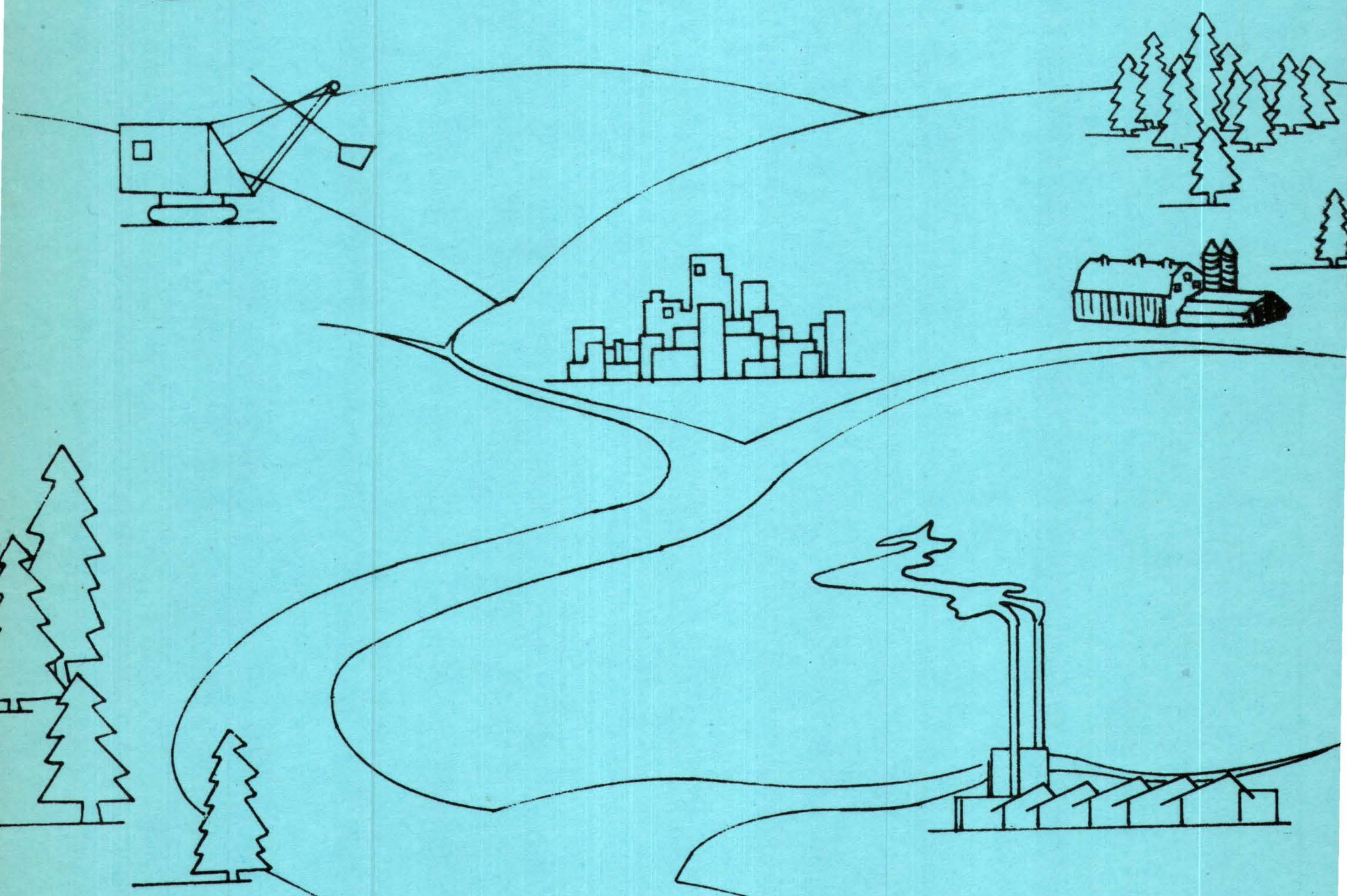
Preliminary Results of Preimpoundment Water-Quality Studies in the Tioga River Basin, Pennsylvania and New York

U.S. GEOLOGICAL SURVEY
WATER RESOURCES INVESTIGATIONS
76-66



Prepared in cooperation with the
U.S. ARMY CORPS OF ENGINEERS, BALTIMORE DISTRICT
SUSQUEHANNA RIVER BASIN COMMISSION

BIBLIOGRAPHIC DATA SHEET	1. Report No.	2.	3. Recipient's Accession No.
4. Title and Subtitle Preliminary Results of Preimpoundment Water-Quality Studies in the Tioga River Basin, Pennsylvania and New York			5. Report Date July 1976 6.
7. Author(s) Janice R. Ward			8. Performing Organization Rept. No. USGS/WRI 76-66
9. Performing Organization Name and Address U.S. Geological Survey, Water Resources Division P. O. Box 1107 Harrisburg, Pennsylvania 17108			10. Project/Task/Work Unit No. 11. Contract/Grant No.
12. Sponsoring Organization Name and Address U.S. Geological Survey, Water Resources Divsiion P. O. Box 1107 Harrisburg, Pennsylvania 17108			13. Type of Report & Period Covered Interim Sept. 1973 to May 1975 14.

15. Supplementary Notes Prepared in cooperation with the U.S. Army Corps of Engineers, Baltimore District, and the Susquehanna River Basin Commission.

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17. Key Words and Document Analysis. 17a. Descriptors

Acid mine water, acidity, alkalinity, mine drainage, carbonates, chemical analyses, *preimpoundment, *water quality

17b. Identifiers/Open-Ended Terms

Susquehanna River basin, Pennsylvania, New York

17c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
NO RESTRICTION ON DISTRIBUTION	UNCLASSIFIED	86
	20. Security Class (This Page) UNCLASSIFIED	22. Price

ERRATA SHEET

Page 22. Sulfate should be 250 mg/l.

Page 26. y axis label should read field alkalinity, in milligrams per litre as $CaCO_3$.

PRELIMINARY RESULTS OF PREIMPOUNDMENT WATER-QUALITY STUDIES IN THE TIOGA RIVER BASIN, PENNSYLVANIA AND NEW YORK

By Janice R. Ward

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations 76-66

Prepared in cooperation with

U.S. Army Corps of Engineers
Baltimore District, and the
Susquehanna River Basin Commission

July 1976

UNITED STATES DEPARTMENT OF THE INTERIOR

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GEOLOGICAL SURVEY

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FACTORS FOR CONVERTING ENGLISH UNITS TO INTERNATIONAL SYSTEM (SI) UNITS

Multiply English units	*By*	*To obtain (SI) units*
Inches (in)	25.40	Millimetres (mm)
Feet (ft)	.3048	Metres (m)
Miles (mi)	1.609	Kilometres (km)
Acres	.4047	Hectare (ha)
Square miles (mi^2)	2.590	Square kilometres (km^2)
Acre-feet (acre-ft)	1.233×10^{-3}	Cubic hectometres (hm^3)
Cubic feet per second (ft^3/s)	.02832	Cubic metres per second (m^3/s)

PRELIMINARY RESULTS OF PREIMPOUNDMENT WATER-QUALITY STUDIES IN THE TIOGA RIVER BASIN, PENNSYLVANIA AND NEW YORK

JANICE R. WARD

ABSTRACT

The Tioga River and its major tributaries were sampled monthly from September 1973 to May 1975. Water quality in the Tioga River is degraded by acid-mine drainage entering the stream near Blossburg from both strip- and deep-mined areas. The stream supports few species of aquatic life from Blossburg to its confluence with Crooked Creek. Alkaline water of tributaries Mill Creek, Crooked Creek, and the Cowanesque River counteract the acidity carried downstream from Blossburg, and the water quality of the Tioga River gradually improves, supporting a more diversified population of fish and aquatic life.

All of the streams in the Tioga River basin carry nutrients sufficient for algae blooms. Dissolved solids range from very high to moderately high throughout the basin. The Tioga River has high concentrations of sulfate and heavy metals, particularly iron and manganese. Dissolved oxygen was usually above 80 percent saturation and never dropped below 7.0 milligrams per litre throughout the basin.

Relationships between selected water-quality parameters have been developed for the sampling stations throughout the basin. Downstream trends were also examined. The relationships will be further refined and implemented in predictive water-quality models as more data are collected.

INTRODUCTION

Three impoundments have been proposed for the Tioga study area by the Baltimore District, U.S. Army Corps of Engineers. They are designed mainly for flood control, but will also provide recreational areas and may improve water quality over that at present downstream from the proposed dams. Two of the reservoirs, Tioga and Hammond Lakes, are presently under construction and will be completed in 1977. Cowanesque Lake is in the planning stages and will be started in the near future.

Since 1973, the U.S. Geological Survey in cooperation with the Corps, has been studying preimpoundment water quality of the Tioga River and its two major tributaries in north-central Pennsylvania in order to provide information useful in the design and operation of the impoundments for optimum water-quality improvement. Hammond Lake will impound alkaline water from Crooked Creek, whereas Tioga Lake will be fed by predominantly acid water from the Tioga River. The acid is a result of mine drainage into tributaries Bear Creek, Coal Creek, and Morris Run, which flow into the Tioga River at Blossburg, Pa. The acid drainage has adversely affected water quality as far as 38 mi (61 km) downstream from active or previously strip- and deep-mined areas.

The main purpose of the impoundments is to alleviate future flooding. Major floods occurred in 1865 and 1946, and in June 1972 tropical storm Agnes flooded the Tioga River and its major tributaries, causing millions of dollars of damage. Other expected benefits of the impoundments are improved water quality and enhanced recreational opportunities in Tioga County. This report summarizes results of the first 21 months of this study.

DESCRIPTION OF THE STUDY AREA

The Tioga study area encompasses a drainage area of 771 mi^2 (2,000 km^2), of which 609 mi^2 (1,580 km^2) lie in Pennsylvania (fig. 1). The Tioga River originates in western Bradford County, Pa., and flows southwestward through Blossburg in Tioga County. From Blossburg the river flows northward for about 25 mi (40 km) to Lindley, N. Y., the downstream limit of the study area. The Tioga River continues north from Lindley and joins the Cohocton River at Painted Post, N. Y., to form the Chemung River, which flows southeast for 45 mi (72 km) to the Susquehanna River.

Steep woodlands and wide valleys characterize the Tioga study area, which lies in the Allegheny Plateau physiographic province. Shale and sandstone dominate the geologic formations, accompanied by coal deposits mined largely in the area just east of Blossburg, Pa.

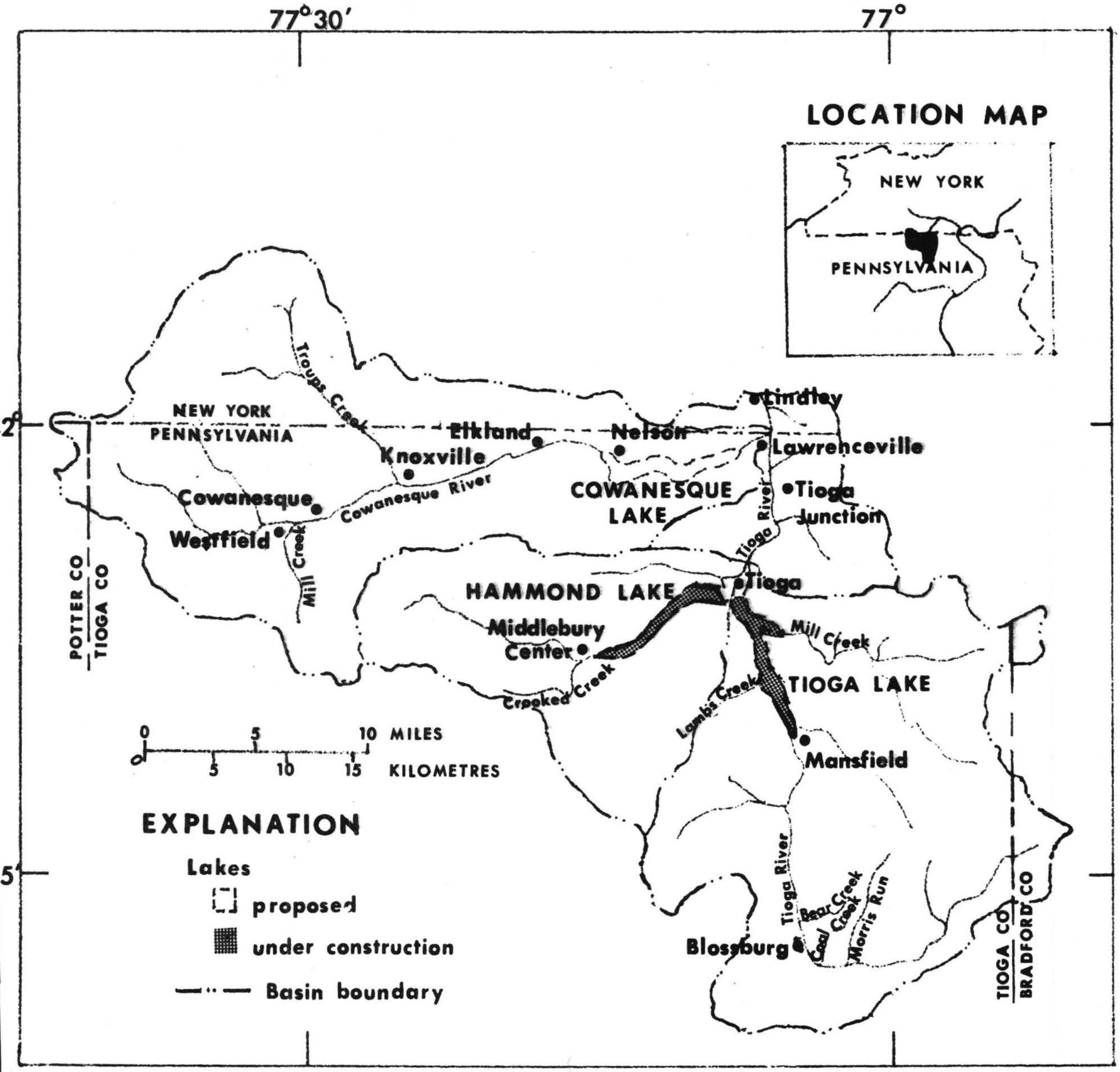


Figure 1.--The Tioga River basin above Lindley.

The average annual precipitation based on 70 years of record is about 38 in (965 mm). On the average, 39 percent of the rainfall becomes runoff and 61 percent is evapotranspired. The mean temperature is 48°F (9°C). Lows usually occur in January and February and highs in July and August.

The largest communities in the Tioga study area are the boroughs of Elkland and Westfield in the Cowanesque River basin and Mansfield in the Tioga River basin. The major part of the study area is forested, although a shift has occurred in the past few years from cultivated land to pasture and forest. Dairy and grassland farming are the main agricultural activities in the area.

LOCATION AND DESCRIPTION OF IMPOUNDMENTS

The Tioga dam (fig. 2) will cross the Tioga River 1.7 mi (2.7 km) upstream from the confluence with Crooked Creek, and the reservoir at spillway elevation will stretch 9.9 mi (15.9 km) upstream into Mansfield, Pa. The Hammond dam will be on Crooked Creek 3.3 mi (5.3 km) upstream from the confluence with the Tioga River, and the reservoir at spillway elevation will extend about 7.8 mi (12.6 km) upstream toward Middlebury Center, Pa. The Cowanesque dam will be on the Cowanesque River 2.2 mi (3.5 km) upstream from its confluence with the Tioga River and will extend about 8 mi (12.9 km) upstream at spillway elevation toward Elkland. Some basic information about the planned impoundments is given in table 1.

The Corps of Engineers plans to build a connecting channel between the Tioga and Hammond Lakes to permit water storage in both the Tioga River and Crooked Creek drainage basins, allowing both reservoirs to be operated as one flood control project. The channel will be a weir with a crest elevation at 1,101 ft msl (336 m msl). It will have a gate structure and a tunnel with an invert at 1,058 ft msl (322 m msl) to allow flow to pass from Tioga Lake to Hammond Lake or vice versa, depending on the elevations of the two lakes.

The main outlet of Tioga-Hammond Lake will be at the Tioga dam. The outlet works are planned for multi-level withdrawal. Under normal conditions, alkaline Crooked Creek water in Hammond Lake will flow through the weir into Tioga Lake and mix with Tioga River water flowing out of the main outlet works of Tioga dam. Normal outflow from Hammond Lake also will be through a 36 in (914 mm) conduit into Crooked Creek.

During extreme floods, water from Tioga Lake will flow through the weir into Hammond Lake and over an ungated spillway into Crooked Creek. Extreme flood flows in Hammond Lake will pass either over the weir into Tioga Lake or over the ungated spillway from Hammond Lake into Crooked Creek.

Outflow from Cowanesque Lake will normally be through a multi-level outlet works into the Cowanesque River. Flood flows will pass over an ungated spillway

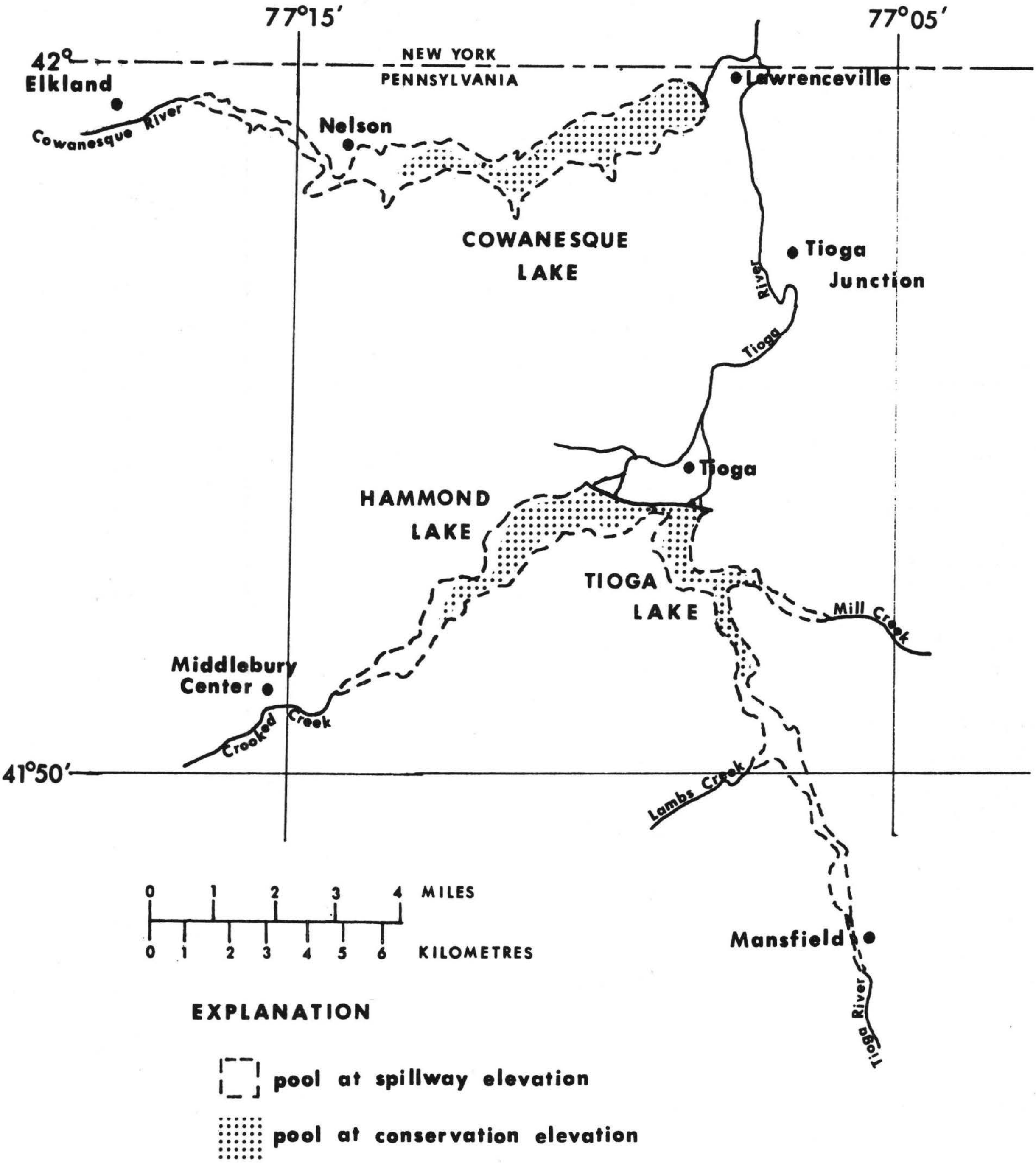


Figure 2.--Location of Tioga, Hammond and Cowanesque Lakes.

Table 1.--Summary of pertinent physical information for the Tioga, Hammond, and Cowanesque Lakes.

	Tioga Lake	Hammond Lake	Cowanesque Lake
Drainage area (mi^2)	280	122	298
Summer pool area (acres)	480	660	410
Summer pool storage (acre-ft)	9,600	8,800	6,975
Maximum summer pool depth (ft)	50	39	45
Spillway elevation (ft msl)	1,131	1,131	1,117
Spillway storage (acre-ft)	62,000	63,000	89,000
Top elevation (ft msl)	1,171	1,168.5	1,151

LOCATION AND DESCRIPTION OF SAMPLING SITES

Beginning in September 1973 water-quality samples were initially collected on a monthly basis for 1 year at 13 sampling sites (fig. 3). After the initial period of data collection, one new site was added and one was moved. A complete list of sampling sites and USGS identification numbers is given in table 2.

Tioga River at Lambs Creek is 6 mi (9.6 km) downstream from Blossburg. It was the closest sampling site to the acid-mine drainage entering the Tioga River near Blossburg before the station on the Tioga River near Mansfield was added in May 1975. Data for Mill Creek near Tioga permits assessment of the water quality at the mouth of Mill Creek, a major tributary of the Tioga River and of the proposed Tioga Lake. The next site, Tioga River at Tioga is located at the proposed damsite for Tioga Lake.

Crooked Creek at Middlebury Center is at the upstream end of Hammond Lake on Crooked Creek. Both Crooked Creek at Tioga stations are near the damsite of Hammond Lake. Water quality for the Tioga River at Tioga Junction, 1.8 mi (2.9 km) downstream from the confluence of the Tioga River and Crooked Creek, reflects the character of water resulting from the mixture of the water of the two streams.

Data from stations on the Cowanesque River at Westfield, Mill Creek at Westfield, and Cowanesque River at Cowanesque indicate the effects of the town of Westfield on the water quality of the Cowanesque River. The station on Troups Creek at Knoxville shows the water quality of that stream, which is a major tributary to the Cowanesque River. The station Cowanesque River at Nelson is near the upstream site of Cowanesque Lake, and data from there are used to evaluate the water quality near the planned inflow of Cowanesque Lake.

The station on the Cowanesque River near Lawrenceville is at the proposed damsite of Cowanesque Lake. Tioga River at Lindley is 1.1 mi (1.8 km) downstream from the junction of the Cowanesque and Tioga Rivers and can be used to evaluate the changes that may occur in the water quality of the Tioga River before and after construction of all three lakes.

SAMPLE COLLECTION

Sampling during the first year of the study consisted of collecting monthly data at 13 sites (fig. 4). The chemical and physical properties that were measured are grouped into three categories, as shown in table 3. In May 1974 the Geological Survey, in cooperation with the Susquehanna River Basin Commission, began collecting additional samples at the four Tioga River sites for determination of heavy metals. The sites are shown in figure 4, and the metals analyzed are listed in table 3. Sample collection, storage, and analysis followed methods outlined in Brown and others (1974).

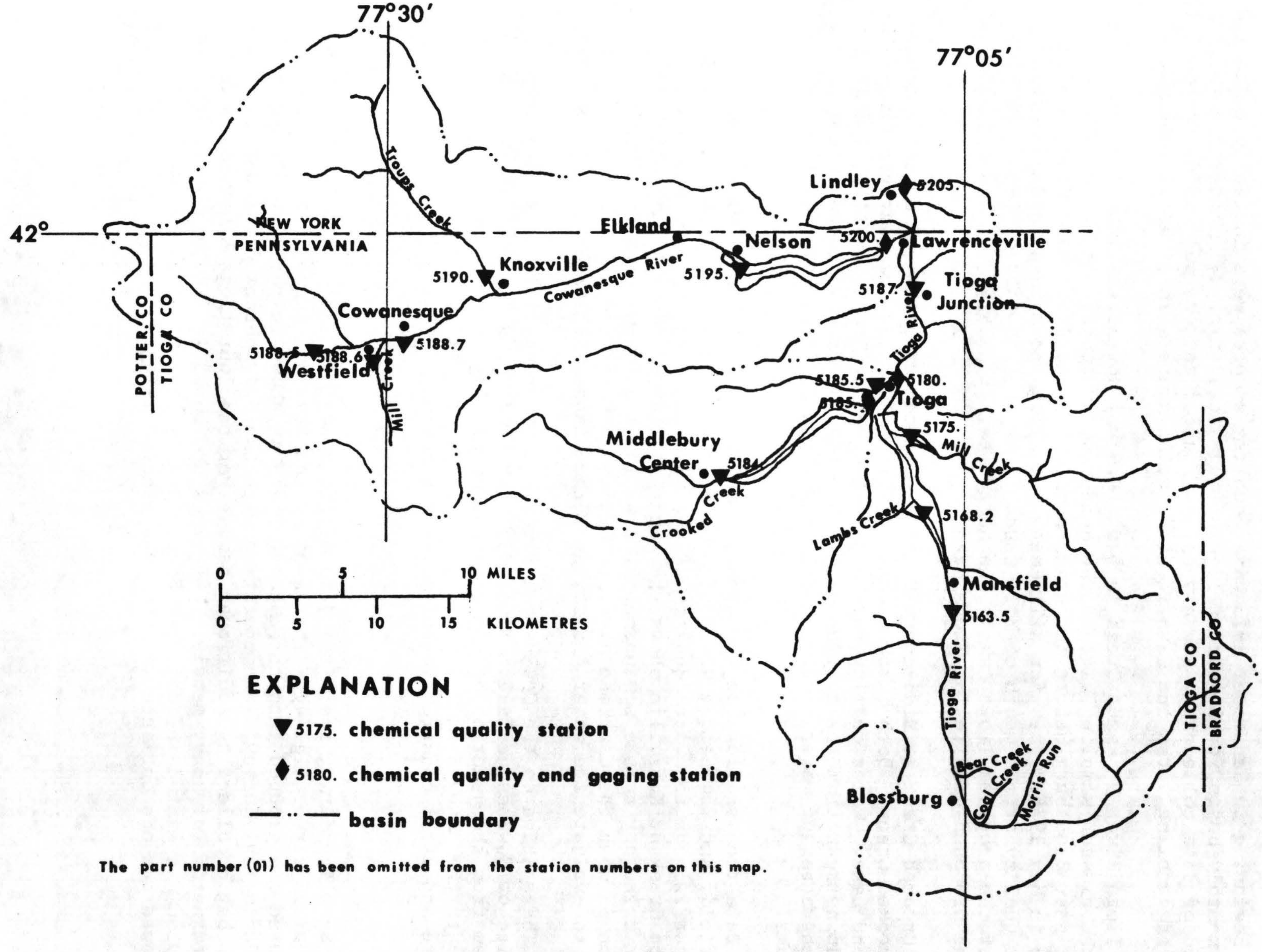
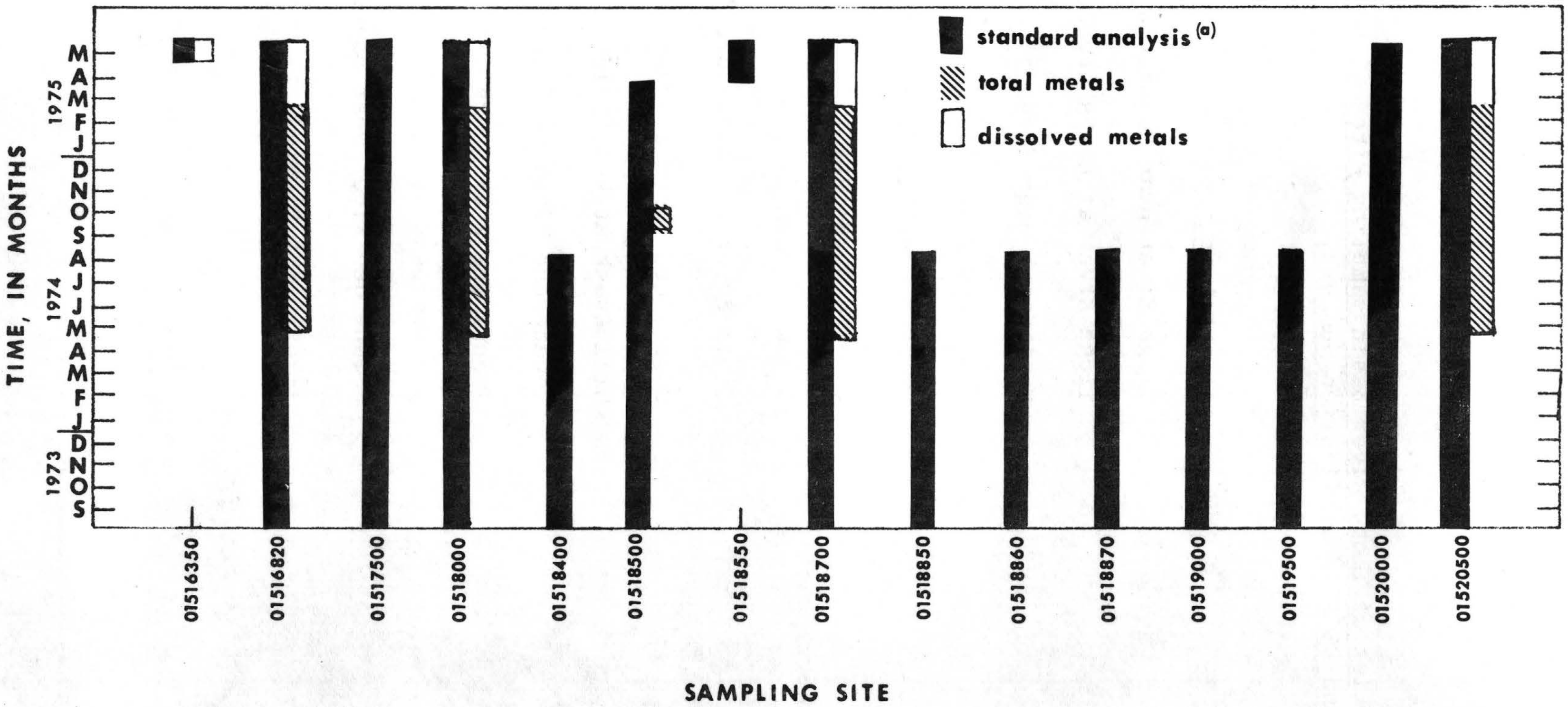


Figure 3.--Location of sampling sites from September 1973 to May 1975.

Table 2.--List of Tioga River basin sampling sites and USGS identification numbers.

USGS identification number	Station name
01516350	Tioga River near Mansfield
01516820	Tioga River at Lambs Creek
01517500	Mill Creek near Tioga
01518000	Tioga River at Tioga
01518400	Crooked Creek at Middlebury Center
01518500	Crooked Creek at Tioga
01518550	Crooked Creek at Tioga
01518700	Tioga River at Tioga Junction
01518850	Cowanesque River at Westfield
01518860	Mill Creek at Westfield
01518870	Cowanesque River at Cowanesque
01519000	Troups Creek at Knoxville
01519500	Cowanesque River at Nelson
01520000	Cowanesque River near Lawrenceville
01520500	Tioga River at Lindley, N.Y.



[a]See table 3 for listing of constituents in each analysis

Figure 4.--Sampling schedule for the Tioga River basin, September 1973 to May 1975.

Table 3.--Water-quality analyses for the Tioga River basin.

Field Measurements	Laboratory determinations	
Discharge (cfs)	Total alkalinity as $CaCO_3$ (mg/l)	Total nitrate as N (mg/l)
pH (units)	Total acidity as $CaCO_3$ (mg/l)	Total ammonia as N (mg/l)
Specific conductance (micromhos at 25°C)	Specific conductance (micromhos/cm at 25°C)	Total organic nitrogen as N (mg/l)
Water temperature (°C)	pH (units)	Total Kjedahl nitrogen as N (mg/l)
Total alkalinity as $CaCO_3$ (mg/l)	Sulfate (mg/l)	
Total acidity as $CaCO_3$ (mg/l)	Chloride (mg/l)	Total phosphorus as P (mg/l)
Dissolved oxygen (mg/l)	Suspended sediment concentration (mg/l)	Total orthophosphate as P (mg/l)

Metal Samples (µg/l)

Aluminum	Iron
Arsenic	Lead
Cadmium	Manganese
Chromium	Mercury
Cobalt	Selenium
Copper	Silver
Zinc	

After 1 year's basic data had been compiled throughout the Tioga River basin, several changes in the sampling program were adopted for more intensive collection in the area surrounding the planned Tioga and Hammond Lakes. Sampling beginning in September 1974 continued monthly at only seven of the 13 original sites: Tioga River at Lambs Creek, Mill Creek near Tioga, Tioga River at Tioga, Crooked Creek at Tioga, Tioga River at Tioga Junction, Cowanesque River near Lawrenceville, and Tioga River at Lindley. The constituents sampled remained the same as listed previously.

Starting in March 1975, the total-metal analyses at the four sites on the Tioga River were replaced with determinations of dissolved metals. In April 1975 sampling at Crooked Creek at Tioga was discontinued at the original site and re-established 2.0 mi (3.2 km) downstream because of construction in the area. In May 1975, a new sampling site was established at Tioga River near Mansfield for the evaluation of water quality above Tioga Lake. Plans for gaging stations at Tioga River near Mansfield, Tioga River at Tioga Junction, and a relocation of the gage now at Cowanesque River at Lawrenceville are underway for fiscal year 1976. Continuous specific conductance, pH, water temperature, and dissolved oxygen will be monitored at Tioga River near Mansfield and Tioga River at Tioga Junction.

PREIMPOUNDMENT WATER QUALITY RESULTS

The Tioga River basin is broken down into five sections, as shown in figure 5, for ease of discussion. Section 1 includes the Tioga River from headwaters to confluence with Crooked Creek. Section 2 includes the entire Crooked Creek River basin. Section 3 includes the Tioga River below the Crooked Creek confluence to the Cowanesque River, and section 4 includes the whole Cowanesque River basin. The Tioga River below its confluence with the Cowanesque River to Lindley, N. Y., constitutes section 5 and completes the study area. Table 4 summarizes the results of water-quality sampling in each study section. Dissolved oxygen was not included in the table because it was nearly always above 80 percent saturation at all sampling sites during the study. The complete tabulation of the results of water-quality sampling from September 1973 to May 1975 is listed in table 6.

Section 1

Almost all of the acid mine drainage that affects the Tioga River is contributed by three small tributaries near Blossburg: Morris Run, Coal Creek and Bear Creek (fig. 6). The area around the village of Morris Run has been extensively deep- and strip-mined. The deep mines are drift mines, which allow water to flow by gravity through and out of the mines, thus eliminating the necessity of pumping. There is presently no active deep mining in the area, and rainfall percolates into and flows through the abandoned deep mines, producing acid mine water that discharges at several places in the basin, into the three acid tributaries, and then into the Tioga River.

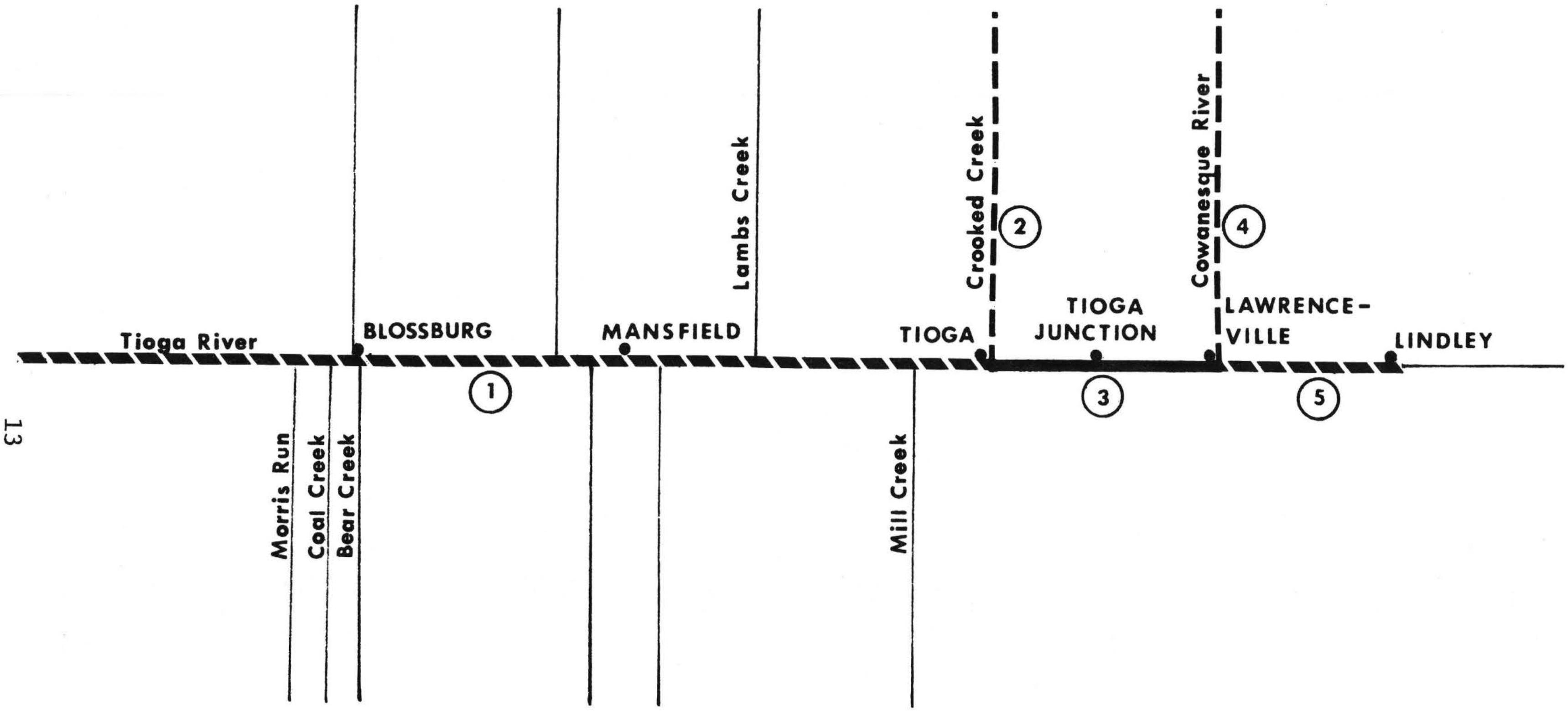


Figure 5.--Tioga River basin study sections.

Table 4.--Maximum, minimum and median results for selected parameters in the Tioga study area.

Station name	Discharge (cfs)	Field pH (units)	Lab specific conductance (micromhos per cm at 25°C)	Field net alkalinity (mg/1)	Total nitrate as N (mg/1)	Total organic nitrogen as N (mg/1)	Total inorganic nitrogen as N (mg/1)	Total phosphorous as P (mg/1)	Sulfate (mg/1)	Chloride (mg/1)	Total iron (µg/1)	Total manganese (µg/1)	Total aluminum (µg/1)	Total zinc (µg/1)
01516820	1,500	6.6	587	-1	.60	.56	2.01	.29	256	10.0	3,400	8,400	12,000	1,300
Tioga River at	29	3.4	109	-160	.23	.08	.28	.02	25	2.5	500	610	20	90
Lambs Creek	190	4.4	223	-51	.57	.20	.73	.04	84	5.6	1,550	2,900	2,900	490
01517500	473	8.9	214	69	1.10	.35	1.17	.08	1.10	10.0				
Mill Creek	6.3	6.3	109	11	.02	.13	.09	.01	.02	2.5	----	----	----	----
near Tioga	76	8.1	137	39	.45	.24	.50	.02	.45	6.0				
01518000	1,880	6.9	413	22	.93	.69	.95	.15	188	11.0	2,600	5,900	7,400	3,100
Tioga River	30	4.3	105	-69	.16	.06	.19	.01	27	2.1	150	450	10	60
at Tioga	255	5.6	192	-6	.59	.18	.69	.03	64	6.0	780	2,000	2,350	255
01518400	453	8.9	225	a/73	1.20	.50	1.27	.36	24	12.0				
Crooked Creek at	3.3	6.2	93	18	.11	.12	.19	.01	14	2.5	----	----	----	----
Middlebury Center	39	7.2	172	53	.39	.21	.43	.03	18	7.4				
01518500	811	8.2	221	79	.88	.66	1.28	.61	28	10.0				
Crooked Creek	10.1	6.4	111	23	.02	.16	.11	.01	15	3.5	----	----	----	----
at Tioga	66	7.3	146	37	.50	.29	.57	.07	19	5.8				

01518700	2,900	7.8	329	31	1.50	1.30	1.64	.49	123	10.0	4,500	5,700	2,600	580
Tioga River	45	5.6	108	-2	.16	.05	.25	.01	25	2.1	20	470	0	60
at Tioga	460	6.9	171	8	.45	.23	.64	.05	51	6.0	715	1,250	1,230	125
01518850	272	8.5	204	a/59	1.00	.36	1.03	.06	23	19				
Cowanesque River	3.1	6.4	88	14	.05	.18	.10	.01	12	2	----	----	----	----
at Westfield	18	7.3	122	31	.44	.21	.44	.03	16	4.4				
01518860	59	9.4	368	a/107	1.00	.48	1.17	.19	32	36				
Mill Creek at	1.2	6.2	129	30	.09	.25	.12	.03	17	5	----	----	----	----
Westfield	7.5	8.0	205	54	.62	.38	.77	.09	20	13				
01518870	540	8.7	572	a/110	1.00	.81	1.32	.14	54	93				
Cowanesque River	7.6	6.4	114	22	.10	.19	.13	.01	17	4	----	----	----	----
at Cowanesque	33	8.0	220	45	.48	.47	.66	.04	24	24				
01519000	312	8.8	239	a/97	1.80	.68	1.90	.11	30	12				
Troups Creek	2.6	6.1	124	27	.20	.19	.25	.01	16	4	----	----	----	----
at Knoxville	14.5	8.0	205	63	.78	.30	.62	.01	21	7.5				
01519500	1,430	9.3	364	a/88	1.90	.63	2.07	.10	38	47				
Cowanesque River	17	6.4	133	28	.02	.20	.10	.02	19	5.5	----	----	----	----
at Nelson	93	7.8	222	58	.60	.41	.65	.04	25	15				
01520000	1,400	9.1	352	90	1.20	.56	1.24	.20	35	39				
Cowanesque River	17	6.3	124	24	.05	.16	.06	.01	20	5	----	----	----	----
near Lawrenceville	175	7.8	189	48	.54	.30	.66	.04	25	14				
01520500	3,280	7.7	342	41	1.20	.21	1.23	.09	93	20	1,200	2,300	920	310
Tioga River	62	6.2	118	15	.08	.01	.12	.01	23	4	0	360	0	50
at Lindley	545	7.1	177	27	.50	.09	.71	.03	44	8.5	330	870	350	105

a/ Total alkalinity as $CaCO_3$ only available for this station.

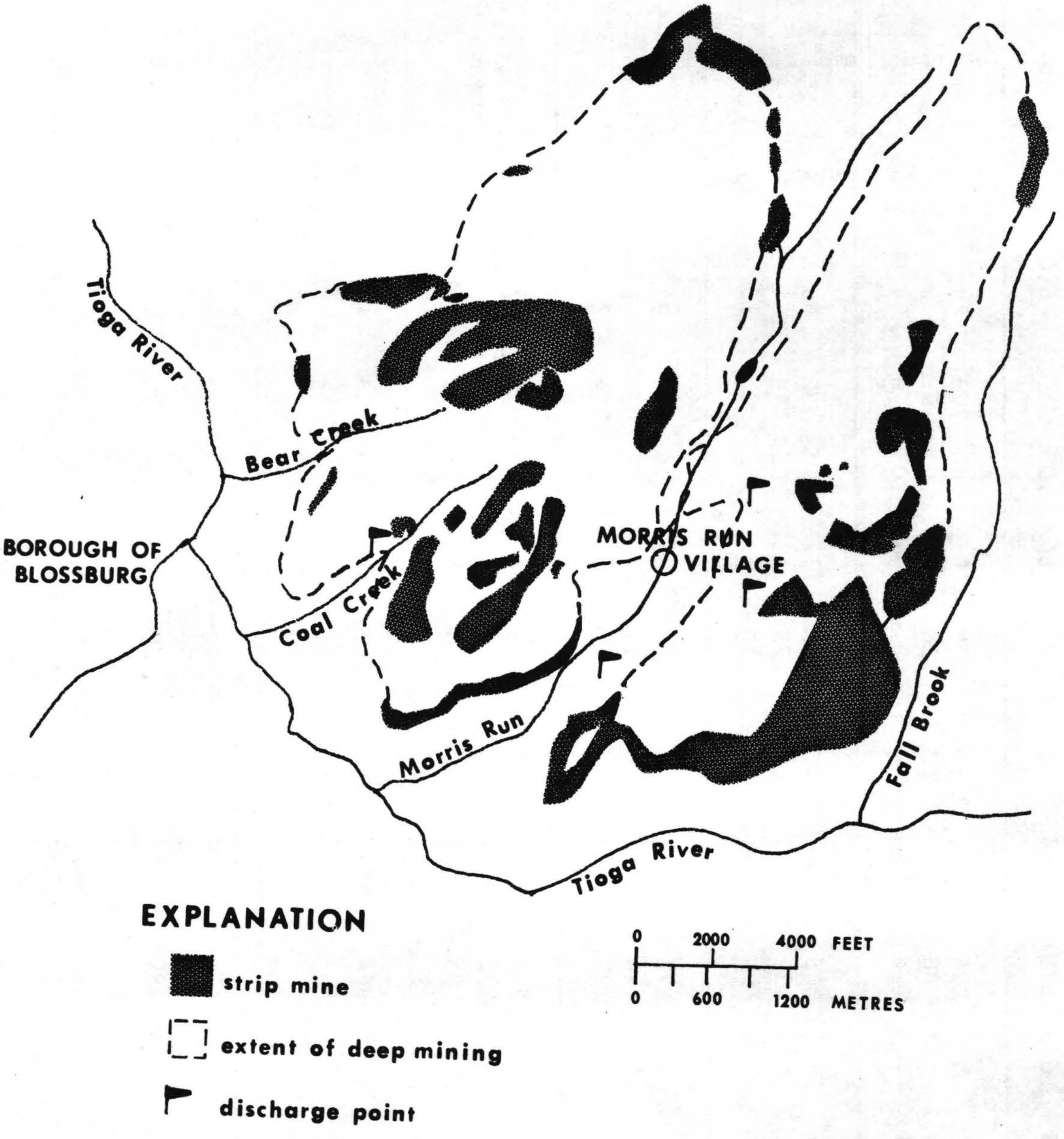


Figure 6.--Strip- and deep-mined areas showing major discharge points near Blossburg.

Acid mine drainage is produced by the oxidation of iron sulfide materials through contact with water and air, and it is possibly catalyzed by different species of iron bacteria. Ferrous sulfate and sulfuric acid are two major products of the oxidation of pyrite (FeS_2), a mineral commonly found in coal mines. Ferrous sulfate, in the presence of oxygen, oxidizes to form ferric sulfate, which then hydrolyzes to form insoluble ferric hydroxide and more sulfuric acid.

$$2FeS_2 + 7O_2 + 2H_2O \rightleftharpoons 2FeSO_4 + 2H_2SO_4$$

$$4FeSO_4 + 2H_2SO_4 + O_2 \rightleftharpoons 2Fe_2(SO_4)_3 + 2H_2O$$

$$Fe_2(SO_4)_3 + 6H_2O \rightleftharpoons 2Fe(OH)_3 + 3H_2SO_4$$

The oxidation of pyrite contributes large quantities of iron, acid, and sulfate to the receiving waters. As a result, the pH of the water is very low, often below pH 3, and many other metals besides iron are dissolved by the acidic water. As the water flows away from the source of contamination, it becomes more alkaline by dilution and reaction with contributions from tributaries and runoff. The iron begins to precipitate as the pH increases, forming a yellow-orange precipitate $Fe(OH)_3$, commonly known as yellow-boy, on the stream bottom. Other metals will also precipitate as their solubilities decrease with increasing pH, and the stream bottom becomes coated with precipitates.

Waters severely affected by acid mine drainage cannot support diversified aquatic life. Warm water fish cannot tolerate a pH below 5.5 and cannot reproduce in waters below pH 6.5. Cold-water species may tolerate a pH as low as 5.0 but cannot reproduce in waters below pH 6.0. At low pHs, little diversity is found in species of microorganisms, algae, and plants. With such a limited environment of aquatic life, recreational assets of acidic streams are restricted.

Of the four stations included in section 1, only Mill Creek near Tioga is not on the Tioga River. Water from Mill Creek, being less mineralized than that of the Tioga River, decreases the specific conductance found upstream at Tioga River at Lambs Creek by about 50 percent at low flow, 20 percent during median flow, and increases the conductance by as much as 10 percent at high flow over the range of flows sampled during the study period (fig. 7). For example, at a discharge of 200 ft^3/s (5.7 m^3/s) at Tioga River at Tioga, the specific conductance of the water is about 150 micromhos. The corresponding specific conductance at Tioga River at Lambs Creek is about 220 micromhos, a decrease of 32 percent.

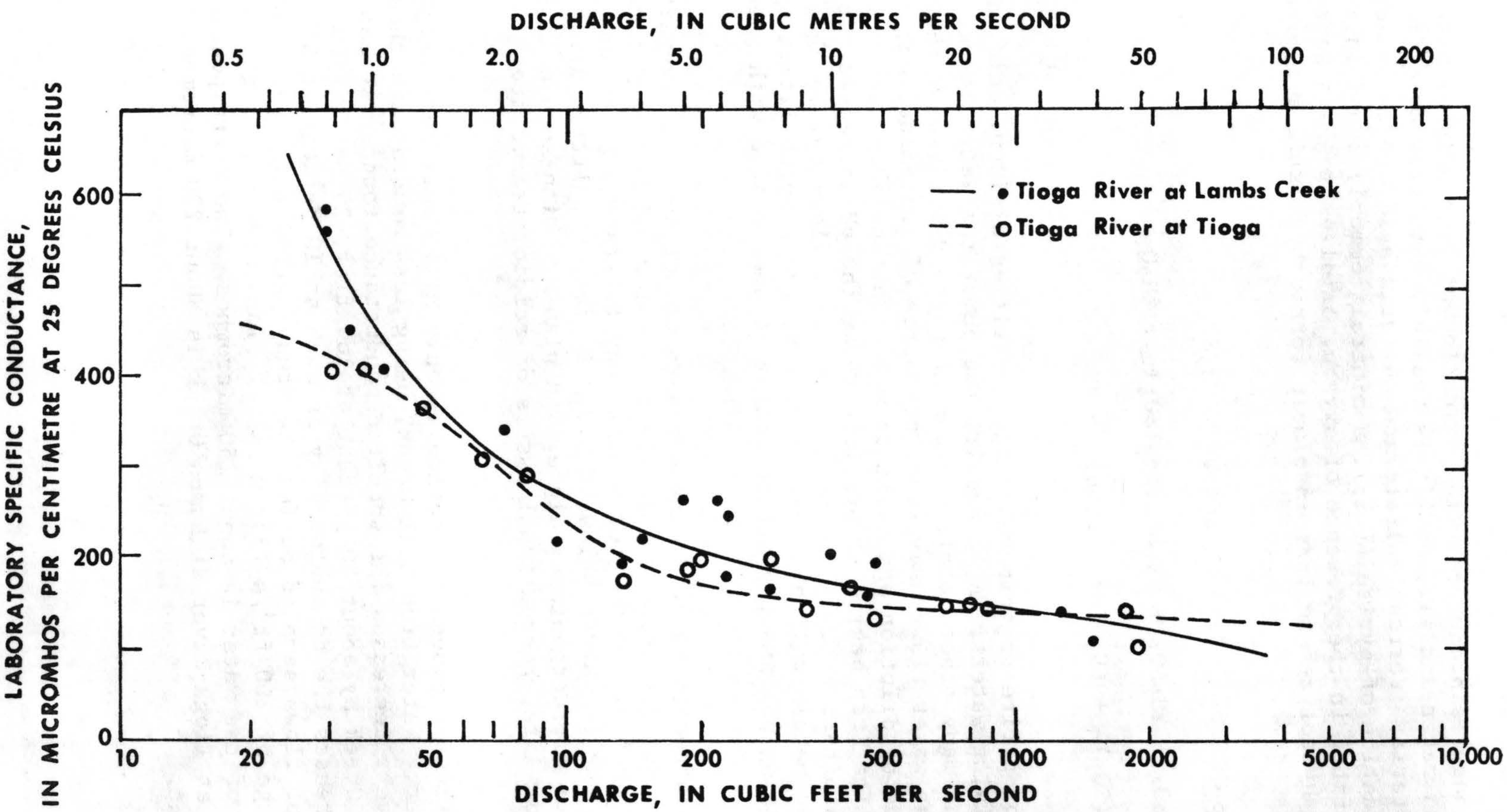


Figure 7.--Discharge versus laboratory specific conductance for two stations in section 1.

Figure 8 shows that net alkalinity[1/] also increases between Tioga River at Lambs Creek and Tioga River at Tioga because Mill Creek has about the same buffering capacity[1/] as Crooked Creek, but Mill Creek, because its discharge is only about 60 percent of that of Crooked Creek, does not enhance the water quality of the Tioga River as significantly as Crooked Creek does. Figure 9 illustrates that the relationship between pH and net alkalinity of the Tioga River is about the same at both Lambs Creek and Tioga.

The extent and degree of beneficial effects of Mill Creek on the impounded Tioga River water, when Tioga Lake is completed, will depend upon the mixing and stratification in the lake.

The station Tioga River near Mansfield was not included in the above discussion because only one sample was collected during the period covered in this report. Interpretation of water quality at this station will be included in the final report, although it is assumed here that the water should be of slightly lower quality than that at Tioga River at Lambs Creek because the Mansfield station is closer to the acid mine drainage.

Acidity is not the only problem associated with acid mine drainage. High sulfate and heavy metals concentrations are found throughout study section 1, with the exception of Mill Creek (table 4). Total iron and total manganese exceeded the U.S. Public Health Service (1962) maximum limits for drinking water at all of the sites on the Tioga River. The limits for selected parameters for drinking water are given in table 5. Sulfate, total iron, total manganese, total aluminum, and total zinc varied proportionately with discharge at all of the Tioga River sites. A discussion of the metals will be deferred until later in this report, where the entire Tioga River basin is discussed as a single unit.

The concentrations of inorganic nitrogen and total phosphorus in Section 1 are well above the minimum concentrations necessary to produce algae blooms in lakes. Sawyer and others (1947) found that a minimum of 0.30 mg/l of inorganic nitrogen as N and 0.01 mg/l of phosphorus as P could cause algae blooms. Even though heavy blooms have not been observed in the Tioga River, the nutrient load could cause nuisance blooms in Tioga Lake.

Section 2

As shown in table 4, Crooked Creek is an alkaline, moderately well buffered stream containing no excessive amounts of sulfate, chloride, or dissolved solids. As in section 1, nutrients in Crooked Creek are abundant enough to produce algae blooms if a favorable environment exists in Hammond Lake.

1/ Definition is found in section on buffer capacity, pp. 34-39.

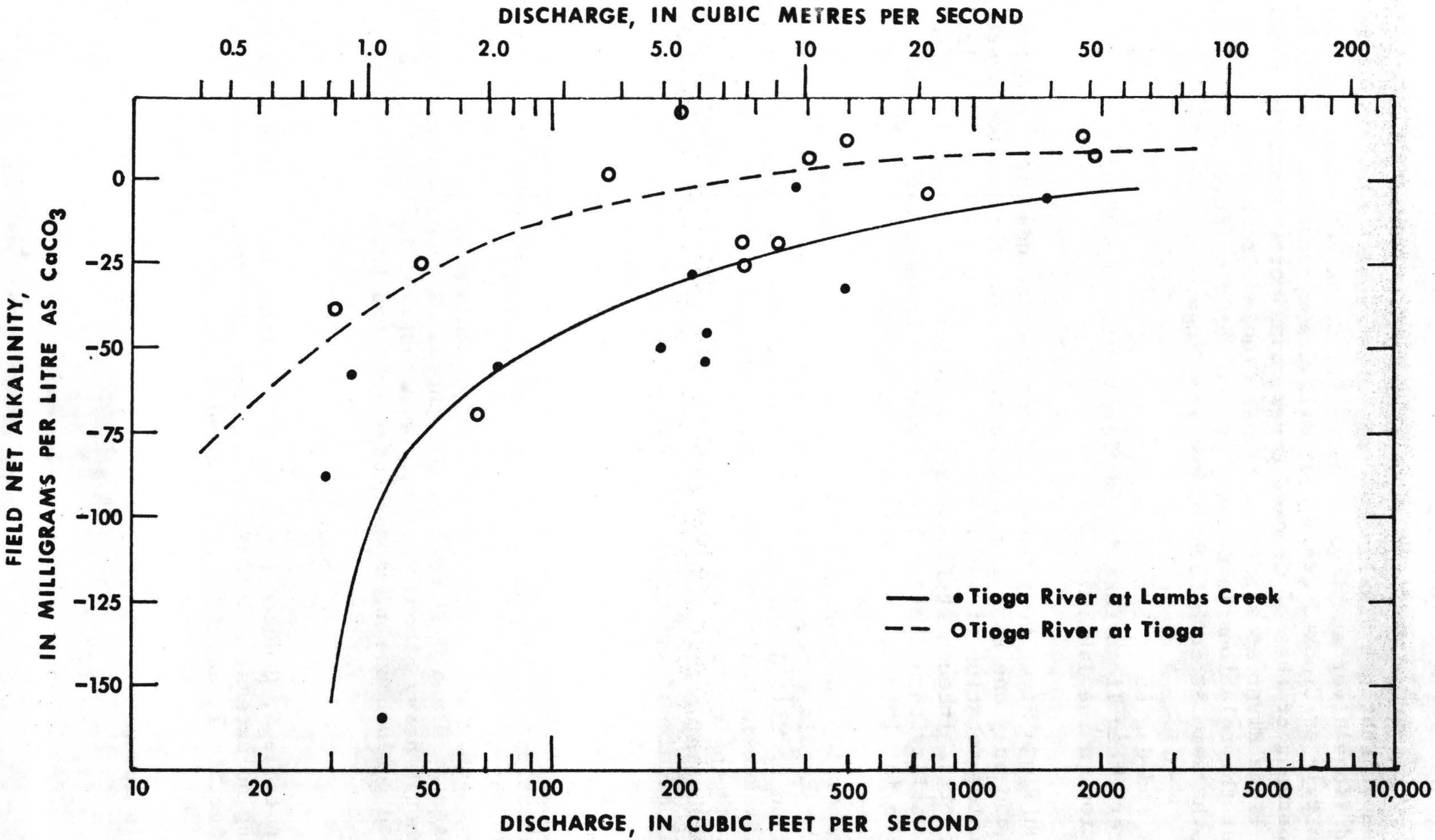


Figure 8.--Discharge versus field net alkalinity for two stations in section 1.

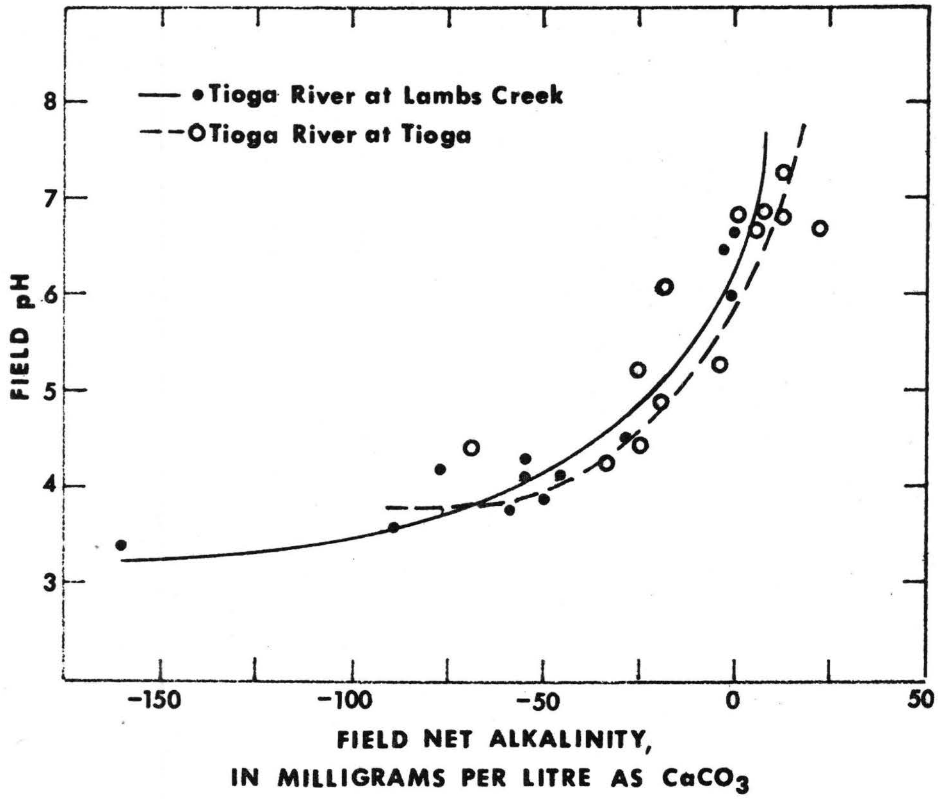


Figure 9.--Field net alkalinity versus field pH for two stations in section 1.

Table 5.--Minimum standards for drinking water and suggested stream criteria for fish and other aquatic life.

[Taken from Moran and Wentz, 1974]

(Results in milligrams per litre, except as noted)

Substnace	Drinking water standards	Suggested criteria for fish and other aquatic life
Arsenic	a/0.05 (0.01)b/	1.0
Barium	a/1.0	---
Cadmium	a/ .01	.01
Chloride	250	---
Chromium	---	.05
Cobalt	---	.50
Copper	b/1.0	.01-.02
Cyanide	a/ .20 (.01)b/	---
Iron	b/ .30	.30
Lead	a/ .05	.05-.10
Manganese	b/ .05	1.0
Mercury	a/ .005	.001
Nickel	---	.05
Nitrate as N	10.2	---
Selenium	a/ .01	1.0
Silver	a/ .05	.0001
Sulfate	.250	---
Zinc	b/5.0	.03-.07
pH (units)	$6 \le pH \le 9$	$6.5 \le pH \le 8.5$

a/ Maximum permissible concentration.

b/ Recommended limit.

One total-metals sample was collected at Crooked Creek at Tioga on October 10, 1973. Of the metals sampled, manganese (130 ug/l) and iron (1,300 ug/l) exceeded the U.S. Public Health Service (1962) drinking water standards.

Figures 10-12 illustrate the relationships found between discharge, laboratory specific conductance, field net alkalinity, and field pH at the two stations in the Crooked Creek basin.2/ Crooked Creek at Middlebury Center is representative of the inflow to Hammond Lake. Crooked Creek at Tioga illustrates the present water quality at the Hammond Lake damsite. After the lake has been constructed, the water quality at the damsite and the outflow from Hammond Lake will probably differ from that found at Crooked Creek at Tioga because of the influence of the impoundment, but measurement of the inflow and proposed damsite does give an indication of the water-quality changes which occur because of small tributary and rainfall contributions to the stream between the two sites.

Both figures 10 and 11 show that there is a good relationship between the parameters graphed. Figure 12 illustrates a general trend between pH and net alkalinity, but any predictions of net alkalinity from a measured pH and vice versa would result in gross errors. The relation between pH and net alkalinity holds throughout the study area, though some sites show more scatter than others.

Section 3

All of the acid mine drainage parameters apparent in section 1 are moderated by the effects of Crooked Creek in section 3, as measured at Tioga River at Tioga Junction. Heavy metals, sulfates, and nutrients are still excessively high, but a median pH of 5.6 permits more abundant aquatic life than found anywhere in the Tioga River from Blossburg to Tioga.

Specific conductance, pH, net alkalinity, and discharge varied similarly to that found at Tioga River at Tioga. Because Tioga and Hammond Lakes will be joined with water flowing between the two reservoirs, information defining the mixing capabilities of Tioga River and Crooked Creek water would be helpful in predicting future water quality of both the reservoirs and the Tioga River downstream from the two impoundments. A section concerning buffer capacity and the prediction of both net alkalinity and pH of mixtures of these waters is included later in this report.

2/ When field net alkalinity values were unavailable, total field alkalinity values were substituted.

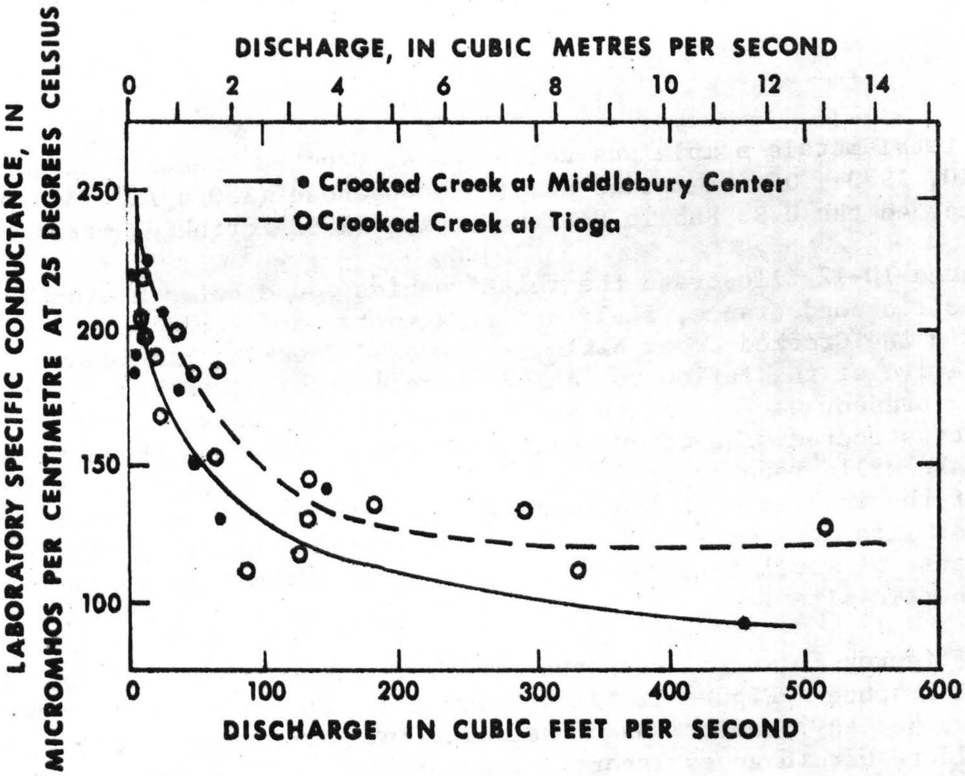


Figure 10.--Discharge versus laboratory specific conductance for section 2.

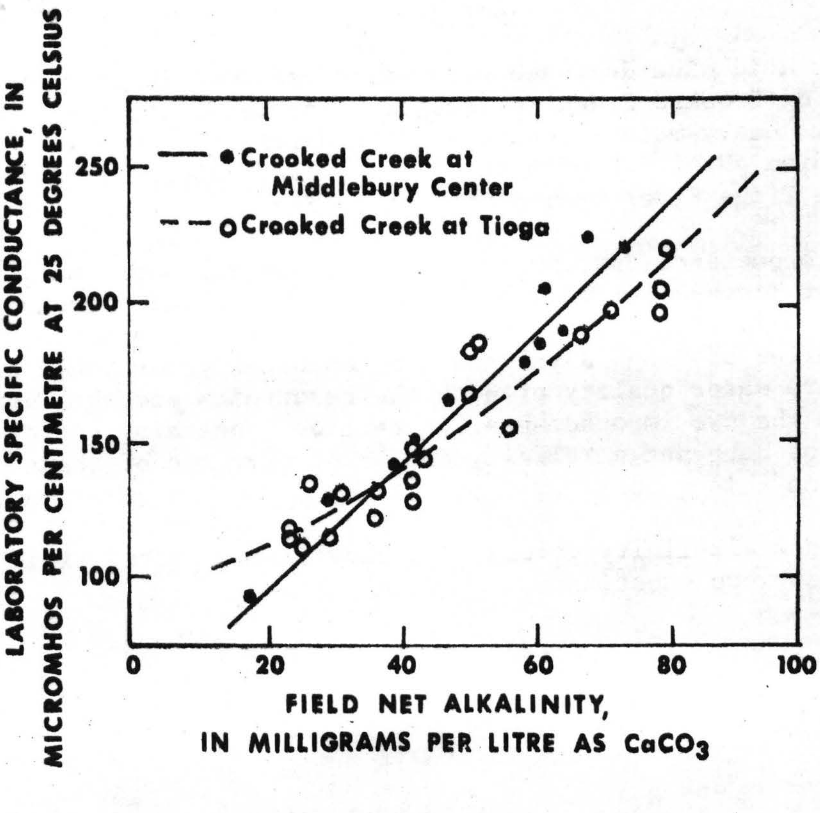


Figure 11.--Field net alkalinity versus laboratory specific conductance for section 2.

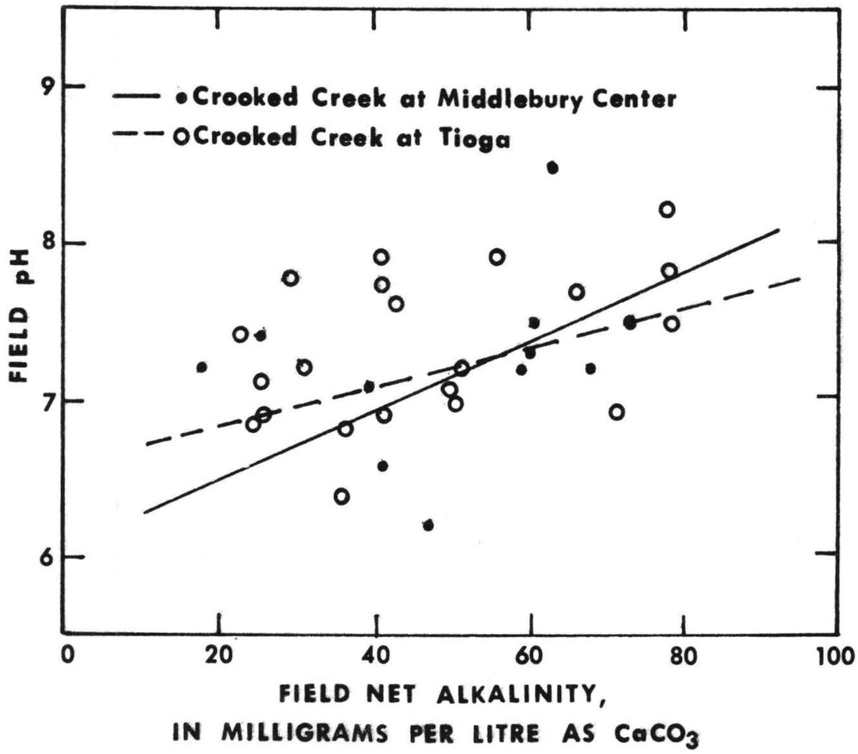


Figure 12.--Field net alkalinity versus field pH for section 2.

Section 4

The water quality of the Cowanesque River was evaluated using six stations from Westfield to Lawrenceville. All of the stations but Cowanesque River near Lawrenceville were discontinued after one year of data collection. The Cowanesque River is not affected by acid mine drainage, but does feel the effects of domestic and industrial pollution from the city of Westfield. Figures 13 and 14 illustrate the changes found in the water quality of the Cowanesque River from above to below Westfield (Cowanesque River at Westfield and Cowanesque River at Cowanesque). The maximum values of specific conductance, total alkalinity, and chloride below Westfield are well above those found anywhere else in the basin. Mill Creek, which discharges into the Cowanesque River at Westfield, carries tannery wastes that apparently produce high chlorides and specific conductances (table 4). Occasional high alkalinities and nutrient loads have also been found, accompanied by algae blooms and noxious odors.

Cowanesque Lake may have many problems with algae blooms and weed growth because of the high alkalinity and nutrient loads in the Cowanesque River. The high alkalinities in the Cowanesque River should insure that the releases from Cowanesque Lake are sufficient to neutralize any acidity still present in the Tioga River at Lawrenceville.

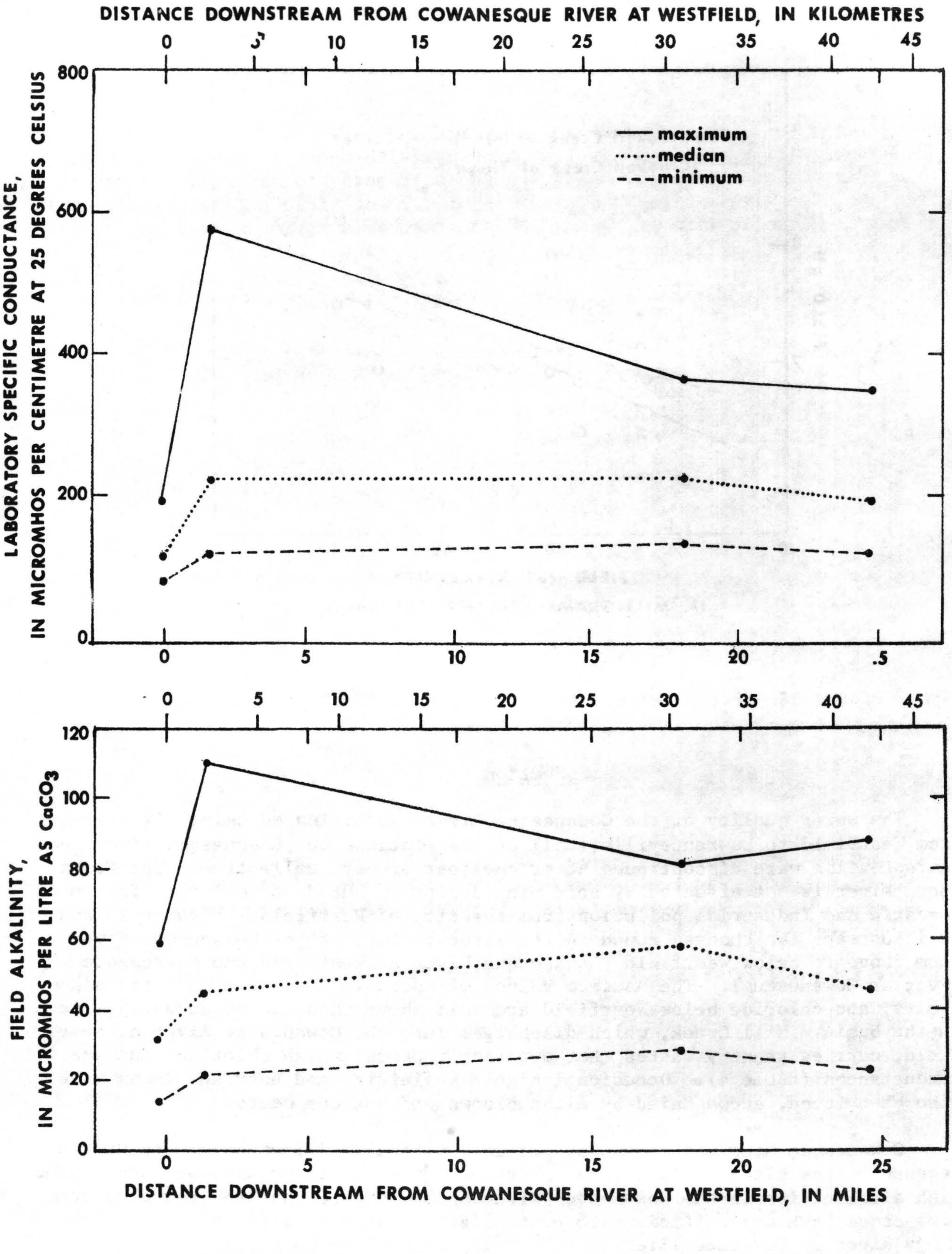


Figure 13.--Cowanesque River laboratory specific conductance and field alkalinity profiles.

Section 5

Water quality at Tioga River at Lindley is the best sampled along the Tioga River below Blossburg. Although the nutrients, total iron, and manganese still are excessively high, a minimum pH of 6.2 and field net alkalinity of 15 mg/l assure aquatic life of a continuously favorable environment. A biological study by Barker (1972) showed 7 families of macroinvertebrates, including mayflies, caddis flies, dolson flies, riffle beetles, and 18 species of fish at Tioga River at Lindley as compared with 6 families of macroinvertebrates and 8 species of fish at Tioga River at Tioga Junction and only one macroinvertebrate family found at Tioga River at Tioga.

TIOGA RIVER PROFILE

Figures 15 through 18 give an overall view of the water quality in the Tioga River. The maximum, minimum, and median flows obtained during the study period September 1973 to May 1975 were exceeded 37 percent of the time when compared to the past 33 years of streamflow record. This indicates that flows during this particular study period were about 13 percent higher than the average for the past 33 years and that water quality may be slightly different during a year of normal or below-normal flow. The maximum and minimum values shown are important when considering the environment of aquatic life present in the stream. Median values represent those conditions which have existed most often throughout the study period. Contributions to the Tioga River from Mill Creek, Crooked Creek, and the Cowanesque River may be estimated by interpolating between the respective stations marked along the Tioga River.

A total of 13 metals samples were collected at the Tioga River stations, including 10 total-metal and 3 dissolved-metal samples. A total-metal sample represents the concentration of the metal contained in the dissolved phase plus an indeterminate amount of the metal which is adsorbed to or present as an integral part of the structure of minerals which comprise the particulate material. A dissolved metal sample consists of that concentration of the metal which passes through a 0.45 micrometer filter paper. No relationships between pH or net alkalinity and total metals can be established at this time. There was a general relationship between total metal concentration and discharge, but the points had a considerable amount of scatter as shown in figure 19 for the four Tioga River stations.

Total aluminum and total iron increase with increasing discharge, and total manganese and total zinc decrease with increasing discharge at all four Tioga stations. Usually, one would expect total metal concentrations to decrease with increasing discharge because of dilution effects both from increased runoff and tributary contributions.

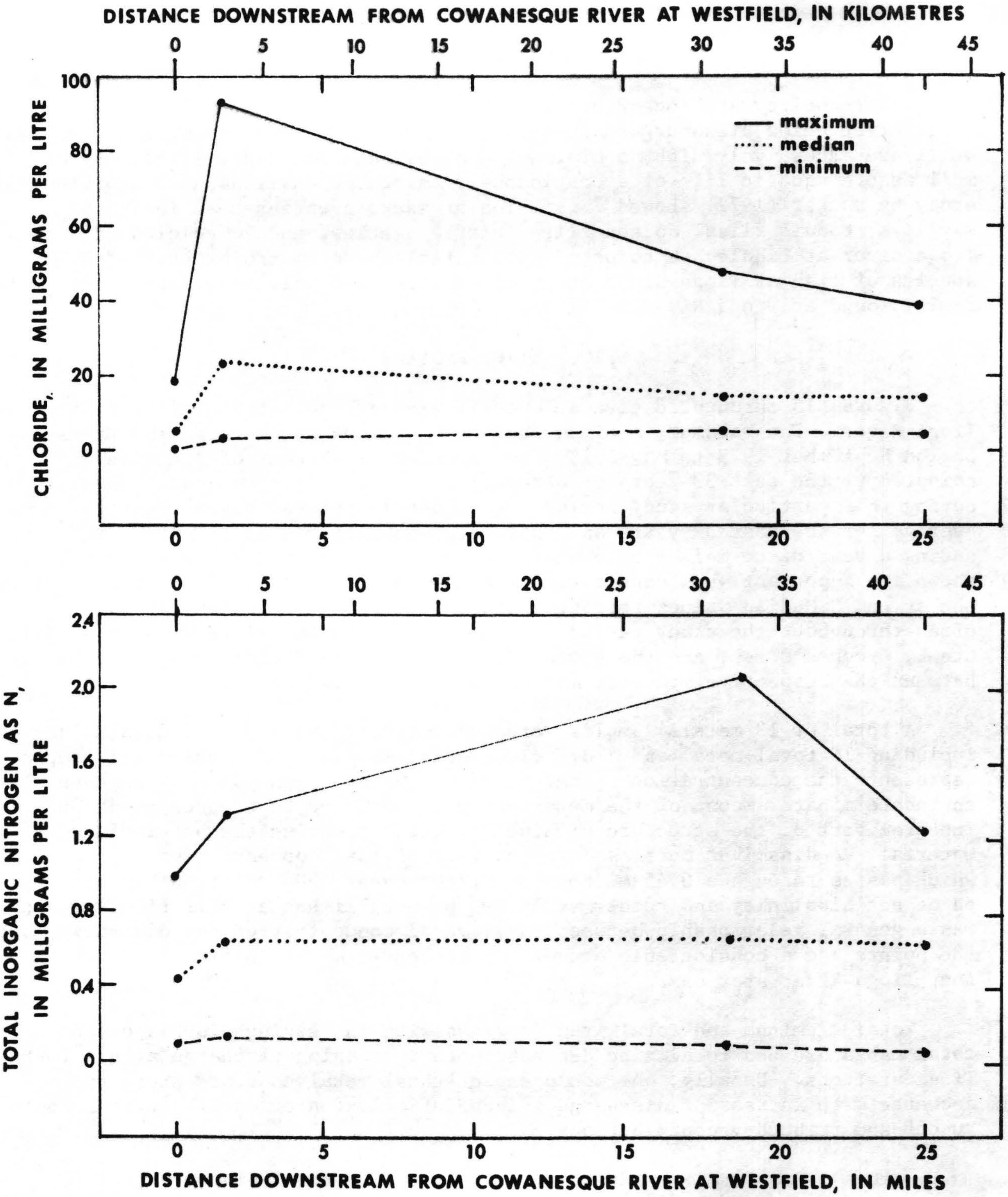


Figure 14.--Cowanesque River chloride and total inorganic nitrogen as N profiles.

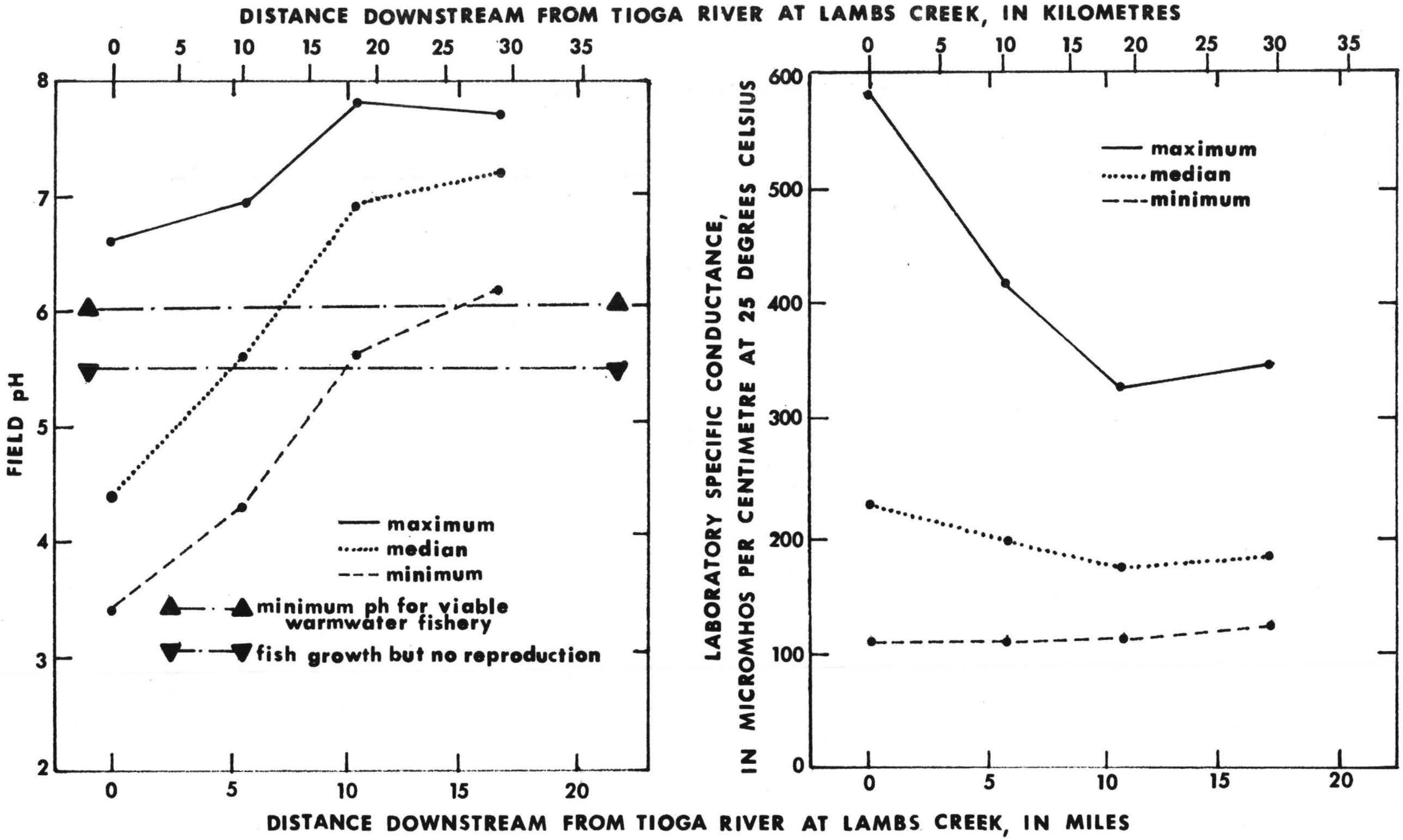


Figure 15.--Tioga River field pH and laboratory specific conductance profiles.

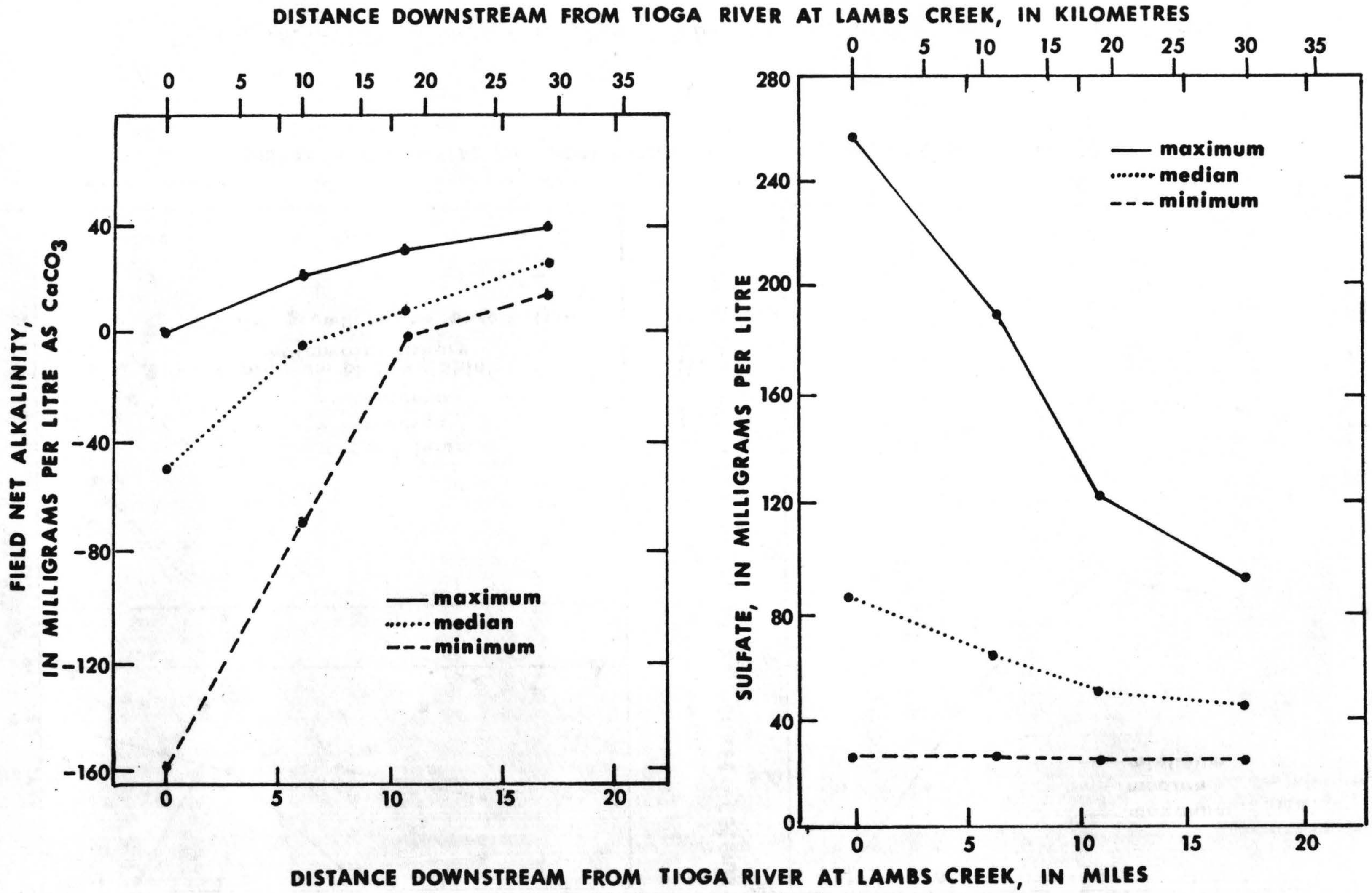


Figure 16.--Tioga River field net alkalinity and sulfate profiles.

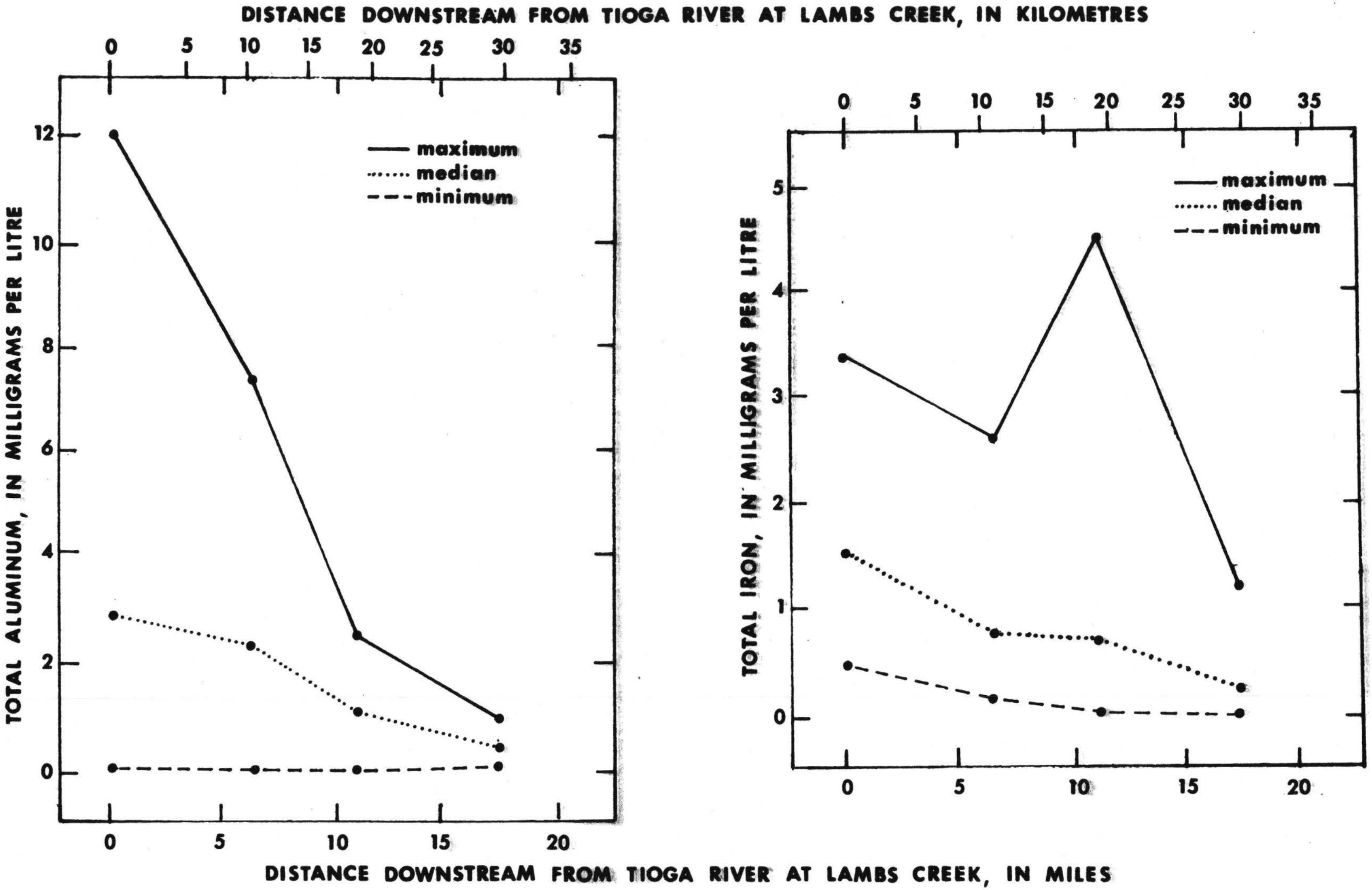


Figure 17.--Tioga River total aluminum and total iron profiles.

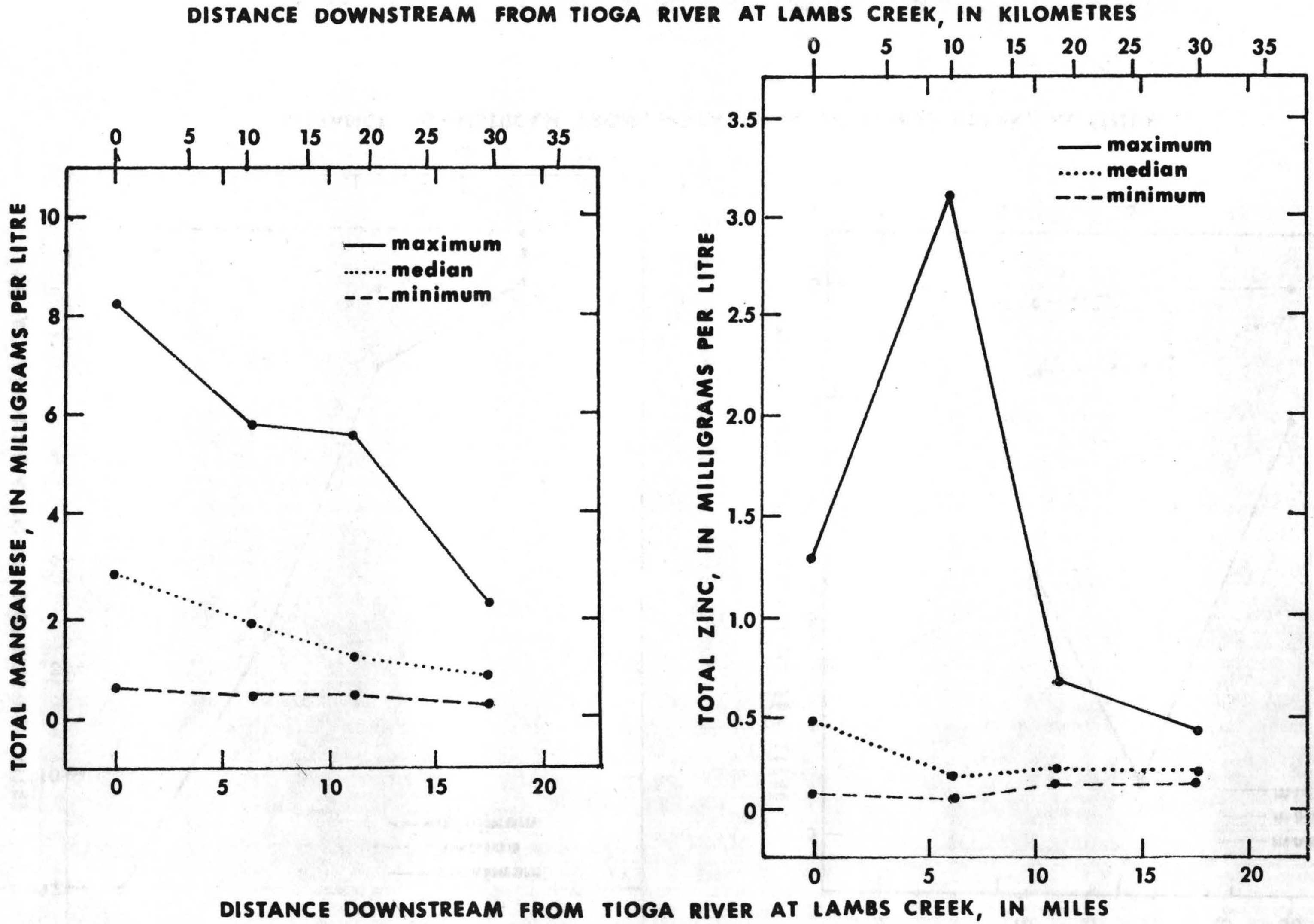


Figure 18.--Tioga River total manganese and total zinc profiles.

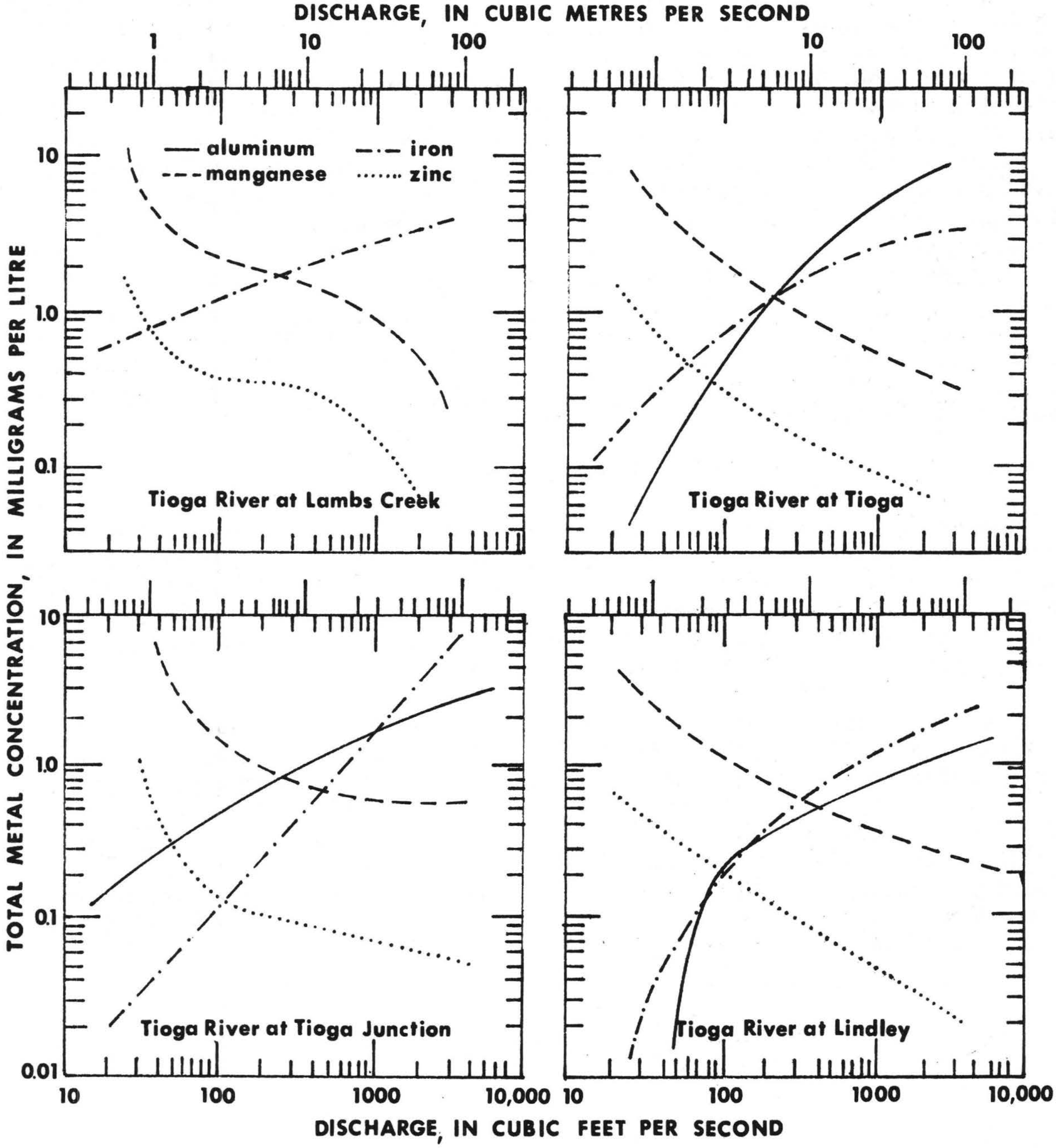


Figure 19.--Discharge versus total metal concentration for the Tioga River.

One reason why total aluminum and iron concentrations increase with increasing discharge can be explained by solubility controls. The solubilities of aluminum and iron are much lower at the pH range found in the upper Tioga River than the solubilities of manganese and zinc. This implies first of all that probably a much larger percentage of aluminum and iron are in the suspended phase rather than in the dissolved phase. Secondly, the total concentrations of manganese and zinc are probably mostly in the dissolved phase. If that is the case, during low flows, when the pH is usually lowest, most of the iron and aluminum would precipitate, lowering the total amount detected, whereas mostly all of the manganese and zinc would continue downstream in the dissolved phase. As flows increase, total concentrations of manganese and zinc are decreased by dilution. Total iron and aluminum, on the other hand, increase because the increasing stream velocities transport some of the precipitate which had remained on the stream bottom, an effect called scouring.

Further samples of both dissolved- and total-metals are needed to either substantiate or disprove the above theory. More dissolved-metals samples will also further define the solubility controls at work in the Tioga River and the resulting mobilities of the different metals.

BUFFER CAPACITY

The buffering capability of water is an important parameter in both stream and reservoir water quality. As mentioned before, the Tioga and Hammond Lakes will be connected by a weir. The mixing capabilities of the Tioga River and Crooked Creek waters are important variables that need to be defined in order to assess the water quality of both the Tioga and Hammond Lakes and the Tioga River downstream from the dams after impoundment.

The buffering capacity of a solution is measured by its ability to accept H^+ or OH^- ions while resisting significant pH changes. In natural water, the main dissolved constituents which contribute to buffering capacity are the carbon dioxide species. Figure 20 is a graph of pH vs log concentration (molar) which shows the distribution of the different ions in the carbonate equilibria at varying pH; H^+ and OH^- are also shown as minor variables in buffering capacity. The graphs are determined from the three equations shown below where K_1 and K_2 are the dissociation constants of carbonate and K_w is the dissociation constant of water.

$$K_1 = \frac{[H^+]\ [HCO_3^-]}{[H_2CO_3]} = 10^{-6.4},\ pK_1 = 6.4$$

$$K_2 = \frac{[H^+]\ [CO_3^{2-}]}{[HCO_3^-]} = 10^{-10.3},\ pK_2 = 10.3$$

$$K_w = \frac{[H^+]\ [OH^-]}{[H_2O]} = 10^{-14},\ pK_w = 14$$

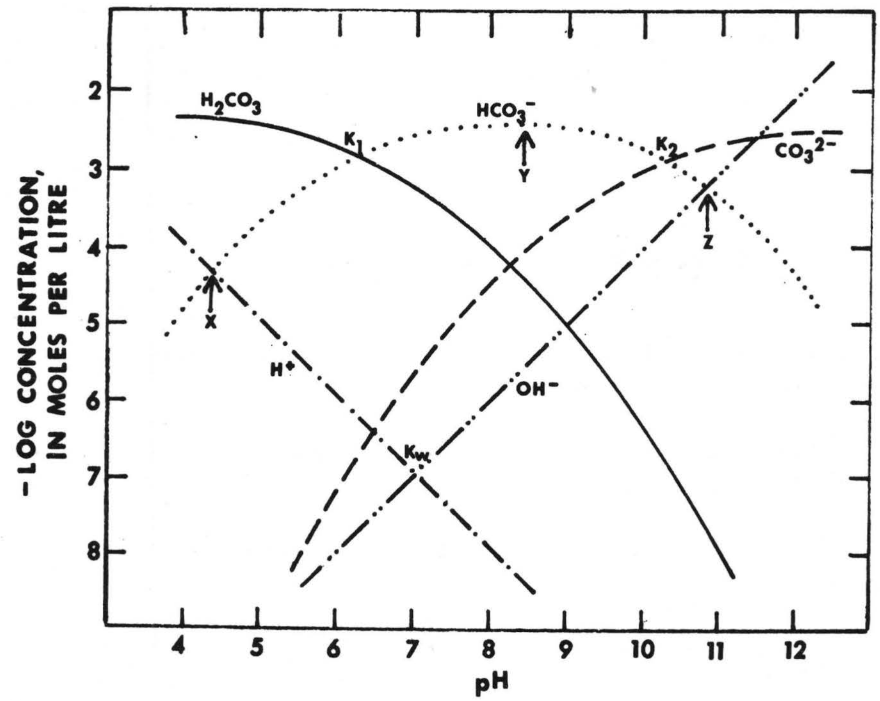


Figure 20.--pH versus -log concentration showing the relationships of CO_3^{2-}, HCO_3^-, H_2CO_3, OH^-, and H^+.

Alkalinity (the ability to accept protons) and acidity (the ability to donate protons) were determined by titrating a sample with a strong acid (0.01639N H_2SO_4) or a strong base (0.0248N NaOH), respectively. The endpoints of the titrations are designated by an x in figure 20 at the alkalinity titration endpoint (pH 4.5) and a y at the acidity titration endpoint (pH 8.3). Any water samples with an initial pH below 4.5 or above 8.3 were titrated for only acidity or alkalinity, respectively. Water samples may contain both alkalinity and acidity at the same time. For a sample having a pH between 4.5 and 8.3, two aliquots were titrated. One was titrated to pH 4.5 with standard acid and one portion was titrated to pH 8.3 using standard base. The acidity calculated, expressed as milligrams per liter as $CaCO_3$, is defined as a negative quantity. The alkalinity calculated from the titration of the other aliquot, also expressed as milligrams per liter as $CaCO_3$, was termed a positive quantity. Algebraic addition of the two quantities provides an index (here called net alkalinity) which allows one to directly calculate the effect of mixing water having a given level of alkalinity with a water having less alkalinity or even acidity.

Predictions of net alkalinity load from the mixture of two different waters 1 and 2 to give the net alkalinity load of water 3 is generally a conservative procedure according to the equation given below:

$$\text{Net alkalinity load}_3 = \frac{(Q_1 \text{ x net alkalinity}_1) + (Q_2 \text{ x net alkalinity}_2)}{Q_1 + Q_2}$$

where Q_1 and Q_2 represent discharges at sites 1 and 2. In the equation the flows of waters 1, 2, and 3 are assumed to be relatively constant over the sampling period.

The above procedure was followed for three stream junctions in the Tioga River basin using the following stations (fig. 3):

Tioga River at Lambs Creek + Mill Creek near Tioga = Tioga River at Tioga

Tioga River at Tioga + Crooked Creek at Tioga = Tioga River at Tioga Junction

Tioga River at Tioga Junction + Cowanesque River near Lawrenceville = Tioga River at Lindley

Graphs relating the observed net alkalinity load to the calculated net alkalinity load according to the above formula were constructed and are shown in figures 21 and 22.

The curves in figure 21 deviate from the calculated values shown by the dashed line because of alkaline contributions from small tributaries between the sites and because of the following assumptions: (1) a relationship between net alkalinity and discharge holds for each tributary contribution, and (2) the relation of the discharge of each tributary to that at a measured station downstream remains constant over the sampling period. More accurate determinations would require that contributions from each tributary between sites 1 and 2 and site 3 be measured for alkalinity and acidity.

Figure 22 shows a slightly different deviation than that in figure 21. The calculated net alkalinity load is lower than the true net alkalinity load at the extreme ends of the scale, while the calculated net alkalinity load is higher than the true load in the middle of the scale. Most of the values plotted on the graph were measured on two consecutive days, thus increasing the amount of error in the calculations by allowing more time for the measured discharges and net alkalinities to fluctuate between measurements. This relationship should be further refined before it can be reliably used.

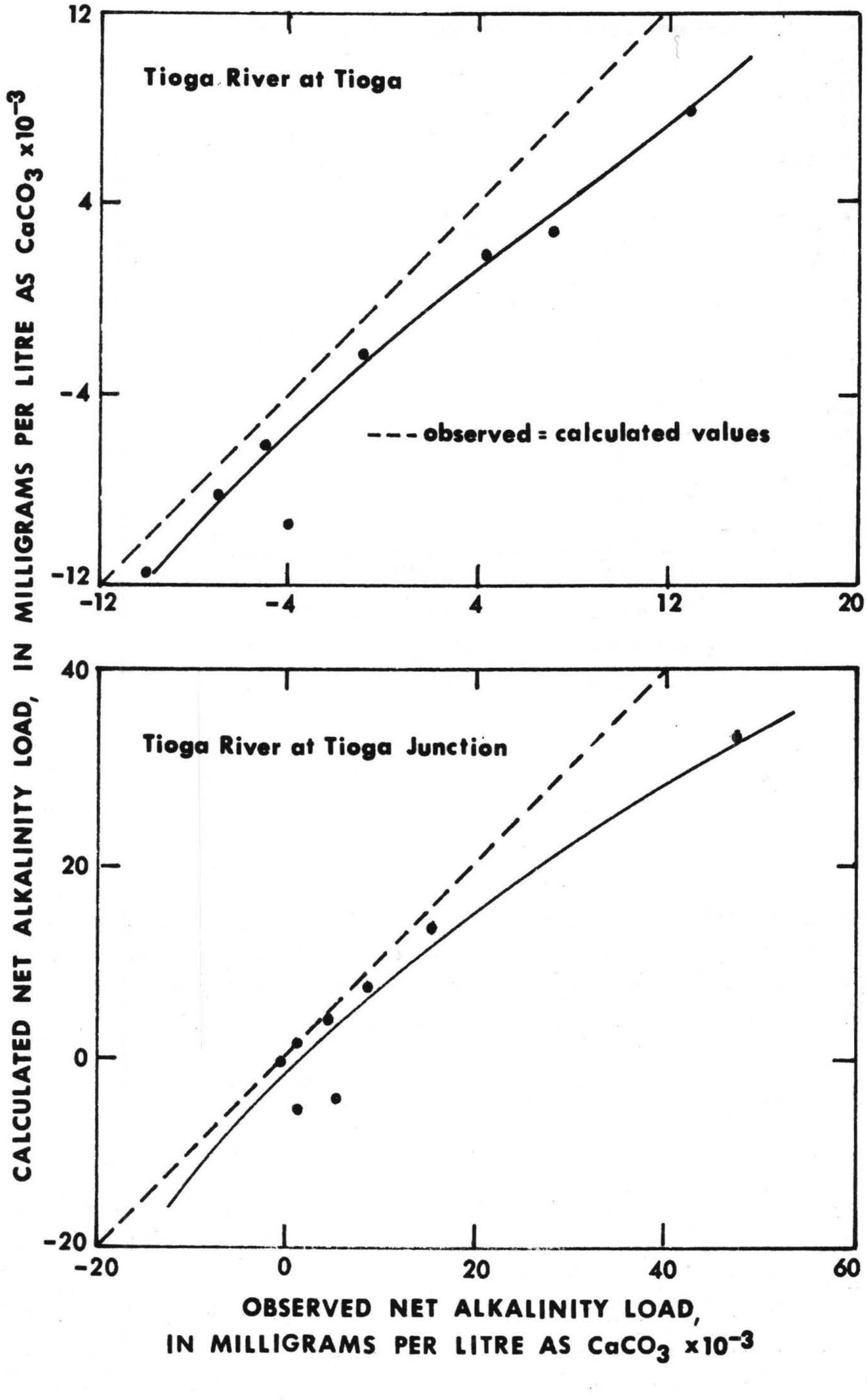


Figure 21.--Observed versus calculated net alkalinity loads for Tioga River at Tioga and Tioga River at Tioga Junction.

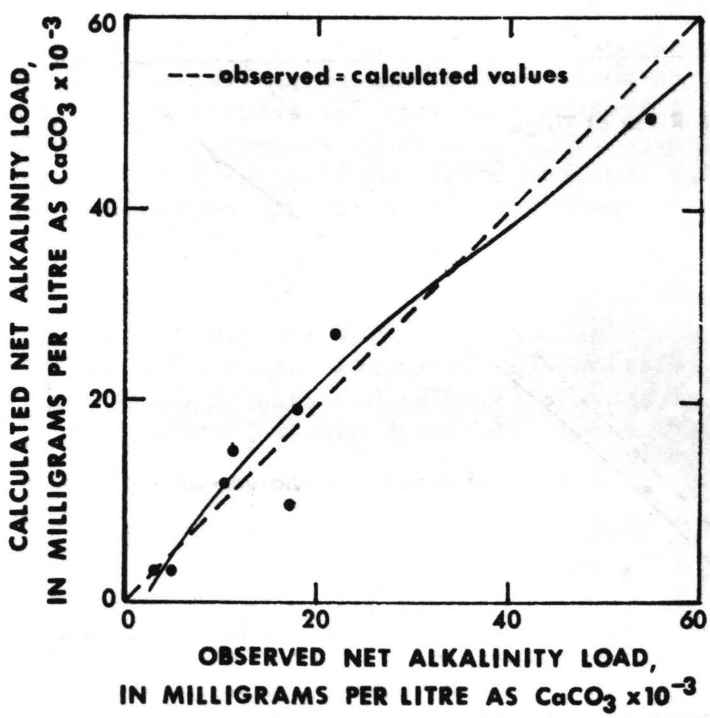


Figure 22.--Observed versus calculated net alkalinity loads for Tioga River at Lindley.

Using the assumptions made above, the resultant net alkalinity load at site 3 can be calculated and the true net alkalinity load picked off the appropriate graph. The net alkalinity concentration can then be calculated from the equation below:

$$\text{Net alkalinity}_3 = \frac{\text{true net alkalinity load}_3}{Q_3}$$

The prediction of pH of a resultant stream from the calculations of net alkalinity is complex. The pH of a solution is defined as the negative $\log_{10}$ of the hydrogen ion activity (molal). For a given partial pressure of carbon dioxide (PCO_2), pH is a function of net alkalinity. Therefore, a general relationship can be constructed between pH and net alkalinity (fig. 23). In natural waters, however, PCO_2 may vary due to the aeration of the stream, temperature of the water, the amount of CO_2 consumed by photosynthesis or produced by respiration, etc. Thus, the scatter of the points in fig. 23 may be a result of the variation of PCO_2.

Until a model is developed from which accurate estimates of the quantity of CO_2 in the water can be made, predictions of pH from net alkalinity are less than satisfactory. The titration endpoints for acidity and alkalinity 8.3 and 4.5, respectively, will need to be redefined because the endpoints of the titration for determining the true amount of alkalinity and acidity in the water sample vary with the amount of CO_2 in the water.

DISCUSSION

The Tioga River and its major tributaries were sampled monthly from September 1973 to May 1975. The relationships developed for selected water-quality parameters in this report provide insight into present water quality. The relationships will be refined as additional samples are collected.

The sampling results included in this report partly satisfy the first object of this study, the assessment of preimpoundment water quality in the Tioga River basin. The data are used not only to define present water quality but also to indicate water quality in the three impoundments proposed for the area. The data suggest that:

(1) Tioga Lake will have an inflow water quality similar to that of Tioga River at Lambs Creek. Mill Creek and Hammond Lake will contribute alkaline water with relatively low concentrations of dissolved solids to the impoundment. The effects of these contributions cannot be predicted, as yet. Outflow water quality will probably change from that now observed at the proposed damsite because of the effects of the impoundment and the added contributions from Hammond Lake via the connecting weir.

(2) Hammond Lake will be an alkaline lake which will probably support a warm-water fishery. Problems may develop with nuisance algae blooms, depending on the size and depth of the lake.

(3) Cowanesque Lake will be an alkaline impoundment probably supporting a diversified fish population. The lake will probably be affected by algae blooms. Dissolved oxygen concentrations may get quite low, controlling the level of aquatic life in the lake.

The conclusions drawn above are only general interpretations from the data obtained during this part of the study. The data in this report and future data will be used to develop a more precise picture of water quality for the basin. Unusual characteristics observed throughout the sampling period will be investigated. Optimally, both the future stream and lake water quality will be incorporated into a predictive water-quality model which will be used to assess key water-quality constituents and characteristics at selected locations throughout the study area.

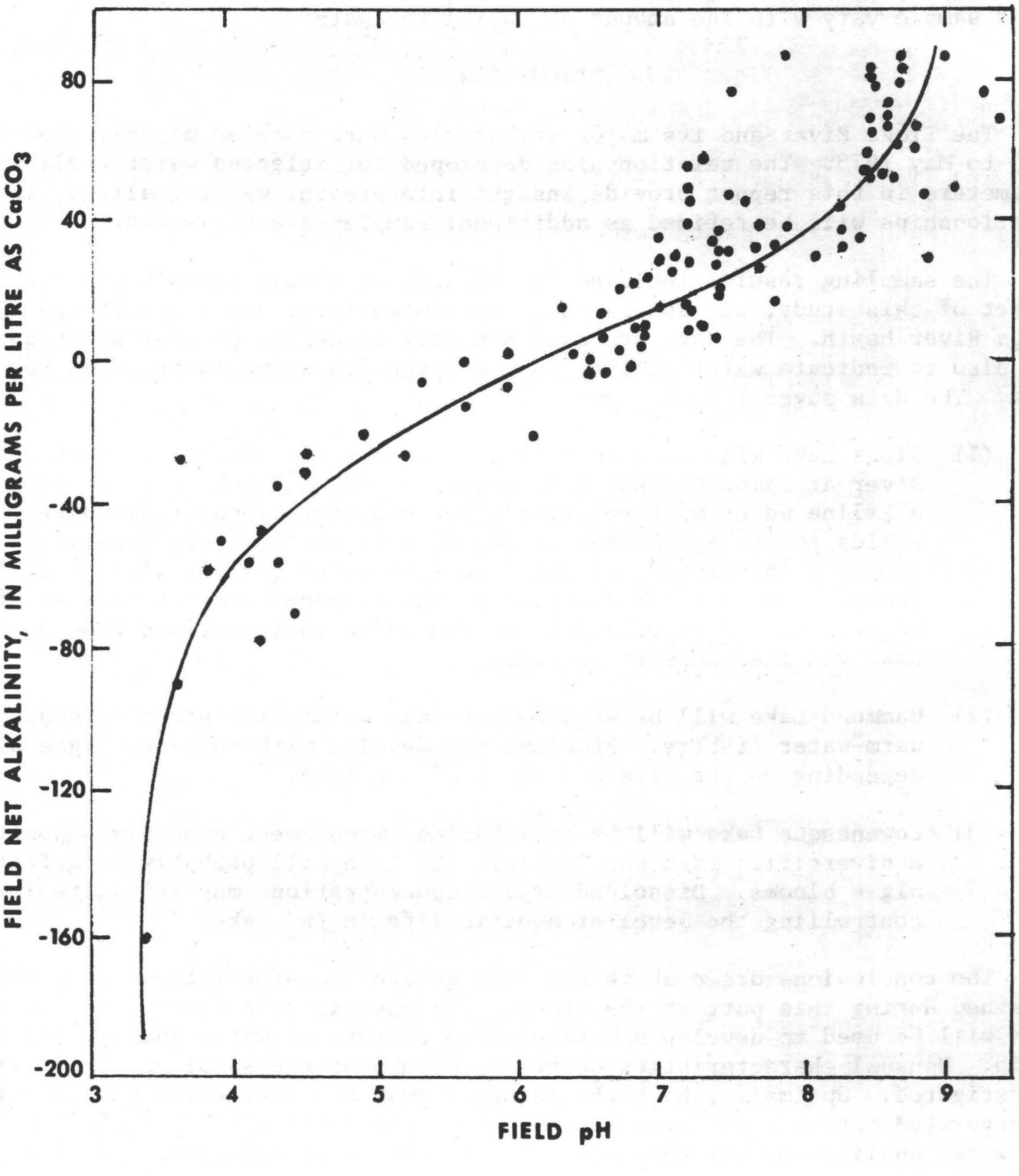


Figure 23.--Field pH versus field net alkalinity for the Tioga River basin.

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Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975.

01516350 TIOGA RIVER NEAR MANSFIELD, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Time	Instantaneous discharge (ft^3/s)	Temperature (°C)	Field pH (units)	Specific conductance (micromhos/cm)	Field alkalinity as $CaCO_3$	Field acidity as $CaCO_3$	Dissolved oxygen	Suspended sediment	Dissolved chloride
1975										
May 14	0830	267	10.5	5.6	163	3	14	10.4	24	3.0

(Micrograms per litre)

Date	Time	Aluminum	Arsenic	Cadmium	Chromium	Cobalt	Copper
				Dissolved			
1975							
May 14	0830	810	1	0	10	19	10

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975.

01516350 TIOGA RIVER NEAR MANSFIELD, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Dissolved sulfate	Bicarbonate	Carbonate	Ammonia nitrogen as N	Total nitrate as N	Total inorganic nitrogen as N	Total organic nitrogen as N	Total nitrogen as N	Total phosphorus as P	Total orthophosphorus as P
1975 May 14	50	2	0	.03	.27	.31	.10	.41	.06	.00

(Micrograms per litre)

Date	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
			Dissolved				
1975 May 14	220	0	1500	<.5	1	0	200

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01516820 TIOGA RIVER AT LAMBS CREEK, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Time	Instantaneous discharge (ft^3/s)	Temperature (°C)	Field pH (units)	Specific conductance (micromhos/cm)	Field alkalinity as $CaCO_3$	Field acidity as $CaCO_3$	Dissolved oxygen	Suspended sediment	Dissolved chloride
1973										
Sep. 06	1100	216	22.0	4.5	265	0	29	11.5	336	7.5
Oct. 09	1430	73	15.5	4.1	349	0	55	9.8	4	8.5
Nov. 08	0910	149	3.0	4.6	223	--	24	12.4	16	4.0
Dec. 13	1145	392	1.5	4.8	208	--	26	13.1	47	2.5
1974										
Jan. 10	1015	--	.0	4.6	250	--	22	14.0	14	7.3
Feb. 13	1315	--	.5	4.6	207	--	24	--	42	6.5
Mar. 13	1315	--	1.0	4.2	173	0	77	13.4	23	4.5
Apr. 02	1130	1250	3.0	5.9	141	--	24	12.8	153	5.0
May 01	1215	285	14.0	5.1	172	--	33	9.9	20	5.6
June 12	1230	96	18.5	4.6	223	--	50	9.4	14	5.5
July 17	1630	40	26.0	3.4	416	0	160	7.6	1	10
Aug. 14	1245	29	26.0	3.5	570	--	--	7.4	2	8.0
Sep. 12	1230	29	22.0	3.6	587	0	89	8.8	E0	10
Oct. 10	1350	33	12.0	3.8	457	0	58	10.4	E0	9.0
Nov. 07	0830	136	8.0	6.5	197	10	12	11.8	22	6.5
Dec. 09	1210	1500	2.5	5.9	109	11	16	12.8	88	25
1975										
Jan. 14	1245	492	.0	3.6	199	0	27	13.2	29	5.0
Feb. 03	1230	180	.5	3.9	274	0	50	12.6	9	5.5
Mar. 05	1215	228	1.0	4.3	256	0	55	12.8	32	5.0
Apr. 01	1200	231	6.0	4.2	185	0	47	12.0	13	5.0
May 14	1115	376	13.5	6.6	161	6	7	9.8	26	4.0

E - Estimated.

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01516820 TIOGA RIVER AT LAMBS CREEK, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Dissolved sulfate	Bicarbonate	Carbonate	Ammonia nitrogen as N	Total nitrate as N	Total inorganic nitrogen as N	Total organic nitrogen as N	Total nitrogen as N	Total phosphorus as P	Total orthophosphorus as P
1973										
Sep. 06	106	0	0	.41	1.6	2.01	.56	2.6	.29	.11
Oct. 09	134	0	0	.05	.23	.28	.31	.59	.04	.04
Nov. 08	98	0	0	.07	.29	.36	.17	.53	.03	.02
Dec. 13	76	0	0	.14	.59	.73	.27	1.0	.10	.10
1974										
Jan. 10	71	0	0	.13	.80	.93	.15	1.1	.03	.01
Feb. 13	82	1	0	.13	.70	.87	.31	1.2	.04	.01
Mar. 13	61	0	0	.14	.72	.86	.17	1.0	.11	.10
Apr. 02	35	19	0	.05	1.0	1.05	.51	1.6	.20	.09
May 01	66	1	0	.12	.40	.52	.20	.72	.04	.02
June 12	106	1	0	.17	.57	.74	.23	.97	.03	.01
July 17	143	0	0	.10	.23	.33	.14	.47	.02	.00
Aug. 14	256	0	0	.18	.34	.52	.23	.75	.04	.01
Sep. 12	118	0	0	.12	.50	.62	.10	.72	.03	.01
Oct. 10	188	0	0	.19	.29	.48	.10	.58	.08	.07
Nov. 07	81	12	0	.06	.32	.38	.21	.59	.07	.02
Dec. 09	2	8	0	.07	.68	.75	.35	1.1	.07	.05
1975										
Jan. 14	84	1	0	.07	.54	.61	.16	.77	.11	.09
Feb. 03	99	0	0	.13	.68	.81	.19	1.0	.03	.02
Mar. 05	120	0	0	.05	.86	.91	.23	1.1	.05	.03
Apr. 01	72	0	0	.04	.72	.76	.08	.84	.03	.02
May 14	53	6	0	.03	.29	.33	.13	.46	.03	.00

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01516820 TIOGA RIVER AT LAMBS CREEK, PA.

CHEMICAL ANALYSES

(Micrograms per litre)

Date	Time	Aluminum	Arsenic	Cadmium	Chromium	Cobalt	Copper
			Dissolved				
1974							
Feb. 13	1315	--	--	--	--	--	--
Mar. 13	1315	--	--	--	--	--	--
Apr. 02	1130	--	--	--	--	--	--
1975							
Mar. 05	1215	3000	1	1	0	50	20
Apr. 01	1200	1800	0	0	0	29	10
May 14	1115	50	0	0	<10	16	10
			Total				
1974							
May 01	1215	2300	1	1	0	28	30
June 12	1230	20	2	0	10	45	20
July 17	1630	3500	<1	1	0	74	40
Aug. 14	1245	12000	0	1	<10	110	40
Sep. 12	1230	5500	1	2	10	140	50
Oct. 10	1350	5300	<1	1	0	100	30
Nov. 07	0830	3100	0	0	0	20	10
Dec. 09	1210	1600	3	1	<10	10	0
1975							
Jan. 14	1245	2700	1	1	0	40	20
Feb. 03	1230	210	2	1	0	56	20

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01516820 TIOGA RIVER AT LAMBS CREEK, PA.

CHEMICAL ANALYSES

(Micrograms per litre)

Date	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
			Dissolved				
1974							
Feb. 13	120	--	--	--	--	--	--
Mar. 13	1200	--	--	--	--	--	--
Apr. 02	70	--	--	--	--	--	--
1975							
Mar. 05	1600	6	2300	<.5	1	0	390
Apr. 01	590	0	1700	<.5	1	0	250
May 14	180	1	1200	<.5	0	0	150
			Total				
1974							
May 01	2100	88	1600	<.5	0	0	550
June 12	1000	3	2700	<.5	1	1	360
July 17	1400	3	4500	<.5	1	0	640
Aug. 14	500	6	8400	<.5	<2	0	1300
Sep. 12	1100	7	8000	<.5	3	1	1300
Oct. 10	1500	2	6100	.8	<2	0	990
Nov. 07	1600	3	1800	<.5	0	0	330
Dec. 09	3400	4	610	<.5	0	0	90
1975							
Jan. 14	2800	4	2000	<.5	1	0	240
Feb. 03	3000	5	3100	<.5	0	0	420

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01517500 MILL CREEK NEAR TIOGA, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Time	Instantaneous discharge (ft^3/s)	Temperature (°C)	Field pH (units)	Specific conductance (micromhos/cm)	Field alkalinity as $CaCO_3$	Field acidity as $CaCO_3$	Dissolved oxygen	Suspended sediment	Dissolved chloride
1973										
Sep. 05	1645	6.3	29.0	8.8	197	62	0	11.2	12	7.8
Oct. 11	0915	10	12.5	7.8	214	84	--	10.1	6	10
Nov. 07	1535	25	4.5	8.5	166	57	0	13.0	4	7.0
Dec. 13	1035	113	1.5	6.6	132	32	--	13.6	E0	2.5
1974										
Jan. 09	1450	--	.0	6.4	143	39	--	13.8	9	5.5
Feb. 13	1400	--	2.0	7.6	129	36	--	13.8	19	6.0
Mar. 13	1445	190	1.0	7.4	109	25	--	13.7	6	4.0
Apr. 02	1330	473	4.5	7.6	123	28	--	12.8	10	4.5
May 01	1345	86	16.0	8.4	137	37	0	10.6	1	4.2
June 12	1345	28	19.5	8.0	152	52	--	9.5	13	6.0
July 17	1545	6.5	26.5	8.7	189	64	0	9.2	1	6.4
Aug. 14	1400	6.9	27.5	8.6	185	69	0	9.6	3	7.0
Sep. 12	1350	7.2	24.0	8.5	192	69	0	9.3	E0	8.2
Oct. 10	1415	8.1	14.0	8.1	202	73	--	10.8	E0	8.0
Nov. 07	1000	41	8.0	7.2	176	57	1	12.8	3	9.0
Dec. 09	1330	394	2.0	8.3	113	39	0	13.6	24	5.0
1975										
Jan. 14	1350	160	.5	6.3	110	21	4	14.2	4	5.0
Feb. 03	1330	--	.5	6.9	124	13	1	13.0	E0	5.0
Mar. 05	1320	78	.5	7.2	121	31	20	13.0	3	5.5
Apr. 01	1305	76	7.0	8.1	114	34	1	12.0	1	6.0
May 14	1225	100	16.0	8.9	120	32	0	10.2	6	3.5

E - Estimated.

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01517500 MILL CREEK NEAR TIOGA, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Dissolved sulfate	Bicarbonate	Carbonate	Ammonia nitrogen as N	Total nitrate as N	Total inorganic nitrogen as N	Total organic nitrogen as N	Total nitrogen as N	Total phosphorus as P	Total orthophosphorus as P
1973										
Sep. 05	23	87	2	.16	.07	.23	.34	.57	.01	.01
Oct. 11	14	100	0	.18	.02	.20	.00	.35	.03	.00
Nov. 07	18	68	0	.08	.14	.22	.19	.41	.01	.00
Dec. 13	20	30	0	.06	.72	.78	.19	.97	.03	.02
1974										
Jan. 09	20	47	0	.09	1.0	1.1	.28	1.4	.01	.01
Feb. 13	17	44	0	.02	.70	.72	.24	.96	.01	.01
Mar. 13	8.2	30	0	.06	.45	.51	.21	.72	.02	.01
Apr. 02	19	31	0	.02	.70	.72	.35	1.1	.08	.02
May 01	19	49	2	.16	.10	.26	.29	.55	.02	.01
June 12	15	69	0	.11	.54	.65	.31	.92	.04	.01
July 17	17	76	6	.05	.16	.21	.14	.35	.01	.00
Aug. 14	12	82	4	.09	.07	.16	.19	.35	.01	.00
Sep. 12	16	82	2	.07	.05	.12	.13	.25	.01	.00
Oct. 10	20	86	1	.07	.02	.09	.13	.22	.01	.00
Nov. 07	27	68	0	.00	.14	.14	.26	.40	.02	.01
Dec. 09	22	29	0	.07	1.1	1.2	.46	1.6	.06	.04
1975										
Jan. 14	21	26	0	.02	.90	.92	.26	1.2	.03	.02
Feb. 03	21	37	0	.02	.68	.70	.30	1.0	.02	.01
Mar. 05	20	36	0	.01	.95	.96	.26	1.2	.02	.01
Apr. 01	19	35	0	.00	.50	.50	.16	.66	.01	.01
May 14	18	41	0	.00	.13	.14	.19	.33	.02	.01

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518000 TIOGA RIVER AT TIOGA, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Time	Instantaneous discharge (ft^3/s)	Temperature (°C)	Field pH (units)	Specific conductance (micromhos/cm)	Field alkalinity as $CaCO_3$	Field acidity as $CaCO_3$	Dissolved oxygen	Suspended sediment	Dissolved chloride
1973										
Sep. 06	1000	197	22.0	4.9	332	--	21	9.4	93	10
Oct. 09	1530	82	16.5	5.0	294	--	25	9.8	9	8.7
Nov. 06	1145	190	4.0	5.3	194	--	13	12.9	29	3.0
Dec. 11	1415	868	2.5	5.7	145	--	12	12.8	44	2.1
1974										
Jan. 08	1125	E230	.0	5.8	213	--	42	11.4	14	6.3
Feb. 13	1435	E200	2.5	5.7	160	--	12	13.6	13	6.0
Mar. 13	1600	699	2.0	5.5	152	--	19	13.4	25	5.0
Apr. 02	1445	1780	7.0	6.8	141	23	12	12.6	113	7.0
May 01	1445	413	16.0	6.7	166	15	10	9.4	23	7.6
June 12	1445	133	19.5	6.8	181	13	11	8.8	17	5.0
July 17	1515	65	24.0	4.4	315	0	69	8.3	26	7.6
Aug. 14	1500	35	29.0	4.5	413	--	--	7.7	6	9.0
Sep. 12	1445	30	25.0	4.3	407	0	34	8.2	9	11
Oct. 10	1520	48	16.0	4.5	377	0	25	9.8	E0	9.5
Nov. 07	1050	194	8.0	6.7	192	24	2	11.8	14	8.0
Dec. 09	1430	1880	2.0	6.9	105	17	10	13.8	65	3.5
1975										
Jan. 14	1500	785	.0	5.3	156	6	11	14.2	20	5.0
Feb. 03	1430	284	.5	4.9	201	1	20	13.6	E0	5.5
Mar. 05	1415	E280	1.0	5.2	206	2	27	13.0	39	5.0
Apr. 01	1345	343	6.0	6.1	146	5	24	12.2	13	5.0
May 14	1430	480	16.5	7.3	145	14	.2	9.4	33	4.0

E - Estimated.

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518000 TIOGA RIVER AT TIOGA, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Dissolved sulfate	Bicarbonate	Carbonate	Ammonia nitrogen as N	Total nitrate as N	Total inorganic nitrogen as N	Total organic nitrogen as N	Total nitrogen as N	Total phosphorus as P	Total orthophosphorus as P
1973										
Sep. 06	130	1	0	.29	.59	.88	.69	1.6	.09	.06
Oct. 09	116	0	0	.03	.16	.19	.18	.37	.03	.02
Nov. 06	78	0	0	.12	.29	.41	.18	.59	.03	.02
Dec. 11	46	7	0	.11	.63	.74	.23	.97	.06	.05
1974										
Jan. 08	73	2	0	.15	.70	.85	.18	1.0	.03	.01
Feb. 13	64	3	0	.13	.80	.93	.26	1.2	.01	.01
Mar. 13	44	16	0	.12	.61	.73	.19	.92	.05	.01
Apr. 02	29	23	0	.03	.90	.93	.15	1.1	.15	.05
May 01	49	14	0	.09	.40	.49	.23	.72	.05	.02
June 12	59	14	0	.17	.52	.69	.39	1.1	.03	.01
July 17	127	0	0	.06	.23	.29	.16	.45	.04	.02
Aug. 14	188	1	0	.15	.32	.47	.15	.62	.01	.01
Sep. 12	117	1	0	.22	.43	.65	.09	.74	.01	.00
Oct. 10	160	2	0	.16	.23	.39	.13	.52	.03	.02
Nov. 07	63	27	0	.05	.18	.23	.22	.45	.03	.02
Dec. 09	27	14	0	.08	.86	.94	.36	1.3	.06	.04
1975										
Jan. 14	61	3	0	.05	.81	.86	.17	1.0	.04	.02
Feb. 03	86	2	0	.08	.61	.69	.22	.91	.02	.01
Mar. 05	85	2	0	.03	.90	.93	.10	1.0	.04	.02
Apr. 01	56	6	0	.02	.93	.95	.20	1.2	.02	.01
May 14	44	17	0	.01	.29	.31	.15	.46	.04	.01

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518000 TIOGA RIVER AT TIOGA, PA.

CHEMICAL ANALYSES

(Micrograms per litre)

Date	Time	Aluminum	Arsenic	Cadmium	Chromium	Cobalt	Copper
			Dissolved				
1974							
Feb. 13	1435	--	--	--	--	--	--
Mar. 13	1600	--	--	--	--	--	--
Apr. 02	1445	--	--	--	--	--	--
1975							
Mar. 05	1415	1400	0	1	0	31	10
Apr. 01	1345	40	1	0	0	19	0
May 14	1430	40	0	0	<10	9	0
			Total				
1974							
May 01	1445	1500	1	0	0	21	20
June 12	1445	10	2	0	10	28	10
July 17	1515	5900	0	1	0	92	50
Aug. 14	1500	4400	0	1	0	72	30
Sep. 12	1445	7400	1	1	<10	120	40
Oct. 10	1520	4900	<1	3	0	3	20
Nov. 07	1050	960	0	0	0	20	0
Dec. 09	1430	1600	1	0	0	8	0
1975							
Jan. 14	1500	2000	1	0	10	28	20
Feb. 03	1430	2700	1	0	0	38	20

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518000 TIOGA RIVER AT TIOGA, PA.

CHEMICAL ANALYSES

(Micrograms per litre)

Date	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
			Dissolved				
1974							
Feb. 13	70	--	--	--	--	--	--
Mar. 13	900	--	--	--	--	--	--
Apr. 02	80	--	--	--	--	--	--
1975							
Mar. 05	470	1	1600	<.5	1	0	260
Apr. 01	170	0	1300	<.5	0	0	160
May 14	40	0	810	<.5	1	0	70
			Total				
1974							
May 01	1700	2	1200	<.5	0	0	140
June 12	790	4	1700	<.5	1	0	210
July 17	380	3	5900	<.5	<1	0	3100
Aug. 14	150	4	5200	<.5	<2	0	710
Sep. 12	310	5	5700	<.5	2	0	900
Oct. 10	720	2	4800	<.5	<2	0	750
Nov. 07	770	0	1100	<.5	0	0	190
Dec. 09	2600	4	450	<.5	0	0	60
1975							
Jan. 14	2200	1	1400	<.5	2	0	140
Feb. 03	1800	2	2300	<.5	0	0	300

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518400 CROOKED CREEK AT MIDDLEBURY CENTER, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Time	Instantaneous discharge (ft^3/s)	Temperature (°C)	Field pH (units)	Specific conductance (micromhos/cm)	Field alkalinity as $CaCO_3$	Field acidity as $CaCO_3$	Dissolved oxygen	Suspended sediment	Dissolved chloride
1973										
Sep. 05	0915	24	22.5	7.5	206	61	--	11.4	8	8.9
Oct. 10	0930	16	14.5	7.2	225	68	--	9.8	14	12
Nov. 07	0820	39	3.5	7.2	179	59	--	12.2	3	8.0
Dec. 12	0845	146	2.0	7.1	141	39	--	13.0	E0	2.5
1974										
Jan. 09	1545	--	.0	6.2	165	47	--	13.8	6	6.2
Feb. 14	1715	--	.5	6.6	145	41	--	14.5	4	7.0
Mar. 15	0900	69	.5	7.4	130	25	--	13.4	E0	5.5
Apr. 04	0915	453	9.5	7.2	93	18	--	10.8	68	3.0
May 03	0915	50	9.5	7.2	151	48	6	10.9	1	5.5
June 14	0845	8.0	14.0	7.3	185	69	9	--	6	7.5
July 18	1525	6.9	25.0	8.5	190	63	0	9.4	E0	7.4
Aug. 16	0830	3.3	18.0	7.5	221	73	--	7.0	6	9.0

E - Estimated.

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518400 CROOKED CREEK AT MIDDLEBURY CENTER, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Dissolved sulfate	Bicarbonate	Carbonate	Ammonia nitrogen as N	Total nitrate as N	Total inorganic nitrogen as N	Total organic nitrogen as N	Total nitrogen as N	Total phosphorus as P	Total orthophosphorus as P
1973										
Sep. 05	17	89	0	.22	.29	.51	.32	.83	.04	.02
Oct. 10	15	105	0	.05	.14	.19	.12	.31	.03	.01
Nov. 07	20	74	0	.06	.29	.35	.18	.53	.02	.02
Dec. 12	24	44	0	.09	.68	.77	.18	.95	.11	.08
1974										
Jan. 09	22	55	0	.07	1.2	1.3	.28	1.6	.02	.01
Feb. 14	18	50	0	.07	.90	.97	.30	1.3	.03	.01
Mar. 15	14	38	0	.05	.70	.75	.18	.93	.01	.01
Apr. 04	17	25	0	.03	.50	.53	.50	1.0	.09	.04
May 03	20	57	0	.11	.20	.31	.20	.51	.02	.01
June 14	19	84	0	.23	.50	.73	.22	.95	.36	.35
July 18	24	76	4	.13	.14	.27	.19	.46	.03	.01
Aug. 16	17	92	0	.13	.11	.24	.23	.47	.08	.06

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518500 CROOKED CREEK AT TIOGA, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Time	Instantaneous discharge (ft^3/s)	Temperature (°C)	Field pH (units)	Specific conductance (micromhos/cm)	Field alkalinity as $CaCO_3$	Field acidity as $CaCO_3$	Dissolved oxygen	Suspended sediment	Dissolved chloride
1973										
Sep. 05	1045	47	23.5	7.0	184	50	--	8.2	64	7.0
Oct. 09	1615	35	16.5	6.9	197	70	--	9.3	9	10
Nov. 06	1300	61	5.0	7.9	153	55	--	11.6	56	5.0
Dec. 11	1300	292	2.5	6.8	134	36	--	12.6	18	1.9
1974										
Jan. 08	1225	E66	.0	6.9	146	41	--	13.0	7	4.5
Feb. 13	1710	E68	2.0	6.4	132	36	--	13.2	E0	5.0
Mar. 13	1800	89	2.5	7.1	111	25	--	13.6	24	3.5
Apr. 02	1625	811	6.0	7.8	117	29	--	12.4	289	4.0
May 01	1545	132	16.0	7.6	144	43	--	10.8	10	4.0
June 12	1550	26	19.5	7.5	168	62	12	8.7	17	5.0
July 17	1415	18	23.0	7.7	190	66	--	8.6	E0	5.8
Aug. 14	1550	11	27.0	8.2	197	78	--	8.2	30	7.0
Sep. 12	1620	10	24.0	7.8	205	78	--	8.6	16	8.0
Oct. 10	1630	10	15.0	7.5	221	83	4	11.6	18	8.5
Nov. 07	1145	64	8.0	7.2	185	54	3	11.4	54	10
Dec. 09	1515	513	2.0	7.7	128	45	4	13.8	50	5.0
1975										
Jan. 14	1545	331	.0	6.8	114	27	3	14.8	19	4.0
Feb. 03	1545	--	.5	6.9	135	31	5	14.0	E0	5.5
Mar. 05	1515	131	1.0	7.2	132	35	4	13.0	10	5.0

E - Estimated.

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518500 CROOKED CREEK AT TIOGA, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Dissolved sulfate	Bicarbonate	Carbonate	Ammonia nitrogen as N	Total nitrate as N	Total inorganic nitrogen as N	Total organic nitrogen as N	Total nitrogen as N	Total phosphorus as P	Total orthophosphorus as P
1973										
Sep. 05	22	73	0	.11	.79	.90	.33	1.2	.14	.08
Oct. 09	15	89	0	.09	.05	.14	.39	.53	.13	.10
Nov. 06	18	63	0	.06	.27	.33	.31	.64	.18	.11
Dec. 11	20	52	0	.07	.50	.57	.22	.79	.17	.07
1974										
Jan. 08	20	50	0	.09	.70	.79	.22	1.0	.03	.02
Feb. 13	17	48	0	.05	.70	.75	.19	.94	.00	.00
Mar. 13	16	32	0	.07	.32	.39	.18	.57	.03	.01
Apr. 02	19	34	0	.12	.80	.92	.66	1.6	.13	.10
May 01	20	54	0	.10	.20	.30	.24	.54	.06	.02
June 12	17	81	0	.09	.41	.50	.30	.80	.06	.02
July 17	19	86	0	.09	.05	.14	.21	.35	.03	.02
Aug. 14	17	97	0	.09	.02	.11	.24	.35	.07	.03
Sep. 12	18	91	0	.07	.07	.14	.16	.30	.07	.04
Oct. 10	19	102	0	.09	.14	.23	.17	.40	.08	.03
Nov. 07	28	67	0	--	--	--	--	--	--	--
Dec. 09	22	48	0	.08	1.2	1.3	.51	1.8	.08	.05
1975										
Jan. 14	20	32	0	.04	.57	.61	.29	.90	.07	.04
Feb. 03	20	46	0	.03	.66	.69	.31	1.0	.07	.03
Mar. 05	20	40	0	.01	.88	.89	.25	1.1	.06	.04

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518500 CROOKED CREEK AT TIOGA, PA.

CHEMICAL ANALYSES

(Micrograms per litre)

Date	Time	Aluminum	Arsenic	Cadmium	Chromium	Cobalt	Copper
			Total				
1974							
Oct. 10	1630	450	<1	1	0	3	0

01518550 CROOKED CREEK AT TIOGA, PA.

(Milligrams per litre unless otherwise noted)

Date	Time	Instantaneous discharge (ft^3/s)	Temperature (°C)	Field pH (units)	Specific conductance (micromhos/cm)	Field alkalinity as $CaCO_3$	Field acidity as $CaCO_3$	Dissolved oxygen	Suspended sediment	Dissolved chloride
1975										
Apr. 01	1445	125	5.5	7.4	117	30	7	11.8	192	4.5
May 14	1530	181	15.0	7.9	136	42	1	10.0	931	3.5

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518500 CROOKED CREEK AT TIOGA, PA.

CHEMICAL ANALYSES

(Micrograms per litre)

Date	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
			Total				
1974							
Oct. 10	1300	2	130	<.5	2	0	40

01518550 CROOKED CREEK AT TIOGA, PA.

(Milligrams per litre unless otherwise noted)

Date	Dissolved sulfate	Bicarbonate	Carbonate	Ammonia nitrogen as N	Total nitrate as N	Total inorganic nitrogen as N	Total organic nitrogen as N	Total nitrogen as N	Total phosphorus as P	Total orthophosphorus as P
1975										
Apr. 01	19	41	0	.02	.50	.52	.28	.80	.16	.11
May 14	17	46	0	.04	.19	.26	.47	.73	.61	.02

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518700 TIOGA RIVER AT TIOGA JUNCTION, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Time	Instantaneous discharge (ft^3/s)	Temperature (°C)	Field pH (units)	Specific conductance (micromhos/cm)	Field alkalinity as $CaCO_3$	Field acidity as $CaCO_3$	Dissolved oxygen	Suspended sediment	Dissolved chloride
1973										
Sep. 05	1540	75	27.0	6.4	276	11	--	10.2	16	9.1
Oct. 09	1700	131	16.5	7.2	252	16	--	9.8	16	9.1
Nov. 06	1350	281	5.0	6.8	185	14	--	12.1	21	5.0
Dec. 11	1500	1300	2.5	7.0	139	15	--	12.4	41	2.1
1974										
Jan. 08	1335	E332	.0	5.9	194	9	--	13.8	21	5.1
Feb. 13	1620	E300	1.5	7.2	165	13	--	13.6	34	5.5
Mar. 13	1715	883	2.0	6.5	133	6	--	13.6	27	4.5
Apr. 02	1545	2900	7.0	7.6	120	22	--	12.2	894	3.0
May 01	1650	610	16.5	6.9	160	19	--	9.8	57	7.0
June 12	1730	178	20.0	6.9	171	19	10	9.2	6	6.0
July 17	1300	93	22.0	6.6	255	48	40	8.4	1	7.0
Aug. 14	1645	52	27.0	7.0	323	14	--	8.0	4	9.0
Sep. 13	0900	45	21.5	6.4	328	10	6	9.0	E0	10
Oct. 11	0915	65	10.0	6.5	329	10	7	10.0	E0	10
Nov. 07	1300	289	8.0	7.0	194	34	3	13.2	17	8.0
Dec. 09	1645	2680	2.0	7.2	108	21	3	12.6	151	4.0
1975										
Jan. 14	1700	1250	.0	5.9	142	12	7	15.6	18	4.5
Feb. 03	1645	--	.5	5.6	161	8	6	13.6	E0	5.0
Mar. 05	1615	E460	1.0	6.6	172	9	11	12.8	52	5.0
Apr. 01	1545	524	6.0	7.4	133	16	7	12.0	17	5.5
May 14	1645	740	17.0	7.8	146	22	2	9.6	66	4.0

E - Estimated

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518700 TIOGA RIVER AT TIOGA JUNCTION, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Dissolved sulfate	Bicarbonate	Carbonate	Ammonia nitrogen as N	Total nitrate as N	Total inorganic nitrogen as N	Total organic nitrogen as N	Total nitrogen as N	Total phosphorus as P	Total orthophosphorus as P
1973										
Sep. 05	29	18	0	.12	.41	.53	.13	.66	.08	.02
Oct. 09	82	19	0	.07	.18	.25	.25	.50	.06	.02
Nov. 06	63	13	0	.11	.34	.45	.31	.76	.06	.02
Dec. 11	40	18	0	.05	.63	.68	.27	.95	.17	.09
1974										
Jan. 08	40	10	0	.12	.90	1.0	.17	1.2	.03	.01
Feb. 13	49	16	0	.11	.70	.81	.23	1.0	.03	.02
Mar. 13	35	9	0	.09	.45	.54	.16	.70	.02	.01
Apr. 02	25	24	0	.14	1.5	1.6	1.3	2.9	.49	.33
May 01	45	26	0	.24	.40	.64	.29	.93	.06	.03
June 12	51	24	0	.08	.61	.69	.21	.90	.02	.01
July 17	87	24	0	.15	.23	.38	.12	.50	.01	.00
Aug. 14	123	16	0	.11	.16	.27	.16	.43	.01	.00
Sep. 13	118	10	0	.09	.34	.43	.05	.48	.01	.00
Oct. 11	132	10	0	.14	.23	.37	.13	.50	.01	.00
Nov. 07	53	40	0	.03	.27	.30	.27	.57	.05	.03
Dec. 09	27	23	0	.08	.81	.89	.56	1.4	.15	.09
1975										
Jan. 14	51	8	0	.05	.63	.68	.24	.92	.03	.02
Feb. 03	63	10	0	.09	.75	.84	.37	1.2	.05	.03
Mar. 05	64	10	0	.02	.99	1.0	.25	1.3	.05	.04
Apr. 01	42	15	0	.01	.66	.67	.20	.87	.03	.02
May 14	35	26	0	.01	.27	.29	.19	.48	.08	.02

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518700 TIOGA RIVER AT TIOGA JUNCTION, PA.

CHEMICAL ANALYSES

(Micrograms per litre)

Date	Time	Aluminum	Arsenic	Cadmium	Chromium	Cobalt	Copper
				Dissolved			
1974							
Feb. 13	1620	--	--	--	--	--	--
Mar. 13	1715	--	--	--	--	--	--
Apr. 02	1545	--	--	--	--	--	--
1975							
Mar. 05	1615	70	0	1	0	18	10
Apr. 01	1545	30	0	0	0	11	0
May 14	1645	70	2	0	<10	6	0
				Total			
1974							
May 01	1650	2600	2	0	0	13	20
June 12	1730	0	1	0	10	16	10
July 17	1300	150	<1	1	0	18	20
Aug. 14	1645	70	0	1	0	34	0
Sep. 13	0900	190	<1	1	<10	75	10
Oct. 11	0915	1700	0	1	0	55	10
Nov. 07	1300	960	2	0	0	13	10
Dec. 09	1645	2300	3	0	<10	8	10
1975							
Jan. 14	1700	1500	1	0	0	19	10
Feb. 03	1645	1800	2	0	0	23	10

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518700 TIOGA RIVER AT TIOGA JUNCTION, PA.

CHEMICAL ANALYSES

(Micrograms per litre)

Date	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
			Dissolved				
1974							
Feb. 13	0	--	--	--	--	--	--
Mar. 13	60	--	--	--	--	--	--
Apr. 02	110	--	--	--	--	--	--
1975							
Mar. 05	170	1	1300	<.5	1	0	170
Apr. 01	70	0	930	<.5	0	0	100
May 14	40	1	530	1.3	0	0	30
			Total				
1974							
May 01	3500	14	930	<.5	0	0	80
June 12	330	2	1200	<.5	1	1	120
July 17	40	0	1300	<.5	1	0	130
Aug. 14	20	1	3000	<.5	0	0	340
Sep. 13	120	2	3900	<.5	<2	1	580
Oct. 11	40	3	5700	<.5	2	0	530
Nov. 07	1100	2	770	<.5	0	0	120
Dec. 09	4500	5	470	<.5	0	0	60
1975							
Jan. 14	1400	2	1000	<.5	0	0	90
Feb. 03	1300	4	1400	<.5	0	0	180

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518850 COWANESQUE RIVER AT WESTFIELD, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Time	Instantaneous discharge (ft^3/s)	Temperature (°C)	Field pH (units)	Specific conductance (micromhos/cm)	Field alkalinity as $CaCO_3$	Field acidity as $CaCO_3$	Dissolved oxygen	Suspended sediment	Dissolved chloride
1973										
Sep. 04	1330	6.8	27.0	6.9	204	48	--	11.0	16	19
Oct. 10	1625	7.7	17.5	8.5	162	57	0	10.3	2	10
Nov. 07	1000	28	4.0	7.3	130	35	--	11.9	1	5.0
Dec. 12	1045	63	1.5	6.9	114	25	--	13.4	E0	2.0
1974										
Jan. 09	1230	--	.0	6.4	113	23	--	14.2	2	4.0
Feb. 14	0945	--	.5	6.9	109	25	--	13.8	6	5.5
Mar. 14	0945	77	.5	6.8	95	17	--	13.6	E0	2.5
Apr. 03	0830	272	2.5	6.4	88	14	--	12.7	21	2.0
May 02	0900	51	7.5	7.4	107	28	--	12.6	2	3.2
June 13	0920	8.0	14.5	7.4	138	46	12	10.2	1	4.0
July 18	0920	7.4	19.0	7.4	143	46	9	9.4	0	4.7
Aug. 15	0930	3.1	18.0	7.5	154	59	--	9.5	4	6.0

E - Estimated.

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518850 COWANESQUE RIVER AT WESTFIELD, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Dissolved sulfate	Bicarbonate	Carbonate	Ammonia nitrogen as N	Total nitrate as N	Total inorganic nitrogen as N	Total organic nitrogen as N	Total nitrogen as N	Total phosphorus as P	Total orthophos-phorus as P
1973										
Sep. 04	23	71	0	.21	.18	.39	.32	.71	.06	.04
Oct. 10	14	68	2	.03	.07	.10	.19	.29	.02	.01
Nov. 07	18	43	0	.06	.43	.49	.24	.73	.01	.01
Dec. 12	18	31	0	.08	.48	.56	.19	.75	.01	.01
1974										
Jan. 09	16	31	0	.10	.70	.80	.20	1.0	.01	.01
Feb. 14	16	30	0	.04	.80	.84	.36	1.2	.01	.01
Mar. 14	14	24	0	.05	.45	.50	.23	.73	.01	.01
Apr. 03	17	18	0	.03	1.0	1.0	.23	1.3	.05	.04
May 02	18	37	0	.12	.10	.22	.19	.71	.02	.00
June 13	12	60	0	.04	.63	.67	.18	.85	.01	.00
July 18	15	56	0	.07	.09	.16	.22	.38	.01	.00
Aug. 15	13	70	0	.13	.05	.18	.19	.37	.01	.00

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518860 MILL CREEK AT WESTFIELD, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Time	Instantaneous discharge (ft^3/s)	Temperature (°C)	Field pH (units)	Specific conductance (micromhos/cm)	Field alkalinity as $CaCO_3$	Field acidity as $CaCO_3$	Dissolved oxygen	Suspended sediment	Dissolved chloride
1973										
Sep. 04	1445	5.0	29.0	8.7	234	65	0	11.2	10	15
Oct. 10	1540	4.2	17.5	9.4	213	72	0	11.0	26	14
Nov. 07	1045	9.5	5.0	7.5	173	52	--	12.0	10	10
Dec. 12	1150	18	2.5	6.7	170	44	--	13.2	E0	10
1974										
Jan. 09	1155	--	.5	6.3	226	51	--	14.0	5	23
Feb. 14	1020	--	.5	6.2	177	49	--	13.8	E0	12
Mar. 14	1035	23	.5	7.3	147	35	--	13.6	27	8.0
Apr. 03	0940	59	3.0	6.5	129	30	--	12.8	25	5.0
May 02	1000	9.5	9.0	8.5	198	56	0	13.4	3	12
June 13	1030	1.2	15.5	8.2	368	107	--	10.0	2	36
July 18	0955	2.0	20.0	8.6	254	75	0	10.4	0	20
Aug. 15	1030	2.0	19.0	8.5	275	83	0	11.0	4	26

E - Estimated.

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518860 MILL CREEK AT WESTFIELD, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Dissolved sulfate	Bicarbonate	Carbonate	Ammonia nitrogen as N	Total nitrate as N	Total inorganic nitrogen as N	Total organic nitrogen as N	Total nitrogen as N	Total phosphorus as P	Total orthophosphorus as P
1973										
Sep. 04	27	83	4	.21	.20	.41	.44	.85	.11	.09
Oct. 10	17	76	11	.03	.09	.12	.25	.37	.03	.02
Nov. 07	20	64	0	.14	.36	.50	.31	.81	.08	.06
Dec. 12	24	52	0	.10	.61	.71	.38	1.1	.05	.04
1974										
Jan. 09	24	63	0	.27	.80	1.1	.33	1.4	.06	.06
Feb. 14	21	59	0	.23	.80	1.0	.48	1.5	.12	.10
Mar. 14	17	44	0	.17	.77	.94	.36	1.3	.10	.06
Apr. 03	20	34	0	.09	1.0	1.1	.41	1.5	.14	.05
May 02	25	69	3	.23	.30	.94	.39	.92	.12	.08
June 13	32	124	6	.17	1.0	1.2	.34	1.5	.19	.18
July 18	20	91	9	.13	.50	.63	.40	1.0	.09	.07
Aug. 15	19	88	9	.21	.63	.84	.42	1.3	.09	.07

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518870 COWANESQUE RIVER AT COWANESQUE, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Time	Instantaneous discharge (ft^3/s)	Temperature (°C)	Field pH (units)	Specific conductance (micromhos/cm)	Field alkalinity as $CaCO_3$	Field acidity as $CaCO_3$	Dissolved oxygen	Suspended sediment	Dissolved chloride
1973										
Sep. 04	1545	15	30.5	8.6	395	73	0	9.2	11	56
Oct. 10	1445	16	17.0	8.7	389	89	0	8.7	3	59
Nov. 07	1140	50	5.0	7.5	170	47	--	12.3	1	12
Dec. 12	1250	117	2.5	6.8	148	35	--	13.6	E0	9.0
1974										
Jan. 09	1115	--	.0	6.4	228	42	--	13.6	2	25
Feb. 14	1045	--	.5	6.6	148	33	--	14.0	6	12
Mar. 14	1130	170	1.0	7.2	145	22	--	13.5	10	11
Apr. 03	1025	540	3.0	6.5	114	22	--	12.5	32	4.0
May 02	1100	76	9.0	8.3	212	36	0	12.4	1	23
June 13	1130	12	17.0	8.5	267	71	0	11.4	2	30
July 18	1030	12	21.0	8.0	469	81	--	7.6	2	76
Aug. 15	1120	7.6	20.0	7.8	572	110	--	8.4	10	93

E - Estimated.

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01518870 COWANESQUE RIVER AT COWANESQUE, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Dissolved sulfate	Bicarbonate	Carbonate	Ammonia nitrogen as N	Total nitrate as N	Total inorganic nitrogen as N	Total organic nitrogen as N	Total nitrogen as N	Total phosphorus as P	Total orthophos-phorus as P
1973										
Sep. 04	54	103	0	.35	.29	.64	.49	1.1	.14	.08
Oct. 10	29	108	3	.02	.11	.13	.19	.32	.01	.00
Nov. 07	20	55	0	.18	.50	.68	.25	.93	.03	.02
Dec. 12	20	42	0	.11	.57	.68	.19	.87	.03	.01
1974										
Jan. 09	26	49	0	.52	.80	1.3	.52	1.8	.04	.03
Feb. 14	19	38	0	.18	.70	.88	.46	1.3	.05	.03
Mar. 14	17	35	0	.24	.57	.81	.36	1.2	.05	.03
Apr. 03	18	27	0	.15	1.0	1.2	.48	1.6	.14	.04
May 02	26	46	0	.34	.10	.44	.64	1.1	.04	.02
June 13	23	82	4	.16	.45	.61	.23	.84	.03	.02
July 18	40	102	0	.59	.18	.77	.72	1.5	.10	.04
Aug. 15	46	130	0	.59	.20	.79	.81	1.6	.12	.07

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01519000 TROUPS CREEK AT KNOXVILLE, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Time	Instantaneous discharge (ft^3/s)	Temperature (°C)	Field pH (units)	Specific conductance (micromhos/cm)	Field alkalinity as $CaCO_3$	Field acidity as $CaCO_3$	Dissolved oxygen	Suspended sediment	Dissolved chloride
1973										
Sep. 04	1645	6.5	30.0	8.8	216	69	0	9.7	13	6.6
Oct. 10	1320	5.3	16.0	8.2	239	97	--	10.7	5	12
Nov. 07	1310	22	5.0	7.6	222	75	--	12.2	4	8.0
Dec. 13	0900	44	.5	7.2	191	57	--	14.3	E0	8.0
1974										
Jan. 09	1025	--	.0	6.5	194	52	--	14.4	3	6.5
Feb. 14	1125	--	.5	6.2	140	40	--	14.2	15	7.5
Mar. 14	1745	109	3.5	7.4	140	32	--	12.8	69	5.0
Apr. 03	1145	312	4.5	6.1	124	27	--	12.5	63	4.0
May 02	1230	39	13.0	8.6	169	55	0	12.0	1	5.2
June 13	1230	5.6	21.0	8.0	213	86	--	--	1	7.5
July 18	1100	3.7	22.0	8.7	232	85	0	10.0	0	7.6
Aug. 15	1240	2.6	24.0	8.5	219	84	0	10.6	4	9.0

E - Estimated.

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01519000 TROUPS CREEK AT KNOXVILLE, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Dissolved sulfate	Bicarbonate	Carbonate	Ammonia nitrogen as N	Total nitrate as N	Total inorganic nitrogen as N	Total organic nitrogen as N	Total nitrogen as N	Total phosphorus as P	Total orthophosphorus as P
1973										
Sep. 04	30	93	2	.05	.20	.25	.61	.86	.01	.01
Oct. 10	22	116	1	.02	.66	.68	.32	1.0	.01	.01
Nov. 07	27	90	0	.09	1.2	1.3	.68	2.0	.01	.00
Dec. 13	26	65	0	.04	.90	.94	.19	1.1	.02	.00
1974										
Jan. 09	26	63	0	.10	1.8	1.9	.22	2.1	.02	.02
Feb. 14	20	49	0	.02	.90	.92	.42	1.3	.07	.02
Mar. 14	16	44	0	.06	1.4	1.5	.33	1.8	.11	.04
Apr. 03	20	32	0	.14	1.7	1.8	.54	2.4	.11	.05
May 02	23	66	4	.08	.20	.28	.26	.54	.02	.00
June 13	20	92	5	.06	.50	.56	.21	.77	.01	.00
July 18	19	102	2	.06	.34	.40	.28	.68	.01	.00
Aug. 15	20	88	5	.07	.23	.30	.19	.49	.01	.00

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01519500 COWANESQUE RIVER AT NELSON, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Time	Instantaneous discharge (ft^3/s)	Temperature (°C)	Field pH (units)	Specific conductance (micromhos/cm)	Field alkalinity as $CaCO_3$	Field acidity as $CaCO_3$	Dissolved oxygen	Suspended sediment	Dissolved chloride
1973										
Sep. 05	1140	55	25.0	8.0	264	69	--	10.8	55	20
Oct. 10	1100	48	16.0	7.4	327	82	--	9.6	2	32
Nov. 07	1415	129	4.5	7.8	220	62	--	12.6	2	16
Dec. 12	1615	317	2.0	7.2	179	49	--	13.6	E0	16
1974										
Jan. 09	0920	--	.0	6.8	224	55	--	15.2	2	13
Feb. 14	1330	--	.5	6.9	166	42	--	14.1	15	12
Mar. 14	1615	319	4.0	7.2	171	39	--	13.2	11	11
Apr. 03	1400	1430	7.0	6.4	133	28	--	12.4	31	5.5
May 02	1630	190	15.0	8.9	195	51	0	11.4	1	13
June 13	1415	32	22.5	8.5	276	82	0	--	6	24
July 18	1415	29	27.5	9.3	310	79	0	11.4	1	34
Aug. 15	1355	17	26.0	8.7	364	81	0	10.8	8	47

E - Estimated.

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01519500 COWANESQUE RIVER AT NELSON, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Dissolved sulfate	Bicarbonate	Carbonate	Ammonia nitrogen as N	Total nitrate as N	Total inorganic nitrogen as N	Total organic nitrogen as N	Total nitrogen as N	Total phosphorus as P	Total orthophosphorus as P
1973										
Sep. 05	25	100	0	.20	.61	.81	.63	1.4	.12	.08
Oct. 10	28	116	0	.31	.14	.45	.50	.95	.08	.04
Nov. 07	24	77	0	.09	.59	.68	.35	1.0	.05	.03
Dec. 12	25	56	0	.03	.61	.64	.20	.84	.06	.04
1974										
Jan. 09	27	64	0	.17	1.9	2.1	.35	2.4	.05	.04
Feb. 14	20	52	0	.14	.80	.94	.48	1.4	.06	.04
Mar. 14	20	44	0	.12	.99	1.1	.32	1.4	.03	.03
Apr. 03	19	34	0	.10	1.3	1.4	.48	1.9	.10	.05
May 02	22	68	9	.09	.10	.19	.33	.52	.03	.01
June 13	31	85	9	.31	.36	.67	.56	1.2	.04	.02
July 18	33	78	12	.08	.02	.10	.34	.44	.02	.01
Aug. 15	38	90	5	.19	.14	.33	.47	.80	.04	.02

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01520000 COWANESQUE RIVER NEAR LAWRENCEVILLE, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Time	Instantaneous discharge (ft^3/s)	Temperature (°C)	Field pH (units)	Specific conductance (micromhos/cm)	Field alkalinity as $CaCO_3$	Field acidity as $CaCO_3$	Dissolved oxygen	Suspended sediment	Dissolved chloride
1973										
Sep. 05	1340	70	27.0	8.1	241	59	--	11.2	51	19
Oct. 09	1740	63	18.0	9.0	309	89	0	10.6	E0	35
Nov. 06	1510	148	5.0	7.8	223	62	--	12.1	9	17
Dec. 12	1510	287	2.5	6.8	176	45	--	13.6	E0	16
1974										
Jan. 08	1545	E170	.0	6.4	205	48	--	14.2	5	14
Feb. 14	1430	E170	.5	6.9	164	41	--	14.4	E0	12
Mar. 14	1450	317	3.5	7.3	158	35	--	13.9	22	9.2
Apr. 03	1625	1400	6.5	6.3	124	24	--	12.2	52	5.0
May 02	1530	215	15.5	9.1	189	52	0	13.2	2	12
June 13	1535	E42	24.0	8.7	274	84	0	--	2	24
July 18	1340	29	27.0	8.8	300	78	0	9.2	2	29
Aug. 15	1500	17	28.0	8.5	337	83	0	9.2	5	38
Sep. 13	0930	30	21.0	7.8	347	83	--	9.0	E0	39
Oct. 11	1010	31	9.0	7.9	352	90	2	11.4	E0	37
Nov. 07	1430	215	8.0	7.2	212	54	6	14.4	4	15
Dec. 10	0930	573	.0	7.6	148	52	4	13.8	8	8.0
1975										
Jan. 15	0930	417	.0	7.1	157	33	1	--	3	9.0
Feb. 04	0945	E180	.0	7.7	163	39	4	14.4	E0	10
Mar. 06	0840	E280	1.0	7.4	164	39	2	12.8	4	10
Apr. 02	0900	304	3.5	7.8	144	37	2	12.0	5	9.5
May 15	0900	261	14.0	8.3	164	45	0	10.2	6	7.5

E - Estimated.

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01520000 COWANESQUE RIVER NEAR LAWRENCEVILLE, PA.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Dissolved sulfate	Bicarbonate	Carbonate	Ammonia nitrogen as N	Total nitrate as N	Total inorganic nitrogen as N	Total organic nitrogen as N	Total nitrogen as N	Total phosphorus as P	Total orthophos-phorus as P
1973										
Sep. 05	23	87	0	.27	.45	.72	.56	1.3	.20	.10
Oct. 09	26	91	12	.01	.05	.06	.16	.22	.02	.02
Nov. 06	25	77	0	.12	.54	.66	.29	.95	.04	.02
Dec. 12	25	47	0	.03	.63	.66	.18	.84	.06	.04
1974										
Jan. 08	26	59	0	.13	1.0	1.1	.38	1.5	.04	.03
Feb. 14	20	50	0	.08	.80	.88	.36	1.2	.08	.04
Mar. 14	20	52	0	.10	.84	.94	.28	1.2	.04	.02
Apr. 03	20	30	0	.12	1.0	1.1	.47	1.6	.10	.05
May 02	21	64	6	.08	.10	.18	.27	.45	.03	.01
June 13	25	78	12	.13	.27	.40	.31	.71	.02	.01
July 18	31	92	2	.06	.07	.13	.27	.40	.02	.01
Aug. 15	32	96	2	.09	.09	.18	.30	.48	.03	.01
Sep. 13	33	100	0	.08	.09	.17	.24	.41	.02	.01
Oct. 11	35	107	0	.05	.05	.10	.22	.32	.01	.00
Nov. 07	30	70	0	.00	.34	.34	.35	.69	.04	.02
Dec. 10	25	48	0	.09	.81	.90	.41	1.3	.04	.03
1975										
Jan. 15	26	42	0	.07	1.0	1.1	.55	1.6	.06	.04
Feb. 04	21	48	0	.08	.95	1.0	.49	1.5	.04	.02
Mar. 06	26	44	0	.04	1.2	1.2	.36	1.6	.04	.02
Apr. 02	25	44	0	.00	.77	.77	.30	1.1	.04	.02
May 15	23	55	0	.00	.09	.10	.17	.27	.02	.01

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01520500 TIOGA RIVER AT LINDLEY, N.Y.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Time	Instantaneous discharge (ft^3/s)	Temperature (°C)	Field pH (units)	Specific conductance (micromhos/cm)	Field alkalinity as $CaCO_3$	Field acidity as $CaCO_3$	Dissolved oxygen	Suspended sediment	Dissolved chloride
1973										
Sep. 05	1445	178	27.5	7.5	256	41	--	10.0	5	14
Oct. 09	1825	182	17.0	6.8	268	41	--	10.2	3	16
Nov. 06	1600	405	5.0	7.0	182	31	--	11.6	10	8.5
Dec. 11	1550	1630	2.5	6.7	148	24	--	12.7	39	6.8
1974										
Jan. 08	1450	440	.0	6.2	200	27	--	13.8	10	15
Feb. 14	1530	E500	.5	6.7	153	28	--	14.0	E0	10
Mar. 14	1400	E1160	2.0	6.7	143	18	--	13.4	22	5.4
Apr. 03	1710	3280	6.5	6.2	118	20	--	12.2	35	4.0
May 02	1430	604	14.0	7.4	172	33	3	10.7	10	7.4
June 13	1430	172	20.0	7.2	216	40	--	--	4	10
July 18	1245	119	24.0	7.2	269	47	6	9.0	1	12
Aug. 15	1355	63	25.0	7.4	328	34	--	9.2	5	17
Sep. 13	1500	83	24.0	7.4	342	36	--	8.4	E0	20
Oct. 11	1115	90	11.0	7.5	329	36	3	10.6	E0	18
Nov. 07	1530	478	8.5	7.0	203	43	6	12.8	9	11
Dec. 10	1015	2040	.5	7.1	125	31	4	14.8	29	5.5
1975										
Jan. 15	1030	1020	.0	7.0	157	20	2	--	10	6.5
Feb. 04	1015	722	.0	7.4	176	24	5	14.0	E0	8.0
Mar. 06	0930	722	.5	6.6	177	22	7	12.7	18	8.0
Apr. 02	0950	728	4.5	7.2	142	23	7	11.6	15	7.0
May 15	1000	755	14.5	7.7	151	31	2	8.8	13	5.5

E - Estimated.

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01520500 TIOGA RIVER AT LINDLEY, N.Y.

CHEMICAL ANALYSES

(Milligrams per litre unless otherwise noted)

Date	Dissolved sulfate	Bicarbonate	Carbonate	Ammonia nitrogen as N	Total nitrate as N	Total inorganic nitrogen as N	Total organic nitrogen as N	Total nitrogen as N	Total phosphorus as P	Total orthophos-phorus as P
1973										
Sep. 05	23	61	0	.21	.50	.71	.23	.94	.09	.06
Oct. 09	61	48	0	.04	.08	.12	.16	.28	.03	.02
Nov. 06	49	38	0	.16	.34	.50	.25	.15	.05	.02
Dec. 11	35	24	0	.04	.66	.70	.23	.93	.07	.05
1974										
Jan. 08	46	32	0	.13	1.0	1.1	.21	1.3	.03	.01
Feb. 14	31	35	0	.20	.70	.90	.35	1.2	.05	.03
Mar. 14	28	24	0	.09	.77	.86	.18	1.0	.02	.02
Apr. 03	23	24	0	.16	.70	.86	.45	1.3	.10	.03
May 02	39	38	0	.08	.20	.28	.20	.48	.03	.01
June 13	56	44	0	.13	.36	.49	.22	.71	.02	.01
July 18	73	36	0	.07	.09	.16	.15	.31	.01	.00
Aug. 15	92	42	0	.16	.16	.32	.22	.54	.02	.00
Sep. 13	84	44	0	.09	.18	.27	.16	.43	.01	.00
Oct. 11	93	44	0	.10	.18	.28	.18	.46	.01	.00
Nov. 07	41	52	0	.01	.32	.33	.32	.65	.04	.02
Dec. 10	31	18	0	.09	.70	.79	.33	1.1	.07	.05
1975										
Jan. 15	44	22	0	.07	.86	.93	.30	1.2	.03	.03
Feb. 04	49	28	0	.05	.86	.91	.29	1.2	.02	.02
Mar. 06	48	26	0	.03	1.2	1.2	.25	1.5	.03	.02
Apr. 02	39	29	0	.01	.72	.73	.23	.96	.03	.02
May 15	32	35	0	.01	.23	.25	.12	.37	.03	.01

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01520500 TIOGA RIVER AT LINDLEY, N.Y.

CHEMICAL ANALYSES

(Micrograms per litre)

Date	Time	Aluminum	Arsenic	Cadmium	Chromium	Cobalt	Copper
				Dissolved			
1974							
Feb. 14	1530	--	--	--	--	--	--
Mar. 14	1400	--	--	--	--	--	--
Apr. 03	1710	--	--	--	--	--	--
1975							
Mar. 06	0930	30	0	0	0	13	10
Apr. 02	0950	20	1	0	0	10	0
May 15	1000	50	1	0	10	4	0
				Total			
1974							
May 02	1430	700	1	0	0	9	20
June 13	1430	0	1	0	<10	9	10
July 18	1245	280	1	1	0	38	20
Aug. 15	1355	80	0	0	0	13	0
Sep. 13	1500	80	1	0	<10	20	10
Oct. 11	1115	230	<1	0	0	35	0
Nov. 07	1530	540	1	0	10	5	0
Dec. 10	1015	920	0	0	0	7	0
1975							
Jan. 15	1030	670	1	1	0	13	10
Feb. 04	1015	470	2	0	0	14	10

Table 6.--Water quality results for the Tioga River basin, September 1973 to May 1975--Continued.

01520500 TIOGA RIVER AT LINDLEY, N.Y.

CHEMICAL ANALYSES

(Micrograms per litre)

Date	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
			Dissolved				
1974							
Feb. 14	20	--	--	--	--	--	--
Mar. 14	50	--	--	--	--	--	--
Apr. 03	80	--	--	--	--	--	--
1975							
Mar. 06	310	2	790	<.5	0	0	90
Apr. 02	180	0	590	<.5	1	0	60
May 15	70	1	390	<.5	0	0	40
			Total				
1974							
May 02	490	14	570	.5	0	0	130
June 13	180	1	890	<.5	<1	0	60
July 18	0	1	2300	<.5	<1	0	310
Aug. 15	70	0	1200	<.5	0	0	100
Sep. 13	150	2	1500	<.5	2	0	200
Oct. 11	160	0	2000	<.5	2	0	290
Nov. 07	650	1	380	<.5	0	0	80
Dec. 10	1200	5	360	<.5	0	0	50
1975							
Jan. 15	900	2	660	<.5	0	0	50
Feb. 04	930	3	850	<.5	0	0	110