000	0.004	0.044	26
Copper (mg/l)	0.003	0.004	0.006	0.002	0.006	0.012	0.004	0.006	0.018	0.004	0.005	0.032	26
Iron (mg/l)	0.00	0.20	1.50	0.17	0.49	0.77	0.00	0.19	9.90	0.15	0.27	8.10	26
Lead (mg/l)	0.000	0.000	0.002	0.000	0.001	0.005	0.000	0.001	0.027	0.000	0.003	0.022	26
Manganese (mg/l)	0.20	0.26	0.30	0.20	0.25	0.45	0.10	0.20	0.66	0.00	0.20	0.49	26
Nickel (mg/l)	0.002	0.005	0.030	0.003	0.008	0.009	0.004	0.006	0.010	0.000	0.005	0.018	26
Zinc (mg/l)	0.02	0.02	0.04	0.01	0.04	0.06	0.02	0.03	0.07	0.02	0.03	0.17	26
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	26
Cyanide, Total (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.000	0.000	0.000	25
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.037	26
Trichloroethylene (ug/l)	0.0	0.0	2.4	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	26
Total Coliforms (MF) (c/.1l)	800	2500	12200	2600	8875	21500	1000	5400	8000	2500	3300	20000	26
Fecal Coliforms (MF) (c/.1l)	7	100	2060	33	185	700	30	460	6000	120	345	10400	26
Aluminum (mg/l)	0.00	0.20	0.34	0.14	0.23	0.97	0.00	0.10	6.30	0.00	0.09	3.63	26
Sulfide (mg/l)	0.00	0.10	5.37	0.00	0.20	1.25	0.00	0.00	0.70	0.00	0.00	0.20	26

Table 6.1-7. New minimum values observed for water quality parameters measured in 1987 at station 377660 on the Schuylkill River.

Season	Parameter	Value	Date
Dec, Jan, Feb	Cadmium (mg/l)	0.000	12/30/87
	Nickel (mg/l)	0.002	12/02/87
Mar, Apr, May	Temperature (C)	3.0	03/24/87
	Chloride (mg/l)	0.0	04/22/87
	Nitrite Nitrogen (mg/l)	0.000	04/08/87
	Cadmium (mg/l)	0.000	04/22/87
	Chromium (mg/l)	0.000	03/24/87
	Nickel (mg/l)	0.003	03/11/87
	Mercury (ug/l)	0.0	03/11/87
	Aluminum (mg/l)	0.14	05/20/87
Jun, Jul, Aug	Dissolved Oxygen (mg/l)	4.9	06/17/87
	Total Dissolved Solids (mg/l)	22	06/17/87
	Calcium (mg/l)	7.9	07/15/87
	Magnesium (mg/l)	9.10	07/15/87
	Cadmium (mg/l)	0.000	06/03/87
	Mercury (ug/l)	0.0	06/03/87
	Aluminum (mg/l)	0.00	07/29/87
Sep, Oct, Nov	Dissolved Oxygen (mg/l)	4.9	09/09/87
	pH	7.08	09/09/87
	Total Alkalinity (mg/l)	0.0	09/09/87
	Total Hardness (mg/l)	78.6	09/09/87
	Specific Conductance (usm/cm)	157	09/09/87
	Sulfate (mg/l)	26.0	09/09/87
	Sodium (mg/l)	8.90	09/09/87
	Magnesium (mg/l)	6.75	09/09/87
	Cadmium (mg/l)	0.000	09/09/87

Table 6.1-8. New maximum values observed for water quality parameters measured in 1987 at station 377660 on the Schuylkill River.

Season	Parameter	Value	Date
Dec, Jan, Feb	Potassium (mg/l)	14.4	02/25/87
	Nitrite Nitrogen (mg/l)	0.480	02/11/87
	Nitrate Nitrogen (mg/l)	4.43	01/28/87
	Cadmium (mg/l)	0.003	12/02/87
	Nickel (mg/l)	0.030	01/28/87
	Sulfide (mg/l)	5.37	02/11/87
Mar, Apr, May	Potassium (mg/l)	7.2	04/22/87
	Nitrite Nitrogen (mg/l)	0.228	03/11/87
	Cadmium (mg/l)	0.001	04/08/87
	Nickel (mg/l)	0.009	04/08/87
	Mercury (ug/l)	0.0	03/11/87
	Aluminum (mg/l)	0.97	04/22/87
Jun, Jul, Aug	Total Alkalinity (mg/l)	111.0	08/26/87
	Specific Conductance (usm/cm)	551	08/26/87
	Total Suspended Solids (mg/l)	329	07/15/87
	Total Dissolved Solids (mg/l)	863	07/01/87
	Nitrite Nitrogen (mg/l)	2.980	06/17/87
	Nitrate Nitrogen (mg/l)	3.46	07/01/87
	Cadmium (mg/l)	0.000	06/17/87
	Iron (mg/l)	9.90	07/15/87
	Manganese (mg/l)	0.66	07/15/87
	Nickel (mg/l)	0.010	07/01/87
	Mercury (ug/l)	0.4	07/15/87
	Aluminum (mg/l)	6.30	07/15/87
	Cyanide, Total (mg/l)	0.008	07/29/87
	Sulfide (mg/l)	0.70	07/15/87
Sep, Oct, Nov	Total Suspended Solids (mg/l)	265	09/09/87
	Total Phosphate Phosphorus (mg/l)	0.52	09/09/87
	Cadmium (mg/l)	0.001	10/21/87
	Copper (mg/l)	0.032	09/09/87
	Iron (mg/l)	8.10	09/09/87
	Manganese (mg/l)	0.49	09/09/87
	Nickel (mg/l)	0.018	10/21/87
	Aluminum (mg/l)	3.63	09/09/87

Table 6.1-9. Summary of Schuylkill River water quality at Station S77140, 20 March 1979 through 30 December 1987.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	-1.0	2.0	9.0	4.0	11.0	21.5	14.0	23.0	30.0	3.5	15.0	24.5	215
Dissolved Oxygen (mg/l)	6.1	11.0	15.0	3.1	10.2	13.9	4.7	7.9	15.0	5.6	8.9	12.6	225
Biochemical Oxygen Demand (mg/l)	0.9	2.9	8.4	0.7	3.0	7.6	1.1	2.8	7.1	0.8	2.2	5.8	229
Chemical Oxygen Demand (mg/l)	0.0	12.8	196.6	0.0	11.7	56.2	0.0	11.7	64.5	0.0	12.3	75.9	227
Total Organic Carbon (mg/l)	0.0	2.5	18.7	0.0	2.4	16.3	0.0	4.0	20.0	0.0	3.5	29.3	221
pH	7.01	7.63	8.21	6.62	7.61	8.98	6.91	7.76	9.19	7.16	7.71	8.67	229
Total Alkalinity (mg/l)	8.9	63.8	172.1	27.7	55.2	74.4	4.3	76.5	131.4	0.0	87.9	130.7	228
Total Hardness (mg/l)	65.2	126.3	675.2	51.9	107.8	160.6	69.2	154.9	724.9	83.5	171.0	448.0	227
Specific Conductance (usm/cm)	156	316	611	157	280	387	215	372	729	189	429	667	229
Total Suspended Solids (mg/l)	0	6	232	0	12	55	0	9	340	0	4	357	228
Total Dissolved Solids (mg/l)	97	214	509	135	207	338	160	294	2290	141	296	453	228
Dissolved Silica (mg/l)	2.09	3.63	8.99	2.01	3.38	4.13	1.66	3.37	4.90	1.08	2.50	3.35	75
Total Inorganic Carbon (mg/l)	23.2	66.7	184.1	29.7	57.5	74.6	4.7	71.7	106.0	52.2	87.0	136.1	123
Chloride (mg/l)	11.7	24.2	62.4	0.0	19.7	51.3	8.8	26.4	81.9	10.6	33.7	59.5	228
Sulfate (mg/l)	24.9	57.9	185.2	29.1	55.2	99.7	28.0	78.0	187.2	31.7	85.5	217.7	228
Sodium (mg/l)	8.50	17.31	98.00	4.90	13.95	29.12	6.74	21.14	58.00	9.07	26.30	42.80	229
Potassium (mg/l)	1.9	3.1	7.3	0.8	2.2	4.8	1.4	3.1	9.7	1.2	4.0	11.1	229
Calcium (mg/l)	14.1	29.0	83.5	5.9	26.5	44.3	9.6	32.3	84.0	6.9	35.0	62.4	229
Magnesium (mg/l)	7.00	13.90	35.80	3.60	13.00	20.30	8.60	17.00	28.93	8.30	20.10	32.30	229
Ammonia Nitrogen (mg/l)	0.000	0.418	2.470	0.000	0.220	1.480	0.000	0.097	0.490	0.000	0.160	0.580	229
Nitrite Nitrogen (mg/l)	0.008	0.040	0.301	0.000	0.067	0.224	0.000	0.073	3.000	0.030	0.090	0.900	228
Nitrate Nitrogen (mg/l)	1.40	3.15	6.19	1.60	2.57	3.63	0.00	2.38	5.83	0.03	2.76	4.68	228
Total Phosphate Phosphorus (mg/l)	0.02	0.17	0.85	0.03	0.12	3.48	0.04	0.23	3.48	0.00	0.27	2.24	219
Ortho Phosphate Phosphorus (mg/l)	0.00	0.12	0.85	0.00	0.07	0.33	0.00	0.15	0.35	0.00	0.19	0.37	227
Cadmium (mg/l)	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	32
Chromium (mg/l)	0.001	0.009	0.060	0.002	0.008	0.068	0.000	0.005	0.070	0.000	0.007	0.036	228
Copper (mg/l)	0.000	0.007	0.072	0.001	0.007	0.039	0.000	0.006	0.055	0.000	0.007	0.044	229
Iron (mg/l)	0.00	0.28	7.45	0.11	0.43	1.54	0.00	0.22	10.80	0.00	0.18	13.80	229
Lead (mg/l)	0.000	0.001	0.025	0.000	0.002	0.014	0.000	0.001	0.023	0.000	0.000	0.039	229
Manganese (mg/l)	0.08	0.24	0.72	0.07	0.24	0.88	0.00	0.11	0.68	0.00	0.06	1.15	229
Nickel (mg/l)	0.001	0.004	0.020	0.005	0.008	0.016	0.004	0.006	0.012	0.002	0.004	0.006	32
Zinc (mg/l)	0.00	0.04	0.70	0.00	0.03	0.89	0.00	0.03	2.56	0.00	0.02	0.16	229
Mercury (ug/l)	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32
Cyanide, Total (mg/l)	0.000	0.000	0.020	0.000	0.000	0.009	0.000	0.000	0.018	0.000	0.000	0.008	226
Phenols (mg/l)	0.000	0.000	0.035	0.000	0.000	0.042	0.000	0.000	0.022	0.000	0.000	0.043	227
Trichloroethylene (ug/l)	0.0	0.0	3.6	0.0	0.0	4.8	0.0	0.0	2.4	0.0	0.0	6.8	199
Total Coliforms (MF) (c/.1l)	13	2200	69000	170	3250	107000	40	5200	102000	140	5900	150000	225
Fecal Coliforms (MF) (c/.1l)	0	245	55000	10	275	11500	2	515	63000	27	400	29000	225
Aluminum (mg/l)	0.00	0.19	3.90	0.21	0.34	1.58	0.07	0.18	8.00	0.00	0.02	5.27	32
Sulfide (mg/l)	0.00	0.00	0.80	0.00	0.00	0.74	0.00	0.00	0.90	0.00	0.00	4.40	57

Table 6.1-10. Summary of Schuylkill River water quality at Station S77140, 14 January 1987 through 30 December 1987.

	Dec, Jan, Feb			Mar, Apr, May			Jun, Jul, Aug			Sep, Oct, Nov			# of
Parameter	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Samples
Temperature (C)	0.0	2.5	7.0	4.0	10.0	15.5	19.5	23.0	28.0	9.0	14.0	21.0	26
Dissolved Oxygen (mg/l)	9.9	11.1	12.2	7.0	9.8	11.1	5.9	6.7	8.2	6.6	8.2	9.0	23
Biochemical Oxygen Demand (mg/l)	1.2	2.9	4.1	2.0	4.1	4.5	2.0	3.1	6.0	2.6	3.3	5.0	26
Chemical Oxygen Demand (mg/l)	0.0	11.3	16.3	0.0	17.9	19.0	0.0	14.0	21.4	0.0	0.0	75.9	26
Total Organic Carbon (mg/l)	2.1	3.4	3.8	2.3	2.5	2.8	2.8	3.8	5.6	2.1	3.3	6.5	26
pH	7.42	7.83	7.91	7.38	7.65	8.01	7.30	7.66	7.82	7.16	7.36	7.69	26
Total Alkalinity (mg/l)	58.0	72.1	89.9	48.9	64.3	74.4	43.8	93.0	111.4	0.0	82.8	92.6	26
Total Hardness (mg/l)	110.0	140.5	171.3	87.1	134.0	153.4	106.3	172.4	191.0	87.2	156.5	171.0	26
Specific Conductance (usm/cm)	241	346	434	219	326	362	245	463	544	189	361	381	26
Total Suspended Solids (mg/l)	1	8	18	6	15	39	2	11	340	4	12	357	26
Total Dissolved Solids (mg/l)	158	190	298	159	234	278	200	353	2290	159	244	287	26
Chloride (mg/l)	16.9	25.8	37.6	0.0	20.8	25.7	21.7	40.8	50.1	19.2	28.3	37.5	26
Sulfate (mg/l)	29.1	54.9	65.8	29.1	45.2	62.1	34.1	64.3	107.0	31.7	63.0	80.6	26
Sodium (mg/l)	8.50	17.50	98.00	11.10	15.55	17.00	11.60	28.00	32.49	10.70	18.55	25.20	26
Potassium (mg/l)	2.6	4.8	7.3	1.9	2.6	4.8	2.6	3.6	6.7	2.6	3.6	4.9	26
Calcium (mg/l)	20.6	35.0	49.6	20.2	27.2	37.2	9.6	34.1	40.6	6.9	34.9	40.2	26
Magnesium (mg/l)	7.00	13.30	16.20	7.86	13.50	15.40	8.60	14.33	17.40	8.30	13.60	16.10	26
Ammonia Nitrogen (mg/l)	0.143	0.370	0.761	0.000	0.223	0.280	0.081	0.161	0.220	0.121	0.195	0.317	26
Nitrite Nitrogen (mg/l)	0.036	0.042	0.270	0.000	0.048	0.224	0.070	0.090	3.000	0.079	0.089	0.113	26
Nitrate Nitrogen (mg/l)	2.47	3.34	6.19	1.96	2.69	3.07	1.84	2.83	3.45	1.47	2.84	3.03	26
Total Phosphate Phosphorus (mg/l)	0.06	0.14	0.28	0.04	0.09	0.17	0.27	0.32	0.40	0.12	0.16	0.58	26
Ortho Phosphate Phosphorus (mg/l)	0.00	0.05	0.14	0.00	0.05	0.14	0.15	0.22	0.28	0.09	0.13	0.26	26
Cadmium (mg/l)	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	26
Chromium (mg/l)	0.001	0.003	0.005	0.002	0.002	0.006	0.000	0.002	0.013	0.000	0.003	0.013	26
Copper (mg/l)	0.002	0.003	0.008	0.003	0.007	0.012	0.004	0.005	0.020	0.003	0.006	0.044	26
Iron (mg/l)	0.10	0.19	0.60	0.19	0.58	0.90	0.00	0.22	10.80	0.10	0.23	13.80	26
Lead (mg/l)	0.000	0.000	0.002	0.001	0.002	0.004	0.000	0.001	0.023	0.000	0.002	0.039	26
Manganese (mg/l)	0.11	0.25	0.30	0.22	0.26	0.53	0.10	0.20	0.68	0.00	0.24	1.15	26
Nickel (mg/l)	0.001	0.004	0.020	0.005	0.008	0.016	0.004	0.006	0.012	0.002	0.004	0.006	26
Zinc (mg/l)	0.00	0.02	0.04	0.01	0.04	0.04	0.02	0.03	0.23	0.03	0.03	0.10	26
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26
Cyanide, Total (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	25
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.000	0.000	0.000	0.043	26
Trichloroethylene (ug/l)	0.0	0.0	2.6	0.0	0.0	4.0	0.0	0.0	2.4	0.0	0.0	0.0	26
Total Coliforms (MF) (c/.1l)	750	2200	14400	2400	9750	17000	500	4000	8000	700	4800	20000	26
Fecal Coliforms (MF) (c/.1l)	9	60	1860	22	170	800	90	390	6000	40	275	14200	26
Aluminum (mg/l)	0.00	0.19	0.34	0.21	0.34	1.58	0.07	0.18	8.00	0.00	0.06	5.27	26
Sulfide (mg/l)	0.00	0.28	0.80	0.00	0.00	0.30	0.00	0.00	0.90	0.00	0.00	0.20	26

Table 6.1-11. New minimum values observed for water quality parameters measured in 1987 at station S77140 on the Schuylkill River.

Season	Parameter	Value	Date
Dec, Jan, Feb	Sodium (mg/l)	8.50	12/02/87
	Magnesium (mg/l)	7.00	12/02/87
	Chromium (mg/l)	0.001	02/25/87
	Nickel (mg/l)	0.001	12/02/87
Mar, Apr, May	Chloride (mg/l)	0.0	04/22/87
	Sulfate (mg/l)	29.1	05/20/87
	Nitrite Nitrogen (mg/l)	0.000	04/08/87
	Cadmium (mg/l)	0.000	03/11/87
	Nickel (mg/l)	0.005	03/11/87
	Mercury (ug/l)	0.0	03/11/87
	Aluminum (mg/l)	0.21	03/24/87
Jun, Jul, Aug	Calcium (mg/l)	9.6	07/15/87
	Magnesium (mg/l)	8.60	07/15/87
	Cadmium (mg/l)	0.000	06/03/87
	Nickel (mg/l)	0.004	07/01/87
	Mercury (ug/l)	0.0	06/03/87
	Aluminum (mg/l)	0.07	06/03/87
Sep, Oct, Nov	pH	7.16	09/09/87
	Total Alkalinity (mg/l)	0.0	09/09/87
	Specific Conductance (usm/cm)	189	09/09/87
	Sulfate (mg/l)	31.7	09/09/87
	Calcium (mg/l)	6.9	09/09/87
	Magnesium (mg/l)	8.30	09/09/87
	Cadmium (mg/l)	0.000	11/04/87
	Nickel (mg/l)	0.002	09/09/87

Table 6.1-12. New maximum values observed for water quality parameters measured in 1987 at station S77140 on the Schuylkill River.

Season	Parameter	Value	Date
Dec, Jan, Feb	Sodium (mg/l)	98.00	12/30/87
	Potassium (mg/l)	7.3	02/11/87
	Nitrate Nitrogen (mg/l)	6.19	01/28/87
	Cadmium (mg/l)	0.002	12/02/87
	Nickel (mg/l)	0.020	01/28/87
	Sulfide (mg/l)	0.80	12/16/87
Mar, Apr, May	Total Alkalinity (mg/l)	74.4	05/20/87
	Potassium (mg/l)	4.8	04/22/87
	Nitrite Nitrogen (mg/l)	0.224	03/11/87
	Cadmium (mg/l)	0.000	05/20/87
	Nickel (mg/l)	0.016	04/08/87
	Mercury (ug/l)	0.0	03/11/87
	Aluminum (mg/l)	1.58	04/22/87
Jun, Jul, Aug	Total Suspended Solids (mg/l)	340	07/15/87
	Total Dissolved Solids (mg/l)	2290	07/01/87
	Nitrite Nitrogen (mg/l)	3.000	06/17/87
	Cadmium (mg/l)	0.000	06/17/87
	Iron (mg/l)	10.80	07/15/87
	Lead (mg/l)	0.023	07/15/87
	Manganese (mg/l)	0.68	07/15/87
	Nickel (mg/l)	0.012	07/15/87
	Mercury (ug/l)	0.0	06/03/87
	Aluminum (mg/l)	8.00	07/15/87
	Sulfide (mg/l)	0.90	07/15/87
	Trichloroethylene (ug/l)	2.4	07/15/87
Sep, Oct, Nov	Total Suspended Solids (mg/l)	357	09/09/87
	Copper (mg/l)	0.044	09/09/87
	Iron (mg/l)	13.80	09/09/87
	Lead (mg/l)	0.039	09/09/87
	Manganese (mg/l)	1.15	09/09/87
	Aluminum (mg/l)	5.27	09/09/87
	Chemical Oxygen Demand (mg/l)	75.9	09/09/87
	Phenols (mg/l)	0.043	09/09/87

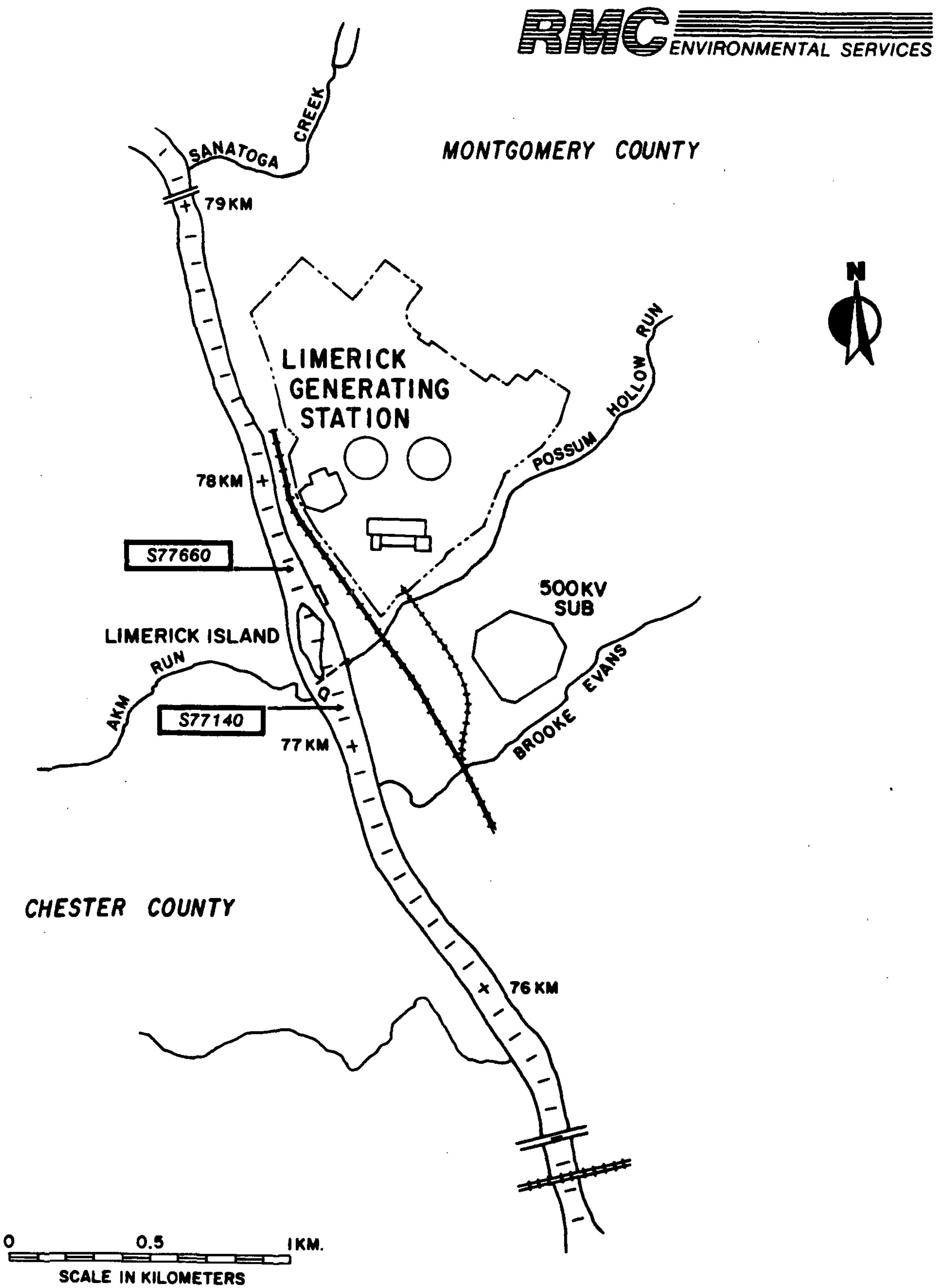


FIGURE 6.1-1 LOCATION OF WATER QUALITY SAMPLE STATIONS ON THE SCHUYLKILL RIVER, 1987.

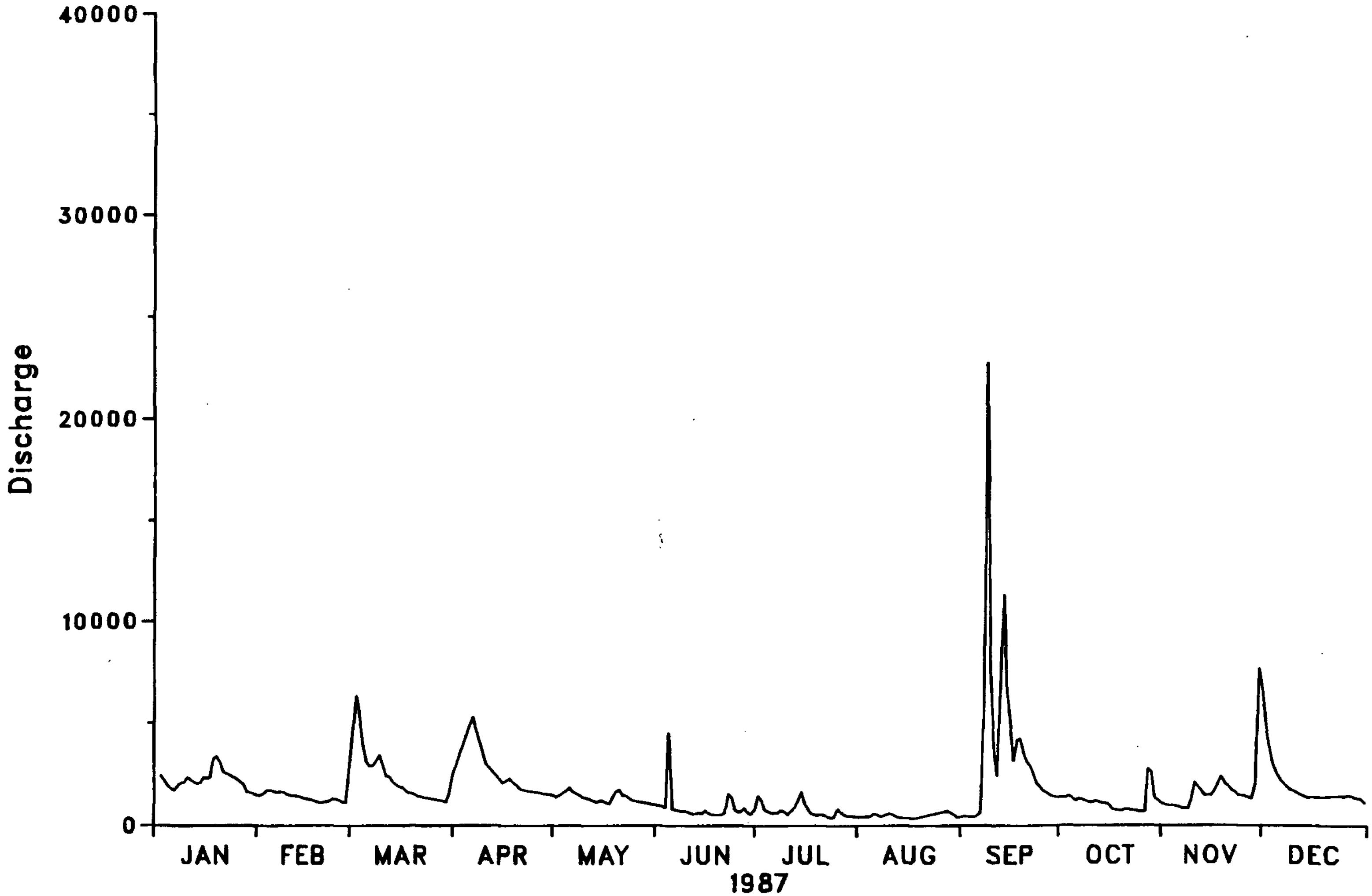


Figure 6.1–2. Schuylkill River mean daily discharge (cfs) during 1987 (Pottstown gage).

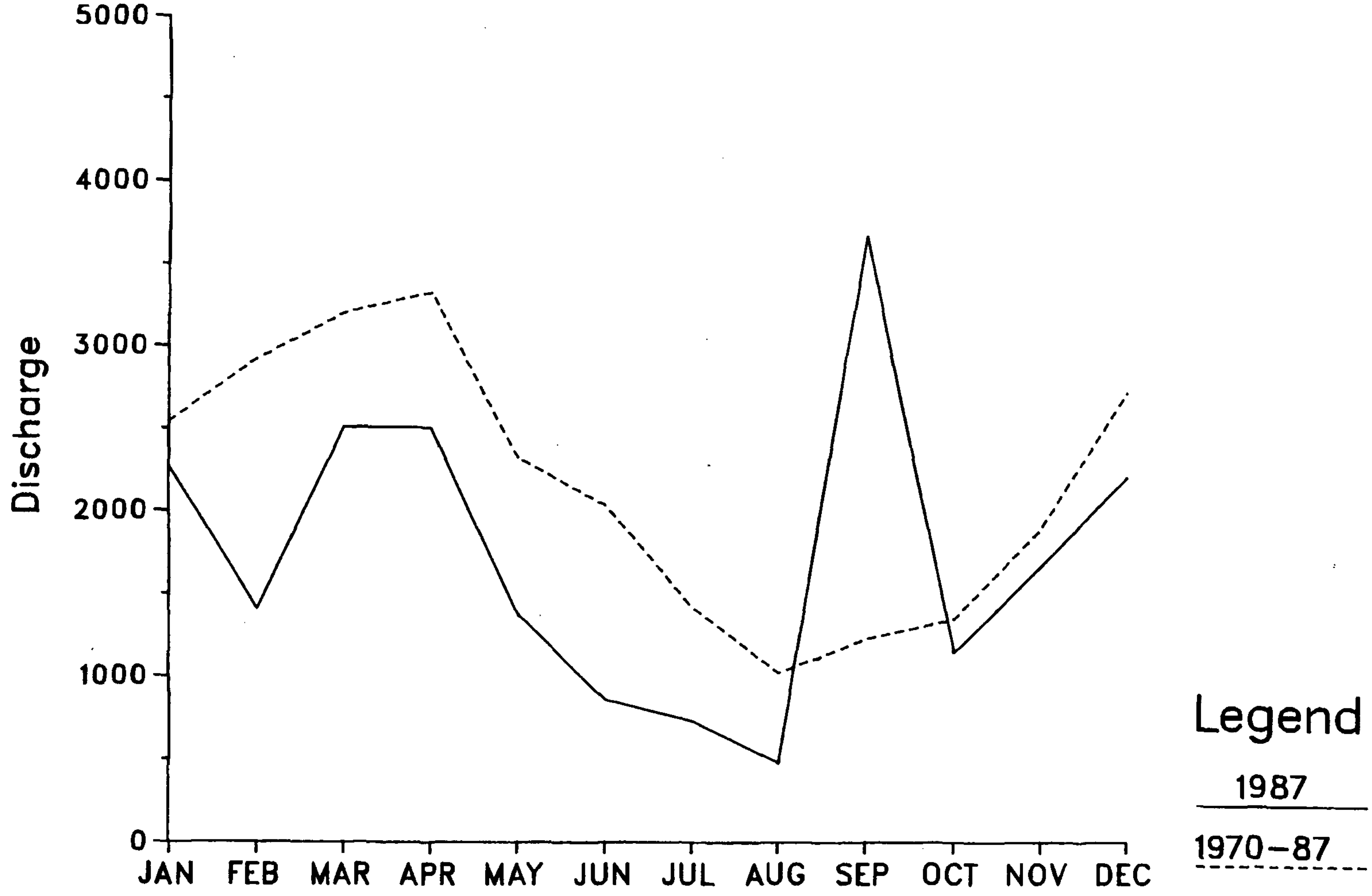


Figure 6.1–3. Schuylkill River mean monthly discharge (cfs) during 1970–1987 and 1987 (Pottstown gage).

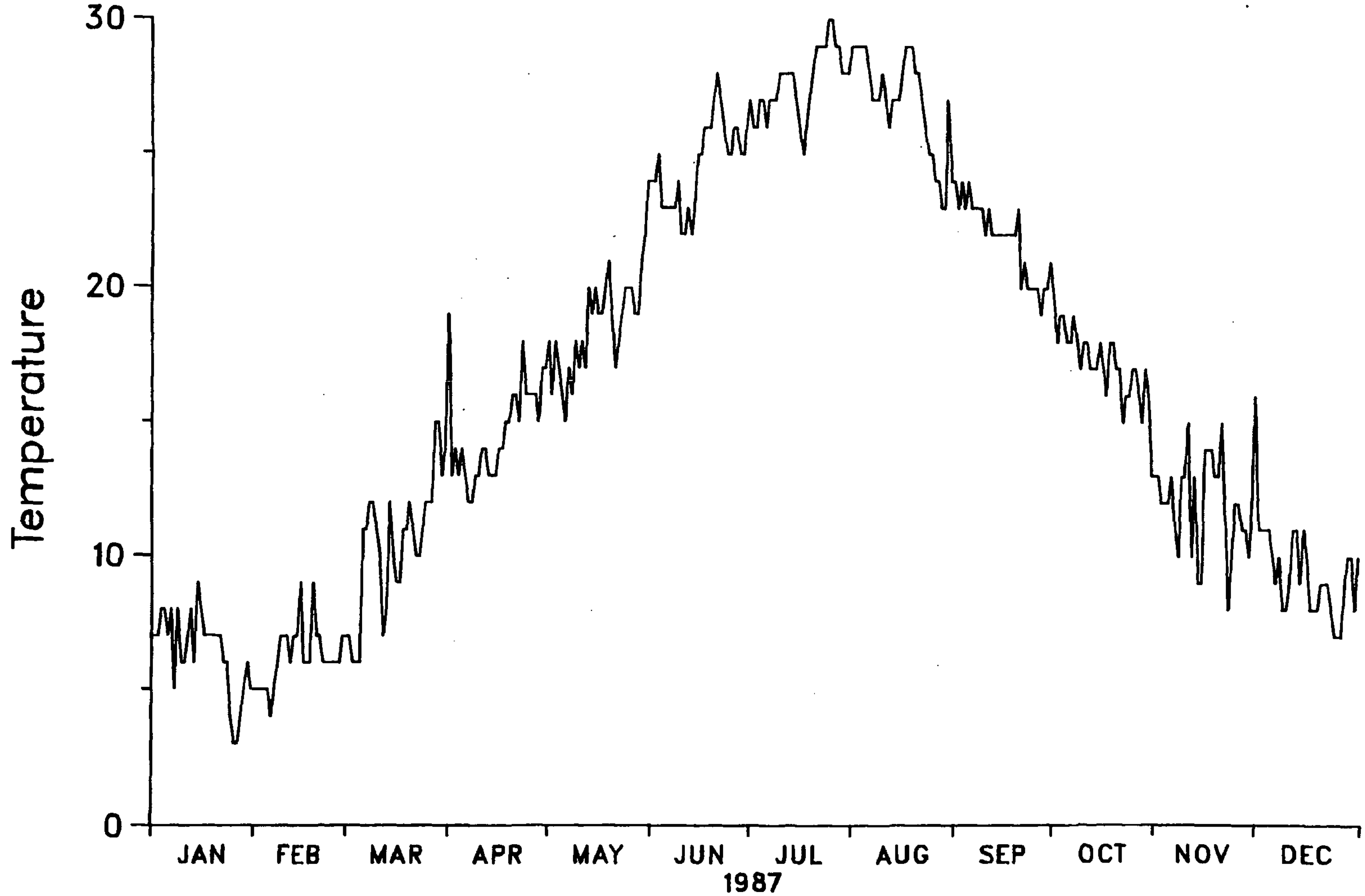


Figure 6.1–4. Schuylkill River daily temperature during 1987.

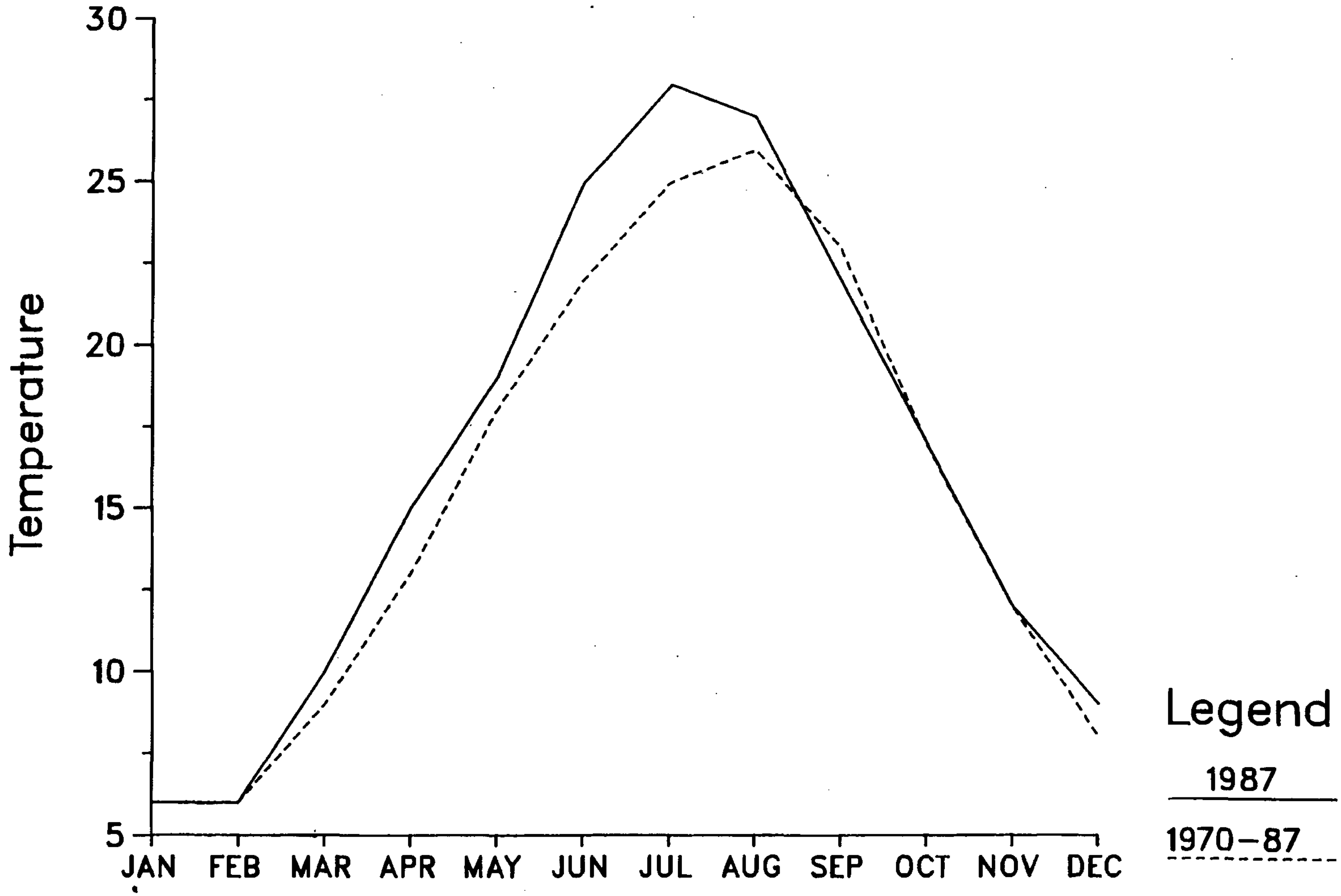


Figure 6.1–5. Schuylkill River mean monthly temperature during 1970–1987 and 1987.

Fig. 6.1-6 (following).

Stiff diagrams of Schuylkill River water quality at station S77660, 1975-1985.

Figure 6.1-6.

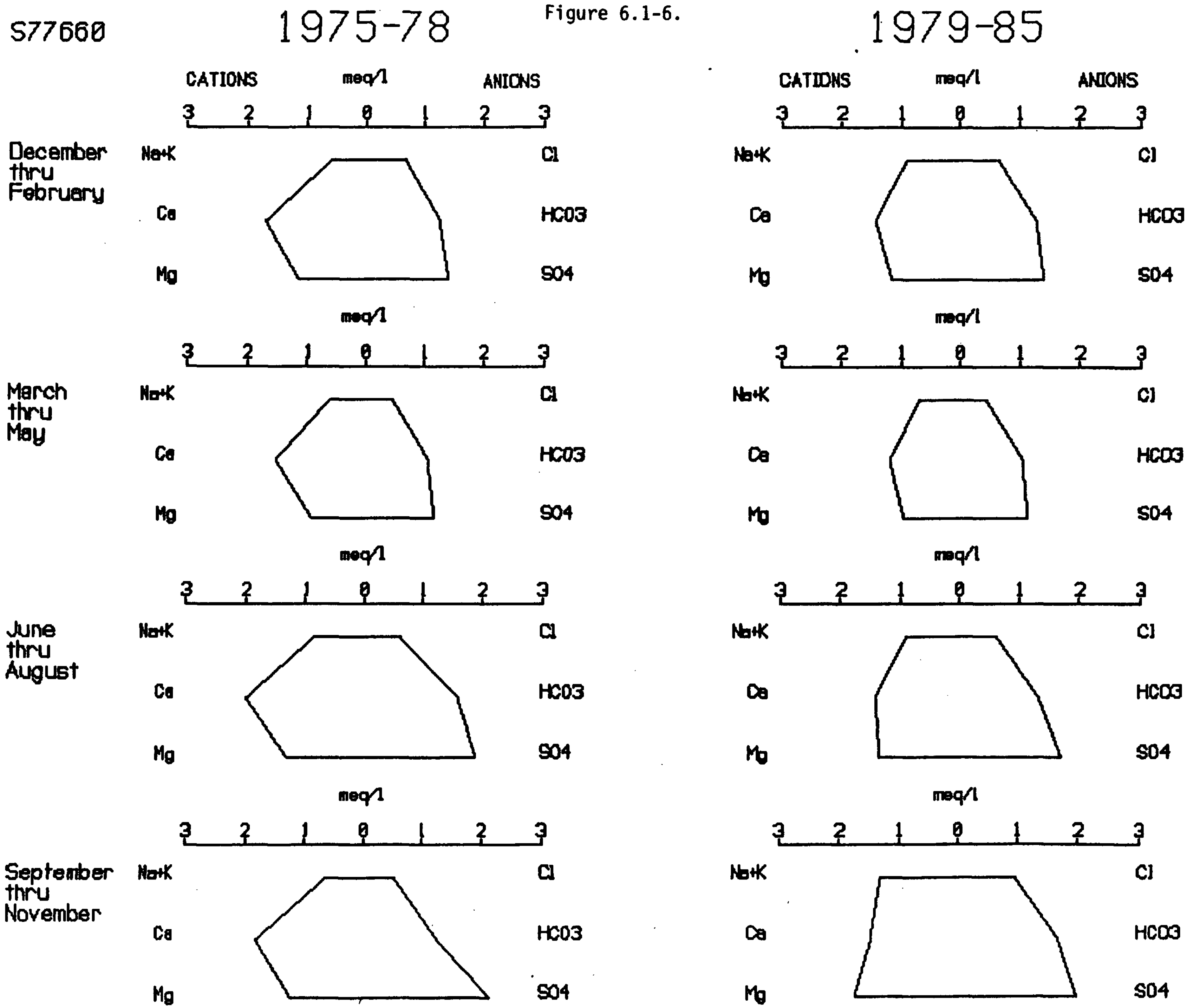

S77660
1975-78
1979-85
CATIONS
meq/l
ANIONS
3 2 1 0 1 2 3
December
thru
February
March
thru
May
June
thru
August
September
thru
November
Na+K
Ca
Mg
Cl
HCO3
SO4

Fig. 6.1-7 (following).

Stiff diagrams of Schuylkill River water quality at stations S77660 and S77140, 1987.

1987 S77660 (Upstream) Figure 6.1-7. S77140 (Downstream)

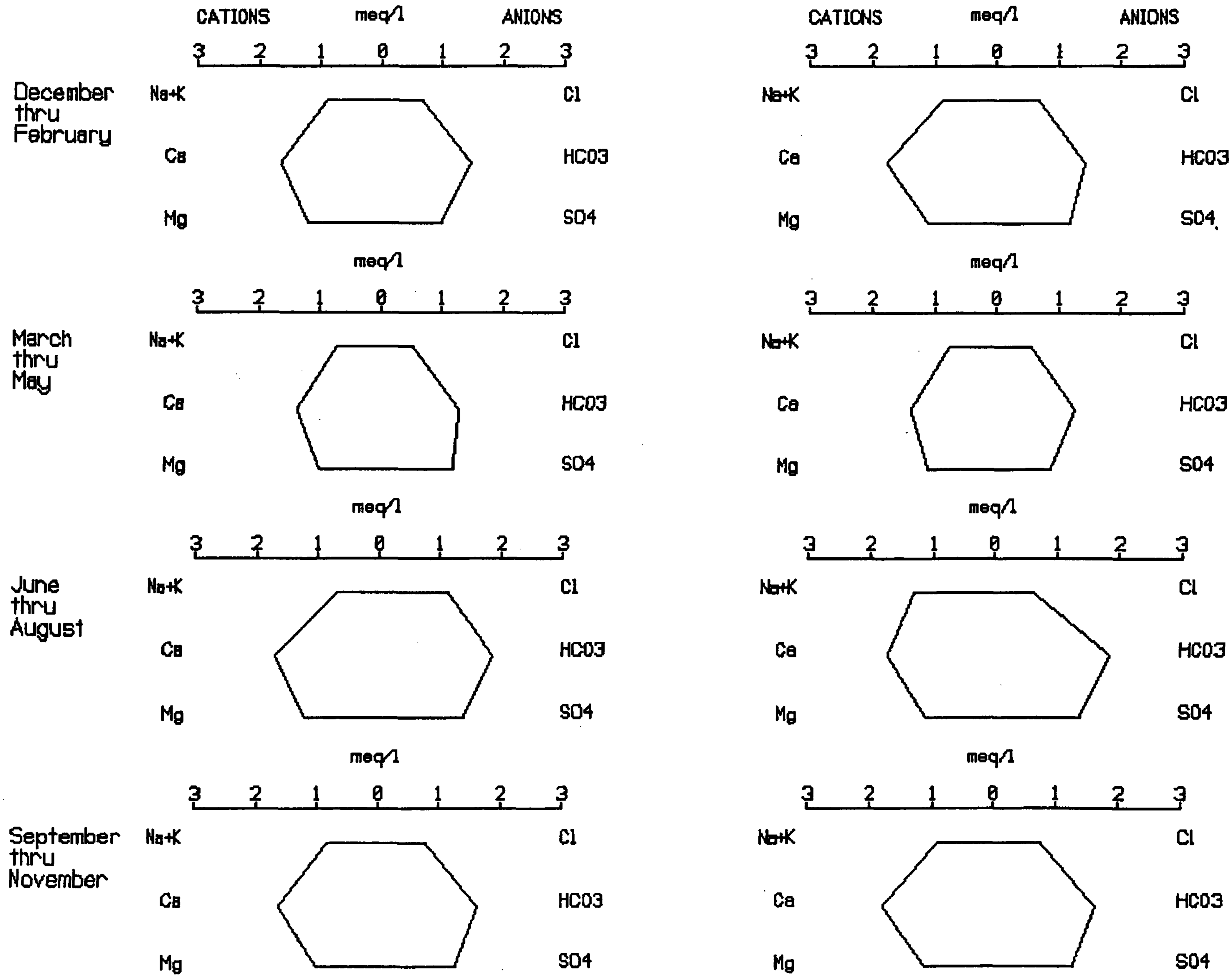


Fig. 6.1-8 to 6.1-39 (following).

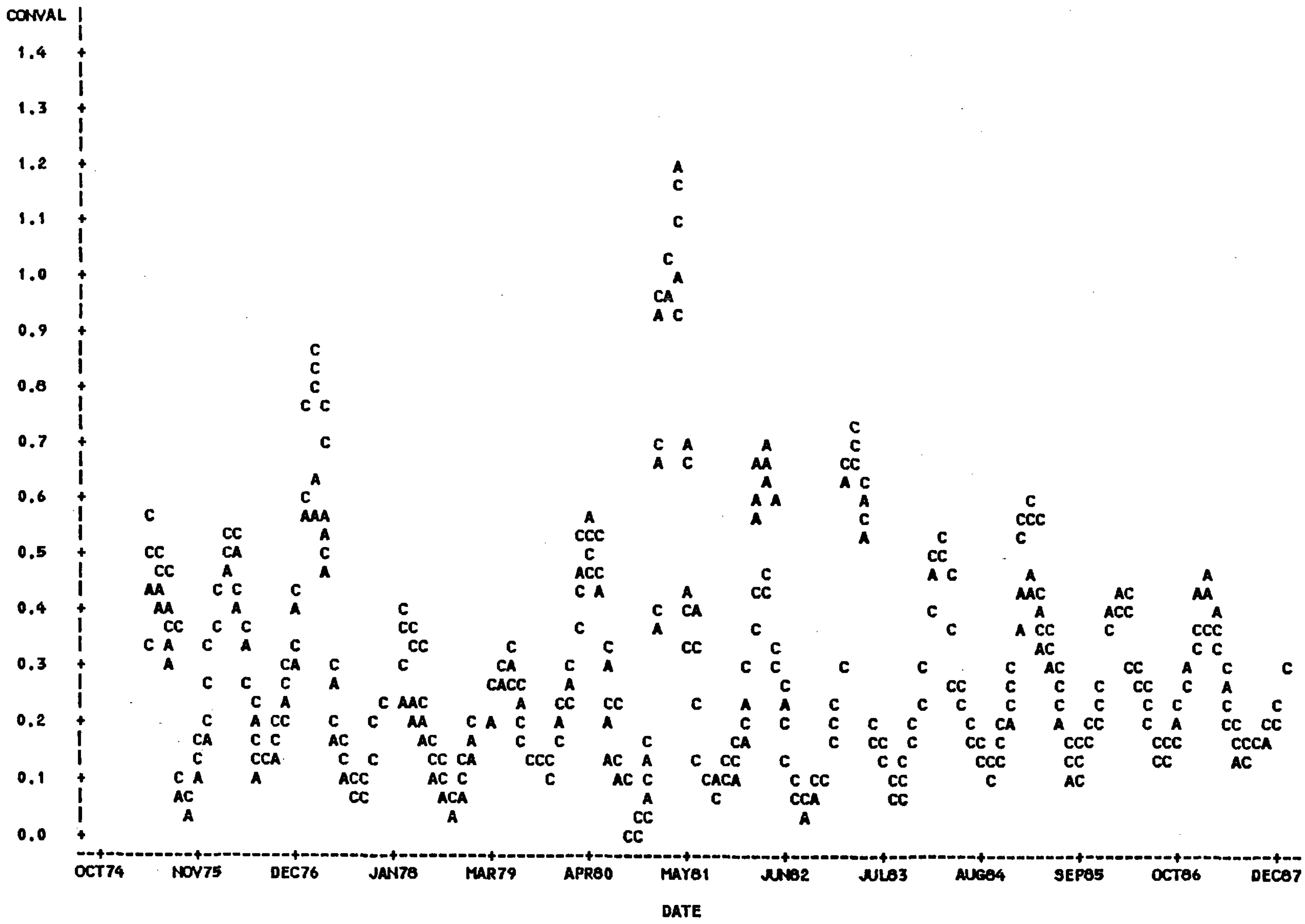
Plots of control station (S77660 upstream) and affected station (S77140 downstream) water quality measurements near LGS. Plotted points represent 3-month running averages calculated from six biweekly samples. See text for additional explanation.

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-8. Ammonia Nitrogen

PARAM=Ammonia Nitrogen (mg/l)

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



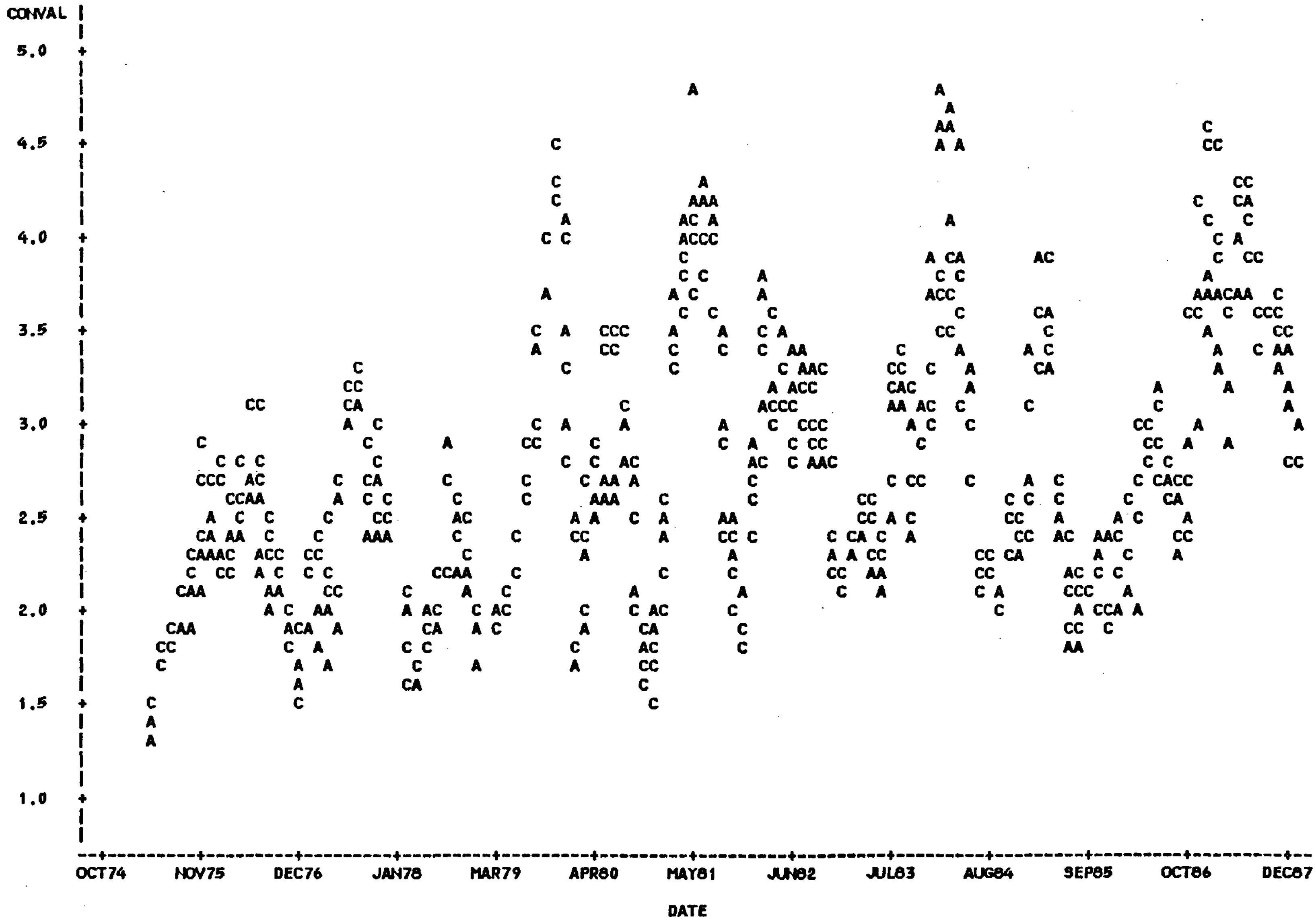
NOTE: 629 OBS HAD MISSING VALUES 289 OBS HIDDEN

SC[illegible]LKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-9. Biochemical Oxygen Demand

PARAM=Biochemical Oxygen Dema

PLOT OF CONVAL*DATE   SYMBOL USED IS C
PLOT OF AFFVAL*DATE   SYMBOL USED IS A



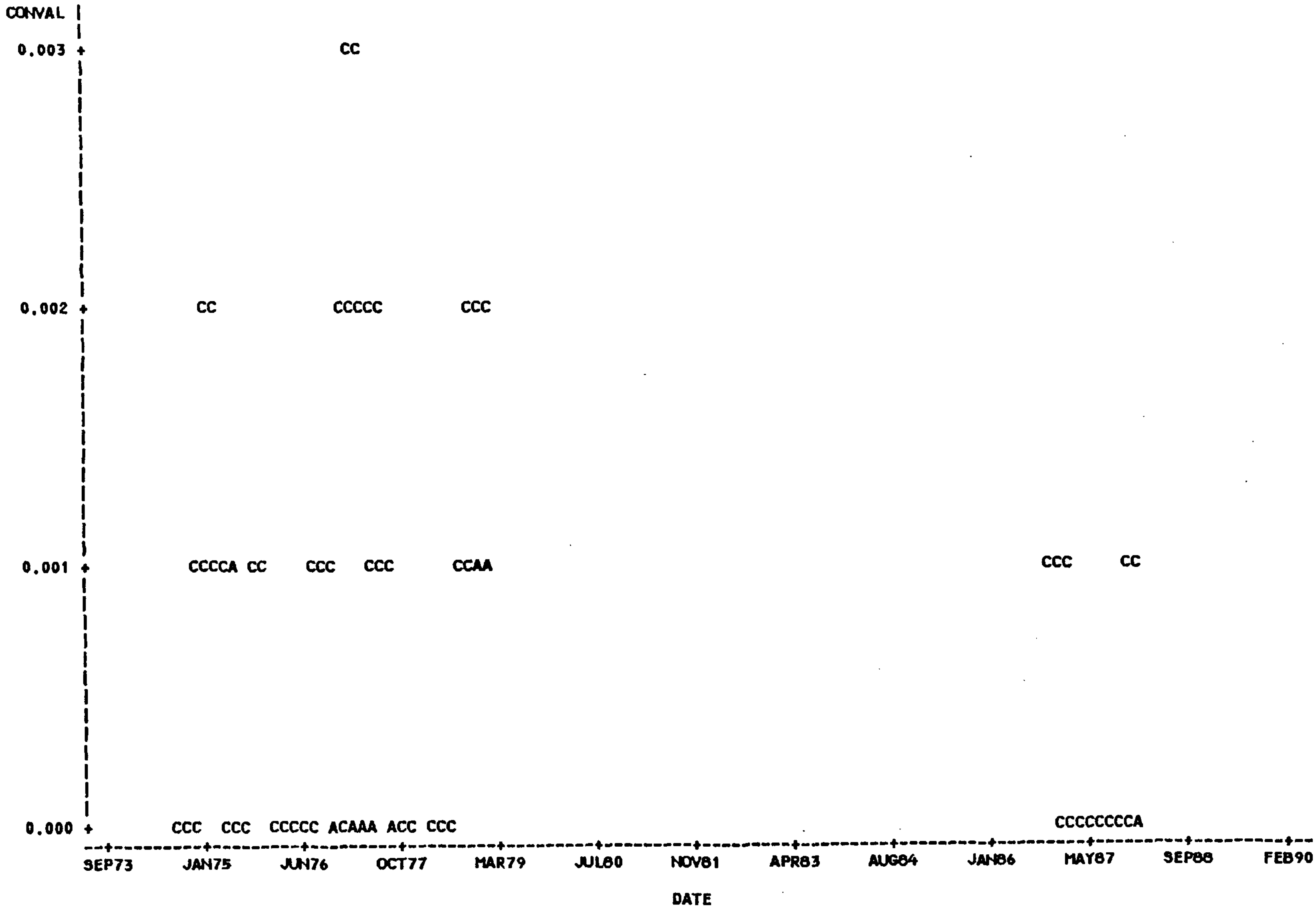
NOTE: 627 OBS HAD MISSING VALUES   183 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-10. Cadmium

PARAM=Cadmium (mg/l)

PLOT OF CONVAL*DATE   SYMBOL USED IS C
PLOT OF AFFVAL*DATE   SYMBOL USED IS A



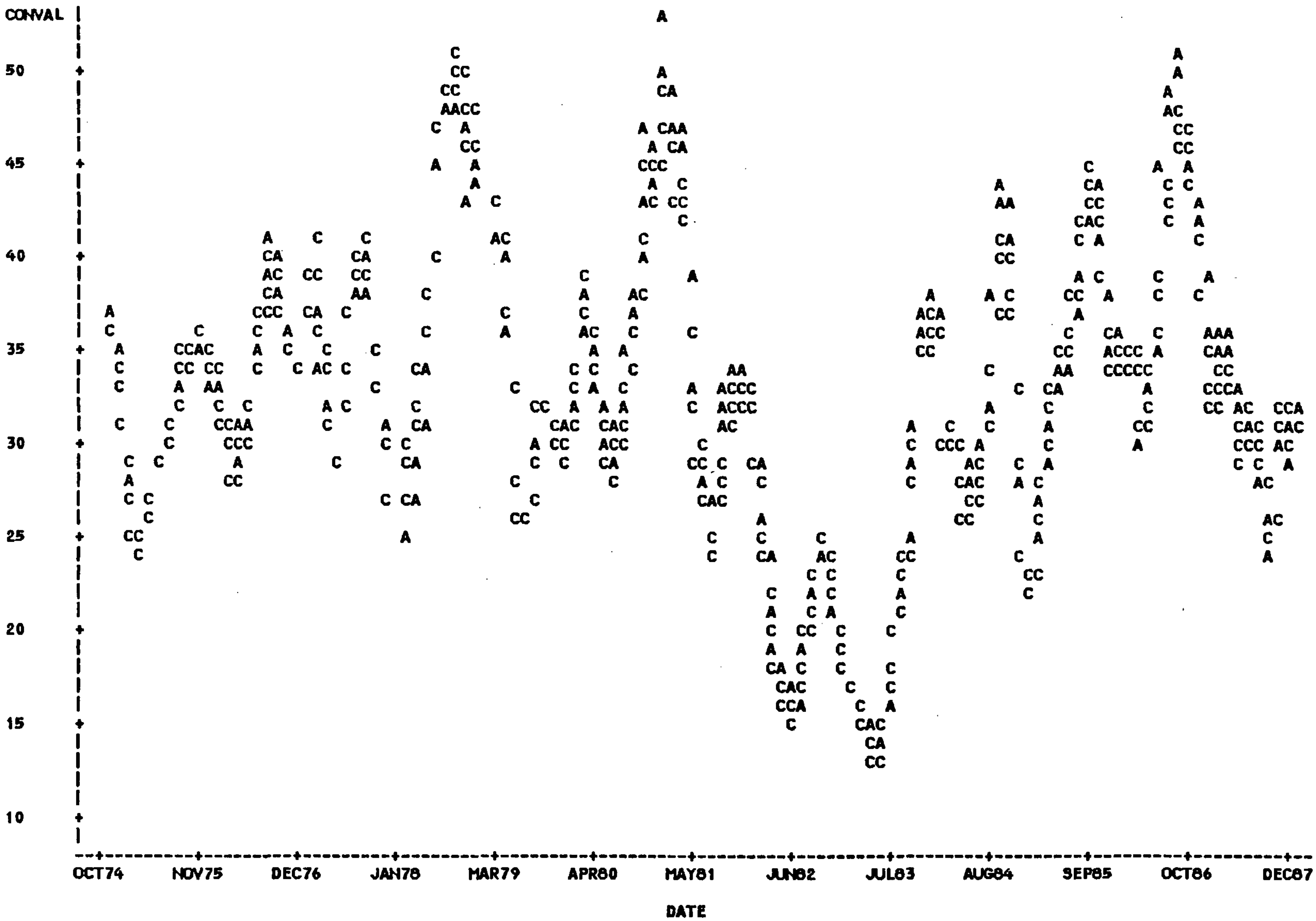
NOTE: 272 OBS HAD MISSING VALUES   207 OBS HIDDEN

SC[illegible]LKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-11. Calcium

PARAM=Calcium (mg/l)

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



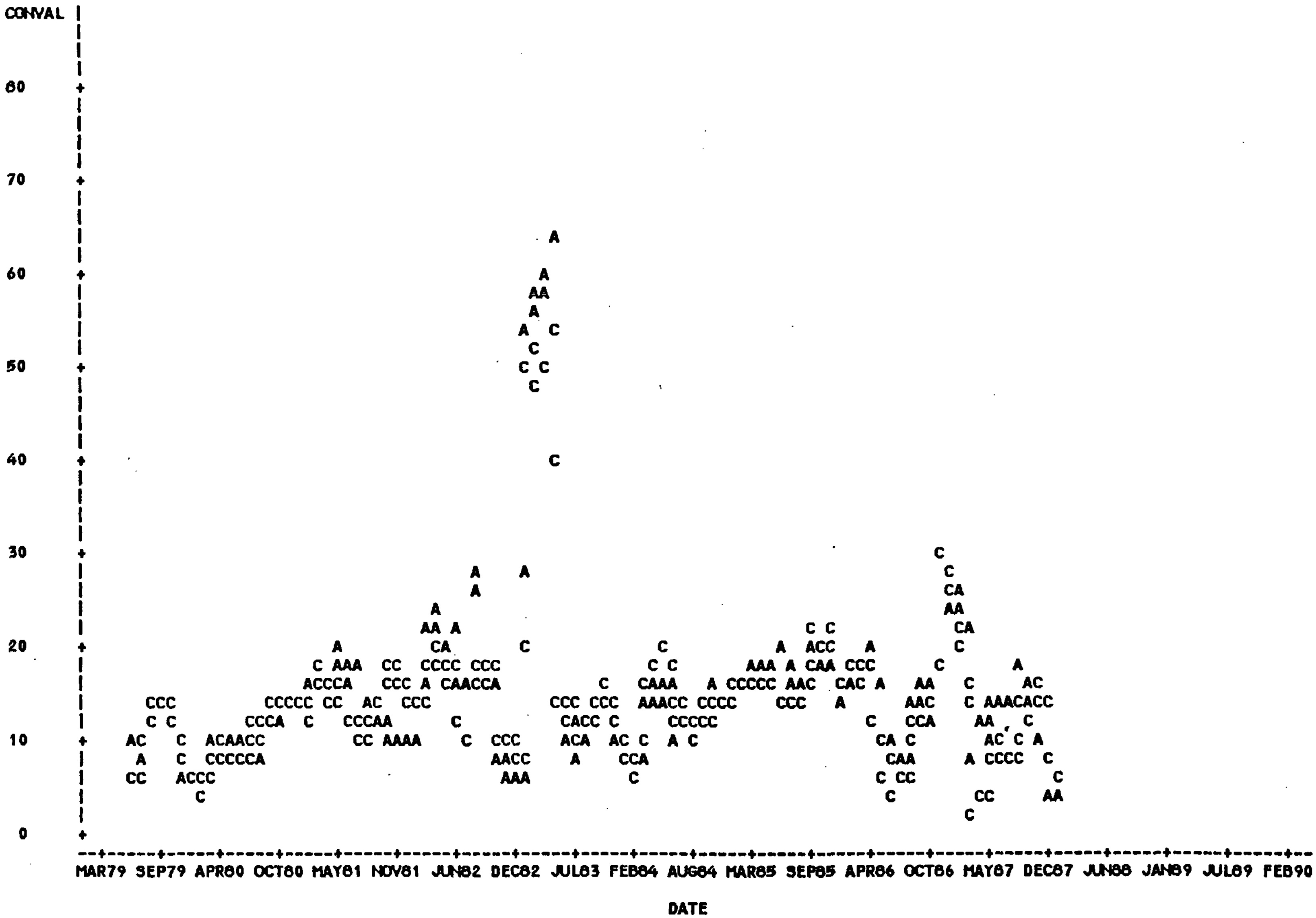
NOTE: 654 OBS HAD MISSING VALUES 225 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-12. Chemical Oxygen Demand

PARAM=Chemical Oxygen Demand

PLOT OF CONVAL*DATE   SYMBOL USED IS C
PLOT OF AFFVAL*DATE   SYMBOL USED IS A



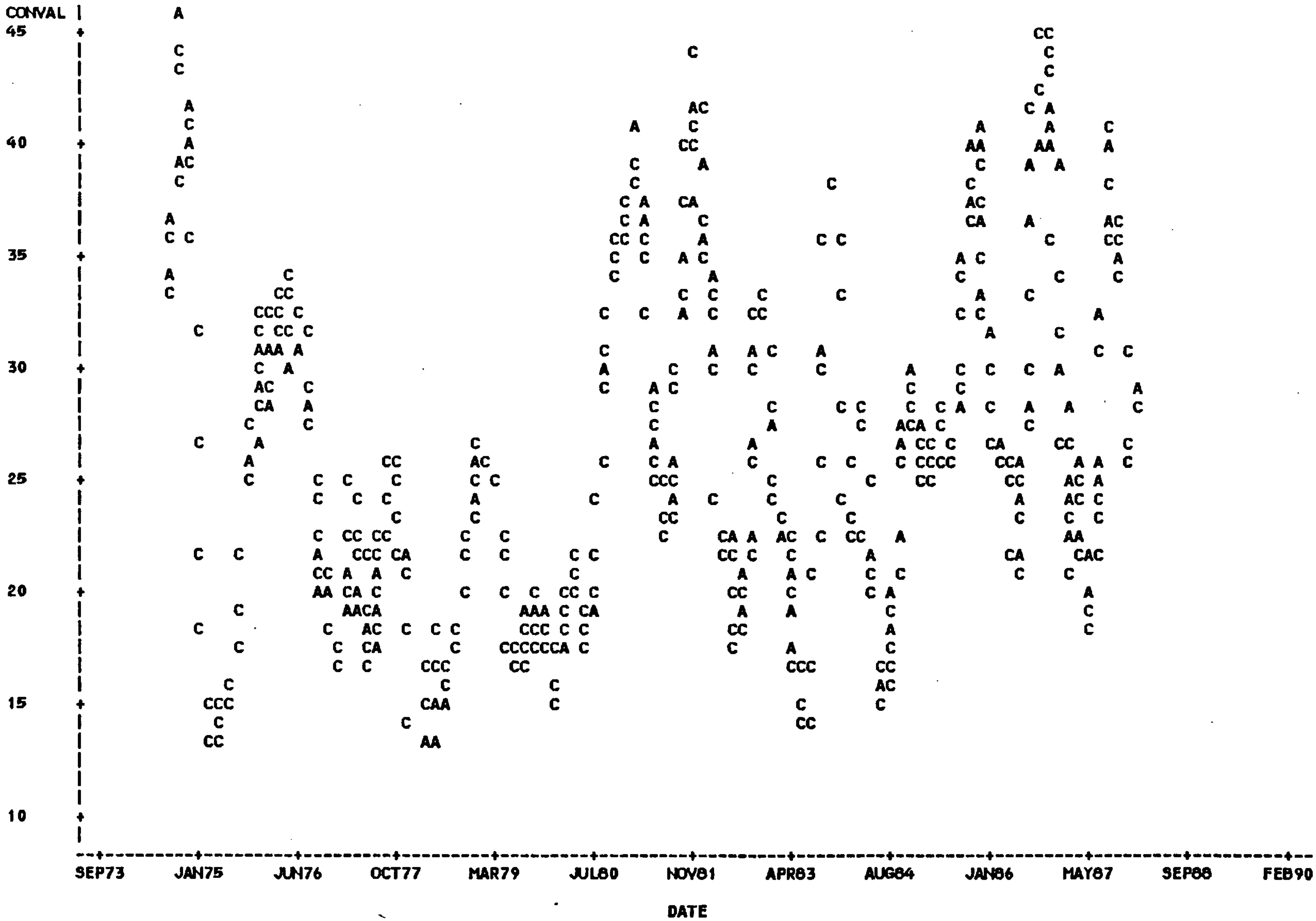
NOTE: 446 OBS HAD MISSING VALUES   186 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-13. Chloride

PARAM=Chloride (mg/l)

PLOT OF CONVAL*DATE   SYMBOL USED IS C
PLOT OF AFFVAL*DATE   SYMBOL USED IS A



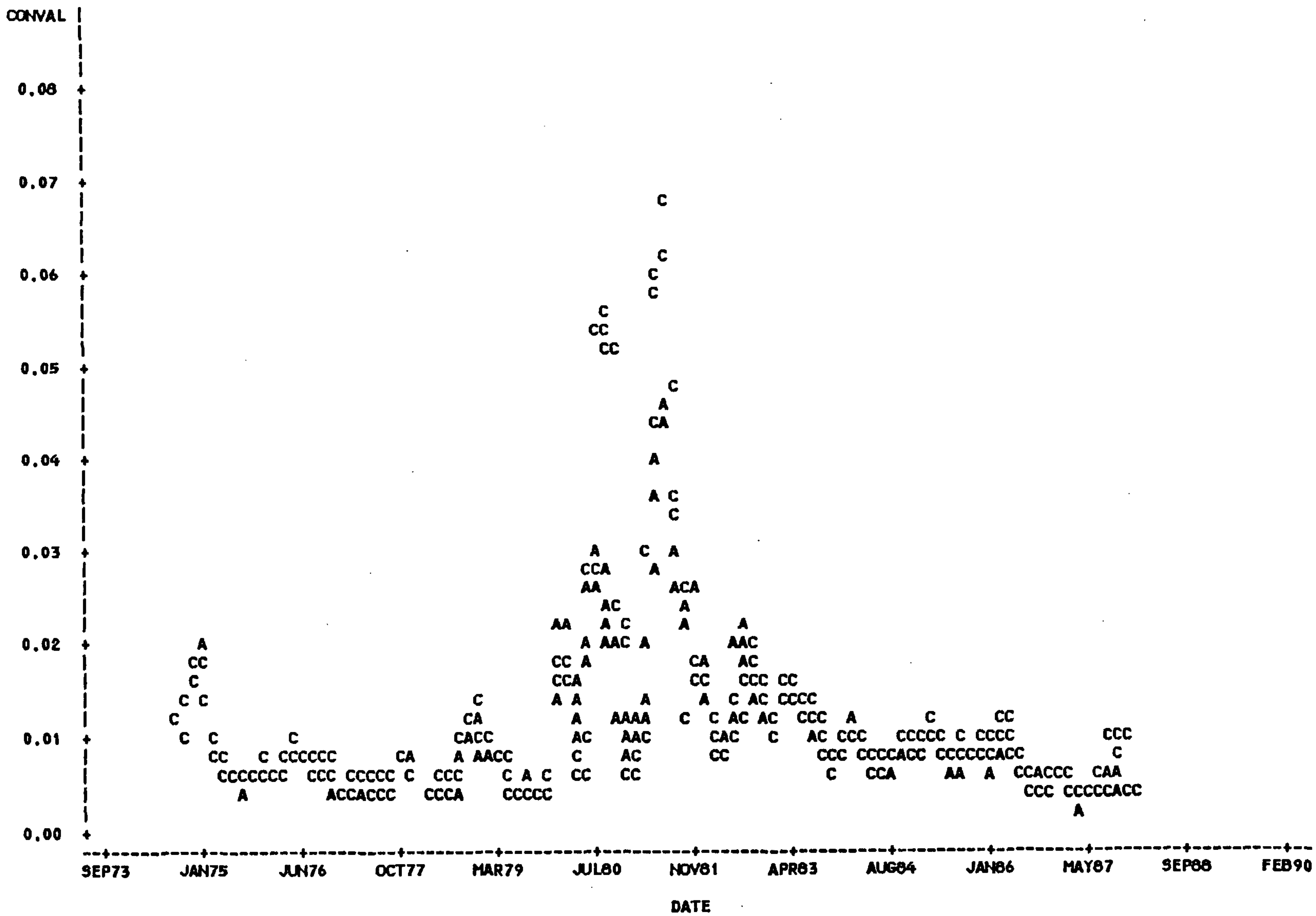
NOTE: 664 OBS HAD MISSING VALUES 271 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-14. Chromium

PARAM=Chromium (mg/l)

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



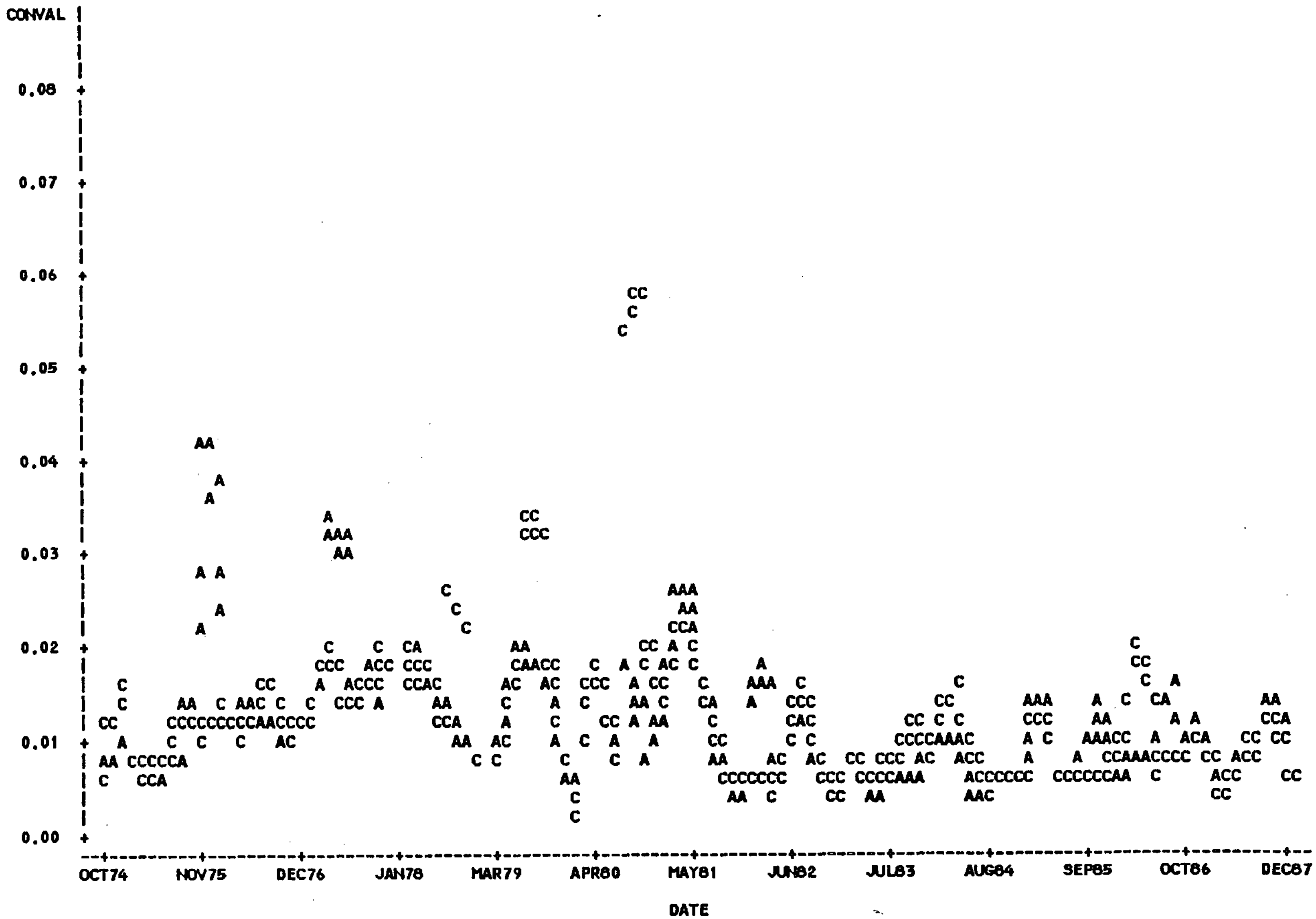
NOTE: 662 OBS HAD MISSING VALUES 414 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-15. Copper

PARAM=Copper (mg/l)

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



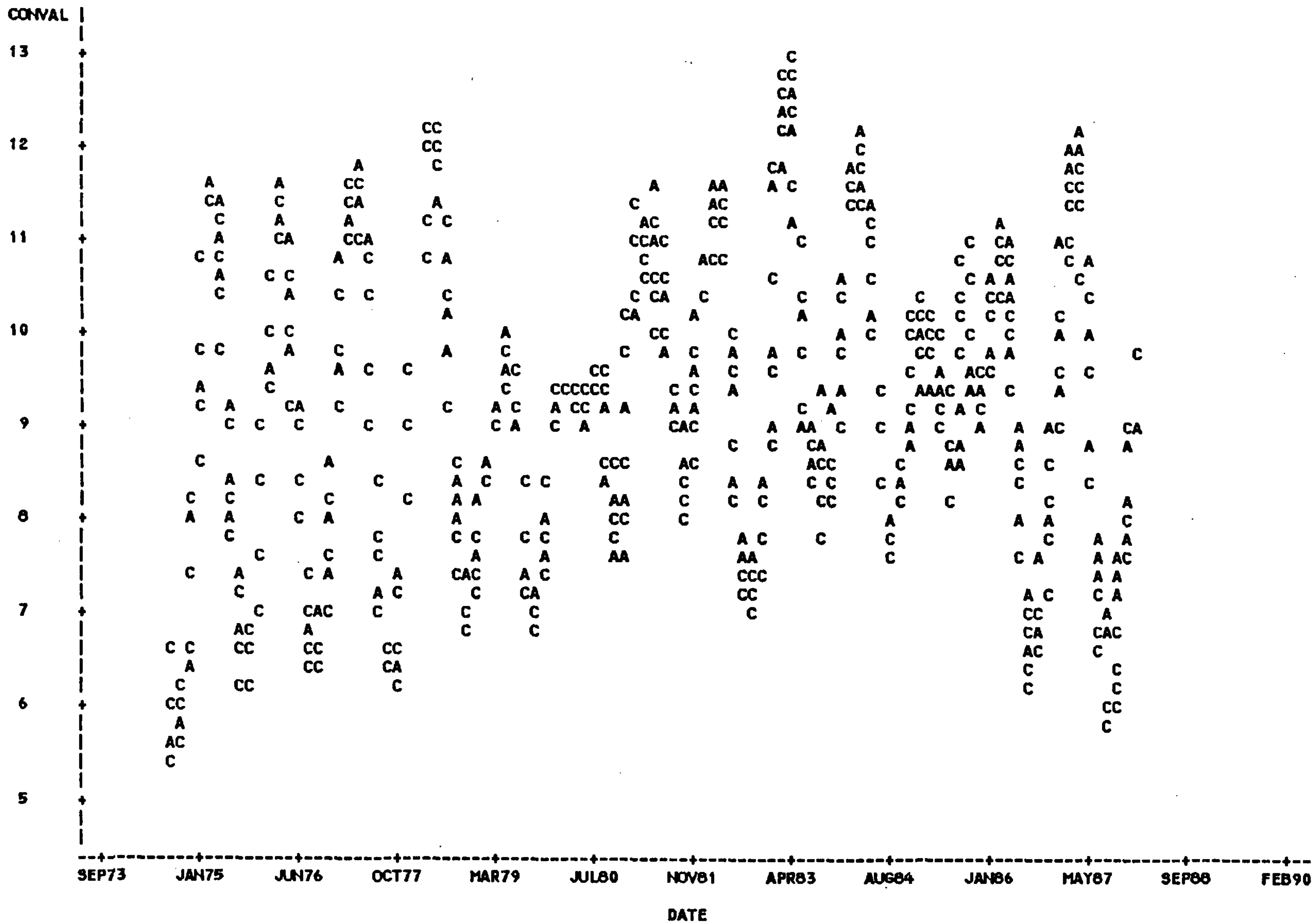
NOTE: 659 OBS HAD MISSING VALUES 334 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-16. Dissolved Oxygen

PARAM=Dissolved Oxygen (mg/l)

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



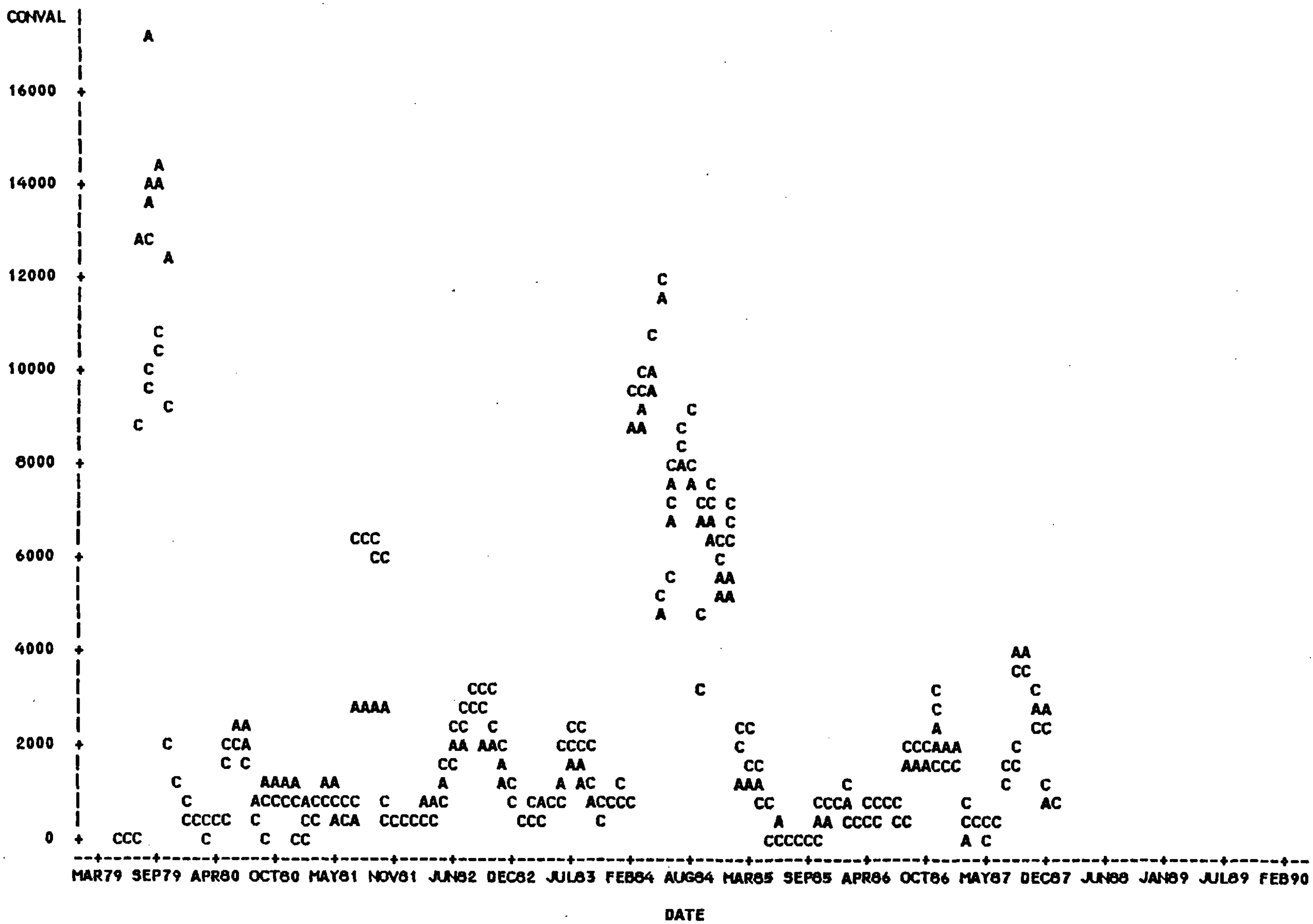
NOTE: 668 OBS HAD MISSING VALUES 221 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-17. Fecal Coliforms

PARAM=Fecal Coliforms (MF) (c

PLOT OF CONVAL*DATE   SYMBOL USED IS C
PLOT OF AFFVAL*DATE   SYMBOL USED IS A



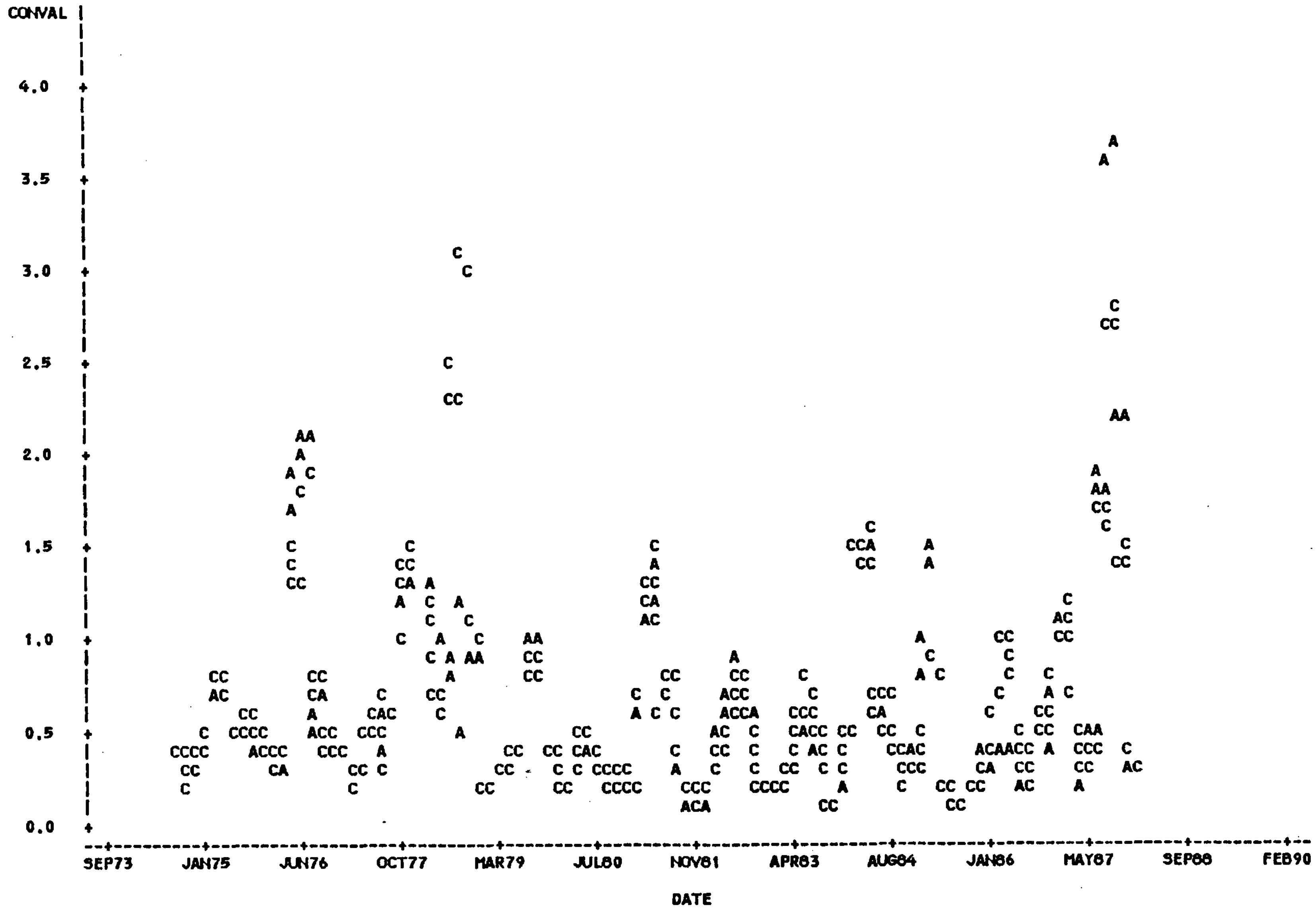
NOTE: 449 OBS HAD MISSING VALUES   212 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 977660 AND 977140

Figure 6.1-18. Iron

PARAM=Iron (mg/l)

PLOT OF CONVAL*DATE   SYMBOL USED IS C
PLOT OF AFFVAL*DATE   SYMBOL USED IS A



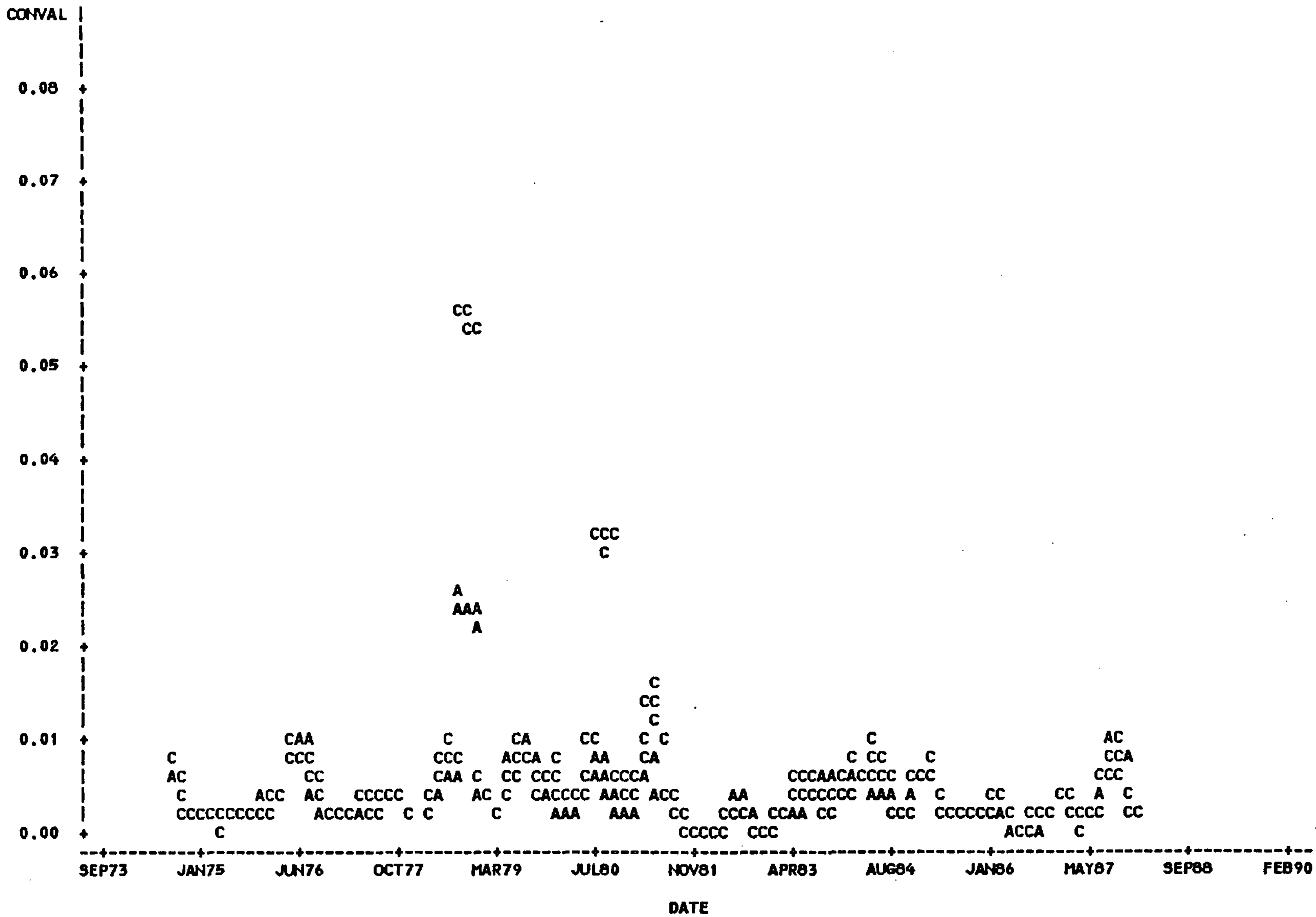
NOTE: 662 OBS HAD MISSING VALUES   384 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-19. Lead

PARAM=Lead (mg/l)

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



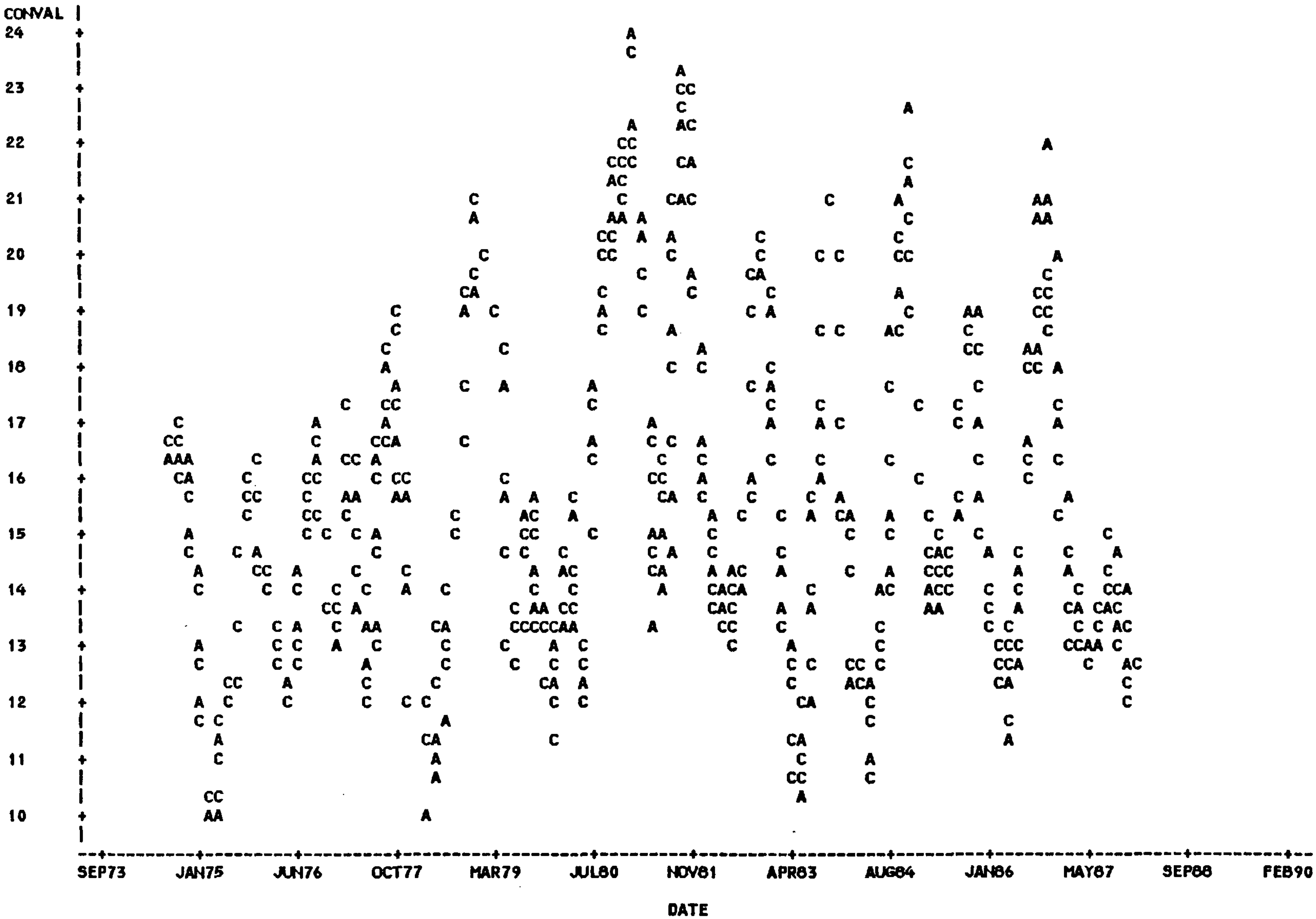
NOTE: 662 OBS HAD MISSING VALUES 451 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-20. Magnesium

PARAM=Magnesium (mg/l)

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



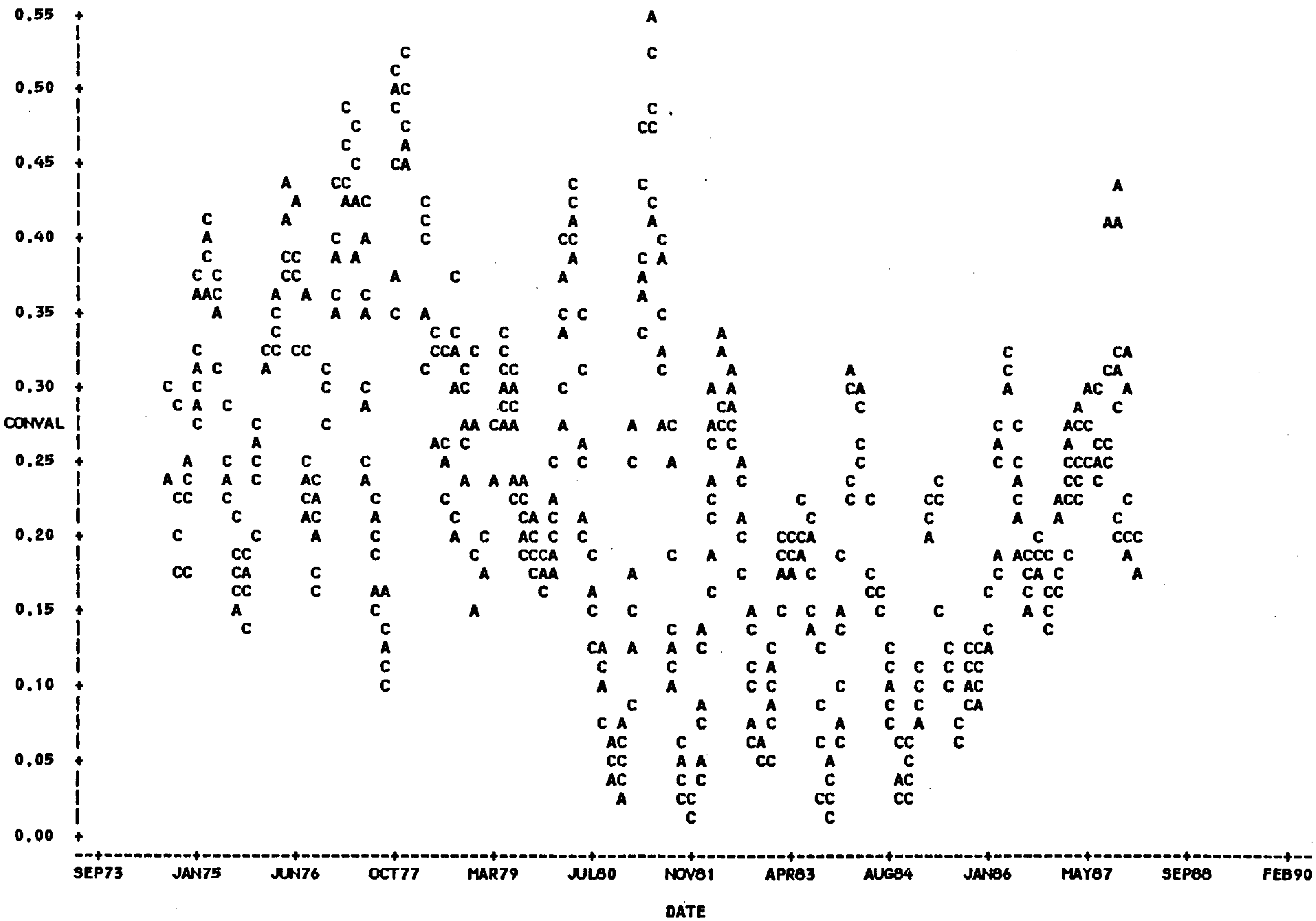
NOTE: 662 OBS HAD MISSING VALUES 225 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-21. Manganese

PARAM=Manganese (mg/l)

PLOT OF CONVAL*DATE   SYMBOL USED IS C
PLOT OF AFFVAL*DATE   SYMBOL USED IS A



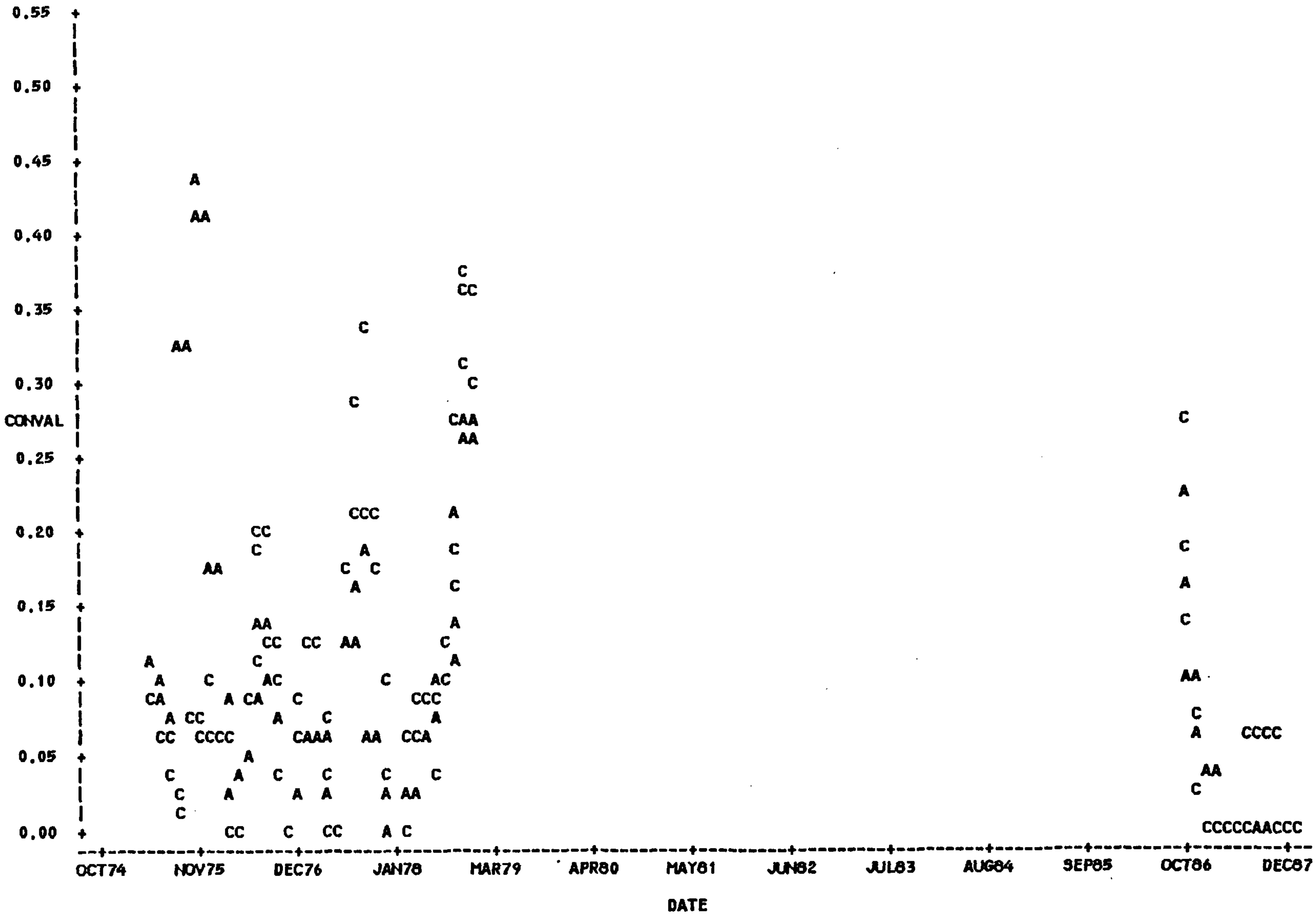
NOTE: 662 OBS HAD MISSING VALUES   229 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-22. Mercury

PARAM=Mercury (ug/l)

PLOT OF CONVAL*DATE   SYMBOL USED IS C
PLOT OF AFFVAL*DATE   SYMBOL USED IS A



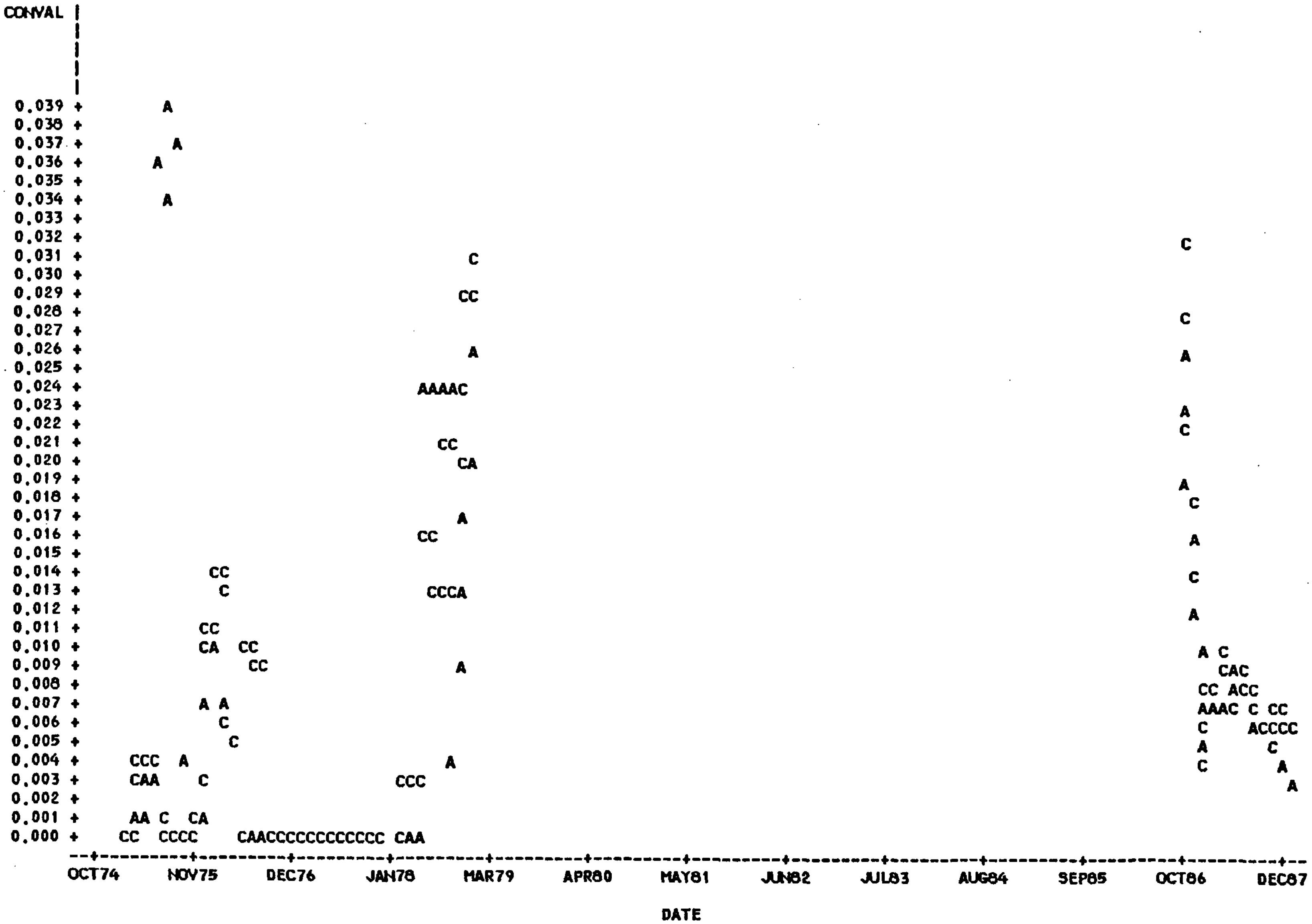
NOTE: 232 OBS HAD MISSING VALUES   102 OBS HIDDEN

SC[illegible]LKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-23. Nickel

PARAM=Nickel (mg/l)

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



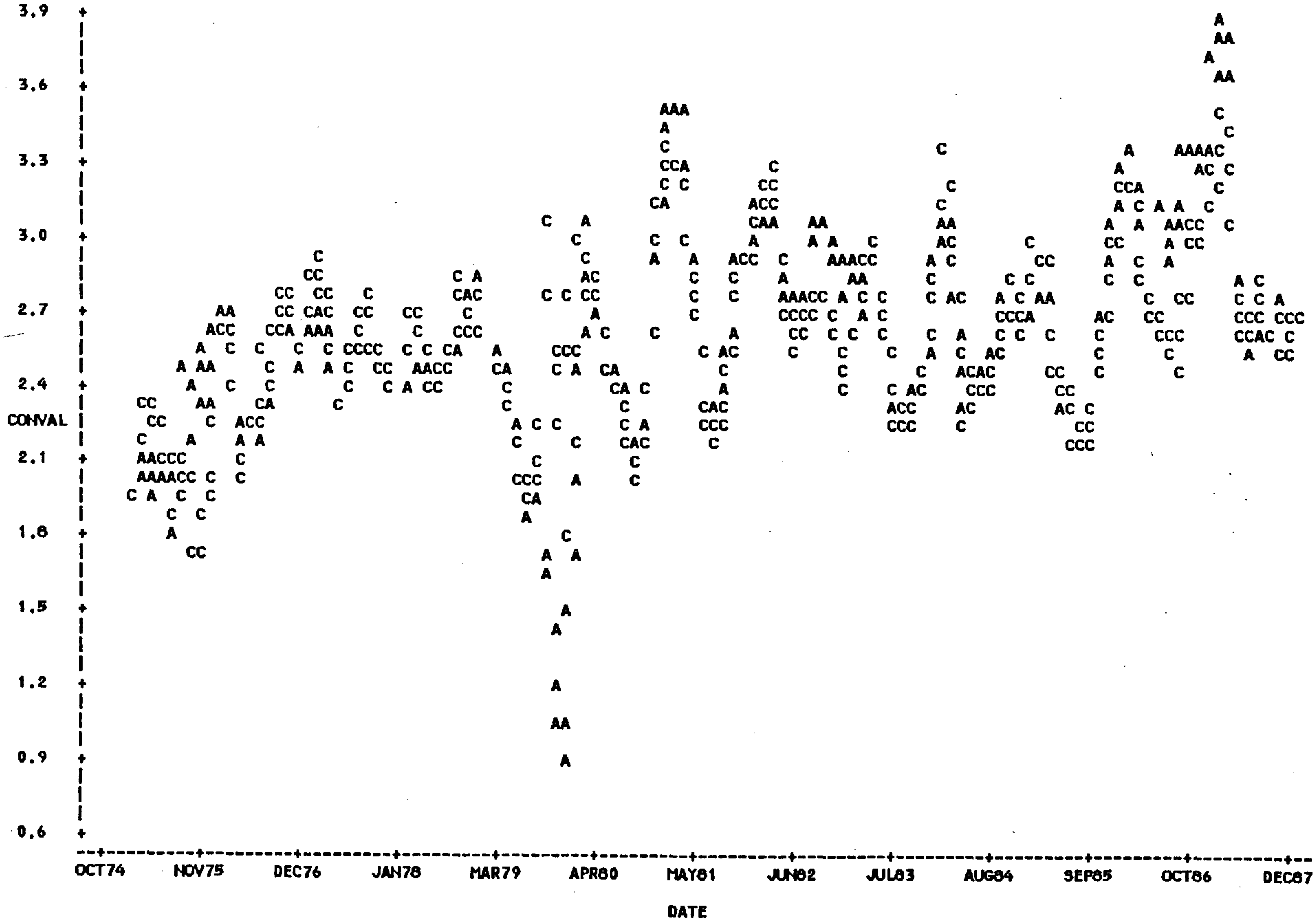
NOTE: 246 OBS HAD MISSING VALUES 127 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-24. Nitrate Nitrogen

PARAM=Nitrate Nitrogen (mg/l)

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



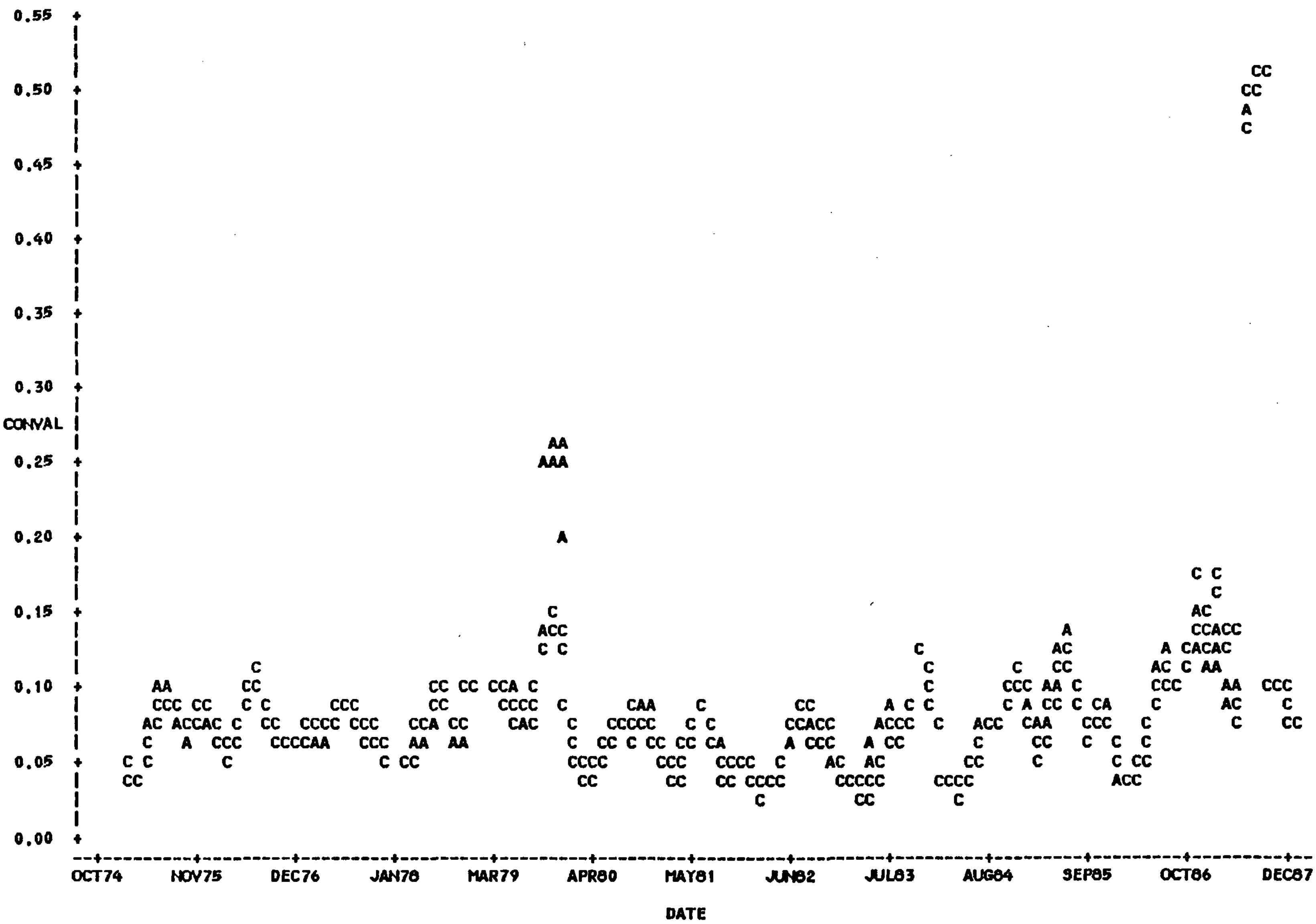
NOTE: 639 OBS HAD MISSING VALUES 235 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-25. Nitrite Nitrogen

PARAM=Nitrite Nitrogen (mg/l)

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



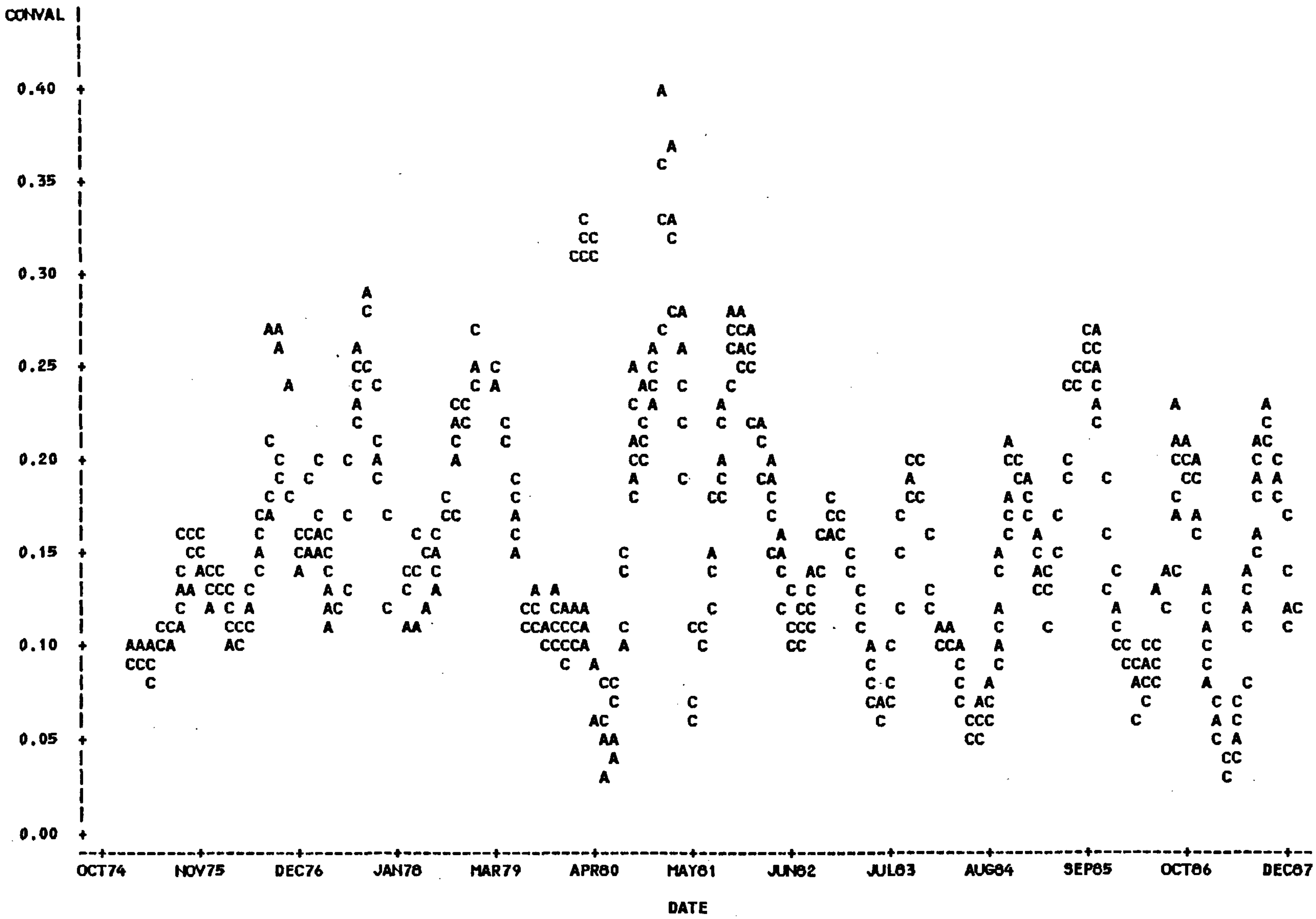
NOTE: 639 OBS HAD MISSING VALUES 374 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-26. Ortho Phosphate Phosphorus

PARAM=Ortho Phosphate Phospho

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



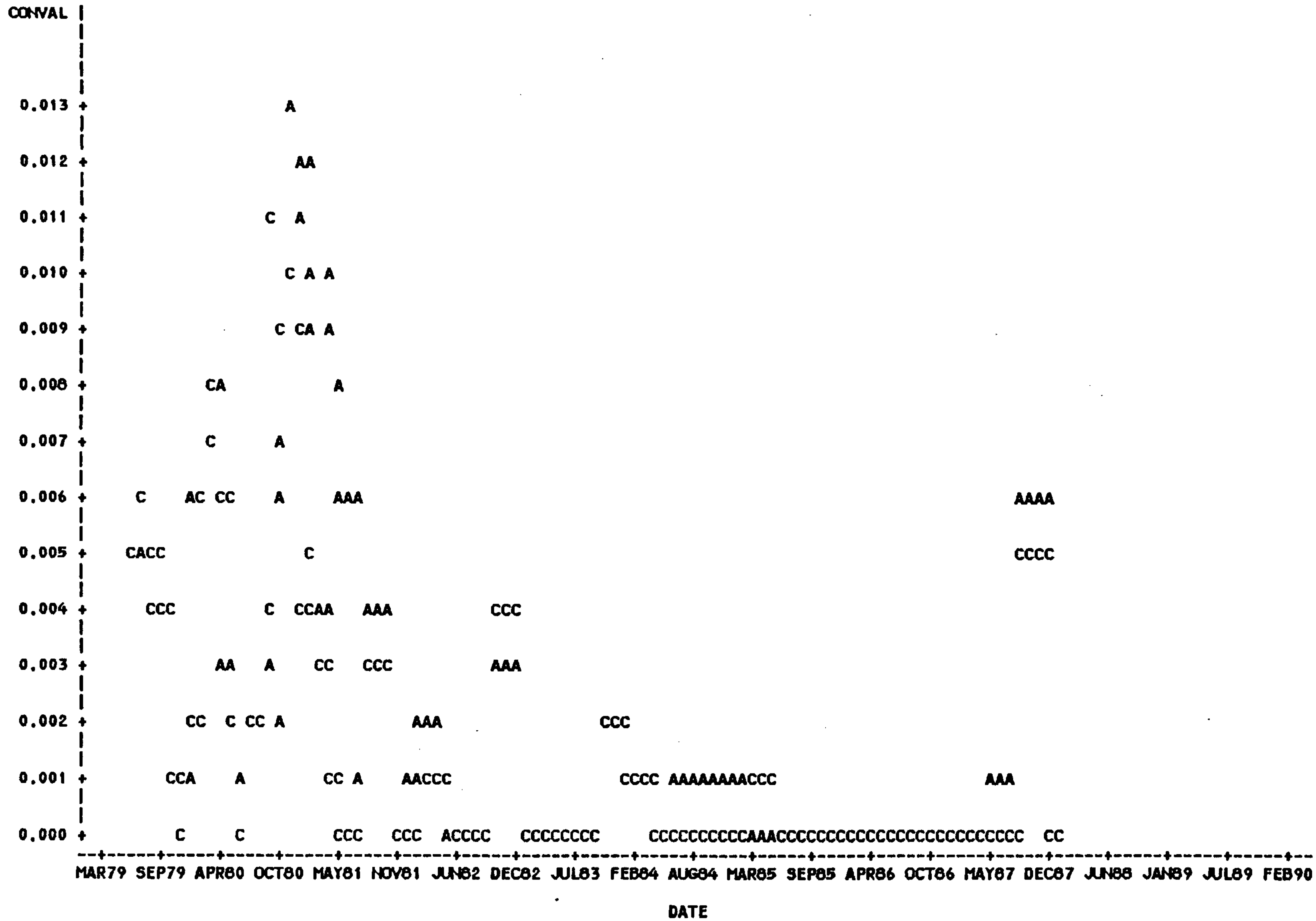
NOTE: 639 OBS HAD MISSING VALUES 247 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-27. Phenols

PARAM=Phenols (mg/l)

PLOT OF CONVAL*DATE   SYMBOL USED IS C
PLOT OF AFFVAL*DATE   SYMBOL USED IS A



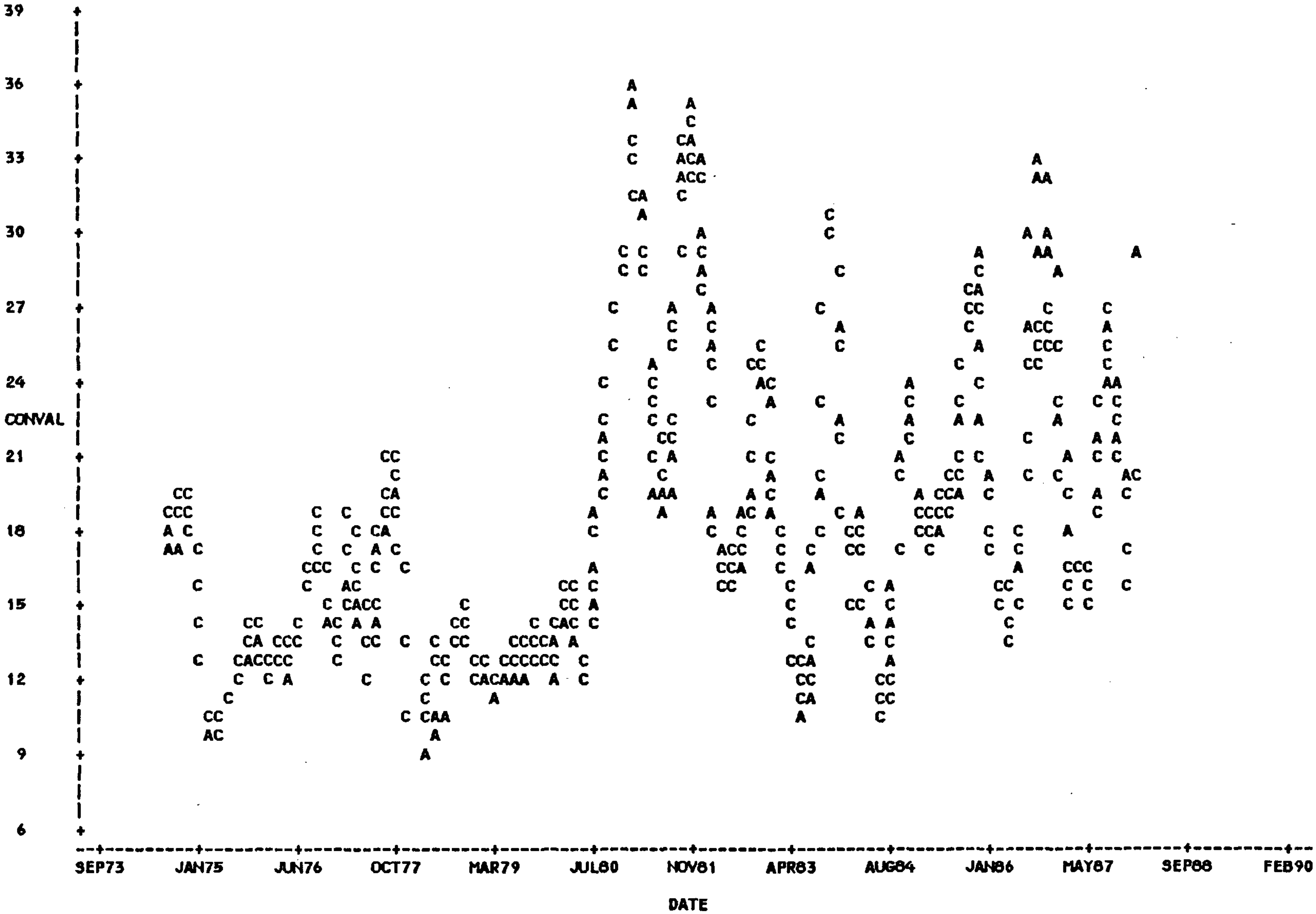
NOTE: 446 OBS HAD MISSING VALUES 279 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-28. Sodium

PARAM=Sodium (mg/l)

PLOT OF CONVAL*DATE   SYMBOL USED IS C
PLOT OF AFFVAL*DATE   SYMBOL USED IS A



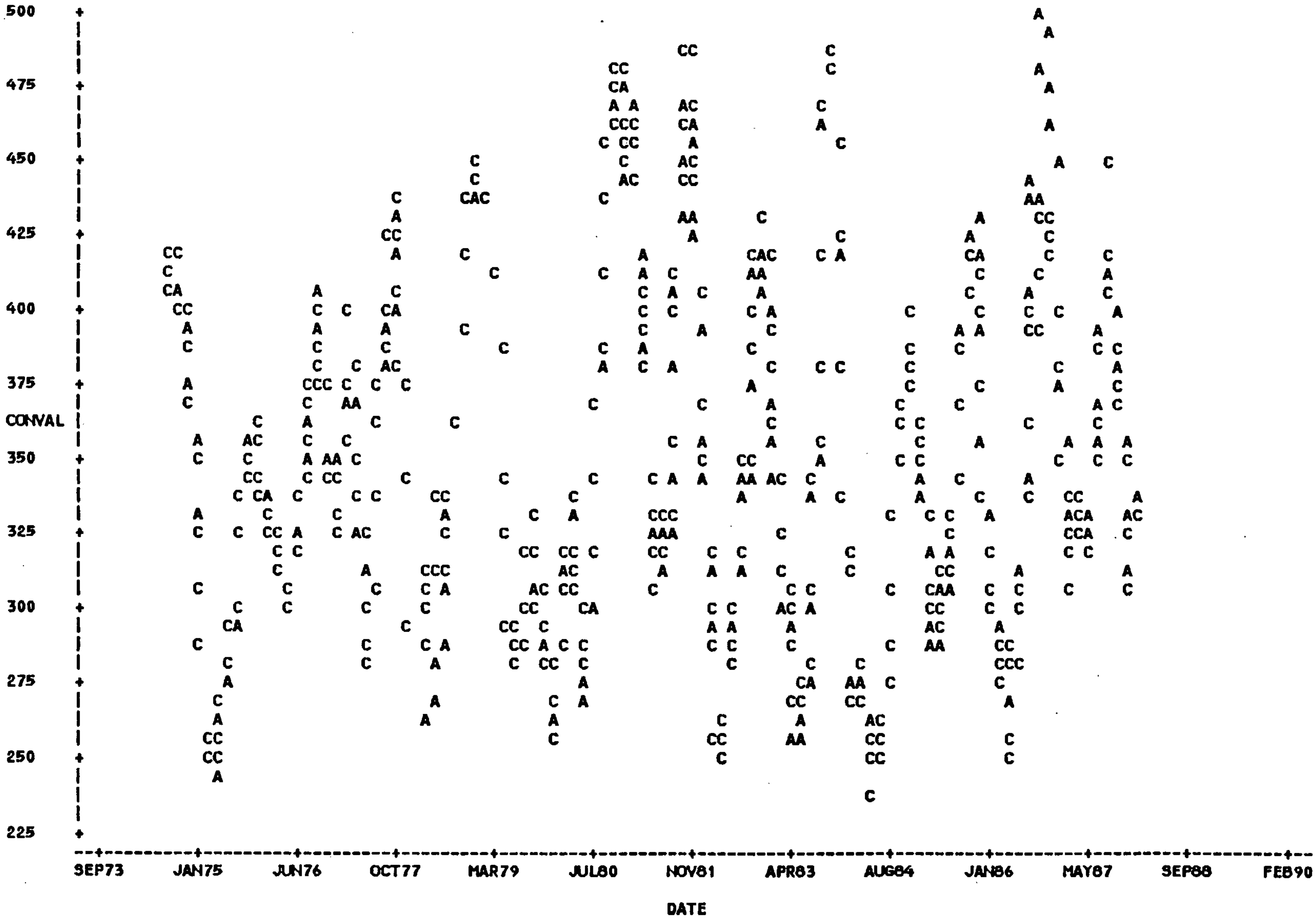
NOTE: 666 OBS HAD MISSING VALUES   300 OBS HIDDEN

S[illegible]LKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-29. Specific Conductance

PARAM=Specific Conductance (u

PLOT OF CONVAL*DATE   SYMBOL USED IS C
PLOT OF AFFVAL*DATE   SYMBOL USED IS A



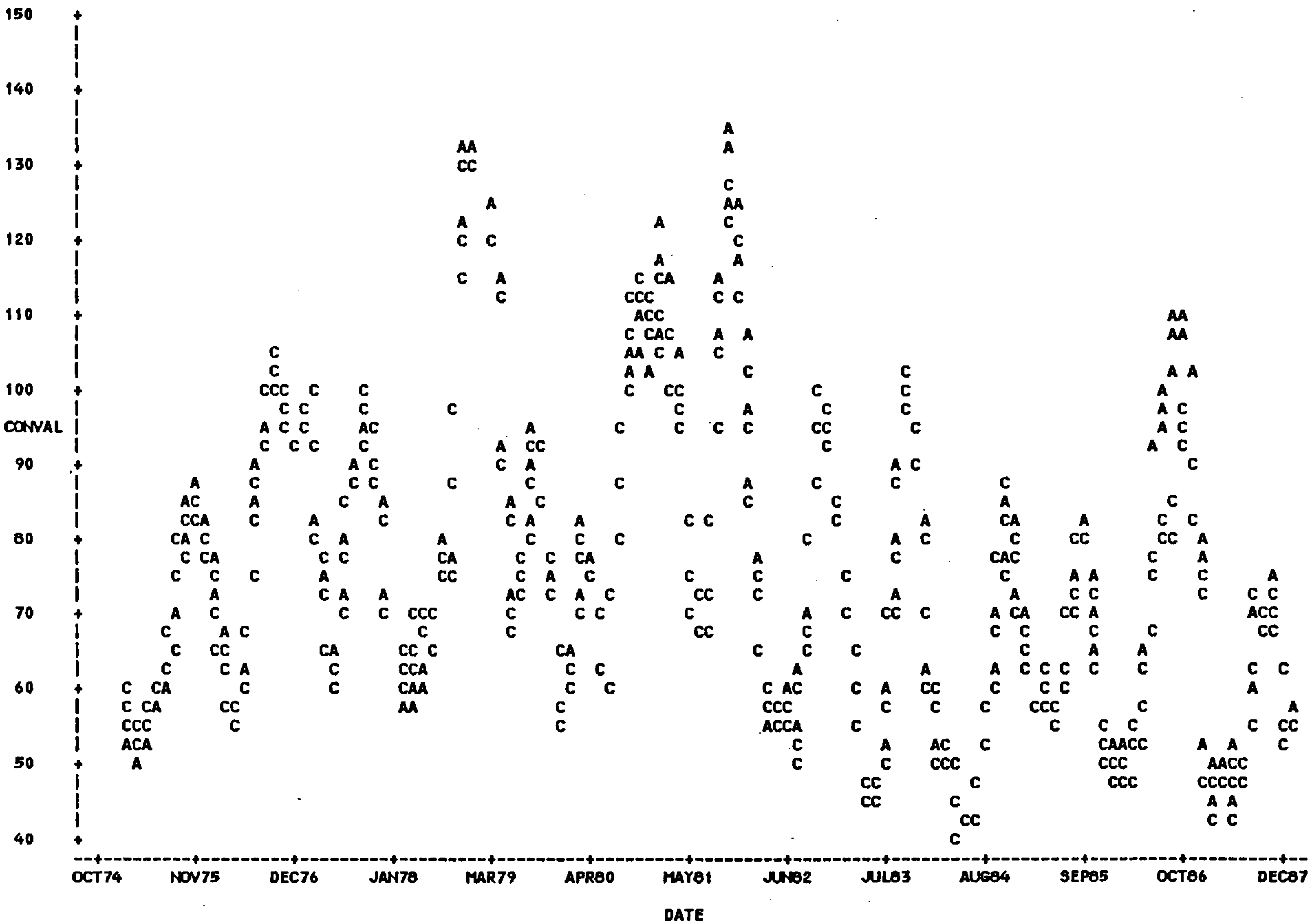
NOTE: 668 OBS HAD MISSING VALUES   232 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-30. Sulfate

PARAM=Sulfate (mg/l)

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



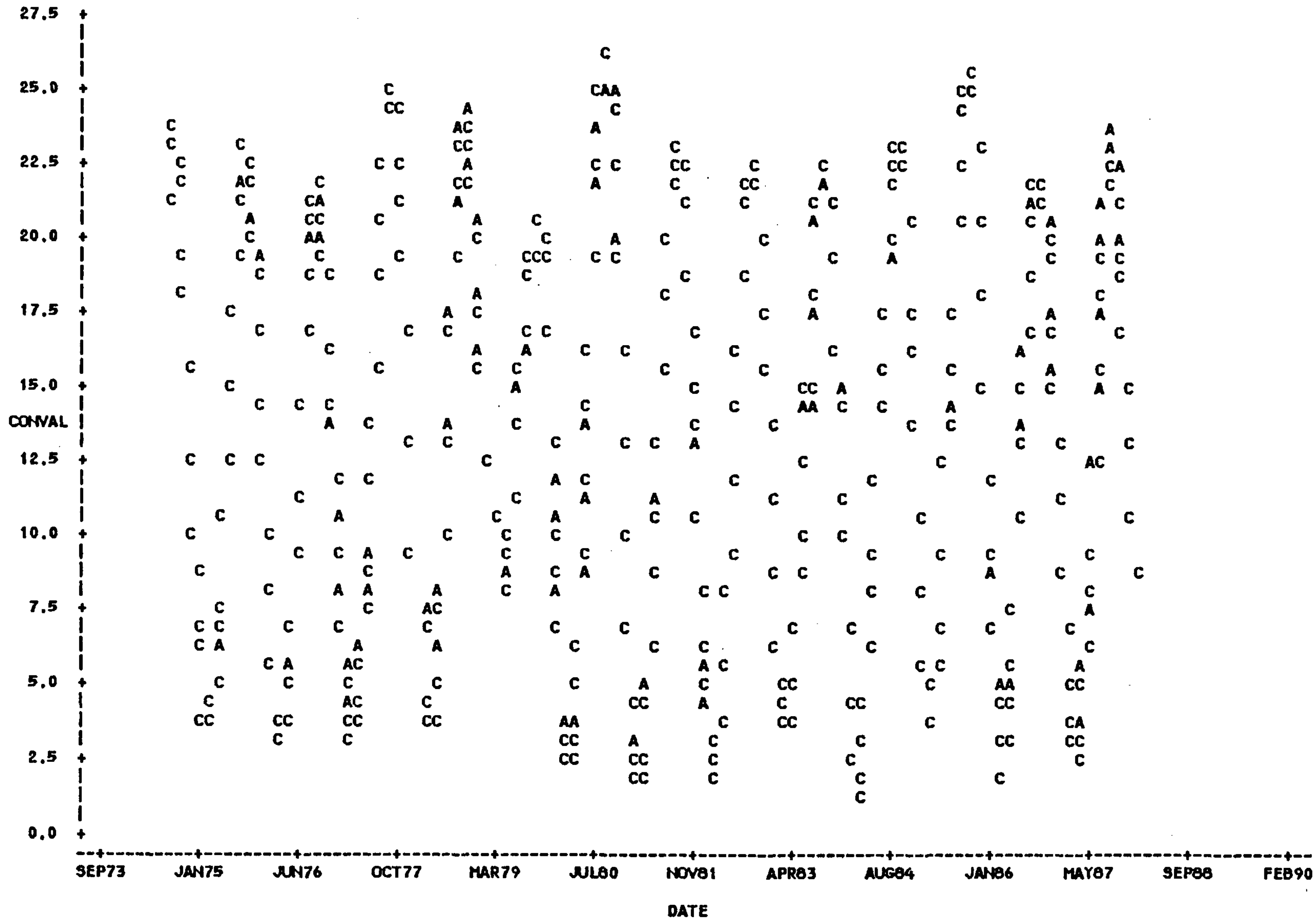
NOTE: 641 OBS HAD MISSING VALUES 238 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-31. Temperature

PARAM=Temperature (C)

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



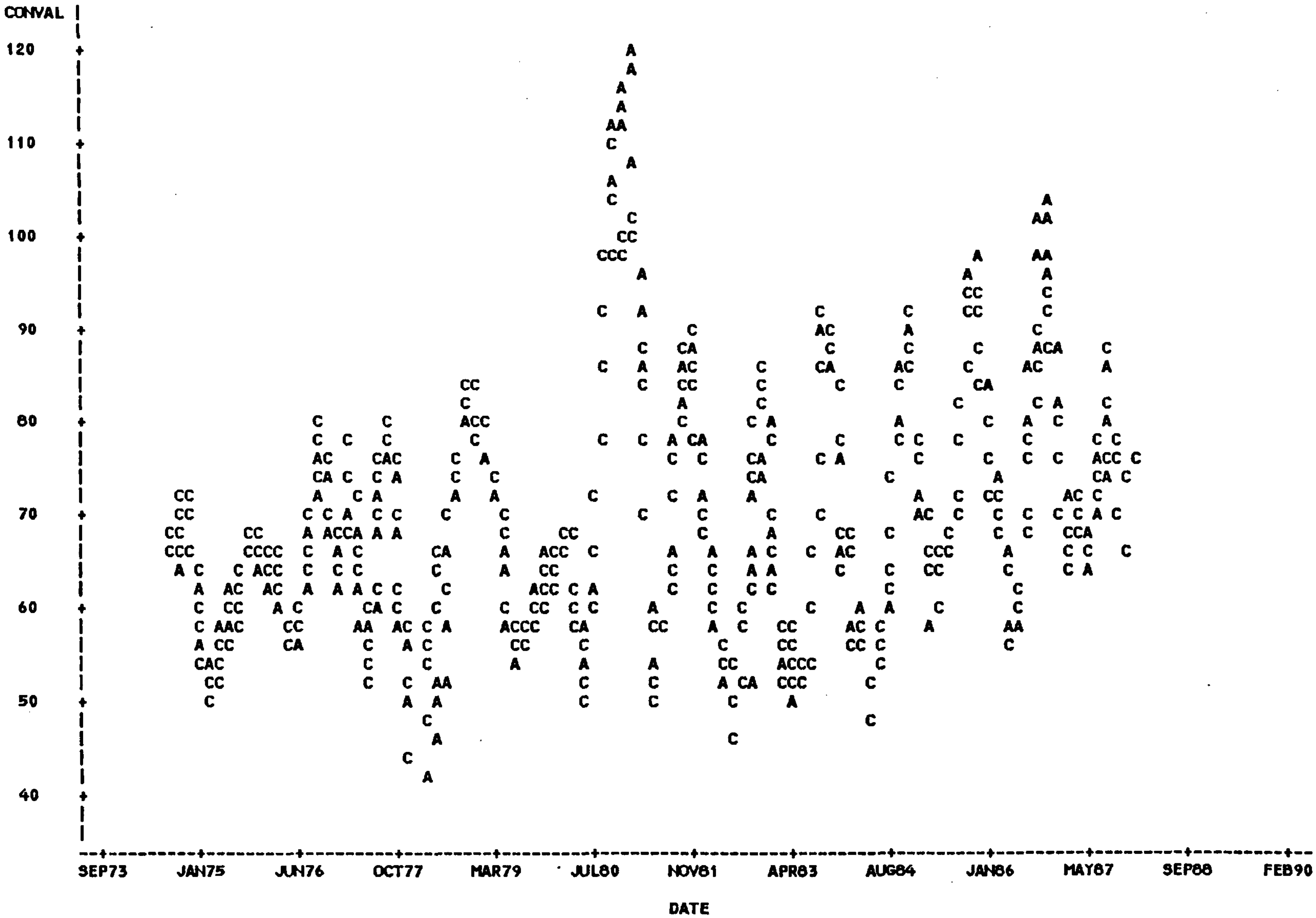
NOTE: 668 OBS HAD MISSING VALUES 286 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-32. Total Alkalinity

PARAM=Total Alkalinity (mg/l)

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



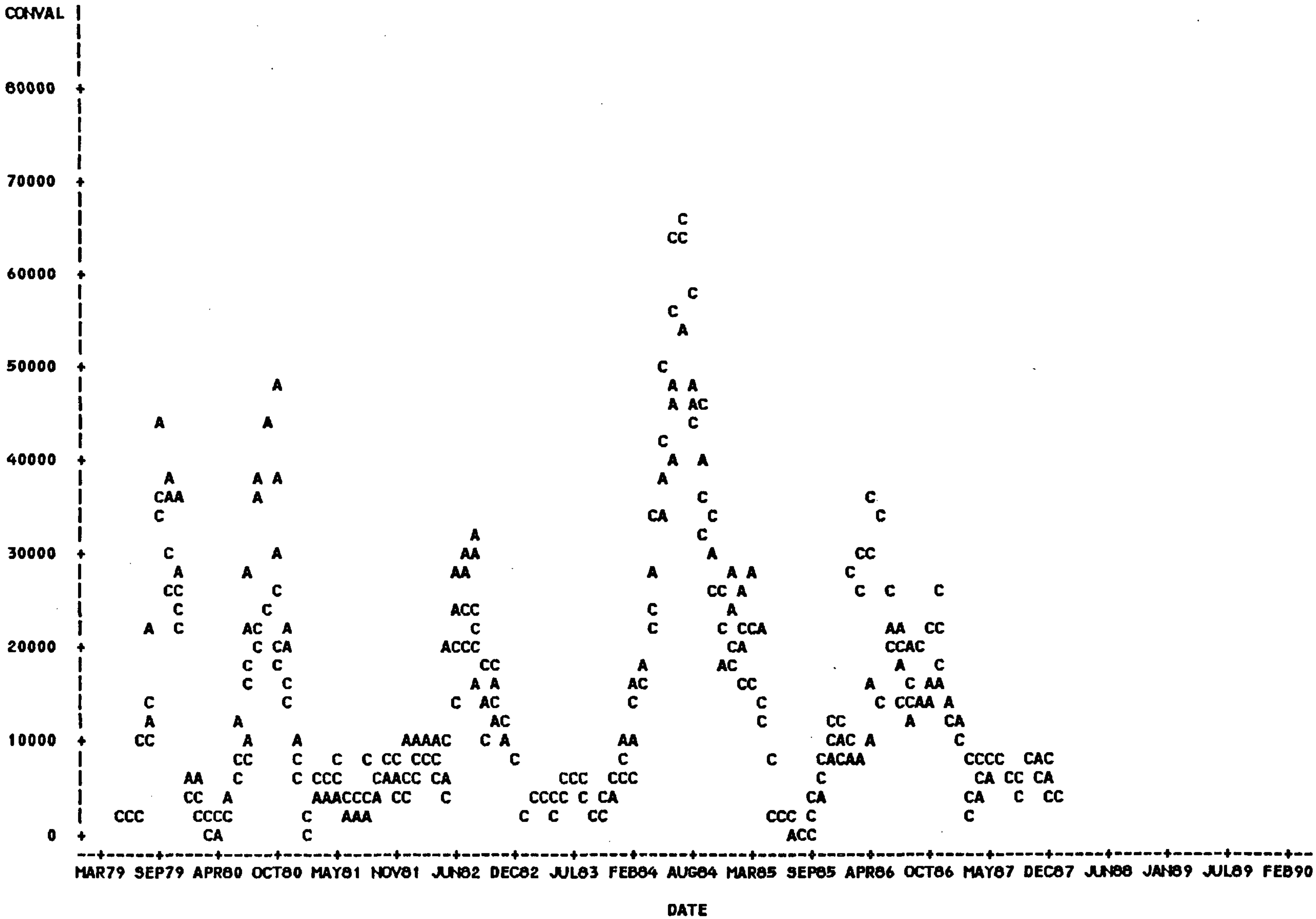
NOTE: 668 OBS HAD MISSING VALUES 268 OBS HIDDEN

SC[illegible]KILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-33. Total Coliforms

PARAM=Total Coliforms (MF) (c

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



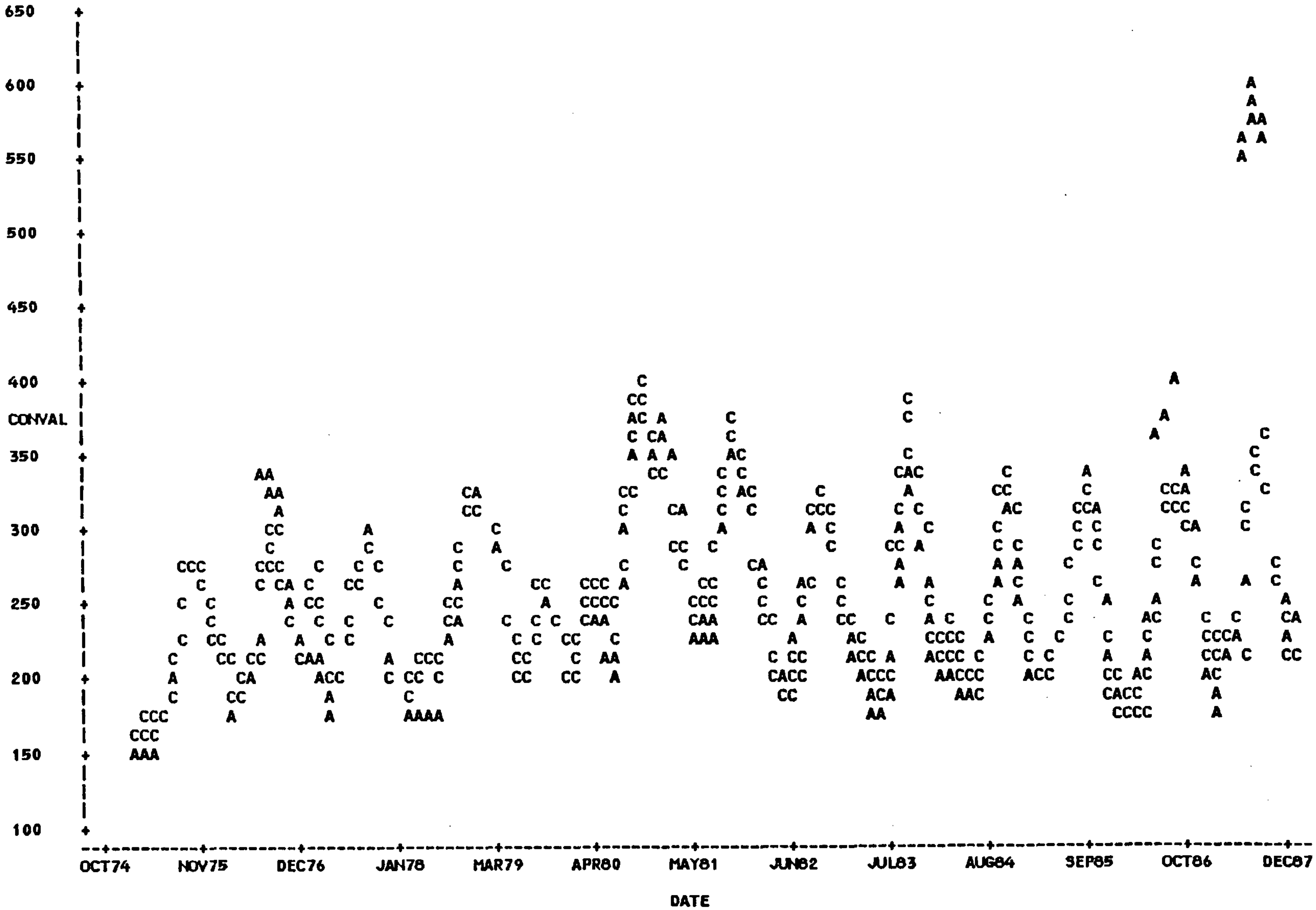
NOTE: 449 OBS HAD MISSING VALUES 187 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-34. Total Dissolved Solids

PARAM=Total Dissolved Solids

PLOT OF CONVAL*DATE   SYMBOL USED IS C
PLOT OF AFFVAL*DATE   SYMBOL USED IS A



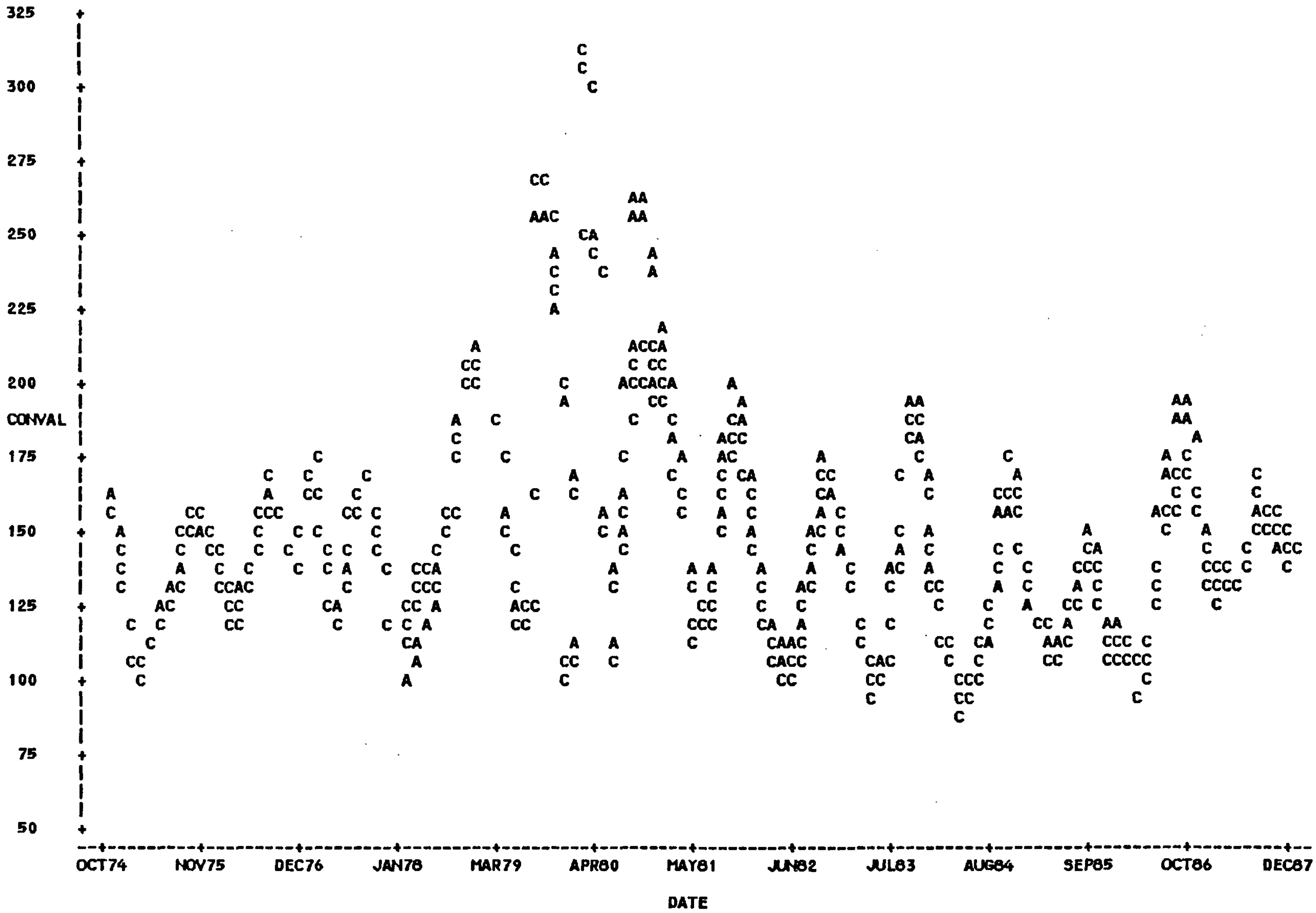
NOTE: 637 OBS HAD MISSING VALUES   263 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-35. Total Hardness

PARAM=Total Hardness (mg/l)

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



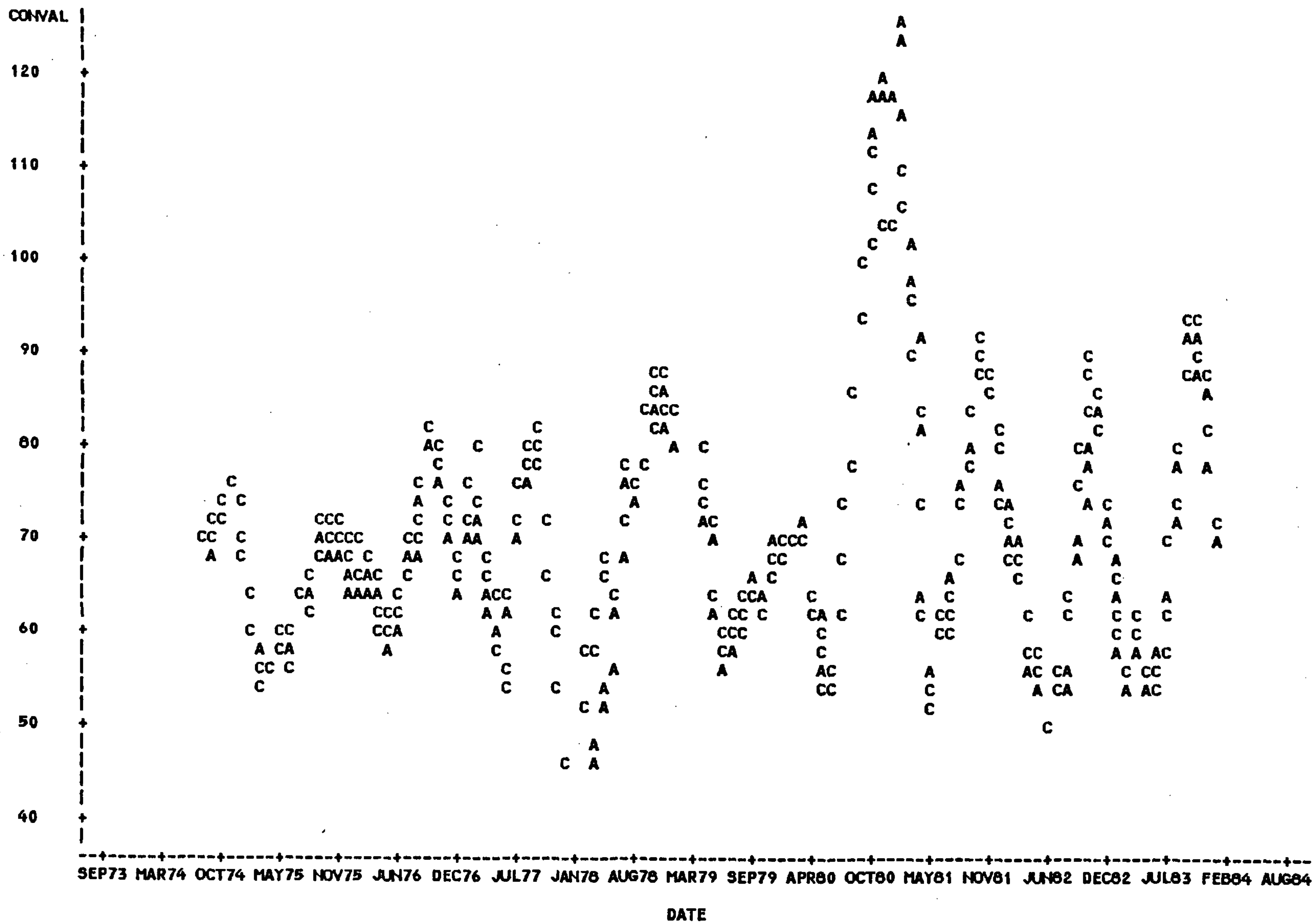
NOTE: 654 OBS HAD MISSING VALUES 284 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-36. Total Inorganic Carbon

PARAM=Total Inorganic Carbon

PLOT OF CONVAL*DATE   SYMBOL USED IS C
PLOT OF AFFVAL*DATE   SYMBOL USED IS A



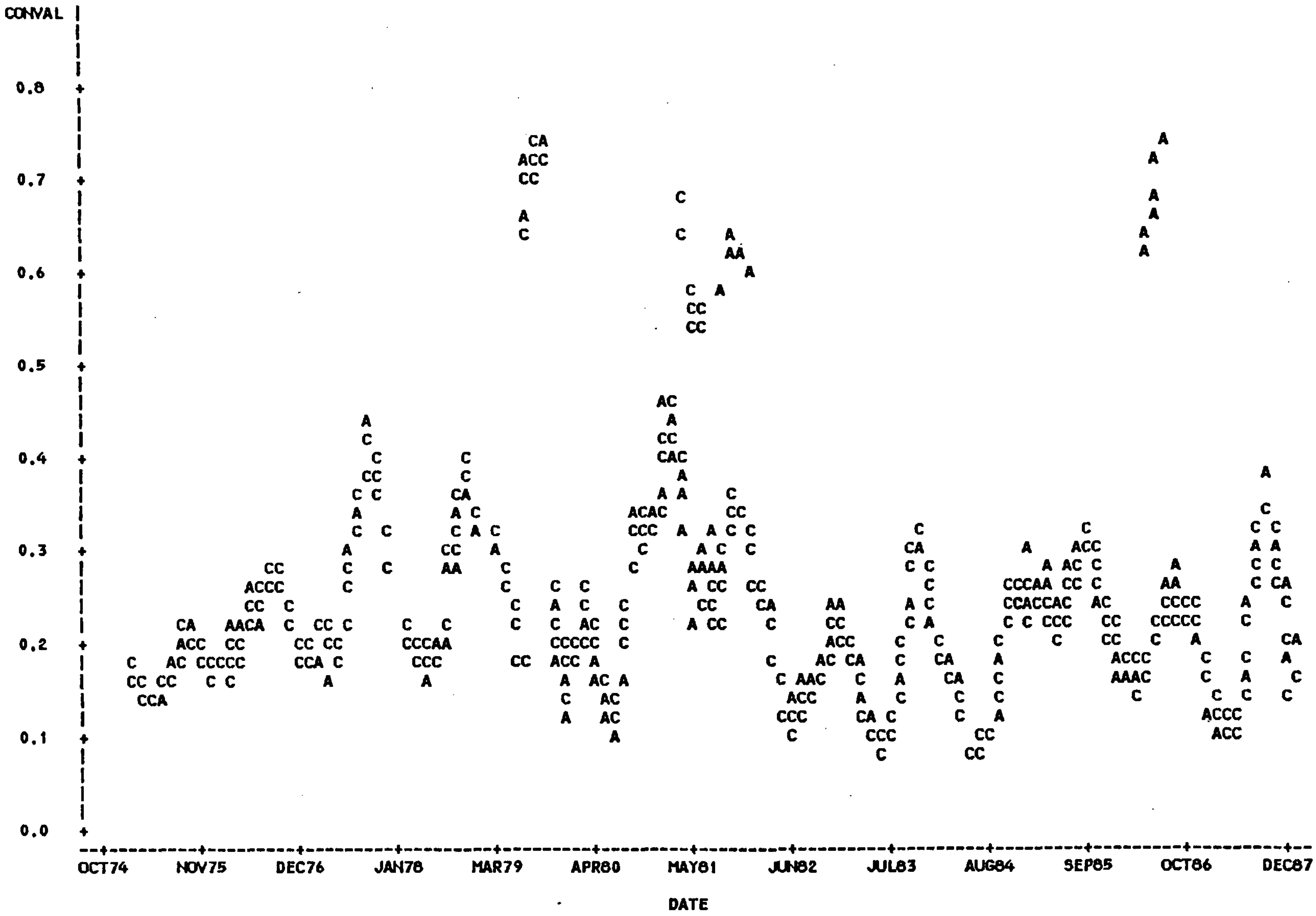
NOTE: 458 OBS HAD MISSING VALUES   154 OBS HIDDEN

SC[illegible]KILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-37. Total Phosphate Phosphorus

PARAM=Total Phosphate Phospho

PLOT OF CONVAL*DATE   SYMBOL USED IS C
PLOT OF AFFVAL*DATE   SYMBOL USED IS A



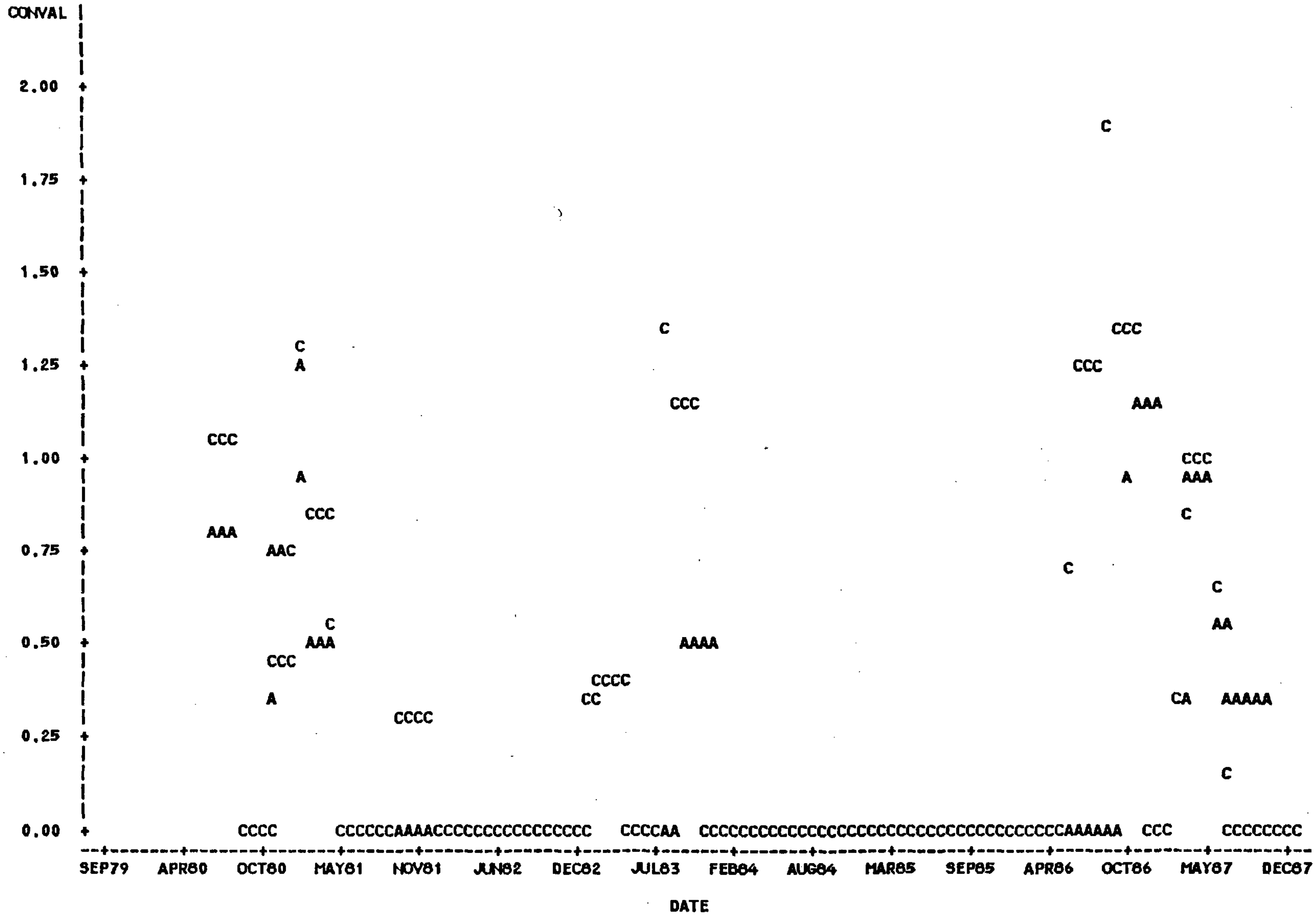
NOTE: 639 OBS HAD MISSING VALUES   287 OBS HIDDEN

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-38. Trichloroethylene

PARAM=Trichloroethylene (ug/l

PLOT OF CONVAL*DATE SYMBOL USED IS C
PLOT OF AFFVAL*DATE SYMBOL USED IS A



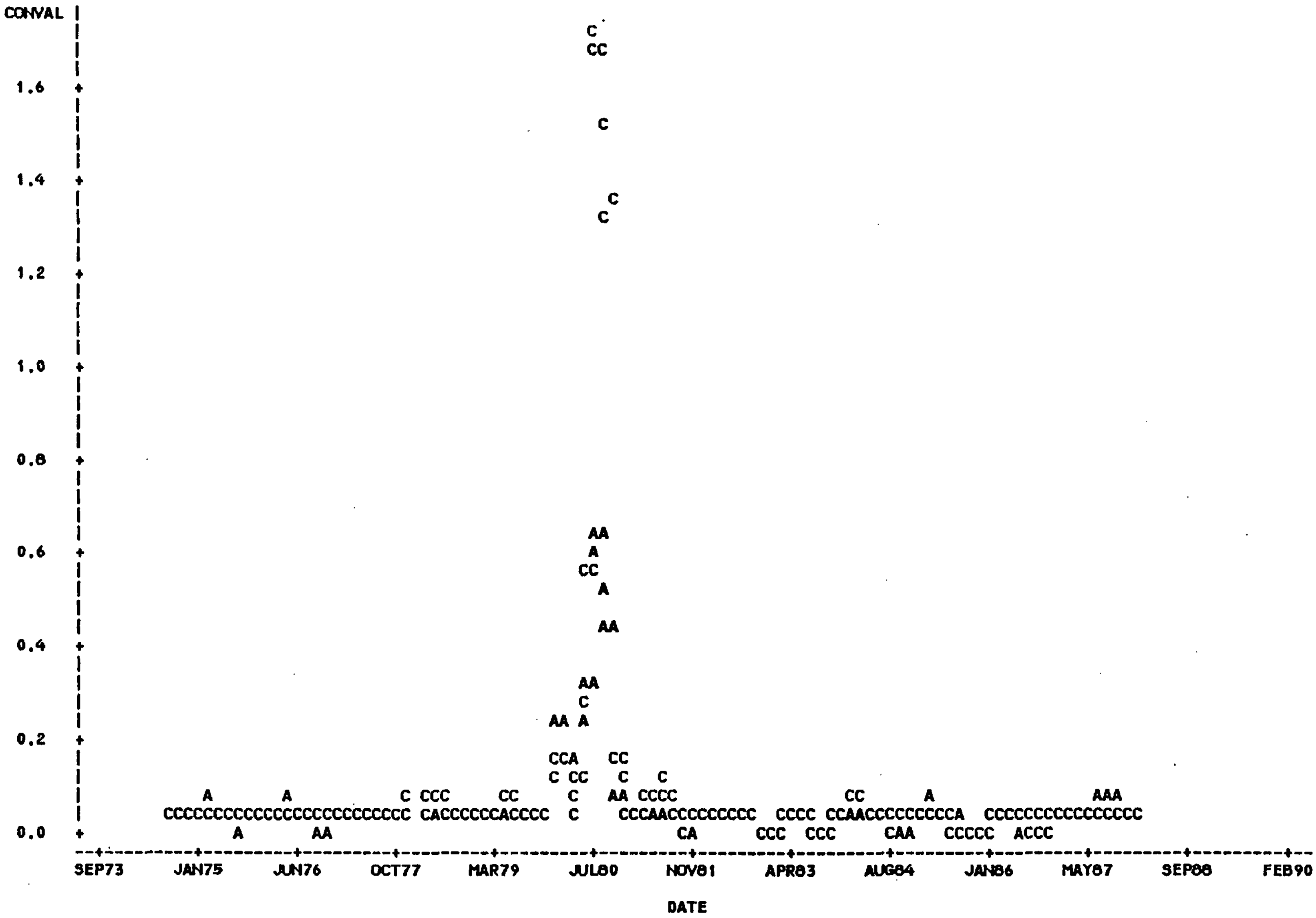
NOTE: 394 OBS HAD MISSING VALUES 233 OBS HIDDEN

SC[illegible]KILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 977660 AND 977140

Figure 6.1-39. Zinc

PARAM=Zinc (mg/l)

PLOT OF CONVAL*DATE   SYMBOL USED IS C
PLOT OF AFFVAL*DATE   SYMBOL USED IS A



NOTE: 662 OBS HAD MISSING VALUES 501 OBS HIDDEN

Fig. 6.1-40 to 6.1-71 (following).

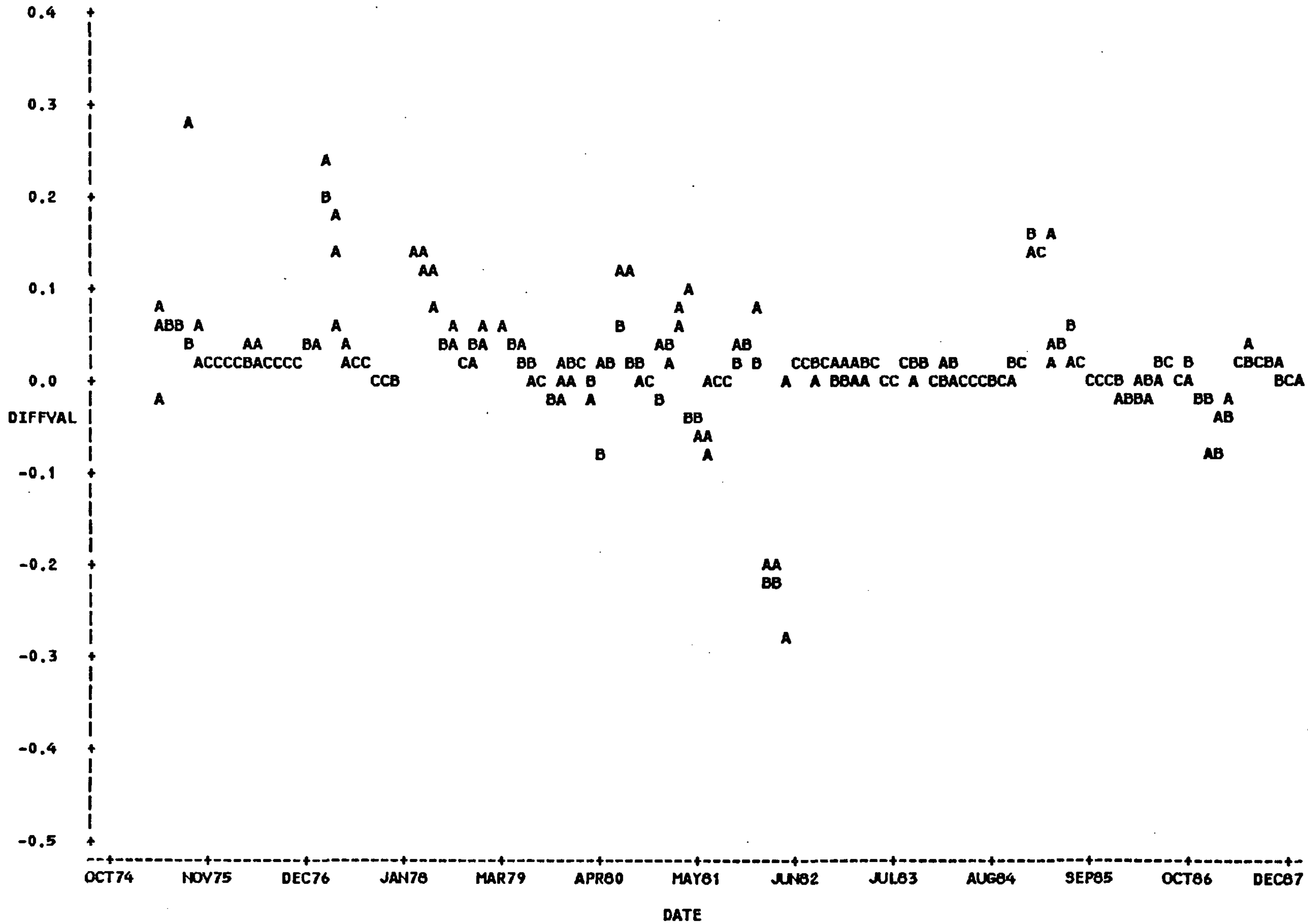
Difference between control station (S77660 upstream) and affected station (S77140 downstream) water quality measurements near LGS. Plotted points represent the difference between stations in 3-month running averages calculated from six biweekly samples. See text for additional explanation.

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-40. Ammonia Nitrogen

PARAM=Ammonia Nitrogen (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



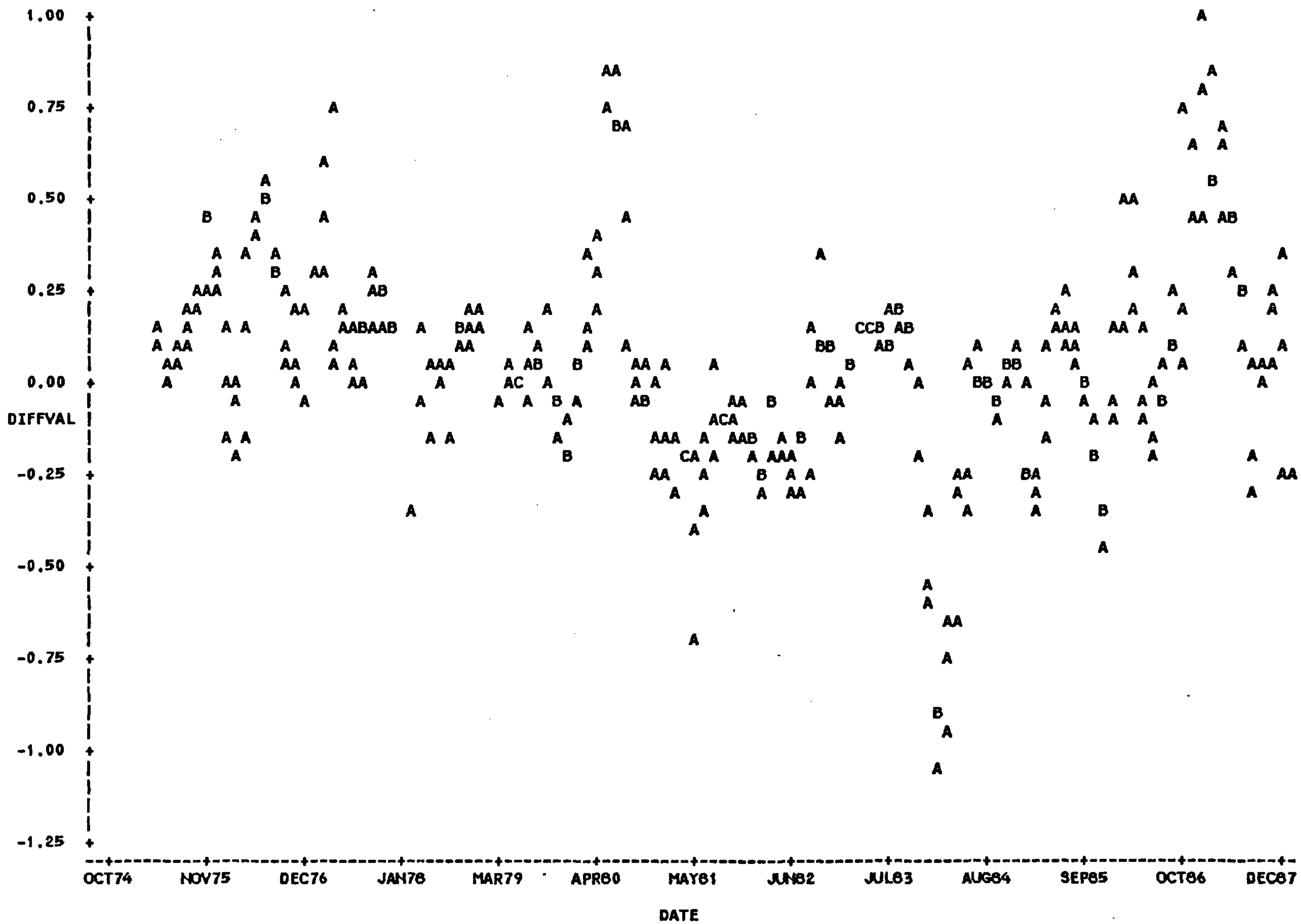
NOTE: 5 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-41. Biochemical Oxygen Demand

PARAM=Biochemical Oxygen Dema

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



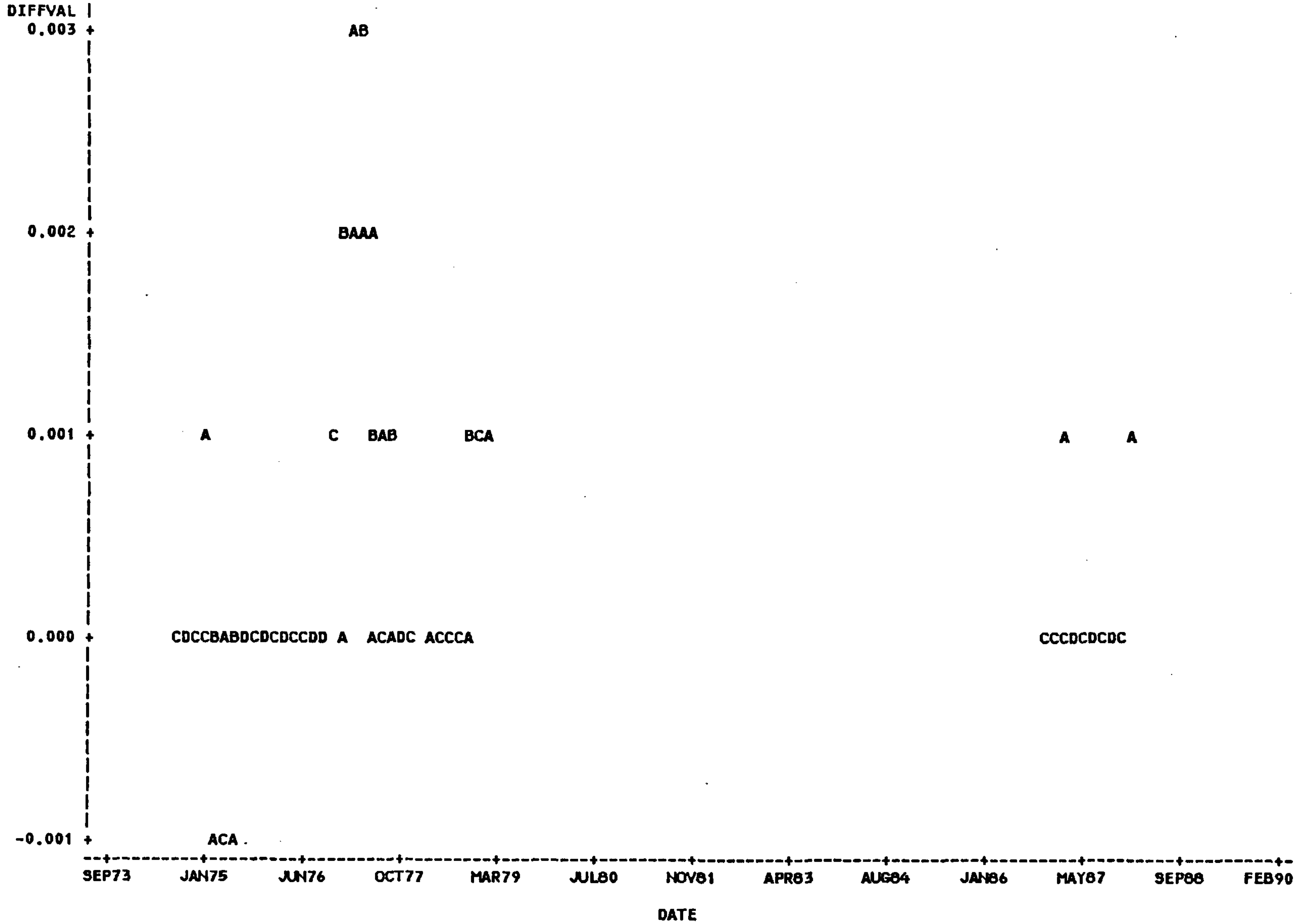
NOTE: 5 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 977660 AND 977140

Figure 6.1-42. Cadmium

PARAM=Cadmium (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



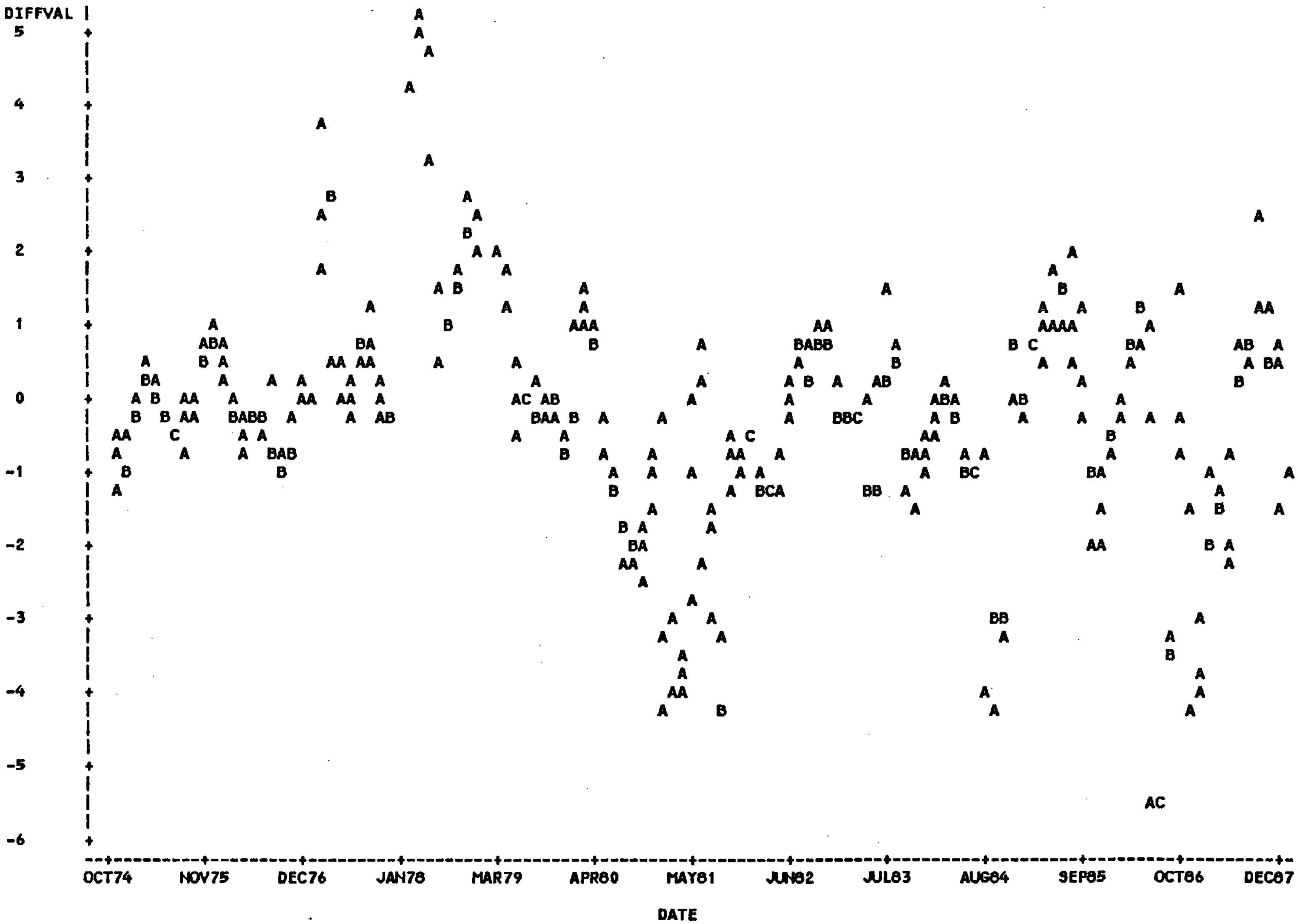
NOTE: 4 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-43. Calcium

PARAM=Calcium (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



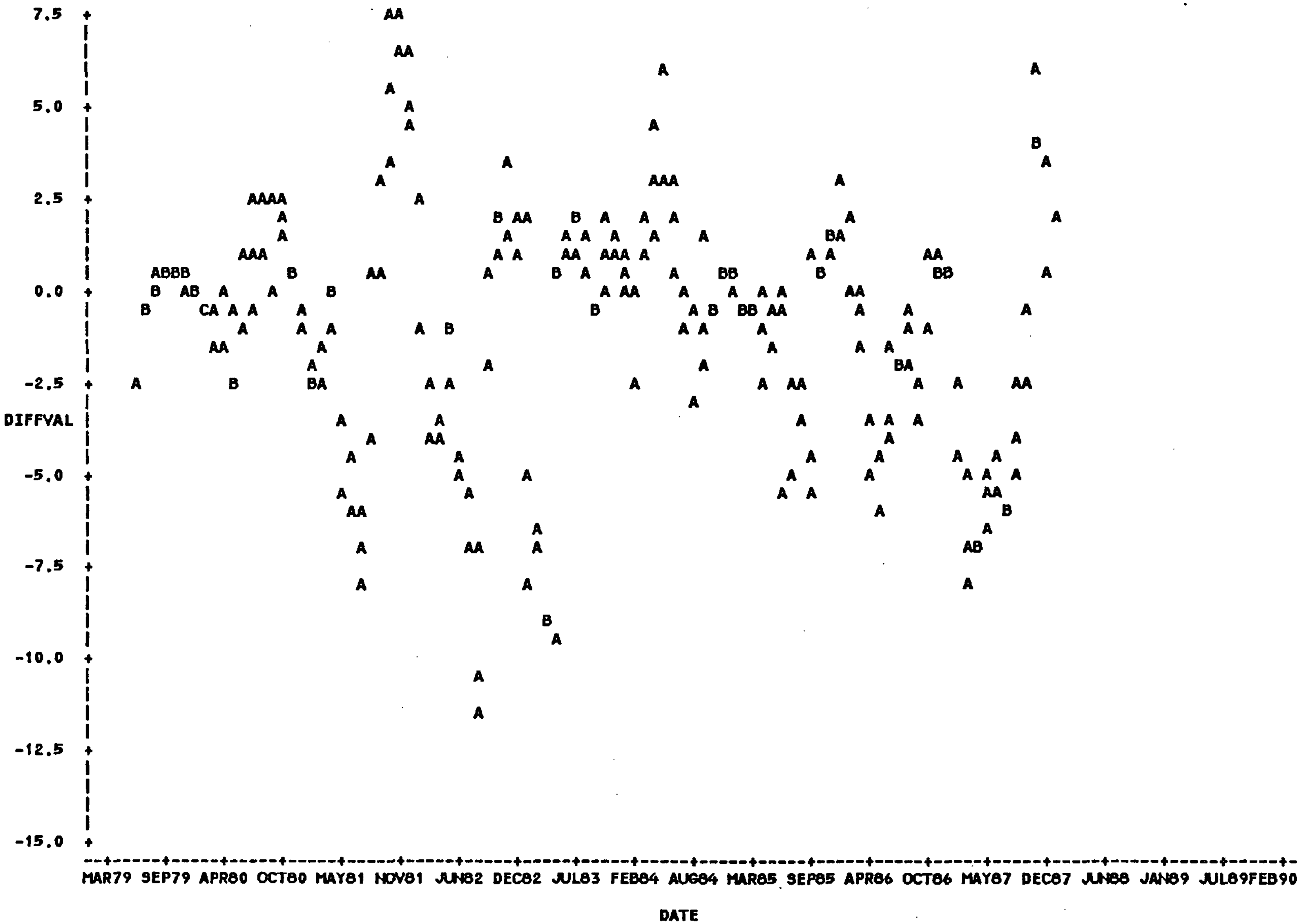
NOTE: 4 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-44. Chemical Oxygen Demand

PARAM=Chemical Oxygen Demand

PLOT OF DIFFVAL*DATE LEGEND: A = 1 OBS, B = 2 OBS, ETC.

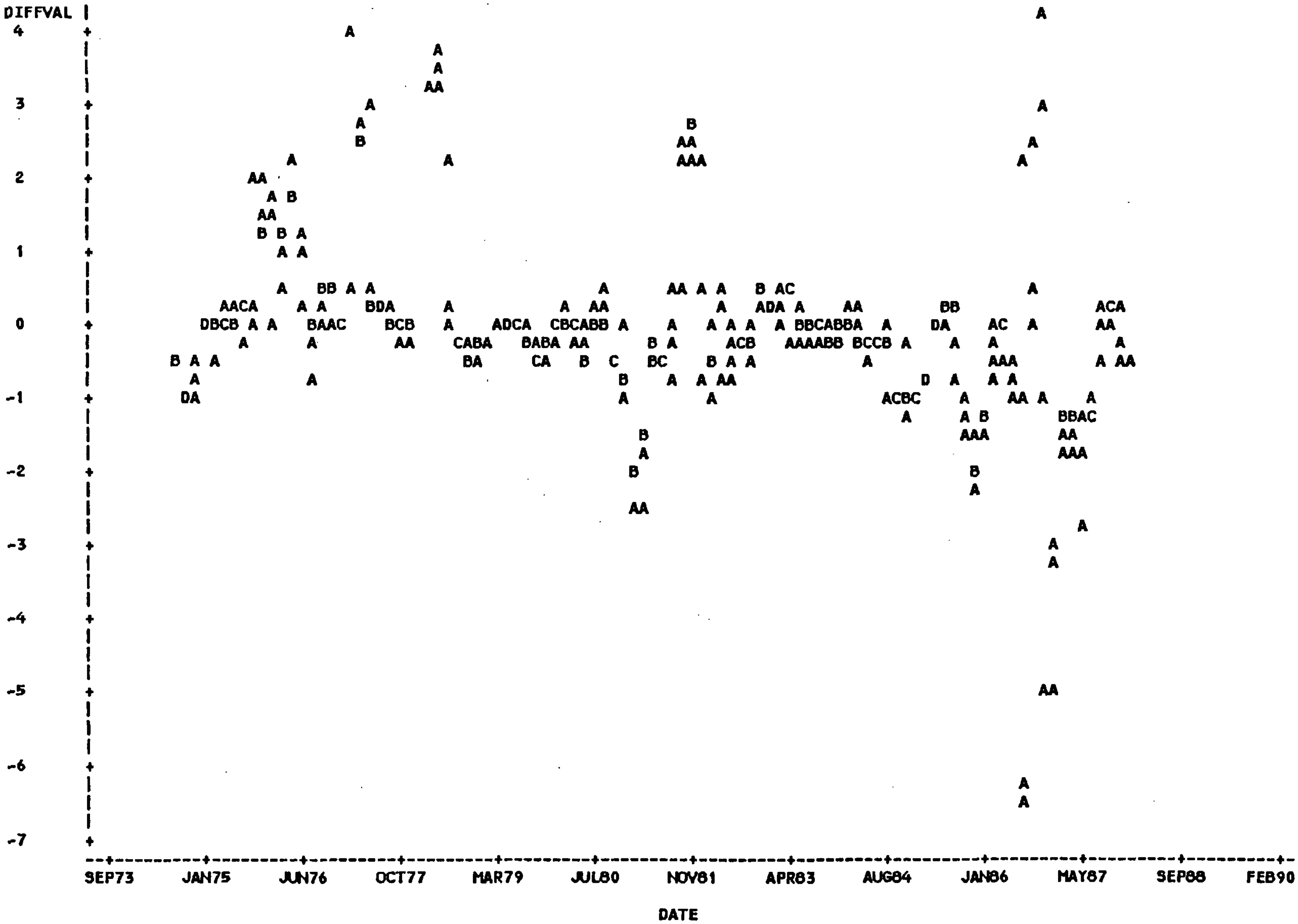


SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 577660 AND 577140

Figure 6.1-45. Chloride

PARAM=Chloride (mg/l)

PLOT OF DIFFVAL*DATE LEGEND: A = 1 OBS, B = 2 OBS, ETC.



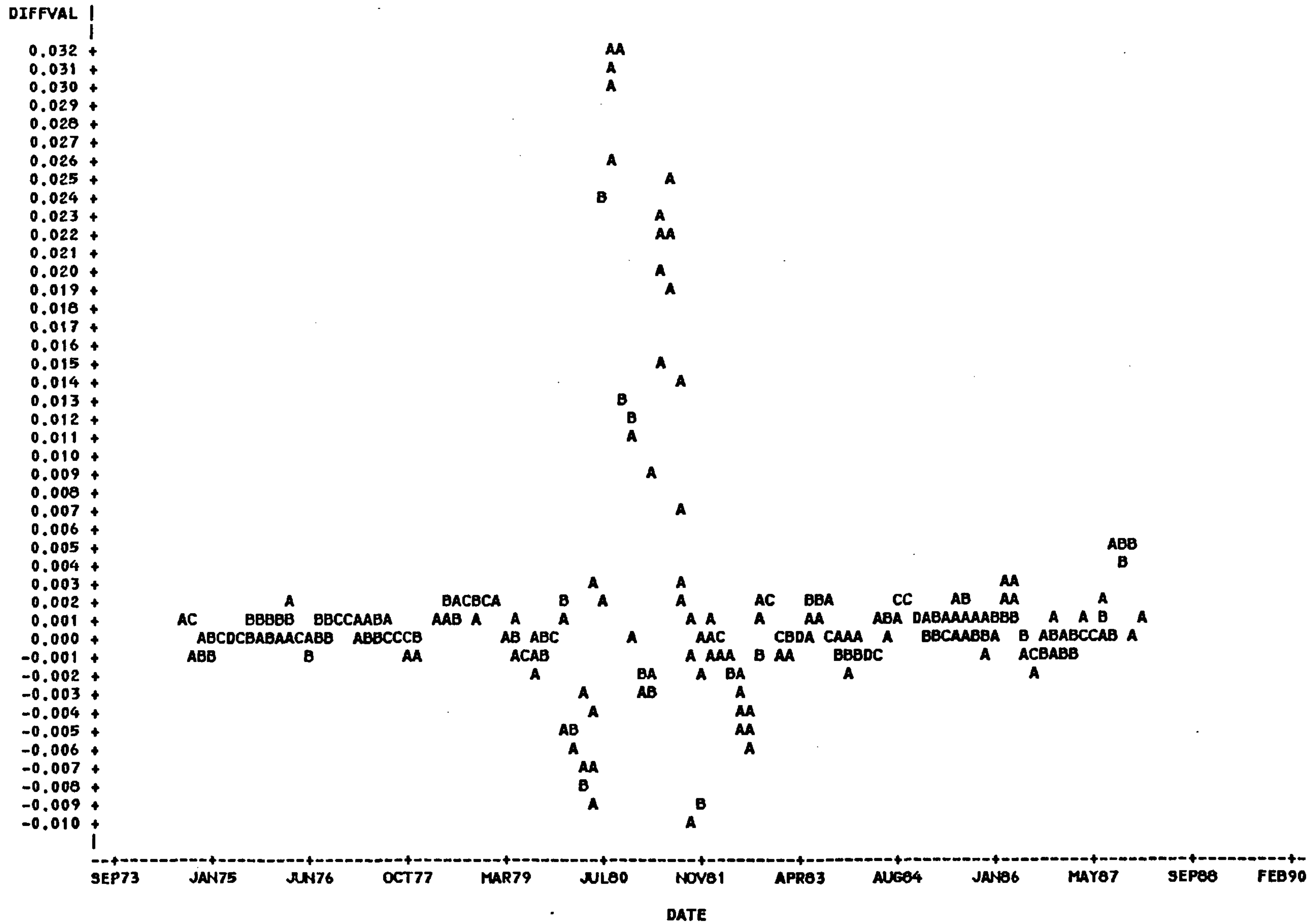
NOTE: 4 OBS HAD MISSING VALUES

S[illegible]LKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-46. Chromium

PARAM=Chromium (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



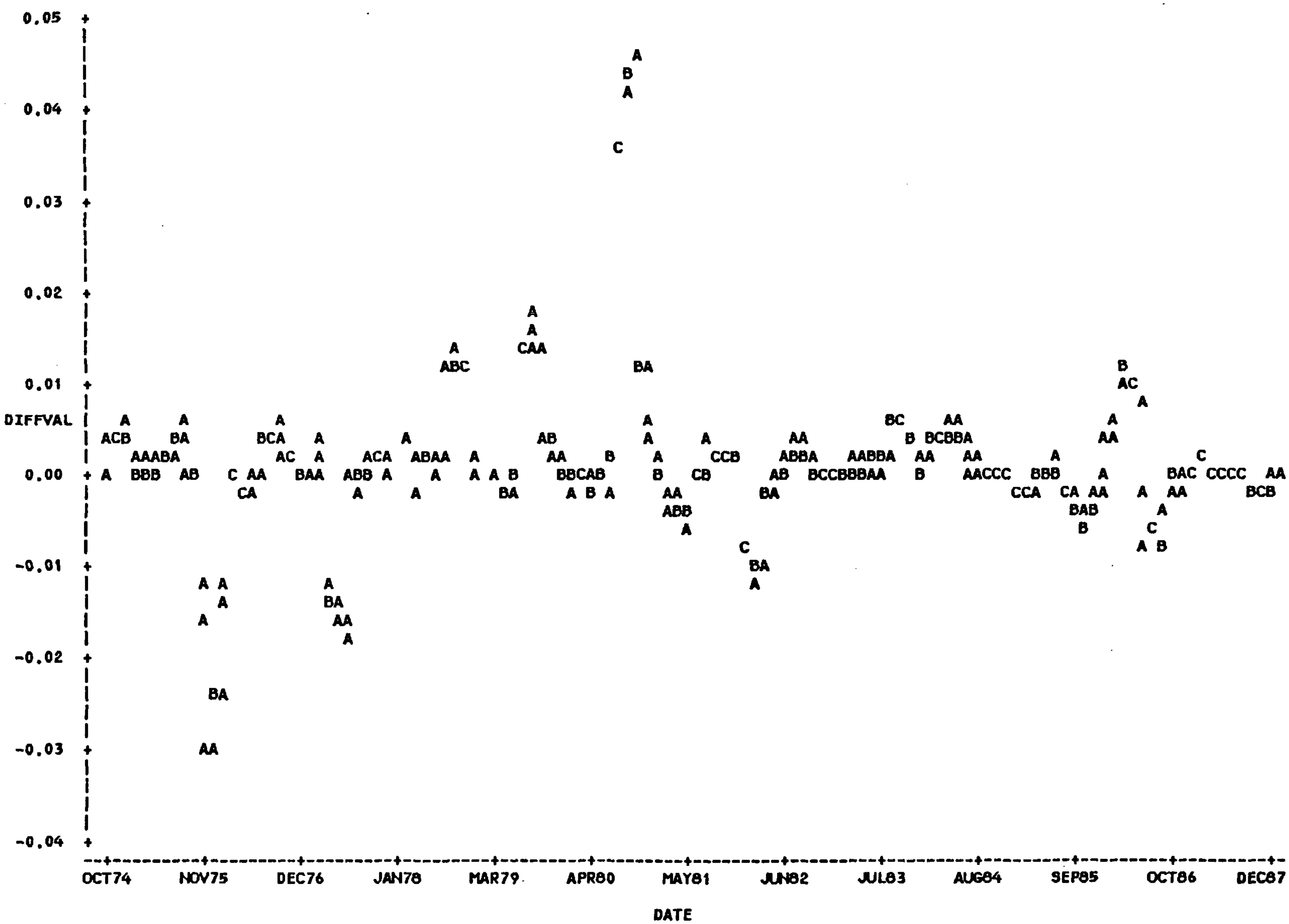
NOTE: 4 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-47. Copper

PARAM=Copper (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



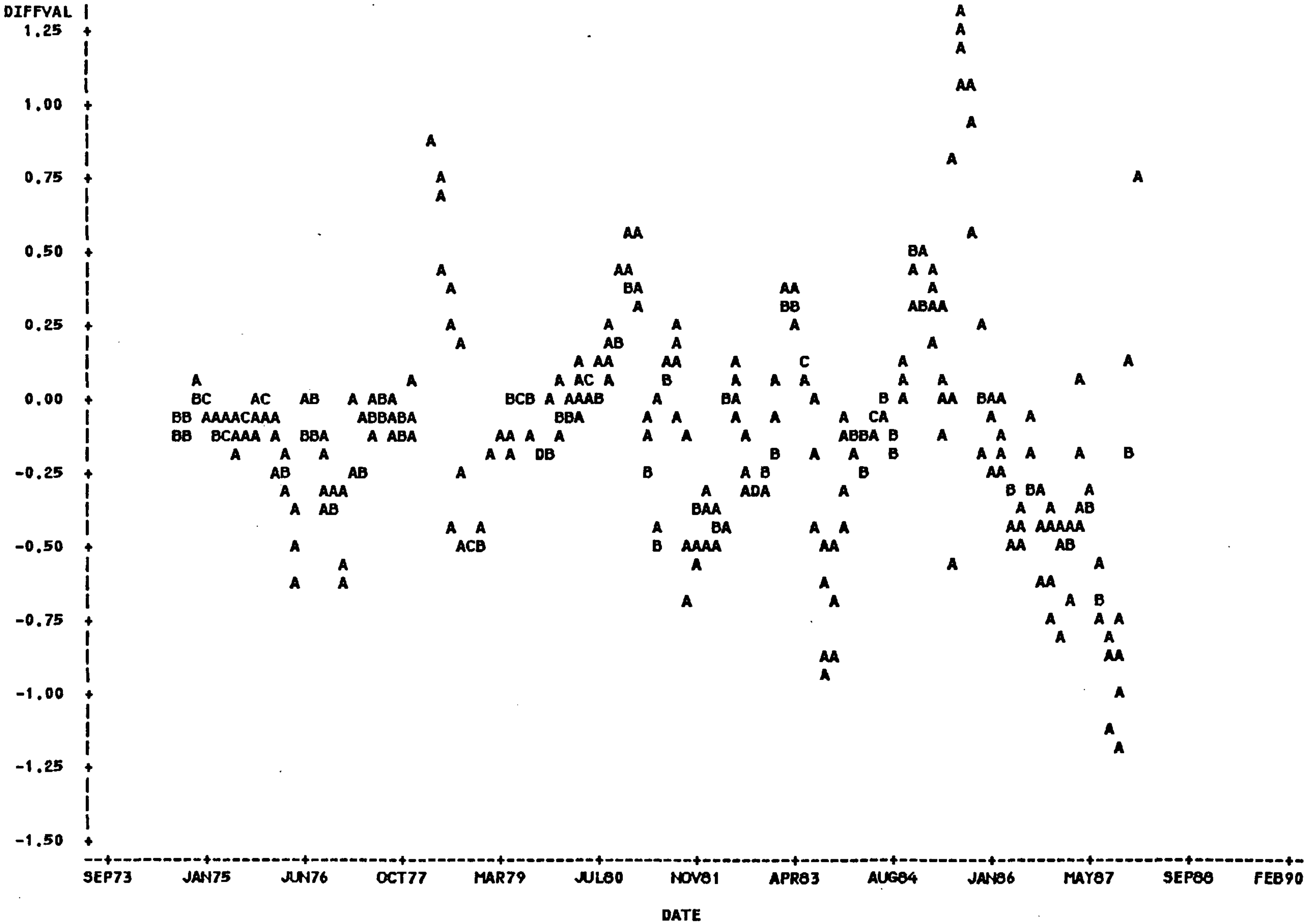
NOTE: 5 OBS HAD MISSING VALUES

S LKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-48. Dissolved Oxygen

PARAM=Dissolved Oxygen (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



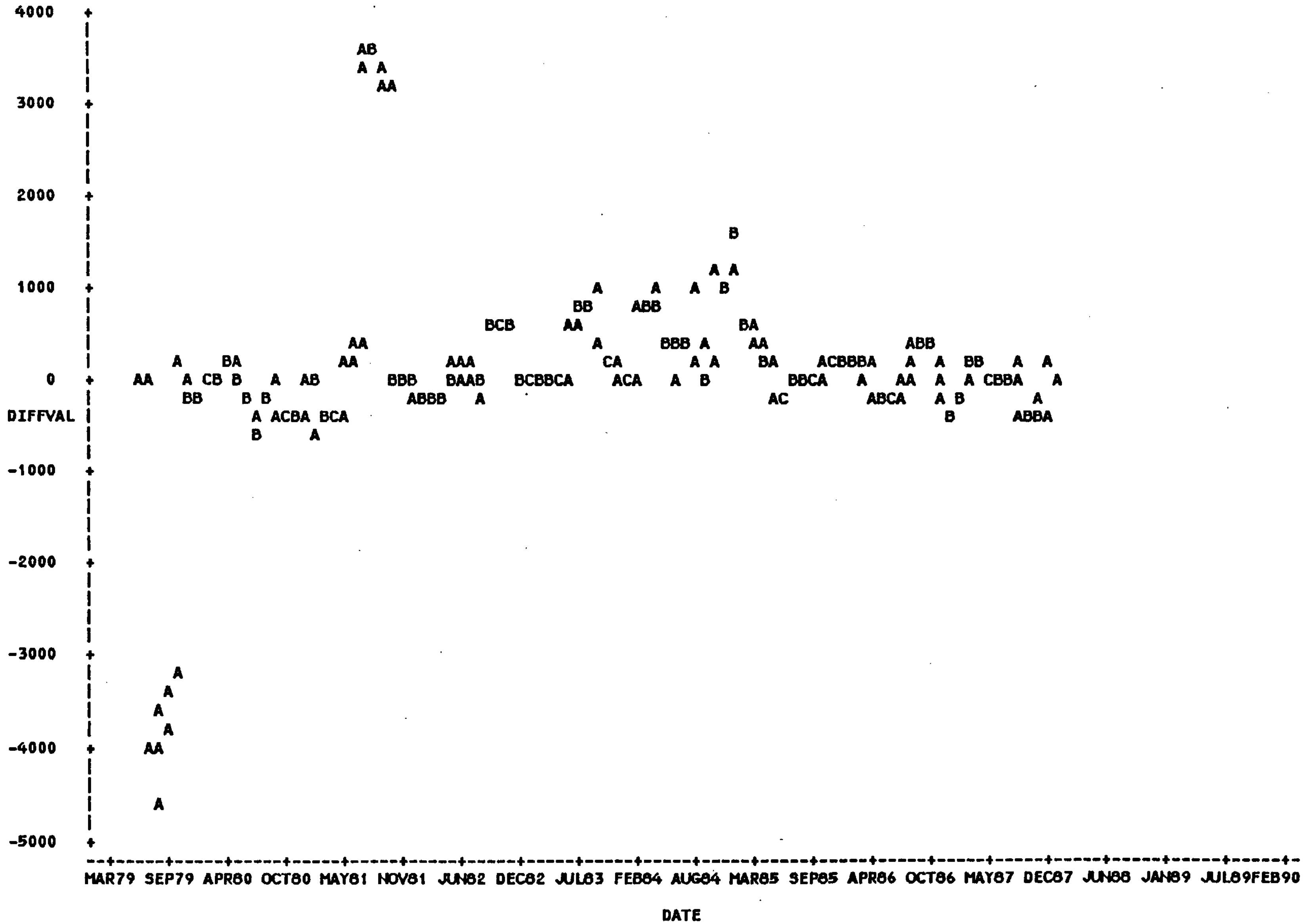
NOTE: 4 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-49. Fecal Coliforms

PARAM=Fecal Coliforms (MF) (c

PLOT OF DIFFVAL*DATE LEGEND: A = 1 OBS, B = 2 OBS, ETC.



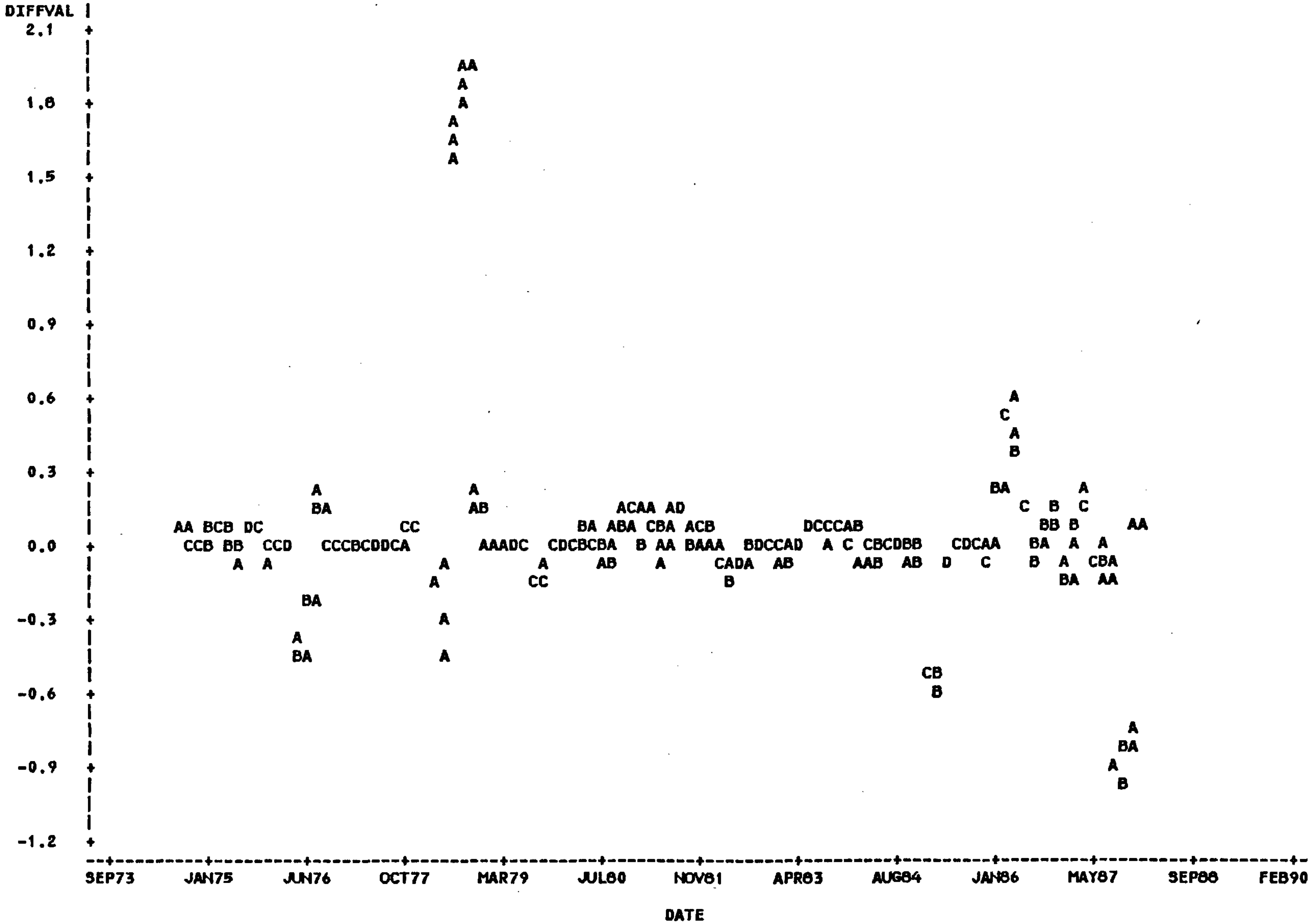
NOTE: 3 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-50. Iron

PARAM=Iron (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



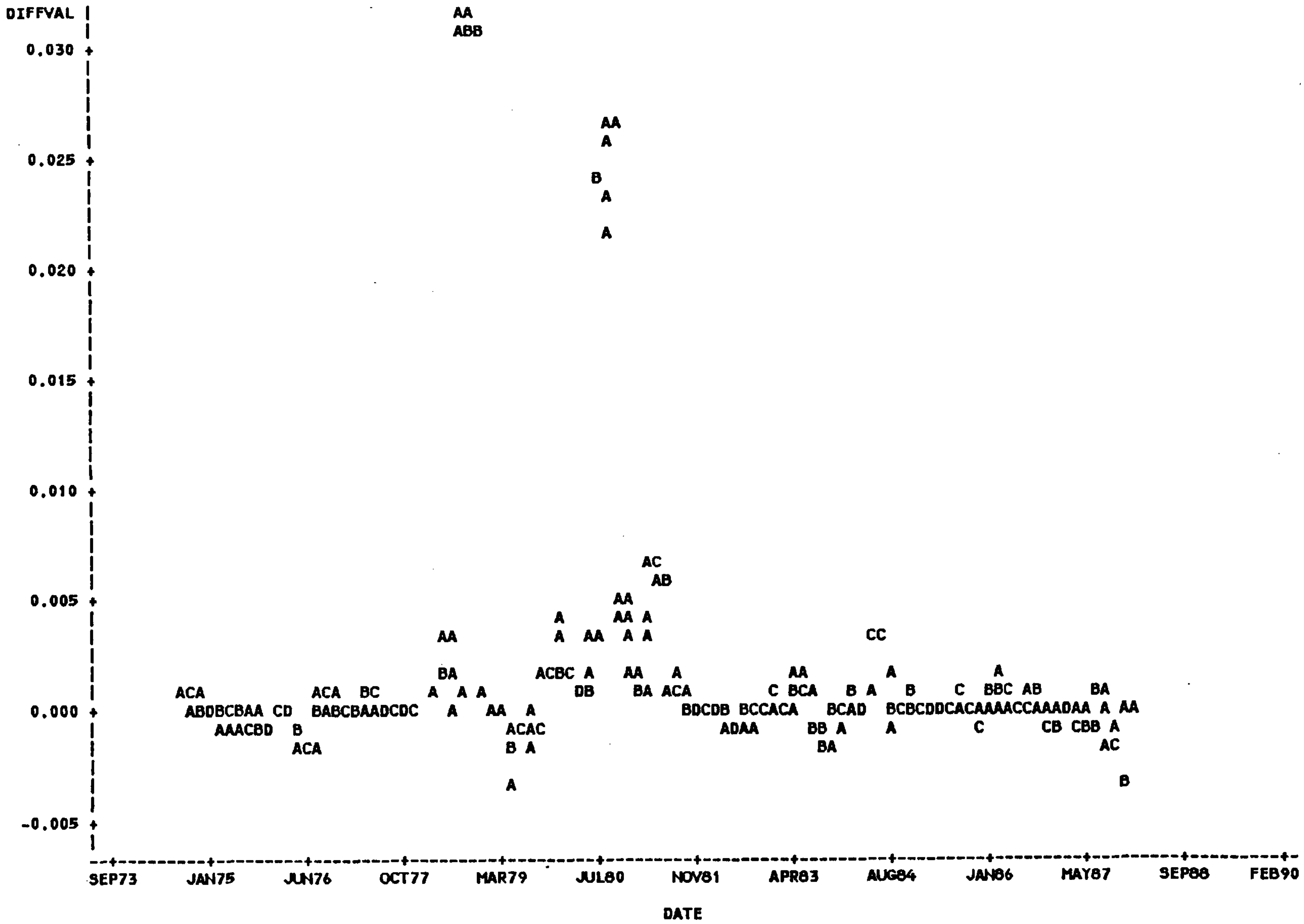
NOTE: 4 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-51. Lead

PARAM=Lead (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



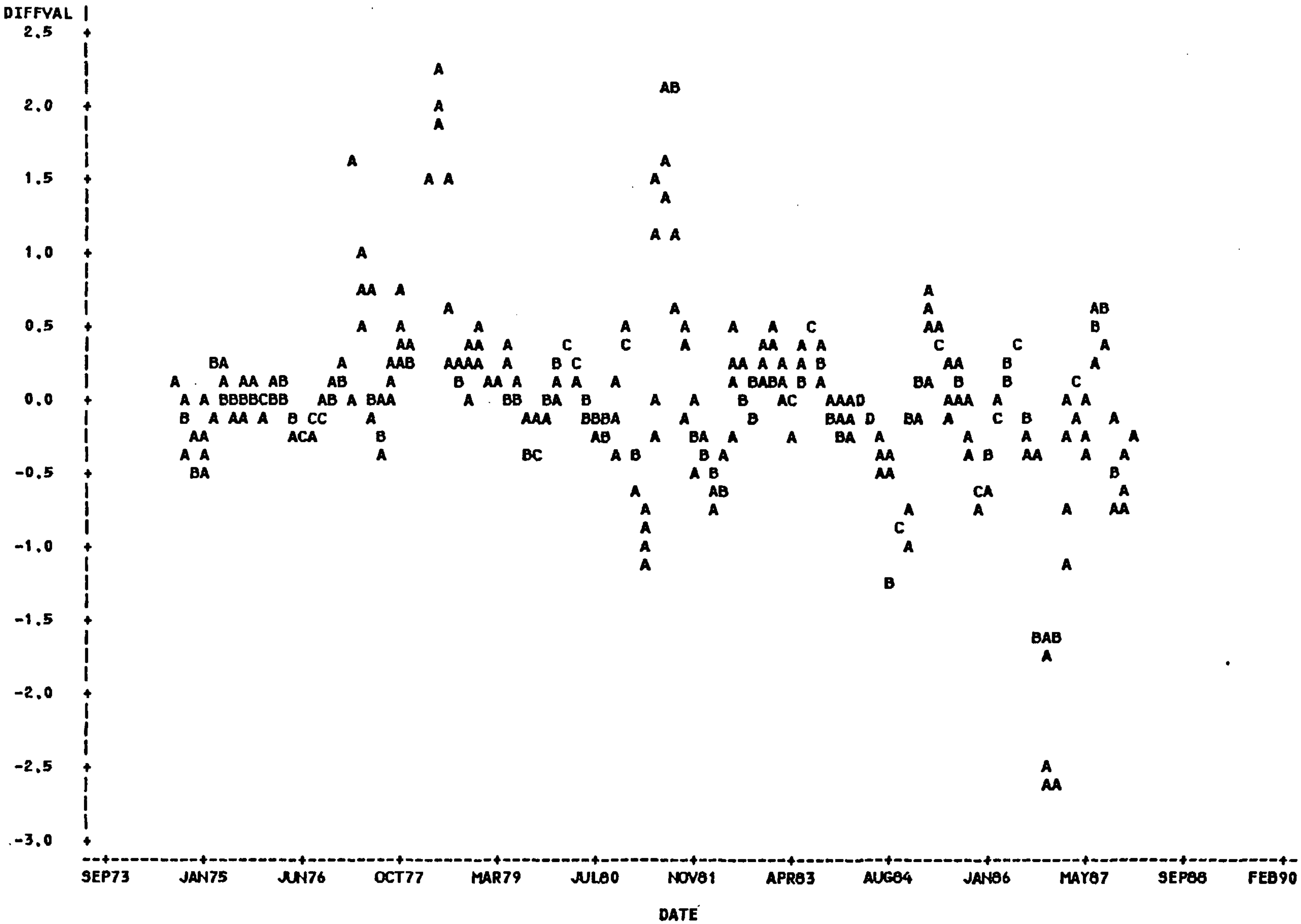
NOTE: 4 OBS HAD MISSING VALUES

S[illegible]KILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 [illegible]/ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-52. Magnesium

PARAM=Magnesium (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



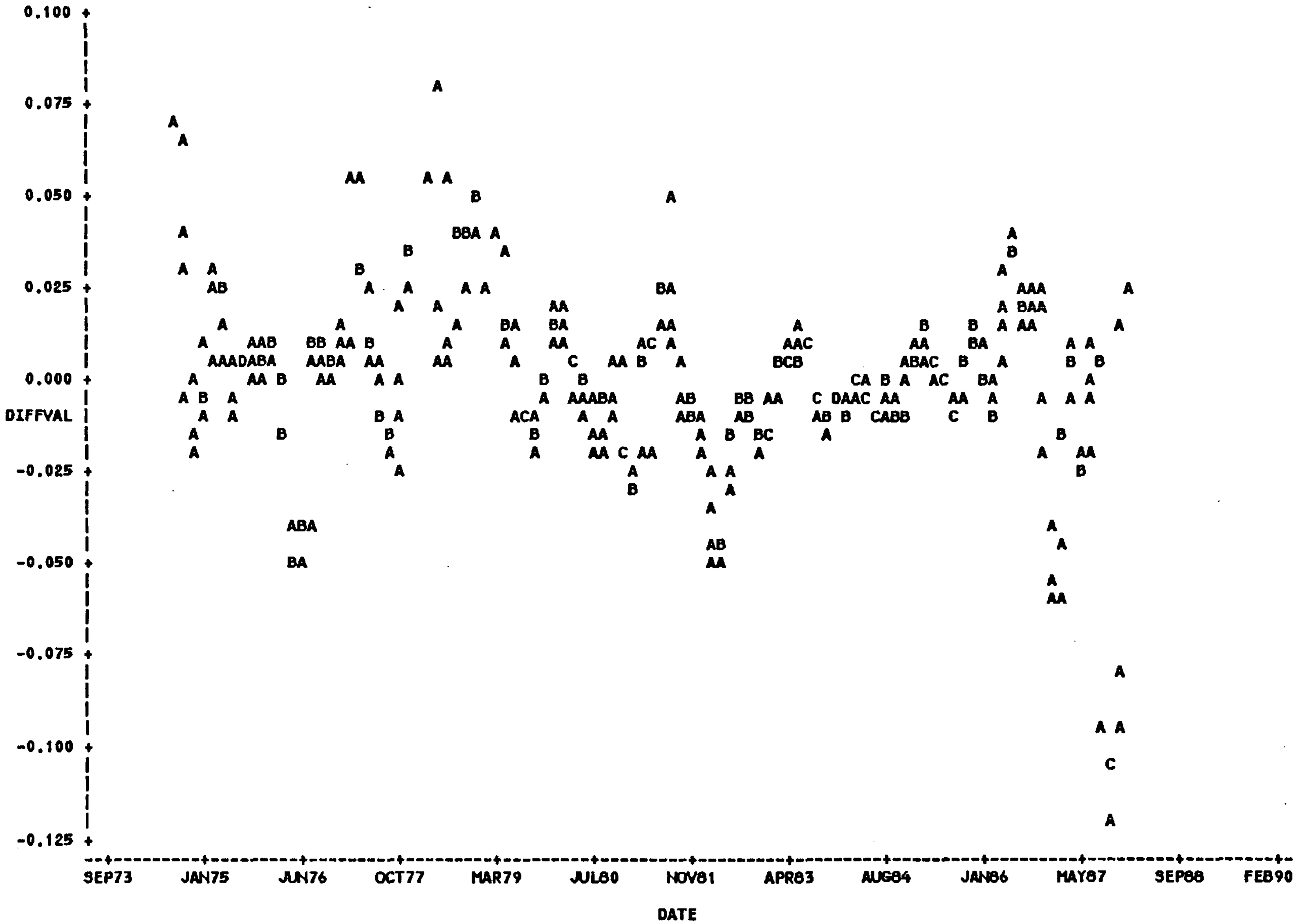
NOTE: 4 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-53. Manganese

PARAM=Manganese (mg/l)

PLOT OF DIFFVAL*DATE LEGEND: A = 1 OBS, B = 2 OBS, ETC.



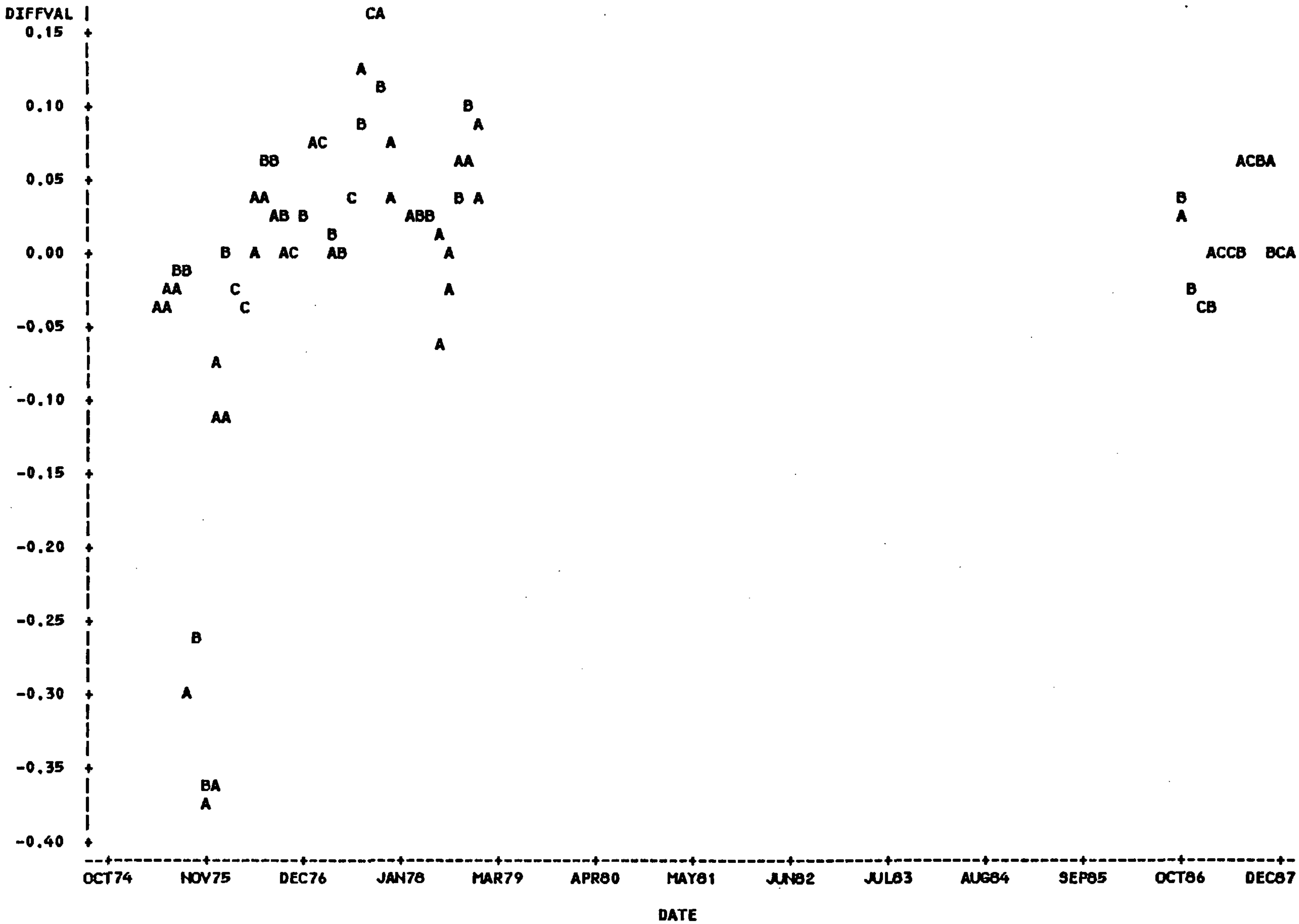
NOTE: 4 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 977660 AND 977140

Figure 6.1-54. Mercury

PARAM=Mercury (ug/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



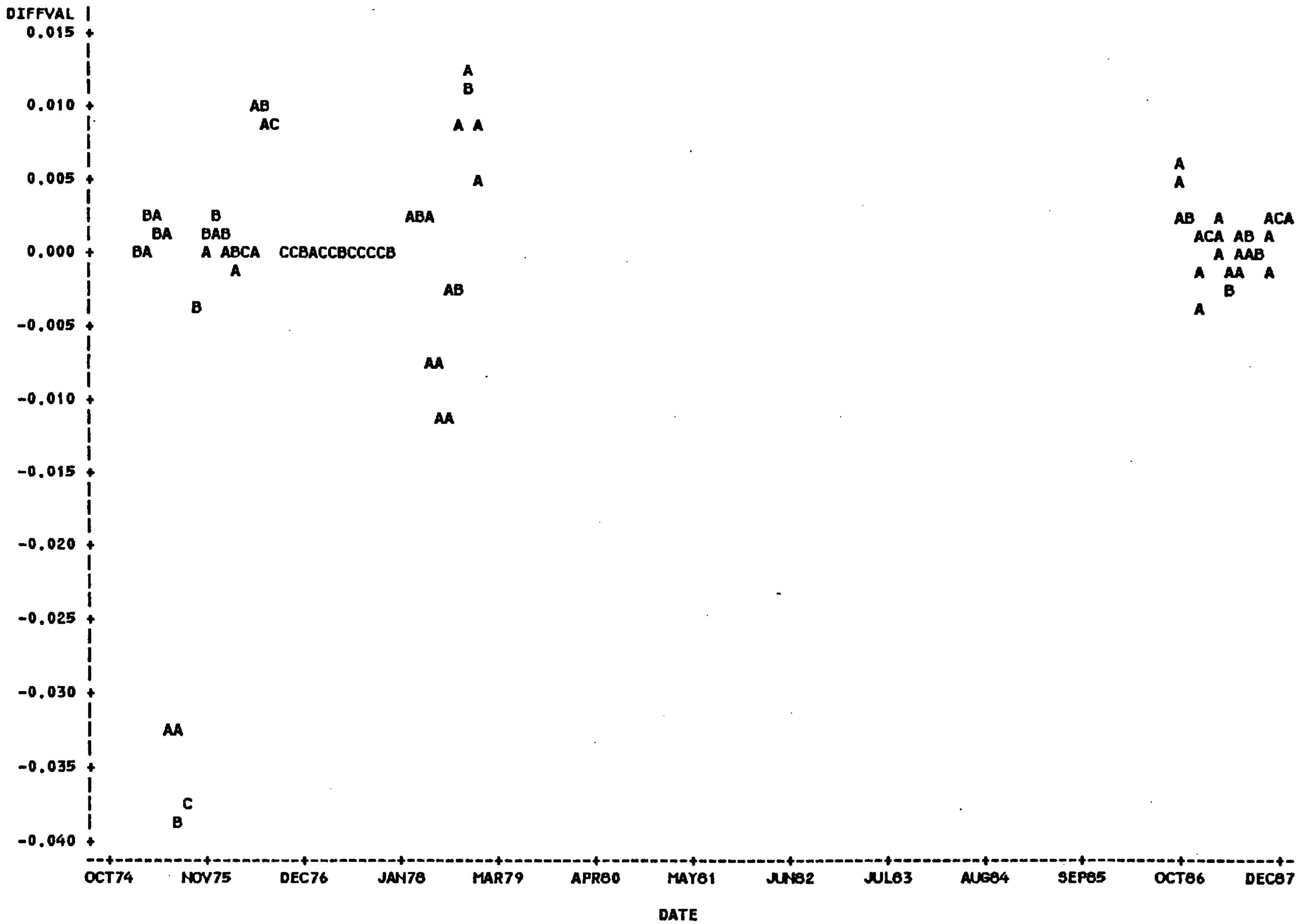
NOTE: 4 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-55. Nickel

PARAM=Nickel (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



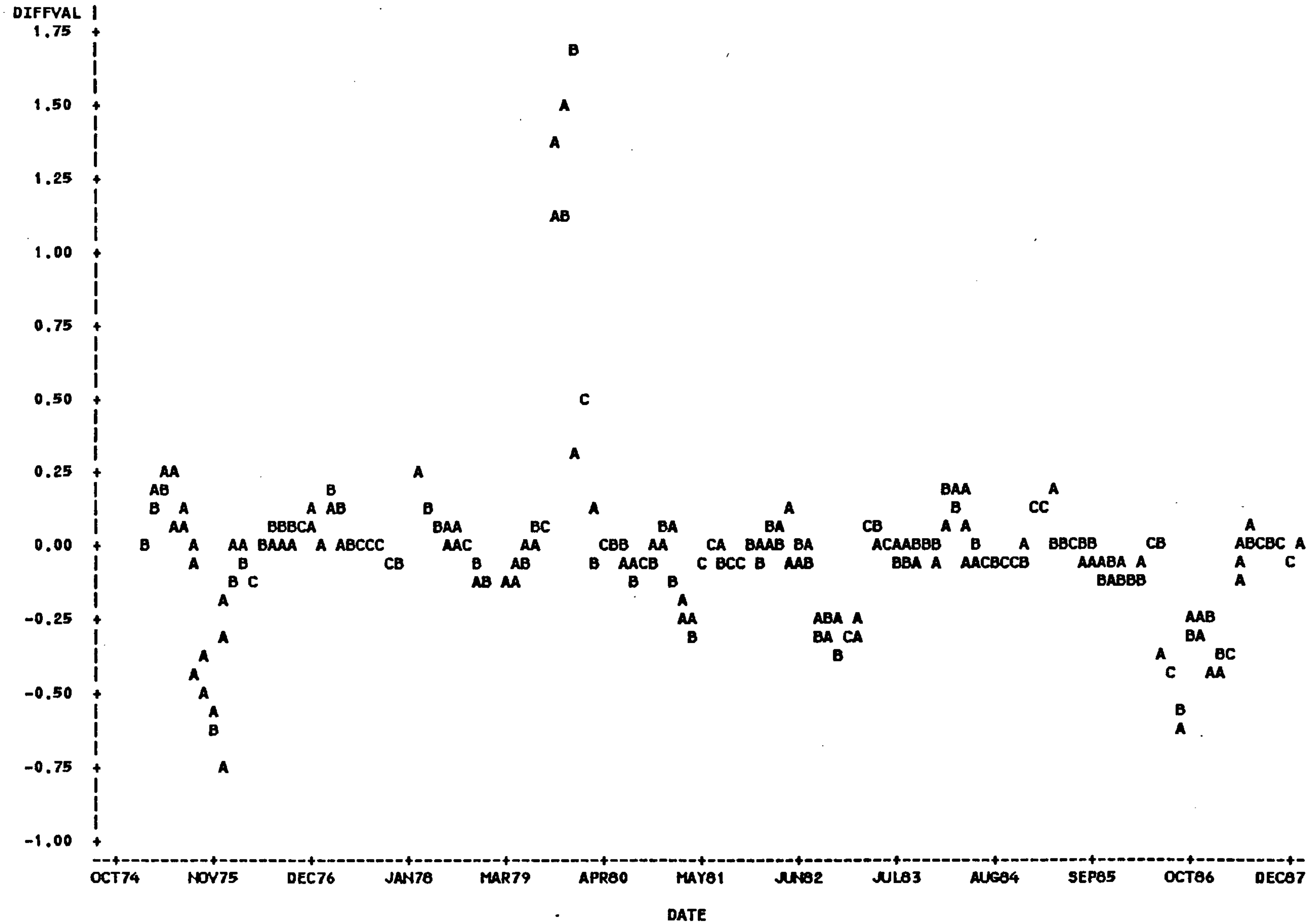
NOTE: 4 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-56. Nitrate Nitrogen

PARAM=Nitrate Nitrogen (mg/l)

PLOT OF DIFFVAL*DATE LEGEND: A = 1 OBS, B = 2 OBS, ETC.



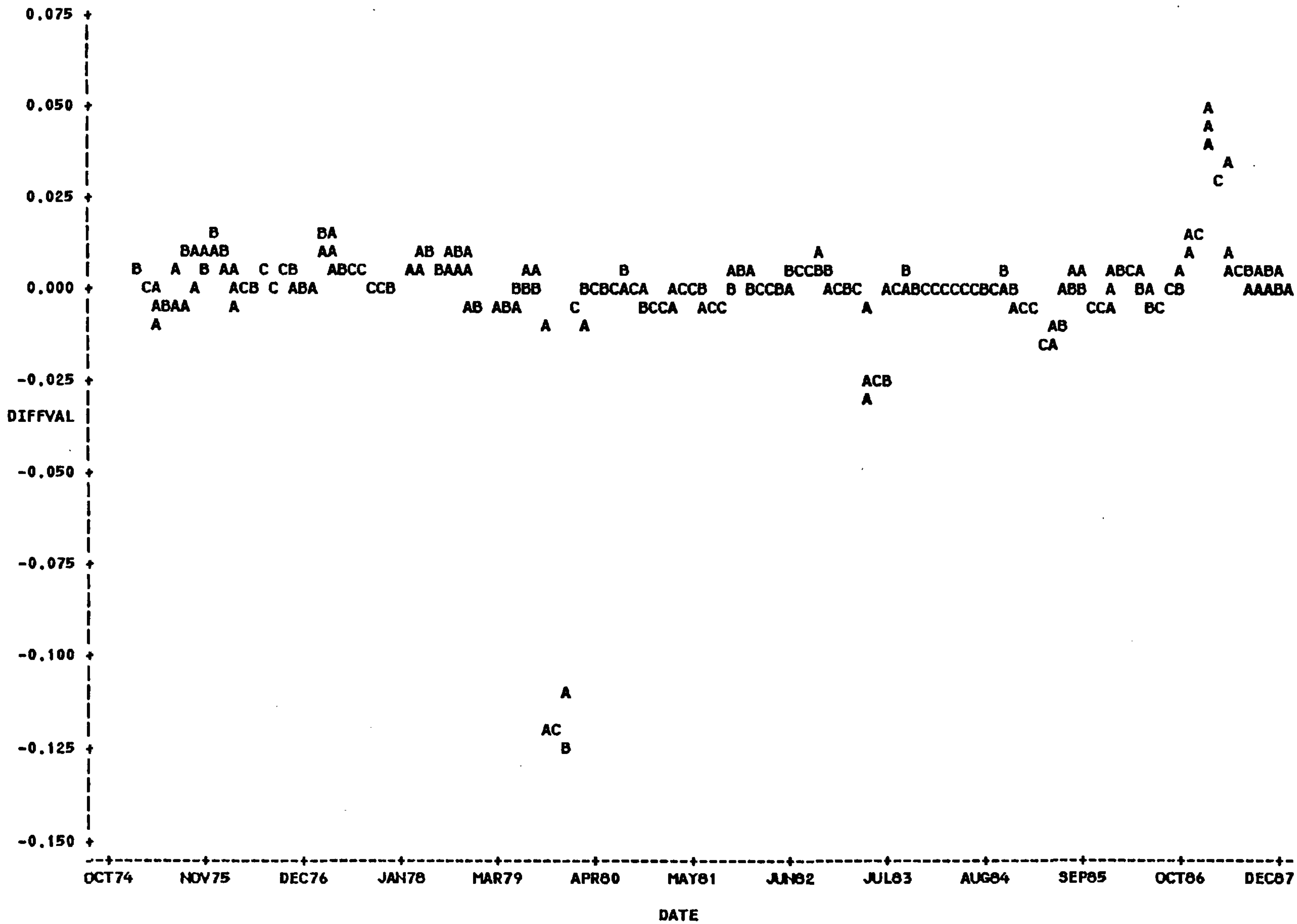
NOTE: 5 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-57. Nitrite Nitrogen

PARAM=Nitrite Nitrogen (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



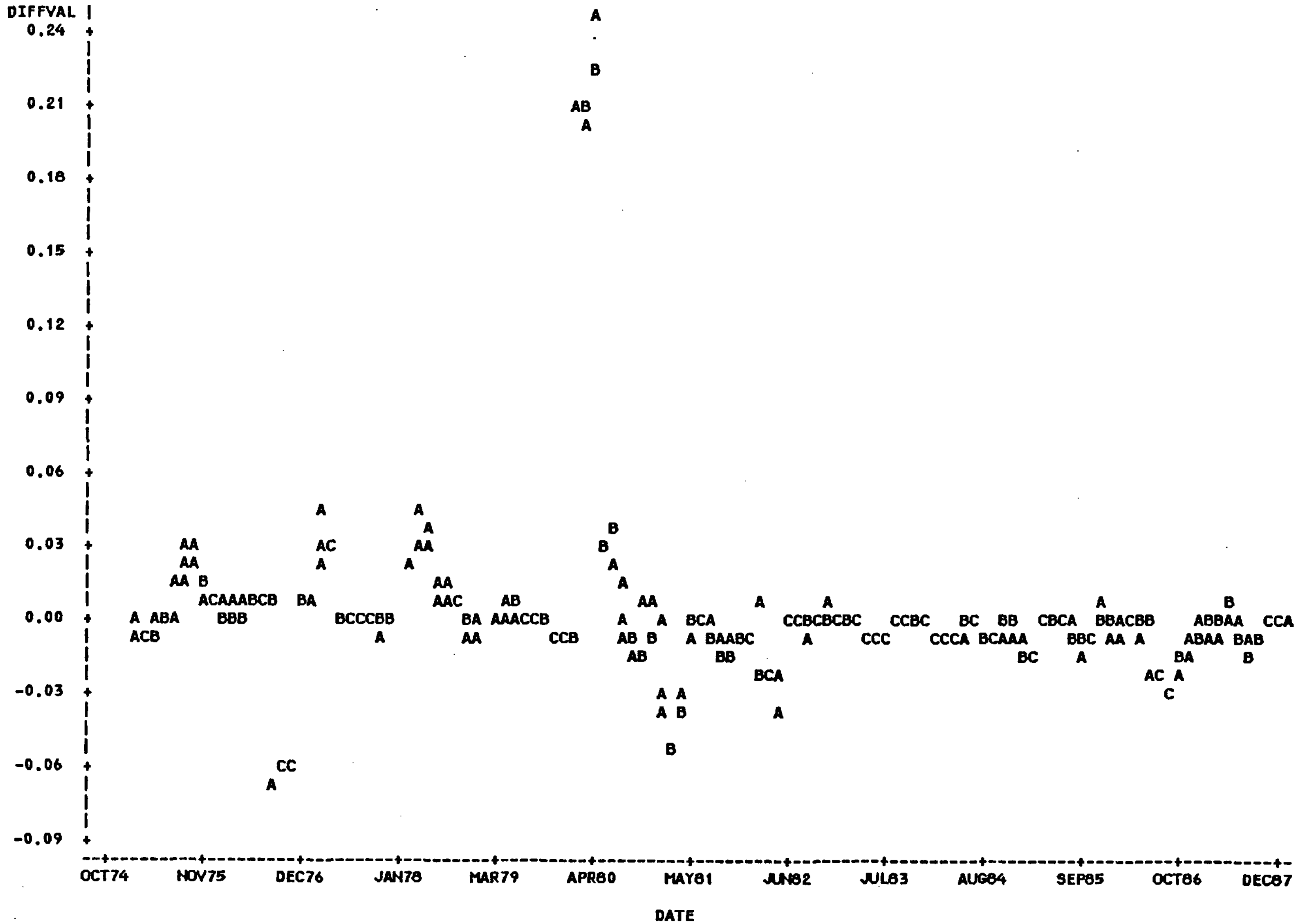
NOTE: 5 OBS HAD MISSING VALUES

SC[hole]LKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-58. Ortho Phosphate Phosphorus

PARAM=Ortho Phosphate Phospho

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



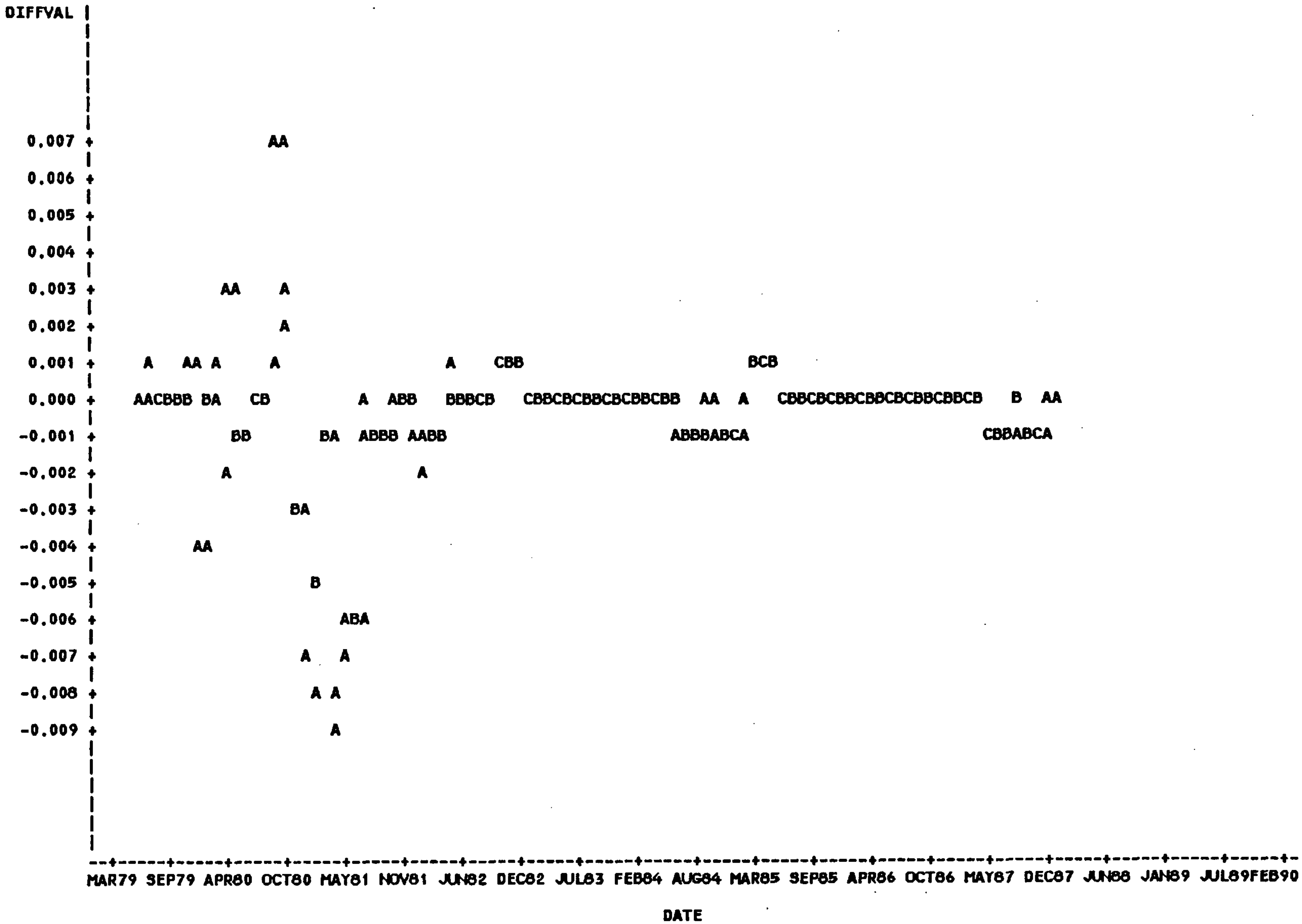
NOTE: 5 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-59. Phenols

PARAM=Phenols (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.

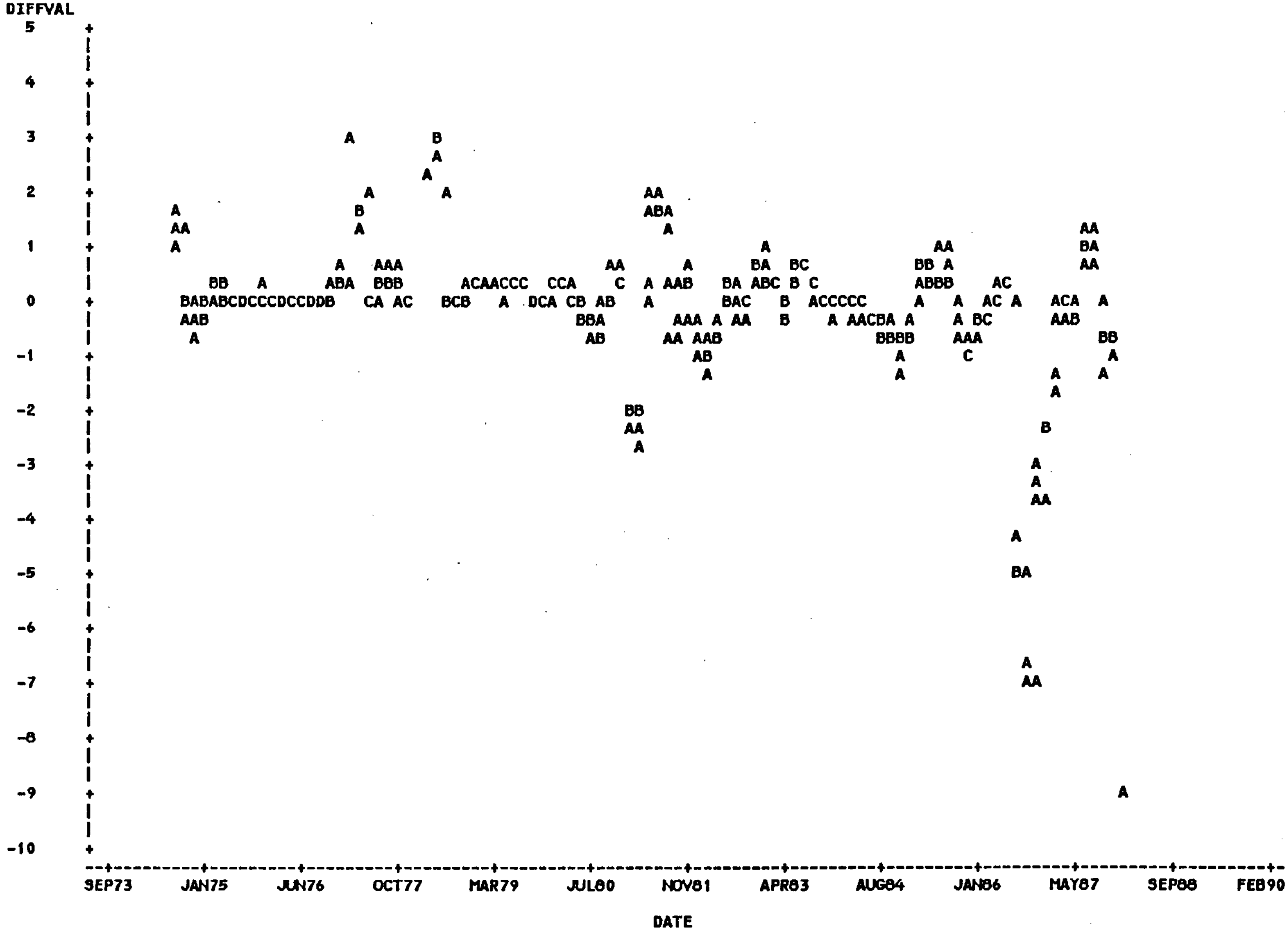


SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-60. Sodium

PARAM=Sodium (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



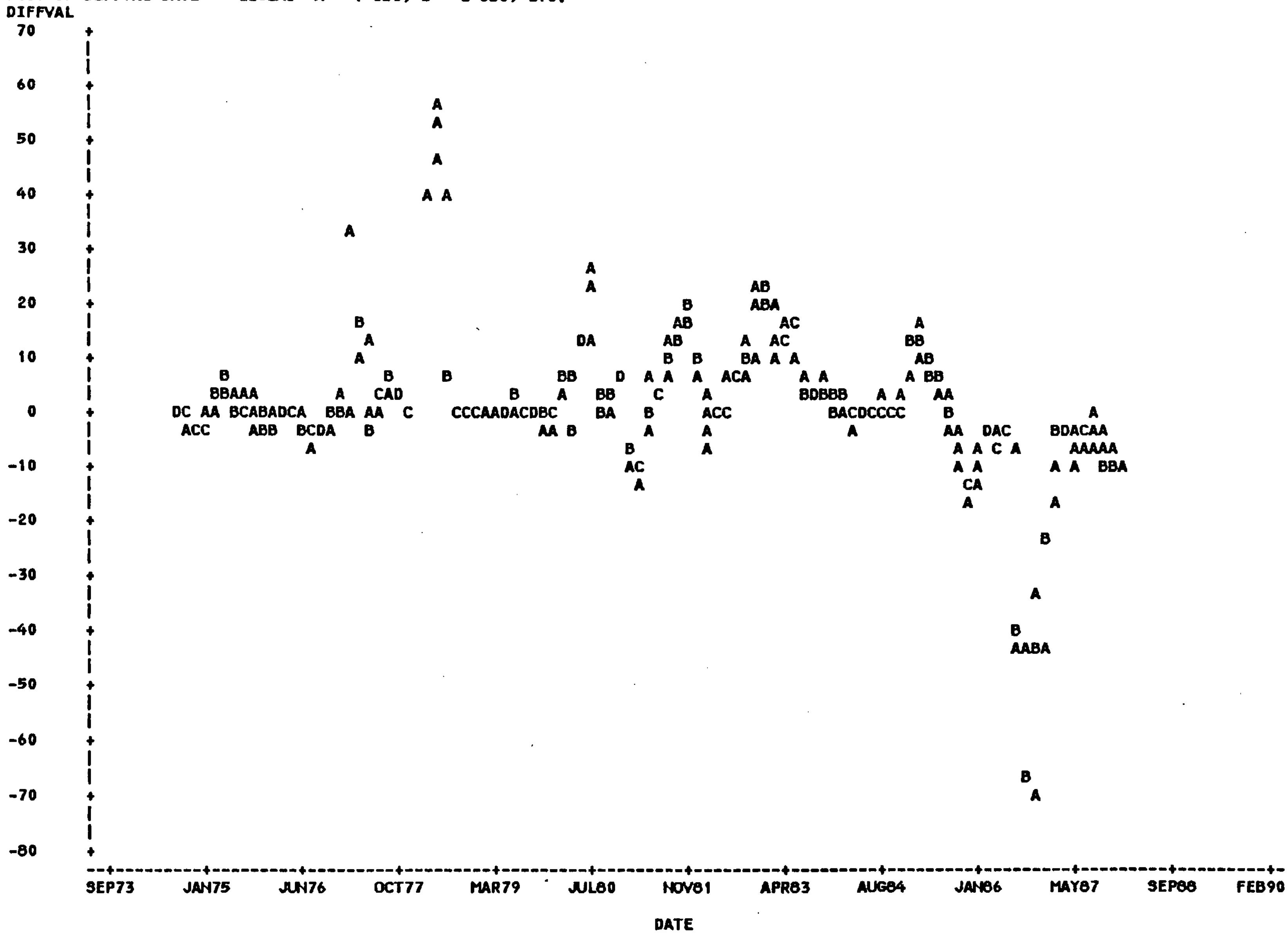
NOTE: 4 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-61. Specific Conductance

PARAM=Specific Conductance (u

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



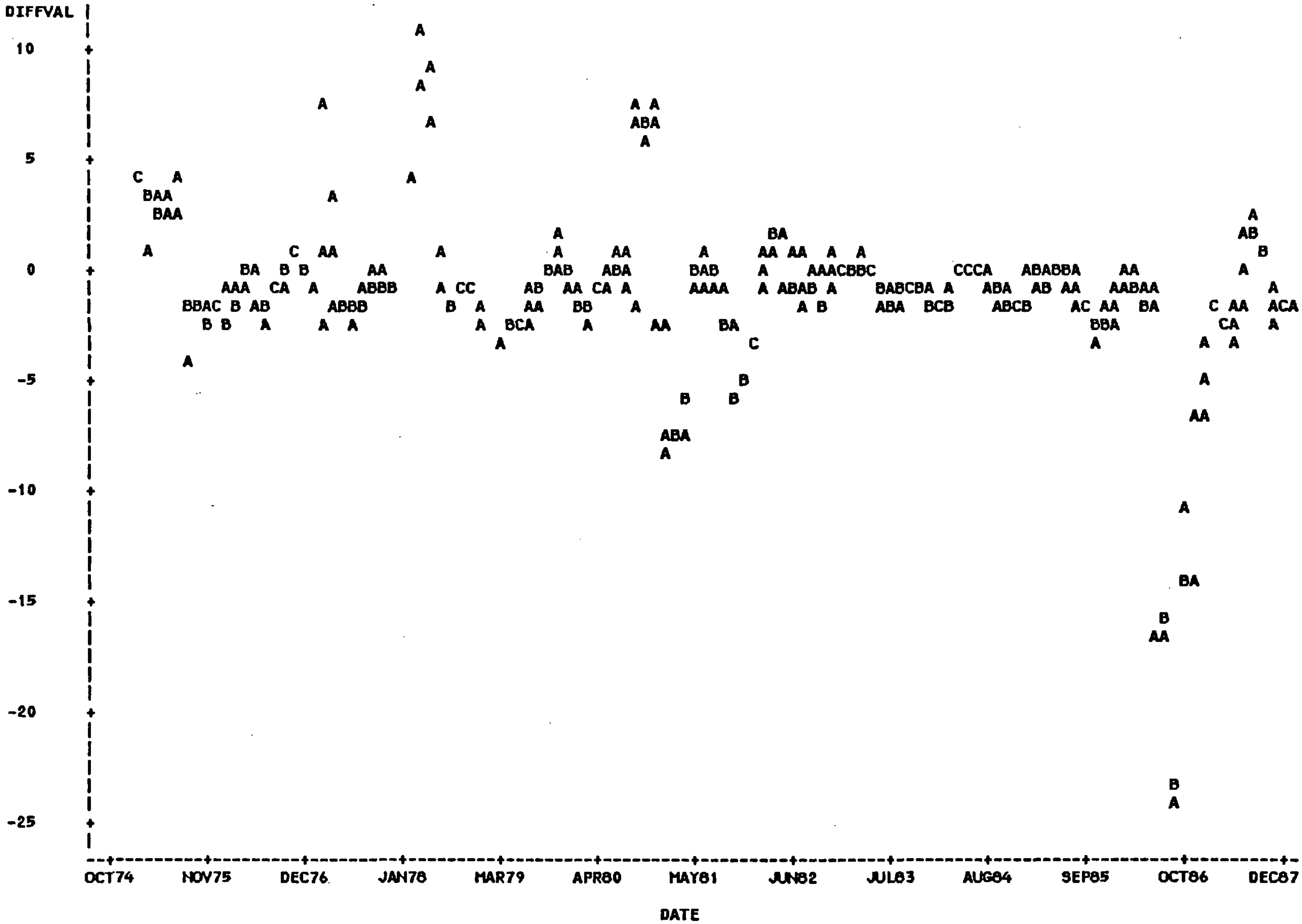
NOTE: 4 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 577660 AND 577140

Figure 6.1-62. Sulfate

PARAM=Sulfate (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



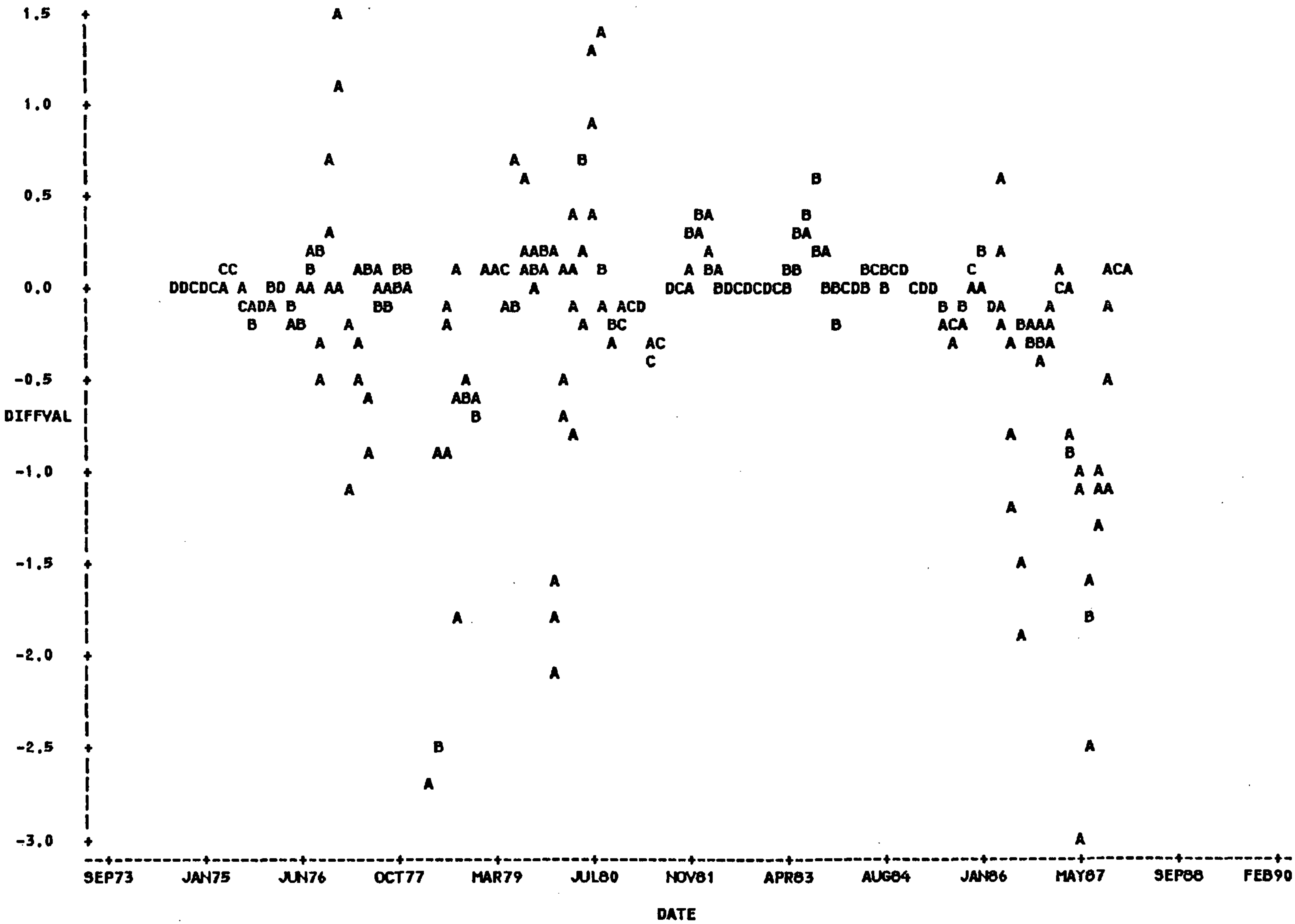
NOTE: 5 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-63. Temperature

PARAM=Temperature (C)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



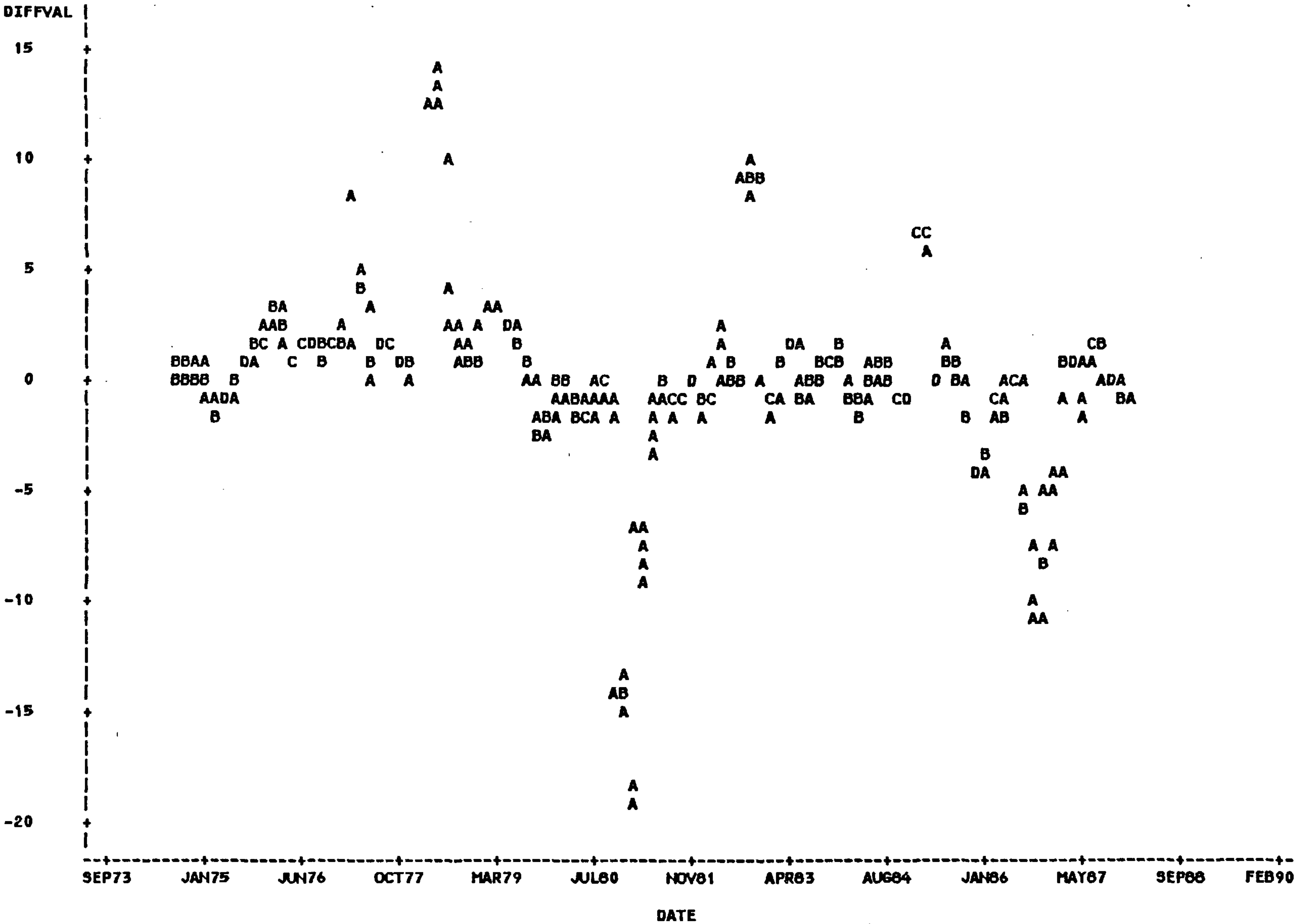
NOTE: 4 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-64. Total Alkalinity

PARAM=Total Alkalinity (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



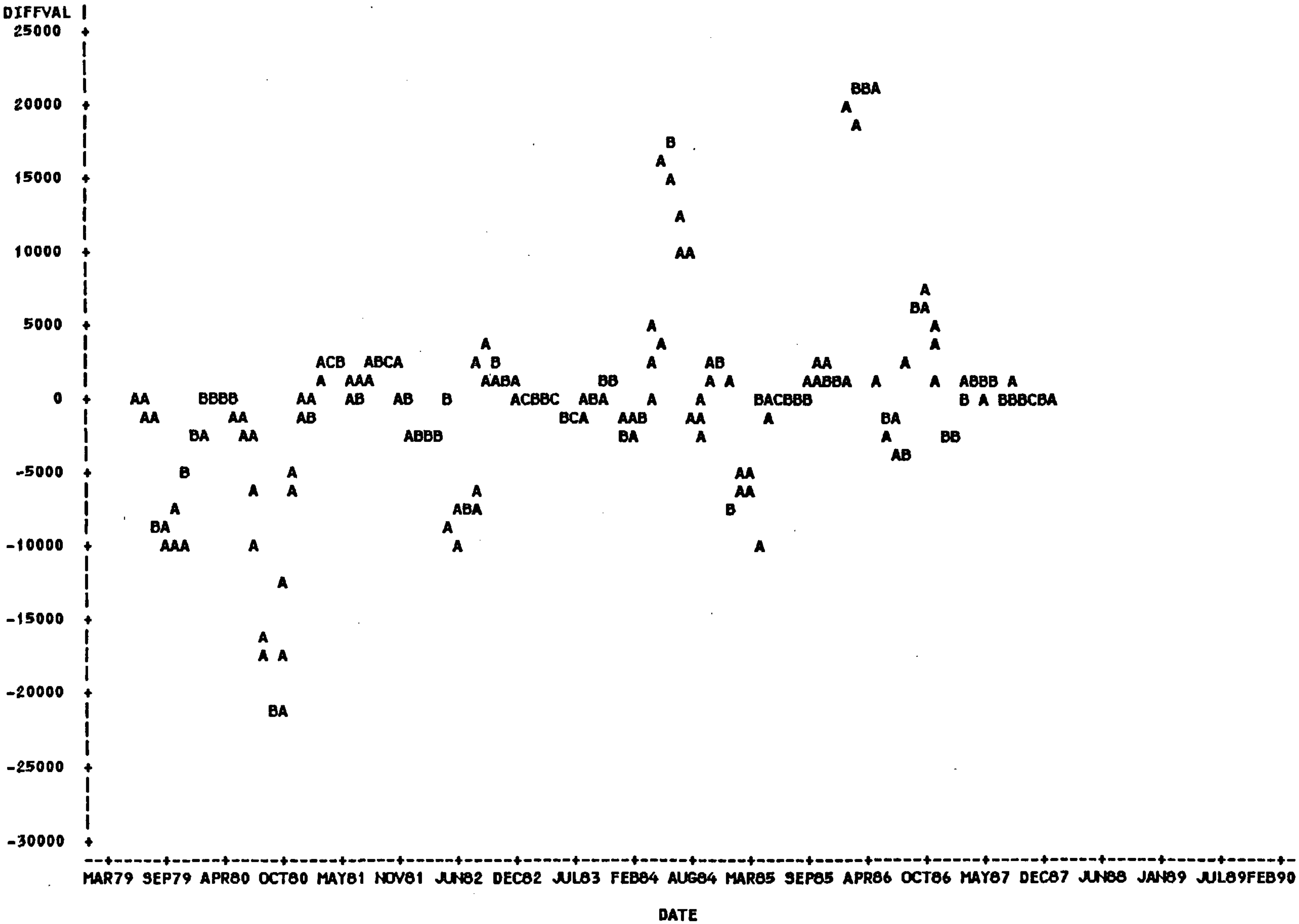
NOTE: 4 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-65. Total Coliforms

PARAM=Total Coliforms (MF) (c

PLOT OF DIFFVAL*DATE LEGEND: A = 1 OBS, B = 2 OBS, ETC.



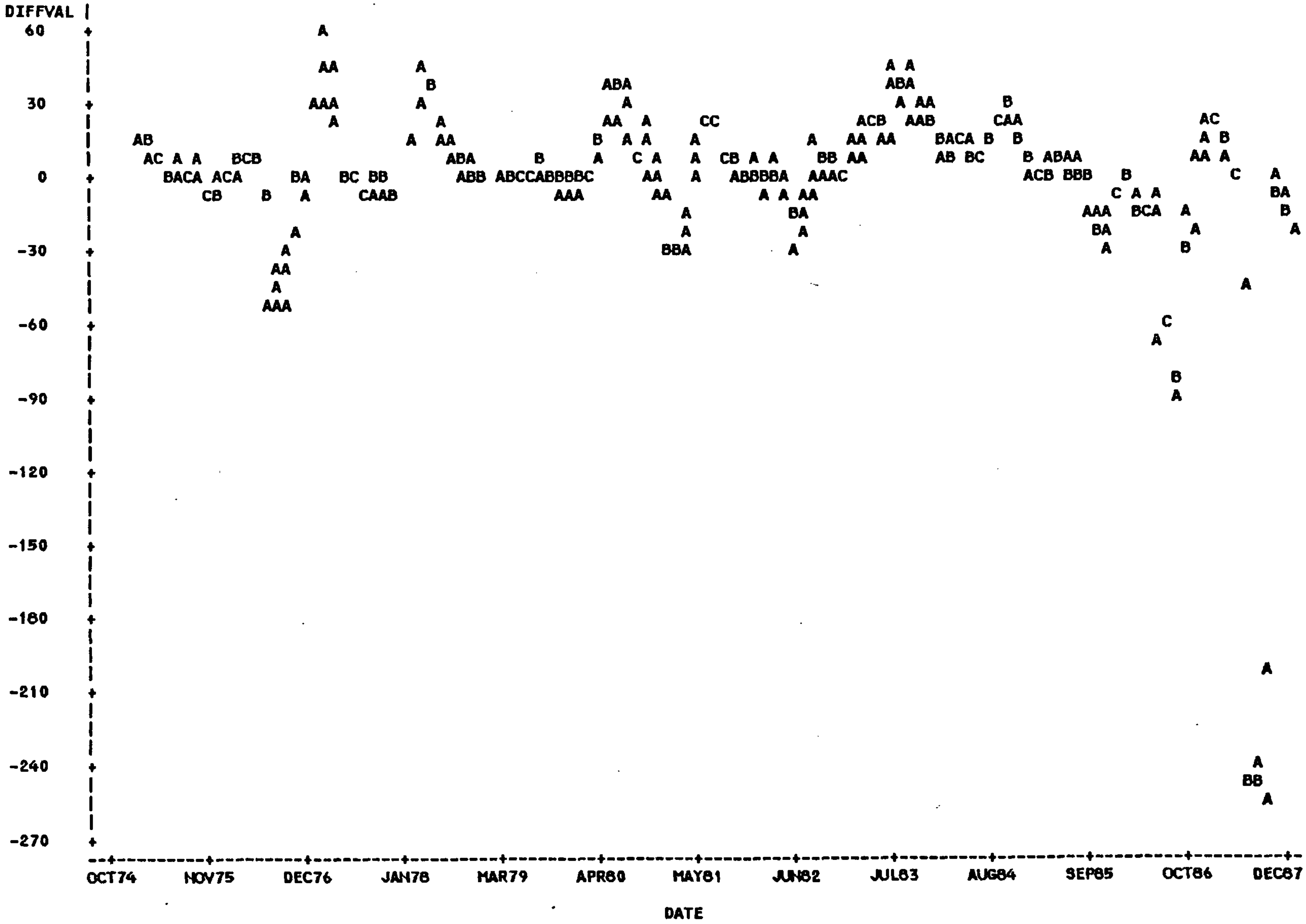
NOTE: 3 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 977660 AND 977140

Figure 6.1-66. Total Dissolved Solids

PARAM=Total Dissolved Solids

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



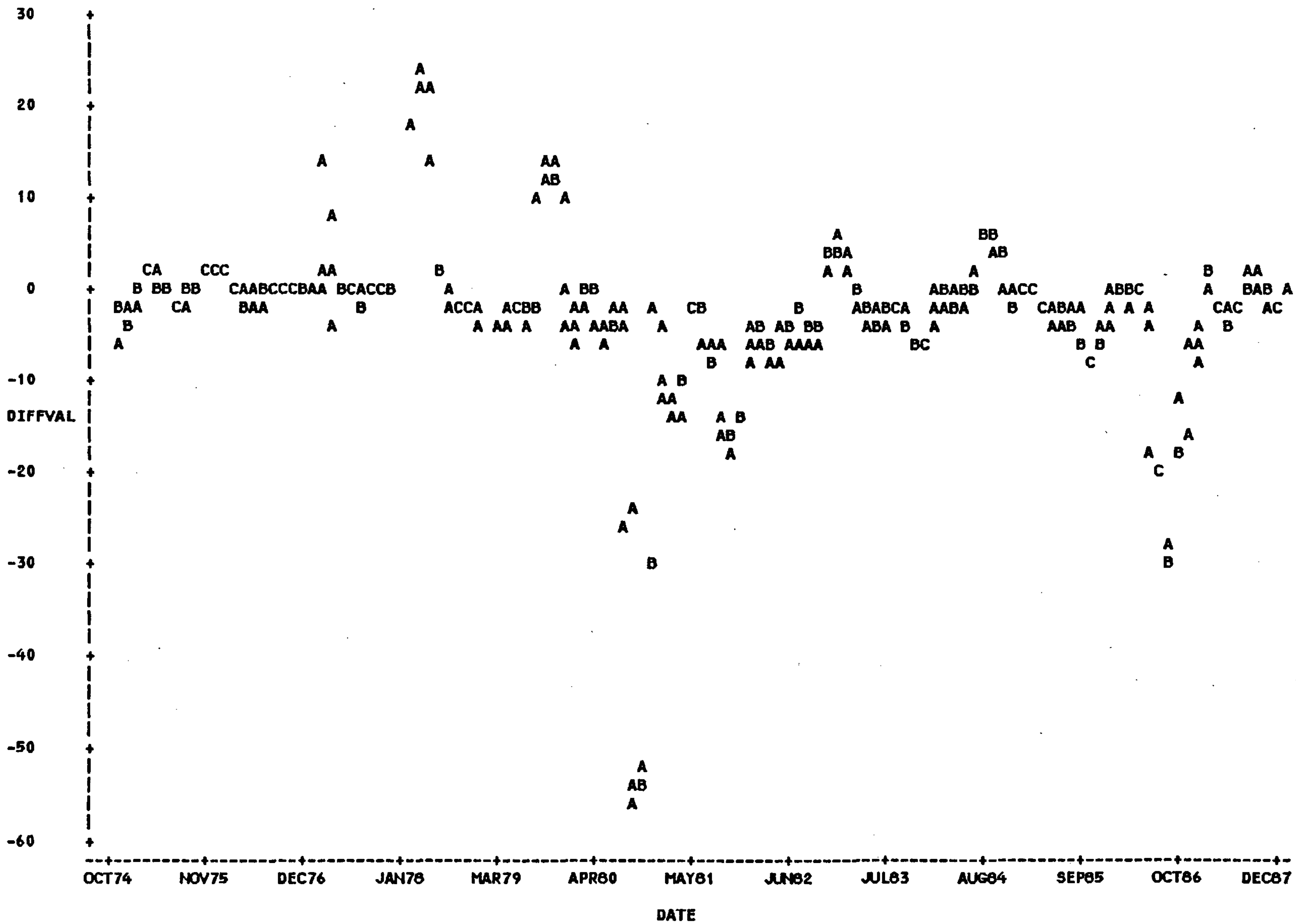
NOTE: 5 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-67. Total Hardness

PARAM=Total Hardness (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



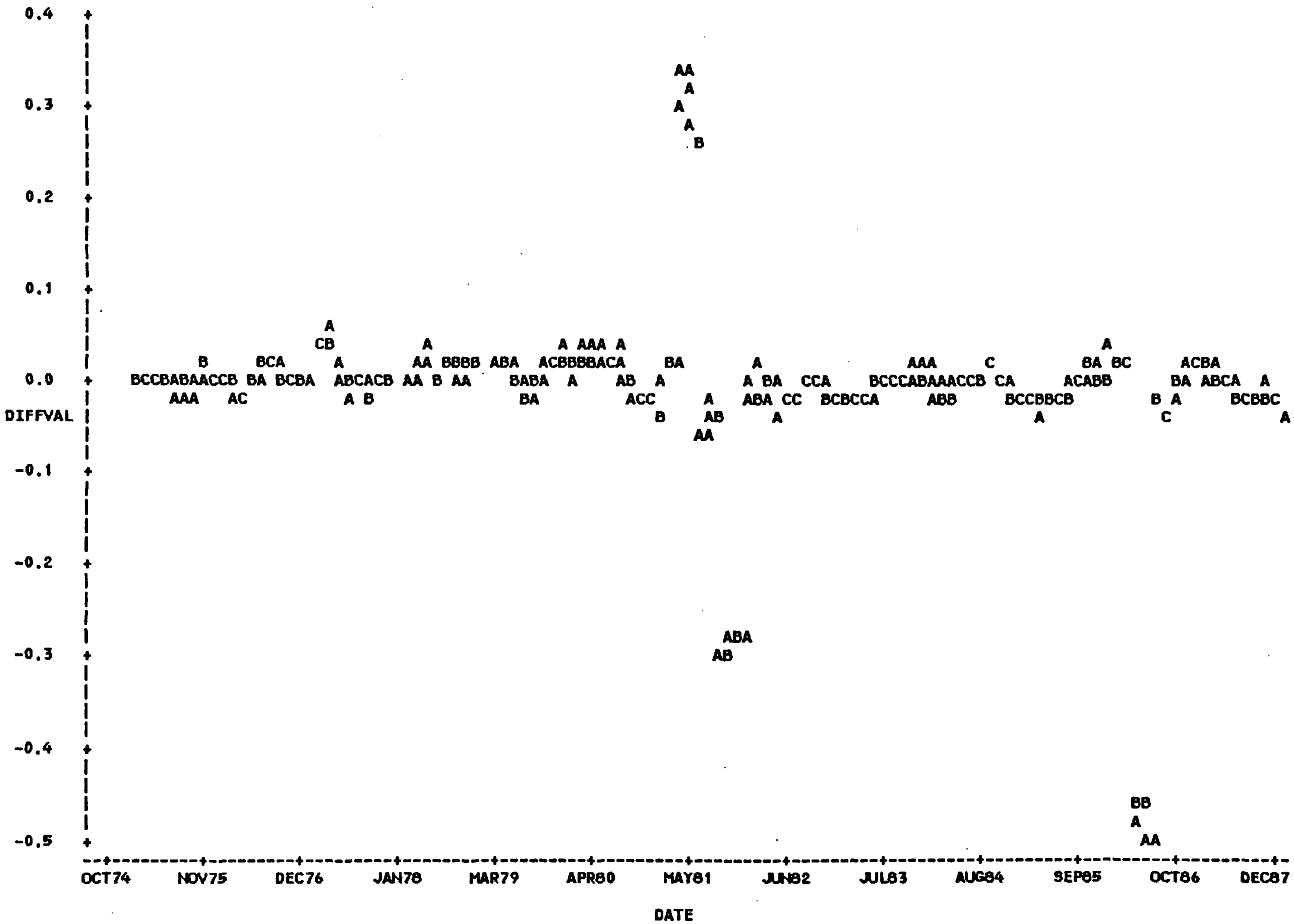
NOTE: 4 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-69. Total Phosphate Phosphorus

PARAM=Total Phosphate Phospho

PLOT OF DIFFVAL*DATE LEGEND: A = 1 OBS, B = 2 OBS, ETC.



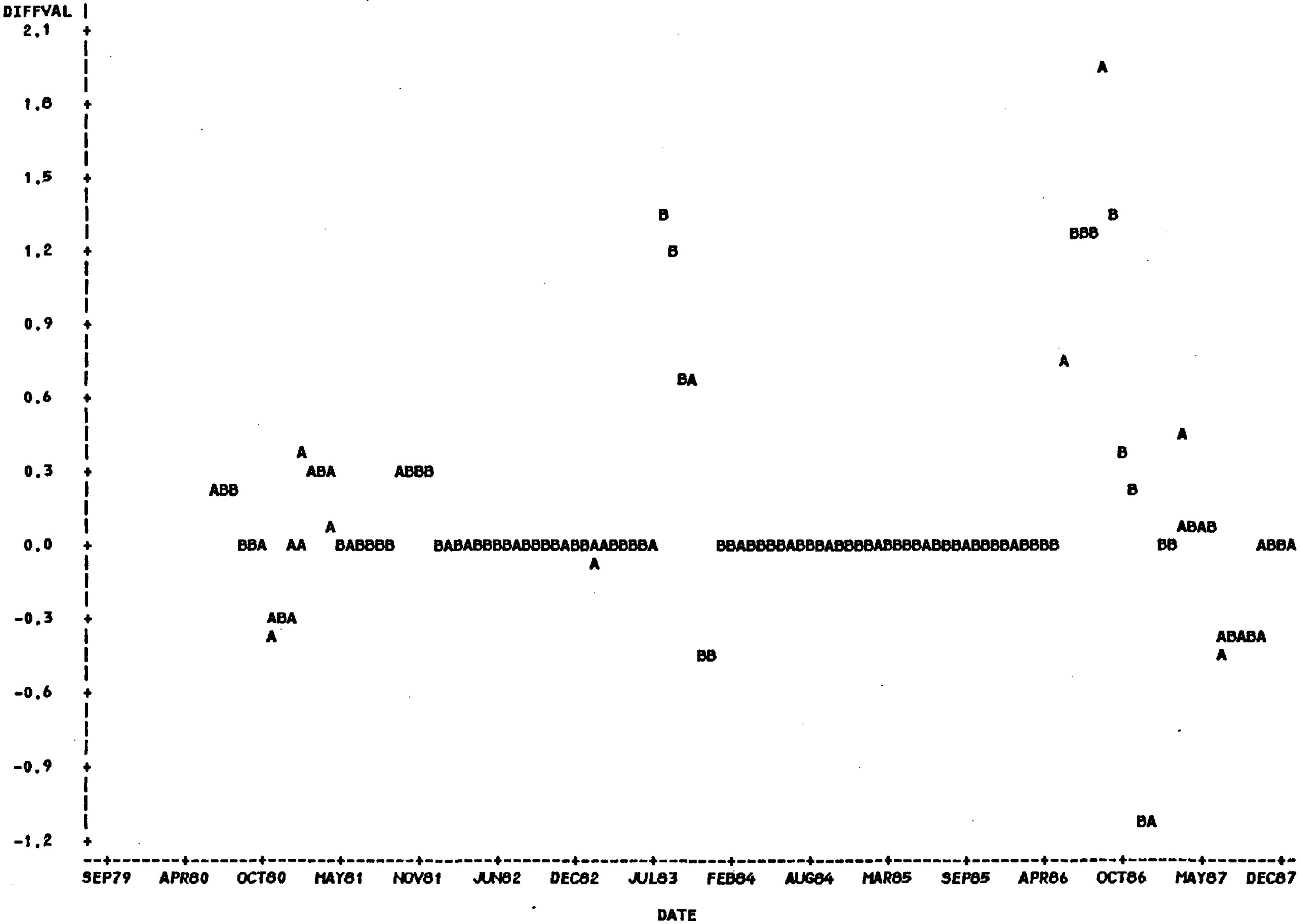
NOTE: 5 OBS HAD MISSING VALUES

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS 377660 AND 377140

Figure 6.1-70. Trichloroethylene

PARAM=Trichloroethylene (ug/l

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



6.2 Benthic Macroinvertebrates

Introduction

Benthic macroinvertebrates are aquatic animals without backbones that live part or all of their lives on or within the substrate and which are large enough to be retained by a 0.595 mm mesh screen. Benthic macroinvertebrates include not only such insect groups as the mayflies, stoneflies, and caddisflies which are familiar to fishermen, but worms, crustaceans, snails, and clams as well. These species are important as fish food and, when considered as a community of species, for their value as a descriptor of water and physical habitat quality.

It is for the latter reason in particular that the benthic macroinvertebrate community in the Schuylkill River in the vicinity of LGS was studied. Electric generating stations can affect benthic macroinvertebrate communities through reduced river flow due to water withdrawal for cooling purposes or by thermal enrichment or water quality changes due to cooling water discharge.

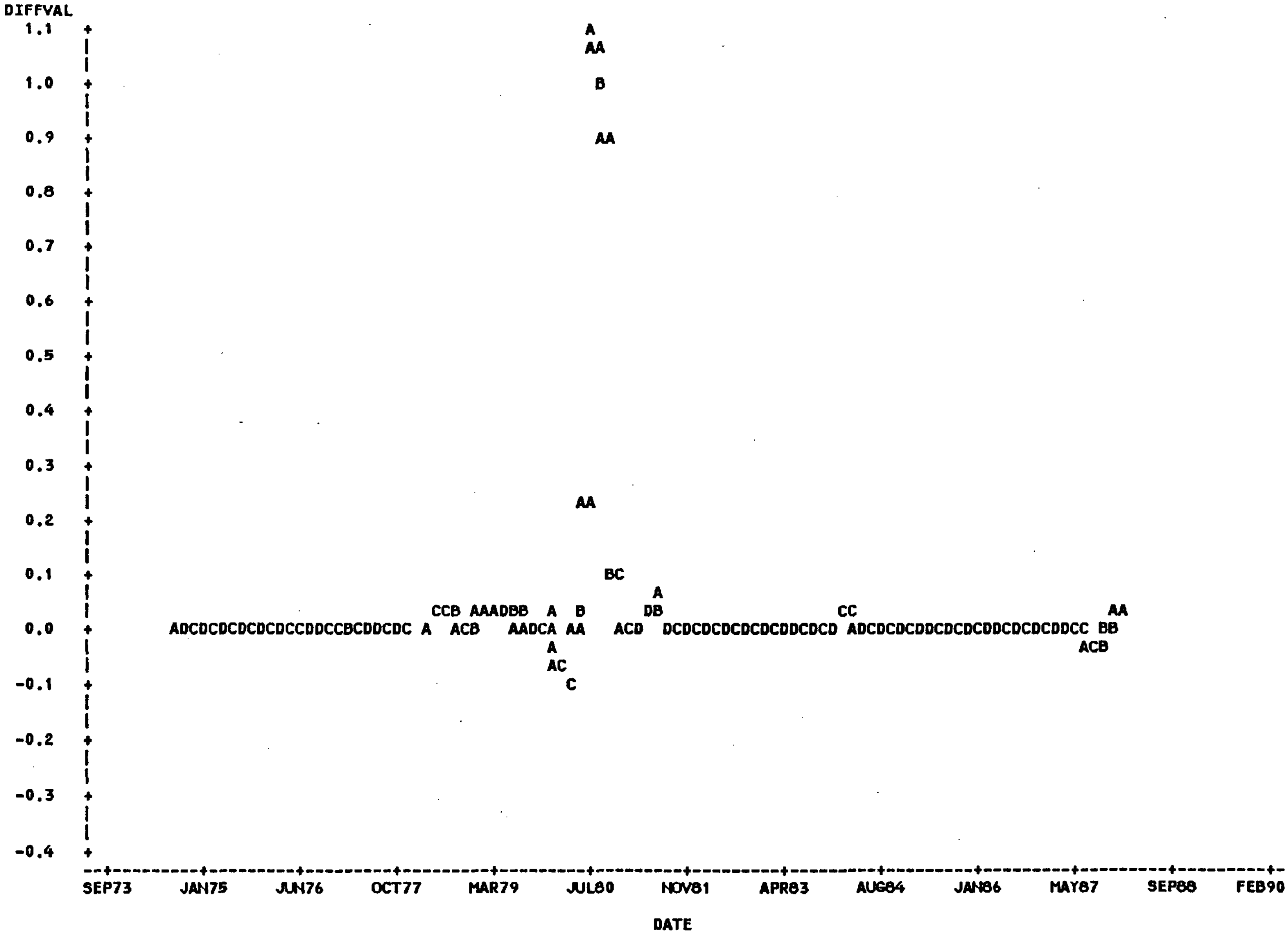
The objective of the macroinvertebrate study was to determine if LGS operation affected the community in the Schuylkill River downstream of plant discharge. To this end, macroinvertebrate samples were collected at locations upstream and downstream of the plant before and after operation. In this fashion, a database was assembled that allowed description of LGS preoperational variation in the ma-

SCHUYLKILL RIVER WATER QUALITY BIWEEKLY DATA ANALYSIS PLAN
3 MO./ 6 SAMPLES
FOR 1974 - 1987 AT STATIONS S77660 AND S77140

Figure 6.1-71. Zinc

PARAM=Zinc (mg/l)

PLOT OF DIFFVAL*DATE   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 4 OBS HAD MISSING VALUES

croinvertebrate community for comparison with variation observed during plant operation.

Studies of the macroinvertebrate community in the Schuylkill River near LGS were conducted in 1970-1976 and were resumed in October 1983 through 1987. Data obtained during the earlier period were reported in the EROL and those obtained in 1983-1986 were reported in subsequent progress reports (RMC Environmental Services 1984, 1985, 1986, and 1987a). Data obtained in 1987 are reported in the first part of this report section, which is then followed by an evaluation of the long term database for the purpose of assessing impacts to benthic macroinvertebrates from LGS operation.

Methods

Four sample stations were located in the Schuylkill River in the vicinity of LGS: S78620 located 1.3 km upstream, and S77120, S76760, and S75770 located 0.2, 0.6, and 1.6 km downstream, respectively (Fig. 6.2-1). Three replicate samples were collected quarterly (in 1987 - 7 January, 23 April, 16 July, and 2 October) at each station using Buried Cylinder Samplers (BCS).

The BCS is a colonization sampler consisting of 5-10 cm diameter cobbles (similar to the dominant Schuylkill River substrate) contained in a perforated steel basket. Each BCS was placed into the riverbed for approximately 90 days prior to retrieval, during which time macroinvertebrates present in the adjacent river bottom were allowed to colonize the enclosed substrate materials. This method of sample collection is similar to that described by Coleman and Hynes (1970).

After retrieval, the BCS were transported to the laboratory and all cobbles were washed and removed from other substrate materials, which were then washed through a 0.35-mm mesh sieve. All sample residue retained by the sieve (substrate and macroinvertebrates) was preserved with 70% isopropanol prior to laboratory processing.

Macroinvertebrates were sorted from sample residue in white enamelled pans without biological stain or magnification. Using a dissection microscope, all macroinvertebrates were identified to the lowest taxon practicable, usually genus.

Macroinvertebrate data were reduced to particular parameters to facilitate analysis and discussion. These parameters included the total number of taxa collected, the identity of all taxa, the standing crop (number of individuals/m^2) of all taxa combined, the identity and standing crop of all taxa that individually represented $\geq$ 2% of all macroinvertebrates collected (numerically important taxa), and the percent composition represented by important taxa. In analysis of 1987 results, these parameters were evaluated by grouping the data on an annual basis, whereas in comparing data collected during LGS preoperational and postoperational time periods, they were evaluated using the data on a seasonal (per sample date) as well as on an annual basis.

Summary of 1987 Sampling Results

The macroinvertebrate samples collected at each station were similar in terms of total number of taxa collected and identity of individual taxa (Table 6.2-1). Of a total of 80 taxa that were identified, 33 taxa were collected at three or more stations.

Annual mean standing crop was similar at S75770, S76760, and S77120 and approximately one-third to one-half that measured upstream at S78620 (Table 6.2-2). Substantial seasonal variation was observed.

Although a large number of taxa was collected, only a few were sufficiently abundant to be considered numerically important (Table 6.2-3). From 4-9 taxa were important at individual stations. Worms (Oligochaeta) and midges (Chironomidae) cumulatively represented the majority of the macroinvertebrates collected at all stations. Midges were dominant at S78620 and worms were dominant at the three downstream stations. The fingernail clam Musculium also was collected in large numbers upstream of LGS at S78620 and was the only other taxon to represent more than 10% of the community at any station.

High standing crops of all taxa combined as well as particular taxa distinguished the community observed at S78620 from those at the downstream stations. Faster current velocity measured at the former station as compared to the downstream stations ($\geq$ 1.3 ft/sec faster on all sample dates) encouraged the establishment of large populations of net-spinning caddisflies (Cheumatopsyche and Hydropsyche), riffle beetles (Stenelmis), and fingernail clams which prefer such conditions. Conversely, the worms that thrive in silt and fine sand substrate were present in larger numbers at the downstream stations where these sediments accumulate.

Over the past several years, sedimentation has increased at S76760 and S77120 located immediately downstream of the mouths of Brooke Evans Creek and Possum Hollow Run, respectively. Sediment load in these streams appeared to be elevated due to increased development in their watersheds. The result has been deposition of fine sediment along the downstream Schuylkill River shoreline, including these sample stations. A sediment sampling program to evaluate differing rates of sedimentation at all of the macroinvertebrate sample stations was established in April. The results of measurements of mean weight (in grams) of fine particle sediment (diameter < 0.35 mm) collected in the BCS during the April, July, and October sample dates generally indicate that larger quantities of fine sediment are being deposited on the substrate surface at S76760 and S77120:

	S78620	S77120	S76760	S75770
April	537.3	1403.7	448.0	562.8
July	620.6	1610.4	1217.7	708.3
October	774.5	1057.1	1494.1	989.5

These fine particle sediment measurements are being continued in order to determine if increased sedimentation at these stations is a long term trend.

LGS Operational Impacts

EROL authors observed that "sedentary benthic macroinvertebrates downriver of the diffuser pipe would be in constant contact with LGS discharge" and predicted that with exception of a small area immediately downriver of the discharge, no measureable change in community structure or productivity is expected because of the small temperature difference. This report section will describe the results of analyses conducted to determine if a measureable impact was observed during three years of LGS postoperational macroinvertebrate study.

Although data collected throughout the period 1973-1976 and 1984-1987 are used, emphasis in this section is placed on analysis of the 1984-1987 findings since these data were the most recently collected. The collection dates used to compare preoperational and postoperational data are shown in Table 6.2-4. The year 1984 was the last full year before LGS became operational. The year 1985 was considered a postoperational period during which LGS operated in a systems testing mode gradually increasing toward full power operation following receipt of its full power license from the Nuclear Regulatory Commission on 8 August.

Evaluation of LGS operational impacts on the macroinvertebrate community was conducted by examining the data on both a seasonal (per sample date) and annual (mean of 4 sample dates) basis. Since the results of both seasonal and annual data evaluation are essentially the same, the seasonal evaluation is omitted from further discussion.

The total number of taxa collected at all stations generally increased through the 1970's into the 1980's (Table 6.2-5). With exception of S76760, the total number of taxa collected at each station varied little during the period 1984-1987. Taxonomic composition also was relatively unchanged at all stations in the 1980's (Tables 6.2-6 to 6.2-9).

Macroinvertebrate standing crop measured at all stations increased greatly from the 1970's to the 1980's (Table 6.2-10). With exception of S75770, standing crop varied substantially year to year at each station during the period 1984-1987. Despite the substantial annual variation observed at S76760 and S77120, measurements made in 1987 were close to those made in 1984 at these stations.

Standing crop and percent composition of numerically important taxa ($\geq$ 2% of total number) indicated that midges (Chironomidae) and worms (Oligochaeta) were the dominant taxa or among the dominant taxa at all stations on most, if not all, sample dates (Tables 6.2-11 to 6.2-14). In addition, other taxa were important at individual or groups of stations on particular sample dates. The dominant taxa at individual stations were fairly consistent from year to year, particularly in the 1980's. However, it is interesting to note the 1970's increase and subsequent 1980's decline in standing crop and numerical importance of the river snail (Goniobasis).

The comparison of macroinvertebrate data collected during years of LGS operation (1985-1987) with those obtained earlier (1973-1976 and 1984) indicates little likelihood of any plant operational impact. The database accumulated over 8 years describes a riverine macroinvertebrate community that displays a fair degree of seasonal as well as annual variability that is superimposed on a framework of long term stability. This variability is observed upstream as well as downstream of LGS water intake and discharge. Furthermore, all fluctuations in community parameters that were observed during plant operation are within ranges established earlier.

Such variability is inherent in macroinvertebrate data and results from a number of causes. These include the problem of collecting samples of organisms that are patchy in their distribution on stream substrate in response to a number of hydraulic and other physical parameters. In addition, year-to-year fluctuation in water temperature often governs development and ultimately the life cycle of macroinvertebrates, thereby injecting additional variation into long term studies.

Increased sedimentation at S76760 and S77120 contributed to variation in the benthic macroinvertebrate community downstream of LGS during postoperational sampling. Lowered total density and an increased proportion of silt-tolerant organisms distinguished these stations from the control station upstream, which was not sedimented to a similar degree. Thus, control and affected stations were not ecologically similar with respect to an environmental condition capable of strongly influencing benthic macroinvertebrate colonization of the sampling device. Because of this unforeseen defect in the sample design, any real effects from blowdown discharge, if present, could not be distinguished from the apparent effects of sedimentation with which they were confounded. However, since postoperational community characteristics were within the range observed during preoperational sampling, any such real LGS effects on benthic macroinvertebrates were necessarily small and unimportant to the aquatic community of the Schuylkill River near LGS.

Table 6.2-1. Macroinvertebrate taxa collected in the Schuylkill River during 1987.

Taxon	S75770	S76760	S77120	S78620
Acroneuria				X
Alboglossiphonia	X	X	X	
Allocapnia	X	X	X	X
Allognosta		X		
Amphinemura				X
Anodonta			X	
Argia	X	X	X	X
Asellus		X	X	X
Baetis	X	X		X
Batracobdella	X		X	
Berosus	X	X	X	X
Caenis	X	X	X	X
Cecidomyiidae			X	
Ceraclea				X
Ceratopogonidae	X	X	X	X
Cheumatopsyche	X	X	X	X
Chimarra		X		X
Chironomidae	X	X	X	X
Corydalus	X			X
Crangonyx	X	X	X	X
Curculionidae		X	X	
Dromogomphus			X	
Dubiraphia	X	X	X	X
Dugesia			X	X
Empididae	X			X
Ephemerella	X		X	X
Ephydridae		X	X	
Erpobdella	X	X		X
Ferrissia	X	X	X	X
Gammarus	X	X	X	X
Gomphus	X		X	X
Goniobasis	X	X	X	X
Gyraulus	X			
Helisoma			X	X
Helobdella	X	X	X	X
Helophorus			X	
Hydropsyche	X	X	X	X
Hydroptila				X
Ischnura	X		X	
Isonychia				X
Lampyridae	X		X	
Lepidostoma				X
Leucotrichia	X			
Libellula			X	
Lymnaea		X	X	
Macromia			X	
Molophilus			X	
Musculium	X	X		X
Neureclipsis	X			
Nigronia			X	X
Oecetis	X	X		
Oligochaeta	X	X	X	X
Ophiogomphus	X	X	X	
Optioservus	X			X
Orconectes	X			X
Paraleptophlebia	X			
Parargyractis				X
Perlesta				X
Phasganophora	X			X
Physa	X	X	X	X
Pisidium	X	X	X	X
Potamanthus	X			
Prostoma		X	X	X
Protoptila	X			X
Psephenus	X		X	X
Sialis	X	X	X	X
Simuliidae	X	X		X
Sphaerium				X
Stenacron	X			X
Stenelmis	X	X	X	X
Stenonema				X
Stratiomyiidae		X	X	
Stratiomys			X	

Table 6.2-1. (continued)

Taxon	S75770	S76760	S77120	S78620
Stygobromus			X	
Tabanidae		X		
Tipula	X	X	X	X
Tipulidae		X		X
Tortricidae		X		
Triaenodes	X		X	X
Tricorythodes	X	X	X	X
Total Number of Taxa	47	39	48	53

Table 6.2-2. Total macroinvertebrate standing crop (mean number/m^2) measured in the Schuylkill River during 1987.

Date	S75770	S76760	S77120	S78620
Jan	21355.2	8863.4	15541.0	15344.3
Apr	13786.9	10633.9	25459.0	26737.7
Jul	13043.7	9076.5	2256.8	29606.6
Oct	7792.3	6633.9	8021.9	29322.4
Mean	13994.5	8801.9	12819.7	25252.7

Table 6.2-3. Macroinvertebrate standing crop (mean number/m^2) measured in the Schuylkill River during 1987.

Taxon	S75770 Density	% Comp	S76760 Density	% Comp	S77120 Density	% Comp	S78620 Density	% Comp
Acroneuria	-	-	-	-	-	-	2.7	+
Alboglossiphonia	2.7	+	1.4	+	2.7	+	-	-
Allocapnia	1.4	+	1.4	+	8.2	+	2.7	+
Allognosta	-	-	2.7	+	-	-	-	-
Amphinemura	-	-	-	-	-	-	2.7	+
Anodonta	-	-	-	-	1.4	+	-	-
Argia	30.1	0.2	27.3	0.3	8.2	+	285.5	1.1
Asellus	-	-	30.1	0.3	4.1	+	2.7	+
Baetis	4.1	+	1.4	+	-	-	8.2	+
Batracobdella	4.1	+	-	-	1.4	+	-	-
Berosus	6.8	+	5.5	+	38.3	0.3	24.6	+
Caenis	1.4	+	2.7	+	1.4	+	10.9	+
Cecidomyiidae	-	-	-	-	1.4	+	-	-
Ceraclea	-	-	-	-	-	-	5.5	+
Ceratopogonidae	6.8	+	10.9	0.1	32.8	0.3	5.5	+
Cheumatopsyche	80.6	0.6	16.4	0.2	13.7	0.1	975.4	3.9
Chimarra	-	-	1.4	+	-	-	4.1	+
Chironomidae	2892.1	20.7	1389.3	15.8	1561.5	12.2	10039.6	39.8
Corydalus	1.4	+	-	-	-	-	5.5	+
Crangonyx	140.7	1.0	457.7	5.2	136.6	1.1	235.0	0.9
Curculionidae	-	-	1.4	+	1.4	+	-	-
Dromogomphus	-	-	-	-	1.4	+	-	-
Dubiraphia	105.2	0.8	28.7	0.3	68.3	0.5	34.2	0.1
Dugesia	-	-	-	-	4.1	+	23.2	+
Empididae	5.5	+	-	-	-	-	16.4	+
Ephemerella	1.4	+	-	-	13.7	0.1	2.7	+
Ephydridae	-	-	5.5	+	1.4	+	-	-
Erpobdella	1.4	+	4.1	+	-	-	38.3	0.2
Ferrissia	204.9	1.5	110.7	1.3	312.8	2.4	1332.0	5.3
Gammarus	691.3	4.9	77.9	0.9	124.3	1.0	1.4	+
Gomphus	2.7	+	-	-	2.7	+	1.4	+
Goniobasis	704.9	5.0	222.7	2.5	606.6	4.7	491.8	1.9
Gyraulus	1.4	+	-	-	-	-	-	-
Helisoma	-	-	-	-	1.4	+	53.3	0.2
Helobdella	5.5	+	1.4	+	6.8	+	8.2	+
Helophorus	-	-	-	-	1.4	+	-	-
Hydropsyche	375.7	2.7	43.7	0.5	27.3	0.2	1347.0	5.3
Hydroptila	-	-	-	-	-	-	2.7	+
Ischnura	4.1	+	-	-	1.4	+	-	-
Isonychia	-	-	-	-	-	-	4.1	+
Lampyridae	1.4	+	-	-	1.4	+	-	-
Lepidostoma	-	-	-	-	-	-	1.4	+
Leucotrichia	2.7	+	-	-	-	-	-	-
Libellula	-	-	-	-	1.4	+	-	-
Lymnaea	-	-	2.7	+	1.4	+	-	-
Macromia	-	-	-	-	2.7	+	-	-
Molophilus	-	-	-	-	4.1	+	-	-
Musculium	20.5	0.1	9.6	0.1	-	-	3736.3	14.8
Neureclipsis	1.4	+	-	-	-	-	-	-
Nigronia	-	-	-	-	1.4	+	1.4	+
Oecetis	1.4	+	2.7	+	-	-	-	-
Oligochaeta	8079.2	57.7	6209.0	70.5	9700.8	75.7	2870.2	11.4
Ophiogomphus	2.7	+	1.4	+	1.4	+	-	-
Optioservus	5.5	+	-	-	-	-	112.0	0.4
Orconectes	1.4	+	-	-	-	-	1.4	+
Paraleptophlebia	1.4	+	-	-	-	-	-	-
Parargyractis	-	-	-	-	-	-	4.1	+
Perlesta	-	-	-	-	-	-	2.7	+
Phasganophora	2.7	+	-	-	-	-	5.5	+
Physa	105.2	0.8	2.7	+	9.6	+	345.6	1.4
Pisidium	97.0	0.7	27.3	0.3	2.7	+	516.4	2.0
Potamanthus	4.1	+	-	-	-	-	-	-
Prostoma	-	-	4.1	+	9.6	+	1.4	+
Protoptila	2.7	+	-	-	-	-	28.7	0.1
Psephenus	8.2	+	-	-	5.5	+	27.3	0.1
Sialis	61.5	0.4	24.6	0.3	9.6	+	86.1	0.3
Simuliidae	6.8	+	4.1	+	-	-	582.0	2.3
Sphaerium	-	-	-	-	-	-	5.5	+
Stenacron	30.1	0.2	-	-	-	-	41.0	0.2
Stenelmis	62.8	0.4	19.1	0.2	58.7	0.5	1853.8	7.3
Stenonema	-	-	-	-	-	-	4.1	+
Stratiomyiidae	-	-	2.7	+	2.7	+	-	-

Table 6.2-3. (continued)

Taxon	S75770 Density	% Comp	S76760 Density	% Comp	S77120 Density	% Comp	S78620 Density	% Comp
Stratiomys	-	-	-	-	1.4	+	-	-
Stygobromus	-	-	-	-	2.7	+	-	-
Tabanidae	-	-	8.2	+	-	-	-	-
Tipula	4.1	+	12.3	0.1	6.8	+	9.6	+
Tipulidae	-	-	2.7	+	-	-	1.4	+
Tortricidae	-	-	1.4	+	-	-	-	-
Triaenodes	1.4	+	-	-	2.7	+	2.7	+
Tricorythodes	214.5	1.5	23.2	0.3	6.8	+	45.1	0.2
*ALL TAXA	13994.5	N/A	8801.9	N/A	12819.7	N/A	25252.7	N/A

"+" - less than 0.1%

Table 6.2-4. Dates of sample collection in 1973-1976 and 1984-1987 that were used in preoperational and postoperational data comparison.

Station	Preoperational Period 1973	1974	1975	1976
S75770	17 Jan	17 Jan	--	--
	19 Apr	24 Apr	--	21 Apr
	15 Aug	13 Aug	--	22 Jul
	12 Oct	15 Oct	--	19 Oct
S76760	16 Jan	17 Jan	12 Feb	21 Jan
	19 Apr	25 Apr	16 Apr	21 Apr
	15 Aug	14 Aug	14 Aug	22 Jul
	10 Oct	--	28 Oct	19 Oct
S77120	--	--	11 Feb	21 Jan
	--	--	15 Apr	21 Apr
	--	13 Aug	14 Aug	22 Jul
	--	15 Oct	28 Oct	19 Oct
S78620	16 Jan	17 Jan	11 Feb	21 Jan
	19 Apr	24 Apr	15 Apr	21 Apr
	16 Aug	13 Aug	14 Aug	22 Jul
	10 Oct	15 Oct	28 Oct	19 Oct

Station	Preoperational Period 1984	Postoperational Period 1985	1986	1987
S75770	10 Jan	28 Jan	7 Jan	7 Jan
	27 Apr	16 Apr	2 Apr	23 Apr
	7 Aug	10 Jul	8 Jul	16 Jul
	17 Oct	8 Oct	9 Oct	2 Oct
S76760	10 Jan	28 Jan	7 Jan	7 Jan
	27 Apr	16 Apr	2 Apr	23 Apr
	7 Aug	10 Jul	8 Jul	16 Jul
	17 Oct	8 Oct	9 Oct	2 Oct
S77120	10 Jan	28 Jan	7 Jan	7 Jan
	27 Apr	16 Apr	2 Apr	23 Apr
	7 Aug	10 Jul	8 Jul	16 Jul
	17 Oct	8 Oct	9 Oct	2 Oct
S78620	10 Jan	29 Jan	7 Jan	7 Jan
	27 Apr	16 Apr	2 Apr	23 Apr
	7 Aug	10 Jul	8 Jul	16 Jul
	17 Oct	8 Oct	9 Oct	2 Oct

Table 6.2-5. Total macroinvertebrate taxa collected in the Schuylkill River during 1973 - 1976 (Selected sample dates only, see Table 6.2-4) and 1984 - 1987.

	Preoperational Period					Operational Period		
Station	1973	1974	1975	1976	1984	1985	1986	1987
S75770	21	45	-	32	50	48	52	47
S76760	39	40	45	44	54	55	53	39
S77120	-	23	45	52	53	55	45	48
S78620	35	38	38	49	51	58	56	53

No samples collected at S77120 in 1973 or S75770 in 1975.

Table 6.2-6. Macroinvertebrate taxa collected in the Schuylkill River at S75770 during 1973 - 1976 (Selected sample dates only, see Table 6.2-4) and 1984 - 1987.

	Preoperational Period					Operational Period		
Taxon	1973	1974	1975	1976	1984	1985	1986	1987
Agraylea		X						
Alboglossiphonia		X				X		X
Allocapnia	X	X			X	X	X	X
Ancyronyx						X		
Antocha					X			
Argia		X		X	X	X	X	X
Asellus				X	X	X	X	
Atherix					X			
Baetis							X	X
Batracobdella		X		X				X
Berosus		X		X	X	X	X	X
Caenis							X	X
Cambarus		X				X		
Ceratopogonidae					X	X	X	X
Cheumatopsyche	X	X		X	X	X	X	X
Chimarra		X				X	X	
Chironomidae	X	X		X	X	X	X	X
Corydalus		X					X	X
Crangonyx	X	X		X	X	X	X	X
Dolichopodidae	X							
Dubiraphia		X		X	X	X	X	X
Dugesia	X	X		X	X	X		
Elliptio					X	X	X	
Empididae	X	X		X	X	X	X	X
Ephemerella							X	X
Ephydridae	X						X	
Erpobdella	X	X		X	X	X	X	X
Ferrissia	X	X		X	X	X	X	X
Gammarus		X				X	X	X
Gomphus								X
Goniobasis	X	X		X	X	X	X	X
Gyraulus					X	X	X	X
Helisoma	X	X			X	X	X	
Helobdella	X	X			X	X	X	X
Hydrolimax		X		X	X	X	X	
Hydroporus				X				
Hydropsyche		X		X	X	X	X	X
Hydroptila		X		X	X	X	X	
Ischnura				X	X	X	X	X
Lampsilis						X		
Lampyridae								X
Lanthus		X		X	X		X	
Leucotrichia								X
Lymnaea						X	X	
Metrobates							X	
Musculium					X	X	X	X
Mycetophilidae		X						
Neureclipsis								X
Oecetis				X	X	X	X	X
Oligochaeta	X	X		X	X	X	X	X
Ophiogomphus				X			X	X
Optioservus		X			X	X	X	X
Orconectes		X		X		X	X	X
Paraleptophlebia								X
Parargyractis					X		X	
Phasganophora					X			X
Physa	X	X		X	X	X	X	X
Pisidium	X	X		X	X	X	X	X
Placobdella					X			
Polycentropus		X						
Potamanthus					X		X	X
Prostoma	X	X		X	X	X	X	
Protoptila					X	X	X	X
Psephenus		X			X	X	X	X
Pseudolimnophila		X						
Psychoda		X			X			

Table 6.2-6. (continued)

Taxon	Preoperational Period					Operational Period		
	1973	1974	1975	1976	1984	1985	1986	1987
Sialis				X	X	X	X	X
Simuliidae				X	X	X	X	X
Sphaerium	X	X		X	X	X		
Stenacron					X	X	X	X
Stenelmis	X	X		X	X	X	X	X
Stenonema		X		X	X	X	X	
Stratiomyiidae		X			X			
Stygobromus	X	X						
Tabanidae		X						
Telmatoscopus		X			X			
Tipula	X	X			X	X	X	X
Triaenodes					X	X	X	X
Tricorythodes		X		X	X	X	X	X
Total Number of Taxa	21	45		32	50	48	52	47

Table 6.2-7. Macroinvertebrate taxa collected in the Schuylkill River at S76760 during 1973 - 1976 (Selected sample dates only, see Table 6.2-4) and 1984 - 1987.

Taxon	Preoperational Period					Operational Period		
	1973	1974	1975	1976	1984	1985	1986	1987
Actinobdella	X							
Alboglossiphonia						X	X	X
Allocapnia				X			X	X
Allognosta								X
Ameletus							X	
Anax						X		
Antocha			X					
Argia	X	X	X	X	X	X	X	X
Asellus		X	X	X	X	X	X	X
Baetis				X	X	X	X	X
Batracobdella			X	X				
Belostoma				X				
Berosus	X	X	X	X	X	X	X	X
Caenis			X				X	X
Calopteryx							X	
Cambarus				X				
Campeloma						X		
Ceraclea					X			
Ceratopogonidae	X	X	X	X	X	X	X	X
Cheumatopsyche	X	X	X	X	X	X	X	X
Chimarra	X	X	X		X	X		X
Chironomidae	X	X	X	X	X	X	X	X
Corydalus					X			
Crangonyx	X	X	X	X	X	X	X	X
Curculionidae								X
Dolichopodidae	X	X					X	
Dromogomphus					X	X	X	
Dubiraphia	X	X	X	X	X	X	X	X
Dugesia		X	X	X	X	X		
Ectopria					X	X		
Empididae	X	X	X		X	X	X	
Ephemera		X	X					
Ephemerella				X			X	
Ephydridae								X
Erpobdella	X	X	X	X	X	X	X	X
Ferrissia	X	X	X	X	X	X	X	X
Gammarus		X				X	X	X
Gomphus							X	
Goniobasis	X	X	X	X	X	X	X	X
Gyraulus	X				X	X		
Helichus			X					
Helisoma	X	X	X	X		X		
Helobdella	X	X	X	X	X	X	X	X
Hydrolimax				X	X	X	X	
Hydrophilidae					X			
Hydroporus			X	X				
Hydropsyche	X	X	X	X	X	X	X	X
Hydroptila	X	X	X		X		X	
Ischnura	X		X	X	X	X	X	
Isonychia						X		
Lampsilis					X			
Lanthus		X	X		X	X	X	
Lepidostoma					X			
Leucotrichia							X	
Libellulidae							X	
Limnophila			X			X		
Lymnaea				X		X		X
Macromia	X							
Manayunkia						X		
Menetus	X							
Musculium					X	X	X	X
Mystacides					X		X	
Nectopsyche					X			
Nemotelus							X	
Neureclipsis				X			X	
Nigronia							X	

Table 6.2-7. (continued)

Taxon	Preoperational Period					Operational Period		
	1973	1974	1975	1976	1984	1985	1986	1987
Oecetis	X			X	X	X		X
Oligochaeta	X	X	X	X	X	X	X	X
Ophiogomphus					X			X
Optioservus	X	X	X	X	X	X	X	
Orconectes		X	X	X	X	X	X	
Ormosia		X						
Paraleptophlebia				X			X	
Parargyractis					X	X		
Peltodytes		X						
Phasganophora					X	X		
Phoridae					X			
Physa	X	X	X	X	X	X	X	X
Pisidium	X	X	X	X	X	X	X	X
Placobdella			X	X				
Potamanthus	X				X			
Prostoma	X		X	X	X	X	X	X
Protoptila					X	X		
Psephenus	X	X	X		X	X	X	
Pseudolimnophila	X							
Psychoda	X	X	X					
Psychomyia				X				
Ptilostomis						X		
Sialis		X	X	X	X	X	X	X
Simuliidae			X		X	X	X	X
Sphaerium	X	X	X	X				
Stenacron					X	X	X	
Stenelmis	X	X	X	X	X	X	X	X
Stenonema	X	X	X	X	X	X	X	
Stratiomyiidae			X			X	X	X
Stygobromus		X						
Stylurus				X				
Tabanidae	X	X	X		X	X		X
Taeniopteryx	X							
Telmatoscopus	X	X		X				
Tipula	X	X	X			X	X	X
Tipulidae								X
Tortricidae								X
Triaenodes				X	X	X	X	
Tricorythodes		X	X	X	X	X	X	X
Total Number of Taxa	39	40	45	44	54	55	53	39

Table 6.2-8. Macroinvertebrate taxa collected in the Schuylkill River at S77120 during 1973 - 1976 (Selected sample dates only, see Table 6.2-4) and 1984 - 1987.

Taxon	Preoperational Period					Operational Period		
	1973	1974	1975	1976	1984	1985	1986	1987
Acroneuria				X				
Alasmidonta			X					
Alboglossiphonia						X		X
Allocapnia				X	X		X	X
Ancyronyx						X		
Anodonta				X				X
Antocha				X				
Argia		X	X	X	X	X	X	X
Asellus			X		X	X	X	X
Baetis				X				
Batracobdella				X				X
Berosus		X	X	X	X	X	X	X
Caenis					X	X		X
Cambarus				X	X			
Cecidomyiidae								X
Ceraclea					X			
Ceratopogonidae			X	X	X	X	X	X
Cheumatopsyche		X	X	X	X	X	X	X
Chironomidae		X	X	X	X	X	X	X
Crangonyx		X	X	X	X	X	X	X
Curculionidae								X
Diplectrona					X			
Dolichopodidae			X				X	
Dromogomphus					X	X	X	X
Dubiraphia		X	X	X	X	X	X	X
Dugesia		X	X	X		X		X
Ectopria						X		
Elliptio					X	X		
Empididae					X	X	X	
Enallagma		X						
Ephemera			X	X				
Ephemerella			X	X			X	X
Ephydridae			X			X	X	X
Erpobdella		X	X	X	X	X	X	
Erythemis					X			
Ferrissia			X	X	X	X	X	X
Gammarus				X		X	X	X
Gomphus								X
Goniobasis		X	X	X	X	X	X	X
Gyraulus				X	X			
Helisoma		X	X			X	X	X
Helobdella		X	X	X	X	X	X	X
Helophorus								X
Hydrolimax		X	X	X	X	X	X	
Hydrophilidae					X			
Hydroporus							X	
Hydropsyche		X	X	X	X	X	X	X
Hydroptila			X	X		X	X	
Ischnura		X	X	X	X	X	X	X
Isonychia			X	X				
Lampyridae								X
Lanthus			X	X	X	X		
Lepidostoma						X		
Leucotrichia				X				
Libellula								X
Lymnaea					X	X		X
Macromia			X	X	X			X
Macronemum					X			
Macronychus						X		
Manayunkia						X		
Molophilus								X
Muscidae			X					
Musculium					X	X	X	
Neureclipsis				X	X			
Nigronia						X	X	X
Oecetis			X	X	X		X	

No samples collected in 1973.

Table 6.2-8. (continued)

Taxon	Preoperational Period					Operational Period		
	1973	1974	1975	1976	1984	1985	1986	1987
Oligochaeta		X	X	X	X	X	X	X
Ophiogomphus				X				X
Optioservus			X	X	X	X	X	
Orconectes		X	X	X	X	X	X	
Parargyractis					X			
Pericoma						X		
Phasganophora						X		
Phoridae					X			
Physa		X	X	X	X	X	X	X
Pisidium		X	X	X	X	X	X	X
Placobdella			X					
Polycentropus				X				
Prostoma			X	X	X	X	X	X
Protoptila					X	X		
Psephenus					X	X	X	X
Pseudolimnophila			X					
Psychoda			X					
Psychomyia				X				
Sialis			X	X	X	X	X	X
Simuliidae			X		X	X	X	
Sphaerium		X	X	X		X		
Stenacron						X	X	
Stenelmis		X		X	X	X	X	X
Stenonema		X	X	X	X			
Stratiomyiidae			X		X			X
Stratiomys							X	X
Stygobromus				X		X	X	X
Tabanidae					X			
Telmatoscopus			X	X	X	X	X	
Tetragoneuria						X		
Tipula			X	X	X	X	X	X
Triaenodes				X	X	X	X	X
Tricorythodes		X	X	X	X	X	X	X
Total Number of Taxa		23	45	52	53	55	45	48

No samples collected in 1973.

Table 6.2-9. Macroinvertebrate taxa collected in the Schuylkill River at S78620 during 1973 - 1976 (Selected sample dates only, see Table 6.2-4) and 1984 - 1987.

	Preoperational Period					Operational Period		
Taxon	1973	1974	1975	1976	1984	1985	1986	1987
Acroneuria	X	X		X	X	X	X	X
Actinobdella							X	
Alboglossiphonia						X	X	
Allocapnia	X			X		X		X
Ameletus		X						
Amphinemura							X	X
Ancyronyx						X	X	
Antocha		X						
Argia	X	X	X	X	X	X	X	X
Asellus			X		X	X	X	X
Baetis	X	X	X	X	X	X	X	X
Batracobdella				X				
Berosus	X	X	X	X	X	X	X	X
Caenis					X	X	X	X
Cambarus	X			X	X			
Ceraclea					X			X
Ceratopogonidae	X				X	X	X	X
Cheumatopsyche	X	X	X	X	X	X	X	X
Chimarra	X	X	X	X		X		X
Chironomidae	X	X	X	X	X	X	X	X
Corydalus					X	X	X	X
Crangonyx	X	X	X	X	X	X	X	X
Dineutus							X	
Dolichopodidae			X					
Dromogomphus						X		
Dubiraphia	X	X	X	X	X	X	X	X
Dugesia		X	X	X	X	X	X	X
Elliptio				X	X			
Empididae	X	X	X	X	X	X	X	X
Ephemerella	X	X		X			X	X
Ephydridae			X					
Erpobdella	X	X	X	X	X	X	X	X
Ferrissia	X	X	X	X	X	X	X	X
Gammarus						X	X	X
Gomphidae					X			
Gomphus				X				X
Goniobasis	X	X	X	X	X	X	X	X
Gyraulus					X	X	X	
Helisoma	X	X	X		X	X	X	X
Helobdella	X	X	X		X	X	X	X
Hydracarina	X							
Hydrolimax			X	X		X	X	
Hydroporus				X				
Hydropsyche	X	X	X	X	X	X	X	X
Hydroptila		X	X			X	X	X
Ischnura			X		X	X	X	
Isonychia				X	X	X	X	X
Isoperla	X							
Lanthus						X		
Lepidostoma						X		X
Leucotrichia				X	X		X	
Limonia	X							
Lymnaea						X	X	
Macronychus					X			
Manayunkia						X		
Muscidae				X				
Musculium					X	X	X	X
Neureclipsis		X	X	X				
Nigronia				X		X	X	X
Oecetis			X	X	X	X		
Oligochaeta	X	X	X	X	X	X	X	X
Ophiogomphus				X				
Optioservus	X	X	X	X	X	X	X	X
Orconectes		X		X	X	X	X	X
Parargyractis		X	X	X	X	X	X	X
Perlesta		X		X				X

Table 6.2-9. (continued)

	Preoperational Period					Operational Period		
Taxon	1973	1974	1975	1976	1984	1985	1986	1987
Phasganophora					X	X	X	X
Phoridae					X			
Physa	X	X	X	X	X	X	X	X
Piscicolaria		X						
Pisidium	X	X	X	X	X	X	X	X
Polycentropus	X					X	X	
Potamanthus					X			
Prostoma		X	X	X		X	X	X
Protoptila					X	X	X	X
Psephenus	X	X	X	X	X	X	X	X
Pseudocloeon				X				
Psychoda			X					
Rhyacophila				X				
Sialis	X		X	X	X	X	X	X
Simuliidae		X	X	X	X	X	X	X
Sphaerium	X	X	X	X	X			X
Stenacron					X	X	X	X
Stenelmis	X	X	X	X	X	X	X	X
Stenonema	X	X	X	X	X	X	X	X
Stygobromus				X				
Tabanidae							X	
Taeniopteryx				X				
Tipula	X	X			X	X	X	X
Tipulidae						X		X
Triaenodes					X	X	X	X
Tricorythodes		X	X	X	X	X	X	X
Total Number of Taxa	35	38	38	49	51	58	56	53

Table 6.2-10. Annual macroinvertebrate standing crop (mean number/m^2), all taxa combined, in the Schuylkill River during 1973 - 1976 (Selected sample dates only, see Table 6.2-4) and 1984 - 1987.

	Preoperational Period					Operational Period		
Station	1973	1974	1975	1976	1984	1985	1986	1987
S75770	2288.9	4970.3	-	6397.5	11207.7	12907.1	14694.0	13994.5
S76760	3250.0	5482.2	11107.6	5669.1	10225.4	14806.0	9101.1	8801.9
S77120	-	6448.8	7935.5	4200.8	12504.1	20623.0	6606.6	12819.7
S78620	6133.2	8633.2	13573.8	13607.6	35471.3	38754.1	29740.4	25252.7

No samples collected at S77120 in 1973 or at S75770 in 1975.

Table 6.2-11. Annual macroinvertebrate standing crop (mean number/m^2) and percent composition of important taxa at 375770 in the Schuylkill River during 1973 - 1976 (Selected sample dates only, see Table 6.2-4) and 1984 - 1987.

	Preoperational Period										Operational Period					
	1973		1974		1975		1976		1984		1985		1986		1987	
Taxon	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%
Cheumatopsyche	3.1	0.1	43.0	0.9	-	-	26.0	0.4	605.2	5.4	187.2	1.5	568.3	3.9	80.6	0.6
Chironomidae	557.4	24.4	647.5	13.0	-	-	1296.4	20.3	2439.9	21.8	3061.5	23.7	3718.6	25.3	2892.1	20.7
Crangonyx	9.2	0.4	23.6	0.5	-	-	359.3	5.6	610.7	5.4	2289.6	17.7	692.6	4.7	140.7	1.0
Ferrissia	80.9	3.5	19.5	0.4	-	-	1.4	0.0	247.3	2.2	110.7	0.9	262.3	1.8	204.9	1.5
Gammarus	-	-	5.1	0.1	-	-	-	-	-	-	1566.9	12.1	982.2	6.7	691.3	4.9
Goniobasis	778.7	34.0	2990.8	60.2	-	-	1338.8	20.9	1267.8	11.3	1056.0	8.2	758.2	5.2	704.9	5.0
Hydropsyche	-	-	1.0	0.0	-	-	16.4	0.3	213.1	1.9	168.0	1.3	527.3	3.6	375.7	2.7
Hydroptila	-	-	41.0	0.8	-	-	329.2	5.1	9.6	0.1	2.7	0.0	5.5	0.0	-	-
Oligochaeta	588.1	25.7	329.9	6.6	-	-	1702.2	26.6	4041.0	36.1	1224.0	9.5	5505.5	37.5	8079.2	57.7
Physa	142.4	6.2	235.7	4.7	-	-	53.3	0.8	157.1	1.4	1236.3	9.6	129.8	0.9	105.2	0.8
Pisidium	1.0	0.0	38.9	0.8	-	-	715.8	11.2	276.0	2.5	348.4	2.7	98.4	0.7	97.0	0.7
Sphaerium	32.8	1.4	376.0	7.6	-	-	248.6	3.9	4.1	0.0	24.6	0.2	-	-	-	-
Stenacron	-	-	-	-	-	-	-	-	184.4	1.6	263.7	2.0	117.5	0.8	30.1	0.2
Stenelmis	10.2	0.4	16.4	0.3	-	-	20.5	0.3	176.2	1.6	333.3	2.6	418.0	2.8	62.8	0.4
Tricorythodes	-	-	1.0	0.0	-	-	1.4	0.0	117.5	1.0	140.7	1.1	362.0	2.5	214.5	1.5

No samples collected in 1975.

Table 6.2-12. Annual macroinvertebrate standing crop (mean number/m^2) and percent composition of important taxa at S76760 in the Schuylkill River during 1973 - 1976 (Selected sample dates only, see Table 6.2-4) and 1984 - 1987.

	Preoperational Period										Operational Period					
	1973		1974		1975		1976		1984		1985		1986		1987	
Taxon	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%
Cheumatopsyche	2.0	0.1	17.8	0.3	178.3	1.6	55.3	1.0	467.2	4.6	140.7	1.0	113.4	1.2	16.4	0.2
Chironomidae	829.9	25.5	785.5	14.3	1812.5	16.3	1347.3	23.8	2520.5	24.6	3407.1	23.0	2192.6	24.1	1389.3	15.8
Crangonyx	53.3	1.6	26.0	0.5	197.7	1.8	277.7	4.9	345.6	3.4	3251.4	22.0	1105.2	12.1	457.7	5.2
Ferrissia	50.2	1.5	66.9	1.2	2.0	0.0	6.1	0.1	564.2	5.5	150.3	1.0	117.5	1.3	110.7	1.3
Gammarus	-	-	9.6	0.2	-	-	-	-	-	-	1945.4	13.1	326.5	3.6	77.9	0.9
Goniobasis	172.1	5.3	2881.1	52.6	5205.9	46.9	1627.0	28.7	2177.6	21.3	568.3	3.8	475.4	5.2	222.7	2.5
Hydropsyche	2.0	0.1	2.7	0.0	131.1	1.2	33.8	0.6	270.5	2.6	112.0	0.8	306.0	3.4	43.7	0.5
Oligochaeta	1915.0	58.9	864.8	15.8	2850.4	25.7	1904.7	33.6	2666.7	26.1	2881.1	19.5	3475.4	38.2	6209.0	70.5
Physa	59.4	1.8	453.6	8.3	31.8	0.3	20.5	0.4	77.9	0.8	189.9	1.3	5.5	0.1	2.7	0.0
Pisidium	8.2	0.3	15.0	0.3	376.0	3.4	114.8	2.0	151.6	1.5	513.7	3.5	17.8	0.2	27.3	0.3
Sphaerium	10.2	0.3	112.0	2.0	24.6	0.2	77.9	1.4	-	-	-	-	-	-	-	-
Stenacron	-	-	-	-	-	-	-	-	140.7	1.4	293.7	2.0	60.1	0.7	-	-
Tricorythodes	-	-	2.7	0.0	2.0	0.0	1.0	0.0	41.0	0.4	87.4	0.6	411.2	4.5	23.2	0.3

Table 6.2-13. Annual macroinvertebrate standing crop (mean number/m^2) and percent composition of important taxa at S77120 in the Schuylkill River during 1973 - 1976 (Selected sample dates only, see Table 6.2-4) and 1984 - 1987.

	Preoperational Period										Operational Period					
Taxon	1973 Mean	%	1974 Mean	%	1975 Mean	%	1976 Mean	%	1984 Mean	%	1985 Mean	%	1986 Mean	%	1987 Mean	%
Argia	-	-	381.1	5.9	14.3	0.2	115.8	2.8	118.9	1.0	38.3	0.2	8.2	0.1	8.2	0.1
Cheumatopsyche	-	-	186.5	2.9	76.8	1.0	43.0	1.0	340.2	2.7	80.6	0.4	58.7	0.9	13.7	0.1
Chironomidae	-	-	118.9	1.8	1749.0	22.0	880.1	21.0	1478.1	11.8	3711.7	18.0	1591.5	24.1	1561.5	12.2
Crangonyx	-	-	43.0	0.7	125.0	1.6	120.9	2.9	603.8	4.8	4374.3	21.2	434.4	6.6	136.6	1.1
Ferrissia	-	-	-	-	10.2	0.1	1.0	0.0	56.0	0.4	113.4	0.5	172.1	2.6	312.8	2.4
Gammarus	-	-	-	-	-	-	1.0	0.0	-	-	1336.1	6.5	131.1	2.0	124.3	1.0
Goniobasis	-	-	4711.1	73.1	3016.4	38.0	1547.1	36.8	3468.6	27.7	710.4	3.4	695.4	10.5	606.6	4.7
Oligochaeta	-	-	51.2	0.8	2600.4	32.8	1098.4	26.1	4786.9	38.3	7098.4	34.4	2676.2	40.5	9700.8	75.7
Physa	-	-	489.8	7.6	4.1	0.1	25.6	0.6	215.8	1.7	814.2	3.9	16.4	0.2	9.6	0.1
Pisidium	-	-	20.5	0.3	80.9	1.0	76.8	1.8	437.2	3.5	700.8	3.4	30.1	0.5	2.7	0.0
Sphaerium	-	-	334.0	5.2	33.8	0.4	57.4	1.4	-	-	1.4	0.0	-	-	-	-
Stenelmis	-	-	4.1	0.1	-	-	2.0	0.0	353.8	2.8	390.7	1.9	221.3	3.3	58.7	0.5

No samples collected in 1973.

Table 6.2-14. Annual macroinvertebrate standing crop (mean number/m^2) and percent composition of important taxa at S78620 in the Schuylkill River during 1973 - 1976 (Selected sample dates only, see Table 6.2-4) and 1984 - 1987.

	Preoperational Period										Operational Period					
	1973		1974		1975		1976		1984		1985		1986		1987	
Taxon	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%
Cheumatopsyche	156.8	2.6	2417.0	28.0	1223.4	9.0	3223.4	23.7	7187.2	20.3	3229.5	8.3	4319.7	14.5	975.4	3.9
Chironomidae	3862.7	63.0	2263.3	26.2	7326.8	54.0	5854.5	43.0	7049.2	19.9	14696.7	37.9	6896.2	23.2	10039.6	39.8
Crangonyx	84.0	1.4	23.6	0.3	155.7	1.1	105.5	0.8	1140.7	3.2	1687.2	4.4	1284.2	4.3	235.0	0.9
Ferrissia	87.1	1.4	105.5	1.2	23.6	0.2	223.4	1.6	1826.5	5.1	676.2	1.7	1625.7	5.5	1332.0	5.3
Goniobasis	6.1	0.1	1229.5	14.2	1837.1	13.5	2125.0	15.6	2680.3	7.6	603.8	1.6	554.6	1.9	491.8	1.9
Helisoma	349.4	5.7	1172.1	13.6	395.5	2.9	-	-	8.2	0.0	21.9	0.1	10.9	0.0	53.3	0.2
Hydropsyche	71.7	1.2	33.8	0.4	809.4	6.0	165.0	1.2	2221.3	6.3	647.5	1.7	2127.0	7.2	1347.0	5.3
Musculium	-	-	-	-	-	-	-	-	120.2	0.3	889.3	2.3	4592.9	15.4	3736.3	14.8
Oligochaeta	311.5	5.1	111.7	1.3	780.7	5.8	228.5	1.7	4334.7	12.2	2169.4	5.6	1733.6	5.8	2870.2	11.4
Physa	753.1	12.3	634.2	7.3	82.0	0.6	500.0	3.7	3158.5	8.9	2657.1	6.9	1019.1	3.4	345.6	1.4
Pisidium	108.6	1.8	19.5	0.2	238.7	1.8	548.2	4.0	512.3	1.4	1632.5	4.2	694.0	2.3	516.4	2.0
Simuliidae	-	-	3.1	0.0	1.0	0.0	10.2	0.1	2060.1	5.8	4557.4	11.8	316.9	1.1	582.0	2.3
Sphaerium	198.8	3.2	377.0	4.4	336.1	2.5	284.8	2.1	1.4	0.0	-	-	-	-	5.5	0.0
Stenacron	-	-	-	-	-	-	-	-	892.1	2.5	1032.8	2.7	176.2	0.6	41.0	0.2
Stenelmis	20.5	0.3	9.2	0.1	12.3	0.1	11.3	0.1	788.3	2.2	1987.7	5.1	3153.0	10.6	1853.8	7.3

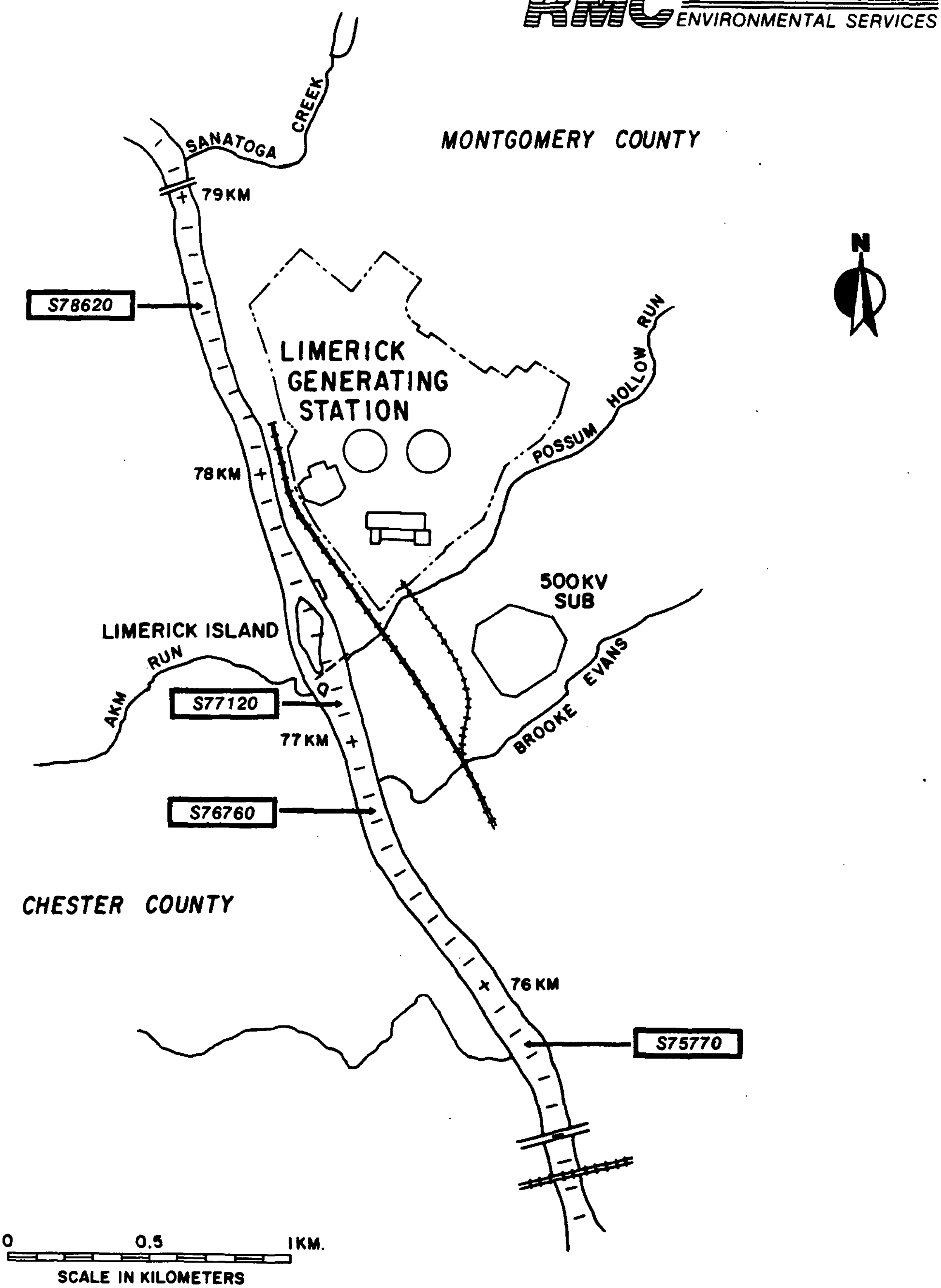


FIGURE 6.2-1 LOCATION OF TRANSECTS SAMPLED FOR BENTHIC MACROINVERTEBRATES IN THE SCHUYLKILL RIVER, 1987.

6.3 Fish

Introduction

Operation of an electrical generating station may impact fish populations through the effects of cooling water withdrawal and discharge. Juvenile and adult fish may be impinged on cooling water intake screens and fish eggs and larvae may be entrained within the cooling system, resulting in a level of mortality that did not exist before. Changes in water quality from effluent discharge may directly or indirectly impact fishes, particularly if thermal enrichment occurs.

Due to their ecological and sociological importance, fish were an aquatic ecosystem component selected for detailed study. The Schuylkill River fish community was investigated from 1970-1978 and from 1980-present. Included in these investigations were population surveys to determine species composition, abundance, and distribution of fishes near LGS; examination of life-history characteristics of important species; and periodic surveys of impingement, entrainment, and recreational fishing. The overall objective of these studies is to determine if LGS operation has an ecologically significant effect on the fish community near the power plant. To meet this objective, characteristics of the fish community present before LGS operation were compared to fish community characteristics in the postoperational period. Comparative techniques are study-specific and are explained later in this report section.

This report section is divided into six categories each of which addresses a different component of the fish monitoring program. In the order presented, these categories are entitled 1) Population Surveys, 2) Biology of Important Species, 3) Age and Growth of Redbreast Sunfish, 4) Impingement, 5) Creel Survey, and 6) Impact Evaluation. The first five categories summarize methods and results of 1987 monitoring studies, while the sixth section, Impact Evaluation, draws upon information contained in the long-term database developed in both the preoperational and postoperational (i.e., status) periods of the LGS project.

An important aspect of this study is the assessment of natural spatial and temporal variation in the ecological variables of interest. It is against this background of natural variation that any LGS-induced effects must be recognized. Where possible, a measure of control over postoperational observations was established to distinguish between natural or anthropogenic events that occur over a wide area from local effects that may be due to power plant operation.

Two features of the Schuylkill River fish community monitoring program were important in terms of meeting study objectives. One was the multi-year sampling effort in both status periods, which permitted natural year-to-year variation to be assessed within and compared between the two status levels. Natural variation is usually considered the best comparative measure of the significance of power plant effects (Green 1979, 1984). The second important feature was the use of an upstream reference station to account for area-wide changes in the fish community that were unrelated to power plant operation. This approach assumed that the reference (i.e., control) station was far enough away from the power plant to be unaffected by it, yet near enough to potentially affected stations that area-wide environmental influences were the same. Ideally, control and affected stations should be ecologically similar, the only difference between them being the presence or absence of power plant influence. The efficacy of this approach depends in part on how well these assumptions are met.

Population Surveys

Collection and Processing of Fishes

Fishes were collected using two methods, seining and electrofishing, that together sample most species from the types of habitat found in the LGS vicinity. Seine collections were scheduled at monthly intervals throughout the year (Table 6.3-1), while electrofishing samples were made primarily from April-October; sampling frequency early in the preoperational period varied more for electrofishing than for seining (Table 6.3-2). Conditions permitting, one station a short distance upstream and one station just downstream of the LGS discharge were electrofished in January-March and November-December of postoperational years to determine if fish were attracted to the power plant's slightly heated effluent. Collection and processing methods for each gear type are presented in more detail below.

Seining

Small fishes including minnows, darters, and the young of larger species were collected from six near-shore stations (Fig. 6.3-1) with a 3.2 mm-mesh, 2.4 mm x 1.2 m seine. Effort consisted of six uniform hauls along 30 m of shoreline at each station. Catches from individual hauls were pooled to form a composite sample from each station on each sample date. Specimens were identified and sorted into 5-mm length intervals in the laboratory, except for occasional large adult fish and sport fish young which were measured in the field and released. Since effort remained constant within and between stations, catch data were intrinsically standardized. Therefore, catch-per-unit-effort (CPUE) was equivalent to total catch.

Electrofishing

Fishes were collected from four stations (Fig. 6.3-2) with a 240-volt, pulsed DC electrofishing boat having fixed electrodes suspended from bow and side booms. Each station was sampled in a downstream direction at a speed slightly faster than the current within two opposing shoreline zones, two adjacent off-shore zones, and one midchannel zone. The amount of time spent fishing a zone was recorded to the nearest minute and used to express catch data as CPUE, computed for each sample as fish/hour.

Fish were identified, measured to the nearest mm FL, weighed to the nearest gram, and examined for overall appearance while noting the presence of disease, parasites, and physical abnormalities, broadly referred to as "disease". Fish smaller than 50 mm FL were excluded to avoid gear bias against small fish. Furthermore, with the exception of cyprinid species that grow to a large adult size, most minnows and darters were also excluded from electrofishing samples.

Summary of 1987 Data Analyses

Species composition and relative abundance of fishes in the Schuylkill River near LGS were estimated by both seining and electrofishing. Species composition was best represented by the species list generated from the combined catch of both gear types, since neither gear effectively sampled all species known to occur near LGS. Due to differences in gear selectivity, relative abundance was determined separately for both gear types as both percent of total fish captured and as CPUE. Catch data were compiled for individual stations and time periods to characterize variation in species relative abundance.

1987 Sampling Results

Species Composition

In 1987, 34 species and two hybrids from ten families were taken by one or both gear types (Table 6.3-3). Bowfin, a relict species rare to the Schuylkill River, was collected for the first time in many years. No new species for the study area was captured in 1987.

Several species and hybrids appearing in past Schuylkill River fish samples were not collected in 1987. However, these fishes are rarely encountered in the river near LGS. Many are introduced game or forage species (e.g., American shad, which were stocked but not collected in 1987; muskellunge and its hybrid with northern pike; walleye; trout; fathead minnow) or are more common in tributaries (redfin pickerel, longnose dace, margined madtom) or impoundments in the watershed (yellow perch).

Relative abundance: Seining

Seining yielded a total of 8,065 fish of 26 species in 1987. The three most abundant species in seine collections were spotfin shiner (53.9% of the 1987 catch), spottail shiner (14.6%), and redbreast sunfish (13.8%). All other species each contributed less than 5% to the total catch for the year.

Catch rate in 1987 rebounded from the historic low noted in 1986, due to successful reproduction by spotfin shiner and spottail shiner. Seine catches for 1987 by sampling station and by sample date are shown in Tables 6.3-4 and 6.3-5, respectively.

Relative abundance: Electrofishing

In 1987, a total of 6,842 fish of 24 species and 2 hybrids was collected in 40.58 hours of electrofishing (Table 6.3-6). Total CPUE, 168.6 fish/hour, was considerably less in 1987 than the total CPUE observed in 1986, 369.5 fish/hour. Decreased abundance of the exceptionally large 1985 year-class of goldfish and carp was largely responsible for the lower CPUE in 1987 compared to 1986.

The most abundant species electrofished were rock bass (19% of the total catch), goldfish (17.6%), redbreast sunfish (15.7%), yellow bullhead (8.8%), pumpkinseed (8.6%), smallmouth bass (7.5%), brown bullhead (7.3%), and white sucker (6.8%). Monthly catches at each electrofishing station are summarized in Table 6.3-7 through Table 6.3-10.

Differences between electrofishing stations were noted in the relative abundance of the more common species (Table 6.3-6). These differences appeared to be related to local habitat conditions at each station. For example, goldfish were 3 to 5 times more abundant (based on CPUE) at S77640 and S76940 (two stations adjacent to LGS) than at

S79310 (upstream of LGS) or S76440 (downstream of LGS). Carp, brown bullhead, pumpkinseed, and largemouth bass displayed similar spatial distributions, reflecting their preference for slower, weedier sections of the Schuylkill River. These species may concentrate around weedbeds, small eddies, and backwaters. Both S77640 and S76940 contained more of these habitat types than the other two stations.

In contrast, yellow bullheads, rock bass, redbreast sunfish, and smallmouth bass tended to be more numerous at either the upstream station (S79310) or both the upstream and downstream (S76440) stations. The upstream station, situated in a river bend, had faster current and a rockier substrate. Station S76440, although slower, also contained an area of exposed boulders where these species tended to congregate.

Based on electrofishing upstream and downstream of the LGS discharge during cold weather, fishes were not attracted to or concentrated in the discharge vicinity. Water temperatures at the time of sampling never differed by more than 1.5 C between ambient areas and the small area receiving LGS effluent discharge.

Biology of Important Species

Introduction

Several species were chosen for intensive study due to their importance to the Schuylkill River fish community (Table 6.3-11).

Spatial and temporal changes in relative abundance were used to assess species-habitat relationships and fluctuations in population density.

Variation in reproductive success plays an important role in the population dynamics of stream fishes. Time of spawning and relative year-class strength were two aspects of reproduction determined for important species. The date that young-of-year (YOY) first appeared in seine collections indexed the approximate onset of spawning. The catch of YOY fish in seine collections was used as an index of year-class strength. For faster growing species, determination of relative year-class formation was augmented later in the year by the electrofishing catch of Age-0 fish.

The incidence of disease was determined for the larger important species collected by electrofishing since disease incidence can reflect the degree of pollution and other stresses on a stream ecosystem (Sinderman 1979). Disease incidence was not assessed for the shorter-lived small species collected only by seine, or for American eels, which were not individually examined because they were difficult to handle.

Species Accounts

American eel

Only ten American eels were captured by electrofishing in 1987, compared to 21-54 eels taken per year between 1976 and 1986. The decline in American eel CPUE may indicate a reduction in population density in the Schuylkill River near LGS. However, the sensitivity of electrofishing CPUE to changes in the abundance of uncommon species is probably not great enough to attach much significance to this observation. In any case, reduced catches of American eels were noted both upstream and downstream of LGS. The spatial pattern of distribution in 1987 remained consistent with past observations. More eels were taken from the farthest upstream and downstream stations than from the two stations adjacent to LGS. Stations where eels were more abundant contained greater amounts of rubble and boulder habitat which this important species appears to prefer.

American shad

The Pennsylvania Fish Commission (PFC) introduced 195,000 postlarval American shad in the Schuylkill River on 4 June 1987, as part of that Agency's shad restoration program. Young American shad were released below the riffle adjacent to LGS. None of these fish was recaptured by RMC personnel, unlike 1986 when several fingerling shad were recaptured in the fall between LGS and Linfield, Pennsylvania. However, PFC personnel reported catching 11 fingerling shad upstream of Cromby Generating Station and 32 more between Spring City and Royersford, Pennsylvania, in September 1987 (Leroy Young, PFC, personal communication).

Muskellunge

Muskellunge or the hybrid cross with northern pike were not stocked by the PFC in the study area in 1987, and none was collected by either sampling gear. In the past, a few small specimens were collected following such introductions. Although catches of these predatory game fish were occasionally reported by anglers, such reports have not come from the LGS study area for quite some time. Anglers usually reported taking muskellunge or hybrids from the tailraces below dams and near the mouths of major tributaries.

Goldfish

Although goldfish ranked second in the electrofishing catch in 1987, this introduced species was not as abundant as in 1985 and 1986. Most goldfish taken by electrofishing were Age II fish spawned in 1985, based on length frequency of goldfish captured in the fall (Fig. 6.3-3). Most goldfish were 170-220 mm FL by the end of their third summer of life.

A total of 49 YOY goldfish were taken by seine, compared to 394 collected in 1985 when the largest year class on record was produced. Spawning took place in late May or early June, as evidenced by the capture of 15-30 mm goldfish fry on 22 June 1987.

Goldfish densities were considerably higher at S77640 and S76940 adjacent to LGS than at the extreme upstream (S79310) or downstream

(S76440) stations. This pattern of distribution was similar to past observations and reflected differences among stations in the amount of preferred habitat as noted previously.

A high percentage (20-40% depending on station) of goldfish in 1987 were infested with anchor worm, a parasitic copepod. Infestations were noted in the goldfish from all stations, particularly during the summer months. The heavy infestation was likely related to the relatively high density of goldfish. Another sign of stress in goldfish was a high incidence of fin erosion often seen in conjunction with severe infestations of anchor worm on individual goldfish.

Swallowtail shiner

Fifty YOY swallowtail shiners were seined from the Schuylkill River in 1987. Fry first appeared in the June sample. This total was much greater than the two YOY seined throughout 1986, and over twice the number seined in 1985. However, the 1987 YOY index was considerably lower than that obtained in any preoperational year except 1975 when only 66 YOY swallowtail shiners were collected.

Despite some successful reproduction, the 1987 seine catch of 172 swallowtail shiners was by far the lowest on record. Given the prior lack of reproductive success over the last two years and this species' short life span, such low population density might be expected.

Although the decline in swallowtail shiner abundance began at the time LGS went into operation, the decline has been coincident with greatly increased predator populations in the study area.

Spotfin shiner

Although this species has remained the most abundant fish in seine collections for many years, relative abundance had declined to record low levels during the first two years of LGS operation. Catches in 1987 rebounded, however, and YOY were nearly four times as abundant as during the previous two years. Greatest recruitment to the sampling gear occurred in September, although some young were collected as early as June.

White sucker

A total of 464 white suckers was electrofished in 1987 at a CPUE of 11.4 fish/hour, the lowest index for any year of the LGS monitoring program. Catches of white sucker were reduced both upstream and downstream of LGS, suggesting that lowered relative abundance was an area-wide phenomenon. This surmise is supported by the spatial distribution of white sucker catches which did not change appreciably despite lowered population density. The CPUE of white sucker was highest at S79310 upstream of LGS, and second highest at S76940 downstream of the LGS discharge. Station S79310 contained much of the swifter habitat preferred by this species, while schools of white sucker were often encountered near the base of the large riffle at S79640, another fast-flowing area.

White sucker electrofishing catches declined steadily from April through August and rose again in September, suggesting movement throughout the area, probably to deeper areas during the summer low-flow period.

Length frequency of white sucker in the fall (Fig. 6.3-4) delineated at least four and possibly five distinct age groups, plus one exceptionally large individual of indeterminant age. The bulk of the population was between 250 and 300 mm FL, and was comprised of members of the strong 1985 year class. It is unclear whether fish between 300 and 350 mm were fast growing Age II or slower growing Age III white suckers. Age I fish spawned in 1986 did not contribute nearly as much to the 1987 catch as did the 1985 year class to the 1986 catch, further evidence that white sucker reproductive success in 1985 was above average, as it was for many species in the Schuylkill River. The 1987 seine catch of 156 YOY white suckers was the third highest on record.

The incidence of disease among adult white suckers was similar in both 1986 and 1987, about 7%. Body wounds and anchor worms were the most common maladies, but individual afflictions were seldom severe.

Brown bullhead

Characteristics of the brown bullhead population were similar in 1987 to those observed the previous year and reflected the dominance of the large 1985 year class. Age II brown bullheads comprised the bulk of the population and were mostly between 180 and 240 mm FL by the end of their third summer of life (Fig. 6.3-5).

Patterns of spatial distribution were consistent with previous observations of habitat use, with brown bullheads being more abundant in the middle two stations near LGS than in the upstream or downstream stations.

Incidence of disease, 22%, was similar to the 21% rate seen in 1986. Presence of parasitic leeches was the most common disease. Few very old, large brown bullheads remained in the population, but those surviving often had cancerous or precancerous lesions on the head and lips. Contact with bottom sediments contaminated by heavy metals may have been a primary factor related to the incidence of tumors in brown bullheads (Reisinger 1981). Given an apparent reduction in pollution stress in recent years, it will be important to note whether members of the 1985 year class develop cancer as they grow older.

Four YOY brown bullheads were collected by seine on 22 June 1987 but none was captured by electrofishing. These observations are indicative of a very low level of natural reproduction in 1987. Production of large year classes by this species in the Schuylkill

River has been an infrequent and sporadic phenomenon. The 1985 year class was the first strong year class produced in the vicinity of LGS since 1977.

Banded killifish

The total number of banded killifish seined in 1987 was 26, which was lower than the catch of this species in any other year. However, catches substantially below average were also recorded in 1975 and 1984 during preoperational sampling. Sixteen of the individuals seined were judged to be YOY fish based on length and time of capture. YOY were first collected in June. It appears that the density of this species can fluctuate widely within the locations sampled. Data were insufficient to identify any particular reason why population density was low in 1987. It is conceivable that banded killifish were preyed upon by the large populations of rock bass and smallmouth bass, but no data exist to evaluate this hypothesis. Given the patchy distribution of many small fishes relative to the location of preferred habitat areas, the unusually low catch might also have been a sampling artifact.

Pumpkinseed

Relative abundance of pumpkinseed in the Schuylkill River has been exceptionally stable throughout the entire period of record, with annual CPUE values ranging between 8 fish/hour in 1985 and 17 fish/hour in 1983 (Table 6.3-12). Relative abundance in 1987 (14 fish/hour) did not deviate from this range.

YOY pumpkinseed were first seined in July at lengths of 16-30 mm, and even more were seined in August. The 41 YOY seined indicated successful reproduction but possibly not as great as in 1983 and 1985 when 226 and 120 YOY pumpkinseed, respectively, were collected. Comparison of seine and electrofishing data indicated that the initial peak (50-70 mm) in the length frequency histogram (Fig. 6.3-6) was comprised of Age I pumpkinseed.

The incidence of disease, 11%, was similar to that seen in 1981-1986 (7-14%). Mild infestations of blackspot occurred on 6% of specimens examined and was the most common affliction of pumpkinseed.

Smallmouth bass

Smallmouth bass CPUE in 1987, 12.7 fish/hour, was the highest index yet recorded (Table 6.3-12). Catch rate was highest at S79310 and was also somewhat higher at S77640 than at the two stations downstream of LGS, which were similar (Table 6.3-6).

Length-frequency analysis of the September-October electrofishing collection (Fig. 6.3-7) agreed with earlier seine results in revealing the presence of a strong 1987 year class of smallmouth bass. YOY were first seined in late June, which is consistent with a late-May through early-June spawning period. Note that the minor rise in river discharge in early June 1987 (see Fig. 6.1-2) did not have the devastating effect of the 25,000 cfs flood event in late May 1984 that virtually destroyed that year class of smallmouth bass.

Since a moderate year class of smallmouth bass was produced in 1986, the absence of a third distinct peak in the length-frequency histogram may indicate considerable size overlap between Age I and Age II fish, or heavy predation on 1986 smallmouth bass fingerlings by fish from the abundant 1985 year-class.

Disease incidence in 1987 ranged from 8-11% among individual stations and averaged 10% for the year. Minor occurrence of blackspot was the predominant disease of smallmouth bass.

Largemouth bass

Once more abundant in the Schuylkill River near LGS than the smallmouth bass (EROL), the largemouth bass was quickly replaced as the dominant species of Micropterus by smallmouth bass as water and habitat quality improved during the late 1970's and early 1980's. Although commonly encountered in the LGS vicinity, largemouth bass population density has remained low and fairly stable throughout preoperational and postoperational survey periods.

Annual electrofishing CPUE averaged 1.02 fish/hour/year from 1976-1983, and 0.90 fish/hour/year since 1985. The 1987 catch rate, 1.6 fish/hour, was the third-highest recorded in any year (Table 6.3-12).

Most of the largemouth bass electrofished in 1987 came from S76940 and S77640 adjacent to LGS. Only nine YOY were seined in July, but large numbers of YOY largemouth bass were never collected in the past. Blackspot or leeches were present on 6% of the individual largemouth bass examined for disease.

Tessellated darter

This small benthic fish species is the only member of the perch family to maintain an appreciable population in the study area, but it is much more abundant in tributary streams. Most of the 37 individuals seined in 1987 were YOY fish, and over half of these were taken in the June sample, primarily from stations downstream of the LGS discharge.

Redbreast sunfish

In 1987, this sunfish species was the third-most abundant species taken by both electrofishing and seining. Most of the redbreast sunfish collected by seine were YOY fish which were recruited in late June. A length-frequency histogram (Fig. 6.3-8) also revealed the presence of a relatively strong 1987 year class of redbreast sunfish.

The pattern of spatial distribution among sampling stations was consistent with past observations and demonstrated this species' preference for areas with fast current and rocky bottom.

The overall rate of disease, 15%, was considerably higher than the 5% rate noted in 1986, due to an outbreak of eye flukes in the population in early spring. The popeye condition caused by these parasitic flatworms was not seen to any great extent except in April.

Redbreast sunfish was selected for detailed analysis of individual growth rates. The 1987 age and growth study for redbreast sunfish is presented in the following subsection of this report.

Age and Growth of Redbreast Sunfish

Introduction and Methods

The scale method (Van Oosten, 1929) was used to determine age-composition and growth rates of Schuylkill River redbreast sunfish. The redbreast sunfish is one of the most abundant important species in the study area. Only one species was chosen for scale analysis because the method is time-consuming, and it was felt that redbreast sunfish would always be present in sufficient numbers to permit long-term study and would tend to reflect trends in growth and year-class formation characteristic of several other important species.

Specimens were collected by electrofishing in October, after most annual growth had been completed. Sample stations along a 3 km segment of the Schuylkill River included one upstream control (S79400) and two downstream stations (S77240 and S76440, intake and discharge affected, respectively). Goals for sample size were 125 fish at each station. Only fish greater than 50 mm in length were collected.

Scales were taken from below the lateral line at the tip of the extended pectoral fin. Scale samples were cross-referenced with FL, weight, and place and time of collection.

Uniformly shaped, non-regenerated scales were placed on a 1-mm thick, preheated plastic slide and permanent impressions were made with a roller press. Scale impressions were viewed at 23X magnification and annuli were identified using the criteria given in Tesch (1968). Ages were assigned according to the number of annuli present.

Anterior scale radius and distances between focus and annuli were measured from one scale from each fish. Five scales from each fish were used to determine radii for use in a body-scale regression.

Linear regression of body length on scale radius was used to describe the body-scale relationship. Fork length at each annulus was back-calculated for each fish, based on the body-scale relationship, using the formula in Tesch (1968):

$$L^1 = C + S^1/S\ (L-C)$$

where: L^1 = length of fish where annulus 'n' was formed
L = length of fish when scale sample was obtained
S^1 = scale radius of annulus 'n'
S = total scale radius
C = the intercept of body-scale regression with the abscissa

Redbreast sunfish ages determined from scales were validated by length-frequency analysis of fish collected in September and October. Length-frequency histograms were used to infer age-composition and relative mortality rates among age cohorts.

Results and Discussion

Schuylkill River redbreast sunfish collected in 1987 were assigned to age-groups I-IV on the basis of the number of annuli present. Mean lengths at annulus back-calculated for 357 fish indicated that greatest linear growth occurred in the second year of life (Table 6.3-13). Little difference in growth rate attributable to sampling station could be detected. Back-calculated mean lengths at annulus for redbreast sunfish collected in 1987 are compared to similar back-calculations for fish collected in previous years (Table 6.3-14).

Back-calculated mean lengths at annulus by age (Table 6.3-15) indicated that first-year growth of redbreast sunfish spawned in 1986 was very good, as it had been for fish spawned in 1985. The good first-year growth coincided with periods of low stable flow and high water temperatures which occurred throughout the 1986 growing season. Back-calculated growth for fish collected in 1987 indicated that overall growth rates of all age-groups remained similar or exceeded previous years.

Redbreast sunfish collected from the Schuylkill River in 1987 displayed an age distribution consisting primarily of Age I and II fish. Only 18 of 357 fish collected (5%) were Age III or IV (Table 6.3-16). The reasons for this distribution were detailed in the 1986 report.

Of primary importance was the continuing predominance of the 1985 year-class. This year-class comprised 89% of the 1986 age and growth collection and 49% of the 1987 collection. The success of the 1985 year-class was extraordinary, but the 1986 year-class was also successful. Age I fish (1986 year-class) comprised 46% of the 1987 sample (Table 6.3-16).

Also of importance was the high annual mortality exhibited by Schuylkill River redbreast sunfish and the poor success of the 1984 year-class. The 1983 year-class was extremely strong in the 1984 and 1985 collections, but its contribution to population numbers plunged in 1986 and 1987. The 1984 year-class comprised less than 10% of the 1985 collection and less than 4% in the 1986 and 1987 collections. The dearth of this year-class was previously related to high flow and low temperatures during spring and early summer of 1984.

A length frequency histogram for redbreast sunfish collected in September and October 1987 (Fig. 6.3-8) demonstrated the continued importance of the 1985 year-class in the redbreast sunfish population. These fish were mostly between 115 and 140 mm in length. Most individuals from the 1986 year-class reached at least 85 mm after two summers of growth. Very few individuals 160 mm in length or larger (Age IV or older) were collected.

Impingement

Introduction and Methods

Fish impingement at the LGS Schuylkill River intake was monitored periodically throughout 1987. The objective of this study was to estimate the number, size, and species of fish impinged at LGS.

Debris from the intake screens was collected in a trash bin, which was checked at approximately weekly intervals except during periods of high river flow when it was checked more frequently. A sheet of plastic was placed over the trash bin to separate the debris of one survey period from that of another. Each new accumulation of debris was sorted manually, and except for decomposed specimens, any fish found was identified and measured to the nearest mm fork length (FL).

Results and Discussion

Fewer fish were impinged in 1987 than in 1986. For the year, 250 fish of 15 species and unidentified *Notropis* minnows were observed compared to 1,633 fish of 15 species collected in 1986. Goldfish comprised 44% of the annual total, more than any other species. In 1986, goldfish comprised 89% of the annual total. Redbreast sunfish comprised a higher percentage of total fish impingement in 1987 than in 1986 (15% versus 2%) but the actual number of redbreast sunfish impinged in both years was similar (38 in 1987 versus 31 in 1986). The observation that colder water temperatures and high river flows contribute to increased impingement (RMC Environmental Services 1985) was also evident in 1987. Over half (57%) of the fish were impinged during the first quarter of 1987 (January-March) when the river was colder and average flow was greater than in the rest of the year.

Several factors contributed to the decrease in the number of fish impinged in 1987. The extended maintenance shutdown of LGS in 1987 and the consequent low volume of water withdrawn helped reduce the number of fish impinged. During the period June-December 1987, only two fish were recovered from debris collected by the intake screens.

Most of the fish impinged in 1986 were small Age-I goldfish spawned in 1985. These 1985 year class goldfish were fewer in number and larger in size in 1987. Both their reduced population density and the ability of larger, stronger goldfish to avoid the screens probably contributed to the decreased impingement observed in LGS in 1987.

With the exception of high flow in September, there was no major fluctuation in Schuylkill River flow during 1987. It is hypothesized that high river flow contributes to impingement because many fish move to shoreline cover to avoid current. A sudden inshore movement in response to a rapid rise in stream discharge may expose more fish to the intake than usual. The rapid increase in discharge that occurred in September 1987 coincided with the shutdown of LGS, thus, no opportunity existed to observe impingement coincident with this high flow.

Compared to the composition of 1987 electrofishing samples, the LGS intake screens appeared to be selective for goldfish and alewife in that both species comprised higher percentages of the total number of impinged fishes than they comprised of the total electrofishing catch. The selectivity of the screens for goldfish may reflect the intake's proximity to shallow weedy habitat preferred by goldfish. Since impingement studies began in 1985, consistently more alewives were taken by the screens than by electrofishing. However, most alewives were impinged during periods of high flow and low temperature when no electrofishing was attempted.

Creel Survey

Introduction and Methods

Recreational fishing was surveyed on a 10-km reach of the Schuylkill River near LGS during April-September 1987 (Fig. 6.3-9). Similar surveys of the area were made every year since 1980, except in 1986. The 1987 survey area was expanded upstream to include a newly opened recreation area located approximately 1.5-km upstream from the original survey boundary.

A roving creel survey based on a nonuniform probability sampling design was used to gather data on the recreational fishery (Pfieffer 1966, Malvestuto et al. 1978). Fishery characteristics investigated were 1) monthly fishing pressure between river meter S71860 (below Vincent Dam) and S8200 (Towpath Park), 2) locations frequented by anglers, 3) monthly catch and harvest by species, 4) species preferred by anglers, 5) access type (shore, boat, or bridge), and 6) age and sex of anglers.

The objective of the survey was to characterize the recreational fishery and provide estimates of angler catch and harvest. Angler harvest can provide a relative measure with which to evaluate the significance of fish impingement losses (Mathur et al. 1977). The creel survey also provided data to augment other studies of fish populations in the Schuylkill River near LGS.

Results and Discussion

Fishing Pressure

Monthly estimates of fishing pressure in angler-hours are presented in Table 6.3-17. A total of 8,910 angler-hours were spent during April-September 1987. Fishing pressure was greatest in May and June and lowest in July. Considering the relatively small amount of fishing effort expended (compared to more intensively fished bodies of water), fishing pressure estimates were reasonably precise as indicated by the average monthly coefficient of variation (30%). These results were in general similar to results from past surveys. Almost all fishing was from shore at points of convenient access, and little fishing adjacent to LGS was observed (Table 6.3-18).

Catch and Harvest

Angler catch including fish caught and released was dominated by smallmouth bass in 1987 (Table 6.3-19). This large catch (and release) was probably related to the high density of Age II smallmouth bass less than the legal size limit (254 mm). The large 1985 smallmouth bass year class should make a substantial contribution to the recreational fishery for several years.

Lepomis sunfish, catfish (mostly brown bullhead), carp, and rock bass comprised much of the remaining catch. In total, an estimated 11,752 fish were caught from the study area by anglers in 1987.

Consistent with past years, anglers kept only a small fraction of the fish they caught. The estimated 1987 harvest of 652 fish was only 5.5% of the estimated total catch. Over one-half of the harvest was comprised of brown bullhead (Table 6.3-20).

The survey was consistent with earlier ones (RMC Environmental Services 1984, 1985, and 1986) in demonstrating that the fishery in the Schuylkill River near LGS is of low intensity and is recreationally oriented rather than oriented toward harvest of fish for human consumption.

Age, Sex, and Preferred Species

Anglers who fished the Schuylkill River near LGS in 1987 were grouped by categories of age and by sex (Table 6.3-21), and were not found to differ substantially in these demographic characteristics from samples of anglers surveyed in past years.

Although "anything" was the response most often given by anglers when asked what they were fishing for, almost as many anglers responded that they were fishing for "bass" (Table 6.3-22), while "catfish" followed "bass" in order of preference.

Impact Evaluation

Introduction

In this section, the extended preoperational-postoperational database is analyzed with the objective to answer the question, has operation of LGS over a three-year period resulted in measurably significant change in the Schuylkill River fish community near the power plant?

Mechanisms of potential environmental impact discussed in the introduction to Section 6.3 imply that some characteristics are more important to examine than others. The characteristics chosen for evaluation at this time include relative weight (a measure of body condition) of several species, trends in species composition and density of more abundant species, and age and growth characteristics of redbreast sunfish. These evaluations, along with results of impingement, entrainment, and creel surveys, were then used to assess the impact of LGS operation.

Historically, environmental impact studies have tried to measure any environmental change, but such attempts have often been thwarted by sampling designs that were inadequate to test specific hypotheses, limited time frames, and small sample size which led to a lack of statistical power (Green 1979). These problems were often exascerbated by the tremendous natural variation characteristic of most ecological systems and the difficulty in obtaining reliable estimates of many environmental variables. Failure to apply ecological principles or to recognize indirect or cumulative impacts has also been a problem (Beanlands and Duinker 1984).

To varying degrees, studies reported here have suffered from one or another of the problems just identified. During the 13-year data collection period, the techniques and thoughts regarding impact detection have continuously evolved. Some approaches were attempted and later found to be inadequate for the purpose originally intended. Therefore, much thought has been given to exactly what has been measured, and to how these measurements may be analyzed. In some cases, statistical hypothesis testing was considered inappropriate. Where such techniques have been applied, justification for their use and an evaluation of underlying statistical and ecological assumptions is presented.

Of primary importance in an impact analysis is the evaluation of impact predictions made prior to LGS operation. These predictions, discussed in the EROL, are briefly presented here. The effects of impingement and entrainment were predicted to have minimal impact on resident fish populations for several reasons, including: 1) the percentage of total river flow withdrawn was small, 2) species most abundant in the ichthyofaunal drift that would be subject to entrainment are abundant throughout much of the Schuylkill River, and no unique, critically important spawning areas exist in the vicinity of LGS, 3) fishes typically reproduce at a level far above what the environment is capable of supporting, so that populations can compensate for wide variations in egg mortality through density dependent changes in growth and survival, 4) indirect effects on fishes through entrainment of food organisms such as zooplankton were not expected because planktonic organisms are not a major portion of the food web in a riverine ecosystem, and 5) experience at generating stations located in similar areas showed that impingement of juvenile fishes is seldom of concern. Similarly, discharge effects were predicted to be of no consequence because 1) the use of cooling towers and design of the effluent diffuser would effectively limit thermal enrichment of the

Schuylkill River and 2) the chemical composition of the effluent would be regulated by NPDES permit limitations established to protect downstream water quality and designated uses including fish and wildlife propagation.

Fish Body Condition

Introduction

Body condition refers to the plumpness of a fish. When provided with an ample food supply, healthy fish in an optimum environment will be heavier at a given length than fish stressed by lack of food, disease, or environmental degradation.

Thermal effluents from power plants can impact body condition of fishes living in heated areas by altering their metabolism and patterns of energy utilization which are strongly regulated by temperature. Indirect effects on food supplies or from other stresses could also affect body condition in fishes.

Impacts on fish body condition near LGS were predicted to be negligible. This prediction was tested by comparing body condition over time among fishes living near LGS and fishes from an upstream area unaffected by station operation. All stations were assumed to be affected similarly by ambient regimes of flow, temperature, and water quality. However, known differences in habitat and species abundances between stations may have influenced body condition differently at each station, depending on variation in local fish density, food availability or other factors.

Methods

A modified Relative Weight Index, Wr, was used to quantify body condition (Wege and Anderson 1978). Wr was computed and compared among stations over time for the species listed in Table 6.3-23. For each species, lengths and weights of fishes collected from all stations in the preoperational period (1976-1984) were natural-log transformed to linearize the relationship between length and weight. Individual fish lengths from both preoperational and postoperational phases were inserted in the species-specific regression equation to obtain a predicted weight. A Wr value was then calculated for each fish by expressing its observed weight as a percentage of its predicted weight.

Values of Wr were averaged within several class variables including stations, years, and LGS operational status. For all status comparisons, the preoperational period was considered both in its entirety and as two separate preoperational periods, early (1976-1978) and late (1981-1984), due to long-term changes in water quality and species abundances that occurred.

Analysis of Variance (ANOVA) using SAS-Software's General Linear Models (GLM) procedure was used to assess spatial and temporal variation in Wr and test the data for evidence of LGS operational impacts. The first GLM tested whether trends among stations in mean Wr remained consistent from one status phase to the next. Subsequent GLM's were constructed to test whether variation in Wr among status levels was significantly different from year-to-year variation which was considered as a random effect nested within the status effect after the effects of stations were removed. Division of the Type III (partial) status mean square by the Type III year mean square considered as a random effect nested within the status effect was used as an F-test to evaluate the significance of status variation. A significant F value ($P \leq 0.05$) would indicate that variation in Wr attributed to the change in status was greater than year-to-year variation in body condition.

Results

Mean values of Wr by species were determined for various combinations of class variables. For brevity, only mean Wr values at each station during early and late preoperational and postoperational status phases is displayed (Table 6.3-24).

Mean Wr tended to be lower in the postoperational phase than in either preoperational phases for several species, especially those that produced exceptionally large year classes in 1985. Increased density and perhaps competition for food may have slightly lowered condition in these species. Such changes appeared to be caused by natural events and not LGS operation because 1) if a decrease in condition occurred at an affected station, a decrease of similar magnitude occurred in the upstream population of fish, and 2) no significant difference between status variation and year-to-year variation was found for any of the species examined.

Since mechanisms that can cause decreased condition in fish, especially thermal enrichment or reduction in food resources, were not evident at LGS, the prediction that operation of the power plant would not noticeably affect body condition appears substantiated based on the data collected to date. Normal seasonal variation in Wr was evident due to changes in reproductive status, and body condition of several species declined after exceptionally large year classes were produced in 1985. These changes were natural events unrelated to operation of LGS.

Community Structure

Introduction

A characteristic of large warmwater streams free of major environmental stress is the presence of a diverse, stable fish community. A community can be impacted by a power plant if its members cannot compensate for the direct effects of mortality or if sublethal effects alter mechanisms regulating community structure.

No impact to the Schuylkill River fish community was anticipated due to the design and operation of LGS. However, LGS has not operated as planned due to the absence of Delaware River diversion water. Consequently, almost all make-up water has come from the Schuylkill River. This operational change warrants scrutiny. One reason LGS was predicted to have negligible impact via impingement and entrainment was that water would not be withdrawn during the seasonal low flow period. Subsequent use during that time of year when larval fish are most abundant has resulted in a somewhat larger-than-anticipated potential for entrainment that will exist unless and until the diversion is available. To date, Schuylkill River water was withdrawn during the summer of 1985, but not in 1986 when LGS was refueled, or in 1987 when the plant was shut down for maintenance (see Fig. 6.0-2).

Methods

Seine and electrofishing data were evaluated for evidence of LGS impact using several methods to examine species composition and relative density of the Schuylkill River fish community. Before these methods are presented, the sample design, assumptions, and limitations of the study must be discussed to understand the rationale behind the impact assessment.

Quantitative fish sampling in rivers is difficult due to variable sampling efficiency among species, places, and times. Fish distributional and behavioral changes can obscure changes in abundance.

Methods to estimate actual population numbers are costly, and therefore fish abundance is usually indexed by the number of fish captured with a standard amount of effort. The resulting CPUE index is assumed to be proportional to population density but can vary independently of the number of fish present if the catchability of fish varies from one time or place to another.

The strategy used to cope with the large variability in fish abundance data was similar in concept to the one used by Purdy et al. (1975) to study the effects of Peach Bottom Atomic Power Station on several ecosystem components in Conowingo Reservoir on the Susquehanna River. They made concomittant observations of ecological variables at potentially affected stations and at one or more control stations assumed to be similar in all respects except for the presence of power plant influence. If this assumption is met, natural variation can be accounted for statistically through analysis of covariance (ANCOVA). A drawback to this approach is that if control-affected relationships are weak, lack of randomization in the sampling design can preclude the use of other analytical techniques. Improper choice or the unavailability of an ecologically similar control station can impair the efficacy of this experimental design.

Electrofishing CPUE at a station in a given month was a function of a signal of ecological interest, i.e., the number of fish present, confounded by a noise component consisting of variation in catchability or patchiness in fish distribution. If signal and noise vectors are similar from one station to another, then CPUE should be positively correlated. If the correlation is high, an equation can be established to predict affected station CPUE based on a concomittant observation at the control station. Then, evidence of a power plant impact would be if observed CPUE fell outside the confidence interval around predicted CPUE more often than chance alone would dictate.

Electrofishing stations each covered 3 to 4 hectares, so that the catch from a station at any given time was in part a function of the number of fish living within a mosaic of individual microhabitats. Although not randomly selected, the mosaic of habitats within each station appeared representative of a longer reach of the river. Electrofishing was relatively unselective within the group of species sampled, and it was assumed that most fish movement occurred within the boundaries of the station or else movements into and out of the station were balanced. For these reasons use of ANCOVA was attempted. Development of the model used to test for LGS impacts is presented in the results of this subsection.

A similar design was intended for the seine survey, but fundamental differences existed between it and the electrofishing survey. The seine sampled only near-shore habitat, and each station was so small that only a fraction of available microhabitats in a stream reach was sampled at any one station. Since most species tend to congregate around areas of preferred habitat, the catch at any one station alone often did not reflect the true character of the local fish community.

Patchiness in fish distribution tended to increase noise depending on whether or not a school of minnows happened to be present along one of the shoreline areas sampled. These factors, plus the fact that stations were not randomly selected from available microhabitats, precluded use of the data for making ecologically meaningful hypothesis tests based on the catches from individual stations. Another problem with the use of a control-affected station approach is that the upstream seine station may not have been far enough from LGS to be completely free of its influence.

The seine survey provided valuable information amenable to other types of analysis. Considered in total, stations included most microhabitat types available, thus the catch from all stations combined probably represented species richness fairly well. Monthly catches during warm weather probably caught most of the more abundant species, while enough effort was expended throughout the year to at least index presence/absence of all but the rarest species. Use of standard units of effort probably correctly identified increasing or decreasing trends in real abundance of many species.

For both seine and electrofishing data, several techniques were used to describe and compare fish community structure based on annual CPUE of species present in two-thirds or more of the annual collections. Nonparametric tests of rank correlation (Seigel 1975) were used to determine the similarity of rank abundance data among years as were indices of percent similarity (Whittaker and Fairbanks

1958) and dissimilarity (Ramsey and Marsh 1984). Clustering techniques (Anderberg 1973) were applied to the outcome of rank correlation, percent similarity, and raw CPUE data, again to determine whether patterns in the abundance of certain species existed that might have been due to LGS operation.

Results

The first step in ANCOVA model development for monthly electrofishing data was to determine the strength of relationships between CPUE at control and affected stations. Linear correlation of CPUE data for ten species (Table 6.3-25) resulted in many significant positive correlations ($P < 0.05$) for both untransformed and natural log-transformed data. Transformation did not consistently affect the degree of correlation but was found to normalize the error variance during subsequent model development.

Although statistically significant, CPUE correlations were not very powerful. Control station CPUE sometimes explained as much as 80%, but more often less than 50%, of the variation in CPUE at an affected station. CPUE correlations for carp, goldfish, white sucker, yellow bullhead, and rock bass were much stronger for the entire period of record than for the preoperational period alone. Extremely high reproductive success in 1985 and high densities thereafter resulted in considerably higher CPUE at all stations for these species than was observed in the preoperational period. This in turn increased the correlation between control and affected station CPUE.

A high frequency of nonsignificant or very weak correlations between control and affected station CPUE were found for species that showed marked segregation by habitat type, especially American eel, carp, goldfish, and pumpkinseed. The latter three species in particular were relatively uncommon at the control station, but were consistently abundant at one or more of the affected stations, due to habitat differences. Under such conditions, CPUE would not be expected to correlate well.

This initial step indicated two things of importance to subsequent model development. First, electrofishing CPUE appeared capable of tracking trends in the abundance of most species, and these trends were similar among stations over time (Fig. 6.3-10). Second, although trends were similar, inherent sampling variation plus the fact that the control station was unlike the affected stations in many physical and biological characteristics introduced so much noise that control station CPUE was in most cases not correlated well enough to be used in a predictive equation.

Annual CPUE usually correlated between control and affected stations better than monthly CPUE. In many cases over 80% of the variance in affected station CPUE was explained by control station CPUE (Table 6.3-26). Annual CPUE tended to track strong or weak year classes with less noise caused by variation in catchability and random error. As with the monthly data, control-affected correlations over the period of record were higher than for the preoperational period alone for several species that produced an exceptionally large 1985 year class. Small sample size (only seven preoperational and three postoperational data points) precluded the use of annual CPUE data for predictive purposes. Based on this analysis, however, density of many species displayed similar trends over time at all stations, which supports the hypothesis that density was regulated by natural phenomena and not by power plant operation.

Rather than use control station CPUE to predict affected station CPUE, monthly CPUE at each affected station was analyzed by species with two SAS GLM procedures that tested whether status variation was significantly different from annual variation. Natural-log transformation of monthly CPUE normalized error and was used in all analyses.

Without adjusting for the concomittant variation in control CPUE, status variation in affected CPUE was in many instances significantly different from annual variation (Table 6.3-27). However, the same was true for many species at the control station which was unaffected by LGS. At affected stations, highly significant differences became nonsignificant or nearly so when the variation explained by control CPUE was accounted for, not because of any cause-and-effect relationship between control and affected CPUE but because both variables were subjected to many of the same natural influences. These results indicate that changes in relative abundance were natural events unrelated to LGS operation.

A series of techniques including rank correlation, percent similarity, dissimilarity, and clustering algorithms were applied to both seine and electrofishing data sets. Similar clusters of years were found in all analyses of data from a single gear type; differences in clustering results between gears were due to selectivity. Clustering techniques identified long-term trends in species abundance and effects of record year class production by many species in 1985, and verified patterns that were evident from data inspection.

Of greatest interest were the results of the dissimilarity procedure (Tables 6.3-28 and 6.3-29) which was applied to annual CPUE at individual electrofishing stations and to the combined catch from all seine stations, with data classified by preoperational and postoperational periods. The dissimilarity index takes on values between 0.5 and 1.0. Values close to 0.5 indicate that two samples are very similar to one another, while an index of 1.0 indicates a minimum degree of similarity. The procedure also indicated which species in a sample contributed the most weight to the overall dissimilarity index.

The results showed that community composition in the preoperational period was similar to that in the postoperational period, although some species abundances changed markedly. These shifts were consistent among electrofishing stations, with many of the same species displaying similar trends over time. Since the index is applied to percentage composition rather than actual density estimates, in some cases a species contributed highly not because its abundance changed but because some other species increased in abundance.

Note that redbreast sunfish tended to contribute more to dissimilarity in the postoperational phase for the seine data, and in the preoperational phase for electrofishing. This was because an unusually large percentage of the 1985 seine catch was comprised of YOY redbreast sunfish that did not contribute similarly to the electrofishing catch, which focused on larger fish.

Although real changes in fish community structure occurred from year to year in the Schuylkill River, the sampling programs used were only able to quantify those changes in relative terms. Variation in community structure and the abundance of many species was evident and can be considered ecologically significant. Such variation appears to result from natural causes; mechanisms likely include the effects of flow and temperature regimes that regulate reproduction and survival, modified further by complex biological interactions that are poorly understood and difficult to measure. Against this background of natural variability, any effects attributable to LGS operation on fish community structure were not recognized by the techniques employed.

However, since the techniques were able to detect trends of ecological significance that were of natural origin, it can be safely concluded that any real LGS operational influences on community structure are unimportant at present.

Age and Growth of Redbreast Sunfish

Introduction and Methods

Discharge of heated power plant effluents into a natural water body can alter the physiological mechanisms that regulate growth, sexual maturation, and spawning behavior of fishes living in thermally enriched areas. Fishes exposed to thermal effluents may spawn earlier in the year than fish living in ambient areas, thus their young have a longer period of time in which to grow. Elevated water temperature in autumn may also extend the growing season of fish living in heated areas. Early growth may be more rapid due to warmer temperatures. Due to their larger size, such YOY fish may outcompete YOY fish hatched later in the year from ambient areas. In extreme cases, bimodal size distributions within an age-class may develop that can be linked to subpopulation differences in spawning dates and growth rates.

In other extreme cases, fish in thermal areas may become acclimated to and forced to remain in water temperatures near their limit of tolerance. Under such periods of stress, little or no growth in length may occur, and fish may lose weight to the point they become emaciated. Indirect effects from alterations in food supplies, patterns of energy utilization, and physiological efficiency can also affect growth rates of fish.

LGS operation was not expected to affect age composition or growth rates of redbreast sunfish for reasons similar to the lack of predicted effects on fish body condition. Thermal enrichment, changes in water quality, and water withdrawal effects were not expected to be great enough to cause changes in the growth and survival of resident fishes. To evaluate this prediction, back-calculated lengths at annulus of redbreast sunfish collected before and after LGS began operation in late 1985 were compared.

Results

Operation of LGS in 1985 had little likelihood of influencing growth of redbreast sunfish as the fish had completed virtually all of their annual growth prior to commencement of full power operation. Thus, growth in 1985 was considered to have occurred in a preoperational mode.

In 1986, growth was influenced favorably by a generally warm and stable flow regime. Growth in 1986 calculated from data pooled over all three sample stations shows that first, second, third, and fourth year growth was 2, 5, 10, and 1 mm greater than preoperational means (Table 6.3-30). A similar analysis of pooled data from just stations

S77240 (near the LGS intake) and S76440 (below the LGS discharge) showed almost identical positive differences of 2, 4, 11, and 1 mm, respectively (Table 6.3-31). At the control station S79400 the relationship between back-calculated growth rates in 1986 and the preoperational means was similar to that found at S77240 and S76440. Growth differences in the first, second, and third years of life between redbreast sunfish collected in 1986 and 1976-1985 were 2, 6, and 8 mm, respectively (Table 6.3-32). No redbreast sunfish $\geq$ 4 years in age was collected in 1987 from S79400, so fourth year growth could not be calculated.

Back calculated growth rates for 1987 will not be available until samples in 1988 or later are collected. However, recruitment of some Age-0 redbreast sunfish to the electrofishing gear (FL $\geq$ 50 mm) by autumn suggests that first-year growth in 1987 was within the normal range.

In summary, mean growth of redbreast sunfish was found to vary from year to year in response to natural causes. Conditions have been favorable for growth since LGS began operating. Similarity of growth rates upstream, adjacent to, and downstream of LGS verified the prediction that redbreast sunfish growth would not likely be affected by LGS operation.

Conclusions

Results of fisheries investigations conducted in the Schuylkill River near LGS have not detected significant operational impacts to the fish community so far. Results presented here tend to verify predictions made in the EROL, despite the fact that make-up water has come solely from the Schuylkill River. Given that LGS was shut down during much of the spawning season in two out of three years, potential entrainment was not realized and was not a likely source of impact. Total impingement in 1987 (estimated at 250 fish) was less than one-half the number of fish harvested in that year by anglers (652) throughout a 10-km reach bracketing LGS. Higher impingement in 1986 was comprised mostly of Age-I goldfish. Since LGS start-up, total impingement represented only a miniscule fraction of the total fish population. No direct effects of effluent discharge on fishes were ever noted, and indirect effects are even less likely, based on evaluation of long-term trends and preoperational-postoperational comparisons of water quality.

The U.S. Nuclear Regulatory Commission (USNRC), in its Final Environmental Statement for the LGS project (USNRC 1984), considered impacts to the Schuylkill River from LGS operation to be insignificant, and that the findings of acceptable overall impact affirmed by the Atomic Safety and Licensing Board were valid. However, the USNRC was of the opinion that localized effects to biota could result from impingement and thermal effluents on a seasonal basis.

Although minor, these stresses would be an addition to an already stressed and degraded environment. This study showed that, with the techniques employed, any such additional stress (if present) was so small as to be undetectable against the great background of natural variability. Furthermore, changes in aquatic biota and improvements in certain water quality conditions over the long term suggest that the Schuylkill River at present is not degraded to the extent that it was judged to be at the time data were collected for impact prediction. Therefore, the significance of any real, albeit undetectable, LGS impact to Schuylkill River biota is even further diminished.

Although acute, short-term effects have not been realized, it is conceivable (although unlikely) that chronic, long-term changes could be discovered in the future. Realization of potential entrainment appears at present to be the only mechanism whereby such impacts might occur. Completion of the Point Pleasant Water Diversion Project would eliminate this concern. Impingement may be of future concern if efforts to restore American shad to the Schuylkill River are successful, given the apparent selectivity of the LGS screens for alewife, a closely related species that enters the Schuylkill River from upstream reservoirs.

Table 6.3-1. Summary of the Schuylkill River seining stations and months 1981 - 1987.

Station		J	F	M	A	M	J	J	A	S	O	N	D	Total
S78460	1975	X	X	X	X	X	X	X	X	X	X	X	X	12
	1976	X	X	X	X	X	X	X	X	X		X	X	11
	1977			X	X	X	X	X	X	X				7
	1981			X	X	X	X	X	X	X	X	X	X	10
	1982		X	X	X	X	X	X	X	X	X	X	X	11
	1983	X	X			X	X	X	X	X	X	X		9
	1984	X		X	X	X	X	X	X	X	X	X	X	11
	1985	X	X	X	X	X	X	X	X	X	X	X	X	12
	1986			X	X	X	X	X	X	X	X	X	X	10
	1987	X	X	X	X	X	X	X	X	X	X	X	X	12
*														105
S77960	1975	X	X	X	X	X	X	X	X	X	X	X	X	12
	1976	X	X	X	X	X	X	X	X	X		X	X	11
	1977			X	X	X	X	X	X	X				7
	1978		X		X	X	X	X	X	X	X	X	X	10
	1981			X	X	X	X	X	X	X	X	X	X	10
	1982		X	X	X	X	X	X	X	X	X	X	X	11
	1983	X	X			X	X	X	X	X	X	X		9
	1984	X		X	X	X	X	X	X	X	X	X	X	11
	1985	X	X	X	X	X	X	X	X	X	X	X	X	12
	1986			X	X	X	X	X	X	X	X	X	X	10
	1987	X	X	X	X	X	X	X	X	X		X	X	11
*														114
S77240	1975	X	X	X	X	X	X	X	X	X	X	X	X	12
	1976	X	X	X	X	X	X	X	X	X		X	X	11
	1977			X	X	X	X	X	X	X				7
	1978		X		X	X	X	X	X	X	X	X	X	10
	1981			X	X	X	X	X	X	X	X	X	X	10
	1982		X	X	X	X	X	X	X	X	X	X	X	11
	1983	X	X			X	X	X	X	X	X	X		9
	1984	X		X	X	X	X	X	X	X	X	X	X	11
	1985	X	X	X	X	X	X	X	X	X	X	X	X	12
	1986			X	X	X	X	X	X	X	X	X	X	10
	1987	X	X	X	X	X	X	X	X	X	X	X	X	12
*														115
S77220	1975	X	X	X	X	X	X	X	X	X	X	X	X	12
	1976	X	X	X	X	X	X	X	X	X		X	X	11
	1977			X	X	X	X	X	X	X				7
	1978		X		X	X	X	X	X	X	X	X	X	10
	1981			X	X	X	X	X	X	X	X	X	X	10
	1982		X	X	X	X	X	X	X	X	X	X	X	11
	1983	X	X			X	X	X	X	X	X	X		9
	1984	X		X	X	X	X	X	X	X	X	X	X	11
	1985	X	X	X	X	X	X	X	X	X	X	X	X	12
	1986			X	X	X	X	X	X	X	X	X	X	10
	1987	X	X	X	X	X	X	X	X	X	X	X	X	12
*														115
S77010	1975	X	X	X	X	X	X	X	X	X	X	X	X	12
	1976	X	X	X	X	X	X	X	X	X		X	X	11
	1977			X	X	X	X	X	X	X				7
	1978		X		X	X	X	X	X	X	X	X	X	10
	1981			X	X	X	X	X	X	X	X	X	X	10
	1982		X	X	X	X	X	X	X	X	X	X	X	11
	1983	X	X			X	X	X	X	X	X	X		9
	1984	X		X	X	X	X	X	X	X	X	X	X	11
	1985	X	X	X	X	X	X	X	X	X	X	X	X	12
	1986			X	X	X	X	X	X	X	X	X	X	10
	1987	X	X	X	X	X	X	X	X	X	X	X	X	12
*														115
S76840	1975	X	X	X	X	X	X	X	X	X	X	X	X	12
	1976	X	X	X	X	X	X	X	X	X		X	X	11
	1977			X	X	X	X	X	X	X				7
	1978		X		X	X	X	X	X	X	X	X	X	10
	1981			X	X	X	X	X	X	X	X	X	X	10
	1982		X	X	X	X	X	X	X	X	X	X	X	11

Table 6.3-1. (continued)

Station		J	F	M	A	M	J	J	A	S	O	N	D	Total
576840	1983	X	X			X	X	X	X	X	X	X		9
	1984	X		X	X	X	X	X	X	X	X	X	X	11
	1985	X	X	X	X	X	X	X	X	X	X	X	X	12
	1986			X	X	X	X	X	X	X	X	X	X	10
	1987	X	X	X	X	X	X	X	X	X	X	X	X	12
														-----
*														115
														=====
														679

Table 6.3-2. Summary of the Schuylkill River electrofishing stations and months 1976 - 1987.

Station		J	F	M	A	M	J	J	A	S	O	N	D	Total
S79310	1976							X	X	X	X	X	X	6
	1977		X	X	X	X	X	X	X	X		X	X	10
	1978				X	X	X	X	X	X	X		X	8
	1981				X		X		X		X			4
	1982				X			X	X		X			4
	1983					X	X	X	X	X	X			6
	1984				X	X	X	X	X	X	X			7
	1985				X	X	X	X	X		X			6
	1986					X	X	X		X	X			5
	1987				X		X	X	X	X	X			6
														62
S77640	1976							X	X	X	X	X	X	6
	1977		X	X	X	X	X	X	X	X		X		9
	1978				X	X	X	X	X	X	X	X	X	9
	1981				X		X		X		X			4
	1982				X			X	X		X			4
	1983		X	X		X	X	X	X	X	X	X		9
	1984			X	X	X	X	X	X	X	X	X	X	10
	1985		X	X	X	X	X	X	X	X	X	X		10
	1986	X		X		X	X	X		X	X		X	8
	1987	X		X	X		X	X	X	X	X	X	X	10
														79
S76940	1977		X	X	X	X	X	X	X	X		X		9
	1978				X	X	X	X	X	X	X	X	X	9
	1981				X		X		X		X			4
	1982				X			X	X		X			4
	1983		X	X		X	X	X	X	X	X	X		9
	1984			X	X	X	X	X	X	X	X	X	X	10
	1985		X	X	X	X	X	X	X	X	X			9
	1986	X		X		X	X	X		X	X		X	8
	1987	X		X	X		X	X	X	X	X	X	X	10
														72
S76440	1976							X	X	X	X	X	X	6
	1977		X	X	X	X	X	X	X	X		X	X	10
	1978				X	X	X	X	X	X	X	X	X	9
	1981				X		X		X		X			4
	1982				X			X	X		X			4
	1983					X	X	X	X	X	X			6
	1984				X	X	X	X	X	X	X			7
	1985				X	X	X	X	X	X	X			7
	1986					X	X	X		X	X			5
	1987				X		X	X	X	X	X			6
														64
														277

Table 6.3-3. List of fishes collected from the Schuylkill River near LGS since 1970, their status, and relative abundance by sampling methods used in 1987.

		Relative abundance in 1987[2]				
		Electrofishing			Seining	
Common name	Status[1]	Number	% Total	CPUE[3]	Number	% Total
Bowfin	I	2	+	0.05	-	-
American eel	N	10	0.2	0.25	-	-
Alewife[4]	RI	1	+	0.02	-	-
American shad[4]	RI	-	-	-	-	-
Brown trout	I	-	-	-	-	-
Rainbow trout	I	-	-	-	-	-
Redfin pickerel	N	-	-	-	-	-
Chain pickerel[4]	N	1	+	0.02	-	-
Muskellunge	I	-	-	-	-	-
Esox hybrid[5]	I	-	-	-	-	-
Goldfish	I	1,202	17.6	29.62	51	0.6
Carp	I	148	2.2	3.65	6	+
Goldfish x Carp	I	11	0.2	0.27	-	-
Cutlips minnow	N		X		1	+
Golden shiner	N	172	2.5	4.24	176	2.2
Comely shiner	N		X		38	0.5
Common shiner	N		X		381	4.7
Spottail shiner	N		X		1,177	14.6
Swallowtail shiner	N		X		172	2.1
Spotfin shiner	N		X		4,348	53.9
Bluntnose minnow	N		X		1	+
Fathead minnow	I		X		-	-
Blacknose dace	N		X		9	0.1
Longnose dace	N		X		-	-
Creek chub	N		X		-	-
Fallfish	N	6	0.1	0.15	2	+
Quillback	N	1	+	0.02	4	+
White sucker	N	464	6.8	11.43	156	1.9
Creek chubsucker	N	14	0.2	0.34	1	+
White catfish	N	2	+	0.05	-	-
Yellow bullhead	N	602	8.8	14.83	9	0.1
Brown bullhead	N	500	7.3	12.32	4	+
Channel catfish	I	1	+	0.02	-	-
Margined madtom	N	-	-	-	-	-
Banded killifish	N		X		26	0.3
Rock bass	I	1,300	19.0	32.03	57	0.7
Unidentified sunfish		-	-	-	4	+

Table 6.3-3. (continued)

Common name	Status[1]	Relative abundance in 1987[2] Electrofishing Number	% Total	CPUE[3]	Seining Number	% Total
Redbreast sunfish	N	1,077	15.7	26.54	1,117	13.8
Green sunfish	I	110	1.6	2.71	24	0.3
Pumpkinseed	N	591	8.6	14.56	48	0.6
Bluegill	I	24	0.4	0.59	108	1.3
Sunfish hybrids		11	0.2	0.27	-	-
Smallmouth bass	I	515	7.5	12.69	99	1.2
Largemouth bass	I	66	1.0	1.63	9	0.1
White crappie	I	5	0.1	0.12	-	-
Black crappie	I	6	0.1	0.15	-	-
Tessellated darter	N		X		37	0.5
Yellow perch	N	-	-	-	-	-
Walleye	I	-	-	-	-	-
Totals		6,842	100.0	168.6[1]	8,065	100.0
Number of species and hybrids by gear		26			26	
Total species and hybrids	Historic:	48		In 1987:	36	

[1]Status: N = Native, I = Introduced, RI = Reintroduced native

[2]"-" = Not collected by gear in 1987; "+" = < 0.1%;
"X" = excluded from electrofishing samples

[3]CPUE = Catch-per-unit-effort in fish/hour

[4]Not listed in EROL

[5]Northern pike x muskellunge hybrid

Table 6.3-4. Total catch and relative abundance of fishes collected by seine from the Schuylkill River by station during 1987.

Species	S76840 Catch	%	S77010 Catch	%	S77220 Catch	%	S77240 Catch	%	S77960 Catch	%	S78460 Catch	%
Goldfish	38	3.4	8	0.6	3	0.1	-	-	2	0.1	-	-
Carp	2	0.2	1	0.1	1	+	-	-	2	0.1	-	-
Cutlips minnow	-	-	-	-	-	-	-	-	1	0.1	-	-
Golden shiner	8	0.7	58	4.3	103	3.1	1	0.4	4	0.2	2	0.5
Comely shiner	-	-	3	0.2	31	0.9	-	-	3	0.2	1	0.3
Common shiner	47	4.1	12	0.9	229	6.9	26	11.5	59	3.6	8	2.2
Spottail shiner	82	7.2	236	17.6	655	19.7	3	1.3	195	11.7	6	1.6
Swallowtail shiner	30	2.6	48	3.6	55	1.7	3	1.3	12	0.7	24	6.6
Spotfin shiner	762	67.2	601	44.7	1689	50.7	100	44.1	929	55.9	267	73.0
Bluntnose minnow	-	-	-	-	1	+	-	-	-	-	-	-
Blacknose dace	6	0.5	-	-	2	0.1	-	-	1	0.1	-	-
Fallfish	-	-	-	-	2	0.1	-	-	-	-	-	-
Quillback	-	-	1	0.1	3	0.1	-	-	-	-	-	-
White sucker	81	7.1	3	0.2	69	2.1	3	1.3	-	-	-	-
Creek chubsucker	-	-	1	0.1	-	-	-	-	-	-	-	-
Yellow bullhead	3	0.3	-	-	-	-	3	1.3	3	0.2	-	-
Brown bullhead	4	0.4	-	-	-	-	-	-	-	-	-	-
Banded killifish	7	0.6	8	0.6	5	0.2	-	-	6	0.4	-	-
Rock bass	3	0.3	11	0.8	14	0.4	12	5.3	14	0.8	3	0.8
Lepomis	-	-	-	-	-	-	4	1.8	-	-	-	-
Redbreast sunfish	26	2.3	298	22.2	426	12.8	23	10.1	292	17.6	52	14.2
Green sunfish	3	0.3	10	0.7	5	0.2	-	-	6	0.4	-	-
Pumpkinseed	10	0.9	6	0.4	6	0.2	-	-	25	1.5	1	0.3
Bluegill	5	0.4	19	1.4	18	0.5	2	0.9	62	3.7	2	0.5
Smallmouth bass	6	0.5	1	0.1	10	0.3	43	18.9	39	2.3	-	-
Largemouth bass	3	0.3	-	-	2	0.1	-	-	4	0.2	-	-
Tessellated darter	8	0.7	19	1.4	4	0.1	4	1.8	2	0.1	-	-
Total Catch	1134		1344		3333		227		1661		366	
Number of Species	20		19		22		13		20		10	
Number of Stations	1		1		1		1		1		1	

+ = Less than 0.1%

Table 6.3-5. Monthly catch (all stations combined) of fishes collected by seine from the Schuylkill River during 1987.

Species	1/12 Catch	2/6 Catch	3/16 Catch	4/22 Catch	5/29 Catch	6/22 Catch	7/17 Catch	8/17 Catch	9/28 Catch	10/23 Catch	11/19 Catch	12/17 Catch	Total Catch
Goldfish	-	1	-	1	-	47	1	1	-	-	-	-	51
Carp	-	-	-	-	-	3	1	2	-	-	-	-	6
Cutlips minnow	-	-	-	-	-	1	-	-	-	-	-	-	1
Golden shiner	-	-	-	-	-	65	73	13	3	20	2	-	176
Comely shiner	-	-	-	5	-	-	-	1	1	3	26	2	38
Common shiner	-	-	-	2	-	282	52	27	4	9	2	3	381
Spottail shiner	2	5	1	2	-	1054	56	4	2	35	7	9	1177
Swallowtail shiner	4	8	4	10	1	21	4	13	12	42	27	26	172
Spotfin shiner	4	10	4	72	24	33	810	938	1259	720	349	125	4348
Bluntnose minnow	-	-	-	-	-	-	1	-	-	-	-	-	1
Blacknose dace	-	1	-	-	-	8	-	-	-	-	-	-	9
Fallfish	-	-	-	-	-	2	-	-	-	-	-	-	2
Quillback	-	-	-	-	-	3	-	-	1	-	-	-	4
White sucker	-	-	-	-	47	109	-	-	-	-	-	-	156
Creek chubsucker	-	-	-	-	-	-	1	-	-	-	-	-	1
Yellow bullhead	-	-	-	-	-	6	3	-	-	-	-	-	9
Brown bullhead	-	-	-	-	-	4	-	-	-	-	-	-	4
Banded killifish	2	1	4	1	1	6	6	1	-	-	-	4	26
Rock bass	1	-	1	4	2	17	24	6	1	1	-	-	57
Lepomis	-	-	-	-	4	-	-	-	-	-	-	-	4
Redbreast sunfish	-	-	2	3	5	641	257	178	19	10	2	-	1117
Green sunfish	-	1	1	-	3	1	11	7	-	-	-	-	24
Pumpkinseed	-	-	1	-	4	1	6	30	2	4	-	-	48
Bluegill	2	2	-	-	1	1	29	60	8	3	1	1	108
Smallmouth bass	-	1	-	2	1	76	15	3	-	1	-	-	99
Largemouth bass	-	-	-	-	-	-	6	-	3	-	-	-	9
Tessellated darter	2	-	-	-	-	23	9	-	-	1	-	2	37
Total catch	17	30	18	102	93	2404	1365	1284	1315	849	416	172	8065
Number of species	7	9	8	10	11	22	19	15	12	12	8	8	
Number of stations	6	6	6	6	6	6	6	6	6	5	6	6	

+ = Less than 0.1%

Table 6.3-6. Annual relative abundance of target fishes from the Schuylkill River electrofished in 1987 (+ = Less than 0.1%, CPUE = fish per hour).

Species		S76440 8.63 Hr	S76940 11.80 Hr	S77640 13.13 Hr	S79310 7.02 Hr	Total 40.58 Hr
Bowfin	Catch	1	1	-	-	2
	%	0.1	0.1	-	-	+
	CPUE	0.12	0.08	-	-	0.05
American eel	Catch	4	2	1	3	10
	%	0.3	0.1	+	0.2	0.2
	CPUE	0.46	0.17	0.08	0.43	0.25
Alewife	Catch	-	-	1	-	1
	%	-	-	+	-	+
	CPUE	-	-	0.08	-	0.02
Chain pickerel	Catch	-	-	1	-	1
	%	-	-	+	-	+
	CPUE	-	-	0.08	-	0.02
Goldfish	Catch	98	375	670	59	1202
	%	7.4	21.4	27.3	4.5	17.6
	CPUE	11.36	31.78	51.03	8.40	29.62
Carp	Catch	22	47	63	16	148
	%	1.7	2.7	2.6	1.2	2.2
	CPUE	2.55	3.98	4.80	2.28	3.65
Golden shiner	Catch	39	61	72	-	172
	%	3.0	3.5	2.9	-	2.5
	CPUE	4.52	5.17	5.48	-	4.24
Fallfish	Catch	-	3	1	2	6
	%	-	0.2	+	0.2	0.1
	CPUE	-	0.25	0.08	0.28	0.15
Minnow hybrid	Catch	2	5	3	1	11
	%	0.2	0.3	0.1	0.1	0.2
	CPUE	0.23	0.42	0.23	0.14	0.27
Quillback	Catch	-	1	-	-	1
	%	-	0.1	-	-	+
	CPUE	-	0.08	-	-	0.02
White sucker	Catch	74	159	128	103	464
	%	5.6	9.1	5.2	7.8	6.8
	CPUE	8.57	13.47	9.75	14.67	11.43
Creek chubsucker	Catch	-	12	2	-	14
	%	-	0.7	0.1	-	0.2
	CPUE	-	1.02	0.15	-	0.34
White catfish	Catch	1	-	1	-	2
	%	0.1	-	+	-	+
	CPUE	0.12	-	0.08	-	0.05
Yellow bullhead	Catch	133	103	189	177	602
	%	10.1	5.9	7.7	13.4	8.8
	CPUE	15.41	8.73	14.39	25.21	14.83
Brown bullhead	Catch	64	195	232	9	500
	%	4.9	11.1	9.5	0.7	7.3
	CPUE	7.42	16.53	17.67	1.28	12.32
Channel catfish	Catch	-	-	1	-	1
	%	-	-	+	-	+
	CPUE	-	-	0.08	-	0.02
Rock bass	Catch	393	242	328	337	1300
	%	29.8	13.8	13.4	25.6	19.0
	CPUE	45.54	20.51	24.98	48.01	32.03
Redbreast sunfish	Catch	251	165	226	435	1077
	%	19.0	9.4	9.2	33.0	15.7
	CPUE	29.08	13.98	17.21	61.97	26.54

Table 6.3-6. (continued)

Species		S76440 8.63 Hr	S76940 11.80 Hr	S77640 13.13 Hr	S79310 7.02 Hr	Total 40.58 Hr
Green sunfish	Catch	27	21	36	26	110
	%	2.1	1.2	1.5	2.0	1.6
	CPUE	3.13	1.78	2.74	3.70	2.71
Pumpkinseed	Catch	116	178	293	4	591
	%	8.8	10.2	11.9	0.3	8.6
	CPUE	13.44	15.08	22.32	0.57	14.56
Bluegill	Catch	9	14	1	-	24
	%	0.7	0.8	+	-	0.4
	CPUE	1.04	1.19	0.08	-	0.59
Lepomis hybrid	Catch	-	6	3	2	11
	%	-	0.3	0.1	0.2	0.2
	CPUE	-	0.51	0.23	0.28	0.27
Smallmouth bass	Catch	75	117	180	143	515
	%	5.7	6.7	7.3	10.8	7.5
	CPUE	8.69	9.92	13.71	20.37	12.69
Largemouth bass	Catch	7	36	21	2	66
	%	0.5	2.1	0.9	0.2	1.0
	CPUE	0.81	3.05	1.60	0.28	1.63
White crappie	Catch	2	2	1	-	5
	%	0.2	0.1	+	-	0.1
	CPUE	0.23	0.17	0.08	-	0.12
Black crappie	Catch	-	5	1	-	6
	%	-	0.3	+	-	0.1
	CPUE	-	0.42	0.08	-	0.15
	Catch	1318	1750	2455	1319	6842
	%					

Table 6.3-7. Monthly species composition and relative abundance of target fishes electrofished from the Schuylkill River at S76440 in 1987 (+ = Less than 0.1%).

Species		Apr 1.02 Hrs	Jun 1.12 Hrs	Jul 1.92 Hrs	Aug 1.45 Hrs	Sep 1.63 Hrs	Oct 1.50 Hrs
Bowfin	Catch	-	-	-	1	-	-
	%	-	-	-	0.7	-	-
	CPUE	-	-	-	0.7	-	-
American eel	Catch	2	-	1	1	-	-
	%	0.7	-	0.6	0.7	-	-
	CPUE	2.0	-	0.5	0.7	-	-
Goldfish	Catch	11	13	28	33	6	7
	%	4.0	6.3	16.8	21.9	3.4	2.1
	CPUE	10.8	11.6	14.6	22.8	3.7	4.7
Carp	Catch	2	7	2	3	3	5
	%	0.7	3.4	1.2	2.0	1.7	1.5
	CPUE	2.0	6.3	1.0	2.1	1.8	3.3
Golden shiner	Catch	1	-	-	-	1	37
	%	0.4	-	-	-	0.6	10.9
	CPUE	1.0	-	-	-	0.6	24.7
Minnow hybrid	Catch	-	1	-	-	-	1
	%	-	0.5	-	-	-	0.3
	CPUE	-	0.9	-	-	-	0.7
White sucker	Catch	52	2	3	5	2	10
	%	18.8	1.0	1.8	3.3	1.1	2.9
	CPUE	51.0	1.8	1.6	3.4	1.2	6.7
White catfish	Catch	-	-	-	1	-	-
	%	-	-	-	0.7	-	-
	CPUE	-	-	-	0.7	-	-
Yellow bullhead	Catch	9	38	19	18	29	20
	%	3.2	18.4	11.4	11.9	16.4	5.9
	CPUE	8.8	33.9	9.9	12.4	17.8	13.3
Brown bullhead	Catch	3	16	15	6	10	14
	%	1.1	7.7	9.0	4.0	5.6	4.1
	CPUE	2.9	14.3	7.8	4.1	6.1	9.3
Rock bass	Catch	76	96	61	37	54	69
	%	27.4	46.4	36.5	24.5	30.5	20.4
	CPUE	74.5	85.7	31.8	25.5	33.1	46.0
Redbreast sunfish	Catch	62	24	21	19	51	74
	%	22.4	11.6	12.6	12.6	28.8	21.8
	CPUE	60.8	21.4	10.9	13.1	31.3	49.3
Green sunfish	Catch	6	2	9	6	-	4
	%	2.2	1.0	5.4	4.0	-	1.2
	CPUE	5.9	1.8	4.7	4.1	-	2.7
Pumpkinseed	Catch	21	6	5	13	9	62
	%	7.6	2.9	3.0	8.6	5.1	18.3
	CPUE	20.6	5.4	2.6	9.0	5.5	41.3
Bluegill	Catch	-	-	-	-	-	9
	%	-	-	-	-	-	2.7
	CPUE	-	-	-	-	-	6.0
Smallmouth bass	Catch	32	2	3	7	11	20
	%	11.6	1.0	1.8	4.6	6.2	5.9
	CPUE	31.4	1.8	1.6	4.8	6.7	13.3
Largemouth bass	Catch	-	-	-	1	1	5
	%	-	-	-	0.7	0.6	1.5
	CPUE	-	-	-	0.7	0.6	3.3

Table 6.3-7. (continued)

Species		Apr 1.02 Hrs	Jun 1.12 Hrs	Jul 1.92 Hrs	Aug 1.45 Hrs	Sep 1.63 Hrs	Oct 1.50 Hrs
White crappie	Catch	-	-	-	-	-	2
	%	-	-	-	-	-	0.6
	CPUE	-	-	-	-	-	1.3

CPUE = Number caught per hour of electrofishing.

Table 6.3-8. Monthly species composition and relative abundance of target fishes electrofished from the Schuylkill River at 376940 in 1987 (+ = Less than 0.1%).

Species		Jan 0.98 Hrs	Mar 0.63 Hrs	Apr 1.23 Hrs	Jun 1.40 Hrs	Jul 1.23 Hrs	Aug 1.38 Hrs	Sep 1.40 Hrs	Oct 1.12 Hrs	Nov 1.40 Hrs	Dec 1.02 Hrs
Bowfin	Catch	-	-	-	-	-	-	-	-	-	1
	%	-	-	-	-	-	-	-	-	-	0.9
	CPUE	-	-	-	-	-	-	-	-	-	1.0
American eel	Catch	-	-	-	-	1	1	-	-	-	-
	%	-	-	-	-	0.7	1.0	-	-	-	-
	CPUE	-	-	-	-	0.8	0.7	-	-	-	-
Goldfish	Catch	62	69	84	69	41	29	11	4	3	3
	%	37.3	56.1	27.6	26.0	28.7	29.6	4.4	2.5	2.2	2.8
	CPUE	63.3	109.5	68.3	49.3	33.3	21.0	7.9	3.6	2.1	2.9
Carp	Catch	3	4	3	8	1	2	9	3	10	4
	%	1.8	3.3	1.0	3.0	0.7	2.0	3.6	1.9	7.5	3.8
	CPUE	3.1	6.3	2.4	5.7	0.8	1.4	6.4	2.7	7.1	3.9
Golden shiner	Catch	2	-	4	11	9	1	8	19	7	-
	%	1.2	-	1.3	4.2	6.3	1.0	3.2	11.8	5.2	-
	CPUE	2.0	-	3.3	7.9	7.3	0.7	5.7	17.0	5.0	-
Fallfish	Catch	-	-	3	-	-	-	-	-	-	-
	%	-	-	1.0	-	-	-	-	-	-	-
	CPUE	-	-	2.4	-	-	-	-	-	-	-
Minnow hybrid	Catch	1	1	-	2	-	-	-	1	-	-
	%	0.6	0.8	-	0.8	-	-	-	0.6	-	-
	CPUE	1.0	1.6	-	1.4	-	-	-	0.9	-	-
Quillback	Catch	1	-	-	-	-	-	-	-	-	-
	%	0.6	-	-	-	-	-	-	-	-	-
	CPUE	1.0	-	-	-	-	-	-	-	-	-
White sucker	Catch	23	3	52	24	9	1	8	4	21	14
	%	13.9	2.4	17.1	9.1	6.3	1.0	3.2	2.5	15.7	13.2
	CPUE	23.5	4.8	42.3	17.1	7.3	0.7	5.7	3.6	15.0	13.7
Creek chubsucker	Catch	3	-	1	-	-	-	5	1	2	-
	%	1.8	-	0.3	-	-	-	2.0	0.6	1.5	-
	CPUE	3.1	-	0.8	-	-	-	3.6	0.9	1.4	-
Yellow bullhead	Catch	21	7	8	17	14	13	5	6	2	10
	%	12.7	5.7	2.6	6.4	9.8	13.3	2.0	3.7	1.5	9.4
	CPUE	21.4	11.1	6.5	12.1	11.4	9.4	3.6	5.4	1.4	9.8
Brown bullhead	Catch	18	15	8	57	7	9	16	8	15	42
	%	10.8	12.2	2.6	21.5	4.9	9.2	6.4	5.0	11.2	39.6
	CPUE	18.4	23.8	6.5	40.7	5.7	6.5	11.4	7.1	10.7	41.2

Table 6.3-8. (continued)

Species		Jan 0.98 Hrs	Mar 0.63 Hrs	Apr 1.23 Hrs	Jun 1.40 Hrs	Jul 1.23 Hrs	Aug 1.38 Hrs	Sep 1.40 Hrs	Oct 1.12 Hrs	Nov 1.40 Hrs	Dec 1.02 Hrs
Rock bass	Catch	13	11	38	27	23	23	49	38	12	8
	%	7.8	8.9	12.5	10.2	16.1	23.5	19.6	23.6	9.0	7.5
	CPUE	13.3	17.5	30.9	19.3	18.7	16.7	35.0	33.9	8.6	7.8
Redbreast sunfish	Catch	2	3	44	16	16	10	27	37	6	4
	%	1.2	2.4	14.5	6.0	11.2	10.2	10.8	23.0	4.5	3.8
	CPUE	2.0	4.8	35.8	11.4	13.0	7.2	19.3	33.0	4.3	3.9
Green sunfish	Catch	1	1	10	4	3	-	1	-	1	-
	%	0.6	0.8	3.3	1.5	2.1	-	0.4	-	0.7	-
	CPUE	1.0	1.6	8.1	2.9	2.4	-	0.7	-	0.7	-
Pumpkinseed	Catch	9	1	25	22	15	8	48	13	23	14
	%	5.4	0.8	8.2	8.3	10.5	8.2	19.2	8.1	17.2	13.2
	CPUE	9.2	1.6	20.3	15.7	12.2	5.8	34.3	11.6	16.4	13.7
Bluegill	Catch	-	-	1	-	-	-	4	7	1	1
	%	-	-	0.3	-	-	-	1.6	4.3	0.7	0.9
	CPUE	-	-	0.8	-	-	-	2.9	6.3	0.7	1.0
Lepomis hybrid	Catch	-	-	2	1	1	-	2	-	-	-
	%	-	-	0.7	0.4	0.7	-	0.8	-	-	-
	CPUE	-	-	1.6	0.7	0.8	-	1.4	-	-	-
Smallmouth bass	Catch	6	7	21	7	2	-	30	17	25	2
	%	3.6	5.7	6.9	2.6	1.4	-	12.0	10.6	18.7	1.9
	CPUE	6.1	11.1	17.1	5.0	1.6	-	21.4	15.2	17.9	2.0
Largemouth bass	Catch	1	-	-	-	1	1	21	3	6	3
	%	0.6	-	-	-	0.7	1.0	8.4	1.9	4.5	2.8
	CPUE	1.0	-	-	-	0.8	0.7	15.0	2.7	4.3	2.9
White crappie	Catch	-	-	-	-	-	-	2	-	-	-
	%	-	-	-	-	-	-	0.8	-	-	-
	CPUE	-	-	-	-	-	-	1.4	-	-	-
Black crappie	Catch	-	1	-	-	-	-	4	-	-	-
	%	-	0.8	-	-	-	-	1.6	-	-	-
	CPUE	-	1.6	-	-	-	-	2.9	-	-	-

CPUE = Number caught per hour of electrofishing.

Table 6.3-9. Monthly species composition and relative abundance of target fishes electrofished from the Schuylkill River at S77640 in 1987 (+ = Less than 0.1%).

Species		Jan 1.25 Hrs	Mar 1.15 Hrs	Apr 1.28 Hrs	Jun 1.33 Hrs	Jul 1.20 Hrs	Aug 1.68 Hrs	Sep 1.50 Hrs	Oct 1.12 Hrs	Nov 1.63 Hrs	Dec 0.98 Hrs
American eel	Catch	-	-	-	1	-	-	-	-	-	-
	%	-	-	-	0.5	-	-	-	-	-	-
	CPUE	-	-	-	0.8	-	-	-	-	-	-
Alewife	Catch	-	-	-	-	-	-	1	-	-	-
	%	-	-	-	-	-	-	0.3	-	-	-
	CPUE	-	-	-	-	-	-	0.7	-	-	-
Chain pickerel	Catch	-	-	-	-	-	-	-	-	-	1
	%	-	-	-	-	-	-	-	-	-	0.5
	CPUE	-	-	-	-	-	-	-	-	-	1.0
Goldfish	Catch	220	231	63	22	12	13	20	5	53	31
	%	50.9	60.2	14.0	11.1	36.4	31.0	5.1	8.1	19.7	16.1
	CPUE	176.0	200.9	49.2	16.5	10.0	7.7	13.3	4.5	32.5	31.6
Carp	Catch	4	10	10	8	-	4	10	1	7	9
	%	0.9	2.6	2.2	4.0	-	9.5	2.6	1.6	2.6	4.7
	CPUE	3.2	8.7	7.8	6.0	-	2.4	6.7	0.9	4.3	9.2
Golden shiner	Catch	21	1	17	3	1	-	16	4	8	1
	%	4.9	0.3	3.8	1.5	3.0	-	4.1	6.5	3.0	0.5
	CPUE	16.8	0.9	13.3	2.3	0.8	-	10.7	3.6	4.9	1.0
Fallfish	Catch	-	-	-	-	-	-	-	-	-	1
	%	-	-	-	-	-	-	-	-	-	0.5
	CPUE	-	-	-	-	-	-	-	-	-	1.0
Minnow hybrid	Catch	-	1	1	-	-	-	1	-	-	-
	%	-	0.3	0.2	-	-	-	0.3	-	-	-
	CPUE	-	0.9	0.8	-	-	-	0.7	-	-	-
White sucker	Catch	18	27	22	1	1	-	30	2	10	17
	%	4.2	7.0	4.9	0.5	3.0	-	7.7	3.2	3.7	8.8
	CPUE	14.4	23.5	17.2	0.8	0.8	-	20.0	1.8	6.1	17.3
Creek chubsucker	Catch	2	-	-	-	-	-	-	-	-	-
	%	0.5	-	-	-	-	-	-	-	-	-
	CPUE	1.6	-	-	-	-	-	-	-	-	-
White catfish	Catch	-	-	-	-	-	-	1	-	-	-
	%	-	-	-	-	-	-	0.3	-	-	-
	CPUE	-	-	-	-	-	-	0.7	-	-	-
Yellow bullhead	Catch	19	24	23	31	11	11	23	2	5	40
	%	4.4	6.3	5.1	15.7	33.3	26.2	5.9	3.2	1.9	20.7
	CPUE	15.2	20.9	18.0	23.3	9.2	6.5	15.3	1.8	3.1	40.8

Table 6.3-9. (continued)

Species		Jan 1.25 Hrs	Mar 1.15 Hrs	Apr 1.28 Hrs	Jun 1.33 Hrs	Jul 1.20 Hrs	Aug 1.68 Hrs	Sep 1.50 Hrs	Oct 1.12 Hrs	Nov 1.63 Hrs	Dec 0.98 Hrs
Brown bullhead	Catch	13	39	17	23	4	3	23	10	51	49
	%	3.0	10.2	3.8	11.6	12.1	7.1	5.9	16.1	19.0	25.4
	CPUE	10.4	33.9	13.3	17.3	3.3	1.8	15.3	8.9	31.3	50.0
Channel catfish	Catch	-	-	-	-	-	-	1	-	-	-
	%	-	-	-	-	-	-	0.3	-	-	-
	CPUE	-	-	-	-	-	-	0.7	-	-	-
Rock bass	Catch	21	8	89	53	4	4	77	10	52	10
	%	4.9	2.1	19.8	26.8	12.1	9.5	19.6	16.1	19.3	5.2
	CPUE	16.8	7.0	69.5	39.8	3.3	2.4	51.3	8.9	31.9	10.2
Redbreast sunfish	Catch	5	7	81	25	-	5	78	5	16	4
	%	1.2	1.8	18.0	12.6	-	11.9	19.9	8.1	5.9	2.1
	CPUE	4.0	6.1	63.3	18.8	-	3.0	52.0	4.5	9.8	4.1
Green sunfish	Catch	4	3	9	10	-	2	5	2	-	1
	%	0.9	0.8	2.0	5.1	-	4.8	1.3	3.2	-	0.5
	CPUE	3.2	2.6	7.0	7.5	-	1.2	3.3	1.8	-	1.0
Pumpkinseed	Catch	84	22	60	13	-	-	58	5	34	17
	%	19.4	5.7	13.3	6.6	-	-	14.8	8.1	12.6	8.8
	CPUE	67.2	19.1	46.9	9.8	-	-	38.7	4.5	20.9	17.3
Bluegill	Catch	-	-	1	-	-	-	-	-	-	-
	%	-	-	0.2	-	-	-	-	-	-	-
	CPUE	-	-	0.8	-	-	-	-	-	-	-
Lepomis hybrid	Catch	-	-	-	1	-	-	2	-	-	-
	%	-	-	-	0.5	-	-	0.5	-	-	-
	CPUE	-	-	-	0.8	-	-	1.3	-	-	-
Smallmouth bass	Catch	18	10	56	6	-	-	35	14	30	11
	%	4.2	2.6	12.4	3.0	-	-	8.9	22.6	11.2	5.7
	CPUE	14.4	8.7	43.8	4.5	-	-	23.3	12.5	18.4	11.2
Largemouth bass	Catch	1	1	1	1	-	-	11	2	3	1
	%	0.2	0.3	0.2	0.5	-	-	2.8	3.2	1.1	0.5
	CPUE	0.8	0.9	0.8	0.8	-	-	7.3	1.8	1.8	1.0
White crappie	Catch	1	-	-	-	-	-	-	-	-	-
	%	0.2	-	-	-	-	-	-	-	-	-
	CPUE	0.8	-	-	-	-	-	-	-	-	-
Black crappie	Catch	1	-	-	-	-	-	-	-	-	-
	%	0.2	-	-	-	-	-	-	-	-	-
	CPUE	0.8	-	-	-	-	-	-	-	-	-

CPUE = Number caught per hour of electrofishing.

Table 6.3-10. Monthly species composition and relative abundance of target fishes electrofished from the Schuylkill River at S79310 in 1987 (+ = Less than 0.1%).

Species		Apr 0.85 Hrs	Jun 1.17 Hrs	Jul 1.42 Hrs	Aug 1.18 Hrs	Sep 0.85 Hrs	Oct 1.55 Hrs
American eel	Catch	-	2	-	-	-	1
	%	-	0.9	-	-	-	0.3
	CPUE	-	1.7	-	-	-	0.6
Goldfish	Catch	1	14	12	7	7	18
	%	0.4	6.3	7.7	3.7	3.2	5.9
	CPUE	1.2	12.0	8.5	5.9	8.2	11.6
Carp	Catch	4	3	1	-	7	1
	%	1.7	1.3	0.6	-	3.2	0.3
	CPUE	4.7	2.6	0.7	-	8.2	0.6
Fallfish	Catch	2	-	-	-	-	-
	%	0.9	-	-	-	-	-
	CPUE	2.4	-	-	-	-	-
Minnow hybrid	Catch	-	1	-	-	-	-
	%	-	0.4	-	-	-	-
	CPUE	-	0.9	-	-	-	-
White sucker	Catch	39	13	8	9	29	5
	%	16.9	5.8	5.1	4.8	13.4	1.6
	CPUE	45.9	11.1	5.6	7.6	34.1	3.2
Yellow bullhead	Catch	15	56	22	21	16	47
	%	6.5	25.1	14.1	11.2	7.4	15.4
	CPUE	17.6	47.9	15.5	17.8	18.8	30.3
Brown bullhead	Catch	1	1	-	-	3	4
	%	0.4	0.4	-	-	1.4	1.3
	CPUE	1.2	0.9	-	-	3.5	2.6
Rock bass	Catch	37	69	59	42	52	78
	%	16.0	30.9	37.8	22.3	24.1	25.6
	CPUE	43.5	59.0	41.5	35.6	61.2	50.3
Redbreast sunfish	Catch	85	47	46	72	73	112
	%	36.8	21.1	29.5	38.3	33.8	36.7
	CPUE	100.0	40.2	32.4	61.0	85.9	72.3
Green sunfish	Catch	1	4	5	15	1	-
	%	0.4	1.8	3.2	8.0	0.5	-
	CPUE	1.2	3.4	3.5	12.7	1.2	-
Pumpkinseed	Catch	2	-	-	1	-	1
	%	0.9	-	-	0.5	-	0.3
	CPUE	2.4	-	-	0.8	-	0.6
Lepomis hybrid	Catch	-	-	-	2	-	-
	%	-	-	-	1.1	-	-
	CPUE	-	-	-	1.7	-	-
Smallmouth bass	Catch	44	13	3	19	27	37
	%	19.0	5.8	1.9	10.1	12.5	12.1
	CPUE	51.8	11.1	2.1	16.1	31.8	23.9
Largemouth bass	Catch	-	-	-	-	1	1
	%	-	-	-	-	0.5	0.3
	CPUE	-	-	-	-	1.2	0.6

CPUE = Number caught per hour of electrofishing.

Table 6.3-11. List of representative important fish species of the Schuylkill River.

Common name	Scientific name
Freshwater eel family	Anguillidae
American eel	*Anguilla rostrata*
Herring family	Clupeidae
American shad	*Alosa sapidissima*
Pike family	Esocidae
Muskellunge	*Esox masquinongy*
Minnow family	Cyprinidae
Goldfish	*Carassius auratus*
Swallowtail shiner	*Notropis procne*
Spotfin shiner	*Notropis spilopterus*
Sucker family	Catostomidae
White sucker	*Catostomus commersoni*
Freshwater catfish family	Ictaluridae
Brown bullhead	*Ictalurus nebulosus*
Killifish family	Cyprinodontidae
Banded killifish	*Fundulus diaphanus*
Sunfish family	Centrarchidae
Redbreast sunfish	*Lepomis auritus*
Pumpkinseed	*Lepomis gibbosus*
Largemouth bass	*Micropterus salmoides*
Smallmouth bass[1]	*Micropterus dolomieui*
Perch family	Percidae
Tessellated darter	*Etheostoma olmstedi*

[1]Not considered in EROL, see RMC Environmental Services (1984).

Table 6.3-12. Annual catch-per-unit effort (CPUE) of more abundant species captured by electrofishing in the Schuylkill River near LGS, 1977-1987.

Status phase:	Preoperational							Postoperational		
Year:	1976	1977	1978	1981	1982	1983	1984	1985	1986	1987
Effort (hrs):	20.9	37.2	35.6	15.7	14.6	31.6	34.1	40.4	33.1	40.6
American eel	2.6	1.3	1.1	2.3	2.2	0.9	1.0	0.9	0.6	0.2
Gold-fish	9.9	46.0	12.3	18.3	12.1	42.9	7.4	125.3	192.5	29.6
Carp	1.0	2.0	0.5	1.7	1.0	17.1	3.0	10.0	14.8	3.6
Golden shiner	2.4	1.7	6.2	4.9	4.0	2.1	1.0	1.4	2.0	4.2
White sucker	34.9	29.2	22.1	37.5	16.2	25.7	19.4	17.8	21.2	11.4
Yellow bullhead	0.9	3.4	4.4	7.0	5.5	4.4	5.9	22.6	21.3	14.8
Brown bullhead	20.1	27.4	9.4	15.9	5.5	4.9	3.5	12.6	13.0	12.3
Rock bass	1.5	1.7	2.7	7.3	6.8	8.2	10.6	11.4	31.3	32.0
Redbreast sunfish	34.6	22.3	23.6	87.1	45.5	41.8	32.9	17.5	39.5	26.5
Green sunfish	7.3	3.3	2.0	3.7	1.3	3.6	2.9	1.6	3.9	2.7
Pumpkin-seed	14.3	11.1	9.1	14.5	17.9	17.2	14.1	8.0	12.3	14.6
Smallmouth bass	0.6	1.5	1.7	6.8	7.5	8.1	6.9	11.3	11.7	12.7
Largemouth bass	2.0	0.3	1.7	0.4	0.7	1.0	1.1	0.2	0.9	1.6

Table 6.3-13. Back-calculated mean lengths (mm) at annulus for redbreast sunfish collected from the Schuylkill River during October 1987.

Year	Location	No. of Specimens	Mean Length at Annulus I	II	III	IV
1987	S79400	128	44	95	125	N/A
	S77240	120	45	94	131	151
	S76440	109	42	93	138	N/A
*		357	43	94	133	151

Table 6.3-14. Back-calculated mean lengths (mm) at annulus for redbreast sunfish collected from the Schuylkill River during 1973, 1977, 1981, 1983, 1984, 1985, 1986, and 1987.

Year	No. of Specimens	Mean Length at Annulus I	II	III	IV	V
1973	521	38	92	130	144	153
1977	331	44	91	124	131	126
1981	355	45	97	133	155	156
1983	318	43	95	133	162	
1984	398	41	89	128	153	163
1985	258	39	84	126	153	156
1986	375	43	90	134	161	184
1987	357	43	94	133	151	

Table 6.3-15. Back-calculated mean lengths (mm) at annulus by age for redbreast sunfish collected from the Schuylkill River during 1981, 1983, 1984, 1985, 1986, and 1987.

Year	Age	No. of Specimens	I	II	III	IV	V
			Mean Length at Annulus				
1981	1	252	45				
	2	44	46	99			
	3	44	47	96	134		
	4	14	48	97	131	156	
	5	1	36	82	120	140	156
*		355					
1983	1	74	34				
	2	52	39	83			
	3	175	48	97	132		
	4	17	47	106	142	162	
*		318					
1984	1	298	42				
	2	29	34	89			
	3	26	39	83	124		
	4	39	46	93	129	153	
	5	6	46	95	132	150	163
*		398					
1985	1	24	30				
	2	142	40	80			
	3	53	38	89	125		
	4	32	45	95	131	156	
	5	7	37	79	110	143	156
*		258					
1986	1	334	43				
	2	12	44	94			
	3	20	41	83	134		
	4	6	42	91	129	156	
	5	3	45	115	150	174	184
*		375					
1987	1	164	44				
	2	175	43	95			
	3	13	41	89	135		
	4	5	42	83	126	151	
*		357					

Table 6.3-16. Age composition of redbreast sunfish collected from the Schuylkill River during 1975, 1981, 1983, 1984, 1985, 1986, and 1987.

		Number of Specimens					
Year	Location	I	II	III	IV	V	Total
1975	S77240	20	8	14	1		43
	S76440	20	14	9	2		45
*		40	22	23	3		88
1981	S79400	87	18	14	1		120
	S77240	61	14	21	11		107
	S76440	104	12	9	2	1	128
*		252	44	44	14	1	355
1983	S79400	36	15	49	5		105
	S77240	27	25	55	8		115
	S76440	11	12	71	4		98
*		74	52	175	17		318
1984	S79400	128	12	3	7		150
	S77240	87	10	11	15	3	126
	S76440	83	7	12	17	3	122
*		298	29	26	39	6	398
1985	S79400	12	50	19	12	2	95
	S77240	4	36	8	6	4	58
	S76440	8	56	26	14	1	105
*		24	142	53	32	7	258
1986	S79400	121	2	2			125
	S77240	111	5				116
	S76440	102	5	18	6	3	134
*		334	12	20	6	3	375
1987	S79400	44	80	4			128
	S77240	63	50	2	5		120
	S76440	57	45	7			109
*		164	175	13	5		357

Table 6.3-17. Monthly estimates of fishing pressure in angler hours and coefficient of variation in percent from the LGS creel survey area on the Schuylkill River in 1987.

Month	Angler-hours		C.V.-%
April	1,260		39.7
May	2,060		21.1
June	2,492		15.6
July	770		27.8
August	1,008		30.3
September	1,320		46.0
Total	8,910	Average C.V.:	30.0

Table 6.3-18. Distribution of angling parties throughout the LGS creel survey area in 1987.

Fishing area	River meter	Number of parties	% total	Number of anglers	% total
Towpath park	82000	27	20.5	41	14.7
Sprogles Run	80300	18	13.6	42	15.1
Sanatoga Creek	79100	14	10.6	28	10.1
RMC boat ramp	77700	3	2.3	7	2.5
LGS discharge	77200	3	2.3	8	2.9
Linfield	75400	31	23.5	69	24.8
Home Water Co.	73880	7	5.3	16	5.8
Vincent pool	72500	7	5.3	15	5.4
Vincent Dam	71960	22	16.7	52	18.7
	Total		132		278

Table 6.3-19. Fishes caught by anglers from the Schuylkill River near LGS by month in 1987.

Species	Apr	May	Jun	Jul	Aug	Sep	Total	%
American eel	-	-	33	-	-	-	33	0.3
Carp	79	76	334	42	-	441	972	8.3
Goldfish	-	19	33	21	-	-	73	0.6
Brown bullhead	171	29	-	-	-	441	641	5.5
Yellow bullhead	26	-	-	63	-	29	118	1.0
Channel catfish	40	-	33	126	212	29	440	3.7
Catfish spp.	79	285	267	400	-	206	1,237	10.5
Trout spp.	-	10	-	-	-	-	10	0.1
Rock bass	106	399	64	-	-	59	628	5.3
Redbreast sunfish	-	19	-	-	-	29	48	0.4
Bluegill	-	-	64	-	-	-	64	0.5
Sunfish spp.	79	989	801	147	-	294	2,310	19.7
Black crappie	13	-	-	-	-	-	13	0.1
Crappie spp.	-	29	-	-	-	-	29	0.2
Smallmouth bass	53	1,246	1,468	189	1,592	588	5,136	43.7
Total	646	3,101	3,097	988	1,804	2,116	11,752	

Table 6.3-20. Fishes harvested by anglers from the Schuylkill River near LGS by month in 1987 (includes only fish caught and kept).

Species	Apr	May	Jun	Jul	Aug	Sep	Total	%
Carp	-	10	-	-	-	59	69	10.6
Goldfish	-	10	33	-	-	-	43	6.6
Brown bullhead	92	19	-	-	-	235	346	53.1
Yellow bullhead	-	-	-	21	-	29	50	7.7
Channel catfish	13	-	-	42	-	29	84	12.9
Rock bass	-	-	-	21	-	-	21	3.2
Redbreast sunfish	-	-	-	-	-	29	29	4.4
Smallmouth bass	-	10	-	-	-	-	10	1.5
Total	105	49	33	84	0	381	652	

Table 6.3-21. Percentages of anglers grouped by age and sex who fished the Schuylkill River near LGS in 1987.

Age	%
65 or older	2
20-64 yrs.	70
13-20 yrs.	15
12 or younger	13
Sex	
Male	89
Female	11

Table 6.3-22. Percentage of angler responses grouped by species of fish sought by anglers who fished the Schuylkill River near LGS in 1987.

Preferred species (grouped by general categories)	% of responses
Anything	31
Bass	29
Catfish	22
Carp	10
Sunfish	4
Muskellunge	2
Trout	1
American eel	1
Rock bass	<1

Table 6.3-23. Least-squares regression coefficients describing the linear relationship between ln-transformed lengths and weights of selected fishes from the Schuylkill River near LGS collected in 1976-1984.

Species	Sample size	Slope	Intercept	Coefficient of determination
Goldfish	2,644	3.10460014	-11.05914056	99
Carp	686	2.94723781	-10.40662330	99
White sucker	4,129	2.99114411	-11.16109878	99
Yellow bullhead	549	3.02266071	-11.24023592	98
Brown bullhead	1,668	3.08407761	-11.54300939	97
Rock bass	746	2.97538227	-10.57709883	98
Pumpkinseed	1,606	3.29393415	-11.96256713	98
Redbreast sunfish	6,201	3.24325837	-11.84168988	98
Smallmouth bass	619	3.00366306	-11.09945026	98

Table 6.3-24. Mean Relative Weight (Wr) by species at four station in the vicinity of LGS determined for early preoperational (1976-1978), late preoperational (1981-1984), and postoperational (1985-1987) status periods. Station S79310 was unaffected by LGS operation.

Species	Station	Status	Sample size	Mean Wr
Carp	S79310	Early preop	10	98.9
		Late preop	6	99.6
		Postop	63	97.1
	S77640	Early preop	18	102.7
		Late preop	215	100.7
		Postop	467	99.9
	S76940	Early preop	14	105.6
		Late preop	336	100.0
		Postop	296	98.4
	S76440	Early preop	8	104.7
		Late preop	80	101.2
		Postop	105	98.7
Goldfish	S79310	Early preop	48	101.3
		Late preop	12	101.5
		Postop	474	100.0
	S77640	Early preop	496	99.8
		Late preop	574	100.6
		Postop	3,402	96.6
	S76940	Early preop	166	103.1
		Late preop	825	101.8
		Postop	4,579	97.3
	S76440	Early preop	330	101.5
		Late preop	195	104.7
		Postop	1,371	99.6

Table 6.3-24. (continued)

Species	Station	Status	Sample size	Mean Wr
White sucker	S79310	Early preop	563	99.2
		Late preop	662	100.8
		Postop	412	102.8
	S77640	Early preop	472	100.7
		Late preop	572	102.6
		Postop	472	100.4
	S76940	Early preop	167	102.6
		Late preop	639	104.4
		Postop	647	103.2
	S76440	Early preop	664	99.5
		Late preop	391	100.4
		Postop	338	101.6
Brown bullhead	S79310	Early preop	96	101.1
		Late preop	46	106.1
		Postop	50	93.0
	S77640	Early preop	579	99.5
		Late preop	201	101.7
		Postop	617	94.6
	S76940	Early preop	134	99.8
		Late preop	206	103.7
		Postop	532	97.9
	S76440	Early preop	277	100.5
		Late preop	130	104.8
		Postop	225	100.7

Table 6.3-24. (continued)

Species	Station	Status	Sample size	Mean Wr
Yellow bullhead	S79310	Early preop	42	101.5
		Late preop	89	100.8
		Postop	645	95.8
	S77640	Early preop	57	99.1
		Late preop	99	101.1
		Postop	523	94.4
	S76940	Early preop	33	106.7
		Late preop	79	101.3
		Postop	453	92.8
	S76440	Early preop	70	96.8
		Late preop	81	103.6
		Postop	580	96.3
Rock bass	S79310	Early preop	12	94.1
		Late preop	66	104.2
		Postop	754	99.8
	S77640	Early preop	38	99.3
		Late preop	159	99.4
		Postop	657	96.9
	S76940	Early preop	28	96.4
		Late preop	258	102.3
		Postop	551	95.8
	S76440	Early preop	49	101.0
		Late preop	137	100.4
		Postop	826	97.7

Table 6.3-24. (continued)

Species	Station	Status	Sample size	Mean Wr
Redbreast sunfish	S79310	Early preop	531	100.2
		Late preop	1,374	102.0
		Postop	1,275	106.4
	S77640	Early preop	483	98.6
		Late preop	1,215	101.2
		Postop	543	106.7
	S76940	Early preop	88	98.7
		Late preop	803	105.3
		Postop	524	107.3
	S76440	Early preop	476	100.2
		Late preop	1,232	102.7
		Postop	728	107.6
Pumpkinseed	S79310	Early preop	56	106.1
		Late preop	25	104.8
		Postop	22	102.1
	S77640	Early preop	231	96.8
		Late preop	434	99.1
		Postop	705	101.2
	S76940	Early preop	48	100.6
		Late preop	420	105.0
		Postop	372	103.3
	S76440	Early preop	250	98.1
		Late preop	143	106.1
		Postop	215	105.7

Table 6.3-24. (continued)

Species	Station	Status	Sample size	Mean Wr
Smallmouth bass	S79310	Early preop	48	106.5
		Late preop	105	99.0
		Postop	354	96.5
	S77640	Early preop	20	94.2
		Late preop	165	99.4
		Postop	460	94.6
	S76940	Early preop	5	96.7
		Late preop	147	101.7
		Postop	243	94.9
	S76440	Early preop	50	106.0
		Late preop	80	104.7
		Postop	294	96.9

Table 6.3-25. Pearson product-moment correlation coefficients between monthly relative abundance indices (CPUE and natural log transformed data) at S79310 (control) and three potentially affected stations near LGS. Correlations calculated separately for the 1976-1987 period of record (POR) and for the 1976-1984 preoperational (PREOP) period.

Species	Index	S77640 POR	S77640 PREOP	S76940 POR	S76940 PREOP	S76440 POR	S76440 PREOP
American eel	CPUE	ns	ns	0.38	0.33	0.58	0.58
	ln CPUE	0.28	ns	0.32	ns	0.48	0.51
Carp	CPUE	0.55	ns	0.62	ns	0.32	ns
	ln CPUE	0.45	ns	0.50	0.40	0.53	0.29
Goldfish	CPUE	0.52	ns	0.89	0.36	0.72	0.36
	ln CPUE	0.48	ns	0.59	ns	0.70	0.52
White sucker	CPUE	0.53	0.47	0.48	0.42	0.43	0.37
	ln CPUE	0.62	0.50	0.42	ns	0.44	0.39
Brown bullhead	CPUE	0.58	0.43	0.76	0.79	0.43	0.63
	ln CPUE	0.53	0.55	0.64	0.69	0.53	0.63
Yellow bullhead	CPUE	0.77	0.79	0.86	0.32	0.91	0.62
	ln CPUE	0.76	0.70	0.78	0.67	0.83	0.65
Rock bass	CPUE	0.81	ns	0.78	0.43	0.74	0.57
	ln CPUE	0.65	ns	0.73	0.53	0.75	0.54
Redbreast sunfish	CPUE	0.53	0.52	0.43	0.42	0.47	0.46
	ln CPUE	0.43	0.56	0.47	0.44	0.61	0.61
Pumpkinseed	CPUE	ns	ns	ns	ns	0.32	0.38
	ln CPUE	ns	ns	ns	ns	0.42	0.50
Smallmouth bass	CPUE	0.62	0.52	0.44	0.53	0.56	0.42
	ln CPUE	0.71	0.70	0.62	0.63	0.69	0.63

ns - no significant correlation found

Table 6.3-26. Pearson product-moment correlation coefficients between annual relative abundance indices (CPUE and natural long-transformed data) at S79310 (control) and three potentially affected stations near LGS. Correlations calculated separately for the 1976-1987 period of record (POR) and for the 1976-1984 preoperational (PREOP) period.

		S77640		S76940		S76440	
Species	Index	POR	PREOP	POR	PREOP	POR	PREOP
American eel	CPUE	ns	ns	0.69	ns	ns	ns
	ln CPUE	ns	ns	ns	ns	0.65	ns
Carp	CPUE	ns	ns	ns	ns	ns	ns
	ln CPUE	ns	ns	ns	ns	ns	ns
Goldfish	CPUE	ns	ns	0.84	ns	0.81	ns
	ln CPUE	0.76	ns	0.79	ns	0.77	ns
White sucker	CPUE	0.69	ns	0.84	0.83	ns	ns
	ln CPUE	ns	ns	0.74	ns	0.72	ns
Brown bullhead	CPUE	0.87	0.95	0.76	0.82	ns	ns
	ln CPUE	0.81	0.95	0.76	0.90	0.67	0.81
Yellow bullhead	CPUE	0.89	0.80	0.82	ns	0.96	0.92
	ln CPUE	0.92	0.80	0.80	ns	0.98	0.94
Rock bass	CPUE	0.94	ns	0.82	ns	0.98	0.98
	ln CPUE	0.93	0.77	0.81	ns	0.97	0.98
Redbreast sunfish	CPUE	0.74	0.93	0.78	0.86	0.86	0.88
	ln CPUE	ns	0.89	0.69	0.83	0.77	0.80
Pumpkinseed	CPUE	ns	ns	ns	ns	ns	ns
	ln CPUE	ns	ns	ns	0.90	ns	ns
Smallmouth bass	CPUE	0.90	0.95	ns	0.80	0.90	0.93
	ln CPUE	0.96	0.98	0.77	0.93	0.92	0.88

ns - no significant correlations found

Table 6.3-27. Significance Probability Level (SPL) of an approximate F-test, status mean square divided by the random year (status) mean square, based on natural-log transformed monthly CPUE, with and without control station CPUE as a covariate. Also listed is the coefficient of determination (r^2) between control and affected station CPUE.

Station:	S76440			S76940		
SPL:	with	without	r^2	with	without	r^2
Rock bass	0.131	0.018	0.56	0.925	0.084	0.53
Brown bullhead	0.043	0.198	0.28	0.475	0.906	0.41
Goldfish	0.834	0.061	0.49	0.629	0.169	0.35
White sucker	0.040	0.015	0.19	0.575	0.065	0.18
Carp	0.580	0.071	0.28	0.833	0.115	0.25
American eel	0.085	0.038	0.23	0.315	0.106	0.10
Pumpkinseed	0.956	0.434	0.17	0.428	0.055	ns
Smallmouth bass	0.101	0.080	0.48	0.717	0.446	0.38
Redbreast sunfish	0.509	0.942	0.37	0.357	0.114	0.22
Yellow bullhead	0.102	0.001	0.69	0.309	0.001	0.61

Station:	S77640			S79310 (control)
SPL:	with	without	r^2	without
Rock bass	0.114	0.027	0.42	0.004
Brown bullhead	0.279	0.430	0.28	0.617
Goldfish	0.618	0.026	0.23	0.183
White sucker	0.627	0.067	0.38	0.031
Carp	0.665	0.018	0.20	0.001
American eel	0.162	0.063	0.08	0.331
Pumpkinseed	0.608	0.766	ns	0.065
Smallmouth bass	0.115	0.072	0.50	0.076
Redbreast sunfish	0.013	0.004	0.18	0.459
Yellow bullhead	0.978	0.006	0.58	0.001

ns = no significant correlation between control and affected station CPUE

Table 6.3-28. Results of a dissimilarity index procedure applied to annual CPUE data from four electrofishing stations near LGS. Dissimilarity index compared preoperational and postoperational data sets.

Station	Dissimilarity Index	Species contributions to dissimilarity[1]		Period of greatest abundance
S76440	0.575	Rock bass	23.4	Postop
		Goldfish	17.4	Postop
		Yellow bullhead	13.0	Postop
		Pumpkinseed	5.4	Preop
		Redbreast sunfish	16.5	Preop
		White sucker	17.5	Preop
S76940	0.550	Goldfish	47.3	Postop
		White sucker	10.5	Preop
		Pumpkinseed	12.3	Preop
		Redbreast sunfish	21.6	Preop
S77640	0.576	Goldfish	39.5	Postop
		White sucker	13.7	Preop
		Redbreast sunfish	31.0	Preop
S79310	0.613	Rock bass	27.7	Postop
		Goldfish	26.4	Postop
		Redbreast sunfish	7.0	Preop
		White sucker	17.2	Preop

[1]Only species contributing > 5% listed

Table 6.3-29. Results of a dissimilarity index procedure applied to annual seine catches combined from stations near LGS. Dissimilarity index compared preoperational and post-operational data sets.

Dissimilarity index	Species contributions to dissimilarity[1]		Period of greatest abundance
0.593	Redbreast sunfish	25.0	Postop
	Spottail shiner	13.0	Postop
	Common shiner	8.7	Postop
	Swallowtail shiner	33.0	Preop

[1]Only species contributing > 5% listed

Table 6.3-30. Back-calculated fork lengths and annual length increments (mm) attained by Schuylkill River redbreast sunfish in the years 1977-1986 (all sample locations pooled). Sample sizes are in parentheses.

Year of growth	Length attained at the end of growing season				
	1	2	3	4	5
1977	48(14)	82(1)			
1978	48(44)	97(14)	120(1)		
1979	46(67)	96(44)	131(14)	140(1)	
1980	46(472)	100(67)	134(44)	156(14)	156(1)
1981	41(113)	96(221)	140(23)		
1982	35(162)	87(113)	131(221)	159(23)	
1983	41(464)	89(88)	129(61)	152(46)	163(6)
1984	37(49)	80(167)	125(59)	157(35)	156(7)
1985	43(507)	92(25)	132(25)	155(6)	184(3)
1986	44(164)	95(174)	135(13)	151(5)	
Mean increment 1977-1985	42(1893)	47(740)	36(448)	24(125)	13(17)
Mean increment 1986	44(164)	52(174)	46(151)	25(5)	

Table 6.3-31. Back-calculated fork lengths and annual length increments (mm) attained by Schuylkill River redbreast sunfish in the years 1977-1986 at locations S77240 and S76440 (pooled). Sample sizes are in parentheses.

Year of growth	Length attained at the end of growing season 1	2	3	4	5
1977	47(13)	82(1)			
1978	47(30)	97(13)	120(1)		
1979	46(44)	97(30)	132(13)	140(1)	
1980	45(327)	104(44)	137(30)	157(13)	156(1)
1981	41(83)	97(163)	141(18)		
1982	35(95)	87(83)	132(163)	159(18)	
1983	40(285)	88(57)	127(46)	154(37)	163(6)
1984	38(31)	80(115)	124(40)	156(23)	160(5)
1985	44(308)	92(19)	134(23)	155(6)	184(3)
1986	44(120)	94(95)	139(9)	151(5)	
Mean increment 1977-1985	42(1217)	48(525)	37(334)	24(98)	13(15)
Mean increment 1986	44(120)	52(95)	48(9)	25(5)	

Table 6.3-32. Back-calculated fork lengths and annual length increments (mm) attained by Schuylkill River redbreast sunfish in the years 1977-1986 at control station S79400. Sample sizes are in parentheses.

	Length attained at the end of growing season				
Year of growth	1	2	3	4	5
1977	55(1)				
1978	49(14)	94(1)			
1979	48(23)	93(14)	125(1)		
1980	46(145)	94(23)	130(14)	140(1)	
1981	40(30)	94(58)	136(5)		
1982	36(67)	86(30)	126(58)	160(5)	
1983	43(179)	91(31)	134(15)	142(9)	
1984	34(18)	80(52)	128(19)	159(12)	146(2)
1985	42(199)	91(6)	112(2)		
1986	45(44)	96(79)	125(4)		
Mean increment 1977-1985	43(676)	46(215)	34(114)	23(27)	10(2)
Mean increment 1986	45(44)	52(79)	42(4)		

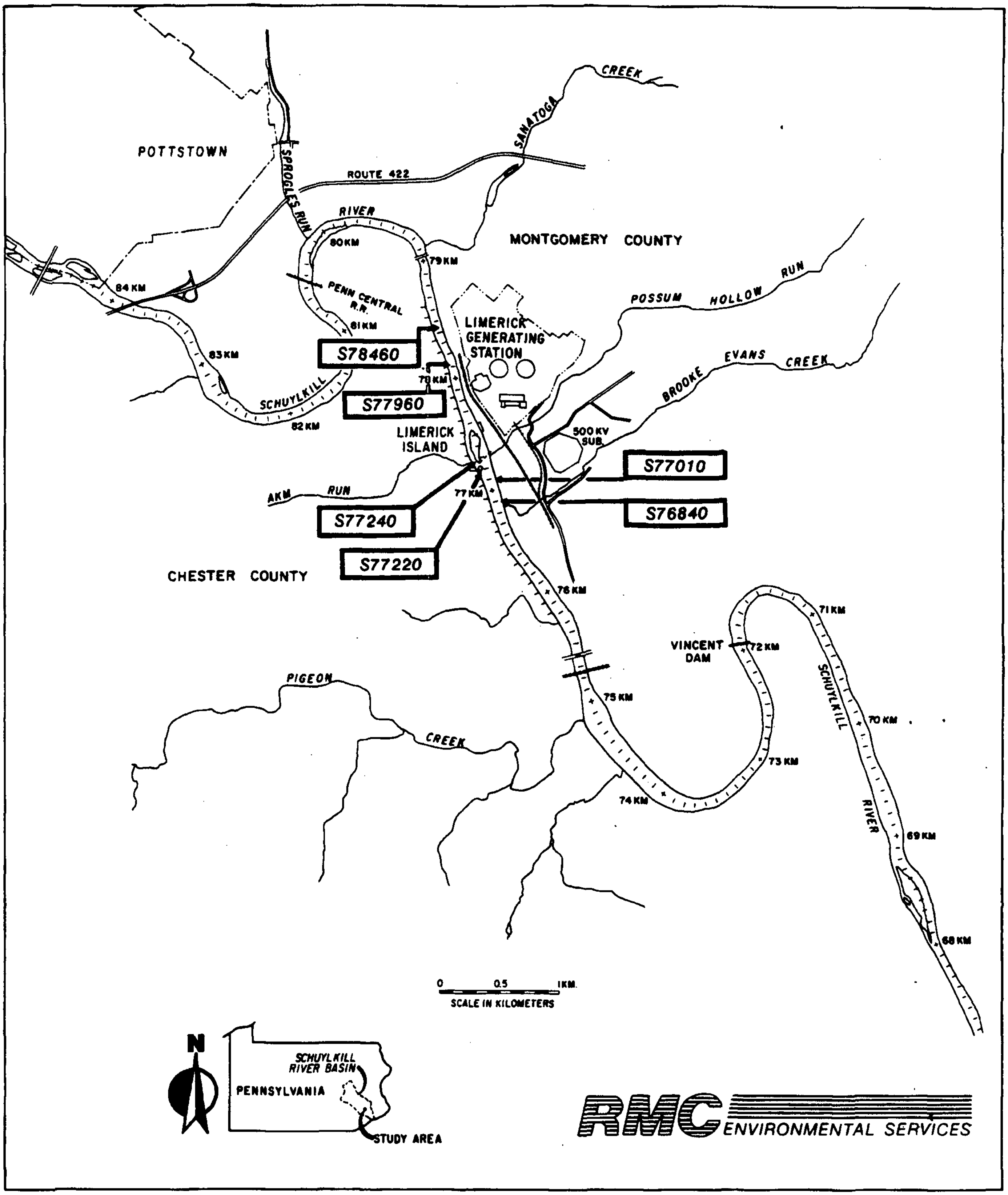


FIGURE 6.3-1 LOCATION OF SCHUYLKILL RIVER SEINE SITES SAMPLED, 1987.

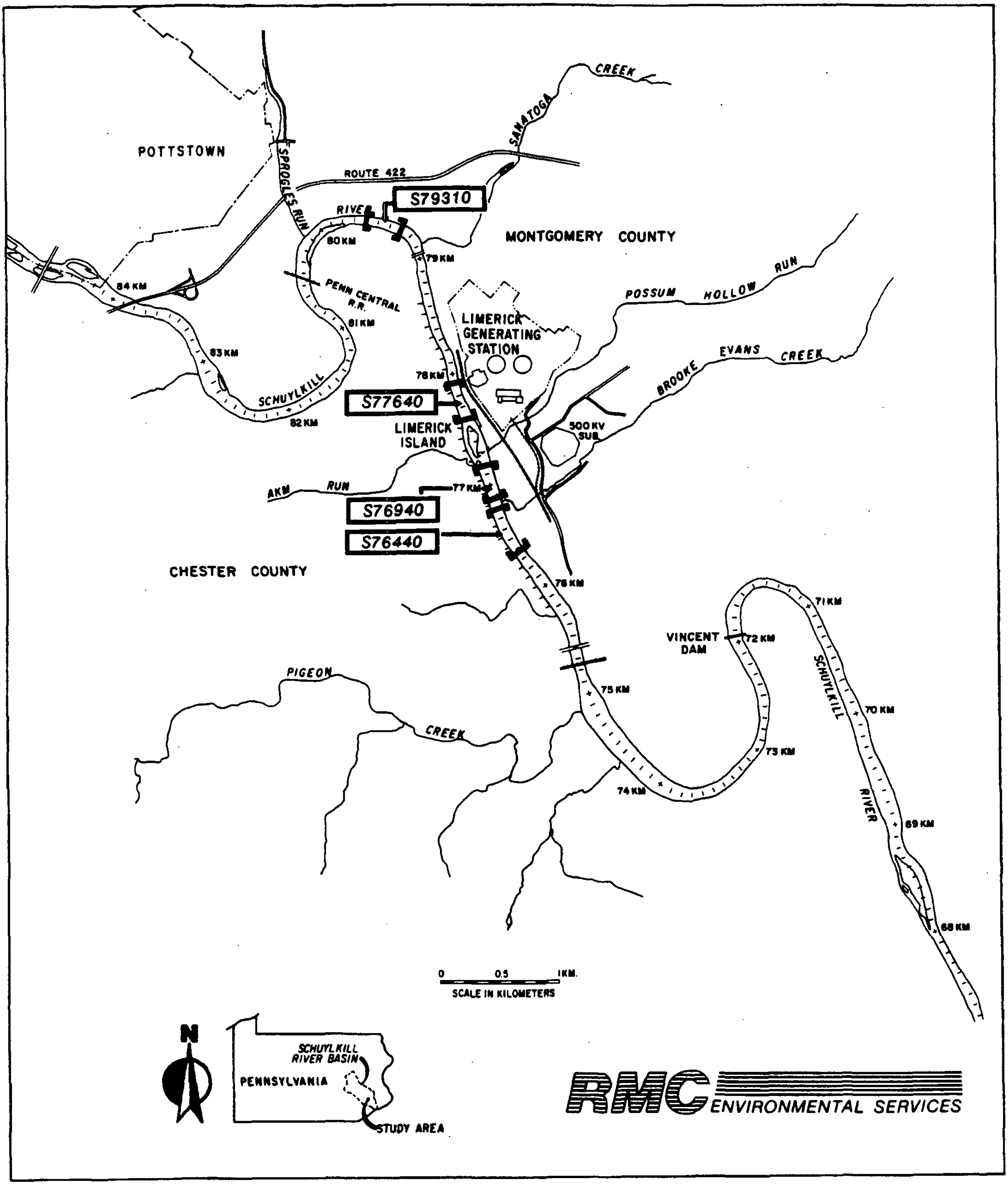


FIGURE 6.3-2 LOCATION OF SCHUYLKILL RIVER ELECTROFISHING SITES, 1987.

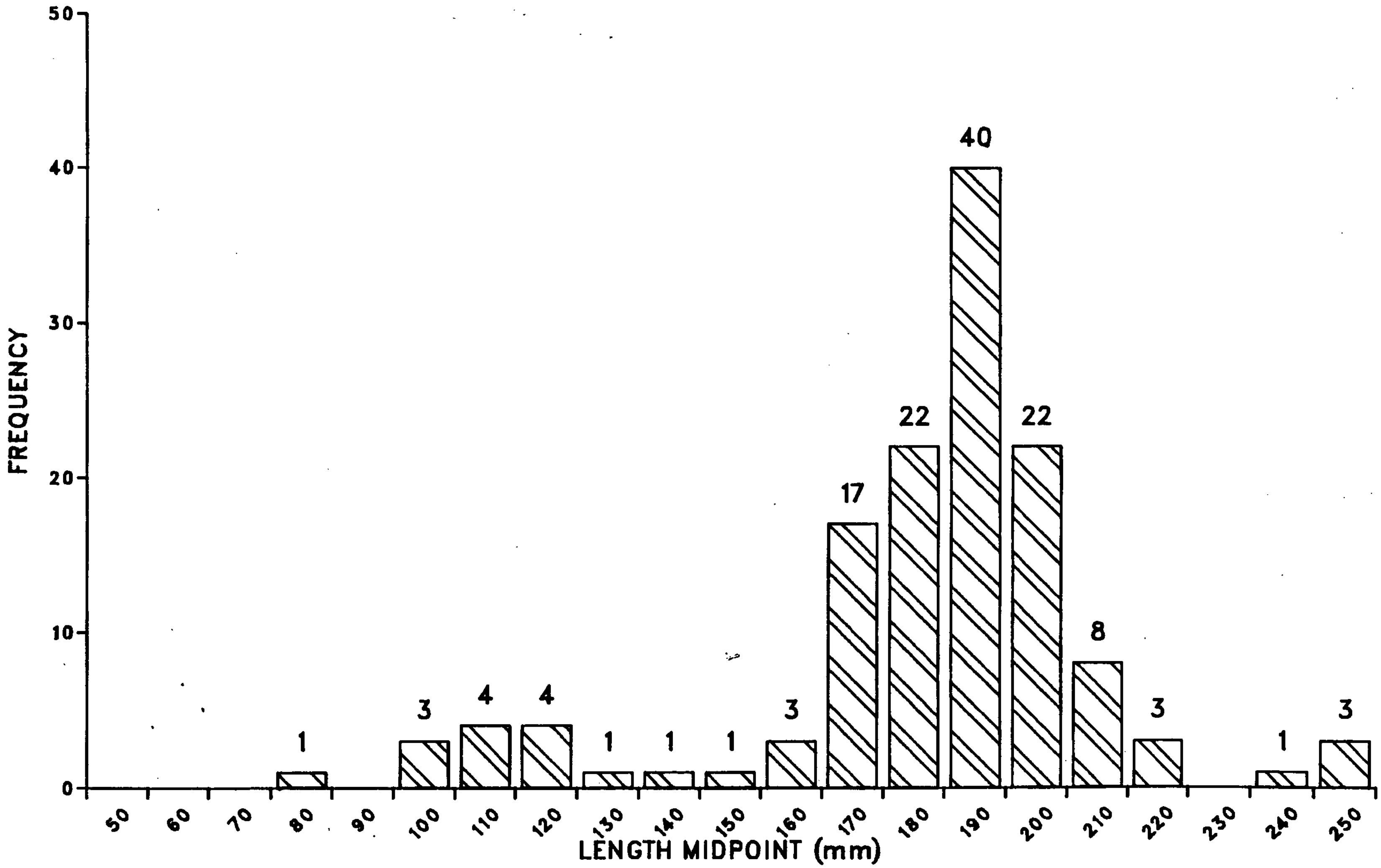


Figure 6.3–3. Length–frequency distribution of goldfish collected from the Schuylkill River, September–October 1987.

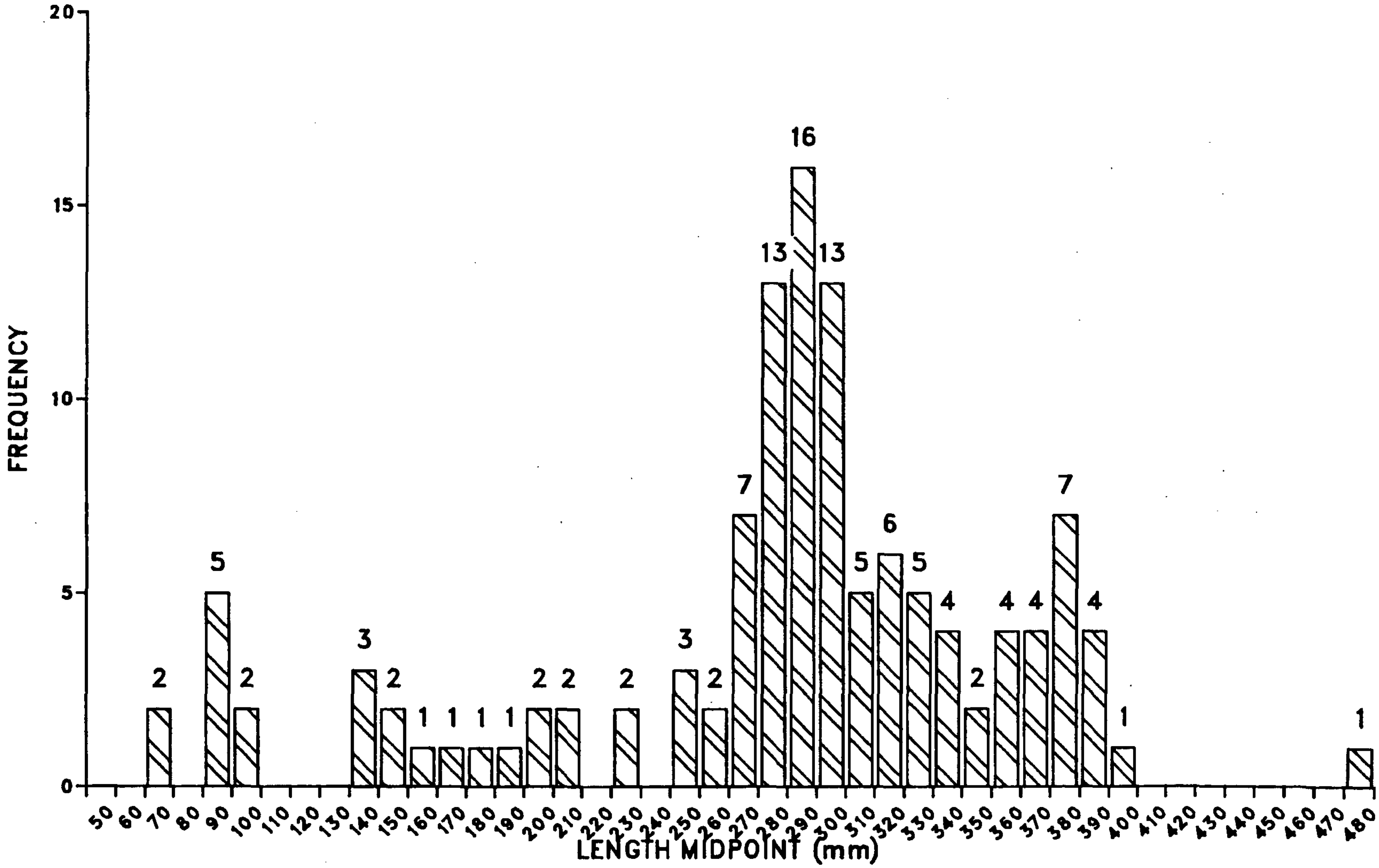


Figure 6.3–4. Length–frequency distribution of white sucker collected from the Schuylkill River, September–October 1987.

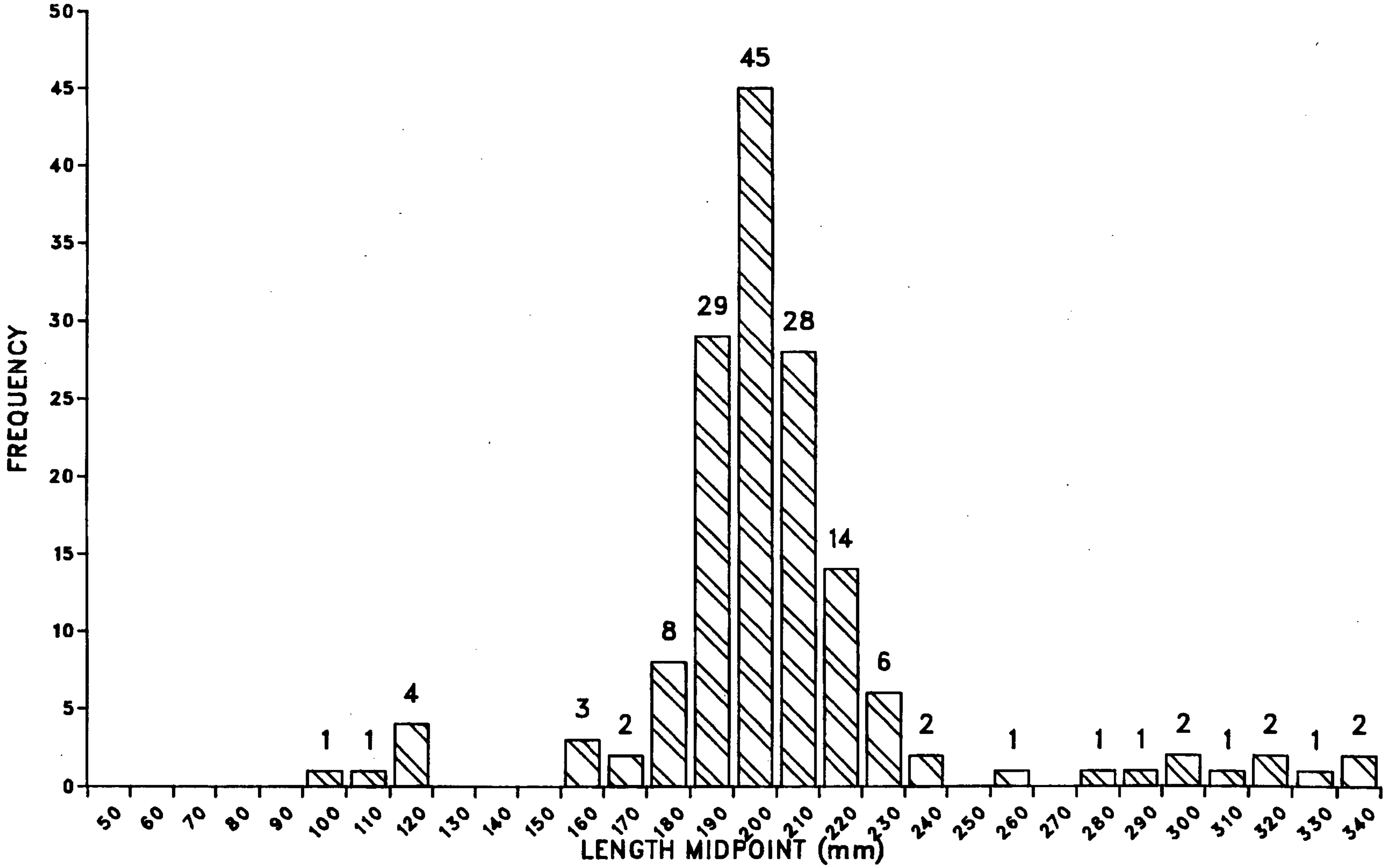


Figure 6.3–5. Length–frequency distribution of brown bullhead collected from the Schuylkill River, September–October 1987.

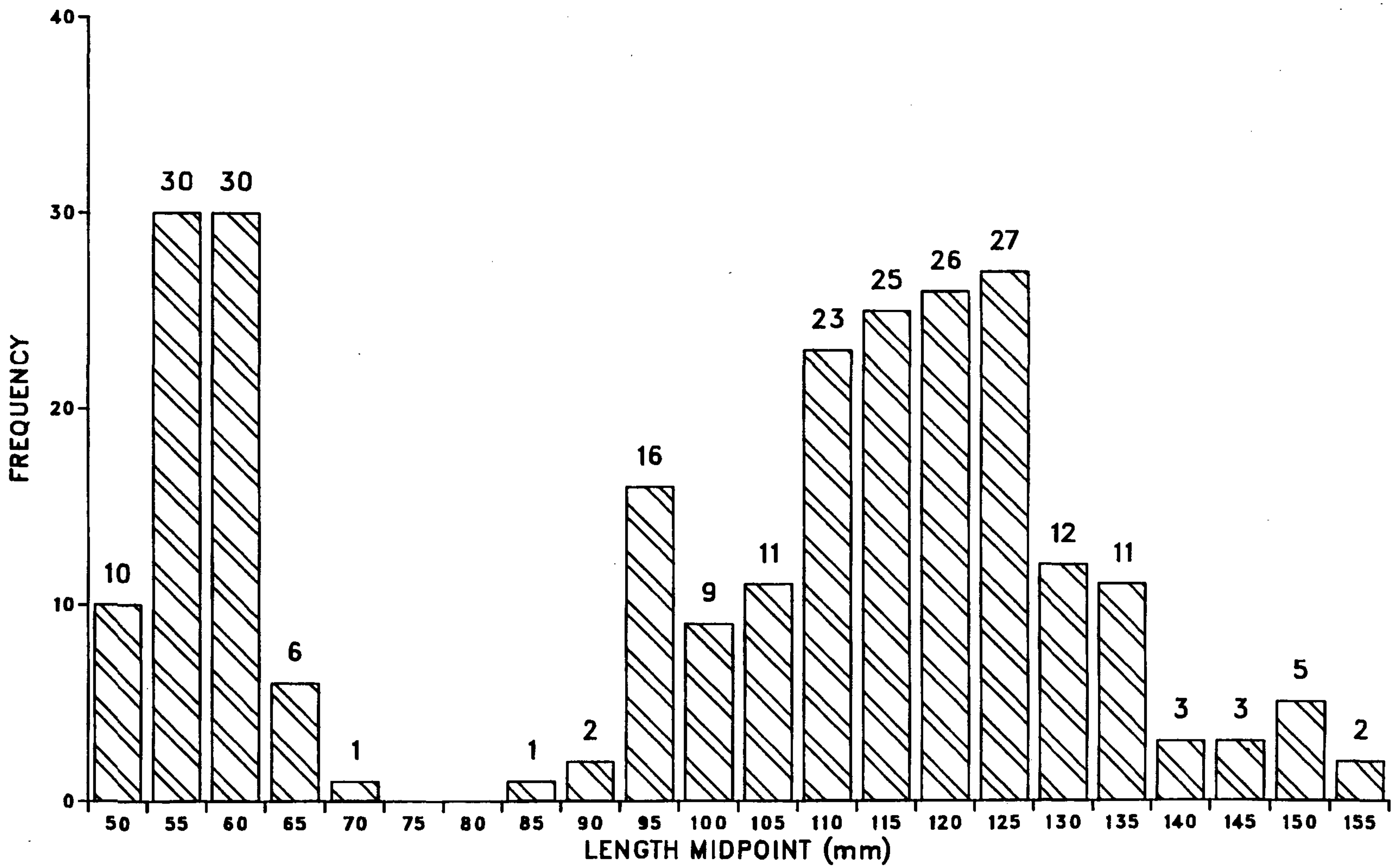


Figure 6.3–6. Length–frequency distribution of pumpkinseed collected from the Schuylkill River, September–October 1987.

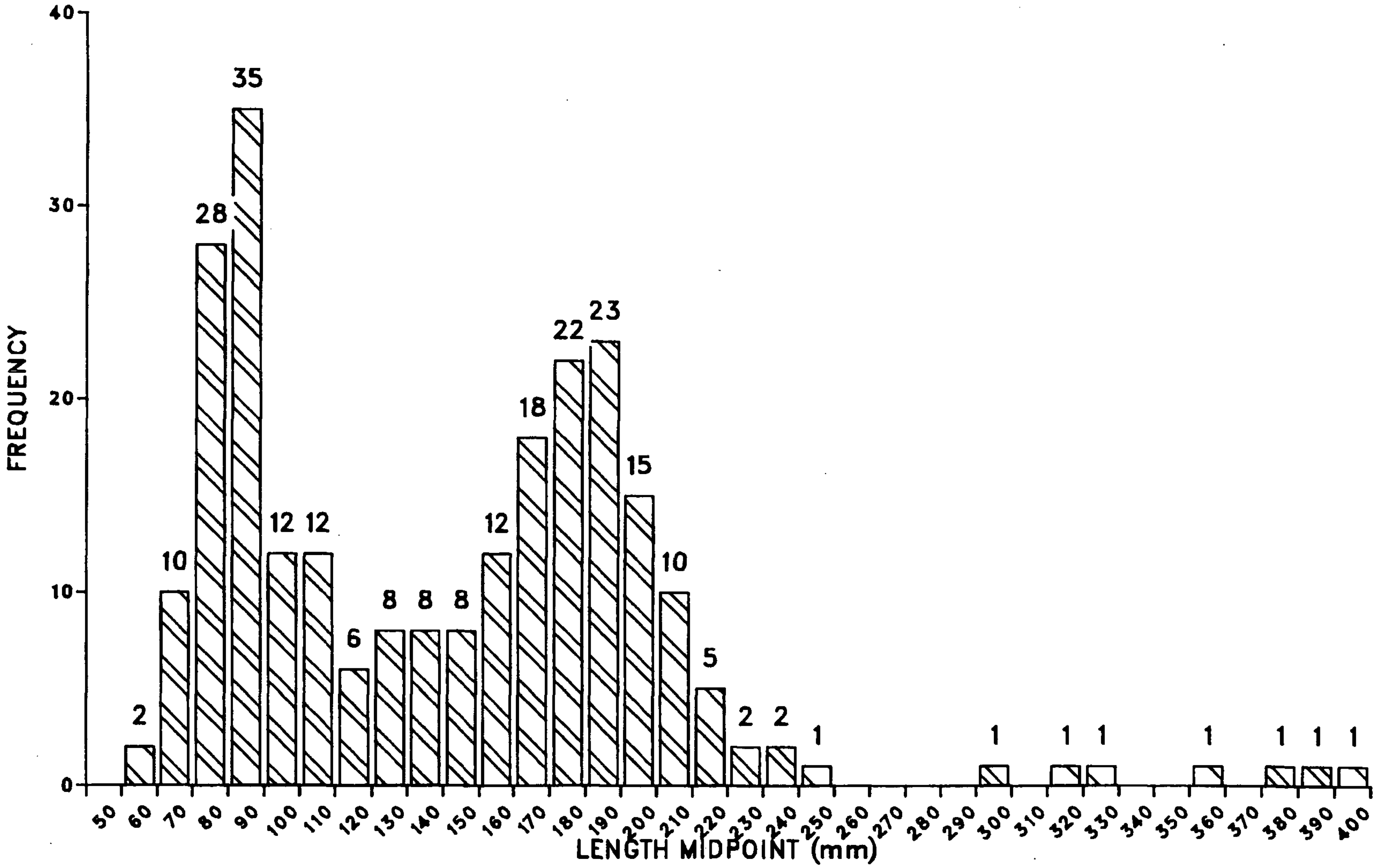


Figure 6.3–7. Length–frequency distribution of smallmouth bass collected from the Schuylkill River, September–October 1987.

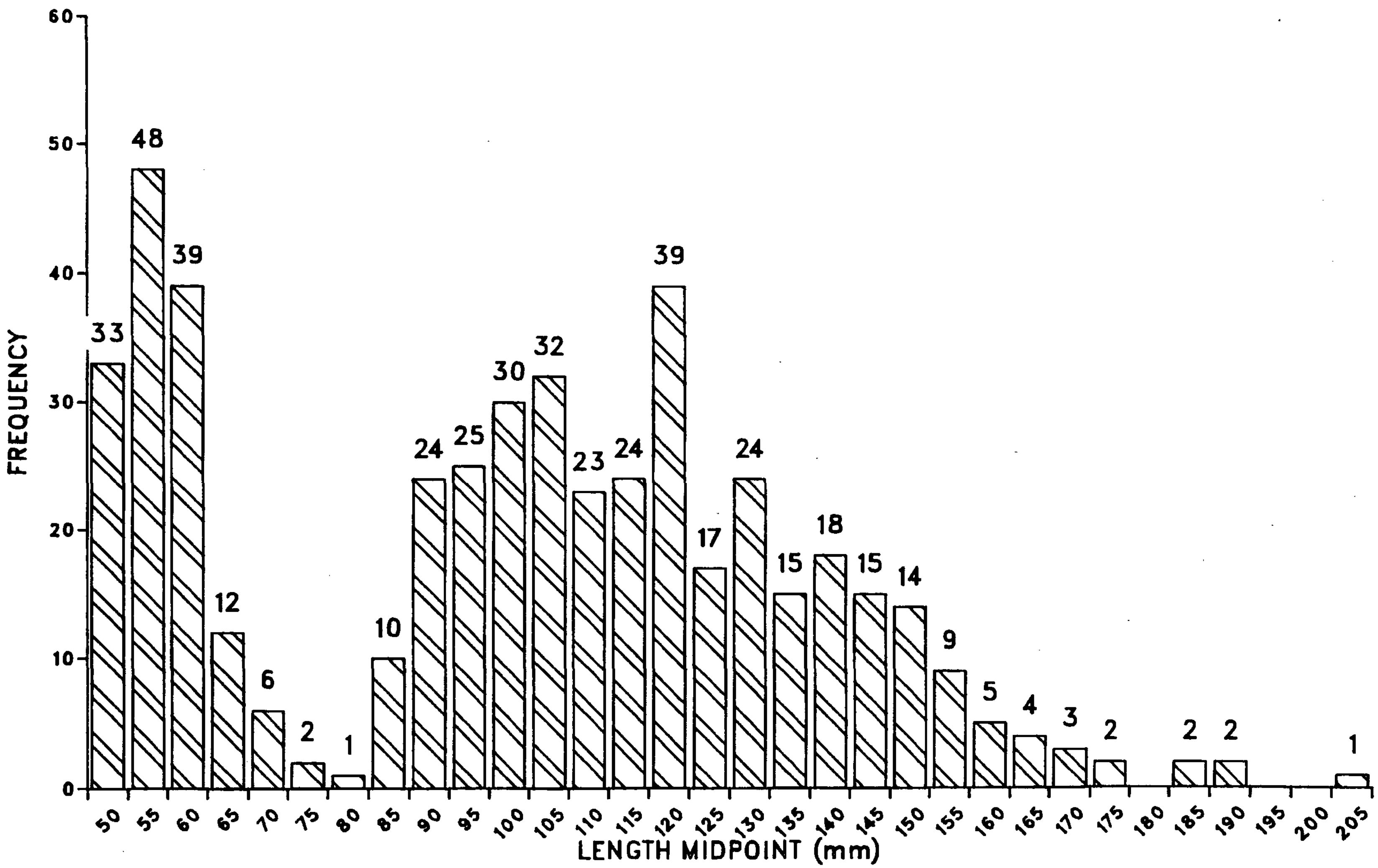


Figure 6.3–8. Length–frequency distribution of redbreast sunfish collected from the Schuylkill River, September–October 1987.

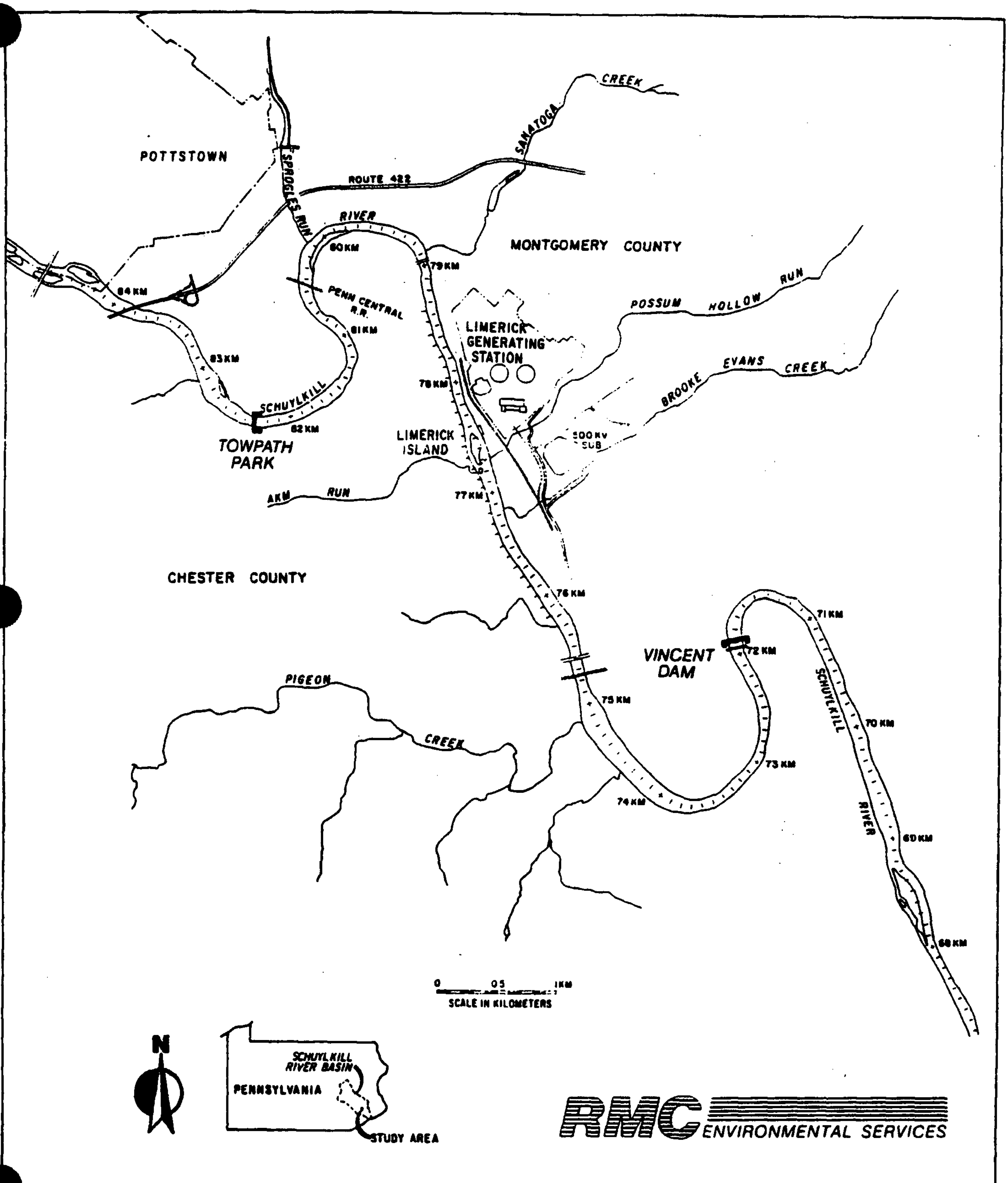


FIGURE 6.3-9 STUDY AREA FOR SCHUYLKILL RIVER CREEL SURVEY, 1987.

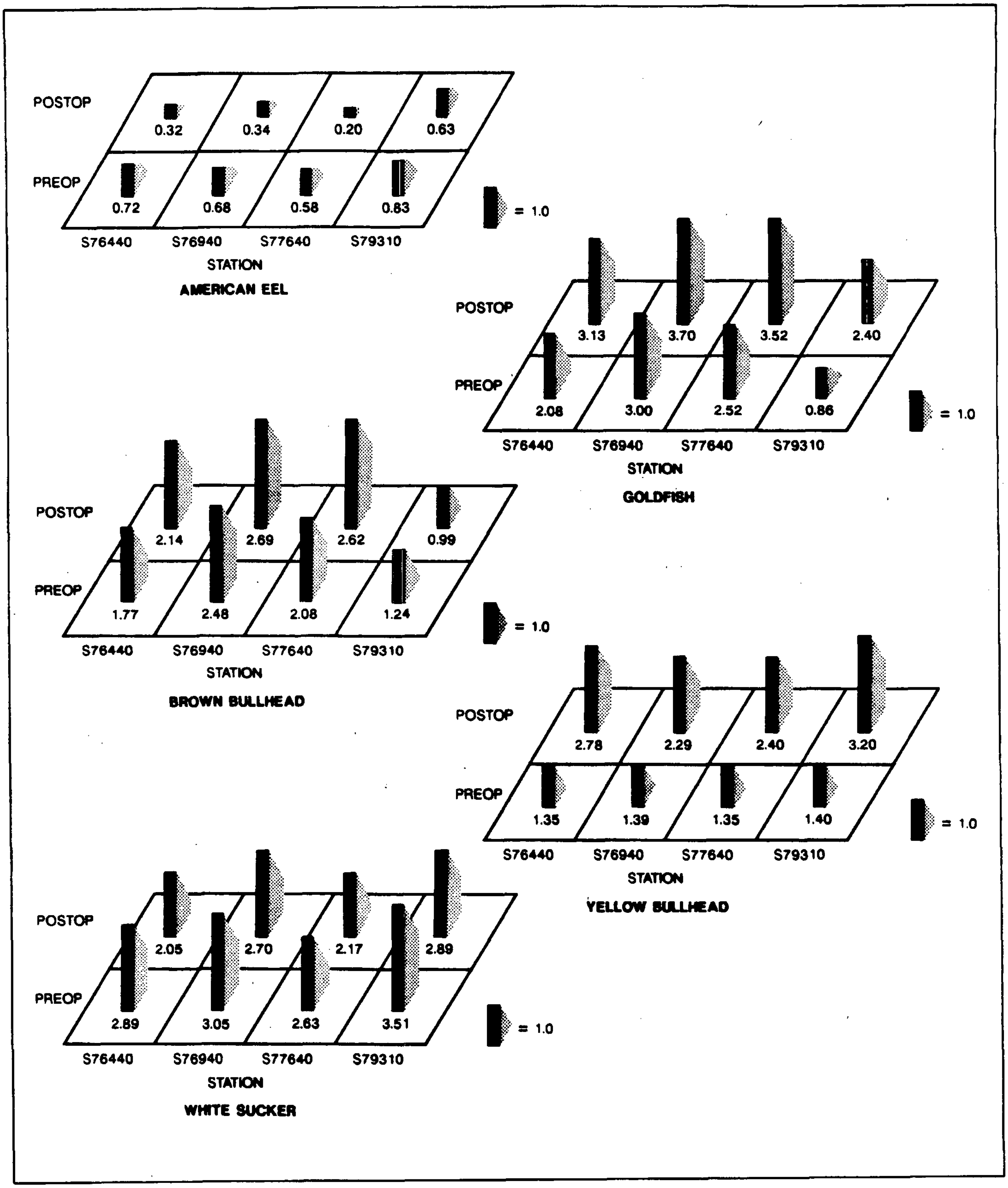


FIGURE 6.3-10 AVERAGE OF MONTHLY CPUE VALUES (ln - transformed) IN BOTH PREOPERATIONAL AND POSTOPERATIONAL TIME PERIODS AT FOUR ELECTROFISHING STATIONS NEAR LGS.

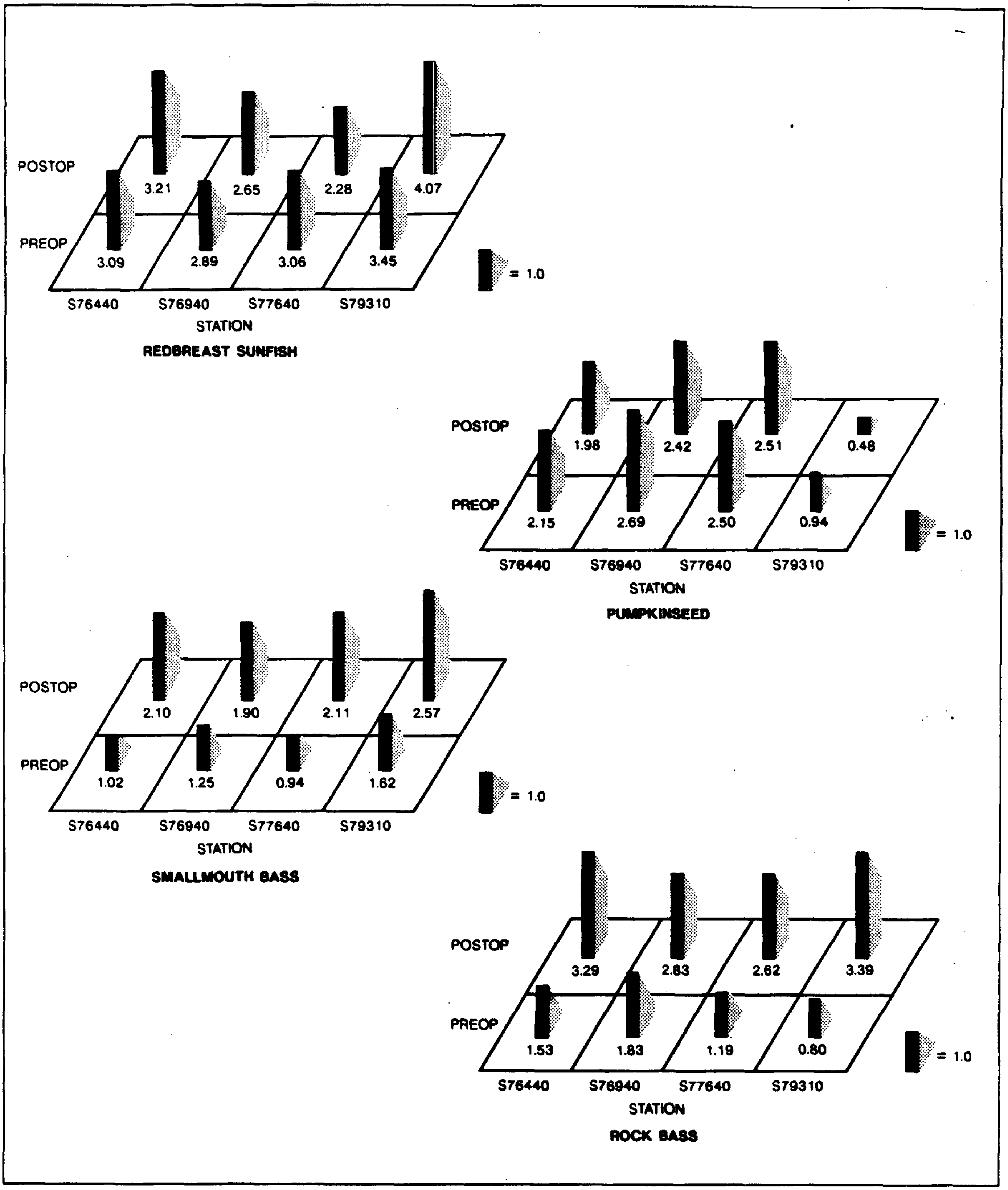


FIGURE 6.3-10 (continued)

7.0 Asiatic Clam

Introduction and Methods

The distribution of Asiatic clam (*Corbicula fluminea*) in the Delaware River, Schuylkill River, and Perkiomen Creek has been surveyed annually since 1982. The results were used to assess the potential threat of this water system-fouling species to PECo generating stations, particularly LGS, and are reported in this document and in previous annual reports (RMC Environmental Services 1984, 1985, 1986, and 1987a).

Methods employed in the 1987 survey were the same used previously. The study reaches consisted of the Delaware River from the Commodore Barry Bridge (river mile 81.8) to Point Pleasant, Pennsylvania (river mile 157.2); the Schuylkill River from its mouth (river mile 0) to LGS (river mile 48); and the Perkiomen Creek from its mouth (river mile 0) to the Schwenksville Road bridge (river mile 12.0). Stations established at 2-8 mile intervals in each stream were sampled for the presence of *Corbicula*. At locations where water depth permitted, the river or stream bottom was visually scanned for *Corbicula* shells. Samples of bottom substrate were collected at all stations, washed through a 3.2-mm mesh sieve, and inspected for *Corbicula*.

Results and Discussion

Sampling in 1987 established continued presence of *Corbicula* in the Delaware River (Table 7.0-1). Specimens were collected from Washington Crossing State Park (river mile 146.0) to the Betsy Ross Bridge (river mile 104.8). Stations downstream of the Betsy Ross Bridge yielded no live *Corbicula*, although the species undoubtedly exists in this reach.

The presence of *Corbicula* at Washington Crossing State Park placed the species approximately 11 miles downstream of the Delaware River intake for the proposed Point Pleasant Diversion. Although *Corbicula* did not extend its range of distribution beyond Washington Crossing State Park in 1987, relative population density appeared to have increased at this station since the 1986 survey.

Corbicula extended its Schuylkill River range of distribution in 1987. *Corbicula* were discovered in the pool above Black Rock Dam. Several *Corbicula* shells and two live specimens were collected near the Pennsylvania Route 113 bridge (river mile 38.0), 2 miles and 10 miles from CGS and LGS, respectively. Established stations and additional stations randomly selected between CGS and Black Rock Dam were sampled thoroughly, but yielded no more *Corbicula*. Probably, *Corbicula* were introduced by boats or fishermen at this heavily used public access area. At present, the density of clams is very low, but could increase rapidly in the future.

Well-established *Corbicula* populations were present in the Schuylkill River at all stations between Black Rock Dam (river mile 36.6) and the Strawberry Mansion Bridge (river mile 11.0) (Table 7.0-2). No specimens were collected in the tidal Schuylkill River downstream of Fairmount Dam (river mile 8.5).

Corbicula was not collected at any station in the Perkiomen Creek despite the species' presence in the Schuylkill River near the Perkiomen Creek confluence (Table 7.0-3).

The East Branch Perkiomen Creek was not part of the 1987 *Corbicula* qualitative survey program. However, the species was not taken at the six stations that are part of the benthic macroinvertebrate sampling program (see Section 4.2, Benthic Macroinvertebrates).

Dead *Corbicula* were found in the Schuylkill River from mid-June to mid-July 1987. Clam mortality also occurred in June-July 1986. As before, the population density in 1987 was reduced at three quantitative sample stations located near Norristown. Dying *Corbicula* were sent to Memphis State University (MSU) and the National Marine Fisheries Service (NMFS) for microbiological examination. However, the cause of the *Corbicula* die-off was not determined from these examinations (Dr. Steve Klaine, MSU; and Dr. Austin Farely, NMFS, personal communications).

Table 7.0-1. Presence/absence of *Corbicula* in the Delaware River, 1982-1987.

Location (river mile)	Distance from Point Pleasant (miles)	1982	1983	1984	1985	1986	1987
Point Pleasant canoe livery (157.2)	0	0	0	0	0	0	0
Canal Park Footbridge, Lumberville, NJ (155.4)	1.8	0	0	0	0	0	0
PA Rt. 263 Bridge, Center Bridge, PA (151.9)	5.3	0	0	0	0	0	0
PA Rt. 179 Bridge, New Hope, PA (148.7)	8.5	0	0	0	0	0	0
Washington Crossing State Park (146.0)	11.2		0	0	X	X	X
100 yds. above PA Rt. 532 Bridge (142.0)	15.2	0	0	X	X	X	X
0.75 mi. above I-95 Bridge (139.7)	17.5	0	0	X			
Under I-95 Bridge (139.0)	18.2		X	X			

Key to Tables 7.0-1 to 7.0-3

X - *Corbicula* present
0 - *Corbicula* not found
Blank - no sample taken

Table 7.0-1. (continued)

Location (river mile)	Distance from Point Pleasant (miles)	1982	1983	1984	1985	1986	1987
Boat ramp, Yardley, PA (138.4)	18.8	0	X	X	X	X	X
1.5 mi. below Yardley boat ramp (136.9)	20.3	0					
Water treatment plant, Morrissville, NJ (134.0)	23.2	X			X	X	X
Below railroad bridge Trenton, NJ (133.0)	24.2	X		X			
Between buoys 105 and 106 (131.7)	25.5	0					
Biles Creek (131.2)	26.0	X			X	X	X
Buoy 97 (130.6)	26.6	X		X			
Buoy 92 (129.1)	28.1	X		X			
0.5 mi. above Newbold Island (127.0)	30.2	X		X			
South tip Newbold Island (124.9)	32.3	X		X	X	X	X

Table 7.0-1. (continued)

Location (river mile)	Distance from Point Pleasant (miles)	1982	1983	1984	1985	1986	1987
Above I-276 Bridge (121.3)	35.9	X		X			
Boat ramp, Florence, NJ (122.6)	34.6	X					
Buoy 45, Burlington Island (118.9)	38.3	X					
Burlington Generating Station (117.0)	40.2	X		X		X	X
1.5 mi. below Neshaminy Creek (114.1)	43.1	X					
Rancocas Creek mouth (111.1)	46.1	X	X		X	X	X
0.5 mi. below Buoy 18 (109.3)	47.9		X	X			
0.5 mi. below Buoy 15 (108.0)	49.2	0	X				
Tacony Palmyra Bridge (107.1)	50.1	0	X		0	X	X
Betsy Ross Bridge (104.8)	52.4	0	X	X	0	0	X

Table 7.0-1. (continued)

Location (river mile)	Distance from Point Pleasant (miles)	1982	1983	1984	1985	1986	1987
Northern tip Petty Island (103.2)	54.0	0	0	X	0	0	0
Richmond Generating Station (104.4)	52.8	0	0	0		0	0
Delaware Generating Station (101.1)	56.1		0	0	0	0	0
Benjamin Franklin Bridge (100.2)	57.0	0		X	0	X	0
Above Walt Whitman Bridge (98.0)	59.2	0	0				
Southwark Generating Station (97.5)	59.7		0	0	0	0	0
Buoy 46A (95.0)	62.2	0			X	0	0
Schuylkill River mouth (92.5)	64.7	0	X	X	0	0	0
Paulsboro, NJ (90.0)	67.2	0				0	0
Eddystone Generating Station (84.3)	72.9		X	X		0	0

Table 7.0-1. (continued)

Location (river mile)	Distance from Point Pleasant (miles)	1982	1983	1984	1985	1986	1987
North tip Tinicum Island (87.5)	69.7	0		X	X	0	0
North tip Mond's Island (85.6)	71.6	0				0	0
Above Commodore Barry Bridge (81.8)	75.4	0			0	0	0

Table 7.0-2. Presence/absence of *Corbicula* in the Schuylkill River, 1982-1987.

Location (river mile)	Distance from LGS (miles)	1982	1983	1984	1985	1986	1987
Limerick Generating Station (48.0)	0	0	0	0	0	0	0
Vincent Dam (44.7)	3.3	0		0	0	0	0
Main Street, Spring City, PA (42.1)	5.9	0		0	0	0	0
0.25 mi. above Cromby Generating Station (CGS) (40.3)	7.7		0	0	0	0	0
Adjacent to CGS (40.0)	8.0		0	0	0	0	0
0.25 mi. below CGS (39.8)	8.2		0	0	0	0	0
Water treatment plant Phoenixville, PA (38.2)	9.8		0	0	0	0	0
PA Rt. 113 Bridge, Phoenixville, PA (38.0)	10.0	0	0	0	0	0	X
Black Rock Dam (36.6)	11.4		0	0	X	X	X
PA Rt. 29 Bridge, Phoenixville, PA (35.6)	12.4	0			X	X	X

Table 7.0-2. (continued)

Location (river mile)	Distance from LGS (miles)	1982	1983	1984	1985	1986	1987
Pawlings Road Bridge, Phoenixville, PA (31.0)	17.0	0		0	0	X	
1.0 mi. above Betzwood Bridge (29.3)	18.7			X			
0.5 mi. above Betzwood Bridge (28.8)	19.2			X	X	X	X
Betzwood Bridge (28.3)	19.7	0	0	X			
0.75 mi. above Abrams Creek (26.5)	21.5		X	X			
Abrams Creek (25.7)	22.3		X	X			
North tip Barbadoes Island (25.2)	22.8		X	X	X	X	X
Barbadoes Generating Station intake (24.6)	23.4		X	X			
U.S. Rt. 202 Bridge, Norristown, PA (24.3)	23.7		X	X	X	X	X
Norristown Dam (24.0)	24.0	X	X	X	X	X	X
I-276 Bridge, Swedesburg, PA (22.5)	25.5	X			X	X	X

Table 7.0-2. (continued)

Location (river mile)	Distance from LGS (miles)	1982	1983	1984	1985	1986	1987
Plymouth Dam (20.7)	28.0	X			X	X	X
Near Montgomery/Philadelphia County line (17.0)	31.0	X			X	X	X
West of Green Lane Bridge (14.0)	34.0	X			X	X	X
Pencoyd Bridge (12.6)	35.4	X			X	0	X
Strawberry Mansion Bridge (11.0)	37.0	X			X	X	X
Fairmount Dam (8.5)	39.5	X	X		X	0	0
Park Drive Bridge, Philadelphia, PA (8.2)	39.8		0	0	0		
Market Street Bridge, Philadelphia, PA (7.5)	40.5		0	X	X		
South Street Bridge, Philadelphia, PA (6.8)	41.2		0	0	0		
Schuylkill Generating Station (SGS) (6.5)	41.5	0	X	X	0	0	0
0.25 mi. below SGS (6.3)	41.7	0	0	X	0	0	

Table 7.0-2. (continued)

Location (river mile)	Distance from LGS (miles)	1982	1983	1984	1985	1986	1987
Passayunk Ave. Bridge, Philadelphia, PA (3.6)	44.4	0	0		0		
South of I-95 Bridge (0.5)	47.5	0		0	0		
Schuylkill River mouth (0)	48.0	0	X	X	0	0	0

Table 7.0-3. Presence/absence of *Corbicula* in the Perkiomen Creek, 1983-1986.

Location (river mile)	1983	1984	1985	1986	1987
Schwenksville Road (12.0)	0	0	0	0	0
PA Rt. 73 (11.3)	0	0	0	0	0
Ott's Road (10.5)	0	0	0	0	0
Graterford Road (9.3)	0	0	0	0	0
PA Rt. 113 (7.3)	0	0	0	0	0
Collegeville Dam (6.5)	0	0	0	0	0
Yerkes Road (4.5)	0	0	0	0	0
Indian Road Dam (2.3)	0	0	0	0	0
Egypt Road (1.5)	0	0	0	0	0
Below Wetherill's Dam (0.8)	0	0	0	0	0

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Whittaker, R. H., and C. W. Fairbanks. 1958. A study of plankton copepod communities in the Columbia Basin, southeastern Washington. Journal Ecology 39:46-65.

E2-12: Enclosure 2: Aquatic Ecology, item J

RMC (RMC Environmental Services). 1989. Progress Report, Non-Radiological Environmental Monitoring for Limerick Generating Station 1988. Prepared for Philadelphia Electric Company. December.

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PROGRESS REPORT

Non-Radiological
Environmental Monitoring
for
Limerick Generating Station

1988

RMC
ENVIRONMENTAL
SERVICES

PROGRESS REPORT

Non-Radiological Environmental Monitoring for Limerick Generating Station

1988

Prepared for

Philadelphia Electric Company

By

RMC Environmental Services
Pottstown, Pennsylvania

December 1989

TABLE OF CONTENTS

LIST OF TABLES

List of Tables (continued)

List of Tables (continued)

LIST OF FIGURES

List of Figures (continued)

1.0 Executive Summary

This report summarizes non-radiological environmental monitoring related to Philadelphia Electric Company's (PECo) Limerick Generating Station (LGS) conducted in 1988, the fourth year of plant operation and the third complete year with a full power license. With exception of Asiatic clam (Corbicula) studies which also were conducted in the Delaware River and Perkiomen Creek, this volume reports only studies conducted in the Schuylkill River. Data for 1988 studies conducted in the Delaware River, Perkiomen Creek, and East Branch Perkiomen Creek regarding the Point Pleasant Diversion were reported in Bradshaw Reservoir NPDES Permit PA-0052221 Reports and Studies prepared by PECo in 1989.

Only LGS Unit 1 operated in 1988; Unit 2 was not operational in 1988. From 1 January 1988, Unit 1 operated almost continuously at nearly full power until it was shutdown for maintenance in early April. It resumed operation on 22 April 1988 and continued to operate at approximately 80% full power until 2 September 1988. After this date, plant operation was gradually reduced to 36% of full power by the end of the year.

Schuylkill River water quality in 1988 was little different from that observed previously. Several new minima and maxima for measured chemical constituents were observed, all probably related to the low river discharge and high water temperature observed, particularly during early summer through the rest of the year.

Macroinvertebrate studies indicate the presence of communities similar to those observed previously at all stations. The effects of sedimentation continue to be observed at two stations located downstream of the LGS discharge. To determine if sedimentation effects mask the impact of LGS operation, samples were collected immediately downstream of the discharge in riffle habitat similar to that present at the sample station located upstream of LGS. The results show much similarity between the samples collected at both locations, thereby confirming little or no observed changes in the Schuylkill River macroinvertebrate community attributable to LGS operation.

Fisheries studies conducted in 1988 did not detect any effects of LGS operation. Observed changes in the fish community were judged to be independent of plant operation and similar to natural variation observed prior to LGS operation. Impingement of only a few fish during the warmer months of 1988 indicated that impingement at LGS is a seasonal phenomenon related to near shore movement of certain species during periods of high river discharge and low water temperature. Successful recruitment of new year classes of several species with freely drifting eggs or larvae suggests that entrainment is unimportant as a regulator of year class formation compared to naturally occurring river physical conditions.

Sampling in 1988 indicated the presence of Asiatic clam (Corbicula) in the Delaware River from near Easton downstream to Point Pleasant, thereby placing Bradshaw Reservoir and ultimately the East Branch Perkiomen Creek in jeopardy of infestation via the Point Pleasant Diversion. Corbicula again was collected in the Black Rock Pool of the Schuylkill River several miles downstream of Cromby Generating Station. No evidence of Corbicula infestation was found in the Schuylkill River near LGS, nor in the Perkiomen Creek.

Small numbers of dead birds were collected in impaction studies conducted at both LGS cooling towers in 1987 and 1988. More specimens and species were collected in 1988, which may be the result of reduced scavenging of dead birds by crows. Bird mortality continued to be insignificant compared to the total number of birds that migrate through the area.

2.0 Introduction

Aquatic ecology of the Delaware River, Schuylkill River, Perkiomen Creek, and East Branch Perkiomen Creek has been studied since 1970 for Philadelphia Electric Company (PECo) by RMC Environmental Services (formerly Ichthyological Associates) to assess possible environmental impacts of Limerick Generating Station (LGS) and its water supply system which includes the Point Pleasant Water Diversion Project. Along with certain terrestrial ecological studies, these assessments are collectively referred to as the LGS Non-radiological Environmental Monitoring Program. Prior to initial LGS operation in 1985, this program's objective was to document natural variation in the ecological variables under study, thereby developing an environmental baseline against which the magnitude and significance of LGS-related impacts could be assessed. These studies have continued for a sufficient period of time after LGS operation to permit detailed environmental impact evaluations of certain components of the station on the environment.

The various study components of the Non-radiological Environmental Monitoring Program and the duration of each are listed in Table 2.0-1. Previous progress reports based on these studies are listed in Table 2.0-2. The results of studies conducted in 1970-1977 were used in preparation of the Environmental Report: Operating License Stage (EROL) for LGS, submitted to the Nuclear Regulatory Commission (NRC) by PECo in 1981.

This report summarizes non-radiological environmental monitoring studies conducted for PECo in 1988, the fourth year of LGS operation and the third complete year with a full power operating license (Unit 1). Unlike previous reports in this series, this volume describes only studies conducted on the Schuylkill River, with exception of Asiatic clam studies which also include the Delaware River, Perkiomen Creek, and East Branch Perkiomen Creek. It is important to note that any potential LGS operational impacts are confined to the effects of water withdrawal from and discharge to the Schuylkill River, since the Point Pleasant Water Diversion Project was not operational. Studies of the Delaware River, Perkiomen Creek, and East Branch Perkiomen Creek conducted in 1988 are not reported in this volume. Data for 1988 studies conducted in these streams were reported in Bradshaw Reservoir NPDES Permit PA-0052221 Reports and Studies prepared by PECo in 1989.

This report presents and discusses data collected in 1988 with qualitative comparison to post-EROL data only. An exception is Section 5.0 - Cooling Tower Birds in which data collected in 1987 also are presented and discussed because they did not appear in the previous report (RMC Environmental Services 1988).

Throughout this report, sample station locations are designated by the letter 'S' for Schuylkill River followed by a number indicating the distance in meters upstream from the river mouth. If a station was comprised of an area of the river instead of a transect or single point location, the distance in meters from the river mouth to the downstream edge of the area was used as the station designation. As points of reference, the LGS intake is located at S77540 and the discharge diffuser is located at S77240.

Table 2.0-1. Ecological and water quality studies conducted in relation to Limerick Generating Station by RMC Environmental Services.

Program	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
<u>Delaware River</u>										
Water quality					X	X	X	X	X	X
Fisheries survey			X	X						
Macroinvertebrate drift			X	X						
Larval fish										
Asiatic clam										
<u>East Branch Perkiomen Creek</u>										
Water quality					X	X	X	X	X	
Periphyton				X	X					
Benthic macroinvertebrates	X		X	X	X		X			
Larval fish				X	X					
Seine	X					X	X	X		
Electrofishing					X	X	X	X	X	
Age and growth				X			X		X	
Creel survey										
<u>Perkiomen Creek</u>										
Water quality					X	X	X	X	X	X
Phytoplankton					X					
Periphyton				X						
Benthic macroinvertebrates	X		X	X	X		X			
Larval fish				X	X	X	X			
Seine	X					X	X	X	X	
Electrofishing					X	X	X	X	X	
Age and growth				X			X		X	
Creel survey										
Asiatic clam										
<u>Schuylkill River</u>										
Water Quality					X	X	X	X	X	X
Phytoplankton				X	X					
Periphyton				X	X					
Macrophytes								X		
Benthic macroinvertebrates	X		X	X	X	X	X	X	X	
Larval fish				X	X	X	X			
Seine	X					X	X	X	X	
Electrofishing				X	X	X	X	X	X	
Trap net		X	X	X	X	X	X			
Age and growth				X		X		X		
Creel survey										
Asiatic clam										
Cooling tower bird mortality										
Impingement										
Entrainment										

Table 2.0-1. (continued)

Program	1980	1981	1982	1983	1984	1985	1986	1987	1988
<u>Delaware River</u>									
Water quality	X	X	X	X	X	X	X	X	X
Fisheries survey			X						
Macroinvertebrate drift									
Larval fish			X	X	X	X	X		
Asiatic clam			X	X	X	X	X	X	X
<u>East Branch Perkiomen Creek</u>									
Water quality				X	X	X	X	X	X
Periphyton									
Benthic macroinvertebrates				X	X	X	X	X	X
Larval fish									
Seine		X	X	X	X	X	X	X	X
Electrofishing		X	X	X	X	X	X	X	X
Age and growth		X		X	X	X	X		X
Creel survey	X	X		X		X	X	X	X
<u>Perkiomen Creek</u>									
Water quality	X	X	X	X	X	X	X	X	X
Phytoplankton									
Periphyton									
Benthic macroinvertebrates									
Larval fish									
Seine									
Electrofishing		X	X	X	X	X	X	X	X
Age and growth									
Creel survey	X	X	X	X		X			
Asiatic clam				X	X	X	X	X	X
<u>Schuylkill River</u>									
Water Quality	X	X	X	X	X	X	X	X	X
Phytoplankton									
Periphyton									
Macrophytes									
Benthic macroinvertebrates				X	X	X	X	X	X
Larval fish									
Seine		X	X	X	X	X	X	X	X
Electrofishing		X	X	X	X	X	X	X	X
Trap net									
Age and growth		X		X	X	X	X	X	
Creel survey	X	X	X	X	X	X		X	
Asiatic clam			X	X	X	X	X	X	X
Cooling tower bird mortality		X	X	X	X	X	X	X	X
Impingement						X	X	X	X
Entrainment							X		

Table 2.0-2. List of progress reports which pertain to non-radiological environmental monitoring for Limerick Generating Station, 1970-1987.

Denoncourt, R. F., and C. H. Hocutt. 1971. An ecological study of the Schuylkill River in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Schuylkill Progress Report No. 1. (Part One).

Brett, J. J., and R. F. Denoncourt. 1971. An ecological study of the Schuylkill River in the vicnity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Schuylkill Progress Report No. 1. (Part Two).

Denoncourt, R. F., C. H. Hocutt, and C. B. Milstein. 1971. An ecological study of the East Branch of the Perkiomen Creek system near Pottstown, Pennsylvania. Ichthyological Associates, Perkiomen Progress Report No. 1. (Part One - Fishes).

Brett, J. J., R. F. Denoncourt, and R. J. Stira. 1971. An ecological study of the East Branch of the Perkiomen Creek system near Pottstown, Pennsylvania. Ichthyological Associates, Perkiomen Progress Report No. 1. (Part Two - Macroinvertebrates).

Harmon, P. L., W. A. Potter, K. W. Knopf, and R. H. Ellis. 1971. An ecological study of the Schuylkill River in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Schuylkill Progress Report No. 2.

Molzahn, R. F. 1971. An ecological study of the East Branch of the Perkiomen Creek system near Pottstown, Pennsylvania. Ichthyological Associates, Perkiomen Progress Report No. 2. (Part one - Fishes).

Knopf, K. W. 1971. An ecological study of the East Branch of the Perkiomen Creek system near Pottstown, Pennsylvania. Ichthyological Associates, Perkiomen Progress Report No. 2. (Part Two - Macroinvertebrates).

Ellis, R. H., T. P. Poe, and D. C. Stefan. 1973. An ecological study of the Schuylkill River in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Schuylkill Progress Report No. 3. (Volume I).

Harmon, P. L., R. F. Molzahn, T. M. Kincaid, A. K. Megay, R. J. Stira, and R. W. Blye. 1973. An ecological study of the Schuylkill River in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Schuylkill Progress Report No. 3. (Volume II).

Molzahn, R. F., and R. P. Rutter. 1973. An ecological study of the East Branch Perkiomen Creek system near Pottstown, Pennsylvania. Ichthyological Associates, Perkiomen Progress Report No. 3.

Table 2.0-2. (continued)

Harmon, P. L., and Associates. 1974. An ecological study in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Inc., Schuylkill Progress Report No. 4.

Harmon, P. L., and Associates. 1974. An ecological study of the East Branch of the Perkiomen Creek system near Graterford, Pennsylvania. Ichthyological Associates, Inc., Perkiomen Progress Report No. 4.

Harmon, P. L., V. M. Douglass, K. R. Fite, T. P. Poe, and Associates. 1976. An ecological study in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Ichthyological Associates, Inc., Schuylkill Progress Report No. 5.

Harmon, P. L., V. M. Douglass, K. R. Fite, T. P. Poe, and Associates. 1976. An ecological study of the East Branch of the Perkiomen Creek system near Graterford, Pennsylvania. Ichthyological Associates, Inc., Perkiomen Progress Report No. 5.

Edinger, J. R., E. M. Buchak, and H. J. Reisinger. 1976. Limerick Water Chemistry Program. 1974 Annual Report. J. E. Edinger Associates, Inc., and Ichthyological Associates, Inc.

Harmon, P. L., V. M. Douglass, K. R. Fite, T. P. Poe, H. J. Reisinger, and Associates. 1978. An ecological study in the vicinity of Limerick Generating Station, Pottstown, Pennsylvania. Radiation Management Corporation, Schuylkill Progress Report No. 6.

Harmon, P. L., V. M. Douglass, K. R. Fite, T. P. Poe, H. J. Reisinger, and Associates. 1978. An ecological study of the East Branch of the Perkiomen Creek system near Graterford, Pennsylvania. Radiation Management Corporation, Perkiomen Progress Report No. 6.

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RMC Environmental Services. 1985. Progress Report: Non-radiological Environmental Monitoring for Limerick Generating Station 1984. Prepared for Philadelphia Electric Company.

RMC Environmental Services. 1986. Progress Report: Non-radiological Environmental Monitoring for Limerick Generating Station 1985. Prepared for Philadelphia Electric Company.

RMC Environmental Services. 1987. Progress Report: Non-radiological Environmental Monitoring for Limerick Generating Station 1986. Prepared for Philadelphia Electric Company.

RMC Environmental Services. 1988. Progress Report: Non-radiological Environmental Monitoring for Limerick Generating Station 1987. Prepared for Philadelphia Electric Company.

3.0 Schuylkill River

The Schuylkill River flows 209 km from its source at Tuscarora Springs in Schuylkill County to its confluence with the Delaware River at Philadelphia. The river drains a 4,972 km^2 watershed that includes portions of the Appalachian Mountain, Great Valley, Reading Prong, Triassic Lowland, Piedmont Upland, and Coastal Plain physiographic regions in southeast Pennsylvania.

Typically, the river in the vicinity of LGS is 100 m wide, low gradient (0.5 m/km), and discharges 53 m^3/second. Except for a 3-km long pool above Vincent Dam, the study area is 95% run habitat over a gravel-rubble substrate. Riffle and shoal habitats comprise most of the remaining study area. Few backwaters are present and those that exist are small in size, but can be important reproductive, nursery, and refuge areas for fish and other aquatic organisms. In most years, dense stands of aquatic vegetation develop during the warmer months. Between the blowdown discharge structure and the cooling water intake, the river is divided into two channels by Limerick Island, the only substantial, heavily wooded island in the study area.

Ecological studies were conducted from 1970 through 1978 and are summarized in Section 2.2.2.1 of the LGS EROL (Philadelphia Electric Company 1981). Additional studies of water quality (1979-1987), benthic macroinvertebrates (1983-1987), and fish (1980-1987) were reported in subsequent progress reports (RMC Environmental Services 1984, 1985, 1986, 1987, and 1988). All non-radiological environmental monitoring programs conducted in 1987, except fish age and growth and creel survey, were continued in 1988.

Ecological studies have focused on a 10-km reach extending upriver from Vincent Dam (S71960) to just above the Hooker Chemical Company plant (S82000) (Fig. 3.0-1). This reach includes an area upriver from and unaffected by LGS, and areas adjacent to and downriver from LGS that are potentially affected by the station. Sources of potential environmental impact include plant-site runoff from areas disturbed by construction of LGS Unit 2, and effects of water withdrawal from and discharge to the Schuylkill River. Discharge from LGS is comprised of cooling tower blowdown mixed with treated domestic wastewater, yard, and roof drainage.

An operational history of LGS reveals that 1988 was the fourth year of plant (Unit 1) operation and the third year of operation in a full-power commercial mode. Consequently, monitoring studies have provided varying quantities of postoperational data, depending on the environmental component studied and its potential exposure to impacts of LGS operation. The objectives of Section 3 are to summarize results of all 1988 non-radiological environmental monitoring programs on the Schuylkill River and to evaluate any environmental impacts from LGS operation that may be evident in these data. Secondly, the 1988 data are evaluated for departure from data previously collected.

A short synopsis of LGS Unit 1's operation during 1988 is necessary for proper interpretation of all biological and chemical study data (Fig. 3.0-2). Except for a short period in February, the plant operated at nearly full power until April when it was shutdown for 13 days for maintenance. Operation was resumed on 22 April and continued through 1 September at approximately 80% of full power. From 2 September through the end of the year, plant operation was gradually reduced to 36% of full power.

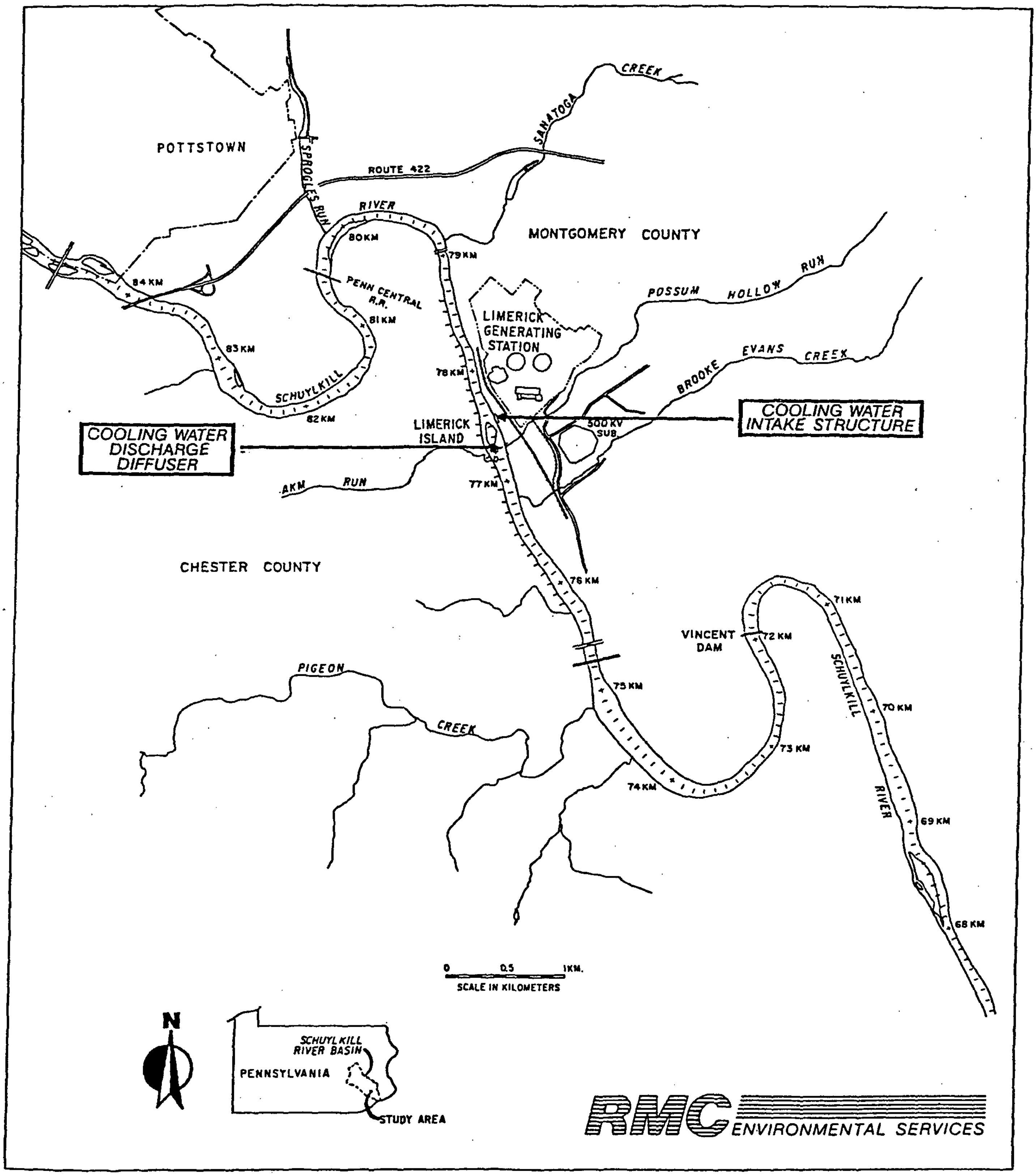

FIGURE 3.0-1 STUDY AREA FOR AQUATIC ECOLOGICAL AND WATER QUALITY STUDIES OF THE SCHUYLKILL RIVER NEAR LGS, 1988.

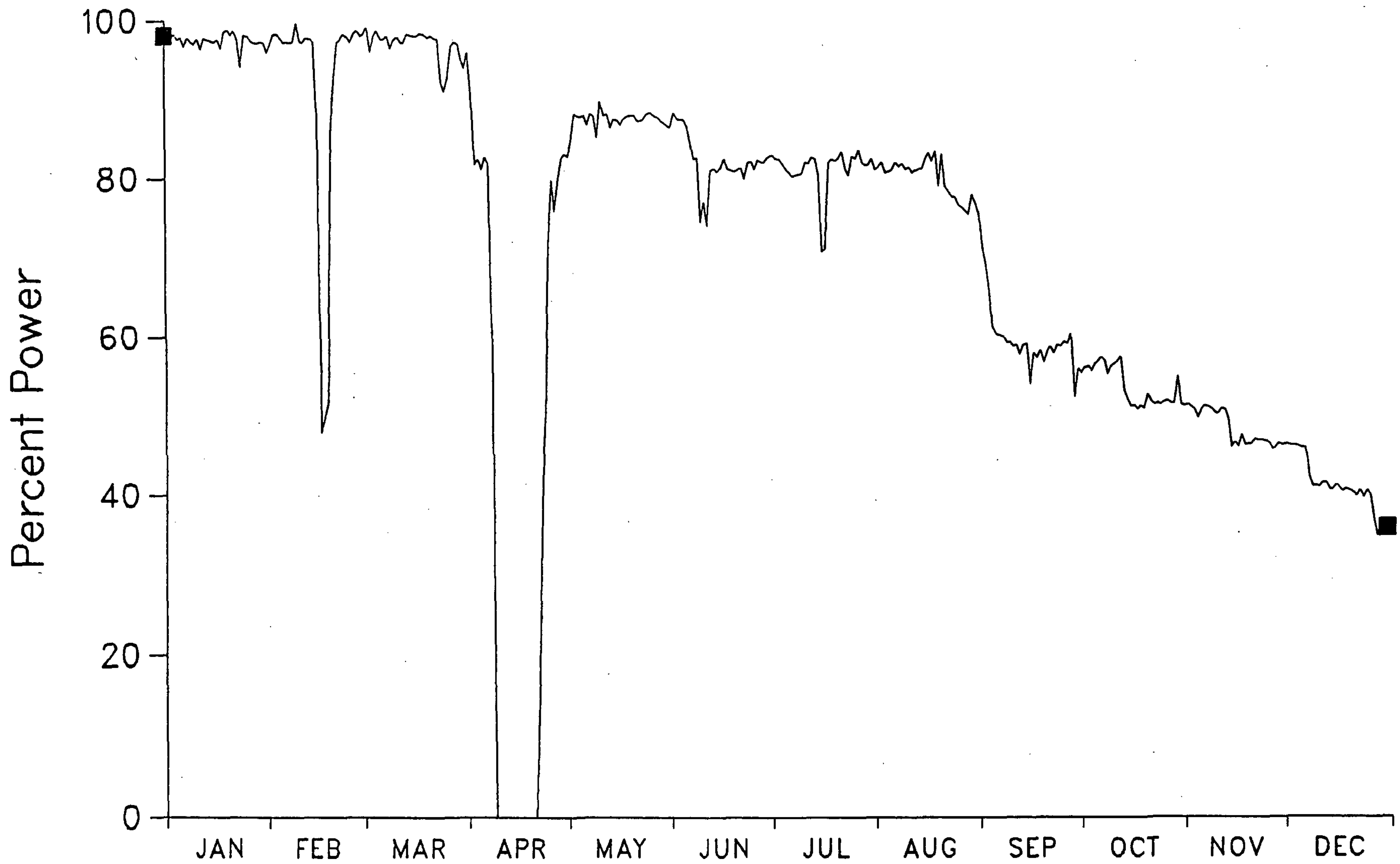

Fig. 3.0-2. Average daily power generation for LGS Unit 1 in 1988.

3.1 Water Quality

INTRODUCTION AND METHODS

Water quality studies of the Schuylkill River in 1988 consisted of 26 bi-weekly samplings during the period 14 January through 27 December. The water quality data obtained in 1988 are summarized in this section. Program objectives were to monitor ambient water quality, complement concurrent ecological studies, and evaluate the effects on water quality in relation to LGS operation.

Ambient river water temperature data were obtained from daily measurements at the Pottstown Water Treatment Plant. Daily river discharge data were obtained from the US Geological Survey (USGS) Pottstown gaging station. Daily flow and temperature records were compiled based on the above two data sources to determine the minimum, maximum, mean, and median values for each month of the year.

Water quality samples were collected at two stations in the Schuylkill River. Station S77660 was located approximately 200-m upstream of the LGS intake and is considered representative of the ambient (background) water quality as well as the intake water quality for LGS. Station S77140 was located approximately 100-m downstream of the LGS diffuser bar and represented the combined flows from all NPDES-permitted LGS discharges added to the flow from Possum Hollow Run. Sample station locations are presented in Figure 3.1-1. Conditions permitting, samples were collected at mid-depth near mid-stream. During periods of high flow, samples were collected near the Montgomery County shoreline. Sample collection, preservation, and analysis followed US EPA methodologies.

RESULTS AND DISCUSSION

1988 River Discharge and Ambient Temperature

The USGS Schuylkill River mean daily discharge records for 1988 are presented in Table 3.1-1 and Figure 3.1-2. Mean monthly discharges for the period 1970-1988 are presented in Table 3.1-2 and Figure 3.1-3. Daily Schuylkill River temperature readings for 1988 at the Pottstown Water Treatment Plant are presented in Table 3.1-3 and Figure 3.1-4 while the mean monthly temperature readings for 1970-1988 are presented in Table 3.1-4 and Figure 3.1-5.

The year 1988 was characterized by low precipitation and record high summer temperatures. The reduced precipitation is reflected in the mean monthly discharges for 1988 being less than the mean for the period of record (1970-1988) for the months of January, March, April, and June through December. Of the remaining two months, mean monthly discharge substantially exceeded the period of record mean only during May, largely the result of elevated river flow measured late in the month (Fig. 3.1-3).

Mean monthly temperature in 1988 equalled or exceeded the monthly means for the period of record for all months except September and October when mean monthly temperatures were 2 C and 1 C less than the means for 1970-1988, respectively. Three new daily maximum temperatures were observed in 1988 in comparison to the period 1970-1987. The new daily maxima were observed on 30 March, 22 June, and 16 August 1988. The March and June maxima represented single date exceedance of the previous records - the 30 March maximum of 18 C exceeding the previous record by 3 C and the 22 June maximum exceeding the previous record by 1 C. However, the previous period of record August maximum of 29 C was exceeded during the interval 12 through 17 August with a new record maximum (31 C) established on 16 August. During the same general period, the previous August maximum of 29 C was equaled on 5, 10, 11, and 18 August.

1988 Water Quality

Seasonal summaries of the water quality data for S77660 for 1979-1988 are presented in Table 3.1-5 and for 1988 in Table 3.1-6. New minimum and maximum values observed in 1988 are presented in Tables 3.1-7 and 3.1-8, respectively. Similar seasonal summaries and new minimum and maximum values for S77140 are presented in Tables 3.1-9 through 3.1-12.

Several new minimum values were observed at both stations in 1988. Most of the new minima represent slight reductions from previously observed minima for 1979-1987. A new minimum dissolved oxygen was observed at both stations on 24 August 1988. These concurrent minimum dissolved oxygen levels were observed during a period of record high temperature and low flow conditions and were unrelated to LGS operations.

On 18 May 1988, several new maximum values were established at both stations. Three new maxima for total suspended solids, aluminum, and iron were observed at both stations. In addition, new maxima were established at S77140 for cadmium and lead on 18 May. The discharge record for the Schuylkill River for the period immediately preceding 18 May (Table 3.1-1) indicates measurements well below the monthly mean for early May. Schuylkill River discharge on 18 May, 3,450 cfs, was twice the previous day's measurement of 1,670 cfs. Discharge peaked on 20 May at 21,900 cfs. Thus, the samples collected on 18 May could represent a first-flush effect in the immediate watershed which may explain the new maxima for cadmium and lead observed at both stations as well as the new maximum total suspended solids concentration.

New maxima for total coliforms were established at S77660 on 10 August and at S77140 on 26 July 1988. New total coliform maxima were observed at both stations on 4 October 1988. The new values at S77660 on 10 August and S77140 on 26 July represent a 30 to 40-fold increase over the previous maximum of 8,000 colonies per 100 ml. The concurrent maxima observed on 4 October represent an 8 to 10-fold increase over the previous maximum of 20,000 colonies per 100 ml. The record temperatures and low river discharges may account in part for the new total coliform maxima.

Data are missing for trichloroethylene for the period September-November in Tables 3.1-6 and 3.1-10 because analysis for trichloroethylene was discontinued in the summer of 1988.

Post-EROL Water Quality

Seasonal water quality data for the post-EROL period (1979-1988) are presented in five previous LGS progress reports (RMC Environmental Services 1984, 1985, 1986, 1987, and 1988). The seasonal water quality summary tables in this report for both stations (Tables 3.1-5 and 3.1-9) compare the 1988 water year to the post-EROL water quality observations. A discussion of the maxima and minima observations for the post-EROL period was presented above.

Several major cations and anions were monitored during the post-EROL period, including the cations sodium, potassium, calcium, and magnesium and the anions chloride, sulfate, and bicarbonate (based on alkalinity determinations). Conversion of the reported seasonal median data in milligrams/liter to the corresponding milli-equivalents per liter enables the data to be expressed stoichiometrically (i.e., one milli-equivalent of a cation will react with one milli-equivalent of a corresponding anion). Graphical display of the concentrations of major cations and anions expressed in milli-equivalents per liter is called a Stiff diagram. The utility of a Stiff diagram is that any major difference in water quality becomes readily apparent.

Comparison of the seasonal Stiff diagrams for the same station provides an indication of seasonal changes in the concentration of the major ions. Comparison of seasonal diagrams between stations provides an indication of spatial changes in ion concentration. In the case of LGS, comparison of S77660 to S77140 provides an indication of the effects of LGS on the concentraion of major ions in the downstream (S77140) sample. Slight variations in the seasonal diagrams can be attributed to normal water quality variability, whereas larger changes may require additional explanation or investigation.

Seasonal Stiff diagrams for 1988 for both stations are presented in Figure 3.1-6. Figure 3.1-7 presents the seasonal Stiff diagrams for 1987 (RMC Environmental Services 1988) and Figure 3.1-8 presents the Stiff diagrams for both stations from 1979-1986. Collectively, Figures 3.1-6, 3.1-7, and 3.1-8 represent the entire post-EROL period up to December 1988. Individually, Figures 3.1-6 and 3.1-7 represent the LGS sustained full power operational observations and Figure 3.1-8 presents a summary of conditions prior to sustained full operation.

Comparison of the three sets of diagrams indicates some expected variability both among seasons and between upstream and downstream stations. The variability observed can be a function of flow conditions, randomness, biological activity, and water temperature. As shown in Figures 3.1-6 and 3.1-7, any effects of LGS operation are not discernible for the ions used to construct the diagrams. This is of special interest for the sulfate anion (SO_4) which is intentionally introduced (as sulfuric acid) into the intake water for pH control. The June through August 1987 diagrams (Fig. 3.1-7) also are of interest in that LGS was in cold shut-down for the entire quarter. The subtle differences observed illustrate natural variability.

Similarly, comparison of the two fully operational diagrams (Figs. 3.1-6 and 3.1-7) to the pre-fully operational post-EROL diagrams (Fig. 3.1-8) indicates no discernible differences for the entire period of 1979-1988.

Table 3.1-1. Mean daily Schuylkill River discharge (cu ft/sec) measured at the Pottstown US Geological Survey gage in 1988.

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
01	1240	1690	2040	1870	1280	2150	617	1390	746	N/A	660	1570
02	1210	3370	1950	1720	1230	2460	630	1170	628	N/A	560	1440
03	1100	6500	1820	1660	1030	2340	620	891	601	874	567	1310
04	1110	6490	2820	1630	1070	1930	587	813	1390	757	523	1240
05	1040	5930	4730	1420	1540	1800	582	772	3730	842	507	1160
06	1150	4310	3820	N/A	2570	1630	672	755	2640	772	1280	N/A
07	1480	2970	3450	1660	2460	1590	650	742	2060	723	1040	1190
08	1650	2740	3550	1990	1980	1510	608	727	1470	712	972	1080
09	1970	2490	2670	1520	1820	1500	635	703	1160	701	766	1210
10	1910	2170	N/A	1410	1890	1730	611	673	972	690	692	840
11	1670	2080	2590	1230	1910	1370	579	661	895	N/A	657	854
12	1770	2560	2380	1270	2030	1150	653	759	946	682	684	759
13	1810	2410	2310	1200	1690	1240	699	793	1160	678	749	940
14	1790	2020	2310	1130	1680	1140	672	641	1430	664	1160	854
15	1480	2040	2210	1170	1460	1010	N/A	584	1010	579	1160	816
16	1400	3440	1940	1130	1320	1070	N/A	553	869	550	899	N/A
17	1500	3230	1660	1140	1670	965	875	547	791	550	1430	775
18	1790	3100	1780	1060	3450	955	1660	746	795	502	1200	692
19	1930	3100	1690	1240	15200	896	879	934	772	434	1010	639
20	4050	5690	1510	1090	21900	895	N/A	758	867	446	3670	691
21	4120	5060	1450	982	14000	1050	2220	684	919	482	7190	662
22	2880	3890	1500	953	10300	914	N/A	604	706	3160	5580	811
23	2220	3450	1610	939	8910	789	1230	587	634	1750	4150	746
24	1910	2850	1330	986	6700	748	4390	1030	653	1220	2540	904
25	N/A	2490	1340	953	5190	967	2680	1590	734	1390	2150	1190
26	1770	2370	1800	1010	4770	1100	1950	908	587	1140	1770	1020
27	1610	2000	2960	1040	3810	808	3530	773	578	874	1630	837
28	1070	1970	2780	1720	3250	676	2630	699	576	780	2620	1110
29	1120	1910	2310	1610	2890	668	1900	827	567	679	2170	992
30	1310		2130	1370	2610	638	1560	1630	650	645	1650	853
31	1250		2160		2430		1460	1220		645		803
Minimum	1040	1690	1330	939	1030	638	579	547	567	434	507	639
Mean	1744	3252	2287	1314	4324	1256	1325	844	1051	854	1721	965
Median	1630	2850	2145	1230	2430	1085	699	758	831	696	1160	854
Maximum	4120	6500	4730	1990	21900	2460	4390	1630	3730	3160	7190	1570

Table 3.1-2. Mean monthly Schuylkill River discharge (cubic feet/second) measured at the Pottstown US Geological Survey gage, 1970 - 1988.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970	982	3717	2217	4889	1613	1175	1459	1045	540	1147	3370	1815
1971	1743	5113	3927	1581	1891	1387	728	2256	1616	1017	2796	2992
1972	2429	2692	4253	2389	2952	7634	2721	825	609	768	3510	4872
1973	3928	3734	2386	4799	3181	3095	2141	1408	1609	1030	1006	4733
1974	3343	2315	2911	4030	1916	1143	843	697	1478	833	766	2660
1975	2962	3402	3718	3249	2645	2500	3189	1399	3433	3348	3263	2025
1976	4953	3619	2588	2556	2002	1686	1562	1124	1033	3870	1716	1428
1977	731	1513	5497	3534	1490	852	795	822	720	2206	3192	5213
1978	5418	1897	5451	2526	3822	1538	1012	1683	949	904	837	2158
1979	7383	4097	4144	2720	2621	1399	991	814	2112	3235	1960	1932
1980	1394	834	3029	3497	2412	1007	611	483	457	487	525	419
1981	316	2933	1101	1675	1687	1230	1080	450	452	505	666	881
1982	1907	2786	2154	3043	1550	4171	1480	993	619	631	936	1320
1983	1392	2807	3535	7820	2654	2169	894	514	357	852	2543	6805
1984	1728	4093	3078	5065	4952	3105	3940	1604	782	743	858	1788
1985	1076	1665	1179	875	1352	826	573	636	1085	867	2321	2427
1986	1714	3603	3762	2658	1357	794	745	1029	636	742	2278	3229
1987	2266	1404	2507	2502	1371	853	725	475	3679	1173	1694	2237
1988	1744	3252	2287	1314	4324	1256	1325	844	1051	854	1721	965
Minimum	250	360	658	533	510	487	326	276	271	328	334	300
Mean	2498	2934	3155	3223	2426	1997	1414	1014	1222	1329	1893	2638
Median	1770	2190	2550	2525	1900	1290	933	810	687	827	1225	1820
Maximum	37800	30865	20600	27400	22600	71200	17100	10488	22900	13000	10400	30100

Table 3.1-4. Mean monthly Schuylkill River temperature (C) measured at the Pottstown Water Treatment Plant, 1970 - 1988.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970	4	5	7	11	19	23	25	26	25	19	14	8
1971	5	6	9	14	18	24	27	25	24	19	13	10
1972	8	6	9	13	18	22	24	26	24	17	12	9
1973	7	6	10	13	16	22	25	26	24	19	13	10
1974	7	6	9	13	19	23	26	27	23	17	13	8
1975	7	6	9	11	18	22	24	26	21	16	12	8
1976	5	6	10	15	19	24	25	25	22	16	9	6
1977	4	5	10	14	19	22	27	26	24	17	14	7
1978	6	5	7	13	15	23	26	26	24	19	15	9
1979	6	2	7	14	19	22	25	26	23	17	13	8
1980	5	5	7	12	17	21	25	27	24	16	10	5
1981	3	5	8	13	17	22	25	25	22	15	10	5
1982	5	8	9	12	18	20	24	24	22	17	13	9
1983	6	6	9	10	16	21	25	26	24	18	11	8
1984	5	7	8	12	15	21	23	24	21	17	12	9
1985	6	6	11	15	20	23	25	26	23	17	15	9
1986	9	7	10	14	20	24	26	25	21	18	12	8
1987	6	6	10	15	19	25	28	27	22	17	12	9
1988	6	8	12	14	18	23	26	27	21	16	14	10
Minimum	1	0	0	7	11	15	19	20	16	10	6	3
Mean	6	6	9	13	18	22	25	26	23	17	12	8
Median	5	6	9	13	18	23	26	26	23	17	13	8
Maximum	13	18	18	22	25	29	30	31	29	23	19	16

Table 3.1-5. Summary of Schuylkill River water quality at S77660, 20 March 1979 through 27 December 1988.

Parameter	Dec, Jan, Feb Min	Dec, Jan, Feb Med	Dec, Jan, Feb Max	Mar, Apr, May Min	Mar, Apr, May Med	Mar, Apr, May Max	Jun, Jul, Aug Min	Jun, Jul, Aug Med	Jun, Jul, Aug Max	Sep, Oct, Nov Min	Sep, Oct, Nov Med	Sep, Oct, Nov Max	# of Samples
Temperature (C)	-1.0	2.0	9.0	3.0	11.0	21.5	14.0	23.0	30.0	3.0	14.5	24.0	267
Dissolved Oxygen (mg/l)	6.6	11.2	14.4	3.2	9.8	13.4	3.8	7.6	15.4	4.9	8.8	12.4	246
Biochemical Oxygen Demand (mg/l)	0.9	2.7	7.1	1.0	3.0	6.2	1.1	2.7	7.3	0.9	2.1	9.4	254
Chemical Oxygen Demand (mg/l)	0.0	11.0	197.5	0.0	11.2	53.9	0.0	11.1	46.9	0.0	12.6	39.5	254
Total Organic Carbon (mg/l)	0.0	3.2	20.9	0.0	2.5	15.3	0.0	3.5	19.0	0.0	3.8	30.6	248
pH	7.06	7.58	8.20	6.73	7.58	8.99	7.16	7.75	9.09	7.08	7.65	8.65	255
Total Alkalinity (mg/l)	14.2	64.6	130.6	28.9	55.8	77.9	2.7	76.5	111.0	0.0	85.3	126.9	255
Total Hardness (mg/l)	64.6	126.6	687.1	37.0	106.5	156.4	88.7	151.3	786.6	78.6	168.4	255.0	254
Specific Conductance (usm/cm)	159	323	537	181	289	386	215	373	551	157	421	581	255
Total Suspended Solids (mg/l)	0	5	238	0	13	72	0	9	329	0	4	265	249
Total Dissolved Solids (mg/l)	127	213	388	101	213	346	22	303	863	138	293	425	280
Dissolved Silica (mg/l)	2.17	3.57	4.40	1.74	3.41	4.30	1.70	3.44	4.21	1.10	2.53	4.00	75
Total Inorganic Carbon (mg/l)	16.7	65.1	142.1	31.5	57.3	76.8	2.9	74.3	108.2	15.3	86.9	132.7	124
Chloride (mg/l)	12.0	24.2	62.0	0.0	20.2	50.2	8.8	27.6	79.0	10.8	33.5	51.6	255
Sulfate (mg/l)	25.5	56.5	146.0	25.9	53.5	105.9	28.0	73.7	141.9	26.0	79.7	209.8	255
Sodium (mg/l)	8.70	16.63	46.90	7.15	14.55	31.00	6.43	21.30	38.20	8.90	24.10	40.40	255
Potassium (mg/l)	1.9	3.1	14.4	1.5	2.3	7.2	1.4	3.1	7.0	1.2	3.9	8.9	255
Calcium (mg/l)	13.7	28.1	63.6	10.8	25.9	41.7	7.9	33.3	52.0	16.9	33.5	60.4	255
Magnesium (mg/l)	7.30	14.10	29.00	6.30	12.50	19.30	9.10	16.70	25.90	6.75	18.98	28.60	255
Ammonia Nitrogen (mg/l)	0.030	0.412	2.680	0.000	0.240	1.200	0.000	0.117	0.560	0.000	0.179	0.580	255
Nitrite Nitrogen (mg/l)	0.009	0.040	0.480	0.000	0.065	0.228	0.000	0.074	2.980	0.030	0.085	0.420	255
Nitrate Nitrogen (mg/l)	1.37	3.09	4.43	1.71	2.52	3.59	0.00	2.40	3.46	0.00	2.78	9.96	255
Total Phosphate Phosphorus (mg/l)	0.00	0.18	0.67	0.04	0.13	2.45	0.04	0.21	3.48	0.00	0.24	0.52	246
Ortho Phosphate Phosphorus (mg/l)	0.00	0.12	1.60	0.00	0.07	0.33	0.00	0.15	0.33	0.00	0.19	0.35	253
Cadmium (mg/l)	0.000	0.000	0.003	0.000	0.000	0.004	0.000	0.000	0.001	0.000	0.000	0.001	58
Chromium (mg/l)	0.001	0.007	0.075	0.000	0.008	0.139	0.000	0.005	0.194	0.000	0.005	0.104	281
Copper (mg/l)	0.000	0.006	0.048	0.000	0.007	0.052	0.000	0.006	0.295	0.000	0.006	0.032	282
Iron (mg/l)	0.00	0.30	6.83	0.10	0.38	2.70	0.00	0.25	9.90	0.00	0.22	8.10	255
Lead (mg/l)	0.000	0.001	0.028	0.000	0.003	0.041	0.000	0.001	0.171	0.000	0.001	0.028	282
Manganese (mg/l)	0.05	0.23	0.76	0.00	0.23	0.68	0.00	0.11	0.66	0.00	0.06	0.49	255
Nickel (mg/l)	0.000	0.005	0.030	0.000	0.008	0.040	0.000	0.004	0.010	0.000	0.004	0.018	85
Zinc (mg/l)	0.00	0.04	0.81	0.00	0.03	1.20	0.00	0.02	8.34	0.00	0.02	0.62	282
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	58
Cyanide, Total (mg/l)	0.000	0.000	0.008	0.000	0.000	0.009	0.000	0.000	0.008	0.000	0.000	0.012	252
Phenols (mg/l)	0.000	0.000	0.030	0.000	0.000	0.019	0.000	0.000	0.020	0.000	0.000	0.050	254
Trichloroethylene (ug/l)	0.0	0.0	3.9	0.0	0.0	6.2	0.0	0.0	8.2	0.0	0.0	9.5	215
Total Coliforms (MF) (c/.11)	4	2700	140000	151	3600	116000	60	7200	305000	140	6650	175000	252
Fecal Coliforms (MF) (c/.11)	0	165	61000	10	268	12100	3	550	43000	8	400	30500	250
Aluminum (mg/l)	0.00	0.19	1.80	0.00	0.19	2.10	0.00	0.10	6.30	0.00	0.00	3.63	58
Sulfide (mg/l)	0.00	0.00	5.37	0.00	0.00	1.72	0.00	0.00	0.70	0.00	0.00	1.80	82

Table 3.1-6. Summary of Schuylkill River water quality at S77660, 14 January 1988 through 27 December 1988.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	0.0	1.3	3.0	6.0	11.0	17.0	20.0	25.0	26.5	6.0	11.0	20.0	25
Dissolved Oxygen (mg/l)	12.4	12.6	14.0	5.9	8.1	12.1	3.8	6.9	11.8	6.6	8.2	12.0	22
Biochemical Oxygen Demand (mg/l)	1.0	2.0	2.8	2.7	4.4	6.1	1.7	2.5	6.3	1.7	2.1	3.2	25
Chemical Oxygen Demand (mg/l)	0.0	5.3	23.5	0.0	7.3	40.2	0.0	10.6	17.1	0.0	0.0	15.1	26
Total Organic Carbon (mg/l)	2.7	3.1	5.2	2.8	3.7	5.5	0.8	3.9	4.7	3.3	3.7	4.3	26
pH	7.23	7.61	7.84	7.21	7.52	8.03	7.24	7.57	8.13	7.46	7.53	7.88	26
Total Alkalinity (mg/l)	60.0	71.6	84.9	52.9	68.2	74.6	59.4	86.6	103.0	58.4	83.0	115.0	26
Total Hardness (mg/l)	104.0	140.3	182.0	93.4	120.0	125.0	114.0	148.0	188.0	107.0	160.0	218.0	26
Specific Conductance (usm/cm)	270	374	488	266	308	348	271	391	446	238	395	533	26
Total Suspended Solids (mg/l)	0	1	2	8	40	72	1	12	50	1	4	30	20
Total Dissolved Solids (mg/l)	175	240	300	158	178	220	205	293	316	175	310	366	25
Chloride (mg/l)	22.4	28.1	36.0	21.5	23.8	27.3	17.3	35.4	38.3	16.9	33.7	49.4	26
Sulfate (mg/l)	33.2	51.9	84.7	39.2	44.1	53.6	44.1	55.8	74.0	35.7	62.1	99.8	26
Sodium (mg/l)	14.50	17.10	23.10	14.40	17.90	31.00	11.00	22.00	29.60	10.20	22.40	30.00	26
Potassium (mg/l)	2.1	2.8	3.7	2.3	2.9	3.6	2.4	3.5	5.0	2.4	3.6	4.5	26
Calcium (mg/l)	21.4	24.3	29.4	17.0	26.7	37.6	21.3	37.0	52.0	16.9	33.0	41.0	26
Magnesium (mg/l)	9.20	11.90	15.20	7.60	11.10	12.60	10.00	13.70	18.00	8.10	15.00	19.06	26
Ammonia Nitrogen (mg/l)	0.360	0.486	0.830	0.210	0.370	0.480	0.046	0.140	0.480	0.114	0.264	0.477	26
Nitrite Nitrogen (mg/l)	0.025	0.039	0.083	0.031	0.061	0.104	0.057	0.095	0.117	0.047	0.084	0.126	26
Nitrate Nitrogen (mg/l)	2.68	3.12	3.46	1.79	2.14	2.63	1.66	2.62	3.13	2.51	3.02	3.11	26
Total Phosphate Phosphorus (mg/l)	0.11	0.22	0.34	0.16	0.17	0.29	0.12	0.21	0.36	0.14	0.17	0.33	26
Ortho Phosphate Phosphorus (mg/l)	0.06	0.11	0.16	0.06	0.09	0.20	0.00	0.11	0.27	0.09	0.16	0.22	26
Cadmium (mg/l)	0.000	0.000	0.001	0.000	0.001	0.004	0.000	0.000	0.001	0.000	0.000	0.001	26
Chromium (mg/l)	0.002	0.005	0.009	0.000	0.006	0.016	0.000	0.002	0.007	0.000	0.002	0.014	26
Copper (mg/l)	0.002	0.005	0.011	0.000	0.004	0.013	0.000	0.000	0.009	0.003	0.005	0.012	26
Iron (mg/l)	0.00	0.20	1.40	0.20	0.30	2.70	0.00	0.23	0.60	0.10	0.27	1.20	26
Lead (mg/l)	0.000	0.000	0.005	0.000	0.000	0.020	0.000	0.002	0.006	0.000	0.004	0.007	26
Manganese (mg/l)	0.10	0.20	0.30	0.00	0.15	0.30	0.00	0.00	0.20	0.00	0.00	0.20	26
Nickel (mg/l)	0.000	0.005	0.006	0.000	0.006	0.040	0.001	0.004	0.005	0.003	0.006	0.008	26
Zinc (mg/l)	0.00	0.04	0.26	0.00	0.03	0.08	0.00	0.03	0.05	0.02	0.03	0.04	26
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26
Cyanide, Total (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				15
Total Coliforms (MF) (c/.1l)	200	2650	7400	1600	5750	17500	20000	36000	305000	1000	30000	175000	26
Fecal Coliforms (MF) (c/.1l)	0	125	400	19	250	4150	100	250	3500	8	290	4800	26
Aluminum (mg/l)	0.00	0.09	0.85	0.00	0.18	2.10	0.00	0.04	0.51	0.00	0.00	0.00	26
Sulfide (mg/l)	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25

Table 3.1-7. New minimum values observed for water quality parameters measured in 1988 at S77660 on the Schuylkill River.

Season	Parameter	Value	Date
Dec, Jan, Feb	Nickel (mg/l)	0.000	02/10/88
Mar, Apr, May	Copper (mg/l)	0.000	04/20/88
	Manganese (mg/l)	0.00	04/20/88
	Nickel (mg/l)	0.000	03/09/88
	Aluminum (mg/l)	0.00	04/20/88
Jun, Jul, Aug	Dissolved Oxygen (mg/l)	3.8	08/24/88
Sep, Oct, Nov	Calcium (mg/l)	16.9	11/29/88
	Cadmium (mg/l)	0.000	09/21/88
	Fecal Coliforms (MF) (c/.1l)	8	10/19/88

Table 3.1-8. New maximum values observed for water quality parameters measured in 1988 at S7766D on the Schuylkill River.

Season	Parameter	Value	Date
Mar, Apr, May	Total Suspended Solids (mg/l)	72	05/18/88
	Sodium (mg/l)	31.00	04/20/88
	Cadmium (mg/l)	0.004	04/06/88
	Iron (mg/l)	2.70	05/18/88
	Nickel (mg/l)	0.040	04/06/88
	Aluminum (mg/l)	2.10	05/18/88
Jun, Jul, Aug	Calcium (mg/l)	52.0	06/29/88
	Cadmium (mg/l)	0.001	08/24/88
	Total Coliforms (MF) (c/.1l)	305000	08/10/88
Sep, Oct, Nov	Total Coliforms (MF) (c/.1l)	175000	10/04/88

Table 3.1-9. Summary of Schuylkill River water quality at S77140, 20 March 1979 through 27 December 1988.

Parameter	Dec, Jan, Feb Min	Dec, Jan, Feb Med	Dec, Jan, Feb Max	Mar, Apr, May Min	Mar, Apr, May Med	Mar, Apr, May Max	Jun, Jul, Aug Min	Jun, Jul, Aug Med	Jun, Jul, Aug Max	Sep, Oct, Nov Min	Sep, Oct, Nov Med	Sep, Oct, Nov Max	# of Samples
Temperature (C)	-1.0	2.0	9.0	4.0	11.0	21.5	14.0	23.0	30.0	3.5	15.0	24.5	239
Dissolved Oxygen (mg/l)	6.1	11.2	15.0	3.1	10.4	13.9	4.2	7.9	15.0	5.6	8.9	12.6	248
Biochemical Oxygen Demand (mg/l)	0.9	2.7	8.4	0.7	3.0	7.6	1.1	2.8	7.1	0.8	2.2	5.8	255
Chemical Oxygen Demand (mg/l)	0.0	12.8	196.6	0.0	12.7	56.2	0.0	11.5	64.5	0.0	10.3	75.9	253
Total Organic Carbon (mg/l)	0.0	3.0	18.7	0.0	2.5	16.3	0.0	4.0	20.0	0.0	3.6	29.3	247
pH	7.01	7.64	8.21	6.62	7.61	8.98	6.91	7.76	9.19	7.16	7.68	8.67	255
Total Alkalinity (mg/l)	8.9	64.4	172.1	27.7	55.7	79.1	4.3	77.5	131.4	0.0	87.8	130.7	254
Total Hardness (mg/l)	65.2	127.4	675.2	51.9	108.4	160.6	69.2	155.7	724.9	83.5	172.0	448.0	253
Specific Conductance (usm/cm)	156	318	611	157	287	387	215	375	729	189	425	667	255
Total Suspended Solids (mg/l)	0	5	232	0	12	72	0	9	340	0	4	357	248
Total Dissolved Solids (mg/l)	97	217	509	135	206	501	160	290	2290	141	296	485	253
Dissolved Silica (mg/l)	2.09	3.63	8.99	2.01	3.38	4.13	1.66	3.37	4.90	1.08	2.50	3.35	75
Total Inorganic Carbon (mg/l)	23.2	66.7	184.1	29.7	57.5	74.6	4.7	71.7	106.0	52.2	87.0	136.1	123
Chloride (mg/l)	11.7	24.2	62.4	0.0	20.5	51.3	8.8	27.2	81.9	10.6	34.3	61.7	254
Sulfate (mg/l)	24.9	57.9	185.2	29.1	53.7	99.7	28.0	76.6	187.2	31.7	81.3	217.7	254
Sodium (mg/l)	8.50	17.31	98.00	4.90	14.75	29.12	6.74	21.12	58.00	9.07	25.31	42.80	255
Potassium (mg/l)	1.9	3.1	7.3	0.8	2.3	4.8	1.4	3.1	9.7	1.2	4.0	11.1	255
Calcium (mg/l)	14.1	28.8	83.5	5.9	26.5	44.3	9.6	32.4	84.0	6.9	35.0	62.4	255
Magnesium (mg/l)	7.00	13.90	35.80	3.60	12.02	20.30	8.60	16.70	28.93	8.30	19.87	32.30	255
Ammonia Nitrogen (mg/l)	0.000	0.420	2.470	0.000	0.236	1.480	0.000	0.099	0.490	0.000	0.163	0.580	255
Nitrite Nitrogen (mg/l)	0.008	0.040	0.301	0.000	0.067	0.224	0.000	0.076	3.000	0.030	0.087	0.900	254
Nitrate Nitrogen (mg/l)	1.40	3.15	6.19	1.60	2.51	3.63	0.00	2.46	5.83	0.03	2.80	4.68	254
Total Phosphate Phosphorus (mg/l)	0.02	0.18	0.85	0.00	0.13	3.48	0.04	0.22	3.48	0.00	0.24	2.24	245
Ortho Phosphate Phosphorus (mg/l)	0.00	0.12	0.85	0.00	0.07	0.33	0.00	0.15	0.35	0.00	0.19	0.37	253
Cadmium (mg/l)	0.000	0.000	0.002	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.001	58
Chromium (mg/l)	0.000	0.008	0.060	0.000	0.007	0.068	0.000	0.005	0.070	0.000	0.006	0.036	254
Copper (mg/l)	0.000	0.007	0.072	0.001	0.006	0.039	0.000	0.006	0.055	0.000	0.007	0.044	255
Iron (mg/l)	0.00	0.28	7.45	0.11	0.41	4.10	0.00	0.22	10.80	0.00	0.19	13.80	255
Lead (mg/l)	0.000	0.001	0.025	0.000	0.002	0.025	0.000	0.001	0.023	0.000	0.000	0.039	255
Manganese (mg/l)	0.08	0.23	0.72	0.00	0.23	0.88	0.00	0.10	0.68	0.00	0.06	1.15	255
Nickel (mg/l)	0.000	0.004	0.020	0.003	0.008	0.050	0.002	0.005	0.012	0.002	0.005	0.007	58
Zinc (mg/l)	0.00	0.04	0.70	0.00	0.03	0.89	0.00	0.03	2.56	0.00	0.03	0.16	255
Mercury (ug/l)	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58
Cyanide, Total (mg/l)	0.000	0.000	0.020	0.000	0.000	0.009	0.000	0.000	0.018	0.000	0.000	0.008	252
Phenols (mg/l)	0.000	0.000	0.035	0.000	0.000	0.042	0.000	0.000	0.022	0.000	0.000	0.043	253
Trichloroethylene (ug/l)	0.0	0.0	3.6	0.0	0.0	4.8	0.0	0.0	2.4	0.0	0.0	6.8	214
Total Coliforms (MF) (c/.1l)	13	2200	69000	170	3300	107000	40	7750	235000	140	6050	200000	251
Fecal Coliforms (MF) (c/.1l)	0	175	55000	10	263	11500	2	500	63000	3	400	29000	251
Aluminum (mg/l)	0.00	0.19	3.90	0.00	0.25	4.10	0.00	0.15	8.00	0.00	0.00	5.27	58
Sulfide (mg/l)	0.00	0.00	0.80	0.00	0.00	0.74	0.00	0.00	0.90	0.00	0.00	4.40	82

Table 3.1-10. Summary of Schuylkill River water quality at S77140, 14 January 1988 through 27 December 1988.

Parameter	Dec, Jan, Feb Min	Med	Max	Mar, Apr, May Min	Med	Max	Jun, Jul, Aug Min	Med	Max	Sep, Oct, Nov Min	Med	Max	# of Samples
Temperature (C)	0.0	1.0	3.0	6.0	11.0	15.0	20.0	24.0	28.0	7.0	10.5	20.0	24
Dissolved Oxygen (mg/l)	12.2	12.8	13.9	5.9	10.6	12.3	4.2	6.9	10.6	6.6	8.6	11.6	23
Biochemical Oxygen Demand (mg/l)	0.9	2.0	3.2	2.8	4.6	6.1	1.9	3.0	5.8	1.8	2.1	3.1	26
Chemical Oxygen Demand (mg/l)	0.0	12.2	23.5	0.0	13.6	32.2	0.0	0.0	31.7	0.0	0.0	10.0	26
Total Organic Carbon (mg/l)	2.8	3.1	5.0	2.6	3.5	4.5	2.2	4.1	4.9	3.6	3.8	4.8	26
pH	7.50	7.69	7.95	7.37	7.62	8.56	7.39	7.74	8.18	7.58	7.60	7.92	26
Total Alkalinity (mg/l)	58.9	71.3	80.3	53.5	66.3	79.1	59.4	93.7	106.0	51.9	81.7	113.0	26
Total Hardness (mg/l)	100.0	140.7	178.0	92.4	118.5	137.0	114.0	180.0	194.0	103.0	175.0	283.0	26
Specific Conductance (usm/cm)	266	382	505	264	311	370	266	438	449	249	421	662	26
Total Suspended Solids (mg/l)	0	1	4	5	39	72	6	21	44	1	9	37	20
Total Dissolved Solids (mg/l)	176	249	304	170	182	501	215	288	323	168	296	485	25
Chloride (mg/l)	22.7	28.4	37.9	21.7	24.0	31.3	16.6	37.3	43.5	16.8	35.4	61.7	26
Sulfate (mg/l)	31.9	53.2	84.7	37.5	44.4	59.3	44.5	69.3	72.5	33.9	63.3	156.0	26
Sodium (mg/l)	12.60	18.55	26.20	14.90	17.80	18.70	9.80	21.10	29.90	10.90	23.70	42.00	26
Potassium (mg/l)	2.3	3.2	3.5	2.3	3.0	3.8	2.0	3.2	5.0	2.8	3.6	6.1	26
Calcium (mg/l)	21.4	24.4	35.3	15.6	26.3	33.8	20.6	32.8	47.0	18.0	35.0	56.0	26
Magnesium (mg/l)	9.50	12.80	18.40	9.40	10.00	10.80	8.70	14.50	16.00	8.30	16.00	21.40	26
Ammonia Nitrogen (mg/l)	0.320	0.500	0.710	0.260	0.334	0.480	0.050	0.202	0.324	0.000	0.180	0.362	26
Nitrite Nitrogen (mg/l)	0.026	0.040	0.075	0.029	0.063	0.121	0.062	0.091	0.107	0.034	0.078	0.108	26
Nitrate Nitrogen (mg/l)	2.63	3.19	3.81	1.98	2.12	2.56	2.27	2.78	3.04	2.52	3.03	4.10	26
Total Phosphate Phosphorus (mg/l)	0.10	0.20	0.24	0.00	0.17	0.34	0.07	0.18	0.37	0.10	0.19	0.34	26
Ortho Phosphate Phosphorus (mg/l)	0.08	0.11	0.16	0.00	0.08	0.12	0.00	0.10	0.30	0.08	0.17	0.33	26
Cadmium (mg/l)	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.001	26
Chromium (mg/l)	0.000	0.005	0.007	0.000	0.005	0.012	0.000	0.002	0.006	0.000	0.002	0.013	26
Copper (mg/l)	0.002	0.004	0.008	0.003	0.005	0.021	0.000	0.000	0.010	0.004	0.008	0.013	26
Iron (mg/l)	0.00	0.20	0.50	0.20	0.35	4.10	0.00	0.20	3.80	0.10	0.30	1.30	26
Lead (mg/l)	0.000	0.000	0.007	0.000	0.000	0.025	0.000	0.000	0.014	0.000	0.000	0.008	26
Manganese (mg/l)	0.10	0.20	0.30	0.00	0.15	0.50	0.00	0.00	0.40	0.00	0.00	0.20	26
Nickel (mg/l)	0.000	0.005	0.006	0.003	0.007	0.050	0.002	0.004	0.008	0.004	0.005	0.007	26
Zinc (mg/l)	0.00	0.02	0.09	0.00	0.04	0.11	0.00	0.03	0.07	0.00	0.03	0.05	26
Mercury (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26
Cyanide, Total (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Phenols (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26
Trichloroethylene (ug/l)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				15
Total Coliforms (MF) (c/.1l)	100	2250	9100	1600	6000	26000	14500	37500	235000	2000	23000	200000	26
Fecal Coliforms (MF) (c/.1l)	0	150	300	18	220	4450	170	400	1900	3	240	4300	26
Aluminum (mg/l)	0.00	0.14	0.28	0.00	0.14	4.10	0.00	0.14	2.20	0.00	0.00	0.00	26
Sulfide (mg/l)	0.00	0.10	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25

Table 3.1-11. New minimum values observed for water quality parameters measured in 1988 at S77140 on the Schuylkill River.

Season	Parameter	Value	Date
Dec, Jan, Feb	Chromium (mg/l)	0.000	12/27/88
	Nickel (mg/l)	0.000	01/27/88
Mar, Apr, May	Total Phosphate Phosphorus (mg/l)	0.00	04/20/88
	Chromium (mg/l)	0.000	04/20/88
	Manganese (mg/l)	0.00	04/20/88
	Nickel (mg/l)	0.003	03/09/88
	Aluminum (mg/l)	0.00	04/20/88
Jun, Jul, Aug	Dissolved Oxygen (mg/l)	4.2	08/24/88
	Nickel (mg/l)	0.002	08/10/88
	Aluminum (mg/l)	0.00	08/10/88
Sep, Oct, Nov	Cadmium (mg/l)	0.000	09/21/88
	Fecal Coliforms (MF) (c/.1l)	3	11/01/88

Table 3.1-12. New maximum values observed for water quality parameters measured in 1988 at S77140 on the Schuylkill River.

Season	Parameter	Value	Date
Mar, Apr, May	Total Alkalinity (mg/l)	79.1	05/04/88
	Total Suspended Solids (mg/l)	72	05/18/88
	Total Dissolved Solids (mg/l)	501	04/06/88
	Cadmium (mg/l)	0.001	05/18/88
	Iron (mg/l)	4.10	05/18/88
	Lead (mg/l)	0.025	05/18/88
	Nickel (mg/l)	0.050	04/06/88
	Aluminum (mg/l)	4.10	05/18/88
Jun, Jul, Aug	Cadmium (mg/l)	0.001	06/15/88
	Total Coliforms (MF) (c/.1l)	235000	07/26/88
Sep, Oct, Nov	Total Dissolved Solids (mg/l)	485	10/19/88
	Chloride (mg/l)	61.7	10/19/88
	Nickel (mg/l)	0.007	11/15/88
	Total Coliforms (MF) (c/.1l)	200000	10/04/88

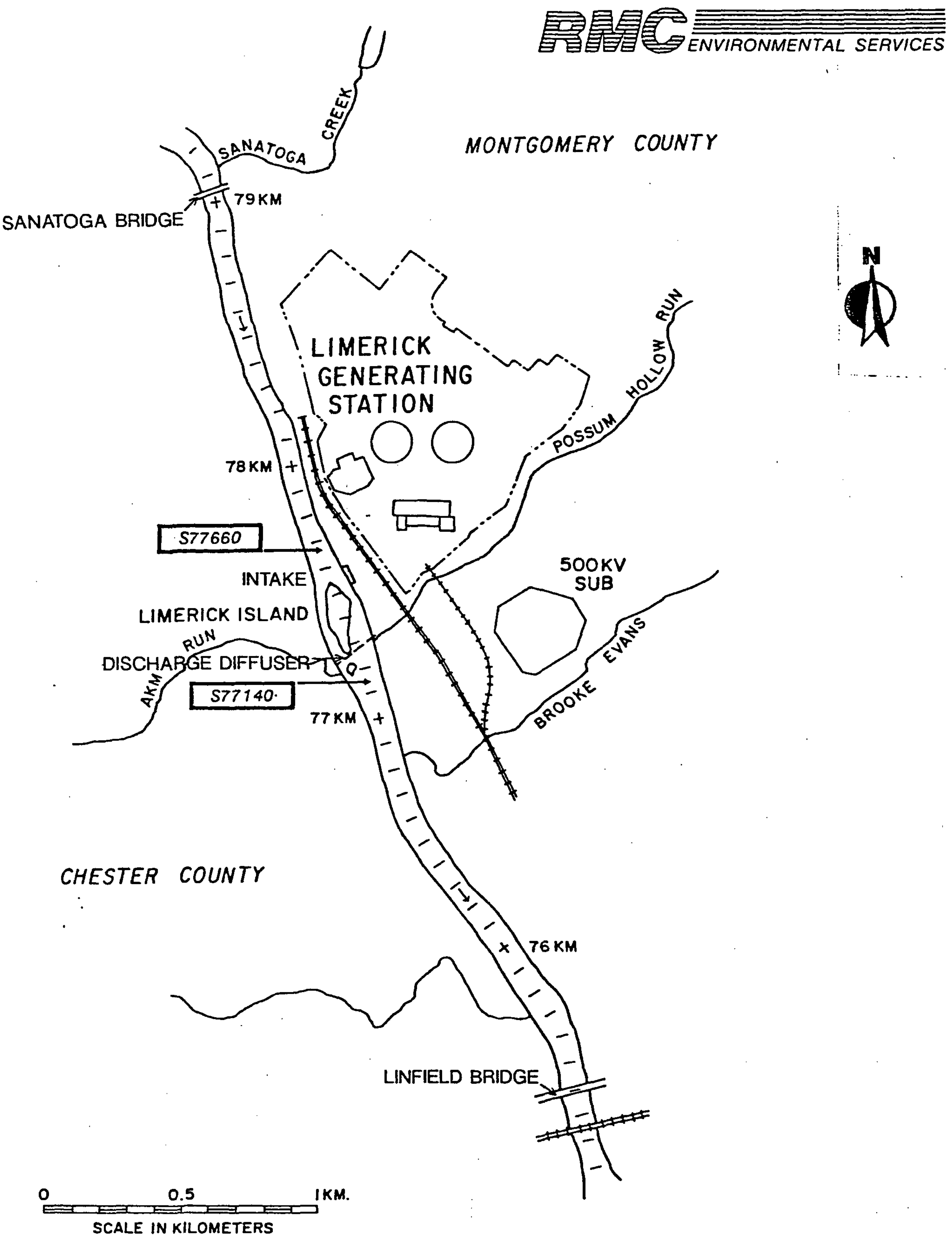

FIGURE 3.1-1 LOCATION OF WATER QUALITY SAMPLE STATIONS IN THE SCHUYLKILL RIVER, 1988.

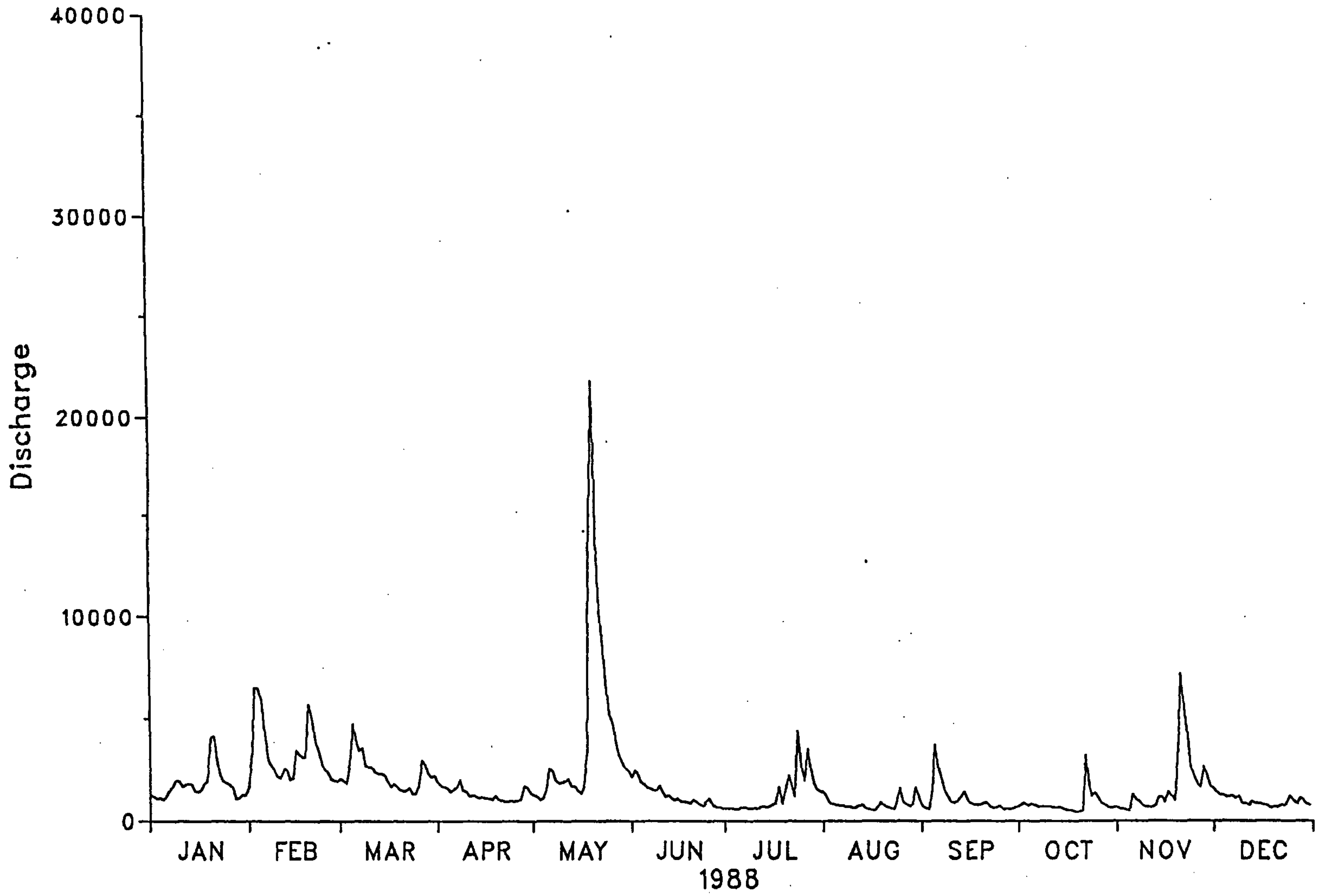

FIGURE 3.1-2 SCHUYLKILL RIVER MEAN DAILY DISCHARGE (cfs) DURING 1988 (POTTSTOWN GAGE, USGS).

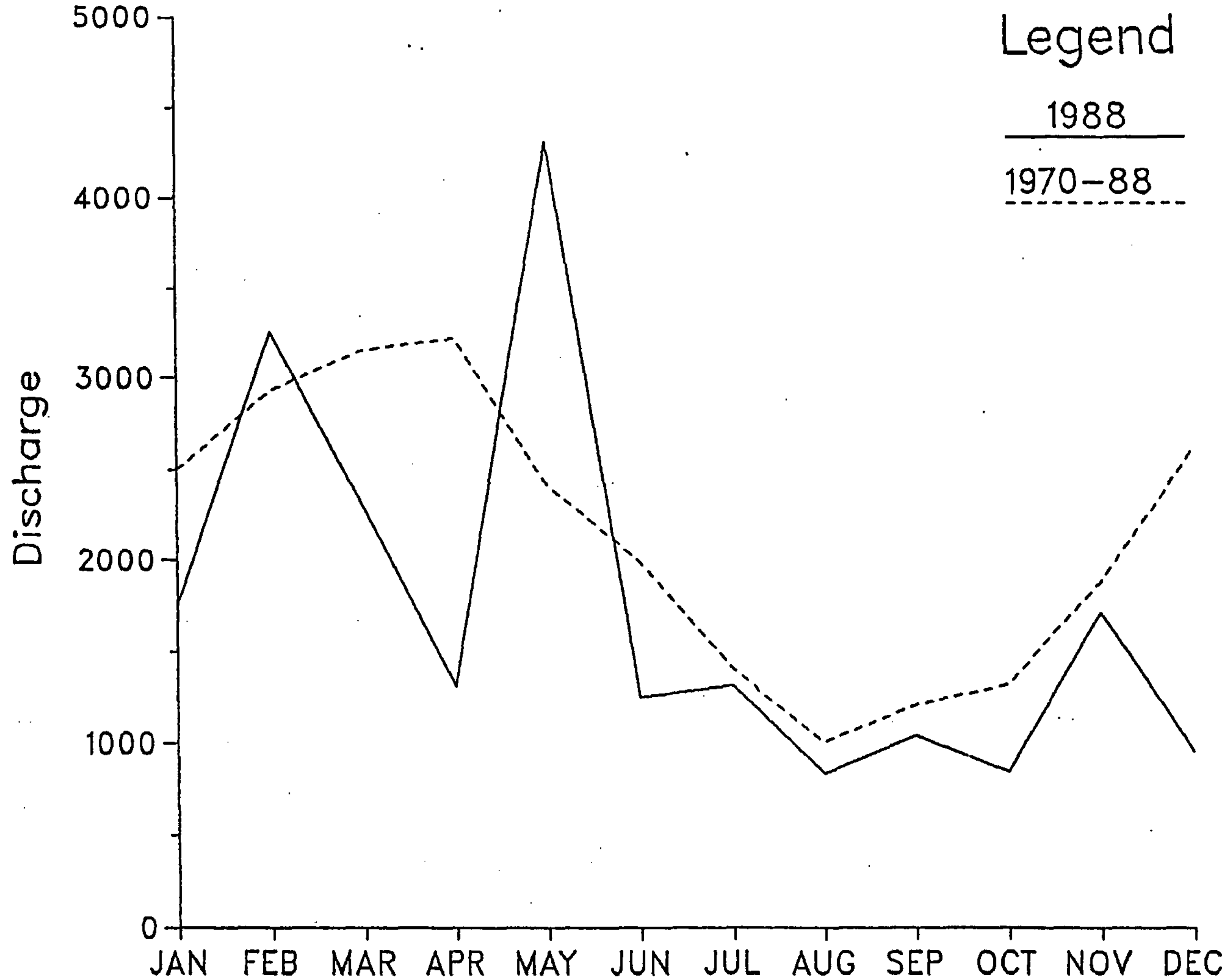

FIGURE 3.1-3 SCHUYLKILL RIVER MEAN MONTHLY DISCHARGE (cfs) DURING 1988 AND 1970-1988 (POTTSTOWN GAGE, USGS).

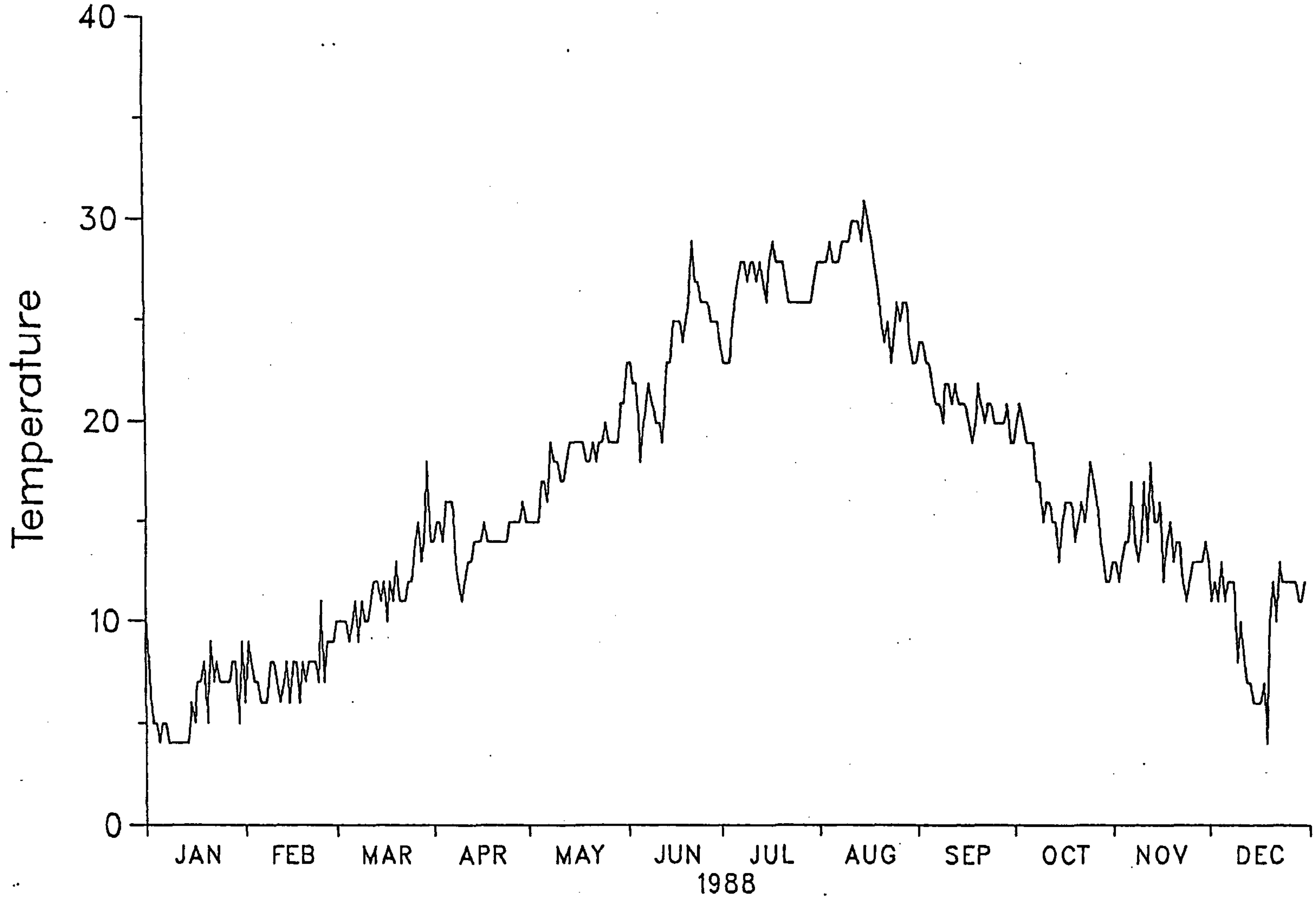

FIGURE 3.1-4 SCHUYLKILL RIVER DAILY TEMPERATURE (°C) DURING 1988 (POTTSTOWN WATER TREATMENT PLANT).

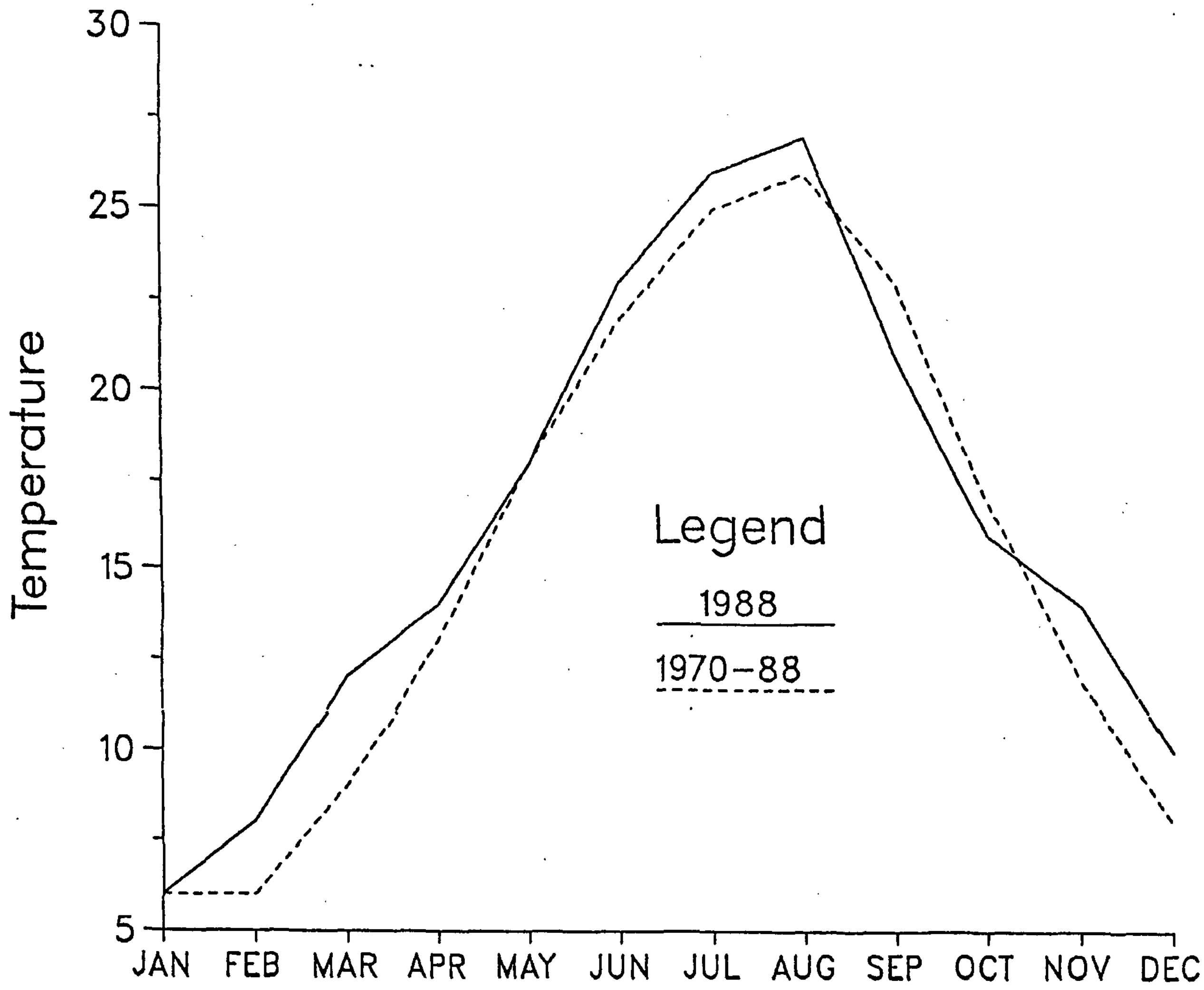

FIGURE 3.1-5 SCHUYLKILL RIVER MEAN MONTHLY TEMPERATURE (°C) DURING 1988 AND 1970-1988 (POTTSTOWN WATER TREATMENT PLANT).

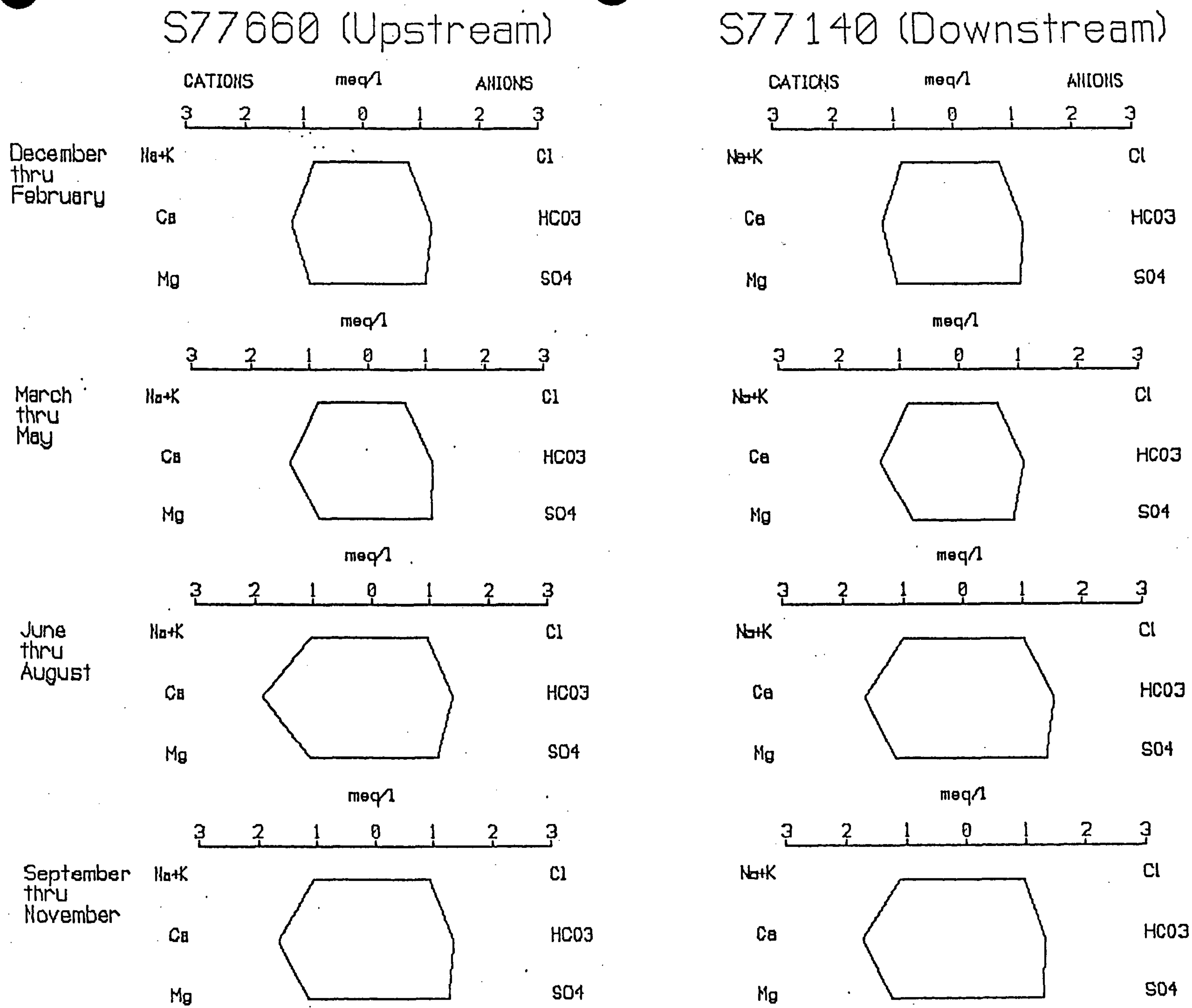

FIGURE 3.1-6 Stiff diagrams of Schuylkill River water quality at S77660 and S77140, 1988.

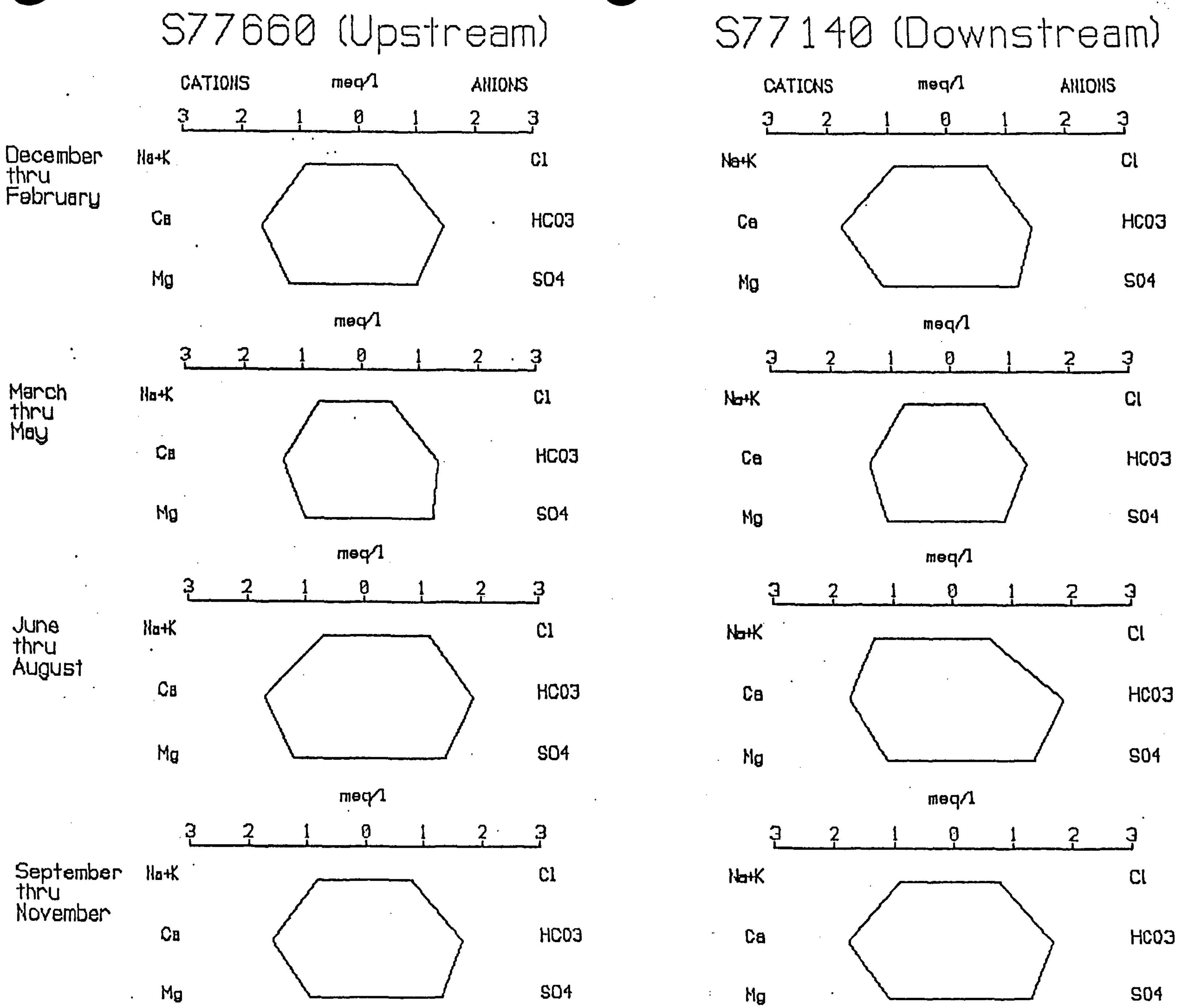

FIGURE 3.1-7 Stiff diagrams of Schuylkill River water quality at S77660 and S77140, 1987.

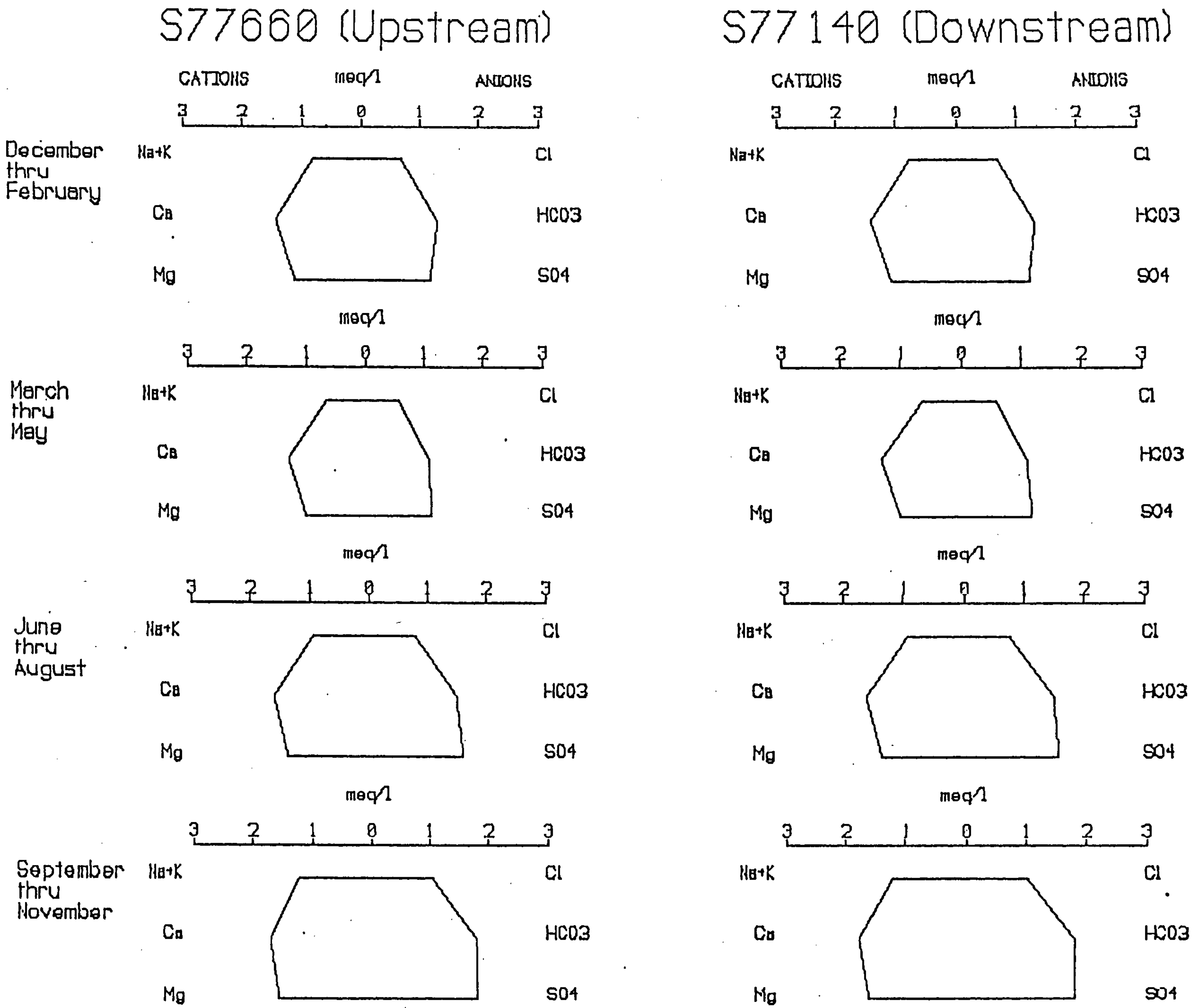

FIGURE 3.1-8 Stiff diagrams of Schuylkill River water quality at S77660 and S77140, 1979-1986.

3.2 Benthic Macroinvertebrates

INTRODUCTION

Benthic macroinvertebrates are aquatic animals without backbones that live part or all of their lives on or within the substrate and which are large enough to be retained by 0.595-mm mesh. Benthic macroinvertebrates include not only insects such as the mayflies, stoneflies, and caddisflies, but other invertebrate groups including worms, crustaceans, snails, and clams as well. These organisms are an important food source for fish and, when considered as a community of species, a valuable descriptor of water and physical habitat quality.

It is for the latter reason in particular that the benthic macroinvertebrate community in the Schuylkill River near LGS was studied. Electric generating stations can affect benthic macroinvertebrate communities through reduced river flow due to water withdrawal for cooling purposes or by thermal enrichment or water quality changes due to cooling water discharge.

The objective of the macroinvertebrate study was to determine if LGS operation affected the benthic community in the Schuylkill River downstream of plant discharge. To this end, macroinvertebrate samples were collected at locations upstream and downstream of the plant before and after operation. In this fashion, a database was assembled that allowed description of LGS preoperational variation in the macroinvertebrate community for comparison with variation observed during plant operation.

Studies of the macroinvertebrate community in the Schuylkill River near LGS were conducted in 1970-1976 and were resumed in October 1983 through 1988. Data obtained during the earlier period were reported in the EROL and those obtained in 1983-1987 are reported in previous reports (RMC Environmental Services 1984, 1985, 1986, 1987, and 1988). Data from 1988 are reported in the first part of this report section, which is then followed by a comparison of these data with that collected throughout 1984-1987 (post-EROL) for the purpose of evaluating any previously unrecognized changes in the benthic macroinvertebrate community that may have resulted from LGS operation. Data collected during the 1970's that are listed in the tables were evaluated in RMC Environmental Services (1988). They enter into discussion in this report only in a qualitative manner.

METHODS

During 1984-1988, four sample stations were located in the Schuylkill River near LGS (Fig. 3.2-1). Station S78620 was located 1.3 km upstream of LGS at the Sanatoga Bridge. Station S77120 was located 0.2 km downstream of the LGS diffuser. Further downstream, Stations S76760 at the mouth of Brooke Evans Run and S75770 near Wells Road, were located 0.6 and 1.6 km downstream of LGS, respectively. Three replicate samples were collected quarterly (in 1988 - 1 February, 25 April, 14 July, and 11 October) at each station using Buried Cylinder Samplers (BCS).

The BCS is a colonization sampler consisting of 5 to 10-cm diameter cobbles (similar to the dominant Schuylkill River substrate) contained in a perforated steel basket. Each BCS was placed into the riverbed for approximately 90 days prior to retrieval, during which time macroinvertebrates present in the adjacent river bottom were allowed to colonize the enclosed substrate materials. This method of sample collection is similar to that described by Coleman and Hynes (1970).

After retrieval, the BCS were transported to the laboratory and all cobbles were washed and removed from other substrate materials, which were then washed through a 0.35-mm mesh sieve. All sample residue retained by the sieve (substrate and macroinvertebrates) was preserved with 70% isopropanol prior to laboratory processing. Macroinvertebrates were sorted from sample residue in white enamelled pans and identified to the lowest taxon practicable, usually genus.

Macroinvertebrate data included the total number of taxa collected, the identity of all taxa, the standing crop (number of individuals/m^2) of all taxa combined, the identity and standing crop of all taxa that individually comprised $\geq$ 2% of all macroinvertebrates collected (termed important taxa), and the percent composition represented by important taxa. In analysis of 1988 results, these parameters were evaluated by grouping the data on an annual and on a sample date basis. Results from 1984-1988 were evaluated on an annual basis.

In recent years (1984-1987), it has been noted that two sample stations located downstream of LGS have been changing in terms of physical conditions so that they no longer are as similar to the upstream station as they were when established in the 1970's. These stations, S76760 and S77120, are located immediately downstream of the mouths of Brooke Evans Creek and Possum Hollow Run, respectively. Presumably due to increased development within their watersheds, these streams have transported large quantities of sediment to the Schuylkill River, forming substantial deltas and thereby creating backwater conditions at the sample stations. These altered physical conditions may result in change of macroinvertebrate community structure that could be misinterpreted as an LGS operational impact. Therefore, an additional sample station was established in 1988 at S77260 immediately downstream from the LGS diffuser in an area where the physical habitat resembled that found at S78620 (Fig. 3.2-1).

Qualitative samples were collected at S77260 on the 14 July and 11 October sample dates by disturbing the substrate in an area of strong current and allowing the dislodged substrate and macroinvertebrates to wash through a standard 0.595 mm mesh net. This is a standardized sampling method employed in aquatic macroinvertebrate studies. A total of ten 10-second duration kicks was composited into one sample on each sample date. All retained residue was then preserved and processed in the laboratory in similar fashion to those from the BCS.

The total number and percent abundance for each taxon collected at S77260 were calculated and compared to those at S78620 on individual sample dates and for both dates combined. In order to statistically compare the communities of both stations, a Morisita index was calculated on the combined data. A Morisita index is a measure of community similarity ranging between 0 (no similarity) and 1 (identical) (Brower and Zar 1977).

RESULTS AND DISCUSSION

1988 Results

The BCS near LGS collected a total of 67 taxa in 1988 (Table 3.2-1). Taxonomic composition was similar at all stations, although from 10 to 14 more taxa were collected at S78620 than at any of the downstream stations. Of all taxa identified, 32 were collected at three or more stations, and of these, 25 were present at all four stations.

Seasonally, nearly the same total number of taxa were collected at S75770 and S76760, whereas the total collected at S77120 differed with no apparent pattern (Table 3.2-2). The number of taxa collected on each sample date was consistently higher at S78620 than the number collected at any of the downstream stations.

Annual mean standing crop was nearly identical at each downstream station and approximately one third that measured upstream at S78620 (Table 3.2-3). Substantial seasonal variation was observed at all stations.

Although a large number of taxa were collected at each station, relatively few were abundant (Table 3.2-4). This was particularly true at the downstream stations where from 43.2 to 69.7 percent of the samples were comprised of worms (Oligochaeta). Midges (Chironomidae) were the only other abundant taxon collected downstream of LGS, comprising 21.6 to 29.9 percent of organisms in the samples. Midges were the most abundant taxon at S78620 (31.8%) followed by Oligochaeta, a fingernail clam (Musculium), blackflies (Simuliidae), and net-spinning caddisflies (Cheumatopsyche and Hydropsyche), which collectively comprised 82.0 percent of the samples.

High standing crops of all taxa combined as well as of particular taxa distinguished the community at S78620 from those at the downstream stations. Faster current velocity measured at S78620 ($\geq$ 0.75 ft/sec faster on all sample dates) encouraged the establishment of large populations of fingernail clams, blackflies, and net-spinning caddisflies which prefer such conditions. Conversely, oligochaete worms that thrive in silt and fine sand were present in larger numbers at the downstream stations where these sediments accumulate.

The amount of interstitial space available as habitat for benthic macroinvertebrates is an important feature of the physical substrate. The large amounts of silt observed at S76760 and S77120 can reduce interstitial space and alter the accessibility of the substrate by organisms. It can also affect the movement of water and gases through the substrate and the nature of accumulated organic matter. It is likely that the depressed communities observed at these downstream stations were largely a result of excessive sedimentation. In order to examine this hypothesis, qualitative kick samples were collected at S77260 and compared to BCS from S78620. The kick samples were collected from an area free of any observable sedimentation where current velocity and substrate resembled those upstream at S78620.

Although comparisons between S77260 and S78620 were limited to two collection dates, the data indicate that similar communities existed at each station (Table 3.2-5). This finding was supported by a Morisita index of 0.872 calculated for both sample dates combined. Of particular interest was an identical percent abundance of Oligochaeta at both stations (7.6%). Oligochaetes represented a substantially lower percentage of the samples collected at S77260 compared to the other downstream (BCS) stations. Virtually all taxa that were common at S78620 were also common at S77260, although there were differences in relative abundance among them attributable to the different sample collection methods used at the two stations (Slack et al. 1976).

Comparison of 1988 and 1984-1987 Data

The purpose of this section is to compare the 1988 data with that collected post-EROL (1984-1987) which was used previously in assessment of LGS operational impacts (RMC 1988). No detailed reanalysis of these latter data is attempted.

The total number of taxa collected in 1988 decreased from 1984-1987 at all stations (Table 3.2-6). Taxonomic composition at all stations remained similar to that observed previously (Tables 3.2-7 to 3.2-10). Those taxa not collected in 1988 were present in low numbers during the previous year.

Annual macroinvertebrate standing crop generally was higher in 1988 than standing crop measured during 1984-1987, particularly at S78620 where the highest standing crop during the entire study period was observed (Table 3.2-11). Standing crop remained nearly unchanged at S75770 in 1988, whereas the year-to-year variation observed previously at the other stations continued in 1988.

Standing crop and percent composition of numerically important taxa ($\geq$ 2% of total number) clearly indicate that Oligochaeta and Chironomidae continued to be the dominant taxa at all stations in 1988 (Tables 3.2-12 to 3.2-15). From one to six other taxa were important at individual stations in 1988. The number and identity of important taxa have remained similar at S78620 from 1984-1987 to 1988. However, greater variation has been observed at the downstream stations. The number of important taxa collected at S75770 and S76760 increased in 1988 nearly to levels recorded prior to 1987. In direct opposition, the number of important taxa collected at S77120 in 1988 continued a downward trend observed since 1985.

Although variable, the standing crop measured for most important taxa tended to fluctuate consistently both upstream and downstream of LGS. Of the eight taxa important at all stations during at least one year, only Oligochaeta and the fingernail clam (Pisidium) exhibited differing trends. Oligochaeta clearly have increased in numbers at all three downstream stations while essentially remaining unchanged at S78620. Conversely, numbers of Pisidium have decreased downstream from LGS while remaining unchanged upstream. These differences likely are a function of increased sedimentation observed at the downstream stations.

The comparison of macroinvertebrate data collected during 1988 with those obtained earlier (1984-1987) support the previous conclusion (RMC Environmental Services 1988) that operation of LGS does not affect the macroinvertebrate community of the Schuylkill River. The database accumulated over five years describes a riverine macroinvertebrate community with seasonal as well as annual variability upstream and downstream of LGS water intake and discharge. Such variability is inherent in macroinvertebrate communities.

Table 3.2-1. Macroinvertebrate taxa collected in the Schuylkill River during 1988.

Taxon	S75770	S76760	S77120	S78620
Acroneuria	X			X
Alboglossiphonia				X
Allocapnia				X
Amphinemura				X
Argia	X	X	X	X
Asellus		X	X	X
Baetis			X	X
Berosus	X	X	X	X
Caenis	X	X	X	X
Cambarus			X	
Campeloma		X		
Ceratopogonidae	X	X	X	X
Cheumatopsyche	X	X	X	X
Chimarra				X
Chironomidae	X	X	X	X
Corydalus	X			X
Crangonyx	X	X	X	X
Dromogomphus	X	X	X	
Dubiraphia	X	X	X	X
Dugesia	X	X	X	X
Empididae	X	X	X	X
Epeorus				X
Ephemerella				X
Erpobdella		X	X	X
Eurylophella				X
Ferrissia	X	X	X	X
Gammarus	X	X	X	
Glossosoma				X
Gomphus	X		X	
Goniobasis	X	X	X	X
Gyraulus		X		X
Helobdella	X	X	X	X
Hexagenia			X	
Hydatophylax			X	
Hydrobius		X		
Hydrolimax	X	X	X	
Hydrophilidae	X			
Hydropsyche	X	X	X	X
Ischnura		X	X	X
Isonychia				X
Libellulidae			X	
Lymnaea		X		X
Macronychus				X
Muscidae				X
Musculium	X	X	X	X
Oecetis			X	
Oligochaeta	X	X	X	X
Optioservus	X	X	X	X
Parargyractis	X	X	X	X
Perlesta				X
Phasganophora	X			X
Physa	X	X	X	X
Pisidium	X	X	X	X
Prostoma			X	
Protoptila	X			

Table 3.2-1. (continued)

Taxon	S75770	S76760	S77120	S78620
Psephenus	X	X		X
Pseudocloeon				X
Sialis	X	X	X	X
Simuliidae	X	X	X	X
Sphaerium				X
Stenacron				X
Stenelmis	X	X	X	X
Stenonema	X	X	X	X
Tanyderidae		X		
Tipula	X		X	
Tricorythodes	X	X	X	X
Unionidae		X		
Total Number of Taxa	36	38	40	50

Table 3.2-2. Total macroinvertebrate taxa collected in the Schulykill River during 1988.

Date	S75770	S76760	S77120	S78620
Feb	21	23	16	29
Apr	15	14	21	31
Jul	29	29	29	33
Oct	23	23	14	27
Mean	22	22	20	30

Table 3.2-3. Total macroinvertebrate standing crop(mean number/m2) measured in the Schuylkill River during 1988.

Date	S75770	S76760	S77120	S78620
Feb	23508.2	5349.7	18666.7	14847.0
Apr	6601.1	7639.3	16535.5	24284.2
Jul	21147.5	28475.4	22710.4	67683.1
Oct	6950.8	9169.4	4174.9	67355.2
Mean	14551.9	12658.5	15521.9	43542.4

Table 3.2-4. Macroinvertebrate standing crop (mean number/m2) measured in the Schuylkill River during 1988.

Taxon	S75770 Density	% Comp	S76760 Density	% Comp	S77120 Density	% Comp	S78620 Density	% Comp
Acroneuria	1.4	+	-	-	-	-	1.4	+
Alboglossiphonia	-	-	-	-	-	-	10.9	+
Allocapnia	-	-	-	-	-	-	1.4	+
Amphinemura	-	-	-	-	-	-	1.4	+
Argia	60.1	0.4	19.1	0.2	8.2	+	293.7	0.7
Asellus	-	-	15.0	0.1	6.8	+	5.5	+
Baetis	-	-	-	-	1.4	+	23.2	+
Berosus	17.8	0.1	28.7	0.2	21.9	0.1	58.7	0.1
Caenis	6.8	+	2.7	+	1.4	+	4.1	+
Cambarus	-	-	-	-	1.4	+	-	-
Campeloma	-	-	1.4	+	-	-	-	-
Ceratopogonidae	4.1	+	2.7	+	5.5	+	4.1	+
Cheumatopsyche	293.7	2.0	183.1	1.4	2.7	+	3453.6	7.9
Chimarra	-	-	-	-	-	-	2.7	+
Chironomidae	3150.3	21.6	3789.6	29.9	3359.3	21.6	13855.2	31.8
Corydalus	1.4	+	-	-	-	-	10.9	+
Crangonyx	310.1	2.1	519.1	4.1	274.6	1.8	493.2	1.1
Dromogomphus	1.4	+	2.7	+	2.7	+	-	-
Dubiraphia	15.0	0.1	45.1	0.4	21.9	0.1	8.2	+
Dugesia	46.5	0.3	5.5	+	1.4	+	12.3	+
Empididae	2.7	+	2.7	+	1.4	+	9.6	+
Epeorus	-	-	-	-	-	-	1.4	+
Ephemerella	-	-	-	-	-	-	6.8	+
Erpobdella	-	-	5.5	+	1.4	+	83.3	0.2
Eurylophella	-	-	-	-	-	-	1.4	+
Ferrissia	32.8	0.2	356.6	2.8	47.8	0.3	1098.4	2.5
Gammarus	342.9	2.4	199.5	1.6	254.1	1.6	-	-
Glossosoma	-	-	-	-	-	-	2.7	+
Gomphus	1.4	+	-	-	1.4	+	-	-
Goniobasis	157.1	1.1	577.9	4.6	383.9	2.5	416.7	1.0
Gyraulus	-	-	5.5	+	-	-	1.4	+
Helobdella	19.1	0.1	15.0	0.1	20.5	0.1	6.8	+
Hexagenia	-	-	-	-	1.4	+	-	-
Hydatophylax	-	-	-	-	1.4	+	-	-
Hydrobius	-	-	1.4	+	-	-	-	-
Hydrolimax	12.3	+	15.0	0.1	8.2	+	-	-
Hydrophilidae	1.4	+	-	-	-	-	-	-
Hydropsyche	112.0	0.8	226.8	1.8	20.5	0.1	3303.3	7.6
Ischnura	-	-	2.7	+	2.7	+	1.4	+
Isonychia	-	-	-	-	-	-	4.1	+
Libellulidae	-	-	-	-	1.4	+	-	-
Lymnaea	-	-	2.7	+	-	-	2.7	+
Macronychus	-	-	-	-	-	-	1.4	+
Muscidae	-	-	-	-	-	-	1.4	+
Musculium	159.8	1.1	6.8	+	9.6	+	4688.5	10.8
Oecetis	-	-	-	-	1.4	+	-	-
Oligochaeta	8043.7	55.3	5463.1	43.2	10819.7	69.7	6114.8	14.0
Optioservus	6.8	+	6.8	+	4.1	+	30.1	+
Parargyractis	1.4	+	4.1	+	1.4	+	295.1	0.7
Perlesta	-	-	-	-	-	-	1.4	+
Phasganophora	4.1	+	-	-	-	-	19.1	+
Physa	613.4	4.2	252.7	2.0	26.0	0.2	2426.2	5.6
Pisidium	36.9	0.3	20.5	0.2	6.8	+	28.7	+
Prostoma	-	-	-	-	1.4	+	-	-

"+" - less than 0.1%

Table 3.2-4. (continued)

Taxon	S75770 Density	% Comp	S76760 Density	% Comp	S77120 Density	% Comp	S78620 Density	% Comp
Protoptila	1.4	+	-	-	-	-	-	-
Psephenus	2.7	+	1.4	+	-	-	26.0	+
Pseudocloeon	-	-	-	-	-	-	1.4	+
Sialis	64.2	0.4	101.1	0.8	17.8	0.1	43.7	0.1
Simuliidae	51.9	0.4	27.3	0.2	6.8	+	4307.4	9.9
Sphaerium	-	-	-	-	-	-	10.9	+
Stenacron	-	-	-	-	-	-	5.5	+
Stenelmis	348.4	2.4	90.2	0.7	86.1	0.6	1547.8	3.6
Stenonema	2.7	+	8.2	+	8.2	+	230.9	0.5
Tanyderidae	-	-	1.4	+	-	-	-	-
Tipula	1.4	+	-	-	4.1	+	-	-
Tricorythodes	623.0	4.3	647.5	5.1	73.8	0.5	582.0	1.3
Unionidae	-	-	1.4	+	-	-	-	-
*ALL TAXA	14551.9	N/A	12658.5	N/A	15521.9	N/A	43542.4	N/A

"+" - less than 0.1%

Table 3.2-5. Total numbers and percent abundance of macroninvertebrates in composites of 10 kick samples collected at S77260 and 3 buried cylinder samples collected at S78620 in 1988.

	14 July				11 October				Both Dates Combined			
	S 77260		S 78620		S 77260		S 78620		S 77260		S 78620	
Taxa	Total	Per cent	Total	Per-cent	Total	Per-cent	Total	Per-cent	Total	Per-cent	Total	Per-cent
Acroneuria	-	-	1	0.0	-	-	-	-	-	-	1	0.0
Alboglossiphonia	-	-	2	0.0	-	-	6	0.0	-	-	8	0.0
Argia	-	-	2	0.0	59	1.0	194	1.6	59	0.5	196	0.8
Asellus	-	-	3	0.0	-	-	-	-	-	-	3	0.0
Baetis	9	0.2	2	0.0	50	0.8	14	0.1	59	0.5	16	0.1
Berosus	-	-	-	-	7	0.1	42	0.3	7	0.1	42	0.2
Caenis	16	0.3	2	0.0	-	-	-	-	16	0.1	2	0.0
Cheumatopsyche	51	0.9	989	8.0	2245	37.4	1445	11.7	2296	19.4	2434	9.8
Chimarra	-	-	2	0.0	-	-	-	-	-	-	2	0.0
Chironomidae	1482	25.4	5047	40.7	1473	24.5	2779	22.5	2955	24.9	7826	31.7
Corydalus	-	-	3	0.0	2	0.0	4	0.0	2	0.0	7	0.0
Crangonyx	1	0.0	267	2.2	-	-	12	0.1	1	0.0	279	1.1
Dromogomphus	-	-	-	-	1	0.0	-	-	1	0.0	-	-
Dubiraphia	-	-	4	0.0	2	0.0	2	0.0	2	0.0	6	0.0
Empididae	-	-	5	0.0	-	-	-	-	-	-	5	0.0
Epeorus	-	-	1	0.0	-	-	-	-	-	-	1	0.0
Erpobdella	2	0.0	34	0.3	2	0.0	8	0.1	4	0.0	42	0.2
Ferrissia	39	0.7	181	1.5	417	6.9	562	4.6	456	3.8	743	3.0
Gammarus	12	0.2	-	-	-	-	-	-	12	0.1	-	-
Gomphus	-	-	-	-	1	0.0	-	-	1	0.0	-	-
Goniobasis	18	0.3	-	-	-	-	20	0.2	18	0.2	20	0.1
Gyraulus	5	0.1	-	-	-	-	-	-	5	0.0	-	-
Helobdella	-	-	2	0.0	-	-	2	0.0	-	-	4	0.0
Hydropsyche	93	1.6	1351	10.9	261	4.3	1044	8.5	354	3.0	2395	9.7
Isonychia	-	-	3	0.0	-	-	-	-	-	-	3	0.0
Lymnaea	-	-	-	-	-	-	1	0.0	-	-	1	0.0
Musculium	15	0.3	127	1.0	250	4.2	3221	26.1	265	2.2	3348	13.5
Oligochaeta	413	7.1	419	3.4	485	8.1	1471	11.9	898	7.6	1890	7.6
Optioservus	4	0.1	5	0.0	27	0.4	11	0.1	31	0.3	16	0.1
Parargyractis	-	-	30	0.2	83	1.4	185	1.5	83	0.7	215	0.9
Phasganophora	-	-	4	0.0	26	0.4	-	-	26	0.2	4	0.0
Physa	156	2.7	912	7.4	-	-	824	6.7	156	1.3	1736	7.0
Pisidium	-	-	1	0.0	6	0.1	2	0.0	6	0.1	3	0.0
Potamanthus	1	0.0	-	-	-	-	-	-	1	0.0	-	-
Psephenus	1	0.0	-	-	13	0.2	8	0.1	14	0.1	8	0.0
Pseudocloeon	24	0.4	1	0.0	-	-	-	-	24	0.2	1	0.0
Sialis	5	0.1	19	0.2	-	-	8	0.1	5	0.0	27	0.1
Simuliidae	1909	32.7	1883	15.2	80	1.3	14	0.1	1989	16.8	1897	7.7
Stenacron	-	-	1	0.0	-	-	-	-	-	-	1	0.0
Stenelmis	152	2.6	657	5.3	260	4.3	278	2.3	412	3.5	935	3.8
Stenonema	-	-	6	0.0	209	3.5	163	1.3	209	1.8	169	0.7
Tricorythodes	1434	24.5	420	3.4	49	0.8	6	0.0	1483	12.5	426	1.7
Total Number	5842	N/A	12386	N/A	6008	N/A	12326	N/A	11850	N/A	24712	N/A
Total Taxa	22	N/A	33	N/A	23	N/A	27	N/A	32	N/A	37	N/A

Table 3.2-6. Total macroinvertebrate taxa collected in the Schuylkill River during 1973 - 1976 and 1984 - 1988.

	Preoperational Period				Operational Period				
Station	1973	1974	1975	1976	1984	1985	1986	1987	1988
S75770	21	45	-	32	50	48	52	47	36
S76760	39	40	45	44	54	55	53	39	38
S77120	-	23	45	52	53	55	45	48	40
S78620	35	38	38	49	51	58	56	53	50

No samples collected at S77120 in 1973 or S75770 in 1975.

Table 3.2-7. Macroinvertebrate taxa collected in the Schuylkill River at S75770 during 1973 - 1976 and 1984 - 1988.

	Preoperational Period					Operational Period			
Taxon	1973	1974	1975	1976	1984	1985	1986	1987	1988
Acroneuria									X
Agraylea		X							
Alboglossiphonia		X				X		X	
Allocapnia	X	X			X	X	X	X	
Ancyronyx						X			
Antocha					X				
Argia		X		X	X	X	X	X	X
Asellus				X	X	X	X		
Atherix					X				
Baetis							X	X	
Batracobdella		X		X				X	
Berosus		X		X	X	X	X	X	X
Caenis							X	X	X
Cambarus		X				X			
Ceratopogonidae					X	X	X	X	X
Cheumatopsyche	X	X		X	X	X	X	X	X
Chimarra		X				X	X		
Chironomidae	X	X		X	X	X	X	X	X
Corydalus		X					X	X	X
Crangonyx	X	X		X	X	X	X	X	X
Dolichopodidae	X								
Dromogomphus									X
Dubiraphia		X		X	X	X	X	X	X
Dugesia	X	X		X	X	X			X
Elliptio					X	X	X		
Empididae	X	X		X	X	X	X	X	X
Ephemerella							X	X	
Ephydridae	X						X		
Erpobdella	X	X		X	X	X	X	X	
Ferrissia	X	X		X	X	X	X	X	X
Gammarus		X				X	X	X	X
Gomphus								X	X
Goniobasis	X	X		X	X	X	X	X	X
Gyraulus					X	X	X	X	
Helisoma	X	X			X	X	X		
Helobdella	X	X			X	X	X	X	X
Hydrolimax		X		X	X	X	X		X
Hydrophilidae									X
Hydroporus				X					
Hydropsyche		X		X	X	X	X	X	X
Hydroptila		X		X	X	X	X		
Ischnura				X	X	X	X	X	
Lampsilis						X			
Lampyridae								X	
Lanthus		X		X	X		X		
Leucotrichia								X	
Lymnaea						X	X		
Metrobates							X		
Musculium					X	X	X	X	X

No samples collected in 1975.

Table 3.2-7. (continued)

Taxon	Preoperational Period 1973	1974	1975	1976	1984	Operational Period 1985	1986	1987	1988
Mycetophilidae		X							
Neureclipsis								X	
Oecetis				X	X	X	X	X	
Oligochaeta	X	X		X	X	X	X	X	X
Ophiogomphus				X			X	X	
Optioservus		X			X	X	X	X	X
Orconectes		X		X		X	X	X	
Paraleptophlebia								X	
Parargyractis					X		X		X
Phasganophora					X			X	X
Physa	X	X		X	X	X	X	X	X
Pisidium	X	X		X	X	X	X	X	X
Placobdella					X				
Polycentropus		X							
Potamanthus					X		X	X	
Prostoma	X	X		X	X	X	X		
Protoptila					X	X	X	X	X
Psephenus		X			X	X	X	X	X
Pseudolimnophila		X							
Psychoda		X			X				
Sialis				X	X	X	X	X	X
Simuliidae				X	X	X	X	X	X
Sphaerium	X	X		X	X	X			
Stenacron					X	X	X	X	
Stenelmis	X	X		X	X	X	X	X	X
Stenonema		X		X	X	X	X		X
Stratiomyiidae		X			X				
Stygobromus	X	X							
Tabanidae		X							
Telmatoscopus		X			X				
Tipula	X	X			X	X	X	X	X
Triaenodes					X	X	X	X	
Tricorythodes		X		X	X	X	X	X	X
Total Number of Taxa	21	45		32	50	48	52	47	36

No samples collected in 1975.

Table 3.2-8. Macroinvertebrate taxa collected in the Schuylkill River at S76760 during 1973 - 1976 and 1984 - 1988.

	Preoperational Period					Operational Period			
Taxon	1973	1974	1975	1976	1984	1985	1986	1987	1988
Actinobdella	X								
Alboglossiphonia						X	X	X	
Allocapnia				X			X	X	
Allognosta								X	
Ameletus							X		
Anax						X			
Antocha			X						
Argia	X	X	X	X	X	X	X	X	X
Asellus		X	X	X	X	X	X	X	X
Baetis				X	X	X	X	X	
Batracobdella			X	X					
Belostoma				X					
Berosus	X	X	X	X	X	X	X	X	X
Caenis			X				X	X	X
Calopteryx							X		
Cambarus				X					
Campeloma						X			X
Ceraclea					X				
Ceratopogonidae	X	X	X	X	X	X	X	X	X
Cheumatopsyche	X	X	X	X	X	X	X	X	X
Chimarra	X	X	X		X	X		X	
Chironomidae	X	X	X	X	X	X	X	X	X
Corydalus					X				
Crangonyx	X	X	X	X	X	X	X	X	X
Curculionidae								X	
Dolichopodidae	X	X					X		
Dromogomphus					X	X	X		X
Dubiraphia	X	X	X	X	X	X	X	X	X
Dugesia		X	X	X	X	X			X
Ectopria					X	X			
Empididae	X	X	X		X	X	X		X
Ephemera		X	X						
Ephemerella				X			X		
Ephydridae								X	
Erpobdella	X	X	X	X	X	X	X	X	X
Ferrissia	X	X	X	X	X	X	X	X	X
Gammarus		X				X	X	X	X
Gomphus							X		
Goniobasis	X	X	X	X	X	X	X	X	X
Gyraulus	X				X	X			X
Helichus			X						
Helisoma	X	X	X	X		X			
Helobdella	X	X	X	X	X	X	X	X	X
Hydrobius									X
Hydrolimax				X	X	X	X		X
Hydrophilidae					X				
Hydroporus			X	X					
Hydropsyche	X	X	X	X	X	X	X	X	X
Hydroptila	X	X	X		X		X		

Table 3.2-8. (continued)

Taxon	Preoperational Period					Operational Period			
	1973	1974	1975	1976	1984	1985	1986	1987	1988
Ischnura	X		X	X	X	X	X		X
Isonychia						X			
Lampsilis					X				
Lanthus		X	X		X	X	X		
Lepidostoma					X				
Leucotrichia							X		
Libellulidae							X		
Limnophila			X			X			
Lymnaea				X		X		X	X
Macromia	X								
Manayunkia						X			
Menetus	X								
Musculium					X	X	X	X	X
Mystacides					X		X		
Nectopsyche					X				
Nemotelus							X		
Neureclipsis				X			X		
Nigronia							X		
Oecetis	X			X	X	X		X	
Oligochaeta	X	X	X	X	X	X	X	X	X
Ophiogomphus					X			X	
Optioservus	X	X	X	X	X	X	X		X
Orconectes		X	X	X	X	X	X		
Ormosia		X							
Paraleptophlebia				X			X		
Parargyractis					X	X			X
Peltodytes		X							
Phasganophora					X	X			
Phoridae					X				
Physa	X	X	X	X	X	X	X	X	X
Pisidium	X	X	X	X	X	X	X	X	X
Placobdella			X	X					
Potamanthus	X				X				
Prostoma	X		X	X	X	X	X	X	
Protoptila					X	X			
Psephenus	X	X	X		X	X	X		X
Pseudolimnophila	X								
Psychoda	X	X	X						
Psychomyia				X					
Ptilostomis						X			
Sialis		X	X	X	X	X	X	X	X
Simuliidae			X		X	X	X	X	X
Sphaerium	X	X	X	X					
Stenacron					X	X	X		
Stenelmis	X	X	X	X	X	X	X	X	X
Stenonema	X	X	X	X	X	X	X		X
Stratiomyiidae			X			X	X	X	
Stygobromus		X							
Stylurus				X					

Table 3.2-8. (continued)

Taxon	Preoperational Period					Operational Period			
	1973	1974	1975	1976	1984	1985	1986	1987	1988
Tabanidae	X	X	X		X	X		X	
Taeniopteryx	X								
Tanyderidae									X
Telmatoscopus	X	X		X					
Tipula	X	X	X			X	X	X	
Tipulidae								X	
Tortricidae								X	
Triaenodes				X	X	X	X		
Tricorythodes		X	X	X	X	X	X	X	X
Unionidae									X
Total Number of Taxa	39	40	45	44	54	55	53	39	38

Table 3.2-9. Macroinvertebrate taxa collected in the Schuylkill River at S77120 during 1973 - 1976 and 1984 - 1988.

	Preoperational Period					Operational Period			
Taxon	1973	1974	1975	1976	1984	1985	1986	1987	1988
Acroneuria				X					
Alasmidonta			X						
Alboglossiphonia						X		X	
Allocapnia				X	X		X	X	
Ancyronyx						X			
Anodonta				X				X	
Antocha				X					
Argia		X	X	X	X	X	X	X	X
Asellus			X		X	X	X	X	X
Baetis				X					X
Batracobdella				X				X	
Berosus		X	X	X	X	X	X	X	X
Caenis					X	X		X	X
Cambarus				X	X				X
Cecidomyiidae								X	
Ceraclea					X				
Ceratopogonidae			X	X	X	X	X	X	X
Cheumatopsyche		X	X	X	X	X	X	X	X
Chironomidae		X	X	X	X	X	X	X	X
Crangonyx		X	X	X	X	X	X	X	X
Curculionidae								X	
Diplectrona					X				
Dolichopodidae			X				X		
Dromogomphus					X	X	X	X	X
Dubiraphia		X	X	X	X	X	X	X	X
Dugesia		X	X	X		X		X	X
Ectopria						X			
Elliptio					X	X			
Empididae					X	X	X		X
Enallagma		X							
Ephemera			X	X					
Ephemerella			X	X			X	X	
Ephydridae			X			X	X	X	
Erpobdella		X	X	X	X	X	X		X
Erythemis					X				
Ferrissia			X	X	X	X	X	X	X
Gammarus				X		X	X	X	X
Gomphus								X	X
Goniobasis		X	X	X	X	X	X	X	X
Gyraulus				X	X				
Helisoma		X	X			X	X	X	
Helobdella		X	X	X	X	X	X	X	X
Helophorus								X	
Hexagenia									X
Hydatophylax									X
Hydrolimax		X	X	X	X	X	X		X
Hydrophilidae					X				
Hydroporus							X		
Hydropsyche		X	X	X	X	X	X	X	X

No samples collected in 1973.

Table 3.2-9. (continued)

Taxon	Preoperational Period					Operational Period			
	1973	1974	1975	1976	1984	1985	1986	1987	1988
Hydroptila			X	X		X	X		
Ischnura		X	X	X	X	X	X	X	X
Isonychia			X	X					
Lampyridae								X	
Lanthus			X	X	X	X			
Lepidostoma						X			
Leucotrichia				X					
Libellula								X	
Libellulidae									X
Lymnaea					X	X		X	
Macromia			X	X	X			X	
Macronemum					X				
Macronychus						X			
Manayunkia						X			
Molophilus								X	
Muscidae			X						
Musculium					X	X	X		X
Neureclipsis				X	X				
Nigronia						X	X	X	
Oecetis			X	X	X		X		X
Oligochaeta		X	X	X	X	X	X	X	X
Ophiogomphus				X				X	
Optioservus			X	X	X	X	X		X
Orconectes		X	X	X	X	X	X		
Parargyractis					X				X
Pericoma						X			
Phasganophora						X			
Phoridae					X				
Physa		X	X	X	X	X	X	X	X
Pisidium		X	X	X	X	X	X	X	X
Placobdella			X						
Polycentropus				X					
Prostoma			X	X	X	X	X	X	X
Protoptila					X	X			
Psephenus					X	X	X	X	
Pseudolimnophila			X						
Psychoda			X						
Psychomyia				X					
Sialis			X	X	X	X	X	X	X
Simuliidae			X		X	X	X		X
Sphaerium		X	X	X		X			
Stenacron						X	X		
Stenelmis		X		X	X	X	X	X	X
Stenonema		X	X	X	X				X
Stratiomyiidae			X		X			X	
Stratiomys							X	X	
Stygobromus				X		X	X	X	
Tabanidae					X				
Telmatoscopus			X	X	X	X	X		

No samples collected in 1973.

Table 3.2-9. (continued)

Taxon	Preoperational Period					Operational Period			
	1973	1974	1975	1976	1984	1985	1986	1987	1988
Tetragoneuria						X			
Tipula			X	X	X	X	X	X	X
Triaenodes				X	X	X	X	X	
Tricorythodes		X	X	X	X	X	X	X	X
Total Number of Taxa		23	45	52	53	55	45	48	40

No samples collected in 1975.

Table 3.2-10. Macroinvertebrate taxa collected in the Schuylkill River at S78620 during 1973 - 1976 and 1984 - 1988.

	Preoperational Period					Operational Period			
Taxon	1973	1974	1975	1976	1984	1985	1986	1987	1988
Acroneuria	X	X		X	X	X	X	X	X
Actinobdella							X		
Alboglossiphonia						X	X		X
Allocapnia	X			X		X		X	X
Ameletus		X							
Amphinemura							X	X	X
Ancyronyx						X	X		
Antocha		X							
Argia	X	X	X	X	X	X	X	X	X
Asellus			X		X	X	X	X	X
Baetis	X	X	X	X	X	X	X	X	X
Batracobdella				X					
Berosus	X	X	X	X	X	X	X	X	X
Caenis					X	X	X	X	X
Cambarus	X			X	X				
Ceraclea					X			X	
Ceratopogonidae	X				X	X	X	X	X
Cheumatopsyche	X	X	X	X	X	X	X	X	X
Chimarra	X	X	X	X		X		X	X
Chironomidae	X	X	X	X	X	X	X	X	X
Corydalus					X	X	X	X	X
Crangonyx	X	X	X	X	X	X	X	X	X
Dineutus							X		
Dolichopodidae			X						
Dromogomphus						X			
Dubiraphia	X	X	X	X	X	X	X	X	X
Dugesia		X	X	X	X	X	X	X	X
Elliptio				X	X				
Empididae	X	X	X	X	X	X	X	X	X
Epeorus									X
Ephemerella	X	X		X			X	X	X
Ephydridae			X						
Erpobdella	X	X	X	X	X	X	X	X	X
Eurylophella									X
Ferrissia	X	X	X	X	X	X	X	X	X
Gammarus						X	X	X	
Glossosoma									X
Gomphidae					X				
Gomphus				X				X	
Goniobasis	X	X	X	X	X	X	X	X	X
Gyraulus					X	X	X		X
Helisoma	X	X	X		X	X	X	X	
Helobdella	X	X	X		X	X	X	X	X
Hydracarina	X								
Hydrolimax			X	X		X	X		
Hydroporus				X					
Hydropsyche	X	X	X	X	X	X	X	X	X
Hydroptila		X	X			X	X	X	
Ischnura			X		X	X	X		X

Table 3.2-10. (continued)

	Preoperational Period					Operational Period			
Taxon	1973	1974	1975	1976	1984	1985	1986	1987	1988
Isonychia				X	X	X	X	X	X
Isoperla	X								
Lanthus						X			
Lepidostoma						X		X	
Leucotrichia				X	X		X		
Limonia	X								
Lymnaea						X	X		X
Macronychus					X				X
Manayunkia						X			
Muscidae				X					X
Musculium					X	X	X	X	X
Neureclipsis		X	X	X					
Nigronia				X		X	X	X	
Oecetis			X	X	X	X			
Oligochaeta	X	X	X	X	X	X	X	X	X
Ophiogomphus				X					
Optioservus	X	X	X	X	X	X	X	X	X
Orconectes		X		X	X	X	X	X	
Parargyractis		X	X	X	X	X	X	X	X
Perlesta		X		X				X	X
Phasganophora					X	X	X	X	X
Phoridae					X				
Physa	X	X	X	X	X	X	X	X	X
Piscicolaria		X							
Pisidium	X	X	X	X	X	X	X	X	X
Polycentropus	X					X	X		
Potamanthus					X				
Prostoma		X	X	X		X	X	X	
Protoptila					X	X	X	X	
Psephenus	X	X	X	X	X	X	X	X	X
Pseudocloeon				X					X
Psychoda			X						
Rhyacophila				X					
Sialis	X		X	X	X	X	X	X	X
Simuliidae		X	X	X	X	X	X	X	X
Sphaerium	X	X	X	X	X			X	X
Stenacron					X	X	X	X	X
Stenelmis	X	X	X	X	X	X	X	X	X
Stenonema	X	X	X	X	X	X	X	X	X
Stygobromus				X					
Tabanidae							X		
Taeniopteryx				X					
Tipula	X	X			X	X	X	X	
Tipulidae						X		X	
Triaenodes					X	X	X	X	
Tricorythodes		X	X	X	X	X	X	X	X
Total Number of Taxa	35	38	38	49	51	58	56	53	50

Table 3.2-11. Annual macroinvertebrate standing crop (mean number/m2), all taxa combined, in the Schuylkill River during 1973 - 1976 and 1984 - 1988.

	Preoperational Period					Operational Period			
Station	1973	1974	1975	1976	1984	1985	1986	1987	1988
S75770	2288.9	4970.3	-	6397.5	11207.7	12907.1	14694.0	13994.5	14551.9
S76760	3250.0	5482.2	11107.6	5669.1	10225.4	14806.0	9101.1	8801.9	12658.5
S77120	-	6448.8	7935.5	4200.8	12504.1	20623.0	6606.6	12819.7	15521.9
S78620	6133.2	8633.2	13573.8	13607.6	35471.3	38754.1	29740.4	25252.7	43542.3

No samples collected at S77120 in 1973 or at S75770 in 1975.

Table 3.2-12. Annual macroinvertebrate standing crop (mean number/m2) and percent composition of important taxa at S75770 in the Schuylkill River during 1973 - 1976 and 1984 - 1988.

	Preoperational Period										Operational Period							
Taxon	1973 Mean	%	1974 Mean	%	1975 Mean	%	1976 Mean	%	1984 Mean	%	1985 Mean	%	1986 Mean	%	1987 Mean	%	1988 Mean	%
Cheumatopsyche	3.1	0.1	43.0	0.9	-	-	26.0	0.4	605.2	5.4	187.2	1.5	568.3	3.9	80.6	0.6	293.7	2.0
Chironomidae	557.4	24.4	647.5	13.0	-	-	1296.4	20.3	2439.9	21.8	3061.5	23.7	3718.6	25.3	2892.1	20.7	3150.3	21.6
Crangonyx	9.2	0.4	23.6	0.5	-	-	359.3	5.6	610.7	5.4	2289.6	17.7	692.6	4.7	140.7	1.0	310.1	2.1
Ferrissia	80.9	3.5	19.5	0.4	-	-	1.4	0.0	247.3	2.2	110.7	0.9	262.3	1.8	204.9	1.5	32.8	0.2
Gammarus	-	-	5.1	0.1	-	-	-	-	-	-	1566.9	12.1	982.2	6.7	691.3	4.9	342.9	2.4
Goniobasis	778.7	34.0	2990.8	60.2	-	-	1338.8	20.9	1267.8	11.3	1056.0	8.2	758.2	5.2	704.9	5.0	157.1	1.1
Hydropsyche	-	-	1.0	0.0	-	-	16.4	0.3	213.1	1.9	168.0	1.3	527.3	3.6	375.7	2.7	112.0	0.8
Hydroptila	-	-	41.0	0.8	-	-	329.2	5.1	9.6	0.1	2.7	0.0	5.5	0.0	-	-	-	-
Oligochaeta	588.1	25.7	329.9	6.6	-	-	1702.2	26.6	4041.0	36.1	1224.0	9.5	5505.5	37.5	8079.2	57.7	8043.7	55.3
Physa	142.4	6.2	235.7	4.7	-	-	53.3	0.8	157.1	1.4	1236.3	9.6	129.8	0.9	105.2	0.8	613.4	4.2
Pisidium	1.0	0.0	38.9	0.8	-	-	715.8	11.2	276.0	2.5	348.4	2.7	98.4	0.7	97.0	0.7	36.9	0.3
Sphaerium	32.8	1.4	376.0	7.6	-	-	248.6	3.9	4.1	0.0	24.6	0.2	-	-	-	-	-	-
Stenacron	-	-	-	-	-	-	-	-	184.4	1.6	263.7	2.0	117.5	0.8	30.1	0.2	-	-
Stenelmis	10.2	0.4	16.4	0.3	-	-	20.5	0.3	176.2	1.6	333.3	2.6	418.0	2.8	62.8	0.4	348.4	2.4
Tricorythodes	-	-	1.0	0.0	-	-	1.4	0.0	117.5	1.0	140.7	1.1	362.0	2.5	214.5	1.5	623.0	4.3

No samples collected in 1975.

Table 3.2-13. Annual macroinvertebrate standing crop (mean number/m2) and percent composition of important taxa at S76760 in the Schuylkill River during 1973 - 1976 and 1984 - 1988.

	Preoperational Period										Operational Period							
Taxon	1973 Mean	%	1974 Mean	%	1975 Mean	%	1976 Mean	%	1984 Mean	%	1985 Mean	%	1986 Mean	%	1987 Mean	%	1988 Mean	%
Cheumatopsyche	2.0	0.1	17.8	0.3	178.3	1.6	55.3	1.0	467.2	4.6	140.7	1.0	113.4	1.2	16.4	0.2	183.1	1.4
Chironomidae	829.9	25.5	785.5	14.3	1812.5	16.3	1347.3	23.8	2520.5	24.6	3407.1	23.0	2192.6	24.1	1389.3	15.8	3789.6	29.9
Crangonyx	53.3	1.6	26.0	0.5	197.7	1.8	277.7	4.9	345.6	3.4	3251.4	22.0	1105.2	12.1	457.7	5.2	519.1	4.1
Ferrissia	50.2	1.5	66.9	1.2	2.0	0.0	6.1	0.1	564.2	5.5	150.3	1.0	117.5	1.3	110.7	1.3	356.6	2.8
Gammarus	-	-	9.6	0.2	-	-	-	-	-	-	1945.4	13.1	326.5	3.6	77.9	0.9	199.5	1.6
Goniobasis	172.1	5.3	2881.1	52.6	5205.9	46.9	1627.0	28.7	2177.6	21.3	568.3	3.8	475.4	5.2	222.7	2.5	577.9	4.6
Hydropsyche	2.0	0.1	2.7	0.0	131.1	1.2	33.8	0.6	270.5	2.6	112.0	0.8	306.0	3.4	43.7	0.5	226.8	1.8
Oligochaeta	1915.0	58.9	864.8	15.8	2850.4	25.7	1904.7	33.6	2666.7	26.1	2881.1	19.5	3475.4	38.2	6209.0	70.5	5463.1	43.2
Physa	59.4	1.8	453.6	8.3	31.8	0.3	20.5	0.4	77.9	0.8	189.9	1.3	5.5	0.1	2.7	0.0	252.7	2.0
Pisidium	8.2	0.3	15.0	0.3	376.0	3.4	114.8	2.0	151.6	1.5	513.7	3.5	17.8	0.2	27.3	0.3	20.5	0.2
Sphaerium	10.2	0.3	112.0	2.0	24.6	0.2	77.9	1.4	-	-	-	-	-	-	-	-	-	-
Stenacron	-	-	-	-	-	-	-	-	140.7	1.4	293.7	2.0	60.1	0.7	-	-	-	-
Tricorythodes	-	-	2.7	0.0	2.0	0.0	1.0	0.0	41.0	0.4	87.4	0.6	411.2	4.5	23.2	0.3	647.5	5.1

Table 3.2-14. Annual macroinvertebrate standing crop (mean number/m2) and percent composition of important taxa at S77120 in the Schuylkill River during 1973 - 1976 and 1984 - 1988.

	Preoperational Period										Operational Period							
Taxon	1973 Mean	%	1974 Mean	%	1975 Mean	%	1976 Mean	%	1984 Mean	%	1985 Mean	%	1986 Mean	%	1987 Mean	%	1988 Mean	%
Argia	-	-	381.1	5.9	14.3	0.2	115.8	2.8	118.9	1.0	38.3	0.2	8.2	0.1	8.2	0.1	8.2	0.1
Cheumatopsyche	-	-	186.5	2.9	76.8	1.0	43.0	1.0	340.2	2.7	80.6	0.4	58.7	0.9	13.7	0.1	2.7	0.0
Chironomidae	-	-	118.9	1.8	1749.0	22.0	880.1	21.0	1478.1	11.8	3711.7	18.0	1591.5	24.1	1561.5	12.2	3359.3	21.6
Crangonyx	-	-	43.0	0.7	125.0	1.6	120.9	2.9	603.8	4.8	4374.3	21.2	434.4	6.6	136.6	1.1	274.6	1.8
Ferrissia	-	-	-	-	10.2	0.1	1.0	0.0	56.0	0.4	113.4	0.5	172.1	2.6	312.8	2.4	47.8	0.3
Gammarus	-	-	-	-	-	-	1.0	0.0	-	-	1336.1	6.5	131.1	2.0	124.3	1.0	254.1	1.6
Goniobasis	-	-	4711.1	73.1	3016.4	38.0	1547.1	36.8	3468.6	27.7	710.4	3.4	695.4	10.5	606.6	4.7	383.9	2.5
Oligochaeta	-	-	51.2	0.8	2600.4	32.8	1098.4	26.1	4786.9	38.3	7098.4	34.4	2676.2	40.5	9700.8	75.7	10819.7	69.7
Physa	-	-	489.8	7.6	4.1	0.1	25.6	0.6	215.8	1.7	814.2	3.9	16.4	0.2	9.6	0.1	26.0	0.2
Pisidium	-	-	20.5	0.3	80.9	1.0	76.8	1.8	437.2	3.5	700.8	3.4	30.1	0.5	2.7	0.0	6.8	0.0
Sphaerium	-	-	334.0	5.2	33.8	0.4	57.4	1.4	-	-	1.4	0.0	-	-	-	-	-	-
Stenelmis	-	-	4.1	0.1	-	-	2.0	0.0	353.8	2.8	390.7	1.9	221.3	3.3	58.7	0.5	86.1	0.6

No samples collected in 1973.

Table 3.2-15. Annual macroinvertebrate standing crop (mean number/m2) and percent composition of important taxa at S78620 in the Schuylkill River during 1973 - 1976 and 1984 - 1988.

	Preoperational Period										Operational Period							
Taxon	1973 Mean	%	1974 Mean	%	1975 Mean	%	1976 Mean	%	1984 Mean	%	1985 Mean	%	1986 Mean	%	1987 Mean	%	1988 Mean	%
Cheumatopsyche	156.8	2.6	2417.0	28.0	1223.4	9.0	3223.4	23.7	7187.2	20.3	3229.5	8.3	4319.7	14.5	975.4	3.9	3453.6	7.9
Chironomidae	3862.7	63.0	2263.3	26.2	7326.8	54.0	5854.5	43.0	7049.2	19.9	14696.7	37.9	6896.2	23.2	10039.6	39.8	13855.2	31.8
Crangonyx	84.0	1.4	23.6	0.3	155.7	1.1	105.5	0.8	1140.7	3.2	1687.2	4.4	1284.2	4.3	235.0	0.9	493.2	1.1
Ferrissia	87.1	1.4	105.5	1.2	23.6	0.2	223.4	1.6	1826.5	5.1	676.2	1.7	1625.7	5.5	1332.0	5.3	1098.4	2.5
Goniobasis	6.1	0.1	1229.5	14.2	1837.1	13.5	2125.0	15.6	2680.3	7.6	603.8	1.6	554.6	1.9	491.8	1.9	416.7	1.0
Helisoma	349.4	5.7	1172.1	13.6	395.5	2.9	-	-	8.2	0.0	21.9	0.1	10.9	0.0	53.3	0.2	-	-
Hydropsyche	71.7	1.2	33.8	0.4	809.4	6.0	165.0	1.2	2221.3	6.3	647.5	1.7	2127.0	7.2	1347.0	5.3	3303.3	7.6
Musculium	-	-	-	-	-	-	-	-	120.2	0.3	889.3	2.3	4592.9	15.4	3736.3	14.8	4688.5	10.8
Oligochaeta	311.5	5.1	111.7	1.3	780.7	5.8	228.5	1.7	4334.7	12.2	2169.4	5.6	1733.6	5.8	2870.2	11.4	6114.8	14.0
Physa	753.1	12.3	634.2	7.3	82.0	0.6	500.0	3.7	3158.5	8.9	2657.1	6.9	1019.1	3.4	345.6	1.4	2426.2	5.6
Pisidium	108.6	1.8	19.5	0.2	238.7	1.8	548.2	4.0	512.3	1.4	1632.5	4.2	694.0	2.3	516.4	2.0	28.7	0.1
Simuliidae	-	-	3.1	0.0	1.0	0.0	10.2	0.1	2060.1	5.8	4557.4	11.8	316.9	1.1	582.0	2.3	4307.4	9.9
Sphaerium	198.8	3.2	377.0	4.4	336.1	2.5	284.8	2.1	1.4	0.0	-	-	-	-	5.5	0.0	10.9	0.0
Stenacron	-	-	-	-	-	-	-	-	892.1	2.5	1032.8	2.7	176.2	0.6	41.0	0.2	5.5	0.0
Stenelmis	20.5	0.3	9.2	0.1	12.3	0.1	11.3	0.1	788.3	2.2	1987.7	5.1	3153.0	10.6	1853.8	7.3	1547.8	3.6

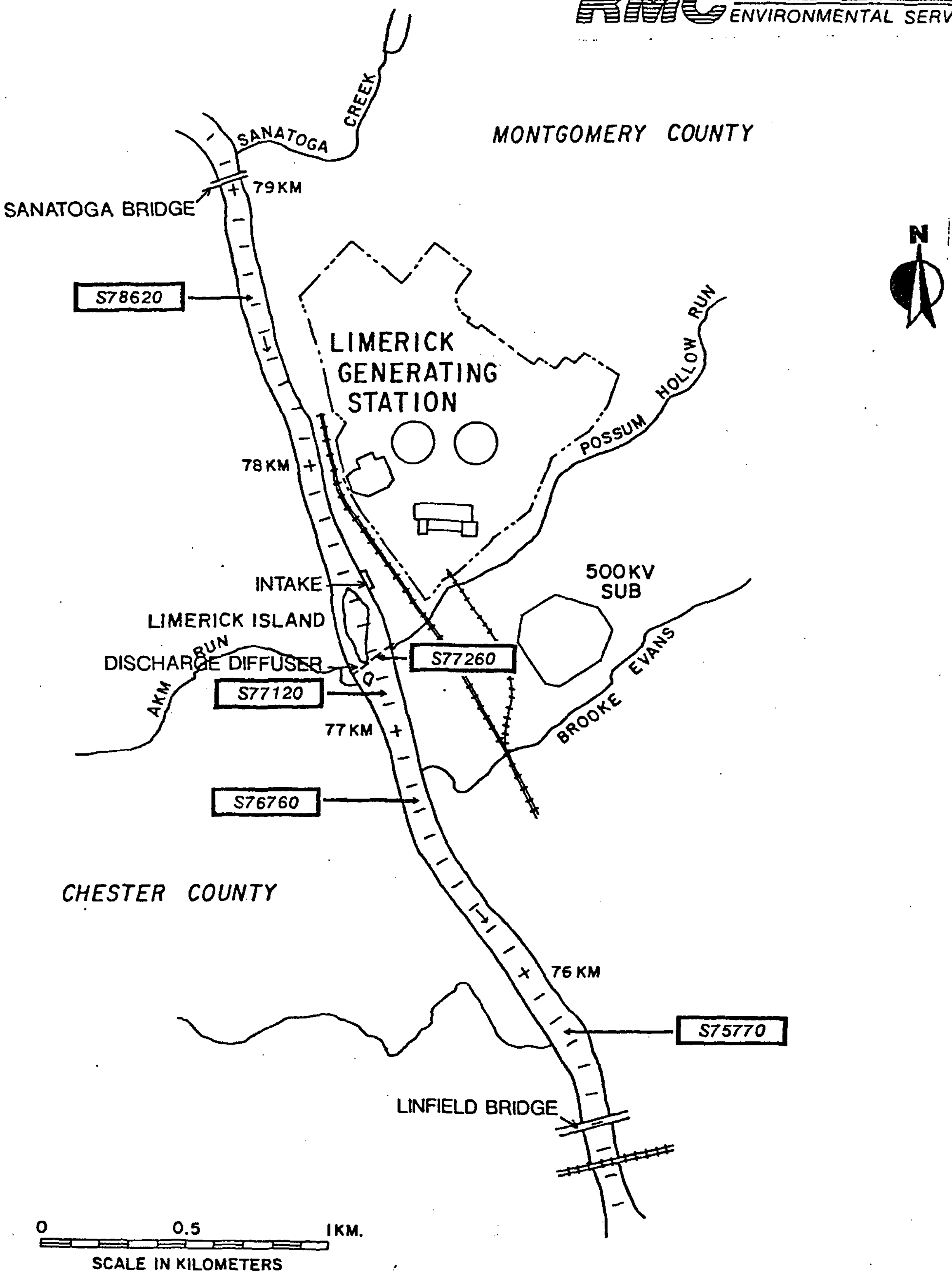

FIGURE 3.2-1 LOCATION OF TRANSECTS SAMPLED FOR BENTHIC MACROINVERTEBRATES IN THE SCHUYLKILL RIVER, 1988.

3.3 Fish

INTRODUCTION

The fish community in the Schuylkill River near LGS was studied from 1970-1978 and from 1980-present to determine any significant effects of LGS operation on the fish community near the power plant. Fish have been studied in detail due to their ecological and sociological importance to the riverine ecosystem and the opportunity for impingement, entrainment, and cooling tower blow-down discharge to affect the Schuylkill River fishery resource.

Studies of Schuylkill River fishes in 1988 consisted of periodic seining, electrofishing, and impingement surveys. Fish species composition, relative abundance, distribution, and life history data for important species were obtained by standardized seining and electrofishing surveys. The impingement survey measured the extent of fish entrapment against the LGS water intake screens.

This report is divided into subsections describing the results of population surveys, the biology of important species, and the result of the impingement survey. These subsections are followed by a discussion that relates 1988 results to the findings of previous Schuylkill River fish community studies.

POPULATION SURVEYS

Fish Collections

Fish were collected from the Schuylkill River near LGS by seining and electrofishing, two methods that collectively sample the range of size and species of fish from habitats found in the study area. Conditions permitting, fish were seined once per month throughout the year (Table 3.3-1), while electrofishing collections were made once per month, April-October (Table 3.3-2).

Seining

The seine used measured 2.4 meters in length, 1.2 meters in depth, and was comprised of 3.2-millimeter mesh netting. Effort consisted of six uniform hauls along 30 meters of shoreline at each of six near-shore stations (Fig. 3.3-1). Catches from individual seine hauls were pooled to form a composite sample from each station on each sample date. Catch data were intrinsically standardized because effort remained constant within and between stations.

The seine captured primarily smaller fishes living near shore such as minnows, darters, and the young of larger species. Larger fishes were captured only occasionally. Larger fishes and any young sport fish were identified, counted, measured, and released. Smaller fishes comprising the bulk of seine collections were preserved and identified, counted, and grouped within 5-millimeter fork length intervals in the laboratory.

Electrofishing

Larger juvenile and adult fishes such as sunfish, bass, catfish, suckers, and other large species that were not appreciably vulnerable to seining were collected by electrofishing. The gear, a 240-volt pulsed direct current, boat-mounted electrofisher, did not efficiently take smaller species and life stages, however. Electrofishing samples, therefore, excluded fish shorter than 50 millimeters fork length, as well as darters and all species of minnows except carp, goldfish, golden shiner, fallfish, and creek chub which usually grow to exceed 50 millimeters fork length.

Four electrofishing stations were established near LGS (Fig. 3.3-2). Stations were described in an earlier progress report (RMC Environmental Services 1984). All stations were 300 meters to 400 meters in length and were oriented with respect to LGS as follows. Station S79310 was located approximately 2 kilometers upriver from LGS and served as a reference station not subjected to the direct influence of any water withdrawal or discharge effects. Station S77640, located adjacent to LGS, was just upriver from the station's pumphouse. Station S76940 was situated directly downstream of the LGS discharge which enters the Schuylkill River through a diffuser set into a concrete stream bed stabilizer. Downstream of S76940, a fourth station was established and designated S76440.

Each station was sampled in a downstream direction at a speed slightly faster than the current within two opposing shoreline zones, two offshore zones, and one mid-channel zone. Sampling time was recorded to the nearest minute and used to standardize catch data as catch-per-unit-effort (CPUE) in units of fish/hour.

Each captured fish was identified, measured to the nearest millimeter fork length, weighed to the nearest gram, and examined for external evidence of disease, parasitism, or physical abnormality. Except for an occasional reference specimen, all fish were released alive.

Summary of Data Analyses

Species composition and relative abundance of fishes in the Schuylkill River near LGS were estimated based on the seining and electrofishing catches.

Species composition was best represented by the species list generated from the combined catch of both gear types, since neither gear alone effectively sampled all species known to occur near LGS. Due to differences in gear selectivity, relative abundance was calculated separately for each gear type as CPUE and as the percent of total fish captured. Catch data were compiled for individual stations and time periods to characterize variation in species abundances.

Sampling Results

Species Composition

In 1988, 32 species of fish from seven families plus hybrid carp x goldfish and sunfish hybrids were collected by one or both sampling methods (Table 3.3-3). The alewife, a member of the herring family stocked as forage in upstream reservoirs, was not seined or electrofished in 1988 but was found in impingement samples. American shad, another herring species occasionally stocked as larvae by the Pennsylvania Fish Commission (PFC), was not introduced to the Schuylkill River near LGS in 1988. Other species and hybrids collected in the past but not in 1988 included bowfin, brown trout, rainbow trout, redfin pickerel, chain pickerel, muskellunge and hybrid muskellunge x northern pike, cutlips minnow, creek chub, margined madtom, creek chubsucker, and walleye. These fishes have been infrequently collected and are either stocked in various waters in the Schuylkill River basin or are more abundant in tributaries.

Unconfirmed reports were received that hybrid striped bass x white bass were caught from the Schuylkill River near LGS by anglers. These hybrid game fish are stocked by the PFC in Blue Marsh Reservoir located on Tulpehocken

Creek upriver from LGS. Reported angler catches indicate that these hybrids may escape from the reservoir and move downstream. Absence of hybrid striped bass x white bass from intensive fisheries surveys near LGS suggests that their rates of reservoir escape and downstream movement are low at present.

Relative Abundance: Seining

In 1988, a total of 6,642 fish was seined from the Schuylkill River near LGS (Table 3.3-4). For the year, the combined samples contained 26 species; spotfin shiner comprised 73% of the total number of individuals. Swallowtail shiner, bluegill, and redbreast sunfish comprised most of the remaining catch. All other species were represented by fewer than 100 and often less than 50 individuals.

Since only 1.6 kilometers separated the farthest upstream station from the farthest downstream station, differences in species composition and relative abundance among stations were relatively minor. Total catch varied by a factor of five and the ordering of the more abundant fishes was similar among stations. The minor differences among stations appeared to be related to differences in microhabitat features such as substrate type, presence or absence of cover, and other features that influence the distribution of stream fishes. The most species (21) and greatest number of individuals (2,160) were collected at S77220 which brackets the confluence of a small tributary. This station featured abundant cover, several substrate types, and sharp velocity and depth gradients compared to the more uniform habitat found at other seine stations.

Monthly seine catches were very low in February and March, but increased rapidly through the warmer months of the growing season (Table 3.3-5). This pattern reflects both the lowered vulnerability of fishes to capture during colder months and the increased population density from recruitment of a new year class in late spring and summer.

Considerable year-to-year variation in abundance of most species has been observed in seine collections (Table 3.3-6). Annual catches have varied by at least an order of magnitude for most species. Natural variation in reproductive success is likely responsible for much of the variation in species abundances in the Schuylkill River and is mediated by weather and flow regime effects. Sampling artifacts and the patchy distribution of stream fishes undoubtedly contribute to sample variation, but the consistency of effort from month to month and from year to year assures that real differences in population density were quantified at least on a relative basis. In 1988, nearly all species were collected in numbers that fell within the range observed prior to LGS operation. However, fewer comely shiners, banded killifish, and tessellated darters were collected in 1988 than in any other year. Most likely, the low relative abundance of these fishes is due to successive years of poor recruitment, perhaps coupled with an increase in predation by rock bass and smallmouth bass which have increased in abundance. Since killifishes are known to proliferate in organically enriched waters, reduced banded killifish abundance may be a sign of the gradual improvement in Schuylkill River water quality seen in recent years.

Relative Abundance: Electrofishing

In 1988, a sample of 3,752 fish containing 21 species and two hybrids was collected in 22.58 hours of electrofishing (Table 3.3-7). Total CPUE, 166.2 fish/hour, was similar to the 1987 catch rate of 168.6 fish/hour. Most of the 1988 sample was comprised of redbreast sunfish (24.9%), rock bass (16.9%), goldfish (11.2%), yellow bullhead (9.3%), smallmouth bass (8.1%) brown bullhead (7.0%), and pumpkinseed (6.7%). No other species contributed as much as five percent to the 1988 electrofishing sample.

Differences among stations existed in the relative abundance of several species (Table 3.3-8 to 3.3-11). American eel, white sucker, yellow bullhead, redbreast sunfish, and to a lesser extent smallmouth bass and rock bass, were more abundant at S79310 upstream from LGS. Goldfish, carp, golden shiner, brown bullhead, pumpkinseed, bluegill, and largemouth bass were more abundant at one or more of the stations adjacent to or downriver from LGS. Differences in the relative abundances of these species among stations have remained consistent over time and reflect differences in habitat. Station S79310 is situated in a river bend where swift currents prevent sediment from being deposited. Consequently, S79310 has a preponderance of cobble, boulder, and bedrock substrate and contains few weed beds or shallow, slow-current areas. Stations near LGS are all fringed by shallow flats having a silty substrate. Beds of Myriophyllum, Heteranthera, and Elodea grow on these flats in summer, and may become very dense during periods of low flow.

Many 1988 CPUE values for individual species were similar to average CPUE observed prior to LGS start-up (Table 3.3-12). For example, relative abundances of goldfish, carp, golden shiner, brown bullhead, green sunfish, pumpkinseed, redbreast sunfish, and largemouth bass were indicative of near-average population levels. Some abundance indices continued along recent increasing trends resulting from production of a dominant year class or several consecutive successful spawns. Smallmouth bass CPUE, for example, was greater in 1988 than in any previous year. Rock bass CPUE, although slightly lower than in 1986 and 1987, was markedly greater than in 1985 or any preoperational year. Conversely, abundance of goldfish and carp has declined from the high level seen in 1985. White sucker has decreased in abundance since 1986. One other notable occurrence in the 1988 electrofishing survey was the increased catch of young quillback, an uncommon species of sucker in the Schuylkill River.

BIOLOGY OF IMPORTANT SPECIES

Introduction

Several species were chosen for closer scrutiny due to their importance to the Schuylkill River fish community (Table 3.3-13). For these species, data were examined to establish the following:

a) spatial and temporal changes in relative abundance to assess species-habitat relationships and fluctuations in population density.
b) time of spawning and relative year-class strength, and
c) incidence of disease and parasitism for the large important species collected by electrofishing.

The results of these analyses compared among stations over time were then used to identify any potential LGS operational influences warranting closer study in the future.

Species Accounts

American eel

Twelve American eels were captured by electrofishing in 1988 at an average rate of 0.53 fish/hour. Compared to the 1987 catch rate of 0.25 fish/

hour, the 1988 CPUE value may represent an increase in abundance, or an increased concentration of American eels within a sampled area rather than an increase in numbers. The variation in CPUE noted in Table 3.3-12 simply may represent the chance outcome of limited sampling of a patchily distributed population of organisms. Nevertheless, a trend exists in the data which suggests that the number of American eels in the study area has declined between preoperational and postoperational periods. The average of seven annual CPUE values determined prior to LGS operation, 1.6 fish/hour, was more than twice the average of 0.6 fish/hour over the four-year postoperational period. Also, the highest annual CPUE value for American eel since LGS start-up, 0.9 fish/hour in 1985, was equal to the lowest annual CPUE value determined prior to 1985. Any such decline is evidently due to causes unrelated to LGS for several reasons. American eels are catadromous (meaning they migrate to the ocean to spawn), thus the young are not exposed to entrainment, nor were larger juvenile and adult American eels impinged. In every year, almost all American eels have been taken at S79310 located upriver from LGS, where any potential water intake or discharge effects are presumably absent.

American shad

No release by the PFC of hatchery reared American shad postlarvae occurred in 1988, nor was this species encountered in the Schuylkill River during any LGS-related sampling program.

Muskellunge

Muskellunge or the hybrid cross with northern pike were not stocked by the PFC in the study area in 1988 and neither was collected by seining or electrofishing.

Goldfish

Abundance of goldfish in the Schuylkill River near LGS continued to decline from the record-levels of 1985-1986 that resulted from production of a dominant 1985 year class. Goldfish was still the third-most abundant species in electrofishing samples and comprised nearly 17% of the total number of fish captured with that gear in 1988. The highest goldfish electrofishing CPUE among stations occurred just downstream of the LGS discharge at S76940. A few young-of-year goldfish were captured in September and October 1988, but the bulk of the population was comprised of individuals from the 1985 year-class that were longer than 200 millimeters fork length (Fig. 3.3-3).

A majority (59%) of goldfish captured in April 1988 exhibited fin damage, and 20% had body sores or wounds. The disease rate, however, dropped greatly in later months except in August 1988, when 64% of the goldfish examined were host to one or more parasitic leeches.

Swallowtail shiner

The 1988 catch of 959 swallowtail shiners was considerably greater than the catch of 172 swallowtail shiners made in 1987. However, fewer swallowtail shiners were caught in any one postoperational year (1985-1988) than were caught in any one preoperational year (1975-1984).

The increased catch of swallowtail shiner in 1988 reverses a declining trend in relative abundance which became evident around the time LGS began operating when the swallowtail shiner catch dropped from 8,837 fish in 1983 to 2,616 fish in 1984. Adult mortality did not appear to increase due to LGS operation since swallowtail shiners were not impinged in appreciable numbers;

neither did entrainment of eggs and larvae appear to be a factor contributing to population decline. From 1985 through 1987 as swallowtail shiner abundance declined, LGS did not operate during most of the late spring and summer when the early lifestages would be present. Furthermore, swallowtail shiner abundance increased in 1988 when LGS remained operational through the spring and summer; young-of-year swallowtail shiners were collected in July 1988 and contributed to the increased relative abundance for the remainder of the year.

Spotfin shiner

The spotfin shiner is probably the most numerically abundant fish species in the study area and consistently dominated the seine catch both before and after LGS start-up. The catch of 4,866 spotfin shiners in 1988 was the highest since 1983, when 6,502 were collected. In 1988, spotfin shiner catches peaked in August and September when the young were fully recruited to the seine; spotfin shiner fry were initially collected in mid-July.

White sucker

Annual seine catches of young-of-year white suckers varied between 6 and 1,222 fish during the preoperational study period. In the postoperational period, the catch of young-of-year white suckers by seine ranged between 6 in 1988 and 252 in 1985; the postoperational average was 120 per year. During the seven-year preoperational period, the average seine catch of young-of-year white suckers was 239 per year if a dominant 1977 year class is included, but only 75 per year if the outlying 1977 catch is excluded. The seine data show that annual recruitment of white sucker in the Schuylkill River is highly variable, but do not show any trends suggestive of an operational impact on recruitment.

Electrofishing catches of juvenile and adult white suckers continued on a downward trend that became evident in 1987. Only 171 white suckers were collected at an average rate of 7.6 fish/hour. Although white suckers still comprised just under 5% of the total electrofishing sample, their catch rate in 1988 was the lowest determined for the species. The trend toward lower relative abundance was evident at all stations including S79310 upstream, indicating that the decline in white sucker density is an area-wide phenomenon having no apparent connection with LGS operation.

Length-frequency data obtained in September and October depicted at least two and possibly three age-groups of immature white suckers (Fig. 3.3-4). The adult population was similarly comprised of at least two and possibly three or more age-groups of older fish. Since growth slows as fish age and can be quite variable within and between individual year-classes, considerable overlap may occur in length-frequency distributions, as is evident in Figure 3.3-4.

The incidence of disease among adult white suckers in 1988 was 7%, similar to the disease rate seen in 1986 and 1987. Body sores and parasitic copepods were the most common diseases.

Brown bullhead

Characteristics of the brown bullhead population in 1988 were similar to those observed in the previous two years. Age III brown bullheads belonging to the dominant 1985 year class comprised the bulk of the population. Most of these fish were between 210 millimeters and 250 millimeters in length

(Fig. 3.3-5). A few larger, older brown bullheads were collected along with one younger specimen probably spawned in 1987. Data collected during LGS-related sampling suggest that the brown bullhead population in the Schuylkill River is largely maintained by the infrequent production of dominant year classes; only two such year classes (1977 and 1985) have been observed. Reproduction in intervening years has been very limited.

Brown bullheads were most often collected from S76940 just downstream of the LGS discharge, where CPUE was approximately three times as great as it was at the other three stations.

Approximately 16% of brown bullheads examined in 1988 were diseased; common afflictions included body sores and fin damage. This disease rate was slightly less than the 21-22% rate observed over the past two years. Brown bullheads of the 1985 year class have yet to develop tumorous growths that were commonly seen on large, old individuals collected in the past.

Banded killifish

The 1988 seine catch of 10 banded killifish was the lowest in 12 years of sampling and confirmed the trend in reduced abundance noted in 1987. Data were insufficient to identify a cause for the low numbers of banded killifish in the study area. However, with the exception of spotfin shiner and swallow-tail shiner, the 1988 seine catches of most small species were less than catches made in previous years.

Pumpkinseed

Of 76 pumpkinseeds collected by seine in 1988, 56 were young-of-year; the new year class was recruited to the electrofishing gear by autumn

(Fig. 3.3-6). Reproductive success and population abundance indices in 1988 were similar in magnitude to values obtained in 1987. This species is noteworthy in that pumpkinseed abundance has remained more stable over time than the abundance of most other large fishes in the Schuylkill River near LGS (Table 3.3-12).

Pumpkinseed abundance at upstream S76310 was considerably lower than at the three downstream stations near LGS. The observed spatial distribution was consistent with past observations and reflected differences in habitat characteristics between S79310 and the other stations.

Blackspot and copepod parasites were the most common forms of disease affecting pumpkinseeds in the Schuylkill River. The overall disease rate in 1988 was 8% which appears normal for this population of sunfish.

Redbreast sunfish

This species is the most abundant sunfish in the Schuylkill River near LGS. A total of 933 redbreast sunfish were collected by electrofishing in 1988 at an overall rate of 41.3 fish/hour, a rate nearly identical to the average annual CPUE observed in the LGS preoperational period (Table 3.3-12). An additional 209 redbreast sunfish, mostly young-of-year, were collected by seining. Young-of-year redbreast sunfish first appeared in the July seine collection at lengths of 11-25 millimeters. By the end of summer, many redbreast sunfish of the 1988 year-class were recruited to the electrofishing gear; at least four older age-groups were also present in the population, based on the frequency distribution of lengths observed in September and October 1988 (Fig. 3.3-7).

Incidence of disease and parasitism among redbreast sunfish was greater in spring than in summer or autumn, due to a higher incidence of eye flukes and fin damage in April 1988. Redbreast sunfish were relatively disease-free through the remainder of the year.

Smallmouth bass

The seine catch of 24 young-of-year smallmouth bass was indicative of moderately successful reproduction by this important species in 1988. By autumn, most of these fish had grown in length to 80-90 millimeters. The new year class is clearly evident as the left-most peak in the length frequency histogram constructed for smallmouth bass collected by electrofishing in September and October 1988 (Fig. 3.3-8).

Relative abundance as electrofishing CPUE was greatest upstream of LGS and least at S76940 near the discharge. Catch rates were higher in both April and October than in other months at S79310. Catch rates rose at all stations in October when young-of-year smallmouth bass were recruited to the electrofishing gear.

Only 5% of the smallmouth bass examined in 1988 were diseased, compared to 10% in 1987. Blackspot and damaged fins were the disease types most often noted.

Largemouth bass

Although common to the Schuylkill River near LGS, largemouth bass relative abundance has remained low and fairly stable before and after LGS came on line. Three young-of-year specimens were collected by seine in 1988, while 41 largemouth bass of various sizes were taken by electrofishing at an overall rate of 1.8 fish/hour.

More largemouth bass were collected from the vicinity of the LGS discharge than elsewhere in the study area, probably because of the abundance of shallow, weedy habitat preferred by largemouth bass which exists on both sides of the river near the discharge.

Of the 41 largemouth bass examined while electrofishing, none was affected by any visible sign of disease.

Tessellated darter

The catches by seine of many smaller species in the Schuylkill River near LGS were below average in 1988; only 18 tessellated darters were collected which was one specimen fewer than the 19 collected by seine in 1975. Sporadic years of low density appear characteristic of the tessellated darter population in the Schuylkill River. This species is far more abundant in the small tributaries which feed the Schuylkill River near LGS.

IMPINGEMENT

Introduction

Fish that have grown to a size larger than the smallest slot width screening a water intake are not subject to entrainment within a power plant's cooling system, but may be trapped against the screen if they cannot swim strongly enough to escape the suction of the water intake pumps. Such entrapment is called impingement and may result in a problematic increase in fish mortality. Therefore, fish impingement at LGS has been studied in every year since the station became operational in 1985. Objectives of the survey were to estimate the number, size, and species of fish impinged and relate impingement to time of year, water temperature, and river discharge. Results of the 1988 impingement survey are reported here and compared to results from previous years.

Methods

Debris from the Schuylkill River intake screen was deposited in a trash bin which was routinely searched for impinged fish. The trash bin was checked weekly except when Schuylkill River flow exceeded 2,000 $feet^3$/second, when it was checked more frequently. The bin was checked less frequently in late summer when almost no impingement occurred for several consecutive weeks.

During each check of the trash bin, all impinged fish were sorted into the lowest identifiable taxon, and measured to the nearest millimeter fork length, except for badly decomposed or physically damaged specimens. After an accumulation of debris was searched, a plastic sheet was placed over the debris to isolate it from the debris to be collected in the forthcoming survey interval. This survey technique approximates a complete count of fish impinged at LGS.

Impingement totals were determined and examined along with corresponding Schuylkill River discharge, water temperature, and LGS operational status to identify any patterns which might aid in determining when and to what degree impingement occurs at LGS.

Results and Discussion

In 1988, 141 fish representing ten species and one additional genus were found during the impingement survey (Table 3.3-14). This total was less than the total number of fish impinged in any previous year; 1988 was also the first year in which goldfish did not comprise the majority of impinged fish. Instead, more alewives (39% of total) were impinged than any other species. Although the decline in impingement of goldfish was consistent with the reduction in their population density throughout the study area, the LGS water intake screen was highly selective for alewife, a species not collected by seining or electrofishing in 1988. Alewives are stocked as forage in upstream impoundments and their presence in the Schuylkill River is probably due to reservoir escape.

Consistent with the past, most impingement occurred in winter during the first quarter of 1988, a time when river discharge is usually higher and water temperature is lower than at other times of the year (Figs. 3.1-2 and 3.1-4).

In past years, the significance of impingement during warmer months could not be fully assessed because LGS was shut down for several weeks in succession; water withdrawal and hence the opportunity for impingement to occur were minimal at those times. In contrast, LGS operated near full-capacity from mid-spring through summer and early autumn in 1988 and typically withdrew 13-16 x 10^6 gallons of water per day from the Schuylkill River. Even though water was withdrawn throughout summer 1988, LGS impinged only nine fish.

Although the greatest number of species (at least nine) and individuals (100) were impinged in the winter quarter, impingement was somewhat higher in the warmer months for brown bullhead, yellow bullhead, and redbreast sunfish. However, impingement is clearly not a problematic source of additional mortality on fish populations in the Schuylkill River near LGS due to the low number of fish involved.

CONCLUSIONS

Schuylkill River fisheries studies have not detected any significant impacts to the fish community near LGS attributable to plant operations. Inspection of the 1988 results reinforces the conclusions drawn from a variety of statistical comparisons between preoperational data and postoperational data through 1987 which failed to show any acute, short-term effects attributable to LGS (RMC Environmental Services 1988).

Despite operating continuously through spring and summer, LGS impinged very few fish during the warmer months of 1988. This observation lends credence to the hypothesis that impingement at LGS is a seasonal phenomenon related to the near-shore movement of certain species during periods of high flow and low temperature. Populations of several species that have freely drifting eggs or larvae were also exposed to entrainment in 1988, yet successful recruitment of a new year class still occurred, particularly for swallowtail shiner and spotfin shiner. Natural river flow and temperature conditions probably are far more important regulators of year class formation than entrainment at LGS, especially since the percentage of river flow withdrawn is low. Entrainment will cease to be a mortality factor in the Schuylkill River once LGS becomes reliant on the recently completed Point Pleasant diversion for make-up water during the warmer months of the year.

Table 3.3-1. Summary of the Schuylkill River seining stations and dates, 1975 - 1988.

Station		J	F	M	A	M	J	J	A	S	O	N	D	Total
S78460	1975	X	X	X	X	X	X	X	X	X	X	X	X	12
	1976	X	X	X	X	X	X	X	X	X		X	X	11
	1977			X	X	X	X	X	X	X				7
	1981			X	X	X	X	X	X	X	X	X	X	10
	1982		X	X	X	X	X	X	X	X	X	X	X	11
	1983	X	X			X	X	X	X	X	X	X		9
	1984	X		X	X	X	X	X	X	X	X	X	X	11
	1985	X	X	X	X	X	X	X	X	X	X	X	X	12
	1986			X	X	X	X	X	X	X	X	X	X	10
	1987	X	X	X	X	X	X	X	X	X	X	X	X	12
	1988		X	X	X		X	X	X	X	X	X	X	10
														115
S77960	1975	X	X	X	X	X	X	X	X	X	X	X	X	12
	1976	X	X	X	X	X	X	X	X	X		X	X	11
	1977			X	X	X	X	X	X	X				7
	1978		X		X	X	X	X	X	X	X	X	X	10
	1981			X	X	X	X	X	X	X	X	X	X	10
	1982		X	X	X	X	X	X	X	X	X	X	X	11
	1983	X	X			X	X	X	X	X	X	X		9
	1984	X		X	X	X	X	X	X	X	X	X	X	11
	1985	X	X	X	X	X	X	X	X	X	X	X	X	12
	1986			X	X	X	X	X	X	X	X	X	X	10
	1987	X	X	X	X	X	X	X	X	X	X	X	X	12
	1988		X	X	X		X	X	X	X	X	X	X	10
														125
S77240	1975	X	X	X	X	X	X	X	X	X	X	X	X	12
	1976	X	X	X	X	X	X	X	X	X		X	X	11
	1977			X	X	X	X	X	X	X				7
	1978		X		X	X	X	X	X	X	X	X	X	10
	1981			X	X	X	X	X	X	X	X	X	X	10
	1982		X	X	X	X	X	X	X	X	X	X	X	11
	1983	X	X			X	X	X	X	X	X	X		9
	1984	X		X	X	X	X	X	X	X	X	X	X	11
	1985	X	X	X	X	X	X	X	X	X	X	X	X	12
	1986			X	X	X	X	X	X	X	X	X	X	10
	1987	X	X	X	X	X	X	X	X	X	X	X	X	12
	1988		X	X	X		X	X	X	X	X	X	X	10
														125

Table 3.3-1. (continued)

Station		J	F	M	A	M	J	J	A	S	O	N	D	Total
S77220	1975	X	X	X	X	X	X	X	X	X	X	X	X	12
	1976	X	X	X	X	X	X	X	X	X		X	X	11
	1977			X	X	X	X	X	X	X				7
	1978		X		X	X	X	X	X	X	X	X	X	10
	1981			X	X	X	X	X	X	X	X	X	X	10
	1982		X	X	X	X	X	X	X	X	X	X	X	11
	1983	X	X			X	X	X	X	X	X	X		9
	1984	X		X	X	X	X	X	X	X	X	X	X	11
	1985	X	X	X	X	X	X	X	X	X	X	X	X	12
	1986			X	X	X	X	X	X	X	X	X	X	10
	1987	X	X	X	X	X	X	X	X	X	X	X	X	12
	1988		X	X	X		X	X	X	X	X	X		9
														124
S77010	1975	X	X	X	X	X	X	X	X	X	X	X	X	12
	1976	X	X	X	X	X	X	X	X	X		X	X	11
	1977			X	X	X	X	X	X	X				7
	1978		X		X	X	X	X	X	X	X	X	X	10
	1981			X	X	X	X	X	X	X	X	X	X	10
	1982		X	X	X	X	X	X	X	X	X	X	X	11
	1983	X	X			X	X	X	X	X	X	X		9
	1984	X		X	X	X	X	X	X	X	X	X	X	11
	1985	X	X	X	X	X	X	X	X	X	X	X	X	12
	1986			X	X	X	X	X	X	X	X	X	X	10
	1987	X	X	X	X	X	X	X	X	X	X	X	X	12
	1988		X	X	X		X	X	X	X	X	X	X	10
														125
S76840	1975	X	X	X	X	X	X	X	X	X	X	X	X	12
	1976	X	X	X	X	X	X	X	X	X		X	X	11
	1977			X	X	X	X	X	X	X				7
	1978		X		X	X	X	X	X	X	X	X	X	10
	1981			X	X	X	X	X	X	X	X	X	X	10
	1982		X	X	X	X	X	X	X	X	X	X	X	11
	1983	X	X			X	X	X	X	X	X	X		9
	1984	X		X	X	X	X	X	X	X	X	X	X	11
	1985	X	X	X	X	X	X	X	X	X	X	X	X	12
	1986			X	X	X	X	X	X	X	X	X	X	10
	1987	X	X	X	X	X	X	X	X	X	X	X	X	12
	1988		X	X	X		X	X	X	X	X	X	X	10
														125

Table 3.3-2. Summary of the Schuylkill River electrofishing stations and dates, 1976 - 1988.

Station		J	F	M	A	M	J	J	A	S	O	N	D	Total
S79310	1976							X	X	X	X	X	X	6
	1977		X	X	X	X	X	X	X	X		X	X	10
	1978				X	X	X	X	X	X	X		X	8
	1981				X		X		X		X			4
	1982				X			X	X		X			4
	1983					X	X	X	X	X	X			6
	1984				X	X	X	X	X	X	X			7
	1985				X	X	X	X	X		X			6
	1986					X	X	X		X	X			5
	1987				X		X	X	X	X	X			6
	1988				X		X		X	X	X			5

														67
S77640	1976							X	X	X	X	X	X	6
	1977		X	X	X	X	X	X	X	X		X		9
	1978				X	X	X	X	X	X	X	X	X	9
	1981				X		X		X		X			4
	1982				X			X	X		X			4
	1983		X	X		X	X	X	X	X	X	X		9
	1984			X	X	X	X	X	X	X	X	X	X	10
	1985		X	X	X	X	X	X	X	X	X	X		10
	1986	X		X		X	X	X		X	X		X	8
	1987	X		X	X		X	X	X	X	X	X	X	10
	1988				X		X		X	X	X			5

														84
S76940	1977		X	X	X	X	X	X	X	X		X		9
	1978				X	X	X	X	X	X	X	X	X	9
	1981				X		X		X		X			4
	1982				X			X	X		X			4
	1983		X	X		X	X	X	X	X	X	X		9
	1984			X	X	X	X	X	X	X	X	X	X	10
	1985		X	X	X	X	X	X	X	X	X			9
	1986	X		X		X	X	X		X	X		X	8
	1987	X		X	X		X	X	X	X	X	X	X	10
	1988				X		X		X	X	X			5

														77

Table 3.3-2. (continued)

Station		J	F	M	A	M	J	J	A	S	O	N	D	Total
S76440	1976							X	X	X	X	X	X	6
	1977		X	X	X	X	X	X	X	X		X	X	10
	1978				X	X	X	X	X	X	X	X	X	9
	1981				X		X		X		X			4
	1982				X			X	X		X			4
	1983					X	X	X	X	X	X			6
	1984				X	X	X	X	X	X	X			7
	1985				X	X	X	X	X	X	X			7
	1986					X	X	X		X	X			5
	1987				X		X	X	X	X	X			6
	1988				X		X		X	X	X			5
														69
S74365	1976							X	X	X	X	X	X	6
	1977		X	X	X	X	X	X	X	X			X	9
	1978				X	X	X	X	X	X	X	X	X	9

														24
S72885	1976							X	X	X	X	X	X	6
	1977		X	X	X	X	X	X	X	X				8

														14

Table 3.3-3. List of fishes collected from the Schuylkill River near LGS since 1970 and relative abundance by sampling method in 1988.

	Relative abundance				
	Electrofishing			Seining	
Common name	N	%	CPUE	N	%
Bowfin	0	0.0	0.00	0	0.0
American eel	12	0.3	0.53	0	0.0
Alewife	0	0.0	0.00	0	0.0
American shad	0	0.0	0.00	0	0.0
Brook trout	0	0.0	0.00	0	0.0
Brown trout	0	0.0	0.00	0	0.0
Rainbow trout	0	0.0	0.00	0	0.0
Redfin pickerel	0	0.0	0.00	0	0.0
Chain pickerel	0	0.0	0.00	0	0.0
Muskellunge	0	0.0	0.00	0	0.0
Hybrid <u>Esox</u>	0	0.0	0.00	0	0.0
Goldfish	420	11.2	18.60	19	0.3
Carp	104	2.8	4.61	24	0.4
Goldfish x carp	11	0.3	0.49	0	0.0
Cutlips minnow	-	-	-	0	0.0
Golden shiner	38	1.0	1.68	15	0.2
Comely shiner	-	-	-	4	+
Common shiner	-	-	-	30	0.5
Spottail shiner	-	-	-	55	0.8
Swallowtail shiner	-	-	-	959	14.4
Spotfin shiner	-	-	-	4,866	73.3
Bluntnose minnow	-	-	-	1	+
Fathead minnow	-	-	-	1	+
Blacknose dace	-	-	-	2	+
Longnose dace	-	-	-	0	0.0
Creek chub	0	0.0	0.00	0	0.0
Fallfish	2	0.1	0.09	1	+
Quillback	34	0.9	1.51	16	0.2
White sucker	171	4.6	7.57	6	+
Creek chubsucker	0	0.0	0.00	0	0.0
White catfish	1	+	0.04	0	0.0
Yellow bullhead	348	9.3	15.41	1	+
Brown bullhead	262	7.0	11.60	2	+
Channel catfish	10	0.3	0.44	2	+
Margined madtom	0	0.0	0.00	0	0.0
Banded killifish	-	-	-	10	0.2
Rock bass	634	16.9	28.07	45	0.7
Redbreast sunfish	933	24.9	41.31	209	3.1
Green sunfish	101	2.7	4.47	6	+
Pumpkinseed	251	6.7	11.11	76	1.1
Bluegill	64	1.7	2.83	246	3.7

Table 3.3-3. (continued)

	Relative abundance				
	Electrofishing			Seining	
Common name	N	%	CPUE	N	%
Hybrid sunfish	2	0.1	0.09	0	0.0
Smallmouth bass	305	8.1	13.51	25	0.4
Largemouth bass	41	1.1	1.82	3	+
White crappie	3	0.1	0.13	0	0.0
Black crappie	4	0.1	0.18	0	0.0
Tessellated darter	-	-	-	18	0.3
Walleye	0	0.0	0.00	0	0.0
Yellow perch	1	+	0.04	0	0.0
Total	3,752				

"-" = Excluded from electrofishing samples.
"+" = Less than 0.1% of total catch.

Table 3.3-4. Total catch and relative abundance of fishes collected by seine from the Schuylkill River by station during 1988.

	S76840		S77010		S77220		S77240		S77960		S78460		Total	
Species	Catch	%	Catch	%	Catch	%	Catch	%	Catch	%	Catch	%	Catch	%
Goldfish	5	0.6	-	-	13	0.6	1	0.1	-	-	-	-	19	0.3
Carp	4	0.4	13	1.1	2	0.1	-	-	5	1.3	-	-	24	0.4
Golden shiner	2	0.2	2	0.2	6	0.3	1	0.1	2	0.5	2	0.1	15	0.2
Comely shiner	-	-	-	-	2	0.1	-	-	-	-	2	0.1	4	0.1
Common shiner	-	-	6	0.5	2	0.1	2	0.3	3	0.8	17	1.2	30	0.5
Spottail shiner	2	0.2	5	0.4	20	0.9	2	0.3	18	4.7	8	0.6	55	0.8
Swallowtail shiner	35	3.9	77	6.8	410	19.0	138	20.7	63	16.3	236	17.1	959	14.4
Spotfin shiner	782	86.4	962	84.4	1396	64.6	472	70.8	172	44.4	1082	78.2	4866	73.3
Bluntnose minnow	-	-	-	-	1	+	-	-	-	-	-	-	1	+
Fathead minnow	1	0.1	-	-	-	-	-	-	-	-	-	-	1	+
Blacknose dace	-	-	2	0.2	-	-	-	-	-	-	-	-	2	+
Fallfish	-	-	1	0.1	-	-	-	-	-	-	-	-	1	+
Quillback	1	0.1	-	-	6	0.3	1	0.1	5	1.3	3	0.2	16	0.2
White sucker	-	-	-	-	5	0.2	-	-	1	0.3	-	-	6	0.1
Yellow bullhead	-	-	1	0.1	-	-	-	-	-	-	-	-	1	+
Brown bullhead	-	-	-	-	1	+	1	0.1	-	-	-	-	2	+
Channel catfish	-	-	-	-	-	-	-	-	1	0.3	1	0.1	2	+
Banded killifish	8	0.9	-	-	2	0.1	-	-	-	-	-	-	10	0.2
Rock bass	3	0.3	6	0.5	12	0.6	6	0.9	12	3.1	6	0.4	45	0.7
Redbreast sunfish	34	3.8	28	2.5	48	2.2	17	2.5	67	17.3	15	1.1	209	3.1
Green sunfish	-	-	1	0.1	5	0.2	-	-	-	-	-	-	6	0.1
Pumpkinseed	17	1.9	13	1.1	30	1.4	6	0.9	3	0.8	7	0.5	76	1.1
Bluegill	2	0.2	20	1.8	187	8.7	7	1.0	30	7.8	-	-	246	3.7
Smallmouth bass	3	0.3	1	0.1	7	0.3	11	1.6	3	0.8	-	-	25	0.4
Largemouth bass	-	-	-	-	2	0.1	-	-	-	-	1	0.1	3	+
Tessellated darter	6	0.7	2	0.2	3	0.1	2	0.3	2	0.5	3	0.2	18	0.3
Total Catch	905		1140		2160		667		387		1383		6642	
Number of Species	15		16		21		14		15		13			
Number of Stations	1		1		1		1		1		1			

+ = Less than 0.1%

Table 3.3-5. Monthly catch (all stations combined) of fishes collected by seine from the Schuylkill River during 1988.

Species	2/11 Catch	3/23 Catch	4/18 Catch	6/10 Catch	7/18 Catch	8/18 Catch	9/12 Catch	10/18 Catch	11/18 Catch	12/22 Catch	TOTAL Catch
Goldfish	-	-	-	-	19	-	-	-	-	-	19
Carp	-	-	-	-	23	1	-	-	-	-	24
Golden shiner	-	-	-	-	8	1	3	1	-	2	15
Comely shiner	-	-	-	-	-	-	1	-	2	1	4
Common shiner	-	-	-	-	5	7	11	3	3	1	30
Spottail shiner	-	-	-	-	41	8	1	1	3	1	55
Swallowtail shiner	3	-	-	3	85	311	113	222	188	34	959
Spotfin shiner	20	6	70	358	794	1210	1161	764	349	134	4866
Bluntnose minnow	-	-	-	-	1	-	-	-	-	-	1
Fathead minnow	-	-	-	-	1	-	-	-	-	-	1
Blacknose dace	-	-	2	-	-	-	-	-	-	-	2
Fallfish	-	-	-	-	1	-	-	-	-	-	1
Quillback	-	-	-	-	16	-	-	-	-	-	16
White sucker	-	-	-	4	2	-	-	-	-	-	6
Yellow bullhead	-	-	-	-	1	-	-	-	-	-	1
Brown bullhead	-	-	-	-	2	-	-	-	-	-	2
Channel catfish	-	-	-	-	2	-	-	-	-	-	2
Banded killifish	-	-	1	-	-	5	-	3	1	-	10
Rock bass	-	-	-	8	31	3	1	-	1	1	45
Redbreast sunfish	-	-	7	10	106	31	26	26	3	-	209
Green sunfish	-	-	-	-	-	3	-	3	-	-	6
Pumpkinseed	-	-	1	4	4	54	7	4	2	-	76
Bluegill	-	-	-	-	1	190	35	9	7	4	246
Smallmouth bass	-	-	-	-	13	7	3	1	-	1	25
Largemouth bass	-	-	-	-	-	2	1	-	-	-	3
Tessellated darter	-	-	3	-	6	1	2	3	3	-	18
Total catch	23	6	84	387	1162	1834	1365	1040	562	179	6642
Number of species	2	1	6	6	21	15	13	12	11	9	
Number of stations	6	6	6	6	6	6	6	6	6	5	

+ = Less than 0.1%

Table 3.3-6. Annual seine catches by species of fishes from the Schuylkill River near LGS, 1975-1988.

Species	1975 Catch	1976 Catch	1977 Catch	1978 Catch	1981 Catch	1982 Catch	1983 Catch	1984 Catch	1985 Catch	1986 Catch	1987 Catch	1988 Catch
Esox hybrid	-	1	-	-	-	-	-	-	2	-	-	-
Goldfish	1	3	273	3	16	1	22	-	394	26	51	19
Carp	-	-	3	1	-	-	1	-	31	3	6	24
Cutlips minnow	-	2	2	6	4	2	4	4	15	3	1	-
Golden shiner	258	274	585	58	37	11	153	12	78	25	176	15
Notropis	-	-	886	-	-	-	-	-	-	-	-	-
Comely shiner	91	73	16	86	47	107	43	33	44	17	38	4
Common shiner	11	38	41	84	49	16	23	13	298	70	381	30
Spottail shiner	33	346	7286	175	121	34	326	22	2166	474	1177	55
Swallowtail shiner	5025	3057	3008	6579	4465	6472	8837	2616	826	606	172	959
Spotfin shiner	3329	3283	2743	12322	10638	7990	6502	3975	1786	1301	4348	4866
Bluntnose minnow	3	7	1	4	2	7	2	4	10	-	1	1
Fathead minnow	-	-	-	-	-	-	-	1	-	-	-	1
Blacknose dace	4	49	11	15	4	18	15	24	56	1	9	2
Longnose dace	-	5	5	2	-	-	-	1	-	-	-	-
Creek chub	-	7	245	3	1	1	17	5	10	2	-	-
Fallfish	1	-	4	1	1	1	4	-	26	1	2	1
Quillback	-	5	4	1	-	-	-	-	4	-	4	16
White sucker	6	227	1222	161	11	7	24	12	272	46	156	6
Creek chubsucker	1	2	2	-	-	-	-	-	1	-	1	-
White catfish	-	-	3	2	1	-	-	-	-	-	-	-
Yellow bullhead	2	4	5	1	1	-	2	-	37	5	9	1
Brown bullhead	8	6	1061	1	2	-	1	1	14	3	4	2
Channel catfish	-	-	-	-	-	1	-	-	1	-	-	2
Margined madtom	-	1	-	-	-	-	-	-	-	-	-	-
Banded killifish	45	131	615	168	374	169	215	82	353	174	26	10
Rock bass	5	19	56	16	35	39	86	22	382	53	57	45
Lepomis	-	-	337	-	-	-	-	-	-	-	4	-
Redbreast sunfish	82	405	547	130	480	241	1094	139	2226	330	1117	209
Green sunfish	40	40	180	17	20	15	15	4	13	5	24	6
Pumpkinseed	54	44	118	48	38	43	253	18	125	37	48	76
Bluegill	16	25	11	163	3	170	44	29	53	45	108	246
Lepomis hybrid	7	1	2	2	-	3	-	-	2	1	-	-
Smallmouth bass	-	5	1	6	9	36	23	9	190	53	99	25
Largemouth bass	5	10	-	13	6	2	10	2	3	7	9	3
White crappie	2	16	-	2	3	14	4	5	-	-	-	-
Black crappie	13	11	1	-	-	-	-	6	-	-	-	-
Tessellated darter	19	118	335	234	70	38	62	69	53	27	37	18
Total Catch	9061	8215	19604	20304	16438	15438	17782	7108	9471	3315	8065	6642
Number of Species	24	30	31	29	26	24	26	25	29	24	27	26

Table 3.3-7. Annual relative abundance of target fishes from the Schuylkill River electrofished in 1988 (+ = less than 0.1%, CPUE = fish per hour).

Species		S76440 5.77 hr	S76940 5.32 hr	S77640 6.70 hr	S79310 4.80 hr	Total 22.58 hr
American eel	Catch	2	1	1	8	12
	%	0.3	0.1	0.1	0.7	0.3
	CPUE	0.35	0.19	0.15	1.67	0.53
Goldfish	Catch	49	206	117	48	420
	%	7.7	21.4	11.3	4.3	11.2
	CPUE	8.49	38.72	17.46	10.00	18.60
Carp	Catch	30	33	23	18	104
	%	4.7	3.4	2.2	1.6	2.8
	CPUE	5.20	6.20	3.43	3.75	4.61
Golden shiner	Catch	5	17	16	-	38
	%	0.8	1.8	1.5	-	1.0
	CPUE	0.87	3.20	2.39	-	1.68
Fallfish	Catch	-	1	-	1	2
	%	-	0.1	-	0.1	0.1
	CPUE	-	0.19	-	0.21	0.09
Carp x goldfish	Catch	3	-	5	3	11
	%	0.5	-	0.5	0.3	0.3
	CPUE	0.52	-	0.75	0.63	0.49
Quillback	Catch	6	21	5	2	34
	%	0.9	2.2	0.5	0.2	0.9
	CPUE	1.04	3.95	0.75	0.42	1.51
White sucker	Catch	28	28	32	83	171
	%	4.4	2.9	3.1	7.4	4.6
	CPUE	4.85	5.26	4.78	17.29	7.57
White catfish	Catch	-	1	-	-	1
	%	-	0.1	-	-	+
	CPUE	-	0.19	-	-	0.04
Yellow bullhead	Catch	51	56	96	145	348
	%	8.0	5.8	9.2	13.0	9.3
	CPUE	8.84	10.53	14.33	30.21	15.41
Brown bullhead	Catch	45	126	51	40	262
	%	7.1	13.1	4.9	3.6	7.0
	CPUE	7.80	23.68	7.61	8.33	11.60
Channel catfish	Catch	4	-	3	3	10
	%	0.6	-	0.3	0.3	0.3
	CPUE	0.69	-	0.45	0.63	0.44
Rock bass	Catch	128	143	187	176	634
	%	20.2	14.9	18.0	15.8	16.9
	CPUE	22.18	26.88	27.91	36.67	28.07

Table 3.3-7. (continued)

Species		S76440 5.77 hr	S76940 5.32 hr	S77640 6.70 hr	S79310 4.80 hr	Total 22.58 hr
Redbreast sunfish	Catch	149	140	196	448	933
	%	23.5	14.6	18.9	40.1	24.9
	CPUE	25.82	26.32	29.25	93.33	41.31
Green sunfish	Catch	8	16	51	26	101
	%	1.3	1.7	4.9	2.3	2.7
	CPUE	1.39	3.01	7.61	5.42	4.47
Pumpkinseed	Catch	63	76	99	13	251
	%	9.9	7.9	9.5	1.2	6.7
	CPUE	10.92	14.29	14.78	2.71	11.11
Bluegill	Catch	5	25	30	4	64
	%	0.8	2.6	2.9	0.4	1.7
	CPUE	0.87	4.70	4.48	0.83	2.83
Lepomis hybrid	Catch	1	-	-	1	2
	%	0.2	-	-	0.1	0.1
	CPUE	0.17	-	-	0.21	0.09
Smallmouth bass	Catch	49	41	120	95	305
	%	7.7	4.3	11.5	8.5	8.1
	CPUE	8.49	7.71	17.91	19.79	13.51
Largemouth bass	Catch	6	26	7	2	41
	%	0.9	2.7	0.7	0.2	1.1
	CPUE	1.04	4.89	1.04	0.42	1.82
White crappie	Catch	-	2	1	-	3
	%	-	0.2	0.1	-	0.1
	CPUE	-	0.38	0.15	-	0.13
Black crappie	Catch	3	1	-	-	4
	%	0.5	0.1	-	-	0.1
	CPUE	0.52	0.19	-	-	0.18
Yellow perch	Catch	-	1	-	-	1
	%	-	0.1	-	-	+
	CPUE	-	0.19	-	-	0.04
	Catch	635	961	1040	1116	3752
	%	16.9	25.6	27.7	29.7	100.0
	CPUE	110.05	180.64	155.22	232.50	166.16

Table 3.3-8. Monthly relative abundance of target fishes from the Schuylkill River electrofished at S79310 in 1988 (+ = less than 0.1%, CPUE = fish per hour).

Species		Apr 0.97 hrs	Jun 0.80 hrs	Aug 1.07 hrs	Sep 0.97 hrs	Oct 1.00 hrs
American eel	Catch	-	4	4	-	-
	%	-	2.5	1.7	-	-
	CPUE	-	5.0	3.7	-	-
Goldfish	Catch	1	10	21	9	7
	%	0.4	6.3	8.8	3.1	3.7
	CPUE	1.0	12.5	19.6	9.3	7.0
Carp	Catch	5	8	5	-	-
	%	2.1	5.0	2.1	-	-
	CPUE	5.2	10.0	4.7	-	-
Fallfish	Catch	-	-	-	-	1
	%	-	-	-	-	0.5
	CPUE	-	-	-	-	1.0
Carp x goldfish	Catch	-	1	2	-	-
	%	-	0.6	0.8	-	-
	CPUE	-	1.3	1.9	-	-
Quillback	Catch	-	-	-	-	2
	%	-	-	-	-	1.1
	CPUE	-	-	-	-	2.0
White sucker	Catch	25	9	5	26	18
	%	10.6	5.7	2.1	8.9	9.5
	CPUE	25.8	11.3	4.7	26.8	18.0
Yellow bullhead	Catch	28	36	41	27	13
	%	11.9	22.6	17.2	9.2	6.9
	CPUE	28.9	45.0	38.3	27.8	13.0
Brown bullhead	Catch	4	10	10	12	4
	%	1.7	6.3	4.2	4.1	2.1
	CPUE	4.1	12.5	9.3	12.4	4.0
Channel catfish	Catch	-	-	2	1	-
	%	-	-	0.8	0.3	-
	CPUE	-	-	1.9	1.0	-
Rock bass	Catch	31	35	37	59	14
	%	13.1	22.0	15.5	20.1	7.4
	CPUE	32.0	43.8	34.6	60.8	14.0
Redbreast sunfish	Catch	104	39	84	127	94
	%	44.1	24.5	35.1	43.3	49.7
	CPUE	107.2	48.8	78.5	130.9	94.0
Green sunfish	Catch	2	-	11	9	4
	%	0.8	-	4.6	3.1	2.1
	CPUE	2.1	-	10.3	9.3	4.0

Table 3.3-8. (continued)

Species		Apr 0.97 hrs	Jun 0.80 hrs	Aug 1.07 hrs	Sep 0.97 hrs	Oct 1.00 hrs
Pumpkinseed	Catch	-	-	5	3	5
	%	-	-	2.1	1.0	2.6
	CPUE	-	-	4.7	3.1	5.0
Bluegill	Catch	-	-	1	1	2
	%	-	-	0.4	0.3	1.1
	CPUE	-	-	0.9	1.0	2.0
Lepomis hybrid	Catch	-	-	1	-	-
	%	-	-	0.4	-	-
	CPUE	-	-	0.9	-	-
Smallmouth bass	Catch	36	7	9	18	25
	%	15.3	4.4	3.8	6.1	13.2
	CPUE	37.1	8.8	8.4	18.6	25.0
Largemouth bass	Catch	-	-	1	1	-
	%	-	-	0.4	0.3	-
	CPUE	-	-	0.9	1.0	-

Table 3.3-9. Monthly relative abundance of target fishes from the Schuylkill River electrofished at S77640 in 1988 (+ = less than 0.1%, CPUE = fish per hour).

Species		Apr 1.27 hrs	Jun 1.37 hrs	Aug 1.15 hrs	Sep 1.50 hrs	Oct 1.42 hrs
American eel	Catch	1	-	-	-	-
	%	0.4	-	-	-	-
	CPUE	0.8	-	-	-	-
Goldfish	Catch	36	16	23	19	23
	%	14.6	6.5	15.1	10.9	10.5
	CPUE	28.3	11.7	20.0	12.7	16.2
Carp	Catch	3	11	5	2	2
	%	1.2	4.4	3.3	1.1	0.9
	CPUE	2.4	8.0	4.3	1.3	1.4
Golden shiner	Catch	2	-	1	3	10
	%	0.8	-	0.7	1.7	4.5
	CPUE	1.6	-	0.9	2.0	7.0
Carp x goldfish	Catch	1	-	2	1	1
	%	0.4	-	1.3	0.6	0.5
	CPUE	0.8	-	1.7	0.7	0.7
Quillback	Catch	-	-	-	-	5
	%	-	-	-	-	2.3
	CPUE	-	-	-	-	3.5
White sucker	Catch	14	3	1	-	14
	%	5.7	1.2	0.7	-	6.4
	CPUE	11.0	2.2	0.9	-	9.9
Yellow bullhead	Catch	22	25	9	28	12
	%	8.9	10.1	5.9	16.1	5.5
	CPUE	17.3	18.2	7.8	18.7	8.5
Brown bullhead	Catch	18	16	2	4	11
	%	7.3	6.5	1.3	2.3	5.0
	CPUE	14.2	11.7	1.7	2.7	7.7
Channel catfish	Catch	-	-	1	1	1
	%	-	-	0.7	0.6	0.5
	CPUE	-	-	0.9	0.7	0.7
Rock bass	Catch	59	70	10	16	32
	%	24.0	28.2	6.6	9.2	14.5
	CPUE	46.5	51.1	8.7	10.7	22.5
Redbreast sunfish	Catch	40	58	32	46	20
	%	16.3	23.4	21.1	26.4	9.1
	CPUE	31.5	42.3	27.8	30.7	14.1
Green sunfish	Catch	14	7	19	4	7
	%	5.7	2.8	12.5	2.3	3.2
	CPUE	11.0	5.1	16.5	2.7	4.9

Table 3.3-9. (continued)

Species		Apr 1.27 hrs	Jun 1.37 hrs	Aug 1.15 hrs	Sep 1.50 hrs	Oct 1.42 hrs
Pumpkinseed	Catch	24	29	4	20	22
	%	9.8	11.7	2.6	11.5	10.0
	CPUE	18.9	21.2	3.5	13.3	15.5
Bluegill	Catch	-	7	6	7	10
	%	-	2.8	3.9	4.0	4.5
	CPUE	-	5.1	5.2	4.7	7.0
Smallmouth bass	Catch	12	6	36	19	47
	%	4.9	2.4	23.7	10.9	21.4
	CPUE	9.4	4.4	31.3	12.7	33.1
Largemouth bass	Catch	-	-	1	3	3
	%	-	-	0.7	1.7	1.4
	CPUE	-	-	0.9	2.0	2.1
White crappie	Catch	-	-	-	1	-
	%	-	-	-	0.6	-
	CPUE	-	-	-	0.7	-

Table 3.3-10. Monthly relative abundance of target fishes from the Schuylkill River electrofished at S76940 in 1988 (+ = less than 0.1%, CPUE = fish per hour).

Species		Apr 1.37 hrs	Jun 0.95 hrs	Aug 1.00 hrs	Sep 1.03 hrs	Oct 0.97 hrs
American eel	Catch	-	-	-	1	-
	%	-	-	-	1.0	-
	CPUE	-	-	-	1.0	-
Goldfish	Catch	136	18	11	20	21
	%	54.2	6.6	8.2	19.2	10.6
	CPUE	99.3	18.9	11.0	19.4	21.6
Carp	Catch	3	6	1	3	20
	%	1.2	2.2	0.7	2.9	10.1
	CPUE	2.2	6.3	1.0	2.9	20.6
Golden shiner	Catch	-	-	-	4	13
	%	-	-	-	3.8	6.6
	CPUE	-	-	-	3.9	13.4
Fallfish	Catch	1	-	-	-	-
	%	0.4	-	-	-	-
	CPUE	0.7	-	-	-	-
Quillback	Catch	-	-	1	-	20
	%	-	-	0.7	-	10.1
	CPUE	-	-	1.0	-	20.6
White sucker	Catch	10	1	2	1	14
	%	4.0	0.4	1.5	1.0	7.1
	CPUE	7.3	1.1	2.0	1.0	14.4
White catfish	Catch	1	-	-	-	-
	%	0.4	-	-	-	-
	CPUE	0.7	-	-	-	-
Yellow bullhead	Catch	11	20	12	12	1
	%	4.4	7.3	9.0	11.5	0.5
	CPUE	8.0	21.1	12.0	11.7	1.0
Brown bullhead	Catch	15	18	52	26	15
	%	6.0	6.6	38.8	25.0	7.6
	CPUE	10.9	18.9	52.0	25.2	15.5
Rock bass	Catch	27	88	3	12	13
	%	10.8	32.1	2.2	11.5	6.6
	CPUE	19.7	92.6	3.0	11.7	13.4
Redbreast sunfish	Catch	29	63	25	14	9
	%	11.6	23.0	18.7	13.5	4.5
	CPUE	21.2	66.3	25.0	13.6	9.3
Green sunfish	Catch	3	8	3	-	2
	%	1.2	2.9	2.2	-	1.0
	CPUE	2.2	8.4	3.0	-	2.1

Table 3.3-10. (continued)

Species		Apr 1.37 hrs	Jun 0.95 hrs	Aug 1.00 hrs	Sep 1.03 hrs	Oct 0.97 hrs
Pumpkinseed	Catch	11	38	6	5	16
	%	4.4	13.9	4.5	4.8	8.1
	CPUE	8.0	40.0	6.0	4.9	16.5
Bluegill	Catch	-	6	3	3	13
	%	-	2.2	2.2	2.9	6.6
	CPUE	-	6.3	3.0	2.9	13.4
Smallmouth bass	Catch	4	5	13	1	18
	%	1.6	1.8	9.7	1.0	9.1
	CPUE	2.9	5.3	13.0	1.0	18.6
Largemouth bass	Catch	-	2	1	2	21
	%	-	0.7	0.7	1.9	10.6
	CPUE	-	2.1	1.0	1.9	21.6
White crappie	Catch	-	1	1	-	-
	%	-	0.4	0.7	-	-
	CPUE	-	1.1	1.0	-	-
Black crappie	Catch	-	-	-	-	1
	%	-	-	-	-	0.5
	CPUE	-	-	-	-	1.0
Yellow perch	Catch	-	-	-	-	1
	%	-	-	-	-	0.5
	CPUE	-	-	-	-	1.0

Table 3.3-11. Monthly relative abundance of target fishes from the Schuylkill River electrofished at S76440 in 1988 (+ = less than 0.1%, CPUE = fish per hour).

Species		Apr 1.50 hrs	Jun 1.18 hrs	Aug 1.13 hrs	Sep 0.80 hrs	Oct 1.15 hrs
American eel	Catch	-	1	-	1	-
	%	-	0.4	-	1.8	-
	CPUE	-	0.8	-	1.3	-
Goldfish	Catch	6	29	6	1	7
	%	4.6	12.8	9.2	1.8	4.5
	CPUE	4.0	24.6	5.3	1.3	6.1
Carp	Catch	-	11	4	-	15
	%	-	4.8	6.2	-	9.6
	CPUE	-	9.3	3.5	-	13.0
Golden shiner	Catch	-	-	-	1	4
	%	-	-	-	1.8	2.5
	CPUE	-	-	-	1.3	3.5
Carp x goldfish	Catch	-	2	-	-	1
	%	-	0.9	-	-	0.6
	CPUE	-	1.7	-	-	0.9
Quillback	Catch	-	-	-	-	6
	%	-	-	-	-	3.8
	CPUE	-	-	-	-	5.2
White sucker	Catch	8	6	1	2	11
	%	6.2	2.6	1.5	3.6	7.0
	CPUE	5.3	5.1	0.9	2.5	9.6
Yellow bullhead	Catch	15	14	10	7	5
	%	11.5	6.2	15.4	12.5	3.2
	CPUE	10.0	11.9	8.8	8.8	4.3
Brown bullhead	Catch	5	4	7	20	9
	%	3.8	1.8	10.8	35.7	5.7
	CPUE	3.3	3.4	6.2	25.0	7.8
Channel catfish	Catch	1	-	1	-	2
	%	0.8	-	1.5	-	1.3
	CPUE	0.7	-	0.9	-	1.7
Rock bass	Catch	40	53	6	7	22
	%	30.8	23.3	9.2	12.5	14.0
	CPUE	26.7	44.9	5.3	8.8	19.1
Redbreast sunfish	Catch	38	75	16	6	14
	%	29.2	33.0	24.6	10.7	8.9
	CPUE	25.3	63.6	14.2	7.5	12.2
Green sunfish	Catch	1	4	1	-	2
	%	0.8	1.8	1.5	-	1.3
	CPUE	0.7	3.4	0.9	-	1.7

Table 3.3-11. (continued)

Species		Apr 1.50 hrs	Jun 1.18 hrs	Aug 1.13 hrs	Sep 0.80 hrs	Oct 1.15 hrs
Pumpkinseed	Catch	9	13	5	6	30
	%	6.9	5.7	7.7	10.7	19.1
	CPUE	6.0	11.0	4.4	7.5	26.1
Bluegill	Catch	-	1	-	4	-
	%	-	0.4	-	7.1	-
	CPUE	-	0.8	-	5.0	-
Lepomis hybrid	Catch	-	1	-	-	-
	%	-	0.4	-	-	-
	CPUE	-	0.8	-	-	-
Smallmouth bass	Catch	7	12	8	1	21
	%	5.4	5.3	12.3	1.8	13.4
	CPUE	4.7	10.2	7.1	1.3	18.3
Largemouth bass	Catch	-	1	-	-	5
	%	-	0.4	-	-	3.2
	CPUE	-	0.8	-	-	4.3
Black crappie	Catch	-	-	-	-	3
	%	-	-	-	-	1.9
	CPUE	-	-	-	-	2.6

Table 3.3-12. Annual catch-per-unit-effort (CPUE) statistics compiled for the more abundant fishes collected by electrofishing in the Schuylkill River near LGS, 1976-1988.

	Preoperational period 1976-1978, 1981-1984			Postoperational period			
				1985	1986	1987	1988
Species	Minimum CPUE	Average CPUE	Maximum CPUE	Total CPUE	Total CPUE	Total CPUE	Total CPUE
American eel	0.9	1.6	2.6	0.9	0.6	0.2	0.5
Goldfish	7.4	21.3	46.0	125.3	192.5	29.6	18.6
Carp	0.5	3.8	17.1	10.0	14.8	3.6	4.6
Golden shiner	1.0	3.2	6.2	1.4	2.0	4.2	1.7
White sucker	16.2	26.4	37.5	17.8	21.2	11.4	7.6
Yellow bullhead	0.9	4.5	7.0	22.6	21.3	14.8	15.4
Brown bullhead	3.5	12.4	27.4	12.6	13.0	12.3	11.6
Rock bass	1.5	5.5	10.6	11.4	31.3	32.0	28.1
Redbreast sunfish	22.3	41.1	87.1	17.5	39.5	26.5	41.3
Green sunfish	1.3	3.4	7.3	1.6	3.9	2.7	4.5
Pumpkinseed	9.1	14.0	17.9	8.0	12.3	14.6	11.1
Smallmouth bass	0.6	4.7	8.1	11.3	11.7	12.7	13.5
Largemouth bass	0.3	1.0	2.0	0.2	0.9	1.6	1.8

Table 3.3-13. List of representative important fish species of the Schuylkill River.

Common name	Scientific name
Freshwater eel family	Anguillidae
American eel	*Anguilla rostrata*
Herring family	Clupeidae
American shad	*Alosa sapidissima*
Pike family	Esocidae
Muskellunge	*Esox masquinongy*
Minnow family	Cyprinidae
Goldfish	*Carassius auratus*
Swallowtail shiner	*Notropis procne*
Spotfin shiner	*Notropis spilopterus*
Sucker family	Catostomidae
White sucker	*Catostomus commersoni*
Freshwater catfish family	Ictaluridae
Brown bullhead	*Ictalurus nebulosus*
Killifish family	Cyprinodontidae
Banded killifish	*Fundulus diaphanus*
Sunfish family	Centrarchidae
Redbreast sunfish	*Lepomis auritus*
Pumpkinseed	*Lepomis gibbosus*
Largemouth bass	*Micropterus salmoides*
Smallmouth bass[1]	*Micropterus dolomieui*
Perch family	Percidae
Tessellated darter	*Etheostoma olmstedi*

[1]Not considered in EROL, see RMC Environmental Services (1984).

Table 3.3-14. Number of fish by species found during the LGS impingement survey by quarter in 1988.

Species	Winter January-March	Spring April-June	Summer July-September	Autumn October-December	Total
Alewife	55	-	-	-	55
Goldfish	10	3	-	-	13
Unidentified minnow	3	-	-	-	3
White sucker	-	2	-	-	2
Brown bullhead	4	6	-	1	11
Yellow bullhead	2	7	1	-	11
Unidentified catfish	7	-	-	-	7
Rock bass	3	3	-	-	6
Redbreast sunfish	4	5	6	1	16
Pumpkinseed	2	1	-	-	3
Unidentified sunfish	1	1	-	-	2
Smallmouth bass	4	-	-	-	4
Black crappie	-	1	-	-	1
Unidentified fish	5	2	1	-	8
Total	100	31	9	2	142

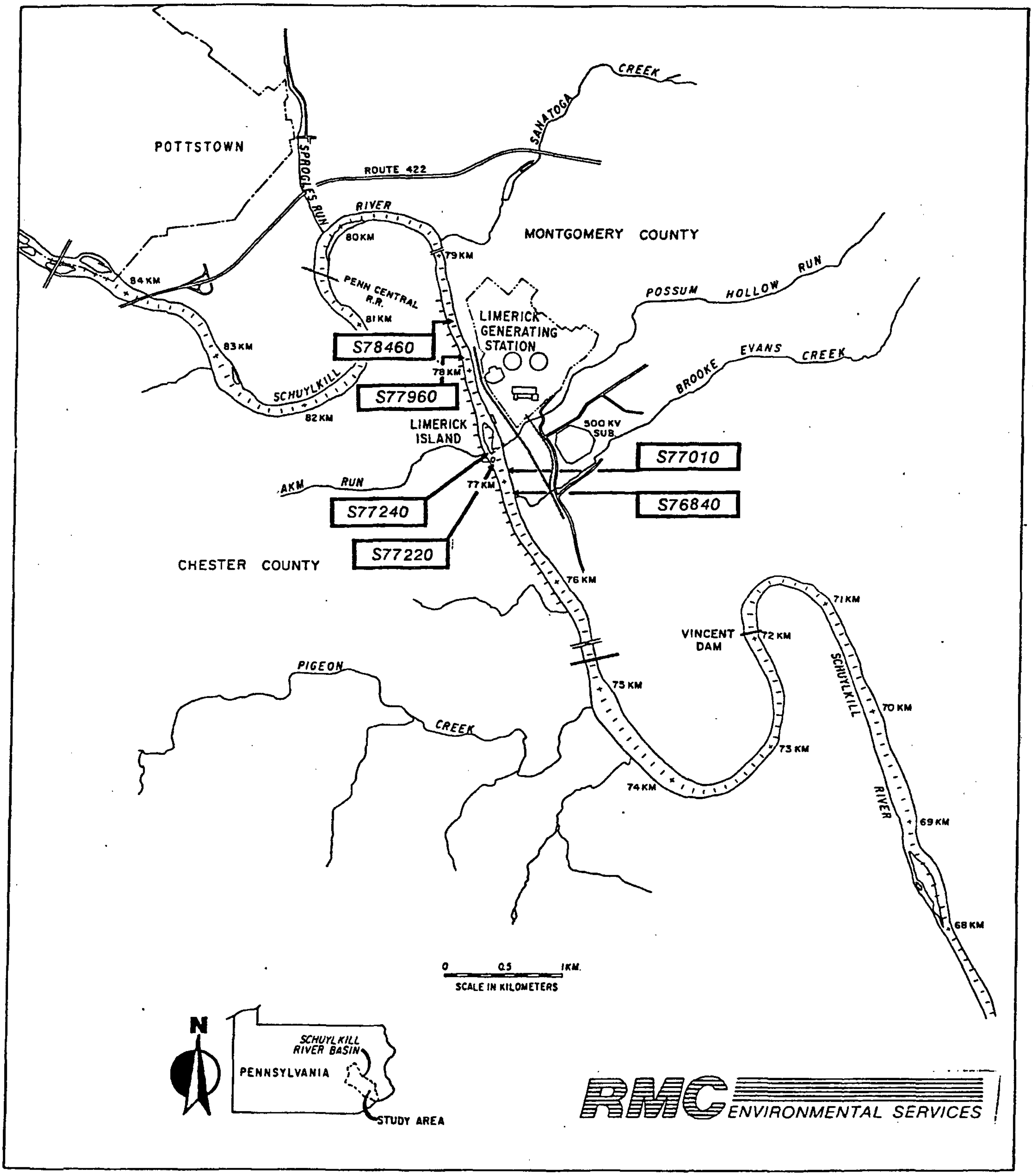

FIGURE 3.3-1 LOCATION OF SCHUYLKILL RIVER SEINE STATIONS, 1988.

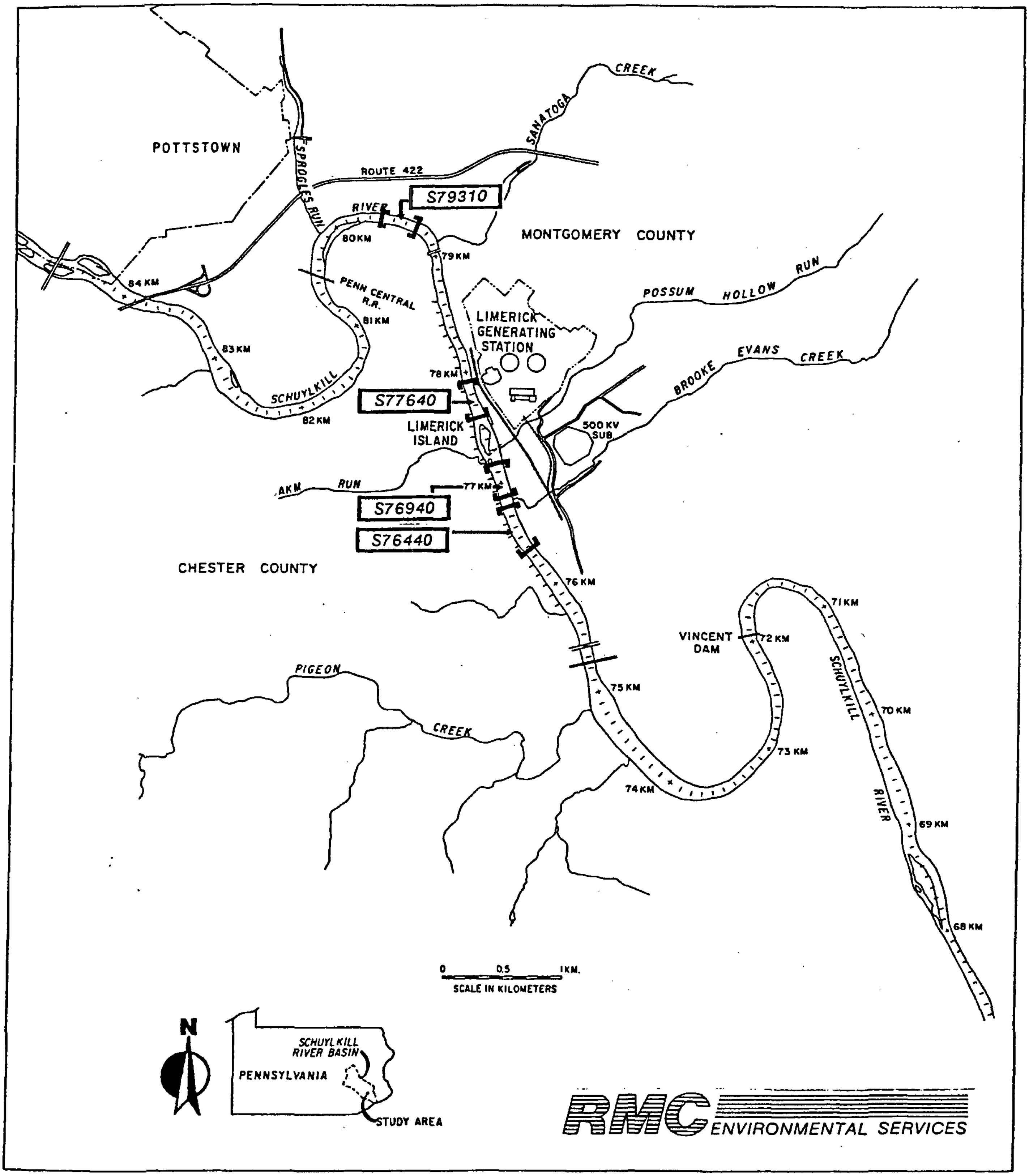

FIGURE 3.3-2 LOCATION OF SCHUYLKILL RIVER ELECTROFISHING STATIONS, 1988.

SCHUYLKILL RIVER LENGTH-FREQUENCY ANALYSIS
GOLDFISH DURING 1988
MONTHS=SEP + OCT
SEP-OCT LENGTH FREQUENCY HISTOGRAMS
POOLED OVER ALL METERS

SPECIES=CA RIV=S YEAR=1988

FREQUENCY BAR CHART
FREQUENCY

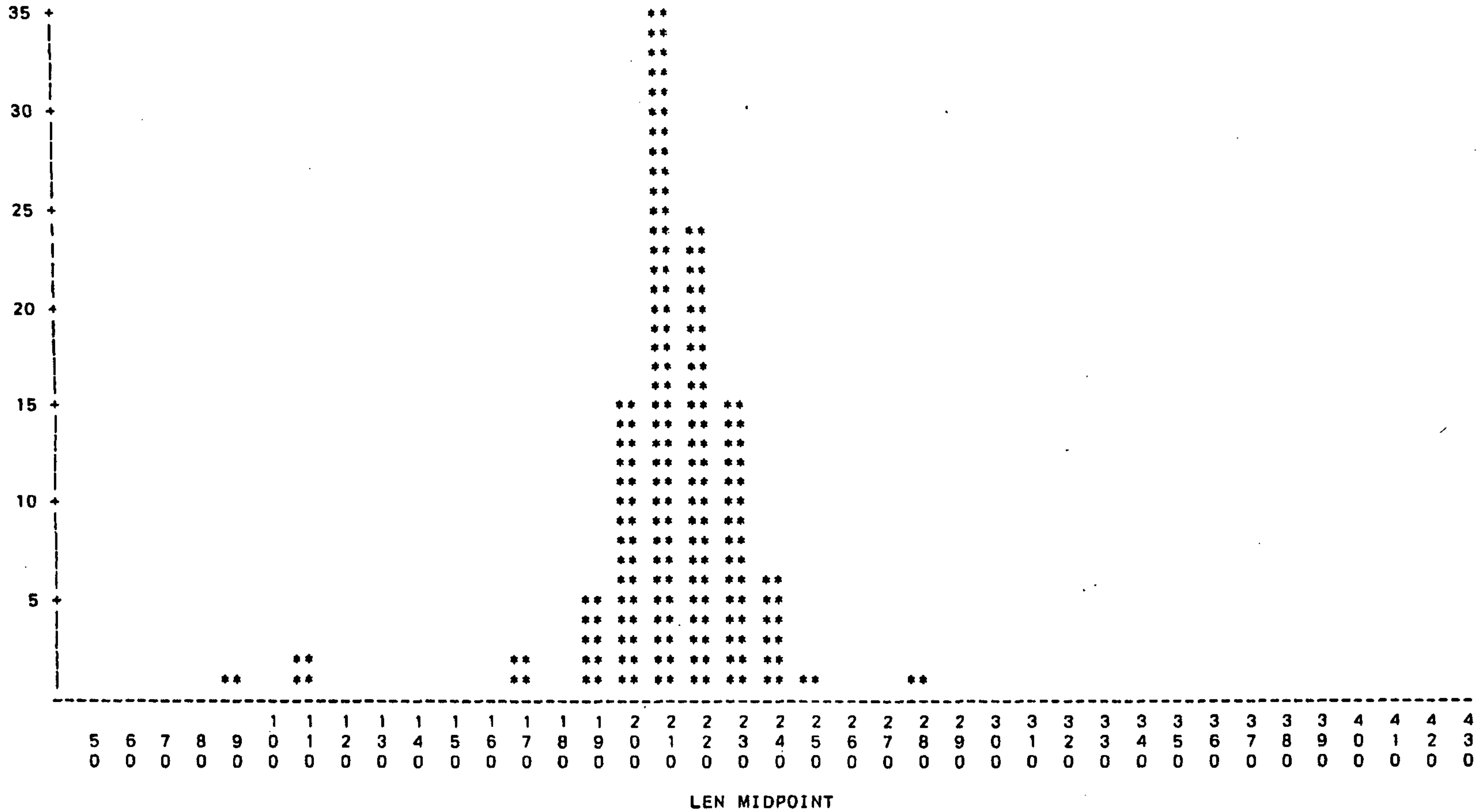

Figure 3.3-3. Length-frequency distribution of goldfish collected from the Schuylkill River, September-October 1988.

SCHUYLKILL RIVER LENGTH-FREQUENCY ANALYSIS
WHITE SUCKER DURING 1988
MONTHS=SEP + OCT
SEP-OCT LENGTH FREQUENCY HISTOGRAMS
POOLED OVER ALL METERS

SPECIES=CC RIV=S YEAR=1988

FREQUENCY BAR CHART
FREQUENCY

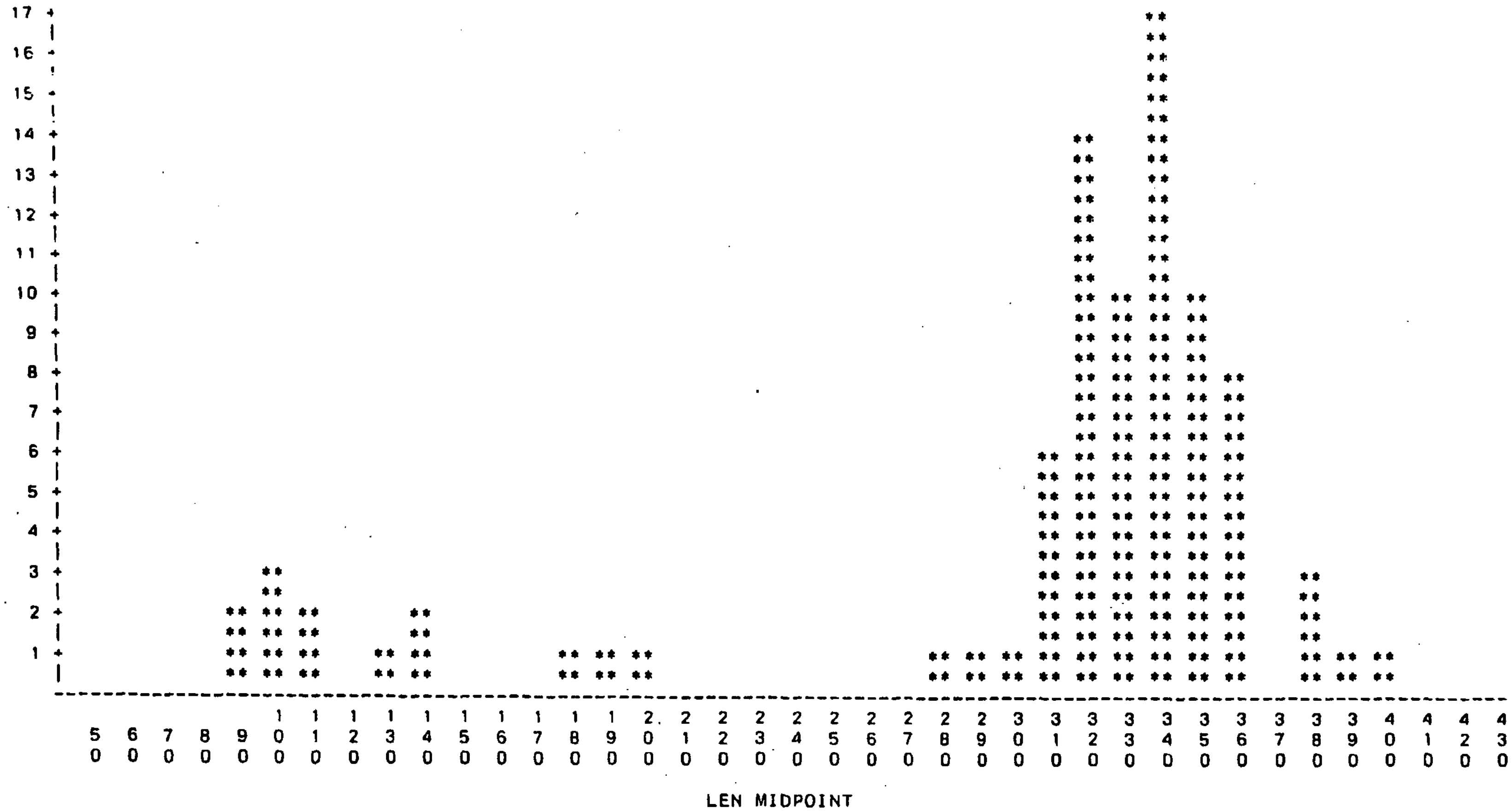

Figure 3.3-4. Length-frequency distribution of white sucker collected from the Schuylkill River, September-October 1988.

SCHUYLKILL RIVER LENGTH-FREQUENCY ANALYSIS
BROWN BULLHEAD DURING 1988
MONTHS=SEP + OCT
SEP-OCT LENGTH FREQUENCY HISTOGRAMS
POOLED OVER ALL METERS

SPECIES=BB RIV=S YEAR=1988

FREQUENCY BAR CHART
FREQUENCY

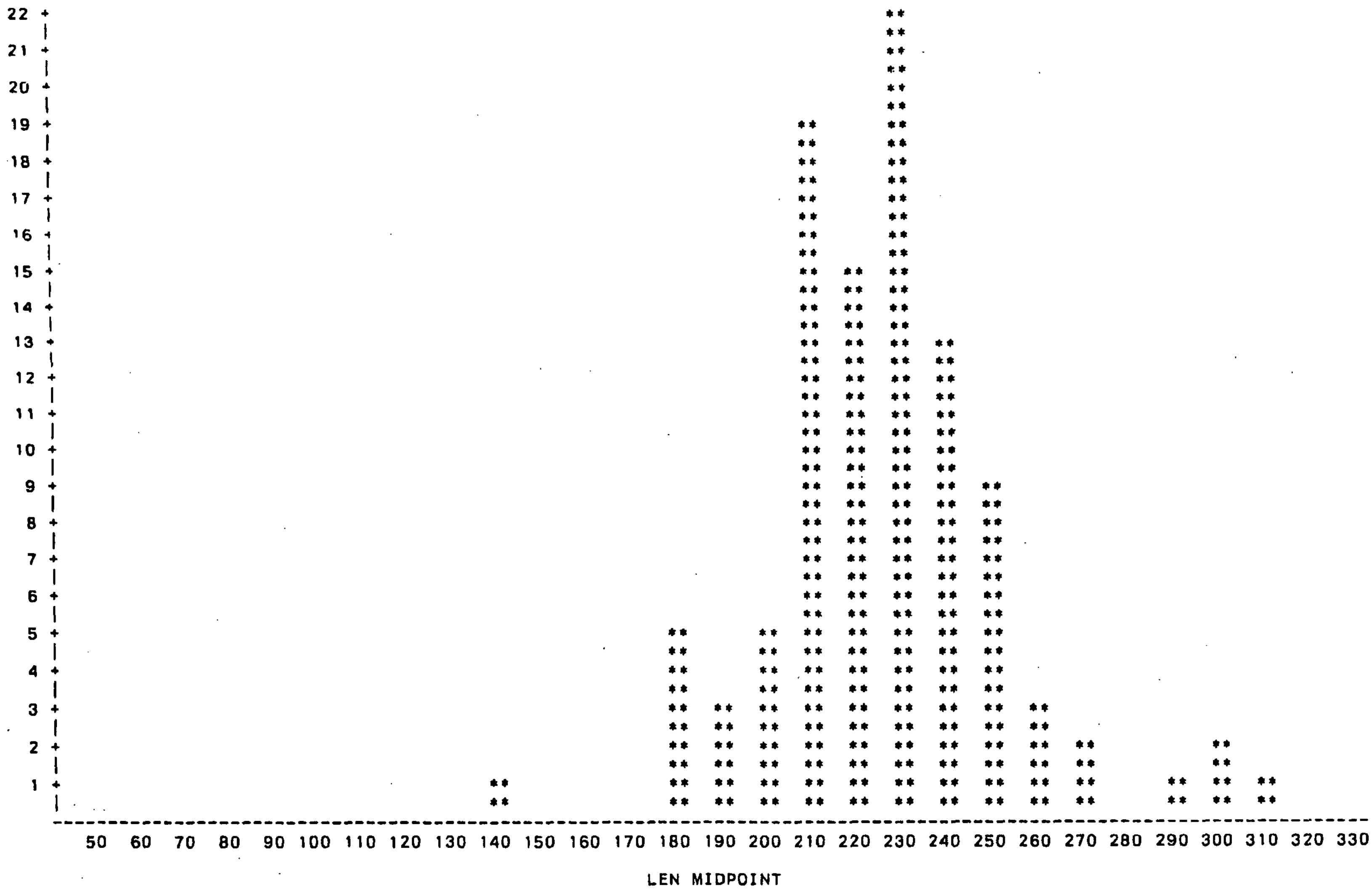

Figure 3.3-5. Length-frequency distribution of brown bullhead collected from the Schuylkill River, September-October 1988.

SCHUYLKILL RIVER LENGTH-FREQUENCY ANALYSIS
PUMPKINSEED DURING 1988
MONTHS=SEP + OCT
SEP-OCT LENGTH FREQUENCY HISTOGRAMS
POOLED OVER ALL METERS

SPECIES=GB RIV=S YEAR=1988

FREQUENCY BAR CHART

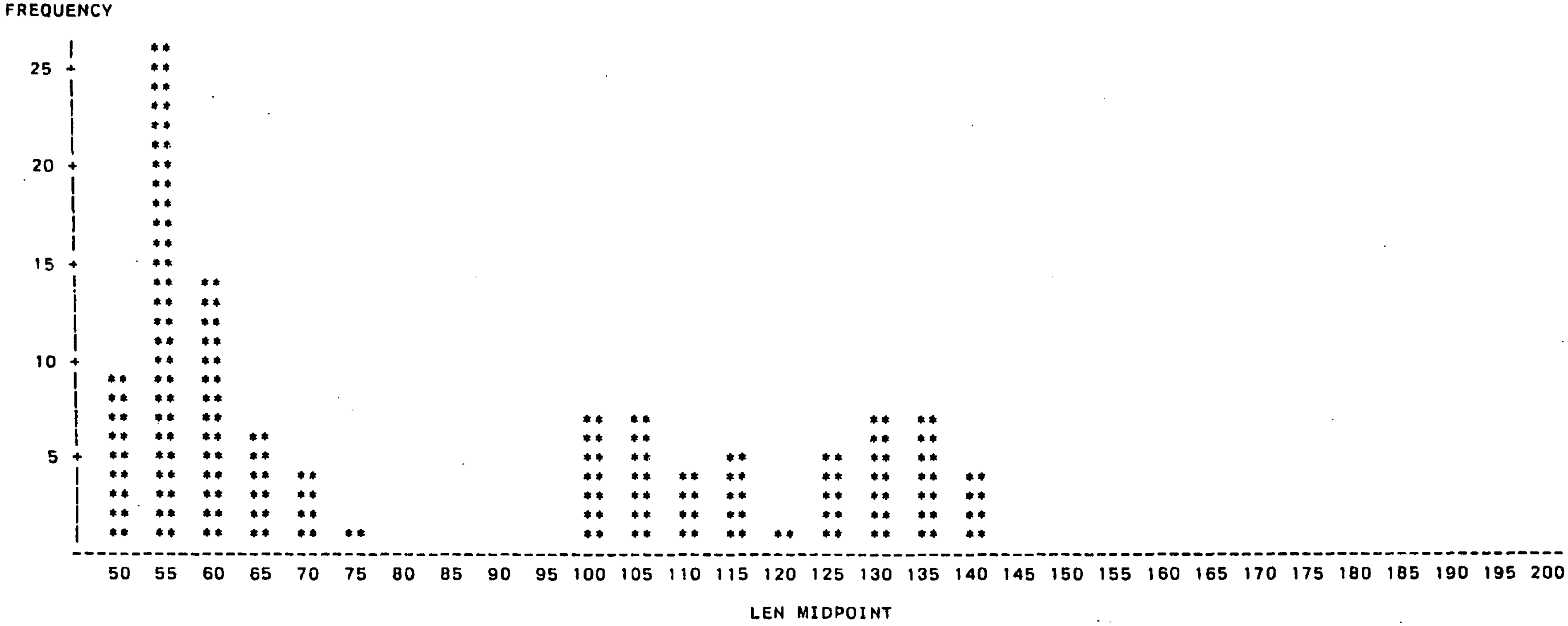

Figure 3.3-6. Length-frequency distribution of pumpkinseed collected from the Schuylkill River, September-October 1988.

SCHUYLKILL RIVER LENGTH-FREQUENCY ANALYSIS
REDBREAST SUNFISH DURING 1988
MONTHS=SEP + OCT
SEP-OCT LENGTH FREQUENCY HISTOGRAMS
POOLED OVER ALL METERS

SPECIES=RB RIV=S YEAR=1988

FREQUENCY BAR CHART
FREQUENCY

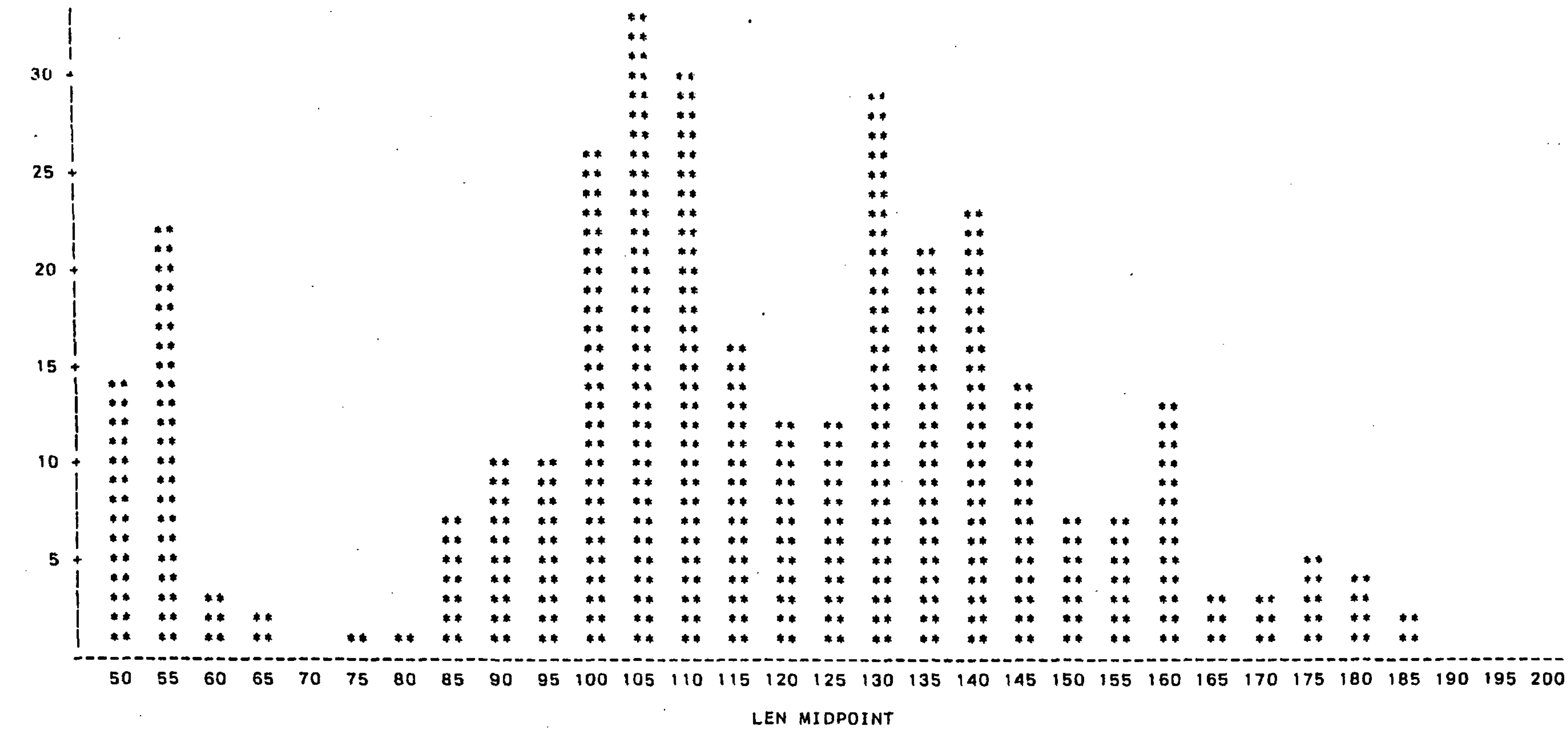

Figure 3.3-7. Length-frequency distribution of redbreast sunfish collected from the Schuylkill River, September-October 1988.

SCHUYLKILL RIVER LENGTH-FREQUENCY ANALYSIS
SMALLMOUTH BASS DURING 1988
MONTHS=SEP + OCT
SEP-OCT LENGTH FREQUENCY HISTOGRAMS
POOLED OVER ALL METERS

SPECIES=MD RIV=S YEAR=1988

FREQUENCY BAR CHART
FREQUENCY

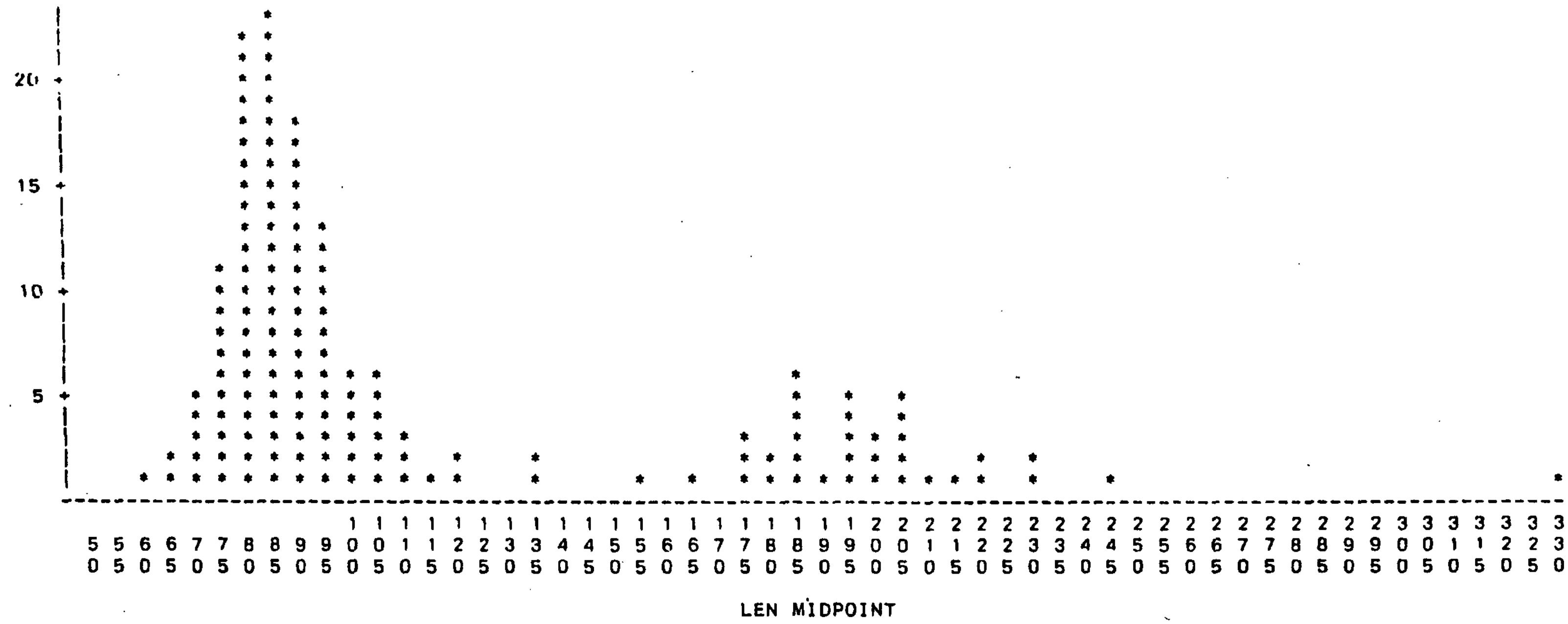

Figure 3.3-8. Length-frequency distribution of smallmouth bass collected from the Schuylkill River, September-October 1988.

4.0 Asiatic Clam

INTRODUCTION AND METHODS

The distribution of Asiatic clam (*Corbicula fluminea*) in the Delaware River, Schuylkill River, and Perkiomen Creek has been surveyed annually since 1982. The results are used to assess the potential threat of this water system-fouling species to PECo generating stations, particularly Limerick Generating Station (LGS), and are reported in this document and in previous annual reports (RMC Environmental Services 1984, 1985, 1986, 1987 and 1988).

Study areas for both the Schuylkill River and the Delaware River were extended several miles upstream in 1988. Acting on a tip from the Norristown office of the Pennsylvania Department of Environmental Resources, the Delaware River study area was extended to Martins Creek, approximately 37 river miles upstream of the intake of the Point Pleasant Diversion. Based on the unexpected discovery of *Corbicula* throughout nearly this entire reach, it was deemed prudent to extend the Schuylkill River study area well above LGS. The Perkiomen Creek study area remained the same.

Methods employed were the same as used previously. Stations established at less than 10 mile intervals in each stream were sampled for the presence of *Corbicula*. At locations where water depth permitted, the river or stream bottom was visually scanned for *Corbicula* shells. Substrate samples were collected at all stations, washed through a 3.2 mm mesh sieve, and inspected for *Corbicula*.

RESULTS AND DISCUSSION

Sampling in 1988 established continued presence of *Corbicula* in the Delaware River and extended the known range of infestation to a point approximately 6 miles upstream of Easton, Pennsylvania (Table 4.0-1). Specimens were collected in close proximity to the Point Pleasant Diversion intake. Corbicula was found as far upstream as Sandt's Eddy (river mile 189.2) and as far downstream as Delaware Generating Station (river mile 101.1).

The average shell length of the specimens collected in the Delaware River in 1988 was 12 mm. Very few clams with shell lengths greater than 20 mm were collected. The largest specimens were collected at Upper Black Eddy (river mile 167.6), the Yardley Boat Ramp (river mile 138.4), and the Tacony Palmyra Bridge (river mile 107.1). Very few of the specimens collected retained larvae in their gills. This may be associated with immaturity or the time of year when the samples were collected.

The Delaware River range extension of nearly 45 miles upstream of that observed in 1987 was unexpected. Small numbers were collected, most of them in the size range less than 14 mm, an indication that the population probably was established within the past two years. This discovery highlights how quickly the species can spread.

In the Schuylkill River, Corbicula did not extend its range of distribution upstream of Black Rock Pool (river mile 38.0), 2 miles and 10 miles downstream of Cromby Generating Station (CGS) and LGS, respectively (Table 4.0-2). Relative population density appeared to remain low in the pool, but could increase rapidly in the future. Stations downstream of Fairmount Dam yielded no live Corbicula.

In an effort to locate any Corbicula populations that may exist upstream of LGS, additional stations as far upstream as Auburn, Pennsylvania (river mile 109.2) were sampled in the Schuylkill River and its major tributaries, but no area infested with Corbicula was found upstream.

Shell lengths of specimens collected in the Schuylkill River were larger than those collected in the Delaware River; shell lengths greater than 20 mm were common. Most of these larger *Corbicula* retained larvae in their gills. The sample station located at the upstream tip of Barbadoes Island (river mile 25.2) appears to have the highest density of *Corbicula*.

Corbicula was not collected in the Perkiomen Creek (Table 4.0-3), nor was it observed in benthic macroinvertebrate samples collected in the East Branch Perkiomen Creek.

Table 4.0-1. Presence/absence of Corbicula in the Delaware River, 1982-1988.

Location (river mile)	Distance from Point Pleasant (miles)	1982	1983	1984	1985	1986	1987	1988
Martins Creek (194.2)	37.0							0
Sandts Eddy (189.2)	32.0							X
Easton (Front Street) (183.9)	26.7							0
Raubsville (177.1)	19.9							X
Fry Run (176.6)	19.4							X
Narrowsville (169.5)	12.3							0
Upper Black Eddy (167.6)	10.4							X
Upper Black Eddy/ Tinicum Park (166.0)	8.8							0
Kingsman Access, NJ (162.9)	5.7							X
Tinicum Park (162.9)	5.7							X
Point Pleasant canoe livery (157.2)	0.0	0	0	0	0	0	0	X

Key to Tables 4.0-1 to 4.0-3

X - Corbicula present
0 - Corbicula not found
Blank - no sample taken

Table 4.0-1 (continued)

Location (river mile)	Distance from Point Pleasant (miles)	1982	1983	1984	1985	1986	1987	1988
Bulls Island Access Area (156.8)	0.4							X
Canal Park Footbridge, Lumberville, NJ (155.4)	1.8	0	0	0	0	0	0	0
PA Rt. 263 Bridge, Center Bridge, PA (151.9)	5.3	0	0	0	0	0	0	0
PA Rt. 179 Bridge, New Hope, PA (148.7)	8.5	0	0	0	0	0	0	X
Washington Crossing State Park (146.0)	11.2		0	0	X	X	X	0
100 yds. above PA Rt. 532 Bridge (142.0)	15.2	0	0	X	X	X	X	0
Boat ramp, Yardley, PA (138.4)	18.8	0	X	X	X	X	X	X
Water treatment plant, Morrisville, NJ (134.0)	23.2	X			X	X	X	X
South tip Newbold Island (124.9)	32.3	X		X	X	X	X	X
Burlington Generating Station (117.0)	40.2	X	X		X	X	X	X
Rancocas Creek Mouth (111.0)	46.1	X	X		X	X	X	X

Table 4.0-1 (continued)

Location (river mile)	Distance from Point Pleasant (miles)	1982	1983	1984	1985	1986	1987	1988
Tacony Palmyra Bridge (107.1)	50.1	0	X		0	X	X	X
Betsy Ross Bridge (104.8)	52.4	0	X	X	0	0	X	0
Richmond Generating Station (104.4)	52.8	0	0	0		0	0	0
Northern tip Petty Island (103.2)	54.0	0	0	X	0	0	0	0
Delaware Generating Station (101.1)	56.1		0	0	0	0	0	X
Benjamin Franklin Bridge (100.2)	57.0	0		X	0	X	0	0
Southwark Generating Station (97.5)	59.7		0	0	0	0	0	0
Buoy 46A (95.0)	62.2	0			X	0	0	0
Schuylkill River mouth (92.5)	64.7	0	X	X	0	0	0	0
Paulsboro, NJ (90.0)	67.2	0				0	0	0
North tip Tinicum Island (87.5)	69.7	0		X	X	0	0	0

Table 4.0-1 (continued)

Location (river mile)	Distance from Point Pleasant (miles)	1982	1983	1984	1985	1986	1987	1988
North tip Mond's Island (85.6)	71.6	0				0	0	0
Eddystone Generating Station (84.3)	72.9		X	X		0	0	0
Above Commodore Barry Bridge (81.8)	75.4		X	X		0	0	0

Table 4.0-2. Presence/absence of <u>Corbicula</u> in the Schuylkill River, 1982-1988.

Location (river mile)	Distance from LGS (miles)	1982	1983	1984	1985	1986	1987	1988
Rt. 895 Bridge Auburn, PA (109.2)	61.2							0
Mouth of Bear Creek (108.0)	60.0							0
Little Schuylkill River mouth (102.1)	54.1							0
Kernsville Dam/ Rt. 22 Overpass (98.6)	50.6							0
Five Points Road (95.7)	47.7							0
Bridge to Centerport (92.6)	44.6							0
Leesport Canoe Launch (86.7)	38.7							0
Abandoned Bridge (85.9)	37.9							0
Epler Access (Felix Dam) (81.8)	33.8							0
Downstream of Penn St. Bridge, Reading, PA (75.5)	27.5							0
Reading Water Treatment Plant (72.8)	24.8							0
Titus Station (71.0)	23.0							0

Table 4.0-2 (continued)

Location (river mile)	Distance from LGS (miles)	1982	1983	1984	1985	1986	1987	1988
Reading Bone Fertilizer (70.5)	22.5							0
Old River Road (68.5)	20.5							0
Bridge at Gibraltar (67.3)	19.3							0
Rt. 82 Bridge, (63.4)	15.4							0
Monocacy Bridge (61.0)	13.0							0
Rt. 100 Bridge (56.6)	8.6							0
Hanover Street Bridge, Pottstown, PA (53.5)	5.5							0
Limerick Generating Station (48.0)	0.0	0	0	0	0	0	0	0
Vincent Dam (44.7)	3.3	0		0	0	0	0	0
Main Street, Spring City, PA (42.1)	5.9	0		0	0	0	0	0
0.25 mi. above Cromby Generating Station (CGS) (40.3)	7.7		0	0	0	0	0	0

Table 4.0-2 (continued)

Location (river mile)	Distance from LGS (miles)	1982	1983	1984	1985	1986	1987	1988
Adjacent to CGS (40.0)	8.0		0	0	0	0	0	0
0.25 mi. below CGS (39.8)	8.2		0	0	0	0	0	0
Water treatment plant Phoenixville, PA (38.2)	9.8		0	0	0	0	0	0
PA Rt. 113 Bridge, Phoenixville, PA (38.0)	10.0	0	0	0	0	0	X	X
Black Rock Dam (36.6)	11.4		0	0	X	X	X	X
PA Rt. 29 Bridge, Phoenixville, PA (35.6)	12.4	0			X	X	X	X
Pawlings Road Bridge, Phoenixville, PA (31.0)	17.0	0		0	0	X		X
0.5 mi. above Betzwood Bridge (28.8)	19.2			X	X	X	X	X
North tip Barbadoes Island (25.2)	22.8		X	X	X	X	X	X
U.S. Rt. 202 Bridge, Norristown, PA (24.3)	23.7		X	X	X	X	X	X
Norristown Dam (24.0)	24.0	X	X	X	X	X	X	X

Table 4.0-2 (continued)

Location (river mile)	Distance from LGS (miles)	1982	1983	1984	1985	1986	1987	1988
I-276 Bridge, Swedesburg, PA (22.5)	25.5	X			X	X	X	X
Plymouth Dam (20.7)	28.0	X			X	X	X	X
Near Montgomery/Philadelphia County line (17.0)	31.0	X			X	X	X	X
West of Green Lane Bridge (14.0)	34.0	X			X	X	X	X
Pencoyd Bridge (12.6)	35.4	X			X	0	X	
Strawberry Mansion Bridge (11.0)	37.0	X			X	X	X	X
Fairmount Dam (8.5)	39.5	X	X		X	0	0	0
Schuylkill Generating Station (SGS) (6.5)	41.5	0	X	X	0	0	0	0
Schuylkill River mouth (0.0)	48.0	0	X	X	0	0	0	0

Table 4.0-3. Presence/absence of <u>Corbicula</u> in the Perkiomen Creek, 1983-1988.

Location (river mile)	1983	1984	1985	1986	1987	1988
Schwenksville Road (12.0)	0	0	0	0	0	0
PA Rt. 73 (11.3)	0	0	0	0	0	0
Ott's Road (10.5)	0	0	0	0	0	0
Graterford Road (9.3)	0	0	0	0	0	0
PA Rt. 113 (7.3)	0	0	0	0	0	0
Collegeville Dam (6.5)	0	0	0	0	0	0
Yerkes Road (4.5)	0	0	0	0	0	0
Indian Road Dam (2.3)	0	0	0	0	0	0
Egypt Road (1.5)	0	0	0	0	0	0
Below Wetherill's Dam (0.8)	0	0	0	0	0	0

5.0 Cooling Tower Bird Mortality

INTRODUCTION AND METHODS

Tall man-made structures such as the LGS cooling towers are potentially lethal obstructions to migrating birds. This was identified early in the environmental impact review process for LGS (US AEC 1973).

Observations of bird mortality at the LGS cooling towers, initiated in the fall of 1981 (RMC Environmental Services 1984), have been continued annually during the spring and fall migration periods. Regular visits at 0700-0900 hours were made to both cooling towers on weekdays from April through June and from August through October 1987 and August through October 1988. In recent years, substantially lower numbers of birds were collected during the spring migrations, and in 1988 the spring monitoring period was discontinued and only the fall migration was monitored.

The procedure consisted of examining the concrete decking adjacent to the vertical tower surface where the bird specimens collect after impact. The collected specimens were examined for probable cause of death and locations with respect to the towers were recorded. Other bird activity, evidence of scavenging by crows, and weather conditions were noted. All specimens were identified and then transferred to the Academy of Natural Sciences of Philadelphia.

RESULTS AND DISCUSSION

A total of 27 birds representing 7 species was found during the 1987 spring and fall monitoring periods; in 1988, 15 species comprising 40 specimens were collected (Table 5.0-1). No waterfowl nor any endangered or threatened species were collected in either year. Vireos accounted for the majority of bird specimens collected during both years.

In 1987, the scavenging activity by common crows that had been observed previously (RMC Environmental Services 1985) increased with the increase of construction activity around the cooling towers. Food scraps discarded from workmen's lunches apparently attracted the crows, which then opportunistically fed on any bird carcasses that they encountered.

In 1988, scavenging activity occurred with less frequency, which corresponded with a decrease in construction activity. Consequently, fewer specimens were disturbed by crows, which we assume led to an increase in the number collected.

The overall number of bird mortalities for both years (27 in 1987; 40 in 1988) is an unknown, but undoubtedly miniscule fraction of the number of birds migrating through the LGS vicinity.

Table 5.0-1. Birds collected at LGS Cooling Towers in 1987 and 1988.

1987 Common Name[1]	May 4	August 25	August 27	September 2	September 3	September 22	September 23	October 5	October 13	October 19	Total
Golden-crowned kinglet								1			1
Solitary vireo	2			1							3
Red-eyed vireo		2	1	4		2		5		1	15
Black-throated green warbler								1	1		2
Black and white warbler				1							1
Common yellowthroat					1		1	1			3
Canada warbler								1			1
Unidentified[2]				1							1
Total	2	2	1	7	1	2	1	9	1	1	27

1988 Common Name[1]	August 29	September 6	September 12	September 14	September 16	September 22	September 29	October 12	October 13	October 17	October 19	Total
White-eyed vireo							1					1
Solitary vireo								1		1	1	3
Yellow-throated vireo						1						1
Philadelphia vireo			2		1							3
Red-eyed vireo		1	8			9			1			19
Tennessee warbler		1										1
Northern parula				1								1
Chestnut-sided warbler		1										1
Black-throated blue warbler		1										1
Blact-throated green warbler		1										1
Black burnian warbler		1										1
Bay-breasted warbler		1	1	1								3
American redstart	1											1
Ovenbird		2										2
Common yellowthroat								1				1
Total	1	9	11	2	1	10	1	2	1	1	1	40

[1]Common names are from the American Ornithologist Union Checklist of North American Birds, Sixth Edition, 1983.
[2]Disposed of 4 January 1988.

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E2-13: <u>Enclosure 2: Aquatic Ecology, item K</u>

Describe any aquatic surveys conducted at the Bradshaw Reservoir, the Wadesville Mine Pool and discharge channel, Bedminster Water Processing Facility, and the Still Creek Reservoir. For example, submit for docketing the response to information need (AQ-2 from the Audit Information Needs).

<u>Exelon Response</u>

The Bradshaw Reservoir is an upland man-made structure, owned and operated by Exelon Generation. It is classified by the PADEP as an industrial wastewater treatment facility. As such, water quality standards do not apply within the Bradshaw Reservoir, and the NPDES Permit #PA 0052221 requires no aquatic surveys within the reservoir. Water quality limitations established in the NPDES permit apply at the outfall to the East Branch Perkiomen Creek. The Delaware River Basin Commission (DRBC) Docket No. D-79-52 CP, which approved reservoir construction and operation, also requires no aquatic surveys within the reservoir.

The Wadesville Mine, owned by Reading Anthracite Company, includes an underground reservoir or pool of water stored in a network of shafts associated with historic coal mining activities. Other than water quality testing of the mine pool discharge, as required by NPDES permits and DRBC project approval, no aquatic surveys are required for the mine pool or discharge channel. Aquatic surveys were conducted downstream (Norwegian Creek, Schuylkill River) in accordance with DRBC monitoring requirements associated with the Schuylkill River Augmentation Demonstration Project started in 2003.

The Bedminster Water Processing Facility consists of a package system that produces ozone and conveys it into a series of below ground mixing chambers to provide sufficient contact time with the water flowing through the transmission main. The water essentially flows through the facility with no aquatic component that could be surveyed.

The Still Creek Reservoir, owned and operated by the Tamaqua Borough Authority (now Tamaqua Area Water Authority) was in operation for public water supply prior to the construction of LGS. The reservoir had already been releasing water into Still Creek, which joins into the Little Schuylkill River. No aquatic surveys associated with Still Creek Reservoir releases to Still Creek were required relating to the Exelon Generation contract with TAWA for water storage and release. Aquatic surveys were conducted downstream (Little Schuylkill River) in accordance with DRBC monitoring requirements associated with the Schuylkill River Augmentation Demonstration Project started in 2003.

E2-14: Enclosure 2: Aquatic Ecology, item L

Describe the frequency that water is withdrawn from the Schuylkill River compared to other sources. For example, submit for docketing the response to information need (AQ-3 from the Audit Information Needs).

Exelon Response

Before 2003 (when a DRBC-sponsored demonstration project was undertaken at the request of Exelon Generation), the frequency of withdrawal from the approved sources was approximately 50% of consumptive use and 100% of non-consumptive use from the Schuylkill River, 4% of consumptive use from Perkiomen Creek natural flow, and 46% of consumptive use from Perkiomen Creek supplemented by water diverted from the Delaware River.

Since implementation of the Wadesville Mine Pool demonstration project in 2003, the frequency of withdrawal has shifted more toward the Schuylkill River, a trend that is expected to continue into the future, predicated on DRBC approval of LGS's docket revision. The percent of the time that consumptive use water will be withdrawn from the Schuylkill River in the future has not been quantified, but is expected to be greater compared to the pre-demonstration project years.

E2-15: Enclosure 2: Aquatic Ecology, item M

Describe the intake velocity, traveling screens, and any other operational procedures or structural designs that limit impingement and entrainment at the Point Pleasant Pumping Station on the Delaware River or at the pumping stations on the Bradshaw Reservoir, Still Creek Reservoir, or Wadesville Mine Pool. For example, submit for docketing the response to information need (AQ-5 from the Audit Information Needs).

Exelon Response

The Point Pleasant Pumping Station intake (owned and operated by Forest Park Water Authority) consists of two rows of fixed cylindrical wedge-wire screens placed in deep water near mid-channel in the Delaware River. Each row contains 12 screens with each screen sized at 40-inches diameter and 80-inches of total screened length. The size of the screen openings is 2 millimeters. As stated in Section 5.3.3.2 of the LGS Final Environmental Statement of 1984 (NRC, 1984), the average intake velocity at the maximum pumping rate of 95 mgd is 0.35 feet per second.

The Bradshaw Reservoir Pumping Station withdraws water from the reservoir using no designs that limit impingement and entrainment. As part of an industrial wastewater treatment facility, the Bradshaw Reservoir serves a water transfer function not intended to support aquatic biota.

The Wadesville Mine Pool is located inside the Wadesville Mine several hundred feet below grade elevation. Pumps installed in a vertical mine shaft facilitate removal of water from the mine via the pool, and there are no design features that limit impingement and entrainment. Conditions in an underground mine pool such as at Wadesville are not conducive for aquatic life.

Water in the Still Creek Reservoir (owned and operated by the Tamaqua Borough Authority - now Tamaqua Area Water Authority) is released by hydrostatic head through two pipelines that penetrate the dam; the water flows through an energy dissipater and into Still Creek. There is no pumping station at this facility and no design features that limit impingement or entrainment.

It should be noted that, as stated in section 2.1.2 in the LGS License Renewal Environmental Report, the Wadesville Mine Pool, Pumphouse, and discharge channel, as well as the Still Creek Reservoir and the Point Pleasant Pumping Station and combined transmission main to the Bradshaw Reservoir, are facilities and components of the LGS makeup water supply system not owned or controlled by Exelon Generation. Exelon Generation has contractual arrangements with the respective owners of these facilities for services to supply water on behalf of LGS. None of these facilities is subject to requirements applicable to cooling water intake structures for Phase II existing facilities under Section 316(b) of the Clean Water Act. The Bradshaw Reservoir is classified by the PADEP as an industrial wastewater treatment facility (NPDES Permit PA 0052221). Hence, its pumphouse intake structure also is not subject to requirements applicable to cooling water intake structures for Phase II existing facilities under Section 316(b) of the Clean Water Act.

E2-16: Enclosure 2: Aquatic Ecology, item N

Describe any impingement or entrainment studies conducted at the Schuylkill or Perkiomen Pumphouse or at the intakes on the Delaware River or the East Branch Perkiomen Creek. For example, submit for docketing the response to information need (AQ-6 from the Audit Information Needs).

Exelon Response

Schuylkill or Pumphouse or Perkiomen Pumphouse

Impingement sampling at the Schuylkill Pumphouse was conducted starting in 1985, soon after LGS came on line, until 1988, as described in Section 3.3 of Non-Radiological Environmental Monitoring for Limerick Generating Station for 1988 (RMC, 1989).

No impingement study was performed at the Perkiomen Pumphouse due to the intake design. The Perkiomen intake structure consists of a series of 15 fixed cylindrical slotted (wedge-wire) screens submerged at mid-stream. Each screen is sized at 24-inches diameter and 72-inches in length. The size of the screen openings is 2 millimeters. The maximum through-slot velocity is less than 0.5 feet per second. This low intake velocity combined with sufficient bypass current velocity enables fish to avoid becoming impinged on the screens.

What would be entrained at both pumphouses was inferred from in-stream biological sampling of the eggs and larvae of fish. No entrainment sampling was done to determine what was being withdrawn from the streams into the intakes.

Point Pleasant Pumping Station (Delaware River)

The Point Pleasant Pumping Station intake structure consists of two rows of fixed cylindrical wedge-wire screens placed in deep water near mid-channel in the Delaware River. Each row contains 12 screens with each screen sized at 40-inches diameter and 80-inches of total screened length. The size of the screen openings is 2 millimeters.

During the first year of post-diversion operation (1989), the presence of a relatively healthy, diverse aquatic community that was typical of large warm water rivers in the mid-Atlantic region was documented (RMC, 1990). In addition, it was determined that the amount of river flow withdrawn had resulted in negligible changes to physical habitat and flow regimes in the Delaware River. Hence, based on these conclusions and the fact that the design of the Point Pleasant Pumping Station intake structure represented state-of-the-art technology for minimizing impingement, it was determined that the likelihood of detecting effects of water withdrawal and slight river flow changes were small, and no subsequent fish sampling in the Delaware River was required. (Normandeau, 1995) [Normandeau Associates RMC Environmental Services Division, 1995. *NPDES Permit PA-0052221, Aquatic Biology Assessment IV, Response to Special Condition K, Part C, Biennial Report 1993-1994 Monitoring Period.* July.]

In 1990, an entrainment study by Environmental Research and Consulting, Inc. (ERC 1991. *Post-Operational Ichthyoplankton Studies for the Point Pleasant Pumping Station.* Report prepared for County of Bucks, Pennsylvania.) documented the effectiveness of intake screens for minimizing entrainment of fish eggs and larvae. RMC (1991).

[*NPDES Permit PA-0052221 Aquatic Biology Assessment II, Response to Special Condition K, Part C, Report for the Second Year of Project Operation (1990*). November 1991.] used the results of the entrainment study to estimate total ichthyoplankton entrainment during 1990, the first complete year of operation of the Delaware River diversion project during which maximum pumping rates were sustained. These estimates agreed with the anticipated effects of water withdrawal on the Delaware River ecosystem based on pre-diversion ichthyoplankton monitoring. Increased mortality of fishes due to entrainment was not significant from a population dynamics view point for any species entrained. Furthermore, the low volume of flow withdrawn and the ability to provide make-up water by releases from the Merrill Creek Reservoir upstream were determined to minimize potential effects from flow regime alteration, particularly changes in water quality and habitat characteristics. Based on such conclusions, no Delaware River ichthyoplankton monitoring was conducted after 1990. [RMC Environmental Services, Ind., 1994. *NPDES Permit PA-0052221 Aquatic Biology Assessment III, 1991-1992,* Section 6.0, "Delaware River Ichthyoplankton, Fish, and Benthic Macroinvertebrate Studies" at page 6-1. March.]

East Branch Perkiomen Creek

No impingement or entrainment studies were conducted at the East Branch Perkiomen Creek because there is no intake structure located along this stream.

E2-17: Enclosure 2: Aquatic Ecology, item O

Describe the extent of a thermal plume as a result of discharges to the Schuylkill River. For example, submit for docketing the response to information need (AQ-7 from the Audit Information Needs).

Exelon Response

The response to information need AQ-7 was as follows:
Studies examining the thermal plume from LGS discharges to the Schuylkill River are identified in the LGS Environmental Report – Operating License Stage of 1984 and NRC's Final Environmental Statement of 1984.

Exelon Generation is currently conducting an updated thermal modeling analysis of the discharge from LGS to the Schuylkill River. The study relies on the Cornell Mixing Zone Expert System (CORMIX) 2 model and will produce an updated analysis for relevant scenarios to demonstrate compliance with applicable Delaware River Basin Commission (DRBC) water quality regulations. The results will support ongoing development of a revised, consolidated DRBC docket for LGS.

Updated information is provided as follows:
The cooling tower blowdown water from each unit's cooling tower is combined and discharged into the Schuylkill River through a submerged multi-port diffuser pipe, which is designed to rapidly diffuse the heat and limit the mixing zone size. Characteristics of the diffused discharge include:

- The141-foot long header is on the east channel which distributes the discharge across the entire east channel.
- There are 283 nozzles, each 1.25-inch diameter, installed 6 inches apart for rapid mixing and a rapid decline in plume centerline temperature within 50 feet.
- The nozzles are tilted approximately 20° up from the horizontal and installed 3 inches above the riverbed to provide a positively buoyant discharge near the bottom of the channel, thus utilizing the entire water column.
- The header is slightly tilted towards the east bank (instead of the main channel), thus the thermal plume mixes with the west channel after the initial 50-foot mixing length, providing a zone of passage on the west side

The NRC Final Environmental Statement (FES) for the operation of LGS states that the predicted downstream temperature rise is normally less than 2.8 °C (5 °F). Consistent with the FES statement, the Pennsylvania Department of Environmental Protection (PADEP) requires in the current LGS NPDES permit that, with respect to the thermal impact of the discharge, the effluent shall not cause more than a 5°F rise above the Schuylkill River ambient temperature until stream temperature reaches 87°F; the permit also requires no temperature rise when the ambient temperature is 87°F or above and the ambient temperature not to be changed by more than 2°F during any one-hour period.

The updated thermal modeling analysis continues in progress, with its scope developing in consultation with PADEP and DRBC.

E2-18: Enclosure 2: Aquatic Ecology, item P

In the ER, LGS stated that three species of concern were identified in the Pennsylvania Natural Diversity Index (PNDI) search for LGS license renewal. However, it was unclear which three species LGS identified and where the species would occur on the LGS site and at the Bradshaw Reservoir. Please state these species (AQ-8 from the Audit Information Needs).

Exelon Response

The PNDI search for the main LGS plant site identified three organisms:

1. The Tooth-cup *(Rotala ramosior)*, a state rare plant under jurisdiction of the Pennsylvania Department of Conservation and Natural Resources (DCNR);
2. A state threatened "sensitive species" under jurisdiction of the Pennsylvania Fish and Boat Commission (PFBC); and
3. Pizzini's cave amphipod (*Stygobromus pizzinii*), a state special concern species under jurisdiction of the PFBC.

The PNDI search for the Bradshaw Reservoir and Pumphouse also identified a state threatened "sensitive species" under jurisdiction of the PFBC.

Requests for further information regarding the results of the PNDI search were made by letters to the DCNR and PFBC dated January 19, 2011 (copies provided in LGS LR-ER Appendix C).

DCNR responded in a letter dated March 9, 2011 (copy provided in LGS LR-ER Appendix C), identifying the Tooth-cup for the four transmission routes (Limerick to Cromby 230kV Transmission Line Route, Cromby to North Wales 230kV Transmission Line Route, Cromby to Plymouth Meeting 230kV Transmission Line Route, and Limerick to Whitpain Meeting 500kV Transmission Line Route).

PFBC responded in a letter dated February 11, 2011 (copy provided in LGS LR-ER Appendix C), identifying the eastern redbelly turtle (*Pseudemys rubriventris*, PA threatened) and a "globally rare amphipod and/or isopod species".

For species under jurisdiction of the PFBC, it is assumed that the state threatened species identified in the PNDI search is the eastern redbelly turtle and that the globally rare amphipod and/or isopod species identified in the letter is Pizzini's cave amphipod.

Therefore, the three species identified by the PNDI search are the 1) Tooth-cup, 2) eastern redbelly turtle (for both the LGS plant site and the Bradshaw facility), and 3) Pizzini's cave amphipod.

E2-19: Enclosure 2: Aquatic Ecology, item Q

In addition, discuss the potential location of the three PNDI species of concern on the LGS site and at the Bradshaw Reservoir and Pumphouse, as discussed on Page 2-44 of the ER (AQ-8 from the Audit Information Needs).

Exelon Response

The PNDI search and subsequent agency consultation for the main Limerick plant identified three species:

1) The Tooth-cup *(Rotala ramosior)* under jurisdiction of Department of Conservation and Natural Resources (DCNR);
2) Eastern redbelly turtle (*Pseudemys rubriventris)* under jurisdiction of Pennsylvania Fish and Boat Commission (PFBC); and,
3) Pizzini's cave amphipod (*Stygobromus pizzinii*) under jurisdiction of PFBC.

The PNDI search and subsequent agency consultation for the Bradshaw Reservoir and Pumphouse also identified eastern redbelly turtle (PFBC).

DCNR responded to a request for further information in a letter dated March 9, 2011, identifying the Tooth-cup and stating that it is known "in a wet wooded stretch along the west side of the Schuylkill River" along the Limerick to Cromby 230 kV Transmission Line Route and "on an exposed mud flat and sandy-cobbly shores of seasonally flooded shallows basins" along the Cromby to Plymouth Meeting 230 kV Transmission Line Route.

PFBC also responded to a request for further information in a letter dated February 11, 2011. This agency identified eastern redbelly turtle and a globally rare amphipod and/or isopod species (i.e., Pizzini's cave amphipod) as "known from the vicinity of the project sites." While the agency provided general habitat descriptions for these taxa, it did not identify specific locations where they were historically found. As discussed in the following reports, no state- or federally-listed threatened or endangered terrestrial species were observed at or in the vicinity of the LGS plant site:

- The Annual Non-Radiological Environmental Operating Reports submitted to the NRC through 2005 in accordance with the LGS Environmental Protection Plan (PECO, 1999; PECO, 2000; Exelon Generation, 2001; Exelon Generation, 2002; Exelon Generation, 2003; Exelon Generation, 2004; Exelon Generation, 2005);
- LGS Non-Radiological Environmental Monitoring Reports, 1979-1988, reporting on cooling tower bird mortality (RMC, 1984; RMC, 1985; RMC, 1986; RMC, 1987); and
- Wildlife Habitat Council's Site Assessment and Wildlife Management Opportunities for Exelon Corporation's Limerick Generating Station (WHC, 2006).

No surveys targeting eastern redbelly turtle were performed for the Bradshaw Reservoir.

Stygonectes pizzinii, a synonym for *Stygobromus pizzinii*, or Pizzini's cave amphipod, was collected from the Schuylkill River between 1970 and 1976 (PECO, 1984). Unidentified *Stygonectes* sp. were collected in the Perkiomen Creek and East Branch Perkiomen Creek during the same time period (PECO, 1984). Unidentified *Stygobromus* sp. were collected in 1983 from the East Branch Perkiomen Creek (RMC, 1984) and from the Schuylkill River in 1985 and 1986 (RMC, 1986; RMC, 1987). Because individuals were not identified to species, it is uncertain whether any specimen collected in 1983, 1985 or 1987 was a Pizzini's cave amphipod. Other studies performed in the mid- to late-1980s and throughout the 2000s in the

East Branch Perkiomen Creek failed to identify this amphipod genus or species (RMC, 1985; RMC, 1987; NAI, 2005, 2007, 2008a, 2008b, 2009, 2010a, 2010b). Field surveys of the benthic community in the Schuylkill River (1983, 1984, 1988, 2009) also did not find any individuals of Pizzini's cave amphipod (RMC, 1984; RMC, 1985; RMC, 1989; NAI, 2010c).

In summary, even though state records indicate that certain species listed as threatened or endangered are known to be present in the area of interest, Exelon Generation has not encountered any of these threatened or endangered species during surveys that have been conducted at or near the LGS plant site.

<u>List of reports reviewed for state- or federally-listed threatened or endangered terrestrial species:</u>

Exelon Generation. 2001. Letter to U.S. Nuclear Regulatory Commission. 2000 Annual Environmental Operating Report (Non-Radiological). April.

Exelon Generation. 2002. Letter to U.S. Nuclear Regulatory Commission. 2001 Annual Environmental Operating Report (Non-Radiological). April.

Exelon Generation. 2003. Letter to U.S. Nuclear Regulatory Commission. 2002 Annual Environmental Operating Report (Non-Radiological). April.

Exelon Generation. 2004. Letter to U.S. Nuclear Regulatory Commission. 2003 Annual Environmental Operating Report (Non-Radiological). April.

Exelon Generation. 2005. Letter to U.S. Nuclear Regulatory Commission. 2004 Annual Environmental Operating Report (Non-Radiological). April.

NAI (Normandeau Associates, Inc.). 2005. East Branch Perkiomen Creek Aquatic Biology Assessment VIII, 2001-2003 Monitoring Period. Prepared for Exelon Nuclear, Limerick Generating Station. August.

NAI (Normandeau Associates, Inc.). 2007. East Branch Perkiomen Creek Aquatic Biology Assessment IX, 2004 Monitoring Period. Prepared for Exelon Nuclear, Limerick Generating Station. July.

NAI (Normandeau Associates, Inc.). 2008a. East Branch Perkiomen Creek Aquatic Biology Assessment X, 2005 Monitoring Period. Prepared for Exelon Nuclear, Limerick Generating Station. March.

NAI (Normandeau Associates, Inc.). 2008b. East Branch Perkiomen Creek Aquatic Biology Assessment XI, 2006 Monitoring Period. Prepared for Exelon Nuclear, Limerick Generating Station. September.

NAI (Normandeau Associates, Inc.). 2009. East Branch Perkiomen Creek Aquatic Biology Assessment XII, 2007 Monitoring Period. Prepared for Exelon Nuclear, Limerick Generating Station. March.

NAI (Normandeau Associates, Inc.). 2010a. East Branch Perkiomen Creek Aquatic Biology Assessment XIII, 2008 Monitoring Period. Prepared for Exelon Nuclear, Limerick Generating Station. May.

NAI (Normandeau Associates, Inc.). 2010b. East Branch Perkiomen Creek Aquatic Biology Assessment XIV, 2009 Monitoring Period. Prepared for Exelon Nuclear, Limerick Generating Station. July.

NAI (Normandeau Associates, Inc.). 2010c. Fish and Benthic Macroinvertebrate Community Composition in the Schuylkill River in the Vicinity of Limerick Generating Station During 2009. February.

PECO (Philadelphia Electric Company). 1984. Environmental Report – Operating License Stage. Limerick Generating Station Units 1&2. 5 vols.

PECO (PECO Nuclear). 1999. Letter to U.S. Nuclear Regulatory Commission. 1998 Annual Environmental Operating Report (Non-Radiological). April.

PECO (PECO Nuclear). 2000. Letter to U.S. Nuclear Regulatory Commission. 1999 Annual Environmental Operating Report (Non-Radiological). April.

RMC (RMC Environmental Services). 1984. Progress Report, Non-Radiological Environmental Monitoring for Limerick Generating Station 1979-1983. Prepared for Philadelphia Electric Company. October.

RMC (RMC Environmental Services). 1985. Progress Report, Non-Radiological Environmental Monitoring for Limerick Generating Station 1984. Prepared for Philadelphia Electric Company. December.

RMC (RMC Environmental Services). 1986. Progress Report, Non-Radiological Environmental Monitoring for Limerick Generating Station 1985. Prepared for Philadelphia Electric Company. September.

RMC (RMC Environmental Services). 1987. Progress Report, Non-Radiological Environmental Monitoring for Limerick Generating Station 1986. Prepared for Philadelphia Electric Company. November.

WHC (Wildlife Habitat Council). 2006. Site Assessment and Wildlife Management Opportunities prepared for Exelon Corporation's Limerick Generating Station. 100 pp. Illustrated. August.

E2-20: Enclosure 2: Hydrology, item A

Submit the last 5-years of monthly records for site groundwater production at all four site supply wells with outage periods identified.

Exelon Response

Monthly water withdrawal information for Well 1 and Well 3 (Alley Well and Batch Plant Well, respectively) is contained in the annual water withdrawal reports submitted to the Pennsylvania Department of Environmental Protection (PADEP). Annual water withdrawal reports for 2006 through 2010 are being provided.

As the LGS License Renewal Environmental Report explains, two additional active groundwater wells are located on the LGS plant site, but away from the main plant structures, and their usage is intermittent and limited to domestic purposes. Withdrawal information for these two minor wells is not recorded.

Doc Number: Act 220
Sheet:
Date: 08/31/2007
Mjr Rev:
Mnr Rev:

Dept Trans: D90956
Facility: LIM
SRRS ID: 2H.103
Doc Type: PERM
Sub Type: NPDS
Addl Type:

DocTitle:
2006 Annual Water Withdrawl Report

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Exelon. Nuclear

Exelon Nuclear
Limerick Generating Station
P.O. Box 2300
Pottstown, PA 19464

www.exeloncorp.com

Act 220

August 31, 2007

Commonwealth of Pennsylvania
Department of Environmental Protection
Division of Water Use Planning
PO Box 8555
Harrisburg, PA 17105-8555

Limerick Generating Station (LGS)

Subject: 2006 Annual Water Withdrawal Reports

Dear Sir:

In accordance with Act 220 and DRBC Docket No. D-69-210 CP, enclosed is the 2006 Annual Water Withdrawal Report for Limerick Generating Station. The report documents the following withdrawal locations: Schuylkill River/Delaware River Withdrawal and Well 1 Alley Well. LGS maintains an active well, Well 3 Batch Plant, which is used exclusively for the fire service water system and is, therefore, exempt.

If you have any questions or require additional information, please contact Bob Alejnikov at 610-718-2513.

Sincerely,

Thomas Basso
Manager Chemistry/Radwaste, LGS
Exelon Generation Company, LLC

Enclosures: Schuylkill River/Delaware River Withdrawal Report
Well 1 Alley Well Report

cc: DRBC

ENCLOSURE 1

Schuylkill River/Delaware River Withdrawal Report

0670401468

WUDS SFID

2057

4. Measuring/Metering Device:

Device Brand: ROSEMOUNT

Device Model No.: 115 10 P5E ZZPB

Max. Capacity Rating (GPM): 75000

Size (inches): 30.0

Device Accuracy: ● Excellent (<5 % Error) ○ Good (<10 % Error) ○ Fair (<25 % Error) ○ Poor (>25 % Error)

Last Date Tested (MM/DD/YYYY): 04/09/2002

Tested By: EXELON

Note: If meter has been tested during this report year, a copy of the test report should be attached to this report.

5. ADDRESS CORRECTION - Please provide complete address

Company Name

Number & Street Address (Primary)

Number & Street Address (Secondary if required)

City

State

Zip Code -

Did you verify the accuracy of this address change at the United States Postal Service web site http://www.usps.gov/ncsc/lookups/lookup_zip+4.htm?

○ Yes ○ No ○ Not Available

6. Please provide contact information of an individual who can be contacted if questions arise concerning your report:

First Name: ROBERT I.: P Last Name: ALEJNIKOV

Title: ENVIRONMENTAL SPECIALIST

Phone Number: (610) 718-2513

Phone Extension:

Fax Number: (610) 718-2721

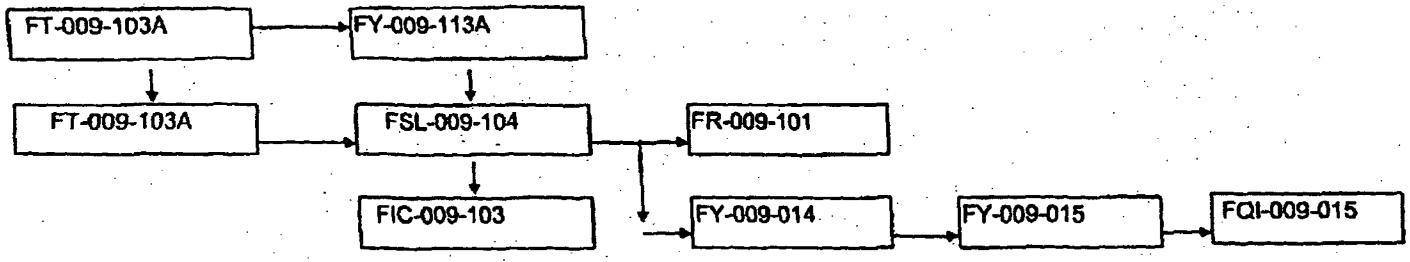
Email Address Please use CAPITAL leters - example All.CAPS@EMAIL.ADDRESS

ROBERT.ALEJNIKOV@EXELONCORP.COM

Signature

[signature]

LOOP NUMBER: FT-009-103A
LGS UNIT 1
DESCRIPTION: SCHUYLKILL MAKE-UP

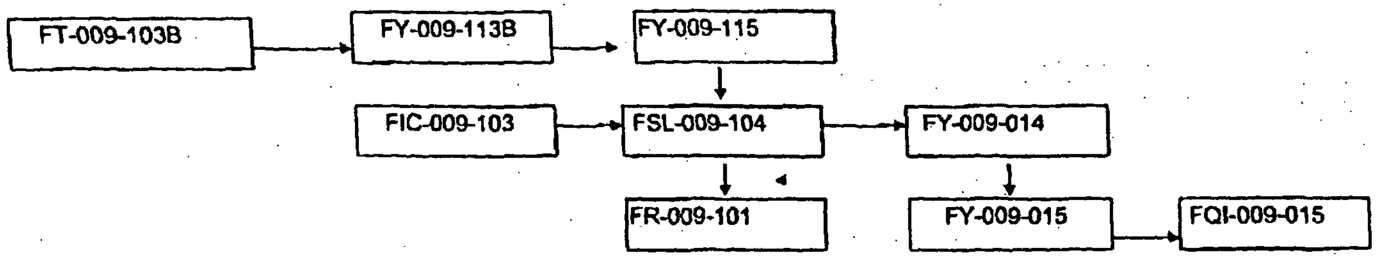


FT-009-103A	ACC. 0.5%	FT-009-103A	ACC. 0.5%	FY-009-113A	ACC. 0.5%	FSL-009-104	ACC. 0.5%
IDEAL IN	ACTUAL IN	IDEAL OUT	ACTUAL OUT	IDEAL OUT	ACTUAL OUT	IDEAL OUT	ACTUAL OUT
* "H2O	* "H2O	MADC	MADC	VDC	VDC	VDC	VDC
61.73	61.73	8.00	8.03	3.000		3.000	
123.46	123.46	12.00	12.01	3.828		3.828	
185.19	185.19	16.00	16.02	4.464		4.464	
246.91	246.91	20.00	20.02	5.000		5.000	

FIC-009-103	ACC. 2.0%	FY-009-014	ACC. 0.5%	FY-009-015	ACC. ---	FQI-009-019	ACC.1.0%
IDEAL OUT	ACTUAL OUT	IDEAL OUT	ACTUAL OUT	IDEAL OUT	ACTUAL OUT	IDEAL OUT	ACTUAL OUT
IND GPM	IND GPM	VDC	VDC	PULSES/MIN	PULSES/MIN	CPM	CPM
10,000	10,200	3.000		100.0		100	
14,140	14,300	3.828		141.4		141	
17,321	17,550	4.464		173.2		173	
20,000	20,000	5.000		200.0		200	

* FT-009-103B MUST BE AT MAX OUTPUT VALUE FOR FSL TO SWITCH FROM LOW RANGE TO THE HIGH RANGE XMTR; SWITCH POINT IS 7,000 GPM.

LOOP NUMBER: FT-009-103B
LGS UNIT 1
DESCRIPTION: SCHUYLKILL MAKE-UP



FT-009-103B	ACC. 0.5%	FT-009-103B	ACC. 0.5%	FY-009-113B	ACC. 0.5%	FY-009-115	ACC. 0.5%
IDEAL IN	ACTUAL IN	IDEAL OUT	ACTUAL OUT	IDEAL OUT	ACTUAL OUT	IDEAL OUT	ACTUAL OUT
"H2O	"H2O	MADC	MADC	VDC	VDC	VDC	VDC
0.00	0.00	4.00	4.08	1.000		1.000	
8.68	8.68	8.00	8.02	3.000		1.750	
17.36	17.36	12.00	12.02	3.828		2.061	
26.04	26.04	16.00	15.98	4.464		2.299	
*							

FSL-009-104	ACC. 0.5%	FR-009-101	ACC. 2.0%	FIC-009-103	ACC. 2.0%	FY-009-014	ACC.0.5%
IDEAL OUT	ACTUAL OUT	IDEAL OUT	ACTUAL OUT	IDEAL OUT	ACTUAL OUT	IDEAL OUT	ACTUAL OUT
VDC	VDC	GPM IND	GPM IND	GPM IND	GPM IND	VDC	VDC
1.000		0	0	0	0	1.000	
1.750		3750	3807	3750	3750	1.750	
2.061		5305	5346	5305	5300	2.061	
2.299		6495	6519	6495	6495	2.099	

* ONLY FOUR POINTS TO BE LOOP CHECKED. LOOP SHIFTS FROM LOW RANGE TO HIGH RANGE XMTR AT 7,000 GPM.

4784401468

3900-FM-WM0021 Rev. 3/2003

WUDS SFID 1 2 9 2 3

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

ANNUAL WATER WITHDRAWAL REPORT FOR THE PENNSYLVANIA PORTION OF THE DELAWARE RIVER BASIN

REPORT YEAR 2 0 0 6

PA Dept of Environmental Protection
Division of Water Use Planning
PO Box 8555
Harrisburg, PA 17105-8555
717-772-4048 FAX 717-787-9549

DEP USE ONLY OTHERID 775001-012
MUNIC 46932
SITEID 475813 WUDS_PFID 27589

NAME or ADDRESS CORRECTIONS **Please complete every line in Section 5 on reverse.**

1. Withdrawal Location: **Source Name:** Well 1 Alley Well

Source Type:

● Well ○ Spring ○ Quarry ○ Deep Mine ○ Infiltration Gallery ○ River Well ○ Pond ○ River/Stream Intake
○ Reservoir Intake ○ Natural Lake ○ Interconnection ○ Other (Please describe)

City, Boro, Twp: Limerick County: Montgomery

Complete as Appropriate:

DRBC Docket / Entitlement Number: 00000 DRBC Docket # Correction:

Groundwater Registration Number: 95 GW Reg # Correction:

PA Water Allocation Number: PA Water Allocation # Correction: W A -

2. Withdrawals

Month	Total Gallons	Days	Month	Total Gallons	Days
Jan	495,671	31	Jul	704,497	31
Feb	510,482	28	Aug	808,229	31
Mar	946,226	31	Sep	791,442	30
Apr	464,974	30	Oct	647,480	31
May	580,183	31	Nov	476,367	30
Jun	653,571	30	Dec	454,233	31

Total Gallons and Days for the Year 7,533,355 365

3. Source Status - Please provide the status of the source during the calenadar year.

○ Proposed - Not in Service
● Active - Used all year
○ Active - Used partial year
○ Reserve or Standby - Not used during the year
○ Abandoned - Not in Service
○ Abandoned - Well capped and sealed

For optimum accuracy, please print in capital letters and avoid contact with the edge of the box. The following will serve as an example.

A B C D E F G H I J K L M N O
P Q R S T U V W X Y Z
1 2 3 4 5 6 7 8 9 0

This form is also available online at
http://www.dep.state.pa.us/dep/deputate/watermgt/Wc/appforms.htm#Water_Allocation

SENSUS METERING SYSTEMS

9495 DELEGATES DRIVE • ORLANDO, FLORIDA 32837-8347

METER TEST RECORD

MODEL W-160, 2", Gal

SERIAL NUMBER 66875115

TESTED BY PB

DATE 7/25/2006

GPM	%
160.0	101.2
10.0	100.3
4.0	99.3

407 859-7830 DSI-ORLANDO

Doc Number: Act 220
Sheet:
Date: 08/01/2008
Mjr Rev:
Mnr Rev:

Dept Trans: D90956
Facility: LIM
SRRS ID: 2H.103
Doc Type: PERM
Sub Type: NPDS
Addl Type:

DocTitle:
2007 Annual Water Withdrawl Report

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Limerick Generating Station
3146 Sanatoga Road
Pottstown, PA 19464

www.exeloncorp.com

Exelon Nuclear

Act 220

August 1, 2008

Commonwealth of Pennsylvania
Department of Environmental Protection
Division of Water Use Planning
PO Box 8555
Harrisburg, PA 17105-8555

Limerick Generating Station (LGS)

Subject: 2007 Annual Water Withdrawal Reports

Dear Sir:

In accordance with Act 220 and DRBC Docket No. D-69-210 CP, enclosed is the 2007 Annual Water Withdrawal Report for Limerick Generating Station. The report documents the following withdrawal locations: Schuylkill River; Well 1 Alley Well; Bradshaw Reservoir; and Perkiomen Creek. LGS maintains an active well, Well 3 Batch Plant, which is used exclusively for the fire water system. This well is exempt, since withdrawal rates are less than 10,000 gallons per day during any thirty-day period.
If you have any questions or require additional information, please contact Bob Alejnikov at 610-718-2513.

Sincerely,

Christopher Cooney
Manager Chemistry/Radwaste, LGS
Exelon Generation Company, LLC

Enclosures: Schuylkill River Report
Well 1 Alley Well Report
Bradshaw Reservoir Report
Perkiomen Creek Report

cc: DRBC

Bcc: C. Mudrick – GML-5 w/o enclosures
C. Cooney-SSB 2-2 w/o enclosures
R. Alejnikov – SSB 2-2 w/enclosures
R. Kreider – SSB 2-4 w/enclosures
D. Helker – KSA-3N w/o enclosures
J. Toro – SSB 4-2 w/enclosures
T. Siglin – KSA-3N w/enclosures

9248040681

3920-FM-WM0290 Rev. 02/2008

Commonwealth of Pennsylvania
Department of Environmental Protection
Division of Water Use Planning
PO Box 8555
Harrisburg, PA 17105-8555

ACT 220 WATER WITHDRAWAL AND USE PRIMARY FACILITY REPORT (Non-Public Water Supply)

Please submit one Primary Facility Report per company, business, or operation.

1. WUDS Primary Facility ID	2. Report Year	3. Full-Time Employees (or equivalent)
27589	2007	704

4. Name of Company, Business, or Operation

EXELON GENERATION COMPANY

5. NAICS Code 221113

Please enter a North American Industry Classification System (NAICS) code for your primary facility, business or operation relative to your water withdrawals. See instructions for abbreviated list. Complete list can be found at www.census.gov/naics/2007/NAICOD07.HTM

6. Storage Facilities	Number	Total Storage Capacity	Unit of Measure: Gallons	Million Gallons	Cubic Feet	Acre Feet
Ponds/Reservoirs	01	29.0	○	●	○	○
Storage Tanks	01	1.0	○	●	○	○

7. Person Preparing Report

False Reporting: You are submitting official information. Any false statement in this report is subject to civil and criminal penalties, including 18 P.S. § 4904 (unsworn falsification to authorities). If you discover that the information you submitted is incorrect, notify us immediately.

I certify that the information presented on this report form is true and correct to the best of my knowledge, information and belief.

Signature: [signature]

Date: 07/28/2008

First Name: ROBERT MI.: P Last Name: ALEJNIKOV

Title: ENVIRONMENTAL SPEC

Number & Street Address: 3146 SANATOGA ROAD

City: POTTSTOWN State: PA Zip Code: 19464 -

Office Phone Number (Include Area Code): 610-718-2513 Fax Phone Number (Include Area Code): 610-718-2721

Email Address (Please use CAPITAL Letters) Example: ALL.CAPS@EMAIL.ADDRESS

ROBERT.ALEJNIKOV@EXELONCORP.COM

DO NOT STAPLE FORM

DO NOT STAPLE FORM

9768040688

SUMMARY OF WATER DISPOSAL AND CONSUMPTION

	Gallons Per Year	Percent of Total Disposal
8. Incorporation Into Product	, , ,	.
9. Evaporation	008,637,767,404	63.9
10. Off-Site Disposal	, , ,	.
11. Waste Stabilization Pond	, , ,	.
12. Irrigation	, , ,	.
13. Livestock and Dairy Use	, , ,	.
14. Deep Well Injection	, , ,	.
15. On-Lot Septic System	, ,	.
16. Discharge to Public Sewage (name up to 3 separate systems)		
Name of System 1: POTTSTOWN WASTEWATER	System 1 Discharge: 000,007,305,000	0.1
Name of System 2:	System 2 Discharge: , , ,	.
Name of System 3:	System 3 Discharge: , , ,	.
17. Direct Discharge to Waterway (Treated or Untreated) — Name of Waterway: SCHUYLKILL RIVER	Waterway Discharge: 002,934,487,173	21.7
18. Other Type of Disposal — Description: RELEASE TO PERKIOMEN	Other Disposal: 001,938,642,800	14.3
19. TOTAL Disposal and Consumption (Sum of 8 - 18)	013,518,202,380	Percent 100

DO NOT STAPLE FORM

DO NOT STAPLE FORM

9622040687

Agricultural Operations

20. Irrigated Crops

Crop	Amount	Unit	Spray	Trickle	Hand Moved	Traveling Gun	Fixed Set	Ditch
Vegetables		(rounded to nearest acre)	○	○	○	○	○	○
Corn for grain		(rounded to nearest acre)	○	○	○	○	○	○
Corn for silage		(rounded to nearest acre)	○	○	○	○	○	○
Potatoes		(rounded to nearest acre)	○	○	○	○	○	○
Forage		(rounded to nearest acre)	○	○	○	○	○	○
Orchard		(rounded to nearest acre)	○	○	○	○	○	○
Nursery		(rounded to nearest acre)	○	○	○	○	○	○
Other		(rounded to nearest acre)	○	○	○	○	○	○
Mushrooms		(square feet)	○	○	○	○	○	○
Greenhouse		(square feet)	○	○	○	○	○	○

Golf Operations

21. Acreage Irrigated (round to nearest acre)

	Acreage	% of Total
Tees		.
Greens		.
Fairways		.
Other		.
Totals		100

22. Date Irrigation System Was Installed

__ / __ / ____

Mining Operations

23. Type of Operation - Choose all that apply

- ○ Underground mine
- ○ Quarry, pit or surface extraction
- ○ Mill
- ○ Coal preparation plant
- ○ Sand and gravel washing/screening
- ○ Other

(If "Other", describe below)

Power Generating Operations

24. Total Generation Capacity(MW)

2388

25. Generating Units 2

Snowmaking Operations

26. Snowmaking Acres

(round to nearest acre)

Livestock Operations

27. Head Counts

Dry Cows/Cattle	Dairy Cows	Hogs/Pigs	Chickens	Other

Log Date (DEP use only)

__ / __ / ____

DO NOT STAPLE FORM DO NOT STAPLE FORM

Enclosure 1

Schuylkill River Report

6809104301

3920-FM-WM0299 Rev. 1/2008

ACT 220 WATER WITHDRAWAL AND USE
SUB FACILITY REPORT

Commonwealth of Pennsylvania
Department of Environmental Protection
Division of Water Use Planning
PO Box 8555
Harrisburg, PA 17105-8555

Only one source per form

1. Report Year: 2007

2. WUDS Primary Facility ID: 2057

3. WUDS Sub Facility ID: 27589

4. Sub Facility Name (source being reported on this form): SCHUYLKILL RIVER

MEASURING/METERING OF WATER

5. Measurement Method

○ Estimated ○ Calculated ● Metered

6. Estimated or Calculated Method Used:

7. Meter-Last Date Tested: 04/09/2002

8. Meter Tested By: EXELON

WITHDRAWALS / USE / PURCHASES / SALES FOR REPORT YEAR

9. Type of Source Being Reported (Only one [1] type of use may be selected)

● Withdrawals (Groundwater, Surface Water, Hauled)

○ Purchases (From a Public Water Supplier)

○ Sales (To a Public Water Supplier)

Bi-directional sources needing to report BOTH purchases AND sales for the same report year must be reported via the internet. See instructions.

10. Monthly Totals

Month	Total	Days	Month	Total	Days
Jan	000,939,608,986	31	Jul	000,982,619,000	31
Feb	000,730,825,036	28	Aug	000,533,304,176	31
Mar	000,531,298,862	31	Sep	000,537,905,464	30
Apr	000,790,798,737	30	Oct	000,559,265,970	31
May	001,035,800,944	31	Nov	000,914,628,624	30
Jun	001,119,346,160	30	Dec	000,928,145,418	31

11. Total Gallons for Year: 009,623,547,377

12. Total Days for Year: 365

DO NOT STAPLE FORM

DO NOT STAPLE FORM

5263104304

THIS SECTION FOR **PUBLIC WATER SUPPLIERS**

13. Surface Water/Groundwater Intake (GPD) ___,___,___

14. Yield (GPD) ___,___,___

15. Permit (GPD) ___,___,___

16. Maximum Water Transfer Capability, GPD

From	To
__,___,___	__,___,___

17. Double Counted ○ Yes (Is double counted) ○ No (Is NOT double counted)

18. Groundwater Level measured ○ Yes ○ No

THIS SECTION FOR THOSE OTHER THAN **PUBLIC WATER SUPPLIERS**

19. Potability ○ Potable (Drinkable) ● Non-Potable (Non Drinkable) ○ Both

False Reporting: You are submitting official information. Any false statement in this registration or map you submit to DEP is subject to civil and criminal penalties, including 18 P.S. § 4904 (unsworn falsification to authorities). If you discover that the information you submitted is incorrect, notify us immediately.

20. Person Preparing Report

I certify that the information presented on this registration form is true and correct to the best of my knowledge, information and belief.

Signature: [signature]

Date: 07 / 28 / 2008

First Name: ROBERT I.: P Last Name: ALEJNIKOV

Title: ENVIRONMENTAL SPEC

Number & Street Address: 3146 SANATOGA ROAD

City: POTTSTOWN State: PA Zip Code: 19464 -

Office Phone Number (Include Area Code): 610 - 718 - 2513

Fax Phone Number (Include Area Code): 610 - 718 - 2721

Email Address (Please use CAPITAL Letters) Example: ALL.CAPS@EMAIL.ADDRESS

ROBERT.ALEJNIKOV@EXELONCORP.COM

Log Date (DEP use only) __ / __ / ____

Enclosure 2

Well 1 Alley Well Report

6809104301

3920-FM-WM0299 Rev. 1/2008

Commonwealth of Pennsylvania
Department of Environmental Protection
Division of Water Use Planning
PO Box 8555
Harrisburg, PA 17105-8555

ACT 220 WATER WITHDRAWAL AND USE SUB FACILITY REPORT

Only one source per form

1. Report Year: 2007

2. WUDS Primary Facility ID: 27589

3. WUDS Sub Facility ID: 12923

4. Sub Facility Name (source being reported on this form): WELL 1 ALLEY WELL

MEASURING/METERING OF WATER

5. Measurement Method

○ Estimated ○ Calculated ● Metered

6. Estimated or Calculated Method Used:

7. Meter-Last Date Tested: 07/25/2006

8. Meter Tested By: SENSUS METERING SYSTEMS

WITHDRAWALS / USE / PURCHASES / SALES FOR REPORT YEAR

9. Type of Source Being Reported (Only one [1] type of use may be selected)

● Withdrawals (Groundwater, Surface Water, Hauled)

○ Purchases (From a Public Water Supplier)

○ Sales (To a Public Water Supplier)

Bi-directional sources needing to report BOTH purchases AND sales for the same report year must be reported via the internet. See instructions.

10. Monthly Totals

Month	Total	Days	Month	Total	Days
Jan	000,000,519,111	31	Jul	000,000,798,902	31
Feb	000,000,542,953	28	Aug	000,000,807,583	31
Mar	000,000,976,399	31	Sep	000,000,651,022	30
Apr	000,000,505,131	30	Oct	000,000,666,998	31
May	000,000,760,047	31	Nov	000,000,446,694	30
Jun	000,000,757,585	30	Dec	000,000,448,578	31

11. Total Gallons for Year: 000,007,881,003

12. Total Days for Year: 365

DO NOT STAPLE FORM

DO NOT STAPLE FORM

5263104304

THIS SECTION FOR **PUBLIC WATER SUPPLIERS**

13. Surface Water/Groundwater Intake (GPD) ___,___,___

14. Yield (GPD) ___,___,___

15. Permit (GPD) ___,___,___

16. Maximum Water Transfer Capability, GPD

From	To
__,___,___	__,___,___

17. Double Counted ○ Yes (Is double counted) ○ No (Is NOT double counted)

18. Groundwater Level measured ○ Yes ○ No

THIS SECTION FOR THOSE OTHER THAN **PUBLIC WATER SUPPLIERS**

19. Potability ● Potable (Drinkable) ○ Non-Potable (Non Drinkable) ○ Both

False Reporting: You are submitting official information. Any false statement in this registration or map you submit to DEP is subject to civil and criminal penalties, including 18 P.S. § 4904 (unsworn falsification to authorities). If you discover that the information you submitted is incorrect, notify us immediately.

20. Person Preparing Report

I certify that the information presented on this registration form is true and correct to the best of my knowledge, information and belief.

Signature: (signed)

Date: 07/28/2008

First Name: ROBERT
I.: P
Last Name: ALEJNIKOV

Title: ENVIRONMENTAL SPEC

Number & Street Address: 3146 SANATOGA ROAD

City: POTTSTOWN
State: PA
Zip Code: 19464 -

Office Phone Number (Include Area Code): 610-718-2513

Fax Phone Number (Include Area Code): 610-718-2721

Email Address (Please use CAPITAL Letters) Example: ALL.CAPS@EMAIL.ADDRESS
ROBERT.ALEJNIKOV@EXELONCORP.COM

Log Date (DEP use only) __/__/____

Enclosure 3

Bradshaw Reservoir Report

6809104301

3920-FM-WM0299 Rev. 1/2008

ACT 220 WATER WITHDRAWAL AND USE
SUB FACILITY REPORT

Commonwealth of Pennsylvania
Department of Environmental Protection
Division of Water Use Planning
PO Box 8555
Harrisburg, PA 17105-8555

Only one source per form

1. Report Year: 2007

2. WUDS Primary Facility ID: 27589

3. WUDS Sub Facility ID: 53965

4. Sub Facility Name (source being reported on this form): BRADSHAW RESERVOIR

MEASURING/METERING OF WATER

5. Measurement Method

○ Estimated ○ Calculated ● Metered

6. Estimated or Calculated Method Used

7. Meter-Last Date Tested: 01/23/2007

8. Meter Tested By: EXELON

WITHDRAWALS / USE / PURCHASES / SALES FOR REPORT YEAR

9. Type of Source Being Reported (Only one [1] type of use may be selected)

● Withdrawals (Groundwater, Surface Water, Hauled)

○ Purchases (From a Public Water Supplier)

○ Sales (To a Public Water Supplier)

Bi-directional sources needing to report BOTH purchases AND sales for the same report year must be reported via the internet. See instructions.

10. Monthly Totals

Month	Total	Days	Month	Total	Days
Jan	000,206,770,000	31	Jul	000,395,870,000	31
Feb	000,207,480,000	28	Aug	000,643,250,000	31
Mar	000,198,090,000	31	Sep	000,624,000,000	30
Apr	000,192,000,000	30	Oct	000,599,850,000	31
May	000,203,670,000	31	Nov	000,202,800,000	30
Jun	000,203,700,000	30	Dec	000,209,870,000	31

11. Total Gallons for Year: 003,887,350,000

12. Total Days for Year: 365

5263104304

THIS SECTION FOR PUBLIC WATER SUPPLIERS

13. Surface Water/Groundwater Intake (GPD) ___,___,___

14. Yield (GPD) ___,___,___

15. Permit (GPD) ___,___,___

16. Maximum Water Transfer Capability, GPD

From ___,___,___ To ___,___,___

17. Double Counted ○ Yes (Is double counted) ○ No (Is NOT double counted)

18. Groundwater Level measured ○ Yes ○ No

THIS SECTION FOR THOSE OTHER THAN PUBLIC WATER SUPPLIERS

19. Potability ○ Potable (Drinkable) ● Non-Potable (Non Drinkable) ○ Both

False Reporting: You are submitting official information. Any false statement in this registration or map you submit to DEP is subject to civil and criminal penalties, including 18 P.S. § 4904 (unsworn falsification to authorities). If you discover that the information you submitted is incorrect, notify us immediately.

20. Person Preparing Report

I certify that the information presented on this registration form is true and correct to the best of my knowledge, information and belief.

Signature [signature]

Date 07/28/2008

First Name ROBERT I. P Last Name ALEJNIKOV

Title ENVIRONMENTAL SPEC

Number & Street Address 3146 SANATOGA ROAD

City POTTSTOWN State PA Zip Code 19464-

Office Phone Number (Include Area Code) 610-718-2513

Fax Phone Number (Include Area Code) 610-718-2721

Email Address (Please use CAPITAL Letters) Example: ALL.CAPS@EMAIL.ADDRESS

ROBERT.ALEJNIKOV@EXELONCORP.COM

Log Date (DEP use only) __/__/____

Enclosure 4

Perkiomen Creek Report

6809104301

3920-FM-WM0299 Rev. 1/2008

ACT 220 WATER WITHDRAWAL AND USE
SUB FACILITY REPORT

Commonwealth of Pennsylvania
Department of Environmental Protection
Division of Water Use Planning
PO Box 8555
Harrisburg, PA 17105-8555

Only one source per form

1. Report Year: 2007

2. WUDS Primary Facility ID: 27589

3. WUDS Sub Facility ID: 53966

4. Sub Facility Name (source being reported on this form): PERKIOMEN CREEK

MEASURING/METERING OF WATER

5. Measurement Method

○ Estimated ○ Calculated ● Metered

6. Estimated or Calculated Method Used:

7. Meter-Last Date Tested: 04 / 12 / 2002

8. Meter Tested By: EXELON

WITHDRAWALS / USE / PURCHASES / SALES FOR REPORT YEAR

9. Type of Source Being Reported (Only one [1] type of use may be selected)

● Withdrawals (Groundwater, Surface Water, Hauled)

○ Purchases (From a Public Water Supplier)

○ Sales (To a Public Water Supplier)

Bi-directional sources needing to report BOTH purchases AND sales for the same report year must be reported via the internet. See instructions.

10. Monthly Totals

	Total	Days		Total	Days
Jan	000,000,000,000	00	Jul	000,214,060,000	31
Feb	000,034,842,000	11	Aug	000,578,230,000	27
Mar	000,006,794,000	26	Sep	000,558,311,000	30
Apr	000,009,396,000	30	Oct	000,465,189,200	27
May	000,053,147,000	27	Nov	000,009,951,000	25
Jun	000,008,153,000	26	Dec	000,010,634,000	31

11. Total Gallons for Year: 001,948,707,200

12. Total Days for Year: 291

DO NOT STAPLE FORM

DO NOT STAPLE FORM

5263104304

THIS SECTION FOR **PUBLIC WATER SUPPLIERS**

13. Surface Water/Groundwater Intake (GPD) ___,___,___

14. Yield (GPD) ___,___,___

15. Permit (GPD) ___,___,___

16. Maximum Water Transfer Capability, GPD

From	To
__,___,___	__,___,___

17. Double Counted ○ Yes (Is double counted) ○ No (Is NOT double counted)

18. Groundwater Level measured ○ Yes ○ No

THIS SECTION FOR THOSE OTHER THAN **PUBLIC WATER SUPPLIERS**

19. Potability ○ Potable (Drinkable) ● Non-Potable (Non Drinkable) ○ Both

False Reporting: You are submitting official information. Any false statement in this registration or map you submit to DEP is subject to civil and criminal penalties, including 18 P.S. § 4904 (unsworn falsification to authorities). If you discover that the information you submitted is incorrect, notify us immediately.

20. Person Preparing Report

I certify that the information presented on this registration form is true and correct to the best of my knowledge, information and belief.

Signature: [signature]

Date: 07/28/2008

First Name: ROBERT I.: P Last Name: ALEJNIKOV

Title: ENVIRONMENTAL SPEC

Number & Street Address: 3146 SANATOGA ROAD

City: POTTSTOWN State: PA Zip Code: 19464-

Office Phone Number (Include Area Code): 610-718-2513

Fax Phone Number (Include Area Code): 610-718-2721

Email Address (Please use CAPITAL Letters) Example: ALL.CAPS@EMAIL.ADDRESS

ROBERT.ALEJNIKOV@EXELONCORP.COM

Log Date (DEP use only) __/__/____

Doc Number: ACT 220
Sheet:
Date: 10/30/2009
Mjr Rev:
Mnr Rev:

Dept Trans: D117329
Facility: LIM
SRRS ID: 2H.103
Doc Type: PERM
Sub Type: NPDS
Addl Type:

DocTitle:
2008 LGS ANNUAL WATER USE REPORT (SUBMITTED VIA DEP WEBSITE)

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DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Primary Facility Report for EXELON LIMERICK GENERATION STA (27589)

REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2008

Client: EXELON GENERATION CO LLC

PRIMARY FACILITY NAME AND MAILING ADDRESS

Current Address: EXELON LIMERICK GENERATION STA (27589)
PO BOX 2300
EVERGREEN & SANATOGA RDS
POTTSTOWN, PA 19464-0920

Change of Address: Yes

Revised Address: EXELON LIMERICK GENERATING STATION
3146 SANATOGA ROAD
POTTSTOWN, PA 19464

NORTH AMERICAN INDUSTRY CLASSIFICATION SYSTEM (NAICS)

NAICS: 221113 - Nuclear Electric Power Generation

SUMMARY OF WATER CONSUMPTION AND RETURNS

Consumption/Return Type	Gallons Per Year
DISCHARGE TO PUBLIC SEWAGE SYSTEM	6,421,000
POTTSTOWN BORO AUTH-SCHUYLKILL RIV	
CONSUMED	11,603,210,644
Consumptive Use Calculation Method: BALANCING EQUATION	
DIRECT DISCHARGE TO RECEIVING WATERWAY	3,050,296,986
SCHUYLKILL RIVER	
NPDES Permit: PAD0051926	
Latitude: 40° 13' 13"	
Longitude: -75° 35' 22"	
DIRECT DISCHARGE TO RECEIVING WATERWAY	3,963,920,000
BRADSHAW RESERVOIR TO E BRANCH PERKIOMEN	
NPDES Permit: PA00552221	
Latitude: 40° 25' 45"	
Longitude: -75° 13' 21"	
TOTAL	18,623,848,630

POWER GENERATING OPERATIONS - CAPACITY

Total generation capacity MW	2,388
Number of Generating Units	2

STORAGE FACILITIES

Storage Facility	Number	Storage	Units
Ponds and reservoirs	1	29	MILLION GALLONS (MG)
Storage Tanks	1	1	MILLION GALLONS (MG)

REPORT CONTACT INFORMATION

Report Contact: CHRIS CONROY
ENVIRONMENTAL CHEMIST

3146 SANATOGA ROAD
POTTSTOWN, PA 19464
Phone: 610-718-2513
Fax: 610-718-2721
Email Address: CHRIS.CONROY@EXELONCORP.COM

Report Preparer: Chris Conroy
3146 Sanatoga Road
Pottstown, PA 19464
Phone: 610-718-2513
Email Address: chris.conroy@exeloncorp.com

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Subfacility Report for BRADSHAW RESERVOIR (53965)

REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2008

Client: EXELON GENERATION CO LLC

Primary Facility: EXELON LIMERICK GENERATION STA

POTABILITY OF USE

Potability of Use NON-POTABLE

MEASURING/METERING OF WATER

Measure Method METERED

Last Date Tested 01/25/2007 (mm/dd/yyyy)

Tested By EXELON

WITHDRAWALS OR USE FOR REPORTING YEAR 2008

Month	Total Gallons	Month	Days
Jan Gallons	209,700,000	Jan Days	31
Feb Gallons	180,400,000	Feb Days	29
Mar Gallons	189,800,000	Mar Days	31
Apr Gallons	217,100,000	Apr Days	30
May Gallons	228,900,000	May Days	31
Jun Gallons	196,000,000	Jun Days	30
Jul Gallons	508,600,000	Jul Days	31
Aug Gallons	692,600,000	Aug Days	31
Sep Gallons	510,520,000	Sep Days	30
Oct Gallons	468,700,000	Oct Days	31
Nov Gallons	333,600,000	Nov Days	28
Dec Gallons	228,000,000	Dec Days	31
Total Gallons	3,963,920,000	Total Days	364

REPORT SUBMISSION INFORMATION

Submitted By: Chris Conroy

Submitted On: 10/30/2009

Submitted By Email: chris.conroy@exeloncorp.com

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Subfacility Report for PERKIOMEN CREEK (53966)
REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2008

Client: EXELON GENERATION CO LLC
Primary Facility: EXELON LIMERICK GENERATION STA

POTABILITY OF USE

Potability of Use	NON-POTABLE

MEASURING/METERING OF WATER

Measure Method	METERED
Last Date Tested	04/16/2002 (mm/dd/yyyy)
Tested By	EXELON

WITHDRAWALS OR USE FOR REPORTING YEAR 2008

Month	Total Gallons	Month	Days
Jan Gallons	9,030,000	Jan Days	31
Feb Gallons	9,167,000	Feb Days	29
Mar Gallons	345,523,304	Mar Days	30
Apr Gallons	4,702,000	Apr Days	27
May Gallons	4,672,000	May Days	30
Jun Gallons	10,622,000	Jun Days	28
Jul Gallons	286,859,599	Jul Days	31
Aug Gallons	603,710,000	Aug Days	31
Sep Gallons	326,096,000	Sep Days	30
Oct Gallons	230,277,000	Oct Days	29
Nov Gallons	162,519,000	Nov Days	29
Dec Gallons	15,555,000	Dec Days	28
Total Gallons	2,008,732,903	Total Days	353

REPORT SUBMISSION INFORMATION

Submitted By:	Chris Conroy
Submitted On:	10/30/2009
Submitted By Email:	chris.conroy@exeloncorp.com

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Subfacility Report for SCHUYLKILL & DELAWARE RIVER (2057)

REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2008

Client: EXELON GENERATION CO LLC

Primary Facility: EXELON LIMERICK GENERATION STA

POTABILITY OF USE

Potability of Use NON-POTABLE

MEASURING/METERING OF WATER

Measure Method METERED

Last Date Tested 04/16/2002 (mm/dd/yyyy)

Tested By EXELON

WITHDRAWALS OR USE FOR REPORTING YEAR 2008

Month	Total Gallons	Month	Days
Jan Gallons	1,037,816,199	Jan Days	31
Feb Gallons	830,507,598	Feb Days	29
Mar Gallons	608,485,209	Mar Days	13
Apr Gallons	1,162,946,593	Apr Days	30
May Gallons	1,180,618,395	May Days	31
Jun Gallons	1,606,212,994	Jun Days	30
Jul Gallons	1,021,337,595	Jul Days	31
Aug Gallons	1,023,891,292	Aug Days	31
Sep Gallons	941,116,978	Sep Days	30
Oct Gallons	958,519,282	Oct Days	31
Nov Gallons	1,230,312,795	Nov Days	30
Dec Gallons	1,043,009,797	Dec Days	31
Total Gallons	12,644,774,727	Total Days	348

REPORT SUBMISSION INFORMATION

Submitted By: Chris Conroy

Submitted On: 10/30/2009

Submitted By Email: chris.conroy@exeloncorp.com

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Subfacility Report for WELL 1 ALLEY WELL (12923)

REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2008

Client: EXELON GENERATION CO LLC

Primary Facility: EXELON LIMERICK GENERATION STA

POTABILITY OF USE

Potability of Use POTABLE

MEASURING/METERING OF WATER

Measure Method METERED

Last Date Tested 07/30/2008 (mm/dd/yyyy)

Tested By METERPRO SERVICE INC.

WITHDRAWALS OR USE FOR REPORTING YEAR 2008

Month	Total Gallons	Month	Days
Jan Gallons	564,262	Jan Days	31
Feb Gallons	634,038	Feb Days	29
Mar Gallons	997,540	Mar Days	31
Apr Gallons	732,152	Apr Days	30
May Gallons	721,751	May Days	31
Jun Gallons	823,700	Jun Days	30
Jul Gallons	829,270	Jul Days	31
Aug Gallons	718,765	Aug Days	31
Sep Gallons	639,650	Sep Days	30
Oct Gallons	572,381	Oct Days	31
Nov Gallons	632,613	Nov Days	30
Dec Gallons	814,404	Dec Days	31
Total Gallons	8,680,526	Total Days	366

REPORT SUBMISSION INFORMATION

Submitted By: Chris Conroy

Submitted On: 10/30/2009

Submitted By Email: chris.conroy@exeloncorp.com

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Subfacility Report for WELL 3 BATCH PLANT (12924)

REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2008

Client: EXELON GENERATION CO LLC

Primary Facility: EXELON LIMERICK GENERATION STA

POTABILITY OF USE

Potability of Use POTABLE

MEASURING/METERING OF WATER

Measure Method ESTIMATED (SYSTEM TEST, TANK LEVEL, ESTIMATE)

WITHDRAWALS OR USE FOR REPORTING YEAR 2008

Month	Total Gallons	Month	Days
Jan Gallons	16,400	Jan Days	31
Feb Gallons	16,400	Feb Days	29
Mar Gallons	16,400	Mar Days	31
Apr Gallons	90,050	Apr Days	30
May Gallons	16,400	May Days	31
Jun Gallons	16,400	Jun Days	30
Jul Gallons	16,400	Jul Days	31
Aug Gallons	16,400	Aug Days	31
Sep Gallons	16,400	Sep Days	30
Oct Gallons	16,400	Oct Days	31
Nov Gallons	16,400	Nov Days	30
Dec Gallons	16,400	Dec Days	31
Total Gallons	270,450	Total Days	366

REPORT SUBMISSION INFORMATION

Submitted By: Chris Conroy

Submitted On: 10/30/2009

Submitted By Email: chris.conroy@exeloncorp.com

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Subfacility Report for SCHUYLKILL & DELAWARE RIVER (2057)
REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2007

Client: EXELON GENERATION CO LLC
Primary Facility: EXELON LIMERICK GENERATION STA

POTABILITY OF USE

Potability of Use NON-POTABLE

MEASURING/METERING OF WATER

Measure Method METERED
Last Date Tested 04/16/2002 (mm/dd/yyyy)
Tested By EXELON

WITHDRAWALS OR USE FOR REPORTING YEAR 2007

Month	Total Gallons	Month	Days
Jan Gallons	1,058,107,004	Jan Days	31
Feb Gallons	952,065,399	Feb Days	28
Mar Gallons	937,619,798	Mar Days	31
Apr Gallons	933,306,090	Apr Days	30
May Gallons	1,163,998,194	May Days	31
Jun Gallons	1,581,718,097	Jun Days	30
Jul Gallons	1,121,769,454	Jul Days	31
Aug Gallons	940,065,199	Aug Days	31
Sep Gallons	758,950,803	Sep Days	30
Oct Gallons	766,027,412	Oct Days	31
Nov Gallons	1,382,250,999	Nov Days	30
Dec Gallons	1,038,274,602	Dec Days	31
Total Gallons	12,634,153,051	*Total Days*	365

REPORT SUBMISSION INFORMATION

Submitted By: Chris Conroy
Submitted On: 10/30/2009
Submitted By Email: chris.conroy@exeloncorp.com

Conroy, Christopher:(GenCo-Nuc)

From: RA-eGovtAct220@state.pa.us
Sent: Friday, October 30, 2009 2:18 PM
To: RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc: RA-eGovtAct220@state.pa.us
Subject: DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2007 Sub-Facility Report
Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589
Sub-Facility: SCHUYLKILL & DELAWARE RIVER WUDS Sub-Facility ID: 2057

Submission Date: 10/30/2009 14:17:51

Conroy, Christopher:(GenCo-Nuc)

From: RA-eGovtAct220@state.pa.us
Sent: Friday, October 30, 2009 2:18 PM
To: RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc: RA-eGovtAct220@state.pa.us
Subject: DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2008 Primary Facility Report Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589

Submission Date: 10/30/2009 14:17:33

Conroy, Christopher:(GenCo-Nuc)

From: RA-eGovtAct220@state.pa.us
Sent: Friday, October 30, 2009 2:18 PM
To: RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc: RA-eGovtAct220@state.pa.us
Subject: DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2008 Sub-Facility Report
Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589
Sub-Facility: PERKIOMEN CREEK
WUDS Sub-Facility ID: 53966

Submission Date: 10/30/2009 14:18:15

Conroy, Christopher:(GenCo-Nuc)

From: RA-eGovtAct220@state.pa.us
Sent: Friday, October 30, 2009 2:18 PM
To: RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc: RA-eGovtAct220@state.pa.us
Subject: DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2008 Sub-Facility Report
Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589
Sub-Facility: BRADSHAW RESERVOIR
WUDS Sub-Facility ID: 53965

Submission Date: 10/30/2009 14:18:04

Conroy, Christopher:(GenCo-Nuc)

From: RA-eGovtAct220@state.pa.us
Sent: Friday, October 30, 2009 2:18 PM
To: RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc: RA-eGovtAct220@state.pa.us
Subject: DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2008 Sub-Facility Report
Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589
Sub-Facility: SCHUYLKILL & DELAWARE RIVER WUDS Sub-Facility ID: 2057

Submission Date: 10/30/2009 14:18:26

Conroy, Christopher:(GenCo-Nuc)

From: RA-eGovtAct220@state.pa.us
Sent: Friday, October 30, 2009 2:19 PM
To: RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc: RA-eGovtAct220@state.pa.us
Subject: DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2008 Sub-Facility Report
Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589
Sub-Facility: WELL 1 ALLEY WELL
WUDS Sub-Facility ID: 12923

Submission Date: 10/30/2009 14:18:35

Conroy, Christopher:(GenCo-Nuc)

From: RA-eGovtAct220@state.pa.us
Sent: Friday, October 30, 2009 2:19 PM
To: RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc: RA-eGovtAct220@state.pa.us
Subject: DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2008 Sub-Facility Report
Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589
Sub-Facility: WELL 3 BATCH PLANT
WUDS Sub-Facility ID: 12924

Submission Date: 10/30/2009 14:18:46

Doc Number: ACT 220
Sheet:
Date: 06/16/2010
Mjr Rev:
Mnr Rev:

Dept Trans: D136826
Facility: LIM
SRRS ID: 2H.103
Doc Type: PERM
Sub Type: NPDS
Addl Type:

DocTitle:
2009 PADEP WATER USE REPORT FOR LIMERICK GENERATING STATION

0900e54e812da320

Conroy, Christopher:(GenCo-Nuc)

From: RA-eGovtAct220@state.pa.us
Sent: Wednesday, June 16, 2010 9:09 AM
To: RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc: RA-eGovtAct220@state.pa.us
Subject: DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2009 Primary Facility Report Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589

Submission Date: 06/16/2010 09:09:28

Conroy, Christopher:(GenCo-Nuc)

From: RA-eGovtAct220@state.pa.us
Sent: Wednesday, June 16, 2010 9:11 AM
To: RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc: RA-eGovtAct220@state.pa.us
Subject: DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2009 Sub-Facility Report
Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589
Sub-Facility: SCHUYLKILL & DELAWARE RIVER WUDS Sub-Facility ID: 2057

Submission Date: 06/16/2010 09:11:01

Conroy, Christopher:(GenCo-Nuc)

From: RA-eGovtAct220@state.pa.us
Sent: Wednesday, June 16, 2010 9:11 AM
To: RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc: RA-eGovtAct220@state.pa.us
Subject: DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2009 Sub-Facility Report
Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589
Sub-Facility: BRADSHAW RESERVOIR
WUDS Sub-Facility ID: 53965

Submission Date: 06/16/2010 09:10:38

From:	RA-eGovtAct220@state.pa.us
Sent:	Wednesday, June 16, 2010 9:11 AM
To:	RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc:	RA-eGovtAct220@state.pa.us
Subject:	DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2009 Sub-Facility Report
Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589
Sub-Facility: PERKIOMEN CREEK
WUDS Sub-Facility ID: 53966

Submission Date: 06/16/2010 09:10:50

Conroy, Christopher:(GenCo-Nuc)

From:	RA-eGovtAct220@state.pa.us
Sent:	Wednesday, June 16, 2010 9:11 AM
To:	RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc:	RA-eGovtAct220@state.pa.us
Subject:	DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2009 Sub-Facility Report
Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589
Sub-Facility: WELL 1 ALLEY WELL
WUDS Sub-Facility ID: 12923

Submission Date: 06/16/2010 09:11:11

Conroy, Christopher:(GenCo-Nuc)

From:	RA-eGovtAct220@state.pa.us
Sent:	Wednesday, June 16, 2010 9:11 AM
To:	RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc:	RA-eGovtAct220@state.pa.us
Subject:	DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2009 Sub-Facility Report
Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589
Sub-Facility: WELL 3 BATCH PLANT
WUDS Sub-Facility ID: 12924

Submission Date: 06/16/2010 09:11:22

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Primary Facility Report for EXELON LIMERICK GENERATION STA (27589)
REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2009

Client: *EXELON GENERATION CO LLC*

PRIMARY FACILITY NAME AND MAILING ADDRESS

Current Address: EXELON LIMERICK GENERATION STA (27589)
PO BOX 2300
EVERGREEN & SANATOGA RDS
POTTSTOWN, PA 19464-0920

Change of Address: Yes

Revised Address: CHRIS CONROY
3146 SANATOGA ROAD
SSB 2-1
POTTSTOWN, PA 19464

NORTH AMERICAN INDUSTRY CLASSIFICATION SYSTEM (NAICS)

NAICS: 221113 - Nuclear Electric Power Generation

SUMMARY OF WATER CONSUMPTION AND RETURNS

Consumption/Return Type	Gallons Per Year
DISCHARGE TO PUBLIC SEWAGE SYSTEM	6,000,000
POTTSTOWN BORO AUTH-SCHUYLKILL RIV	
DIRECT DISCHARGE TO RECEIVING WATERWAY	2,844,218,641
SCHUYLKILL RIVER	
NPDES Permit: PAD0051926	
Latitude: 40° 13' 13"	
Longitude: -75° 35' 22"	
DIRECT DISCHARGE TO RECEIVING WATERWAY	2,385,000,000
BRADSHAW RESERVOIR TO E BRANCH PERKIOMEN	
NPDES Permit: PA00552221	
Latitude: 40° 25' 45"	
Longitude: -75° 13' 21"	
CONSUMED	11,964,878,658
Consumptive Use Calculation Method: BALANCING EQUATION	
TOTAL	17,200,097,299

POWER GENERATING OPERATIONS - CAPACITY

Total generation capacity MW	2,388
Number of Generating Units	2

STORAGE FACILITIES

Storage Facility	Number	Storage	Units
Ponds and reservoirs	1	29	MILLION GALLONS (MG)
Storage Tanks	1	1	MILLION GALLONS (MG)

REPORT CONTACT INFORMATION

Report Contact: CHRIS CONROY

DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

ENVIRONMENTAL CHEMIST
3146 SANATOGA RD
POTTSTOWN, PA 19464
Phone: 610-718-2513
Fax: 610-718-2721
Email Address: CHRIS.CONROY@EXELONCORP.COM

Report Preparer: Chris Conroy
3146 Sanatoga Road
Pottstown, PA 19464
Phone: 610-718-2513
Email Address: chris.conroy@exeloncorp.com

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Subfacility Report for SCHUYLKILL & DELAWARE RIVER (2057)
REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2009

Client: EXELON GENERATION CO LLC
Primary Facility: EXELON LIMERICK GENERATION STA

POTABILITY OF USE

Potability of Use NON-POTABLE

MEASURING/METERING OF WATER

Measure Method METERED
Last Date Tested 04/16/2002 (mm/dd/yyyy)
Tested By EXELON

WITHDRAWALS OR USE FOR REPORTING YEAR 2009

Month	Total Gallons	Month	Days
Jan Gallons	1,259,989,799	Jan Days	31
Feb Gallons	1,071,974,281	Feb Days	28
Mar Gallons	954,728,800	Mar Days	31
Apr Gallons	1,197,490,719	Apr Days	30
May Gallons	1,208,760,396	May Days	31
Jun Gallons	1,232,657,197	Jun Days	30
Jul Gallons	1,563,801,786	Jul Days	31
Aug Gallons	1,288,654,395	Aug Days	31
Sep Gallons	1,229,499,681	Sep Days	30
Oct Gallons	1,490,775,658	Oct Days	31
Nov Gallons	1,172,785,201	Nov Days	30
Dec Gallons	1,079,386,396	Dec Days	31
Total Gallons	14,750,504,309	Total Days	365

REPORT SUBMISSION INFORMATION

Submitted By: Chris Conroy
Submitted On: 06/16/2010
Submitted By Email: chris.conroy@exeloncorp.com

DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Subfacility Report for BRADSHAW RESERVOIR (53965)
REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2009

Client: EXELON GENERATION CO LLC
Primary Facility: EXELON LIMERICK GENERATION STA

POTABILITY OF USE

Potability of Use NON-POTABLE

MEASURING/METERING OF WATER

Measure Method METERED
Last Date Tested 01/25/2007 (mm/dd/yyyy)
Tested By EXELON

WITHDRAWALS OR USE FOR REPORTING YEAR 2009

Month	Total Gallons	Month	Days
Jan Gallons	86,200,000	Jan Days	21
Feb Gallons	214,700,000	Feb Days	28
Mar Gallons	209,300,000	Mar Days	31
Apr Gallons	243,000,000	Apr Days	30
May Gallons	183,500,000	May Days	31
Jun Gallons	188,300,000	Jun Days	30
Jul Gallons	236,200,000	Jul Days	31
Aug Gallons	185,500,000	Aug Days	31
Sep Gallons	188,800,000	Sep Days	30
Oct Gallons	233,000,000	Oct Days	31
Nov Gallons	190,100,000	Nov Days	30
Dec Gallons	226,400,000	Dec Days	31
Total Gallons	2,385,000,000	Total Days	355

REPORT SUBMISSION INFORMATION

Submitted By: Chris Conroy
Submitted On: 06/16/2010
Submitted By Email: chris.conroy@exeloncorp.com

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Subfacility Report for PERKIOMEN CREEK (53966)
REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2009

Client: EXELON GENERATION CO LLC
Primary Facility: EXELON LIMERICK GENERATION STA

POTABILITY OF USE

Potability of Use NON-POTABLE

MEASURING/METERING OF WATER

Measure Method METERED
Last Date Tested 04/16/2002 (mm/dd/yyyy)
Tested By EXELON

WITHDRAWALS OR USE FOR REPORTING YEAR 2009

Month	Total Gallons	Month	Days
Jan Gallons	7,812,000	Jan Days	27
Feb Gallons	11,379,490	Feb Days	28
Mar Gallons	10,753,500	Mar Days	31
Apr Gallons	8,276,000	Apr Days	25
May Gallons	3,488,000	May Days	15
Jun Gallons	7,843,000	Jun Days	30
Jul Gallons	8,661,000	Jul Days	31
Aug Gallons	380,000	Aug Days	7
Sep Gallons	0	Sep Days	0
Oct Gallons	0	Oct Days	0
Nov Gallons	0	Nov Days	0
Dec Gallons	0	Dec Days	0
Total Gallons	58,592,990	Total Days	194

REPORT SUBMISSION INFORMATION

Submitted By: Chris Conroy
Submitted On: 06/16/2010
Submitted By Email: chris.conroy@exeloncorp.com

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

***Subfacility Report for* WELL 1 ALLEY WELL (12923)**
REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2009

Client: EXELON GENERATION CO LLC
Primary Facility: EXELON LIMERICK GENERATION STA

POTABILITY OF USE

Potability of Use POTABLE

MEASURING/METERING OF WATER

Measure Method METERED
Last Date Tested 07/30/2008 (mm/dd/yyyy)
Tested By METERPRO SERVICE INC.

WITHDRAWALS OR USE FOR REPORTING YEAR 2009

Month	Total Gallons	Month	Days
Jan Gallons	497,410	Jan Days	31
Feb Gallons	525,351	Feb Days	28
Mar Gallons	771,189	Mar Days	31
Apr Gallons	772,779	Apr Days	30
May Gallons	796,009	May Days	31
Jun Gallons	872,714	Jun Days	30
Jul Gallons	813,923	Jul Days	31
Aug Gallons	742,731	Aug Days	31
Sep Gallons	661,893	Sep Days	30
Oct Gallons	586,121	Oct Days	31
Nov Gallons	671,243	Nov Days	30
Dec Gallons	554,185	Dec Days	31
Total Gallons	8,265,548	Total Days	365

REPORT SUBMISSION INFORMATION

Submitted By: Chris Conroy
Submitted On: 06/16/2010
Submitted By Email: chris.conroy@exeloncorp.com

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Subfacility Report for WELL 3 BATCH PLANT (12924)
REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2009

Client: EXELON GENERATION CO LLC
Primary Facility: EXELON LIMERICK GENERATION STA

POTABILITY OF USE

Potability of Use NON-POTABLE

MEASURING/METERING OF WATER

Measure Method ESTIMATED (SYSTEM TEST, TANK LEVEL, ESTIMATE)

WITHDRAWALS OR USE FOR REPORTING YEAR 2009

Month	Total Gallons	Month	Days
Jan Gallons	16,400	Jan Days	31
Feb Gallons	16,400	Feb Days	28
Mar Gallons	16,400	Mar Days	31
Apr Gallons	63,050	Apr Days	30
May Gallons	16,400	May Days	31
Jun Gallons	16,400	Jun Days	30
Jul Gallons	16,400	Jul Days	31
Aug Gallons	16,400	Aug Days	31
Sep Gallons	16,400	Sep Days	30
Oct Gallons	16,400	Oct Days	31
Nov Gallons	16,400	Nov Days	30
Dec Gallons	16,400	Dec Days	31
Total Gallons	243,450	Total Days	365

REPORT SUBMISSION INFORMATION

Submitted By: Chris Conroy
Submitted On: 06/16/2010
Submitted By Email: chris.conroy@exeloncorp.com

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

CHAPTER 110 (formerly ACT 220) AND WATER ALLOCATION WATER WITHDRAWAL AND USE REPORTING

Back to Act 220 Water Withdrawal and Use Reporting

Submitted Reports for EXELON LIMERICK GENERATION STA

PRIMARY FACILITY REPORTS

		Report Year	Primary Facility	Client
View	1	2010	EXELON LIMERICK GENERATION STA	EXELON GENERATION CO LLC
View	2	2009	EXELON LIMERICK GENERATION STA	EXELON GENERATION CO LLC
View	3	2008	EXELON LIMERICK GENERATION STA	EXELON GENERATION CO LLC

SUBFACILITY REPORTS

		Date Submitted	Report Year	WUDS ID	Subfacility Name	Primary Facility Name
View	1	06/24/2011	2010	53965	BRADSHAW RESERVOIR	EXELON LIMERICK GENERATION STA
View	2	06/24/2011	2010	53966	PERKIOMEN CREEK	EXELON LIMERICK GENERATION STA
View	3	06/24/2011	2010	2057	SCHUYLKILL & DELAWARE RIVER	EXELON LIMERICK GENERATION STA
View	4	06/24/2011	2010	12923	WELL 1 ALLEY WELL	EXELON LIMERICK GENERATION STA
View	5	06/24/2011	2010	12924	WELL 3 BATCH PLANT	EXELON LIMERICK GENERATION STA
View	6	06/16/2010	2009	53965	BRADSHAW RESERVOIR	EXELON LIMERICK GENERATION STA
View	7	06/16/2010	2009	53966	PERKIOMEN CREEK	EXELON LIMERICK GENERATION STA
View	8	06/16/2010	2009	2057	SCHUYLKILL & DELAWARE RIVER	EXELON LIMERICK GENERATION STA
View	9	06/16/2010	2009	12923	WELL 1 ALLEY WELL	EXELON LIMERICK GENERATION STA
View	10	06/16/2010	2009	12924	WELL 3 BATCH PLANT	EXELON LIMERICK GENERATION STA

Previous Set Next Set

Conroy, Christopher:(GenCo-Nuc)

From: RA-eGovtAct220@state.pa.us
Sent: Friday, June 24, 2011 3:24 PM
To: RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc: RA-eGovtAct220@state.pa.us
Subject: DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2010 Primary Facility Report Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589

Submission Date: 06/24/2011 15:24:02

Conroy, Christopher:(GenCo-Nuc)

From: RA-eGovtAct220@state.pa.us
Sent: Friday, June 24, 2011 3:24 PM
To: RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc: RA-eGovtAct220@state.pa.us
Subject: DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2010 Sub-Facility Report
Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589
Sub-Facility: BRADSHAW RESERVOIR
WUDS Sub-Facility ID: 53965

Submission Date: 06/24/2011 15:24:24

Conroy, Christopher:(GenCo-Nuc)

From: RA-eGovtAct220@state.pa.us
Sent: Friday, June 24, 2011 3:25 PM
To: RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc: RA-eGovtAct220@state.pa.us
Subject: DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2010 Sub-Facility Report
Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589
Sub-Facility: PERKIOMEN CREEK
WUDS Sub-Facility ID: 53966

Submission Date: 06/24/2011 15:24:42

Conroy, Christopher:(GenCo-Nuc)

From: RA-eGovtAct220@state.pa.us
Sent: Friday, June 24, 2011 3:25 PM
To: RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc: RA-eGovtAct220@state.pa.us
Subject: DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2010 Sub-Facility Report
Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589
Sub-Facility: SCHUYLKILL & DELAWARE RIVER WUDS Sub-Facility ID: 2057

Submission Date: 06/24/2011 15:25:01

Conroy, Christopher:(GenCo-Nuc)

From: RA-eGovtAct220@state.pa.us
Sent: Friday, June 24, 2011 3:25 PM
To: RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc: RA-eGovtAct220@state.pa.us
Subject: DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2010 Sub-Facility Report
Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589
Sub-Facility: WELL 1 ALLEY WELL
WUDS Sub-Facility ID: 12923

Submission Date: 06/24/2011 15:25:20

Conroy, Christopher:(GenCo-Nuc)

From: RA-eGovtAct220@state.pa.us
Sent: Friday, June 24, 2011 3:26 PM
To: RA-eGovtAct220@state.pa.us; Conroy, Christopher:(GenCo-Nuc)
Cc: RA-eGovtAct220@state.pa.us
Subject: DEP Water Resources Reporting Receipt

Thank you for using DEP's web-based system to submit your report. This email confirms that DEP has received the following report.

Report Type: 2010 Sub-Facility Report
Primary Facility: EXELON LIMERICK GENERATION STA WUDS Primary Facility ID: 27589
Sub-Facility: WELL 3 BATCH PLANT
WUDS Sub-Facility ID: 12924

Submission Date: 06/24/2011 15:25:39

DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Primary Facility Report for EXELON LIMERICK GENERATION STA (27589)
REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2010

Client: EXELON GENERATION CO LLC

PRIMARY FACILITY NAME AND MAILING ADDRESS

Current Address:	EXELON LIMERICK GENERATION STA (27589) PO BOX 2300 EVERGREEN & SANATOGA RDS POTTSTOWN, PA 19464-0920 CHEMIST RAD WASTE MGR
Phone:	610-718-2700
Facility e-mail:	
Change of Address:	Yes
Revised Address:	EXELON GENERATION COMPANY, LLC LIMERICK GENERATING STATION 3146 SANATOGA RD, SSB 2-1 POTTSTOWN, PA 19464
Contact Information:	CHRIS CONROY ENVIRONMENTAL CHEMIST
Phone:	610-718-2513
Facility e-mail:	CHRIS.CONROY@EXELONCORP.COM

NORTH AMERICAN INDUSTRY CLASSIFICATION SYSTEM (NAICS)

NAICS: 221113 - Nuclear Electric Power Generation

WATER CONSUMPTION

Consumption	Gallons Per Year
CONSUMED	12,129,520,249

Consumptive Use Calculation Method: BALANCING EQUATION

SUMMARY OF WATER DISPOSALS

No Water Disposal Information Was Reported.

REPORT CONTACT INFORMATION

Report Preparer: CHRIS CONROY
3146 SANATOGA ROAD
POTTSTOWN, PA 19464
Phone: 610-718-2513
Email Address: CHRIS.CONROY@EXELONCORP.COM

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Subfacility Report for SCHUYLKILL & DELAWARE RIVER (2057)
REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2010

Client: EXELON GENERATION CO LLC
Primary Facility: EXELON LIMERICK GENERATION STA

POTABILITY OF USE

Potability of Use	NON-POTABLE

MEASURING/METERING OF WATER

Measure Method	METERED
Last Date Tested	04/16/2002 (mm/dd/yyyy)
Tested By	EXELON

WITHDRAWALS OR USE FOR REPORTING YEAR 2010

Month	Total Gallons	Month	Days
Jan Gallons	1,316,100,719	Jan Days	31
Feb Gallons	1,068,531,001	Feb Days	28
Mar Gallons	997,080,000	Mar Days	31
Apr Gallons	1,189,870,997	Apr Days	30
May Gallons	1,223,433,803	May Days	31
Jun Gallons	1,196,114,001	Jun Days	30
Jul Gallons	1,565,747,956	Jul Days	31
Aug Gallons	1,176,778,501	Aug Days	31
Sep Gallons	762,210,601	Sep Days	30
Oct Gallons	1,421,043,300	Oct Days	31
Nov Gallons	1,093,546,200	Nov Days	30
Dec Gallons	908,842,080	Dec Days	31
Total Gallons	13,919,299,159	Total Days	365

REPORT SUBMISSION INFORMATION

Submitted By:	Chris Conroy
Submitted On:	06/24/2011
Submitted By Email:	chris.conroy@exeloncorp.com

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Subfacility Report for WELL 1 ALLEY WELL (12923)
REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2010

Client: EXELON GENERATION CO LLC
Primary Facility: EXELON LIMERICK GENERATION STA

POTABILITY OF USE

Potability of Use POTABLE

MEASURING/METERING OF WATER

Measure Method METERED
Last Date Tested 07/16/2010 (mm/dd/yyyy)
Tested By METERPRO SERVICE INC.

WITHDRAWALS OR USE FOR REPORTING YEAR 2010

Month	Total Gallons	Month	Days
Jan Gallons	631,639	Jan Days	31
Feb Gallons	552,277	Feb Days	28
Mar Gallons	968,553	Mar Days	31
Apr Gallons	941,008	Apr Days	30
May Gallons	717,961	May Days	31
Jun Gallons	793,768	Jun Days	30
Jul Gallons	877,585	Jul Days	31
Aug Gallons	930,210	Aug Days	31
Sep Gallons	886,193	Sep Days	30
Oct Gallons	912,802	Oct Days	31
Nov Gallons	462,293	Nov Days	30
Dec Gallons	451,926	Dec Days	31
Total Gallons	9,126,215	Total Days	365

REPORT SUBMISSION INFORMATION

Submitted By: Chris Conroy
Submitted On: 06/24/2011
Submitted By Email: chris.conroy@exeloncorp.com

DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Subfacility Report for WELL 3 BATCH PLANT (12924)
REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2010

Client: EXELON GENERATION CO LLC
Primary Facility: EXELON LIMERICK GENERATION STA

POTABILITY OF USE

Potability of Use NON-POTABLE

MEASURING/METERING OF WATER

Measure Method METERED
Last Date Tested 01/24/2011 (mm/dd/yyyy)
Tested By METERPRO SERVICE INC.

WITHDRAWALS OR USE FOR REPORTING YEAR 2010

Month	Total Gallons	Month	Days
Jan Gallons	466,400	Jan Days	31
Feb Gallons	109,900	Feb Days	28
Mar Gallons	109,900	Mar Days	31
Apr Gallons	16,400	Apr Days	30
May Gallons	16,400	May Days	31
Jun Gallons	16,400	Jun Days	30
Jul Gallons	16,400	Jul Days	31
Aug Gallons	16,400	Aug Days	31
Sep Gallons	16,400	Sep Days	30
Oct Gallons	16,400	Oct Days	31
Nov Gallons	16,400	Nov Days	30
Dec Gallons	16,400	Dec Days	31
Total Gallons	833,800	Total Days	365

REPORT SUBMISSION INFORMATION

Submitted By: Chris Conroy
Submitted On: 06/24/2011
Submitted By Email: chris.conroy@exeloncorp.com

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Subfacility Report for PERKIOMEN CREEK (53966)

REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2010

Client: EXELON GENERATION CO LLC

Primary Facility: EXELON LIMERICK GENERATION STA

POTABILITY OF USE

Potability of Use NON-POTABLE

MEASURING/METERING OF WATER

Measure Method METERED

Last Date Tested 04/12/2002 (mm/dd/yyyy)

Tested By EXELON

WITHDRAWALS OR USE FOR REPORTING YEAR 2010

Month	Total Gallons	Month	Days
Jan Gallons	0	Jan Days	0
Feb Gallons	0	Feb Days	0
Mar Gallons	251,000	Mar Days	1
Apr Gallons	6,483,000	Apr Days	29
May Gallons	5,347,000	May Days	26
Jun Gallons	6,393,500	Jun Days	28
Jul Gallons	85,282,720	Jul Days	12
Aug Gallons	136,349,000	Aug Days	21
Sep Gallons	511,284,000	Sep Days	30
Oct Gallons	70,661,500	Oct Days	27
Nov Gallons	32,097,000	Nov Days	28
Dec Gallons	110,328,000	Dec Days	31
Total Gallons	964,476,720	Total Days	233

REPORT SUBMISSION INFORMATION

Submitted By: Chris Conroy

Submitted On: 06/24/2011

Submitted By Email: chris.conroy@exeloncorp.com

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATERSHED MANAGEMENT

Subfacility Report for BRADSHAW RESERVOIR (53965)
REPORT FOR CALENDAR YEAR JAN 1 TO DEC 31, 2010

Client: EXELON GENERATION CO LLC
Primary Facility: EXELON LIMERICK GENERATION STA

POTABILITY OF USE

Potability of Use NON-POTABLE

MEASURING/METERING OF WATER

Measure Method METERED
Last Date Tested 03/22/2011 (mm/dd/yyyy)
Tested By EXELON

WITHDRAWALS OR USE FOR REPORTING YEAR 2010

Month	Total Gallons	Month	Days
Jan Gallons	197,500,000	Jan Days	31
Feb Gallons	190,400,000	Feb Days	28
Mar Gallons	152,600,000	Mar Days	31
Apr Gallons	257,200,000	Apr Days	30
May Gallons	217,400,000	May Days	31
Jun Gallons	204,400,000	Jun Days	30
Jul Gallons	319,500,000	Jul Days	31
Aug Gallons	343,700,000	Aug Days	31
Sep Gallons	766,700,000	Sep Days	30
Oct Gallons	209,200,000	Oct Days	31
Nov Gallons	217,200,000	Nov Days	30
Dec Gallons	386,800,000	Dec Days	31
Total Gallons	3,462,600,000	Total Days	365

REPORT SUBMISSION INFORMATION

Submitted By: Chris Conroy
Submitted On: 06/24/2011
Submitted By Email: chris.conroy@exeloncorp.com