LEHIGH RIVER

2001 WATER

QUALITY MONITORING

Prepared for

U.S. Army Corps of Engineers
Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107

Prepared by

Versar, Inc.
ESM Operations
9200 Rumsey Road
Columbia, MD 21045

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William H. Burton
Principal Investigator

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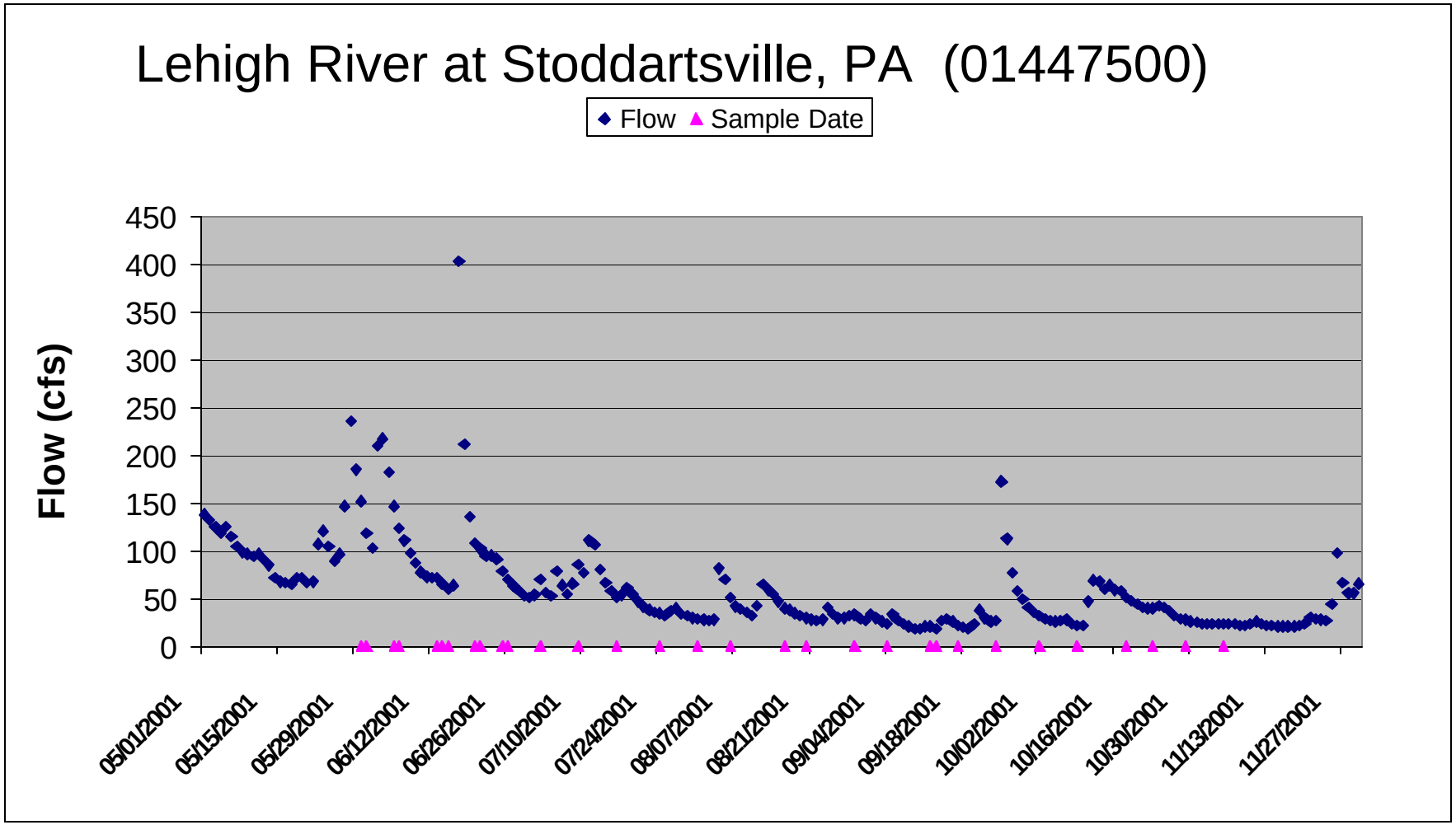
APPENDIX

USGS Flow Data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250
200
150
100
50
0
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05/15/2001
05/29/2001
06/12/2001
06/26/2001
07/10/2001
07/24/2001
08/07/2001
08/21/2001
09/04/2001
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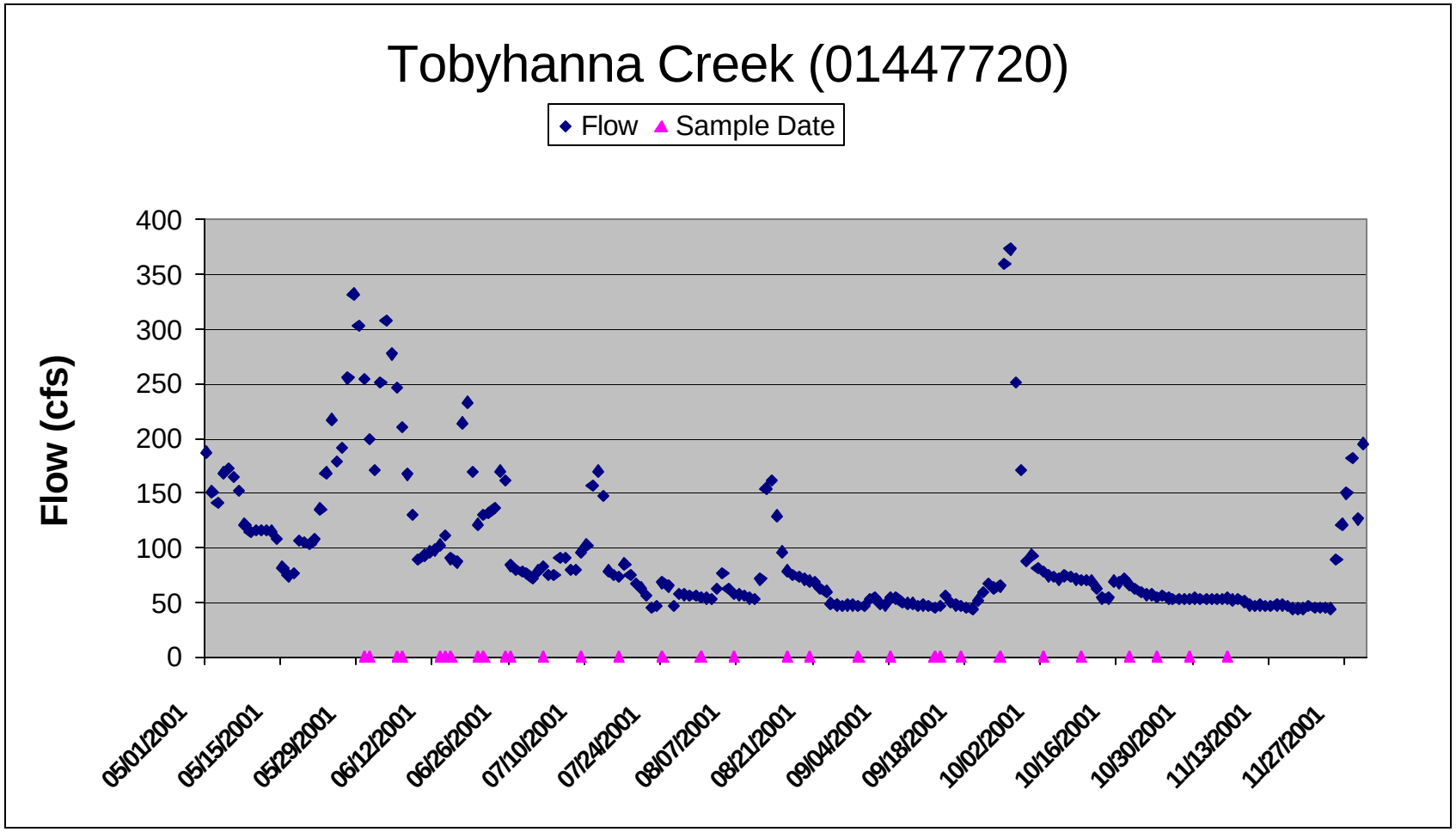
10/16/2001
10/30/2001
11/13/2001
11/27/2001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Flow
Sample Date
Flow (cfs)
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350
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250
200
150
100
50
0
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05/15/2001
05/29/2001
06/12/2001
06/26/2001
07/10/2001
07/24/2001
08/07/2001
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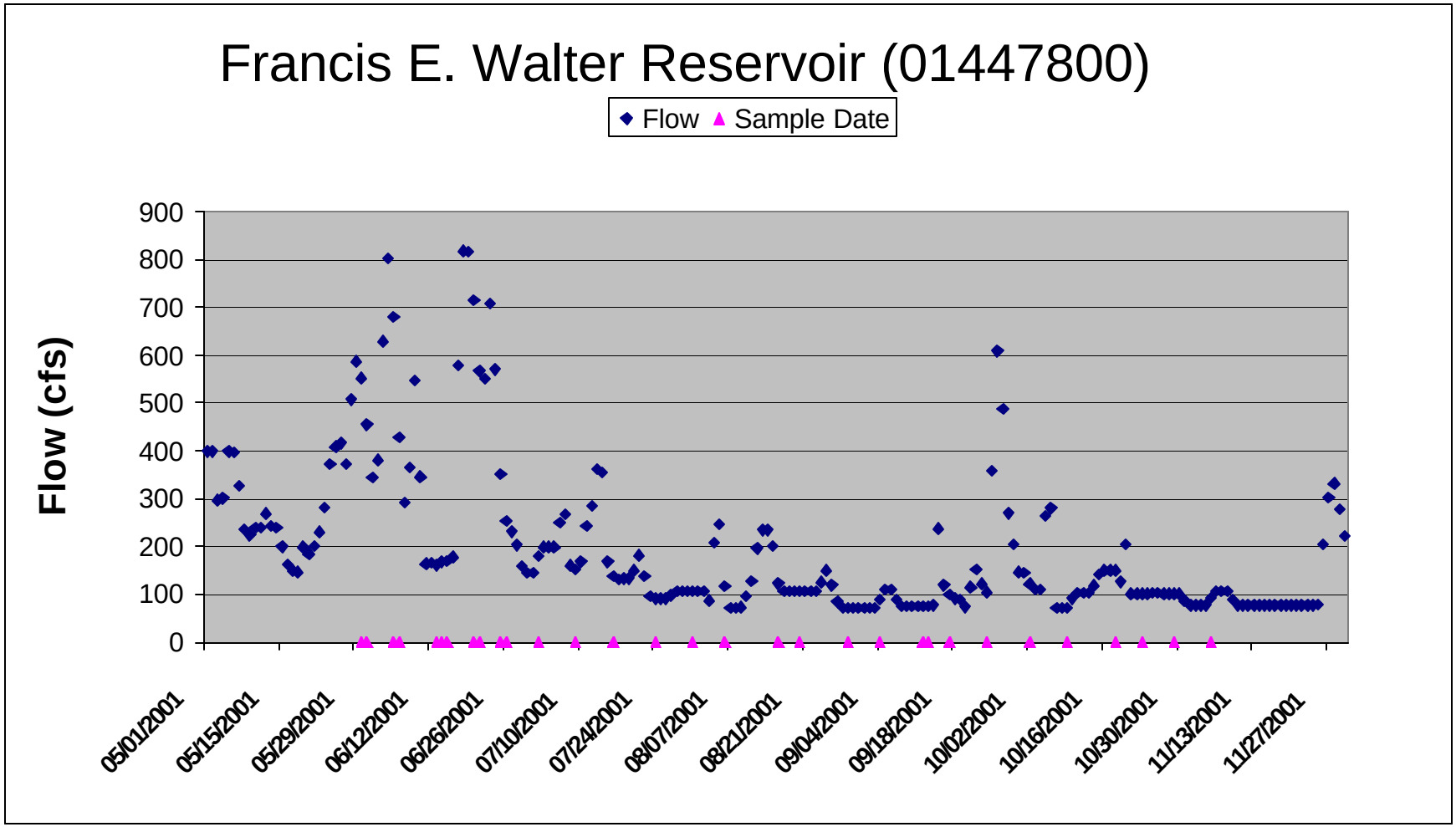
10/16/2001
10/30/2001
11/13/2001
11/27/2001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600
500
400
300
200
100
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05/15/2001
05/29/2001
06/12/2001
06/26/2001
07/10/2001
07/24/2001
08/07/2001
08/21/2001
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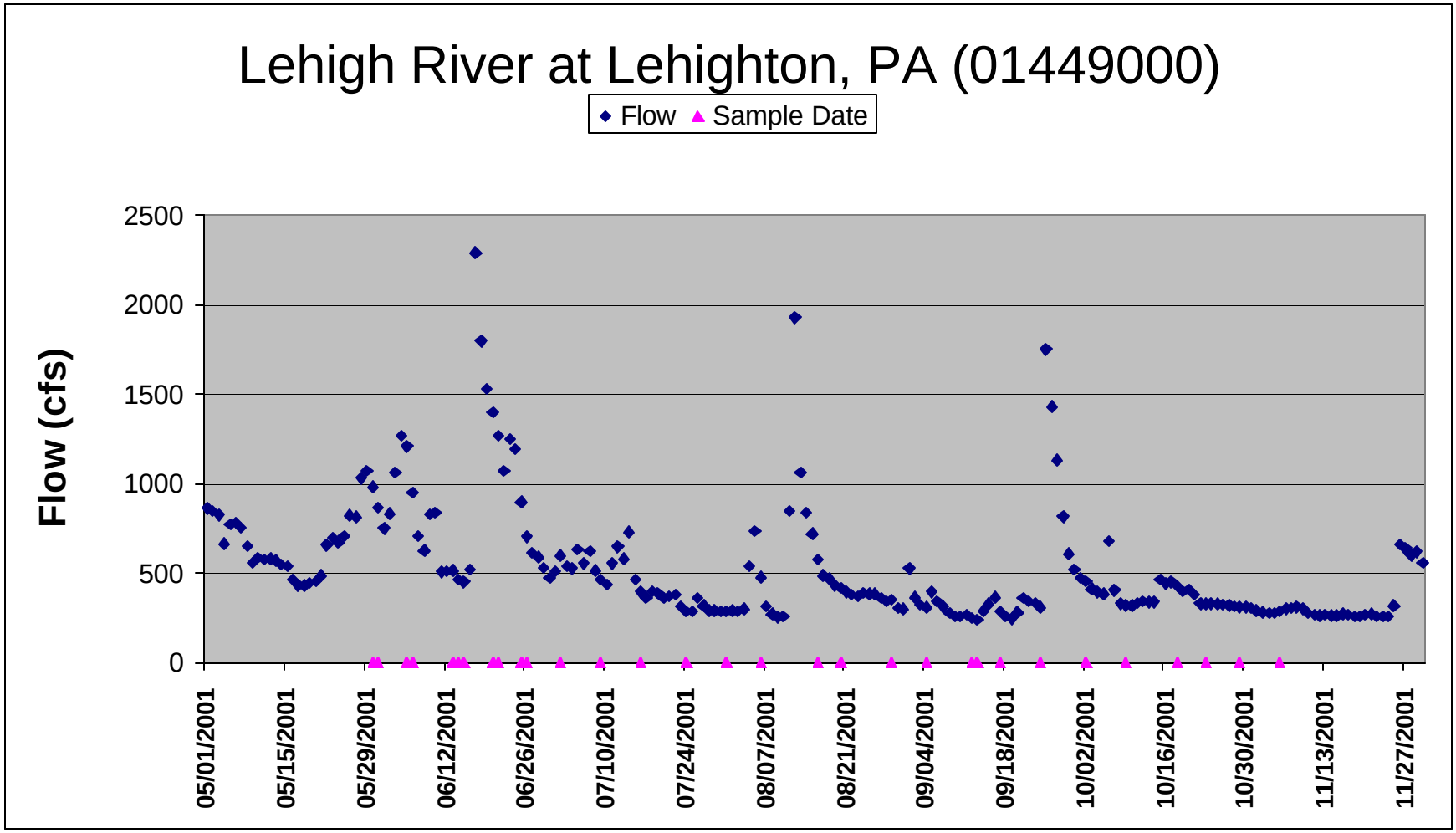
09/18/2001
10/02/2001
10/16/2001
10/30/2001
11/13/2001
11/27/2001

Appendix 5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Sample Date
Flow (cfs)
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2000
1500
1000
500
0
05/01/2001
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05/29/2001
06/12/2001
06/26/2001
07/10/2001
07/24/2001
08/07/2001
08/21/2001
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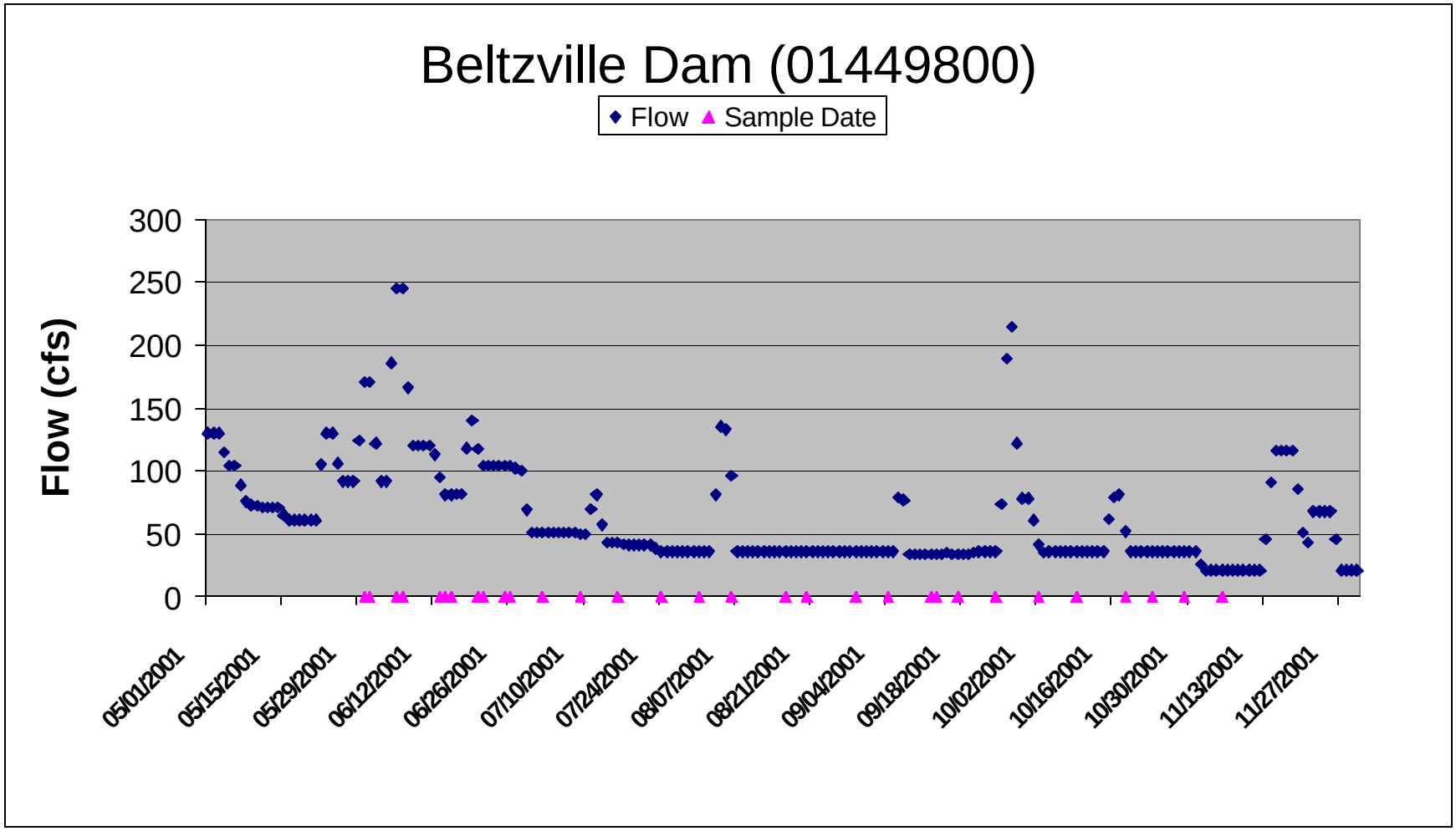
10/02/2001
10/16/2001
10/30/2001
11/13/2001
11/27/2001

Appendix 6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250
200
150
100
50
0
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06/26/2001
07/10/2001
07/24/2001
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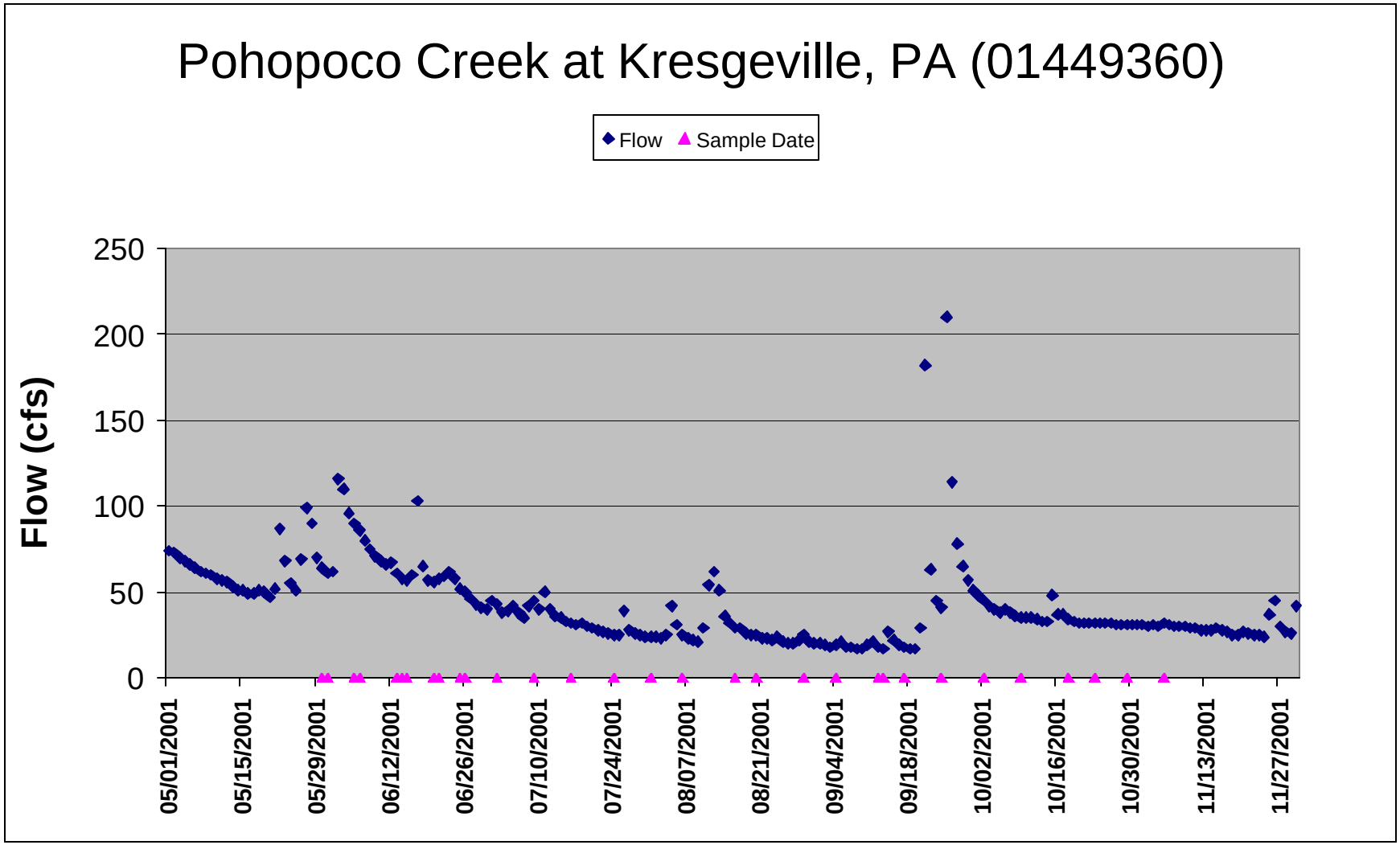
10/16/2001
10/30/2001
11/13/2001
11/27/2001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Sample Date
Flow (cfs)
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150
100
50
0
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05/15/2001
05/29/2001
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06/26/2001
07/10/2001
07/24/2001
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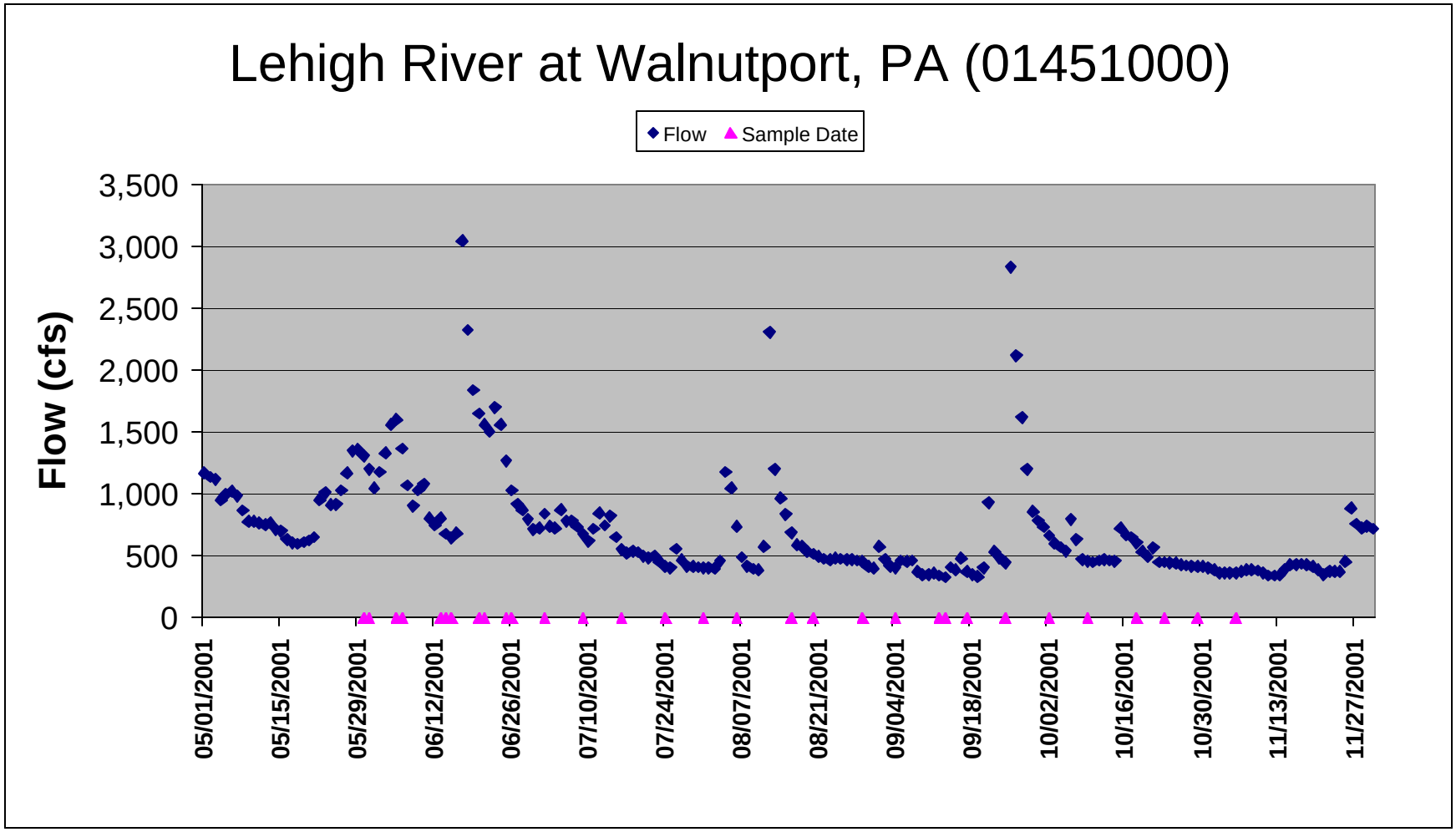
10/16/2001
10/30/2001
11/13/2001
11/27/2001


Lehigh River at Walnutport, PA (01451000)
Flow
Sample Date
Flow (cfs)
3,500
3,000
2,500
2,000
1,500
1,000
500
0
05/01/2001
05/15/2001
05/29/2001
06/12/2001
06/26/2001
07/10/2001
07/24/2001
08/07/2001
08/21/2001
09/04/2001
09/18/2001
10/02/2001
10/16/2001
10/30/2001
11/13/2001
11/27/2001

Appendix 9

Appendix 10

ACKNOWLEDGEMENTS

Numerous individuals, groups, agencies and companies cooperated in the planning, development and completion of this study. Without their dedication and work effort this study would not have been possible. Listed below are the study partnership members and their main contributions.

U.S. Army Corps of Engineers, Philadelphia District
The Secretary of the Army, acting through the Chief of Engineers is authorized through Section 22 of the Water Resources Development Act of 1974, as amended, to assist States with comprehensive plans for development, utilization and conservation of water and related resources of drainage basins, watersheds or ecosystems located within a State's boundary. The Philadelphia District secured partial funding to conduct the Lehigh River Water Quality Study under this act. In addition, the Philadelphia District was the lead agency for the study. In cooperation with the study partners, the district coordinated study meetings and field sampling, developed and implemented study plans, secured and managed the sampling contract and was responsible for producing the final report.

Delaware River Basin Commission
The Delaware River Basin Commission took the role of non-federal sponsor for this effort and provided technical oversight for the project. In addition, the Commission provided in-kind services toward the project. This was provided through meetings and field sampling efforts.

Pennsylvania Fish and Boat Commission
The Pennsylvania Fish and Boat Commission dedicated many hours of in-kind services to include attending meetings, field sampling, establishing gauging stations at sampling locations and developing flow rating curves for those sites, and providing technical oversight for the project. In addition, the Pennsylvania Fish and Boat Commission partnered with the Pennsylvania Department of Environmental Protection in developing a database containing the past 5 years of water quality information for the Lehigh River ending in 2000.

Pennsylvania Department of Environmental Protection
The Pennsylvania Department of Environmental Protection provided partial funding toward the project. In addition, a location for meetings was made available, technical and sampling recommendations were provided, and in cooperation with the Pennsylvania Fish and Boat Commission historic sampling data for the river over the past five years ending in 2000 was placed into a database. This was used to assess the quantity and general quality of available data for the river.

Wildlands Conservancy
The Wildlands Conservancy was instrumental in evaluating and recommending sampling locations for the study area as well as securing access at various sampling station locations. In addition, they dedicated numerous personnel and hours on a volunteer basis throughout the study.

United States Fish and Wildlife Service
The Service was unable to dedicate personnel to the study but did provide study oversight.

Lehigh River Watch, Parkland High School
The Lehigh River Watch Team voluntarily maintained a water quality sampling station at Northampton during the study period. This data was incorporated into the study database.

Pennsylvania Department of Conservation and Natural Resources, Lehigh Gorge State Park
The Department of Conservation and Natural Resources provided security and gate access for sampling stations located in the Lehigh Gorge State Park.

Blue Ridge Real Estate, Jack Frost Ski Resort
Blue Ridge Real Estate permitted property access to the Lehigh River and Tobyhanna Creek confluence for establishment of a sampling station adjacent to their property boundary.

Northampton Borough Municipal Authority
The Northampton Bureau Water Authority permitted gate access that allowed the establishment of a sampling station on the Lehigh River adjacent to their property boundary.

Lehighton Water Authority
The Lehighton Water Authority provided personnel access that allowed establishment of a sampling station on the Lehigh River adjacent to their property boundary and water intake.

Boy Scouts of America
The Boy Scouts of America provided gate access that allowed establishment of a sampling station on their property boundary to the Lehigh River and Tobyhanna Creek confluence. Access was provided through the Acahela Boy Scout Camp.

C & S Railroad Company
The C & S Railroad allowed gate access to the rail line access road for establishment of a sampling station on a tributary station adjacent to their rail line property boundary.

Lehigh University
Lehigh University provided student volunteers to participate in field sampling activities on numerous occasions.

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1.0 INTRODUCTION

The Delaware River Basin Commission (DRBC) and the Pennsylvania Department of Environmental Protection (PADEP) have been working toward determining flow needs and related water quality issues on the Lehigh River. An ad hoc committee of the Flow Management Technical Advisory Committee made up of staff of the PADEP; Pennsylvania Fish and Boat Commission (PFBC); U.S. Army Corps of Engineers (USACE); Wildlands Conservancy (WC) and the DRBC determined that in order to predict the impacts of water flows on the uses of the Lehigh River, it would be necessary to measure existing water quality conditions and develop a predictive water quality computer model to assess the flow relationships. PADEP and PFBC personnel compiled available water quality data for the past five years on the Lehigh River from F.E. Walter Reservoir downstream to its confluence with the Delaware. An examination of this database revealed that water quality data collected in the upper and middle sections of the Lehigh River were insufficient to develop and calibrate a reliable water quality/flow model.

Water quality conditions in the Lehigh River downstream of Walter and Beltzville Reservoirs are affected by storage and operations of the reservoirs as well as by point source discharges and watershed conditions, including acid-mine drainage. Of particular interest to resource managers of the river are river water temperature, pH, metals concentration, and to a lesser extent, nutrients and how these parameters may be affected and possibly improved by operational changes of the reservoirs. These key parameters can affect fish and other biota in the river through high temperatures, low pH, and possibly toxic metal concentrations, particularly during low flow or drought conditions.

To provide the data needed to model water quality in the Lehigh a monitoring program was developed and implemented in the spring of 2001. The program was designed to characterize the existing water quality conditions in the Lehigh River. These data were collected in anticipation of follow-up work using existing water quality models such as CE-QUAL-W2 and QUAL2E. Using Section 22 funds from the Water Resources Development Act and in a joint effort between PFBC, DRBC, WC, and USACE, an intensive water quality monitoring effort was conducted between May and November 2001. The collection and the analyses of the samples at the stream boundaries and on the Lehigh mainstem were conducted by a combination of staff from the PFBC, PADEP, Wildlands Conservancy, USACE contractors, and other volunteer sources. Approximately 600 samples were analyzed in the 2001 monitoring effort. If additional funding is secured, these data will be utilized to develop a water quality flow model to determine water flow impacts on water quality and related water use issues on the entire length of the Lehigh River.

2.0 METHODS

2.1 FIELD AND LABORATORY

Seventeen stations were monitored for 24 continuous weeks to define the water quality conditions of the Lehigh River and its tributaries between May and November 2001. Seven stations were located on the mainstem of the Lehigh River, while ten were located in tributaries leading into the Lehigh (Figure 2-1). The first water quality station (LH1) was placed above F.E. Walter Dam, at the confluence of Tobyhanna Creek and the Lehigh River. Additional stations were added at major tributaries further downstream to the last sampling station (LH17) located near Northampton, PA. Table 2-1 lists the station designations used for this study, PADEP water use category for each station and the station coordinates.

Table 2-1. Station descriptions for the Lehigh water quality monitoring study conducted between May and November 2001.

Station	PADEP Water Use Category	Mainstem or Tributary	Location Description	Latitude	Longitude
LH1	HQ-CWF	Main	Upstream of Walters Dam at confluence of Tobyhanna Creek	41° 7.339	75° 38.955
LH2	HQ-CWF	Main	1,000 feet downstream of Walters Dam	41° 6.592	75° 43.516
LH3	HQ-CWF	Main	At Tannery Bridge	41° 2.318	75° 45.655
LH4	HQ-CWF	Tributary	Hayes Creek	41° 2.083	75° 44.632
LH5	HQ-CWF	Tributary	Sandy Run	41° 1.082	75° 44.462
LH6	HQ-CWF	Tributary	Buck Mountain Creek	40° 57.921	75° 45.417
LH7	HQ-CWF	Tributary	Black Creek	40° 56.740	75° 44.818
LH8	HQ-CWF	Main	Glen Onoko	40° 52.966	75° 45.595
LH9	HQ-CWF	Tributary	Nesquehoning Creek	40° 52.492	75° 45.802
LH10	TSF	Main	Near Lehighton water intake	40° 50.969	75° 42.570
LH11	CWF	Tributary	Downstream of Lehighton sewage treatment outfall on Mahoning Creek	40° 49.484	75° 42.030
LH12	CWF	Tributary	Pohopoco Creek leading from Beltzville Reservoir	40° 49.028	75° 40.363
LH13	TSF	Tributary	Lizard Creek	40° 47.728	75° 39.923
LH14	TSF, MF	Tributary	Aquashicola	40° 47.590	75° 36.779
LH15	TSF	Main	Walnutport Gauge	40° 45.158	75° 36.086
LH16	CWF	Tributary	Bertsch Creek	40° 44.126	75° 34.646
LH17	TSF	Main	Northampton treatment plant intake	40° 42.108	75° 30.993

In-situ instruments, which measured temperature, pH, dissolved oxygen, chlorophyll, turbidity, and conductivity every hour, were installed at four mainstem Lehigh River stations. These units were maintained at the confluence of Tobyhanna Creek and the Lehigh River above

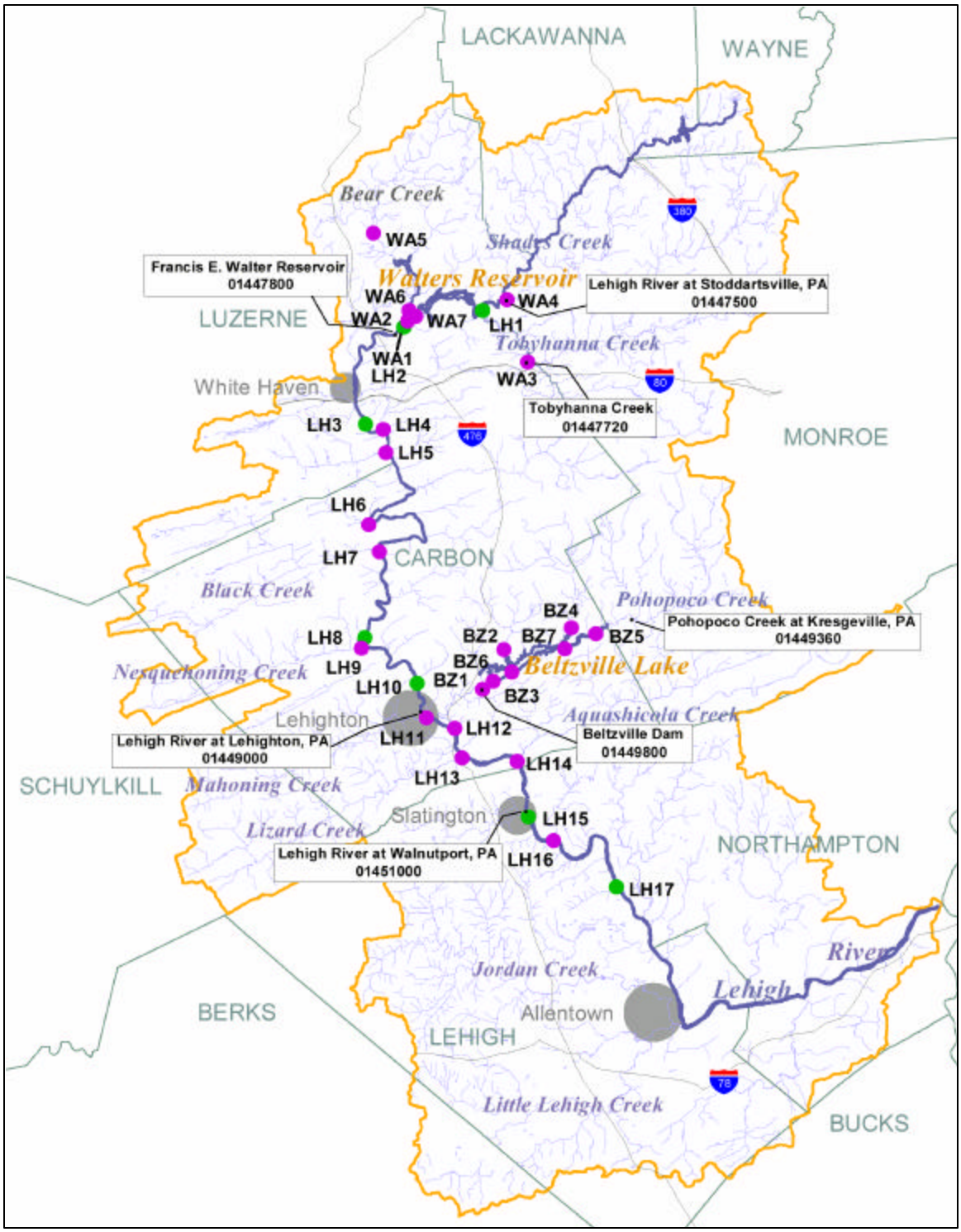


Figure 2-1. Sampling locations for the 2001 Lehigh river water quality monitoring program. Stations indicated in green were located in the mainstem of the river. Boxes indicate position and name of nearby USGS gauging stations.

F.E. Walter Reservoir (LH1), below F.E. Walter Reservoir (LH2), and at two sites on the Lehigh River (LH10 and LH17). Station LH10 was located near the Lehighton water authority plant intake while station LH17 was positioned on the intake structure for the Northampton water treatment facility. YSI® 6600 data logging water quality meters were deployed at stations LH1, LH2, and LH10. At station LH17 a Hydrolab® water quality meter was deployed and maintained by the Lehigh River Watch group. Point measurements of dissolved oxygen, pH, conductivity, and temperature levels were also measured each week at all 17 stations with a Hydrolab®. Ambient water temperature was recorded every ½ hour with Onset Computer Corporation TidbiT^{tm} probes at all sampling stations. Water grab sampling was conducted weekly at all 17 stations between May and November 2001 for a total of 24 weeks. The parameters measured at each station are listed in Table 2-2.

Table 2-2. Nutrient parameters and method detection limits used during the Lehigh River water quality monitoring study conducted between May and November 2001

Parameter	EPA Method Number	Detection Limit
Alkalinity	310.3	1 mg/L
Soluble Reactive Phosphorus	365.2	0.05 mg/L
Phosphorus	365.2	0.05 mg/L
Ammonium Nitrogen	350.3	0.1 mg/L
Nitrate Nitrogen	4500 NO_3	0.1 mg/L
Nitrite Nitrogen	4500 NO_3	0.1 mg/L
Total Inorganic Carbon	415.1	5 mg/L
Total Organic Carbon	415.1	5 mg/L
Chlorophyll a	445.0	0.2 ug/L
Dissolved Silica	370.1	2 mg/L
5-Day BOD	SM5210B	5 mg/L

Water samples for total metals analysis was conducted at eight stations once during the months of May, June, August and September. Sampling was performed during varied flow conditions to include one low flow, two mid-flow and one-high flow event. Samples were analyzed for aluminum, cadmium, iron, manganese, zinc, and hardness. Both total and dissolved concentrations were analyzed during a high flow period in June 2001. All other samples were total concentrations only. Table 2-3 provides a breakdown of the laboratory methods and target detection limits for the metals parameters examined during the monitoring program.

Table 2-3. Metal parameters and method detection limits used during the Lehigh water quality monitoring study conducted between May and November 2001

Parameter	EPA Method Number	Detection Limit
Aluminum	200.7	0.02 mg/L
Cadmium	200.7	0.005 mg/L
Iron	200.7	0.005 mg/L
Manganese	200.7	0.005 mg/L
Zinc	200.7	0.005 mg/L

Many of the nutrient parameters monitored during this study are similar water quality parameters that have been measured in yearly monitoring programs conducted by the USACE in Walter and Beltzville Reservoirs since the 1970s.

Air temperature, relative humidity, solar radiation, wind speed, and direction were monitored every ½ hour with a YSI 6200 meteorological station installed and maintained at both the Walter and Beltzville Reservoir discharge towers. Local weather conditions were recorded with these units from the end of May through the first week in November 2001.

In-stream flows were recorded at nine tributary stations each week with staff gauges that were installed at the monitoring stations (flows were monitored at stations that did not have nearby USGS flow data available). Flows (cfs) during each sampling event were estimated based on rating curves developed under different discharge levels by Pennsylvania Fish and Boat Commission personnel. Rating curves and flow rates were monitored and produced at tributary stations LH4 (Hayes Creek), LH5 (Sandy Run), LH6 (Buck Mountain), LH7 (Black Mountain), LH9 (Nesquehoning Creek), L11 (Mahoning Creek), LH13 (Lizard Creek), LH14 (Aquashicola Creek), and LH16 (Bertsch Creek). Rating curves and associated data are included in the CD-ROM database accompanying this report.

2.2 ADDITIONAL RESERVOIR SAMPLING

To provide additional data and support to the Lehigh River monitoring project, the USACE established two new stations in the main body of the Walters reservoir (WA-6 and WA-7). These two stations plus the 5 regular Walters monitoring stations and the 7 Beltzville stations were sampled in April and October 2001 in addition to the regular monthly sampling between May and September. Parameters monitored at these sites included BOD, total carbon, total organic carbon, total inorganic carbon, total suspended solids, alkalinity, total dissolved phosphorus, dissolved phosphate, total phosphorus, ammonia nitrogen, nitrate and nitrite nitrogen, total Kjeldahl nitrogen, and chlorophyll a. These data are summarized in the annual reports for the Walters (Versar 2002a) and Beltzville (Versar 2002b) reservoirs and are provided electronically in the data CD attached to this report.

2.3 DATABASE

Data from the in-situ water quality meters, temperature probes, chemical analytical laboratory, and meteorological stations were reviewed for out of range parameters, data anomalies, and probe malfunction. After removing bad data from the files the information was stored in Excel spreadsheets for subsequent data analysis. Data gaps in the plots and Excel spreadsheets are a result of removing spurious data. Program data are included in this document in the attached CD that serves as data appendices for this report. The data file structure stored on the CD is presented in Table 2-4.

Table 2-4. File structure for Lehigh River CD database

Folder Name	File Names	Description
Meterological	Beltzville Met.xls	Air temperature, wind speed, direction and solar radiation monitored at the Beltzville and Waters dam towers.
	Walters Met.xls	
Phys In Situ	Lehigh In Situ.xls	Continuous monitoring data for DO, temperature, pH, turbidity, chlorophyll, and conductivity at the four long-term monitoring stations.
Phys Point Meas	Lehigh Phys Point Meas.xls	Point measurements of DO, temperature, pH, turbidity, chlorophyll, and conductivity taken at all 17 stations each week of the monitoring program.
Reservoirs	Beltz Phys Meas.xls	Point measurements of DO, temperature, pH, and conductivity taken once a month at the Beltzville Reservoir monitoring stations.
	Reservoir Wet Chem.xls	Nutrient and BOD data collected once a month at the USACE reservoir monitoring stations.
	Walters Phys Meas.xls	Point measurements of DO, temperature, pH, and conductivity taken one a month at the Walters Reservoir monitoring stations.
Temp Probes	All Tem Data.xls	Temperatures recorded every half hour at the 17 Lehigh River monitoring stations.
	Mean Daily Temp.xls	Mean daily temperatures from the continuous monitors placed at all 17 Lehigh River stations.
Water Quality	Chlorophyll.xls	Chlorophyll concentrations observed in grab samples (units ug/L)
	Flow Estimates.xls	Flow monitored with staff gauges. Calculated by PFBC in cubic feet per second (cfs)
	Metals.xls	Total and dissolved metals concentrations observed in grab samples (units mg/L)
	USGS Flows.xls	Provisional flows taken from nearby USGS gauging stations.
	Wet Chem.xls	Nutrient concentrations observed in grab samples (units mg/L) taken weekly at all 17 Lehigh River monitoring sations.

3.0 RESULTS

3.1 FLOWS

Average flows in the nine tributary stations ranged from a low of 3.6 cfs at LH16 (Bertsch Creek) to a high of 49.1 at LH14 (Aquashicola Creek) (Table 3-1). Base flow in Hayes Creek averaged about 15.5 cfs and peaked on September 26, 2001 when high flows were observed at all staff gauge monitoring sites. Minimum flows of 6.7 cfs were observed at station LH4 on week 16 of the monitoring program. Sandy Run (LH5) base flows averaged 25 cfs and lowest flows were estimated for the last day of the monitoring period. Maximum flows were also observed on September 26 at this station. Buck Mountain Creek flows averaged 8.7 cfs throughout the monitoring period which peaked at 23.5 cfs on September 26 while lowest flows were recorded during week 21 of the study period. Black Creek base flows were among the highest recorded (34.4 cfs) and maximum flows were observed on week 17. Lowest flows occurred during week 7 when levels dropped to 11.3 cfs. Average flow between Nesquehoning Creek (LH9) and Mahoning Creek (LH11) were similar at about 17 cfs as were minimum and maximum flows. While minimum flow occurred in about the same time period (between week 16 and 18) maximum flow were observed early on (week 4) at LH11 (65.6 cfs) and much later after week 18 for LH9 (68.1). Maximum flows were recorded between week 5 and 6 (122.5 cfs) at Lizard Creek while minimum flow were observed during week 17 for this station. Aquashicola creek had the highest average (49.1), minimum (24.2), and maximum (157.4) flows recorded among the nine stations monitored during the 2001 sampling season. In contrast, Bertsch Creek (LH16) had the lowest average (3.6), minimum (1.0), and maximum (10.3) flows observed in the time series. Figures 3–1 through 3-9 summaries the flow data relative to the 24 weekly sampling dates for stations LH-4 through LH16, respectively.

Flows for mainstem stations monitored by established USGS gauging stations are presented in the Appendix.

Table 3-1. In-stream flows (cfs) estimated from staff gauge readings and flow rating curves developed for the nine tributary stations monitored in the Lehigh River between May and November 2001.

		LH4	LH5	LH6	LH7	LH9	LH11	LH13	LH14	LH16
		Hayes Creek	Sandy Run	Buck Mountain Creek	Black Creek	Nesquehoning Creek	Mahoning Creek	Lizard Creek	Aquashicola Creek	Bertsch Creek
Date	Sampling Week	Est Q (cfs)	Est Q (cfs)	Est Q (cfs)	Est Q (cfs)	Est Q (cfs)	Est Q (cfs)	Est Q (cfs)	Est Q (cfs)	Est Q (cfs)
30-May-01							21.9	47.7	86.0	10.3
31-May-01	1	13.8	19.1	6.5	36.3	34.5				
4-Jun-01							43.6	53.7	107.9	3.4
5-Jun-01	2	16.0	22.1	6.5	47.4	44.6		47.7	101.8	2.7
11-Jun-01		12.2					20.9	26.5	58.9	1.2
12-Jun-01			22.7	6.5	37.3	23.4				
13-Jun-01	3	12.6	20.3	6.5	52.7					
14-Jun-01						27.9		25.7	53.6	
20-Jun-01	4			6.5	44.9	47.9	65.6	60.4	35.3	5.1
21-Jun-01	5	26.6								
25-Jun-01		19.7	24.8	6.5	40.4	35.7	58.0	122.5	81.2	8.9
2-Jul-01	6						30.3	57.0	63.5	6.1
3-Jul-01		17.0	21.5	6.5	42.6	23.8				
9-Jul-01	7	15.5	19.1	6.5	11.3	20.0	23.7	37.7	56.7	5.3
16-Jul-01	8	12.2	18.0	6.5	29.4	14.3	13.9	22.2	38.8	4.2
19-Jul-01		17.5	19.1	6.5	26.4	13.8	13.4			
20-Jul-01								18.1	36.0	3.2
24-Jul-01	9	10.8	15.2	6.5	19.7	12.0	10.1	14.7	32.8	2.6
31-Jul-01	10	10.2	13.9	6.5	19.2	12.0	9.7	14.7	31.6	2.5
6-Aug-01	11	11.2	21.5	6.5	23.7	15.8	16.4	46.3	34.7	2.1
9-Aug-01					17.3	10.9	8.5	23.5	30.4	1.6
10-Aug-01		9.9	15.2	6.5						
16-Aug-01	12	14.6	59.0		31.0	13.8	10.1	19.7	30.4	1.8
20-Aug-01	13	11.9	39.4		23.7	10.2	8.5	16.1	29.3	1.7
28-Aug-01			23.4	12.7		7.7				
29-Aug-01	14	11.5	24.8	13.0	25.0	8.6	8.5	13.1	29.3	1.1
30-Aug-01								11.6		
4-Sep-01	15	19.7	36.1	12.1	17.3	9.5	6.2	10.0	26.1	1.0
12-Sep-01	16	6.7	17.5	9.0	14.0	6.1	5.9	10.0	24.2	1.2
17-Sep-01	17				152.4	6.3	6.2	9.6	26.1	2.4
18-Sep-01				8.2	13.6	6.3	5.5		24.2	
24-Sep-01	18	9.1	36.1	8.4	17.3	7.0	7.3	13.9	46.9	2.8
26-Sep-01		56.3	76.6	23.5	102.4	68.1	32.8	83.6		
27-Sep-01									157.4	4.8
2-Oct-01	19	18.1	31.4	13.2	36.3	12.0	11.4	29.8	56.7	3.8
9-Oct-01	20	13.8	21.5	11.2	25.0	8.6	8.5	18.6	37.4	3.4
18-Oct-01	21	16.0	19.7	3.4	27.1	12.0	11.8	25.7	39.6	4.2
23-Oct-01	22	13.0	16.1	10.2	22.5	8.0	9.7	18.6	34.7	3.5
29-Oct-01	23	10.2	13.5	9.2	24.4	9.8	8.5	15.3	31.0	4.6
5-Nov-01	24	11.5	7.2	9.9	17.7	7.5	8.9	14.7	31.0	5.9
Average		**15.5**	**25.0**	**8.7**	**34.4**	**17.9**	**17.3**	**31.0**	**49.1**	**3.6**
Minimum		**6.7**	**7.2**	**3.4**	**11.3**	**6.1**	**5.5**	**9.6**	**24.2**	**1.0**
Maximum		**56.3**	**76.6**	**23.5**	**152.4**	**68.1**	**65.6**	**122.5**	**157.4**	**10.3**

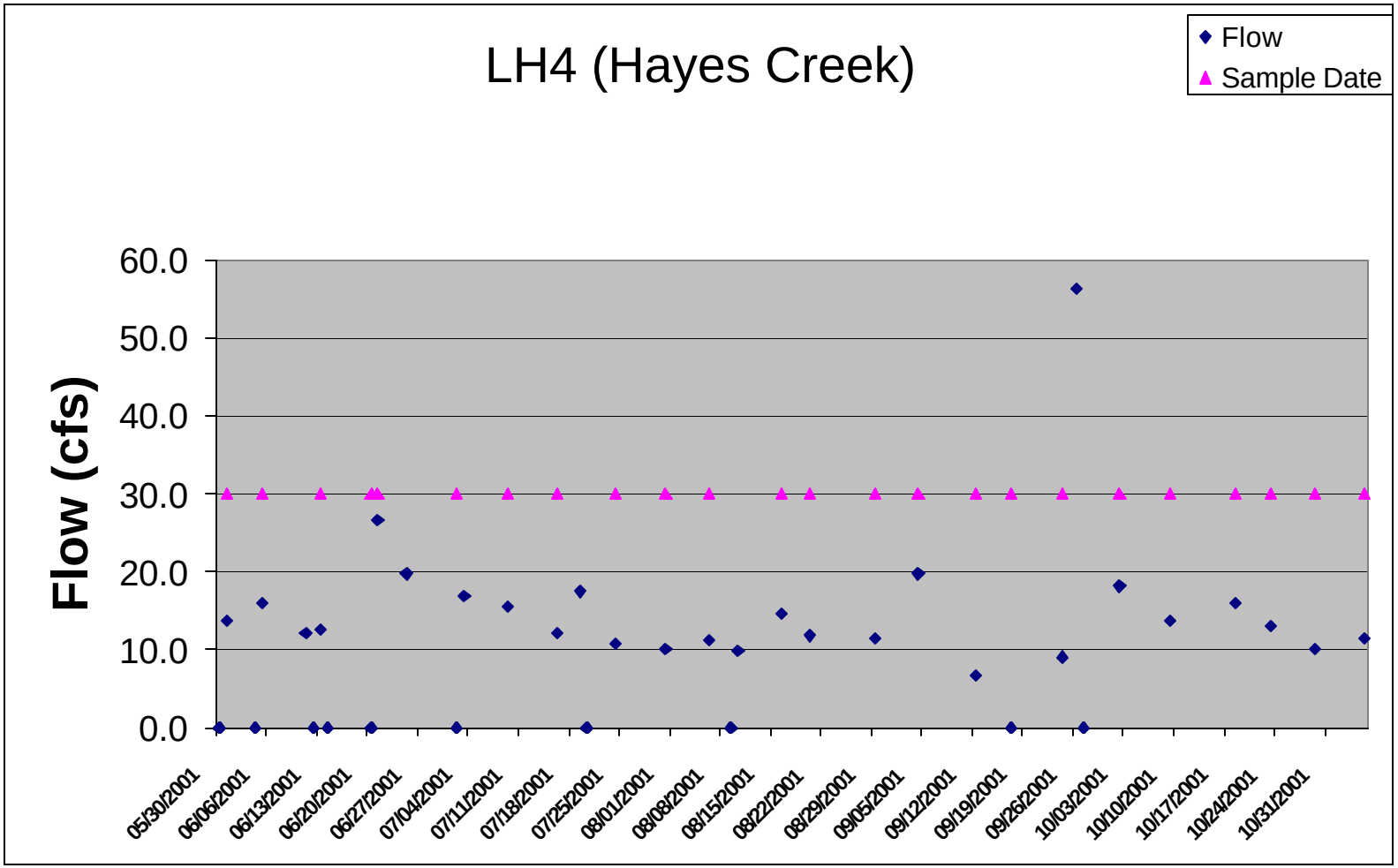


Figure 3-1. Flows (cfs) monitored at Hayes Creek (LH4) based on staff gauge reading conducted during the Lehigh River water quality monitoring study between May and November 2001. Water sampling dates are indicated with the triangular points. Flows plotted on the x-axis were not recorded or indeterminate for that date.

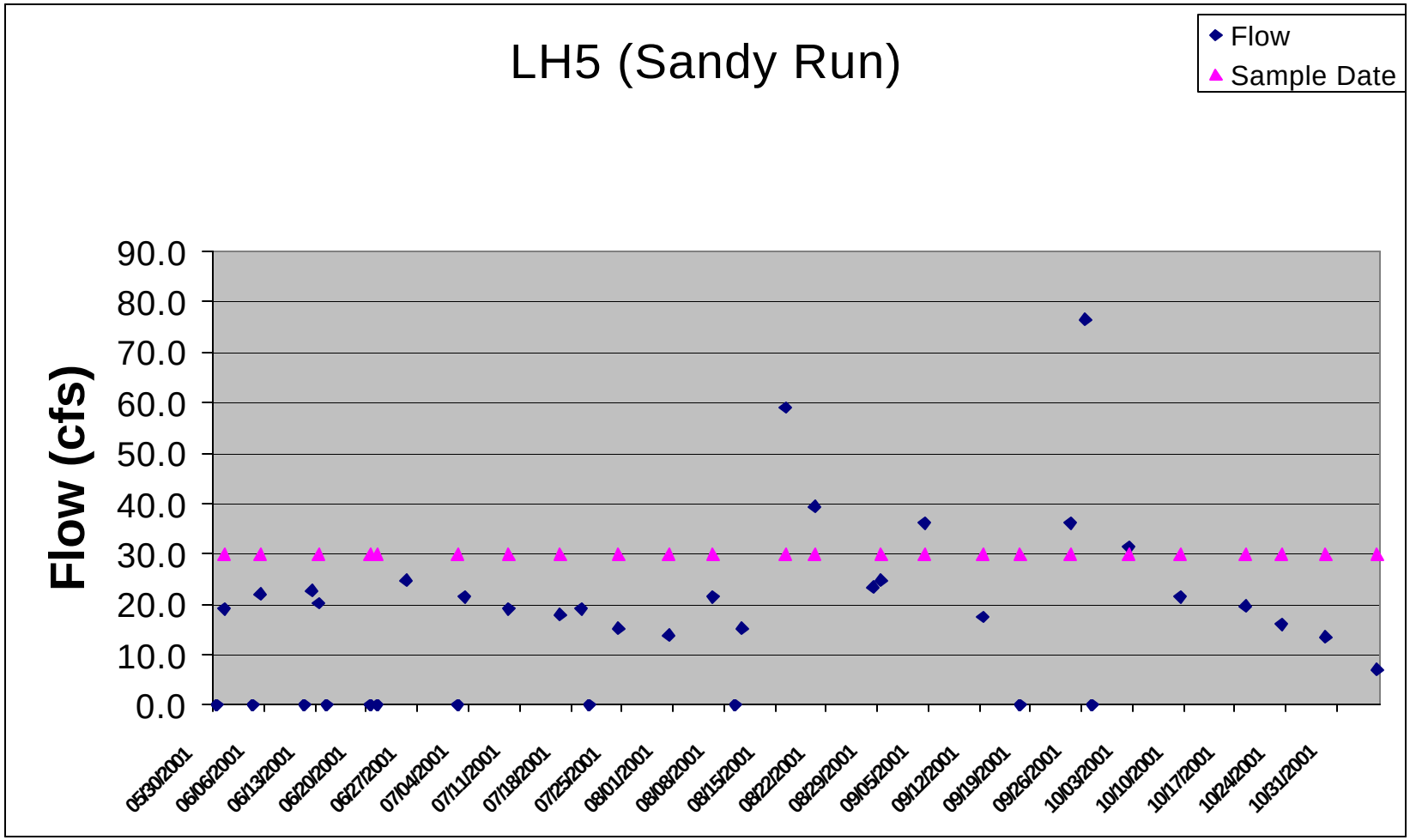


Figure 3-2. Flows (cfs) monitored at Sandy Run (LH5) based on staff gauge reading conducted during the Lehigh River water quality monitoring study between May and November 2001. Water sampling dates are indicated with the triangular points. Flows plotted on the x-axis were not recorded or indeterminate for that date.

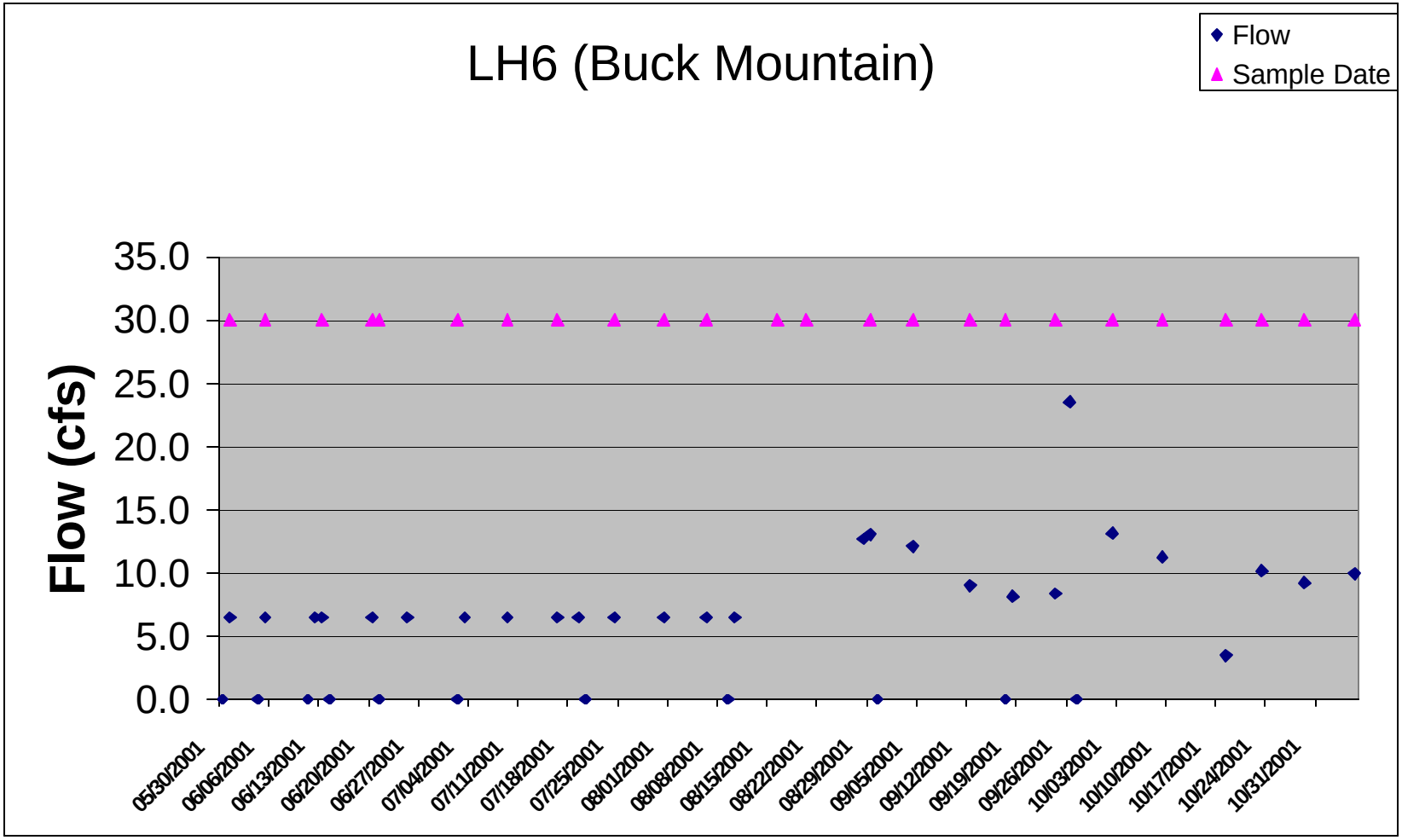


Figure 3-3. Flows (cfs) monitored at Buck Mountain (LH6) based on staff gauge reading conducted during the Lehigh River water quality monitoring study between May and November 2001. Water sampling dates are indicated with the triangular points. Flows plotted on the x-axis were not recorded or indeterminate for that date.

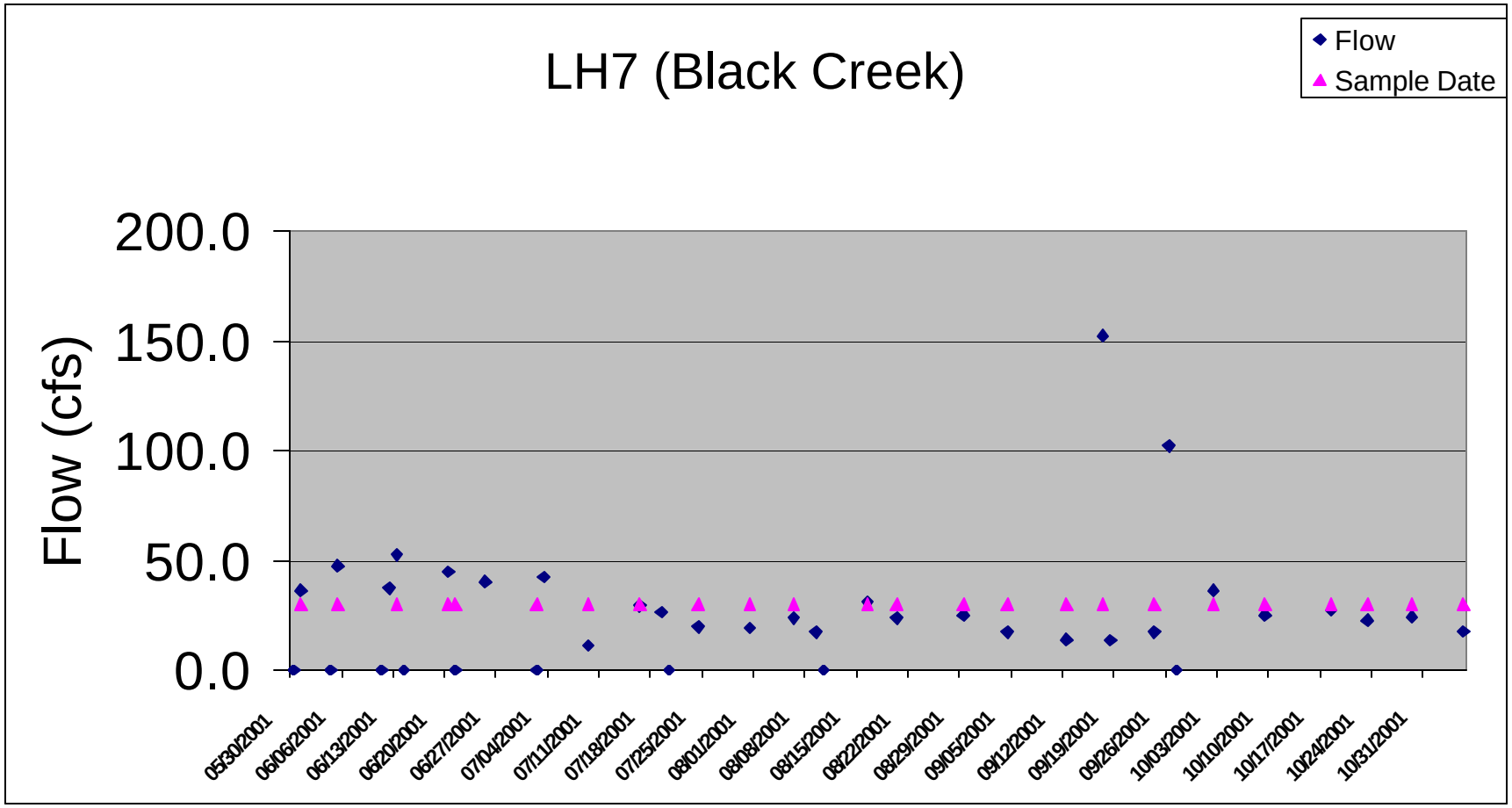


Figure 3-4. Flows (cfs) monitored at Black Creek (LH7) based on staff gauge reading conducted during the Lehigh River water quality monitoring study between May and November 2001. Water sampling dates are indicated with the triangular points. Flows plotted on the x-axis were not recorded or indeterminate for that date.

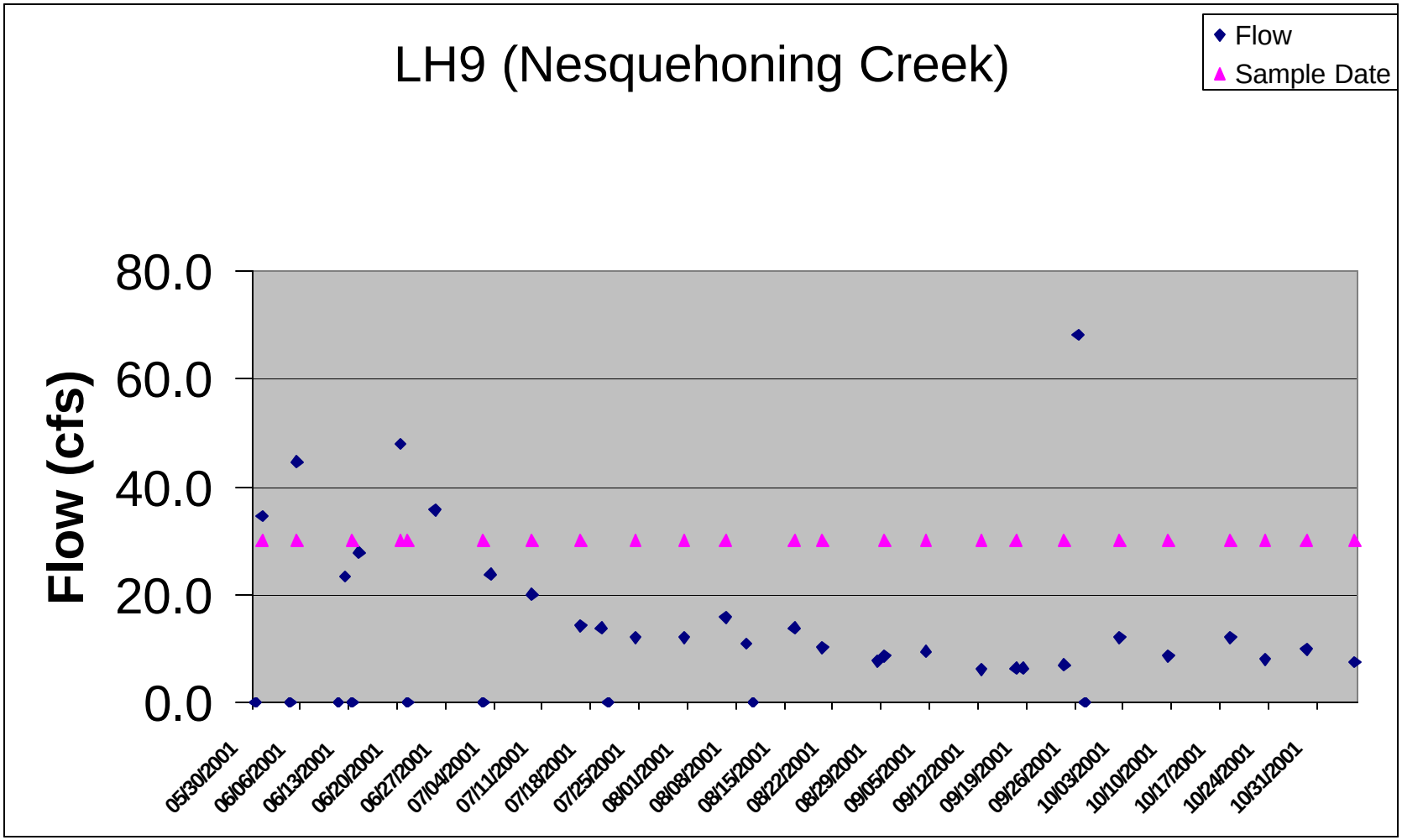


Figure 3-5. Flows (cfs) monitored at Nesquehoning Creek (LH9) based on staff gauge reading conducted during the Lehigh River water quality monitoring study between May and November 2001. Water sampling dates are indicated with the triangular points. Flows plotted on the x-axis were not recorded or indeterminate for that date.

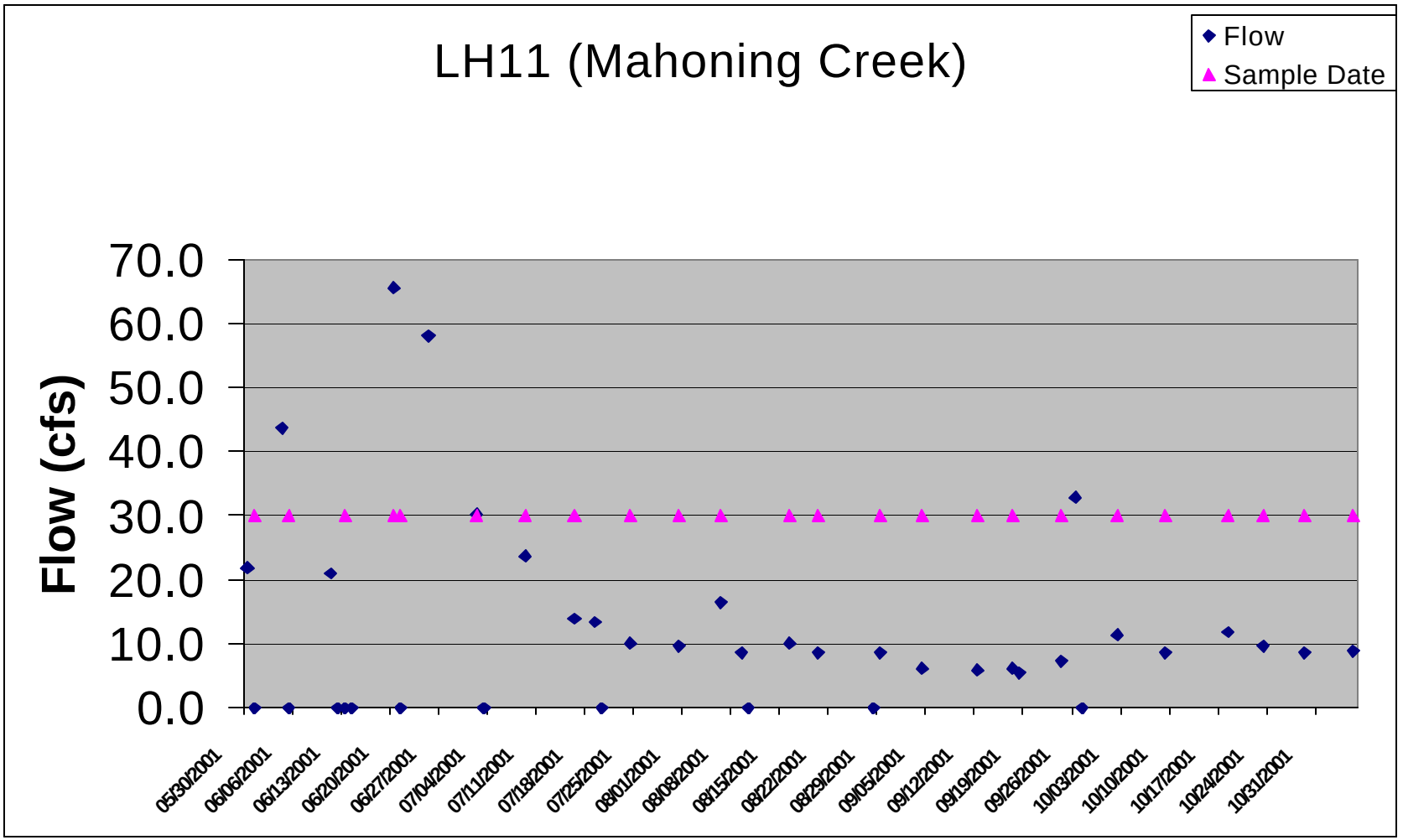


Figure 3-6. Flows (cfs) monitored at Mahoning Creek (LH11) based on staff gauge reading conducted during the Lehigh River water quality monitoring study between May and November 2001. Water sampling dates are indicated with the triangular points. Flows plotted on the x-axis were not recorded or indeterminate for that date.

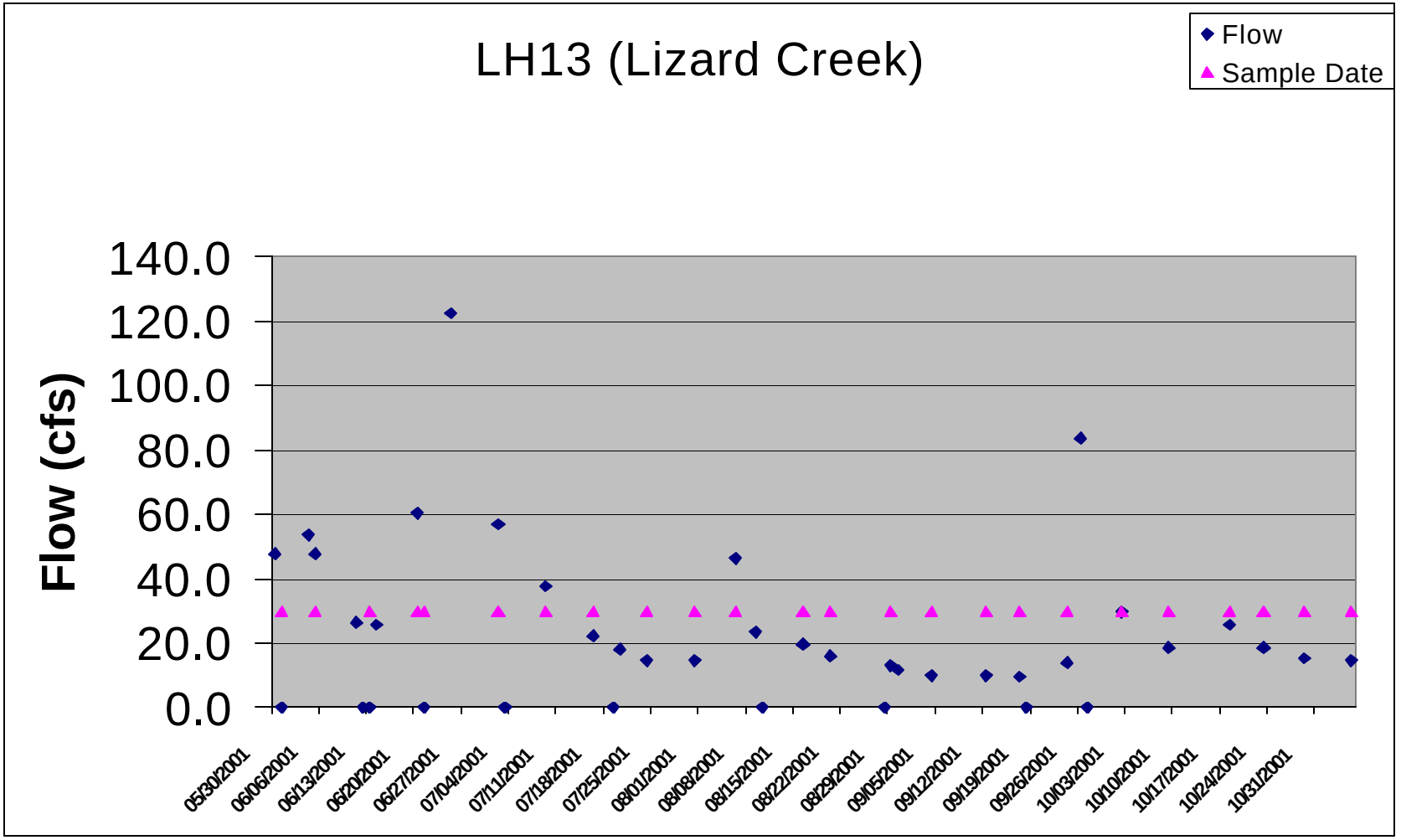


Figure 3-7. Flows (cfs) monitored at Lizard Creek (LH13) based on staff gauge reading conducted during the Lehigh River water quality monitoring study between May and November 2001. Water sampling dates are indicated with the triangular points. Flows plotted on the x-axis were not recorded or indeterminate for that date.

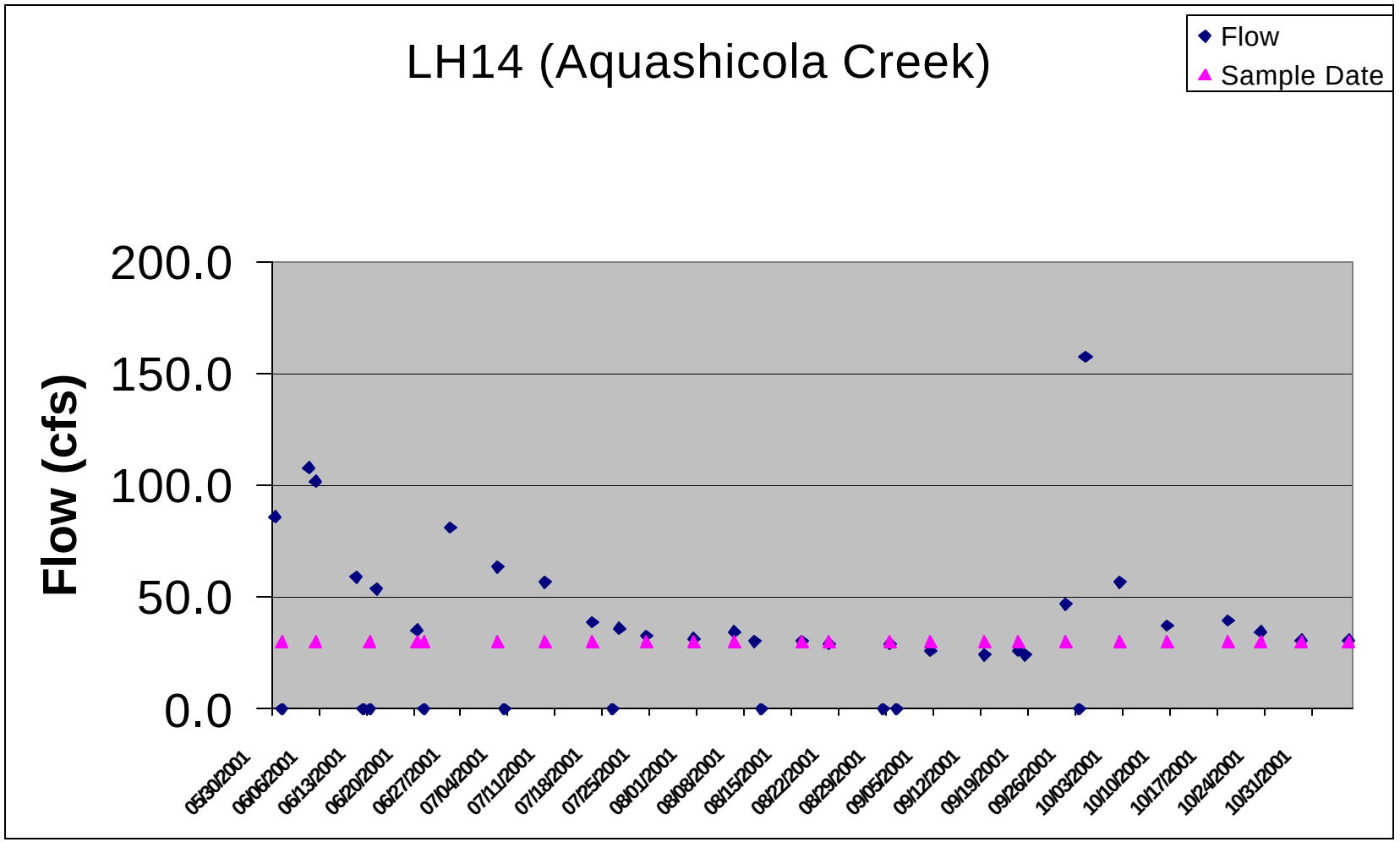


Figure 3-8. Flows (cfs) monitored at Aquashicola Creek (LH14) based on staff gauge reading conducted during the Lehigh River water quality monitoring study between May and November 2001. Water sampling dates are indicated with the triangular points. Flows plotted on the x-axis were not recorded or indeterminate for that date.

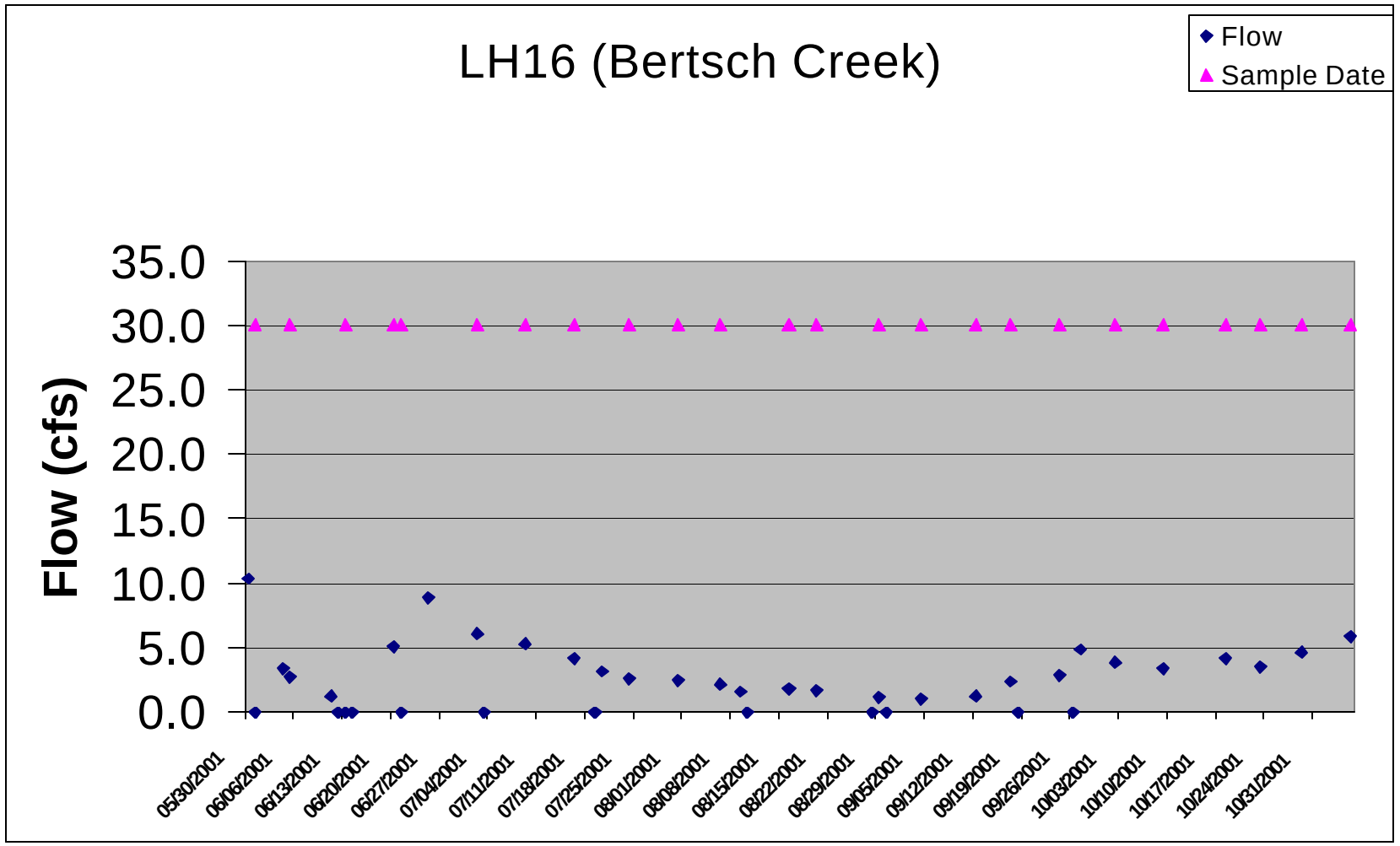


Figure 3-9. Flows (cfs) monitored at Bertsch Creek (LH16) based on staff gauge reading conducted during the Lehigh River water quality monitoring study between May and November 2001. Water sampling dates are indicated with the triangular points. Flows plotted on the x-axis were not recorded or indeterminate for that date.

3.2 TEMPERATURES

Daily mean temperatures calculated from the data recorded by the TidbiT^{tm} probes deployed at all seventeen Lehigh River monitoring stations were examined and compared to PADEP water use criteria for temperature. Upstream stations LH1 through LH5 were plotted together along with the season specific temperature criteria for High Quality Cold Water Fisheries (HQ-CWF; Fig. 3-10). Stations LH6 through LH9 and downstream station LH16 (Bertsch Creek) are also categorized as a HQ-CWF (PADEP $Temp_1$) and the daily mean water temperatures are presented in Figure 3-11. Stations LH10 and downriver to LH17 are classified as a either a Trout Stocking Fishery (TSF) or a Cold Water Fishery (CW) and observed water temperatures relative to seasonal specific temperature criteria (PADEP $Temp_3$) are presented in Figure 3-12. This analysis indicated that station LH1 (placed above F.E. Walter Dam, at the confluence of Tobyhanna Creek and the Lehigh River), LH2 (just below the Walter's dam outfall), and mainstem station LH3 (several miles downstream of the dam) exceeded temperature requirements for a cold water fishery for most of monitoring period (Fig. 3-10). In contrast, water temperatures at tributary stations LH4 (Hayes Creek) and LH5 (Sandy Run) located just downstream of station LH3 were well below the temperature requirements for a CWF use category.

Similarly high temperatures (i.e. above critical use criteria) were found at the mainstem stations LH8, and LH16 located near Glen Onoko, Lehighton, and Bertsch Creek, respectively (Fig. 3-11). Tributary station LH7 (Black Creek) was occasionally over the CWF temperature criteria in June and July, but generally below criteria after mid-August 2001. In contrast, water temperatures at tributary stations LH6 (Buck Mountain) and LH9 (Nesquehoning Creek) were well below the CWF criteria for most of the monitoring period (Fig. 3-11).

The sampling stations from the Lehighton Intake (LH10) downstream to LH17 (Northampton) were either categorized as a Trout Stocking Fishery or a Cold Water Fishery by the PADEP ($Temp_3$). Figure 3-12 compares the season water temperature requirements to those observed from the in-situ temperature monitors. These data show that, with only a few exceptions in the summer months, most the tributaries and mainstem stations met the PADEP $Temp_3$ requirements (Fig. 3-12).

3.3 DISSOLVED OXYGEN

Dissolved oxygen concentrations were monitored at four sites in the mainstem of the Lehigh River during the monitoring period. The observed concentrations at LH1 (above the Walters Reservoir), LH2 (below the Walters dam), LH10 (near the Lehighton sewage treatment plant intake), and LH17 (at Northampton) are presented in Figures 3-13 through 3-16, respectively. Reference lines representing the PADEP required concentrations relative to each station's critical use category are also plotted in the figures. Dissolved oxygen levels below the recommended 7.0 mg/L HQ-CWF DO criteria was observed in about 25% of the observations recorded at LH1 (Fig. 3-13). This station was located on the confluence of Tobyhanna Creek

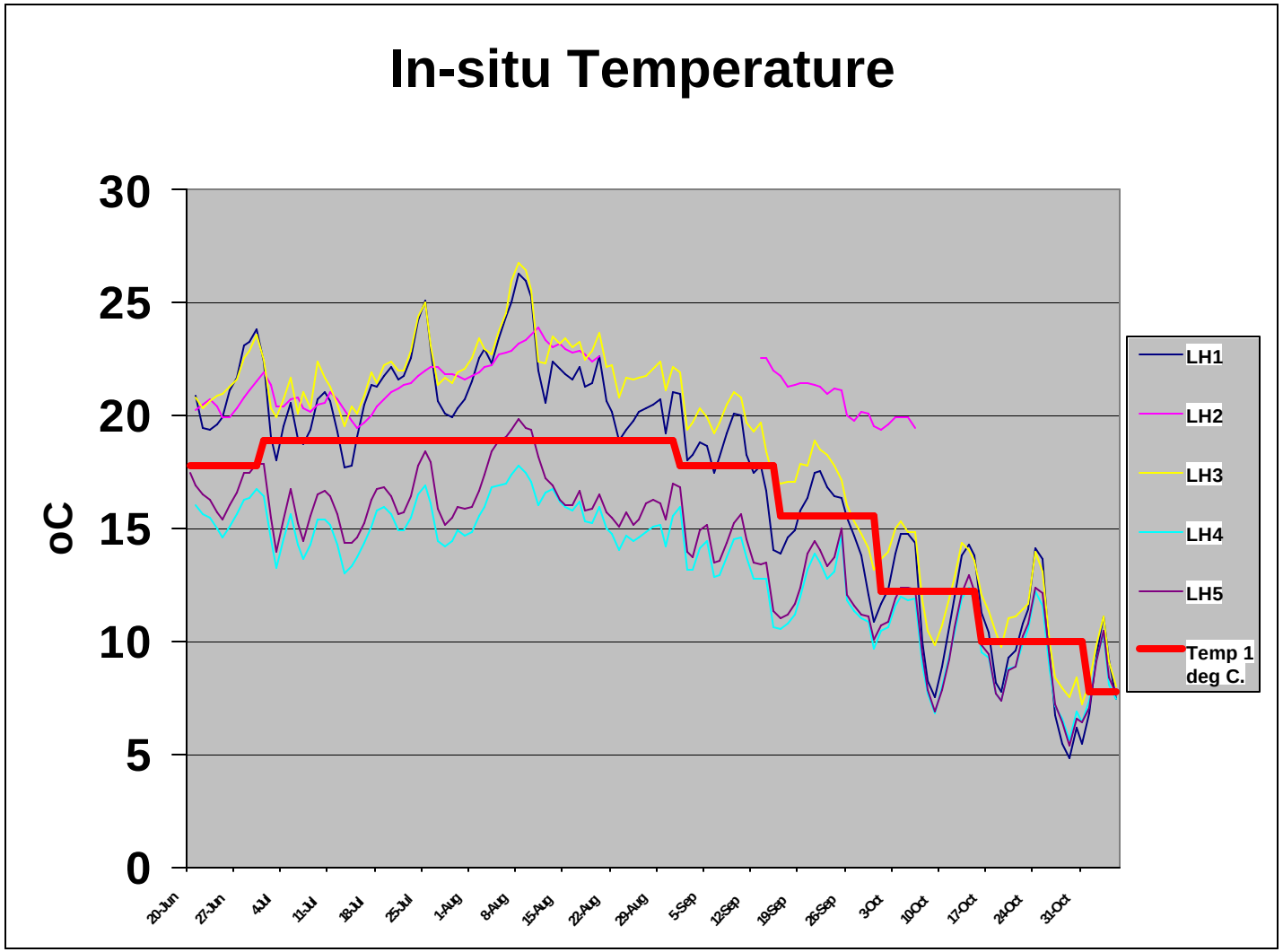


Figure 3-10. Temperature monitored at stations LH1, LH2, LH3, LH4, and LH5 with the TidbiT^{tm} in-situ meters during the Lehigh River water quality monitoring study conducted between May and November 2001. Season specific PADEP HQ-CWF temperature requirements are plotted in red.

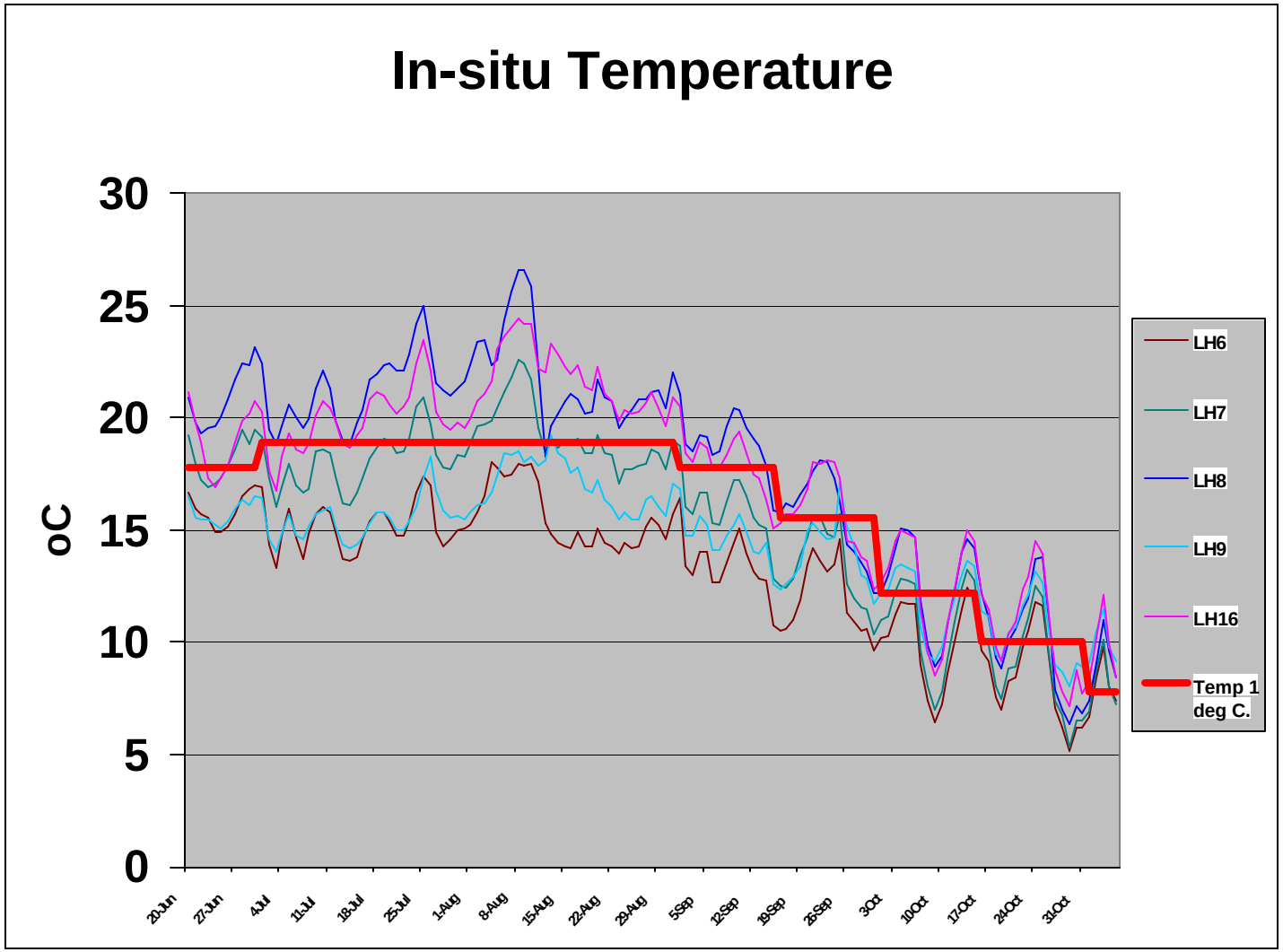


Figure 3-11. Temperature monitored at stations LH6, LH7, LH8, LH9, and LH16 with the TidbiT^{tm} in-situ meters during the Lehigh River water quality monitoring study conducted between May and November 2001. Season specific PADEP HQ-CWF temperature requirements are plotted in red.

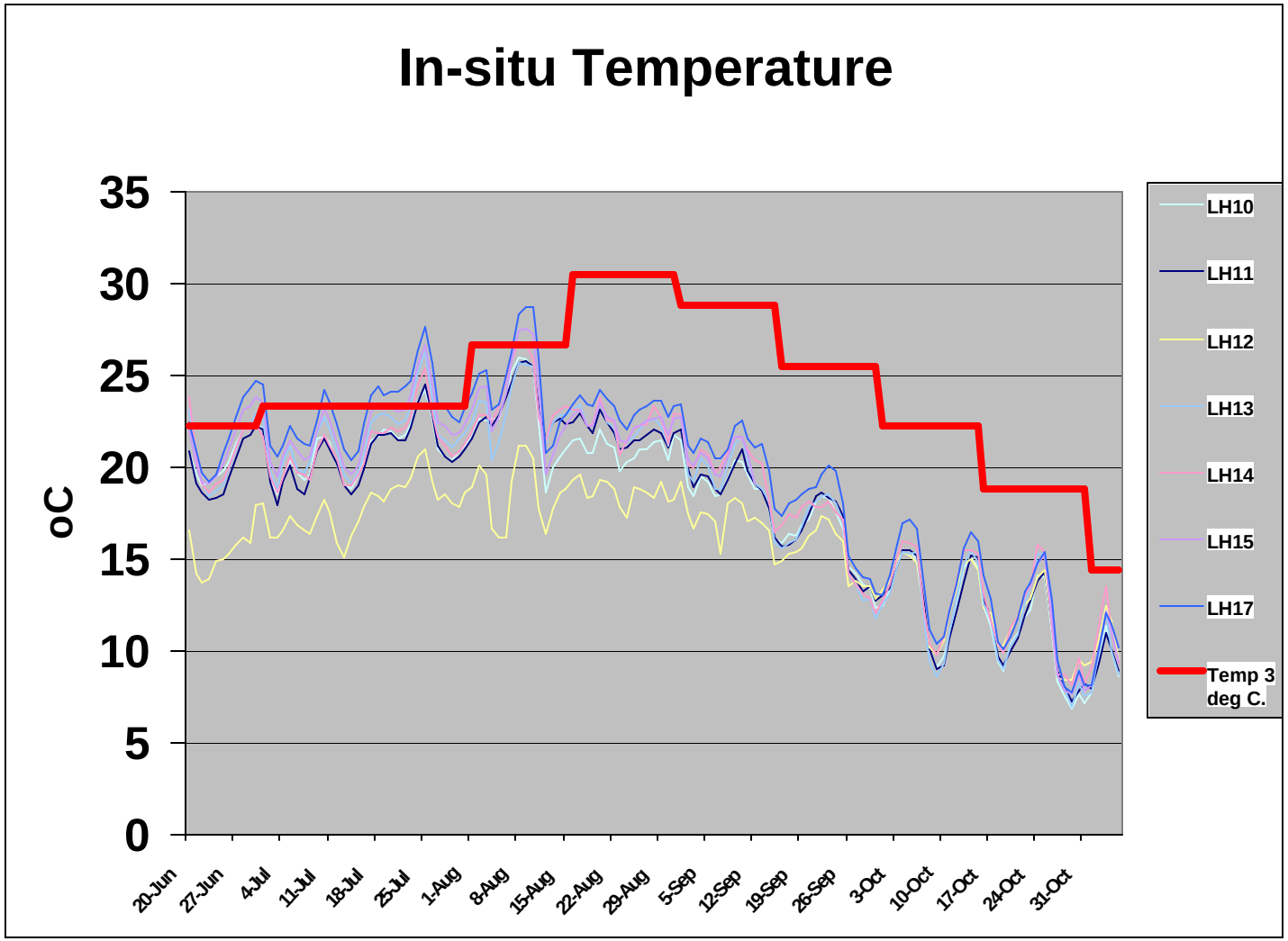


Figure 3-12. Temperature monitored at stations LH10, LH11, LH12, LH13, LH14, LH15, and LH17 with the TidbiT^{tm} in-situ meters during the Lehigh River water quality monitoring study conducted between May and November 2001. Season specific PADEP TSF temperature requirements are plotted in red.

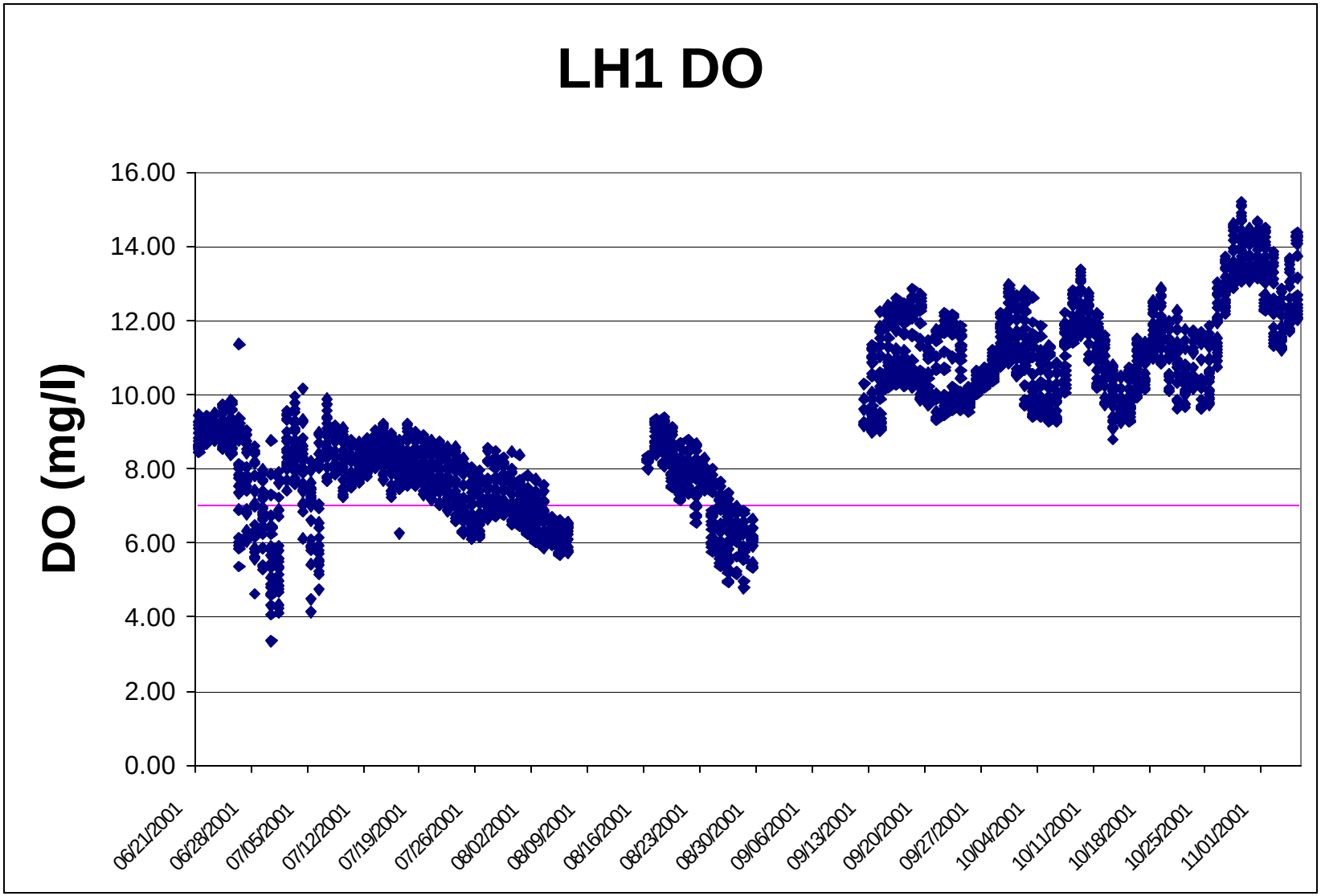


Figure 3-13. Hourly dissolved oxygen concentrations (mg/L) monitored at station LH1 with the YSI in-situ data logger during the Lehigh River water quality monitoring study conducted between May and November 2001. PADEP critical use criterion for this station is a minimum of 7.0 mg/L.

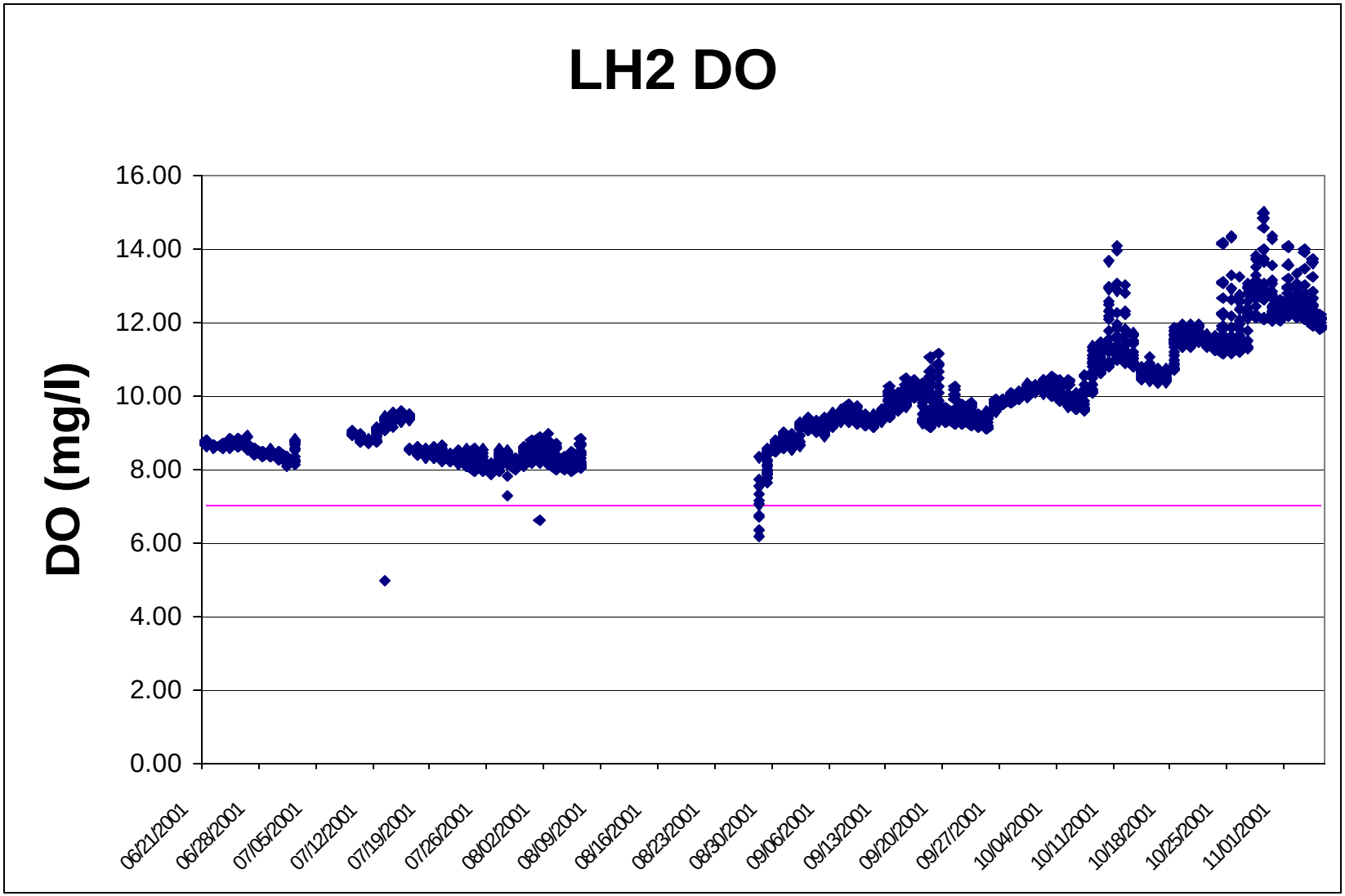


Figure 3-14. Hourly dissolved oxygen concentrations (mg/L) monitored at station LH2 with the YSI in-situ data logger during the Lehigh River water quality monitoring study conducted between May and November 2001. PADEP critical use criterion for this station is a minimum of 7.0 mg/L.

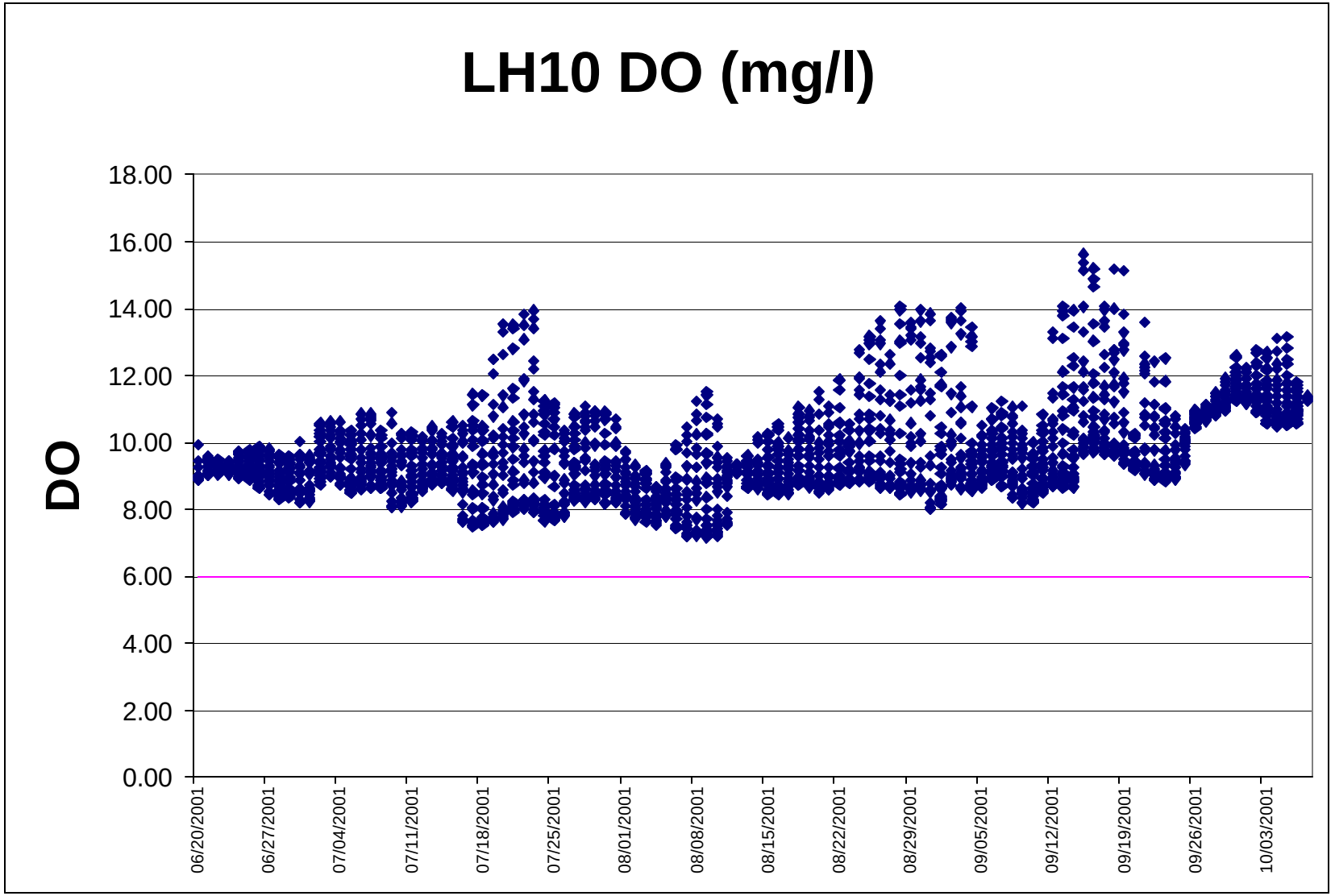


Figure 3-15. Hourly dissolved oxygen concentrations (mg/L) monitored at station LH10 with the YSI in-situ data logger during the Lehigh River water quality monitoring study conducted between May and November 2001. PADEP critical use criterion for this station is a daily average of 6.0 mg/L and a minimum of 5.0 mg/L.

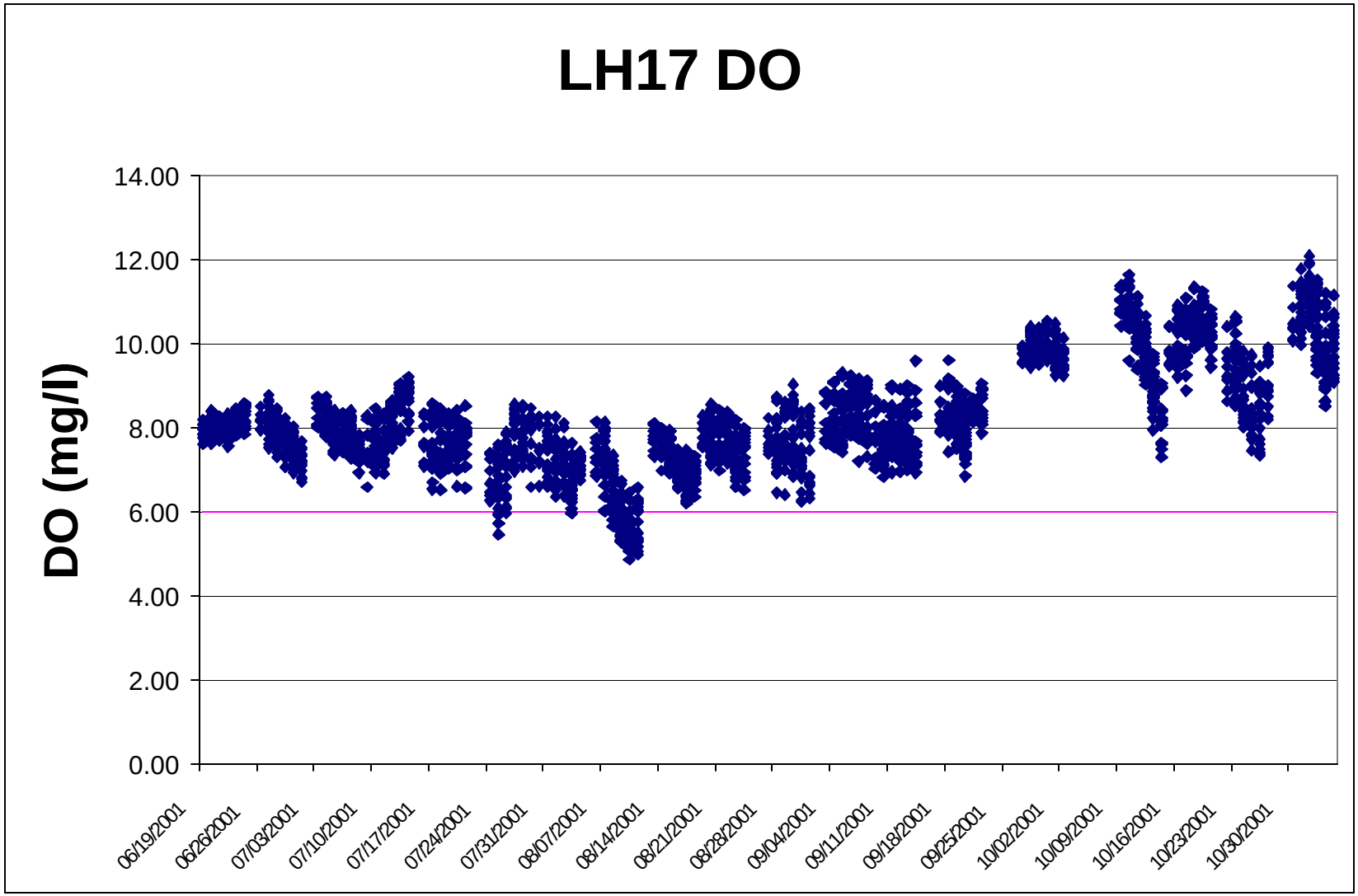


Figure 3-16. Hourly dissolved oxygen concentrations (mg/L) monitored at station LH17 with the Hydrolab in-situ data logger during the Lehigh River water quality monitoring study conducted between May and November 2001. PADEP critical use criterion for this station is a daily average of 6.0 mg/L and a minimum of 5.0 mg/L.

and the Lehigh River and represents the water entering the Walters Reservoir for the upper watershed. Low DO concentrations (below 5 mg/L) occurred mostly during the end of June and into the beginning of July 2001. By mid-July DO levels were generally above 7.0 mg/L, although occasional readings at or below 6.0 mg/L were observed. By the fall of 2001 dissolved oxygen levels were well above the HQ-CWF criteria, reflecting the cooler temperatures and higher capacity for the water to hold oxygen. Fall 2001 DO levels were often at supersaturated conditions that may have been caused by seasonally high algal epiphytic growth.

Station LH2 situated a few thousand feet downstream of the Walter Dam is also categorized as HQ-CWF by PADEP. Dissolved oxygen levels at this station were rarely below 7.0 mg/L indicating the discharges for the reservoir were not adversely impacting DO concentrations in downstream habitats (Fig. 3-14). Concentrations in the summer months of 2001 were consistently just above 8.0 mg/L and increased to well above 10 mg/L by October 2001. The high dissolved oxygen concentrations recorded below the dam is consistent with USACE DO stratification monitoring in the reservoir that indicated that high levels were maintained throughout the water column in the summer 2001 season (Versar 2002a).

Dissolved oxygen levels at LH10 monitored in the mainstem near Lehighton water plant intake were consistently above the 6.0 mg/L TSF requirement throughout the entire time series (Fig. 3-15). Concentrations at this station were never below the criteria, even in the warmer months. Similarly high levels were observed at station (LH17) located near the Northampton water treatment facility where DO concentrations were typically above 6.0 mg/L (Fig. 3-16). This station is also classified as a Trout Stocking Fishery by PADEP that requires a daily average of 6.0 mg/L and minimum levels of 5.0 mg/L. Out of 2,298 DO observations recorded in 2001 at this station, only two records were slightly below 5.0 mg/L minimum criteria and daily averages were generally well above the 6.0 mg/L requirement.

3.4 PH LEVELS

Monitoring of the pH levels among the four in-situ stations revealed that pH levels typically stayed within the 6 to 9 pH range required by PADEP (Figs. 3-17 to 3-20). At station LH1 upstream of the Walter Dam only one value out of nearly 3,000 records was below 6.0 (Fig. 3-17). At the station immediately downstream of the dam, pH levels were typically within the required range (Fig. 3-18), with the exception of about 25 records at the end of August 2001. This reduction in pH coincided with lower values recorded in the lower water column of the reservoir during the summer 2001 months (Versar 2002a). Measured pH levels were within the required range at station LH10 for most of the time series (Fig. 3-19). However, approximately 11 observations below 6.0 were recorded in mid-August out of a total of 3,300 pH values logged by the water quality units. No pH values below 6.0 were recorded with the Hydrolab unit deployed at Northampton station LH17 (Fig. 3-20), and none of the in-situ meters ever recorded pH over the maximum concentration of 9.0.

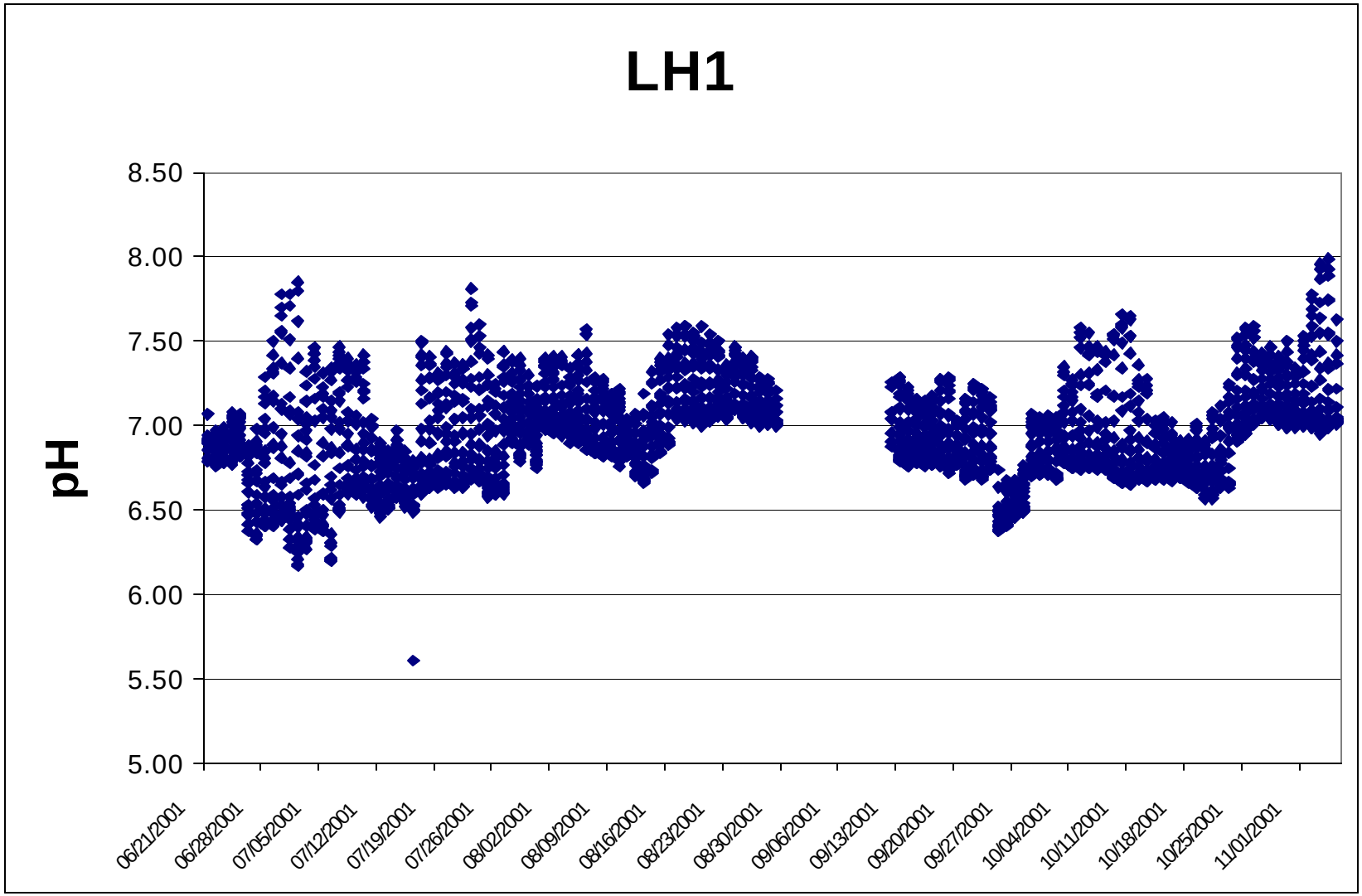


Figure 3-17. Hourly pH levels monitored at station LH1 with the YSI in-situ data logger during the Lehigh River water quality monitoring study conducted between May and November 2001. PADEP water quality requirements for pH are between pH 6 and pH 9.

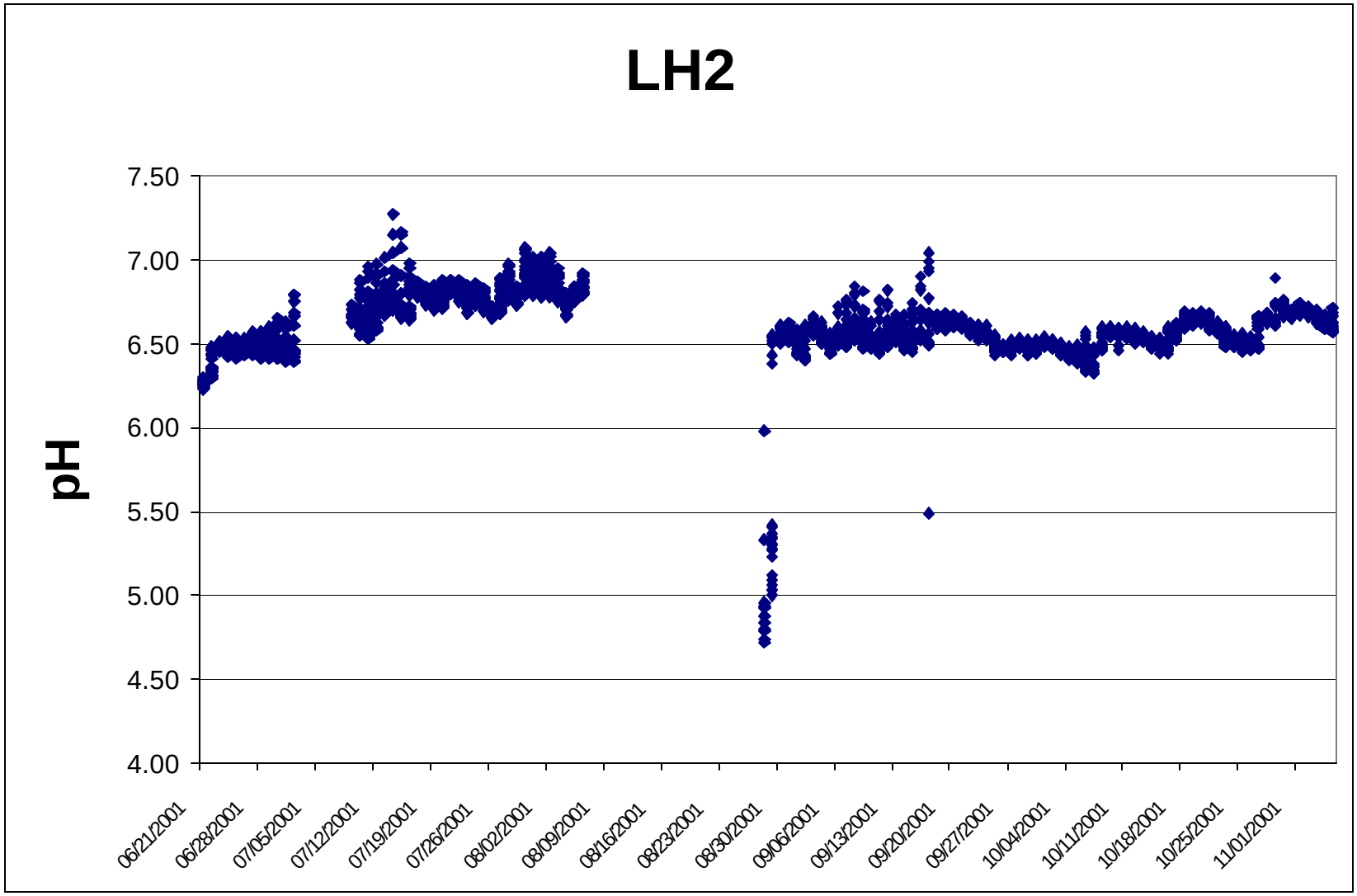


Figure 3-18. Hourly pH levels monitored at station LH2 with the YSI in-situ data logger during the Lehigh River water quality monitoring study conducted between May and November 2001. PADEP water quality requirements for pH are between pH 6 and pH 9.

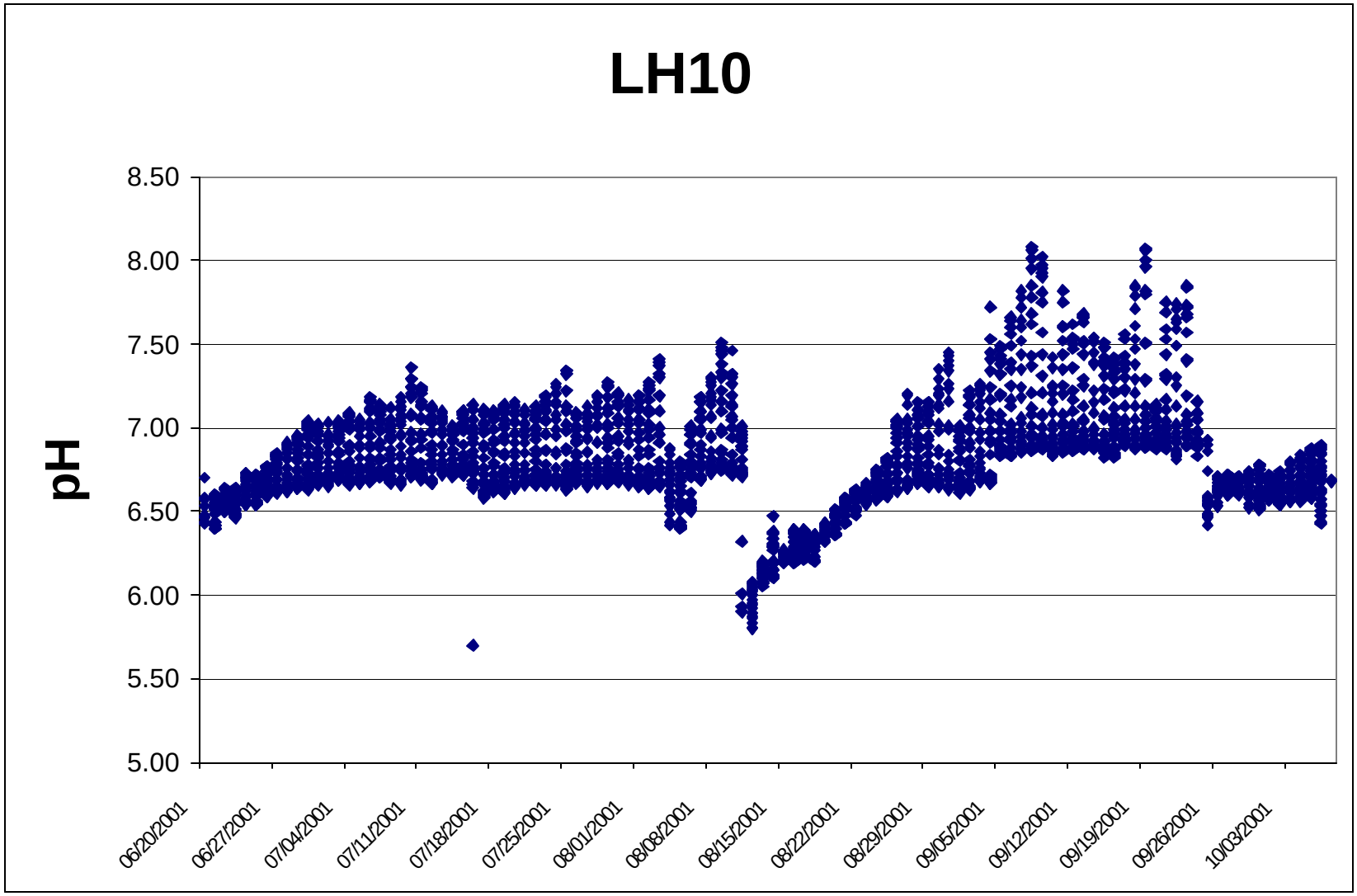


Figure 3-19. Hourly pH levels monitored at station LH10 with the YSI in-situ data logger during the Lehigh River water quality monitoring study conducted between May and November 2001. PADEP water quality requirements for pH are between pH 6 and pH 9.

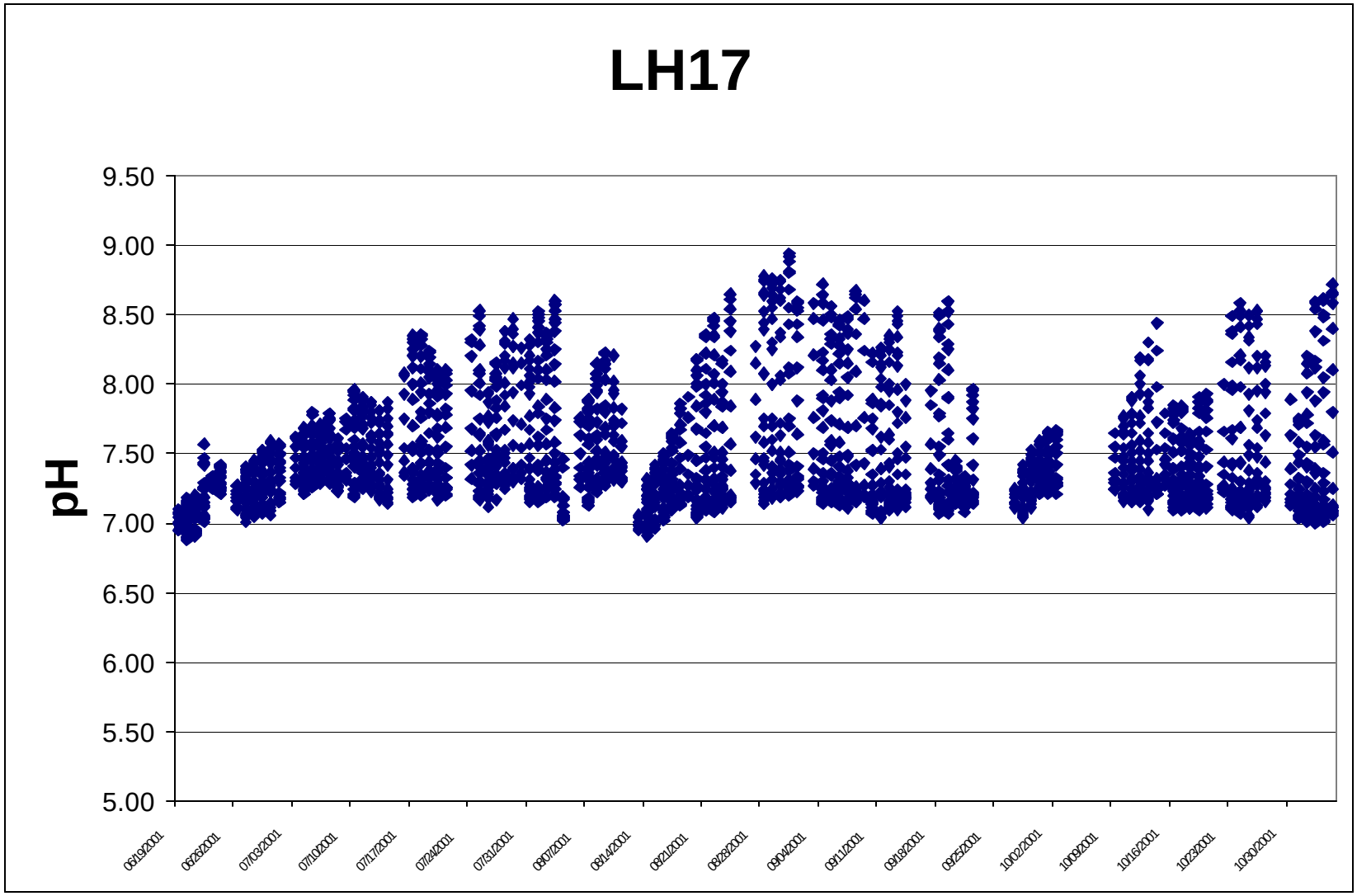


Figure 3-20. Hourly pH levels monitored at station LH17 with the Hydrolab in-situ data logger during the Lehigh River water quality monitoring study conducted between May and November 2001. PADEP water quality requirements for pH are between pH 6 and pH 9.

3.5 NUTRIENT LEVELS

Measures of nutrient concentrations were taken weekly at all 17 Lehigh River and tributary stations for the entire 24-week monitoring period. These data are summarized in Table 3-2. Average ammonia nitrogen, nitrite, and nitrate concentration among the monitoring stations was consistently higher at LH11 located in Mahoning Creek just downstream of the Lehighton sewage treatment facility (Fig. 3-21). Ammonia levels averaged about 0.1 to 0.2 mg/L at all stations with the exception of LH11 where ammonia averaged about 5.5 mg/L throughout the 24-week time series. Higher than average concentrations of nitrate were also observed (1.4 mg/L) at LH11 and there is a suggestion that higher levels were generally seen at stations downstream of Nesquehoning Creek (LH9) where nitrate concentration averaged about 0.5 mg/L (Fig. 3-21). Averaged among weeks, nitrite concentrations were low throughout the system (generally less than 0.02 mg/L) but again was elevated downstream of the Lehighton sewage treatment outfall (0.11 mg/L). PADEP ammonia water quality criteria are dependent on temperature and pH (Table 3-3). Ammonia levels observed during the monitoring program rarely violated the PADEP ammonia criteria for the given temperature and pH measured at the time of collection.

Phosphorus levels and 5-day Biochemical Oxygen Demand (BOD) were also elevated at station LH11 relative to the other monitoring stations (Fig. 3-22). Phosphorus levels at LH11 averaged 0.38 mg/L and were second only to station LH3 (Tannery Bridge) that averaged about 0.2 mg/L during the monitoring period. Phosphorus levels at all other stations averaged less that 0.1 mg/L. BOD levels were consistent (2.0 to 2.5 mg/L) among all stations with the exception of LH11 where BOD approached 5.0 mg/L (Fig. 3-22). However, most of the measures for BOD were below the 1.0 to 3.0 mg/L method detection limits (Table 3-2).

Several other water quality parameters were measured in the weekly grab sampling including alkalinity, silica (Fig. 3-23), and total inorganic and organic carbon (Fig. 3-24). Measures of alkalinity were generally lower in the upper portion of the watershed (station LH8 at Glen Onoko and above) relative to downriver stations that averaged about 30 mg/L CaCO. Silica levels were lowest (about 1.25 mg/L or not detected) at the upper three stations; (LH1 above the Walters dam, LH2 below the Dam, and at LH3 near Tannery Bridge). Silica levels from Hayes Creek (LH4) to Northampton were higher averaging about 2.0 to 3.0 mg/L (Fig. 3-23). Very few differences were observed in total inorganic and organic carbon among the monitoring stations, but these parameters were mostly below the 5.0 mg/L test detection limits (Table 3-2).

Table 3-2. Summary of nutrient concentrations and various chemical parameters monitored each week at 17 stations in the Lehigh River watershed between May and November 2001. All units are in mg/L.

TRIP	STATION	DATE	ALKALINITY	NH3-N	BOD-5	NITRATE	NITRITE	P, diss	PO4, diss	SIO2-diss	TIC	TOC
1	LH1	05/31/2001	7	<0.1	<3	0.7	<0.005	<0.05	0.07	<1	<5	<5
	LH2	05/30/2001	5	<0.1	<3	0.6	<0.005	<0.05	<0.05	1	<5	<5
	LH3	05/30/2001	6	<0.1	<3	0.6	<0.005	<0.05	<0.05	<1	<5	<5
	LH4	05/30/2001	4	<0.1	<3	0.6	<0.005	<0.05	0.06	<1	<5	<5
	LH5	05/30/2001	<1	<0.1	<3	0.6	<0.005	<0.05	0.06	2	<5	<5
	LH6	05/30/2001	<1	<0.1	<3	0.9	<0.005	<0.05	0.05	<2	<5	<5
	LH7	05/30/2001	2	<0.1	<3	0.7	<0.005	<0.05	0.05	<2	<5	<5
	LH8	05/30/2001	5	<0.1	<3	0.6	<0.005	<0.05	<0.05	<1	<5	<5
	LH9	05/31/2001	22	<0.1	<3	0.6	<0.005	<0.05	0.12	1	<5	<5
	LH10	05/30/2001	6	<0.1	<3	0.6	<0.005	<0.05	0.05	<2	<5	<5
	LH11	05/30/2001	23	0.7	<3	1.6	0.028	0.11	0.35	1	<5	<5
	LH12	05/30/2001	11	<0.1	<3	0.9	<0.005	<0.05	<0.05	3	<5	<5
	LH13	05/30/2001	26	<0.1	<3	1.2	0.006	<0.05	<0.05	<2	<5	<5
	LH14	05/30/2001	34	0.3	<3	1.3	0.012	<0.05	0.07	<2	<5	7
	LH15	05/30/2001	14	0.1	<3	0.8	<0.005	<0.05	0.07	1	<5	<5
	LH16	05/31/2001	46	<0.1	<3	1.6	<0.005	<0.05	0.06	<2	<5	10
	LH17	05/31/2001	15	<0.1	<3	0.9	<0.005	<0.05	<0.05	1	<5	<5
2	LH1	06/05/2001	6	<0.1	<3	0.4	<0.005	<0.05	0.06	1.3	<5	<5
	LH2	06/06/2001	4	<0.1	<3	0.4	<0.005	<0.05	0.06	2.4	<5	<5
	LH3	06/06/2001	4	<0.1	<3	0.4	<0.005	<0.05	0.09	1.5	<5	<5
	LH4	06/06/2001	4	<0.1	<3	0.5	<0.005	<0.05	0.07	1.7	<5	<5
	LH5	06/05/2001	<1	<0.1	<3	0.5	<0.005	<0.05	0.07	2	<5	<5
	LH6	06/05/2001	<1	<0.1	<3	0.7	<0.005	<0.05	0.09	2.6	<5	<5
	LH7	06/05/2001	<1	<0.1	<3	0.5	<0.005	<0.05	0.07	1.6	<5	<5
	LH8	06/05/2001	4	0.2	<3	0.8	<0.005	<0.05	0.09	2.2	<5	<5
	LH9	06/05/2001	12	0.2	<3	0.4	0.005	0.09	0.27	1.4	<5	<5
	LH10	06/05/2001	6	0.2	<3	0.4	0.005	<0.05	0.07	3	<5	<5
	LH11	06/05/2001	22	0.3	<3	1.5	0.042	0.11	0.35	1.4	<5	<5
	LH12	06/05/2001	10	0.1	<3	0.7	0.006	<0.05	0.09	1.3	<5	<5
	LH13	06/05/2001	24	<0.1	<3	1	0.008	<0.05	0.08	1.4	<5	<5
	LH14	06/05/2001	34	0.2	<3	0.7	0.013	<0.05	0.12	2.6	<5	<5
	LH15	06/05/2001	10	0.1	<3	0.8	0.006	0.08	0.24	2.2	<5	<5
	LH16	06/05/2001	26	0.1	<3	0.8	0.012	0.09	0.27	1.6	<5	<5
	LH17	06/05/2001	12	0.1	<3	0.6	0.007	0.05	0.15	1.3	<5	<5

Table 3-2. (Continued)

TRIP	STATION	DATE	ALKALINITY	NH3-N	BOD-5	NITRATE	NITRITE	P, diss	PO4, diss	SIO2-diss	TIC	TOC
3	LH1	06/13/2001	8	0.2	<2	<0.1	<0.005	<0.05	0.05	2	<5	<5
	LH2	06/13/2001	7	0.2	<2	0.1	<0.005	<0.05	0.05	2	<5	<5
	LH3	06/13/2001	6	<0.1	<2	<0.1	0.005	<0.05	0.07	2	<5	<5
	LH4	06/13/2001	5	<0.1	<2	<0.1	<0.005	<0.05	<0.05	2	<5	<5
	LH5	06/13/2001	<1	0.2	<2	<0.1	<0.005	<0.05	<0.05	3	<5	<5
	LH6	06/13/2001	<1	<0.1	<2	<0.1	<0.005	<0.05	<0.05	2	<5	<5
	LH7	06/13/2001	9	<0.1	<2	<0.1	<0.005	<0.05	0.13	2	<5	<5
	LH8	06/13/2001	7	<0.1	<2	<0.1	<0.005	<0.05	<0.05	3	<5	<5
	LH9	06/14/2001	19	0.1	4	<0.1	<0.005	0.05	0.15	2	<5	<5
	LH10	06/14/2001	10	0.2	<2	<0.1	<0.005	<0.05	<0.05	2	<5	<5
	LH11	06/14/2001	25	0.2	10	<0.1	0.025	0.11	0.35	2	<5	9
	LH12	06/14/2001	14	0.3	<2	<0.1	<0.005	<0.05	0.05	2.3	<5	<5
	LH13	06/14/2001	13	1.1	<2	<0.1	<0.005	<0.05	0.06	2	<5	<5
	LH14	06/15/2001	41	<0.1	<2	<0.1	0.017	<0.05	<0.05	1.5	<5	<5
	LH15	06/15/2001	16	<0.1	<2	0.4	0.005	<0.05	<0.05	0.9	<5	<5
	LH16	06/15/2001	31	<0.1	<2	<0.1	0.006	<0.05	0.09	1.9	<5	<5
	LH17	06/15/2001	18	<0.1	<2	<0.1	0.006	<0.05	<0.05	0.8	<5	<5
4	LH1	06/21/2001	7	<0.1	<2	0.1	<0.005	<0.05	<0.05	<1	<5	5
	LH2	06/21/2001	4	<0.1	<2	0.1	<0.005	<0.05	<0.05	<1	<5	5
	LH3	06/21/2001	5	<0.1	<2	0.1	<0.005	0.06	<0.05	<1	<5	5
	LH4	06/21/2001	4	<0.1	<2	0.1	<0.005	<0.05	0.08	<1	<5	<5
	LH5	06/20/2001	<1	<0.1	<2	0.2	<0.005	<0.05	0.08	<1	<5	<5
	LH6	06/20/2001	1	<0.1	<2	0.3	<0.005	0.07	0.21	2	<5	<5
	LH7	06/20/2001	1	<0.1	<2	0.2	<0.005	<0.05	0.11	1	<5	<5
	LH8	06/20/2001	3	<0.1	<2	0.1	<0.005	<0.05	0.06	1	<5	<5
	LH9	06/20/2001	11	<0.1	<2	0.1	<0.005	0.05	0.14	2	<5	<5
	LH10	06/20/2001	5	<0.1	<2	0.1	<0.005	<0.05	<0.05	1	<5	<5
	LH11	06/20/2001	18	0.2	<2	0.9	0.026	0.32	0.1	1	<5	<5
	LH12	06/20/2001	15	<0.1	<2	0.3	<0.005	<0.05	<0.05	<1	<5	<5
	LH13	06/20/2001	23	<0.1	<2	0.9	0.008	<0.05	<0.05	1	<5	<5
	LH14	06/20/2001	42	0.2	<2	0.4	0.018	<0.05	0.09	1	<5	11
	LH15	06/20/2001	9	<0.1	<2	0.3	<0.005	0.11	<0.05	1	<5	<5
	LH16	06/20/2001	27	<0.1	<2	0.3	0.007	0.14	<0.05	2	6	<5
	LH17	06/20/2001	9	<0.1	<2	0.2	<0.005	<0.05	<0.05	1	<5	<5

Table 3-2. (Continued)

TRIP	STATION	DATE	ALKALINITY	NH3-N	BOD-5	NITRATE	NITRITE	P, diss	PO4, diss	SIO2-diss	TIC	TOC
5	LH1	06/26/2001	6	<0.1	<3	0.1	<0.005	<0.05	0.12	<1	<5	5
	LH2	06/26/2001	2	<0.1	<3	0.2	<0.005	0.11	<0.05	<1	<5	<5
	LH3	06/25/2001	8	<0.1	<3	0.3	0.007	<0.05	0.13	<1	<5	<5
	LH4	06/25/2001	4	<0.1	<3	0.5	<0.005	0.71	2.18	1	<5	<5
	LH5	06/25/2001	<1	<0.1	<3	0.3	<0.005	0.07	<0.05	1	<5	<5
	LH6	06/25/2001	1	<0.1	<3	0.2	<0.005	0.06	0.19	1	<5	<5
	LH7	06/25/2001	<1	0.2	<3	0.2	<0.005	0.06	0.18	2	<5	<5
	LH8	06/25/2001	4	<0.1	<3	0.2	<0.005	0.17	0.52	1	<5	<5
	LH9	06/25/2001	16	<0.1	<3	0.2	<0.005	0.58	0.19	<1	<5	<5
	LH10	06/25/2001	7	<0.1	<3	0.2	<0.005	0.13	<0.05	2	<5	<5
	LH11	06/25/2001	18	0.1	<3	0.1	0.022	0.28	0.09	<1	<5	<5
	LH12	06/25/2001	10	<0.1	<3	0.1	0.005	0.11	<0.05	2	<5	<5
	LH13	06/25/2001	20	0.1	<3	0.1	0.007	0.16	0.05	2	<5	<5
	LH14	06/25/2001	37	0.2	<3	0.1	0.019	0.18	0.06	<1	<5	<5
	LH15	06/25/2001	12	<0.1	<3	0.2	0.005	0.06	0.18	1	<5	<5
	LH16	06/25/2001	35	0.1	<3	0.2	0.011	0.18	0.06	2	<5	6
	LH17	06/25/2001	16	<0.1	<3	0.2	0.006	0.17	0.06	1	<5	<5
6	LH1	07/02/2001	10	<0.1	<2	0.148	<0.01	<0.05	<0.05	<1	<5	5
	LH2	07/02/2001	6	<0.1	<2	0.136	<0.01	0.22	0.07	3	<5	<5
	LH3	07/02/2001	7	<0.1	<2	0.167	<0.01	<0.05	0.12	2.2	<5	<5
	LH4	07/02/2001	6	<0.1	<2	<0.01	<0.01	<0.05	0.11	2.6	<5	<5
	LH5	07/02/2001	<1	<0.1	<2	0.292	<0.01	0.12	<0.05	<5	<5	<5
	LH6	07/02/2001	<1	<0.1	<2	0.502	<0.01	<0.05	0.09	3	<5	<5
	LH7	07/02/2001	<1	0.1	<2	0.301	<0.01	<0.05	0.11	2.2	<5	<5
	LH8	07/02/2001	4	<0.1	<2	0.168	<0.01	0.09	<0.05	2.6	<5	<5
	LH9	07/02/2001	24	0.1	<2	0.453	<0.01	0.07	0.22	<2	<5	<5
	LH10	07/02/2001	8	0.2	<2	0.229	<0.01	<0.05	0.09	2.9	<5	<5
	LH11	07/02/2001	22	0.7	<2	1.798	<0.01	0.15	0.47	3.2	<5	<5
	LH12	07/02/2001	12	0.2	<2	0.784	<0.01	0.06	<0.05	2.8	<5	<5
	LH13	07/02/2001	27	0.2	<2	1.128	<0.01	0.1	<0.05	2.9	<5	<5
	LH14	07/02/2001	40	0.5	<2	1.31	<0.01	<0.05	0.07	2.7	<5	<5
	LH15	07/02/2001	18	0.2	<2	0.518	<0.01	0.09	<0.05	2	<5	<5
	LH16	07/02/2001	37	0.3	<2	1.142	<0.01	0.06	0.18	2.6	<5	<5
	LH17	07/02/2001	21	0.3	<2	0.727	<0.01	<0.05	0.11	1.6	<5	<5

Table 3-2. (Continued)

TRIP	STATION	DATE	ALKALINITY	NH3-N	BOD-5	NITRATE	NITRITE	P, diss	PO4, diss	SIO2-diss	TIC	TOC
7	LH1	07/10/2001	7	0.2	<3	<0.01	<0.01	<0.05	<0.05	<1	<5	<5
	LH2	07/10/2001	6	0.2	<3	<0.01	0.307	<0.05	<0.05	<1	<5	<5
	LH3	07/10/2001	7	0.2	<3	0.975	0.333	<0.05	0.05	<1	<5	<5
	LH4	07/10/2001	4	0.1	<3	<0.01	0.82	<0.05	<0.05	<1	<5	<5
	LH5	07/10/2001	1	0.1	<3	0.343	<0.01	<0.05	<0.05	1.2	<5	<5
	LH6	07/10/2001	1	<0.1	<3	0.68	<0.01	<0.05	<0.05	1.2	<5	<5
	LH7	07/10/2001	1	<0.1	<3	0.663	<0.01	<0.05	<0.05	1.4	<5	<5
	LH8	07/10/2001	4	<0.1	<3	0.275	<0.01	<0.05	<0.05	<1	<5	<5
	LH9	07/10/2001	34	<0.1	<3	0.762	<0.01	0.08	0.26	1.1	<5	<5
	LH10	07/10/2001	8	<0.1	<3	0.221	<0.01	<0.05	<0.05	<1	<5	<5
	LH11	07/10/2001	25	0.3	4	4.216	<0.01	0.22	0.67	1.6	<5	<5
	LH12	07/10/2001	13	<0.1	<3	2.197	<0.01	<0.05	<0.05	1.6	<5	<5
	LH13	07/10/2001	30	0.1	<3	1.189	<0.01	<0.05	<0.05	1.7	<5	<5
	LH14	07/10/2001	48	<0.1	<3	1.239	<0.01	<0.05	0.14	2.3	<5	<5
	LH15	07/10/2001	18	<0.1	<3	0.691	<0.01	<0.05	0.09	2.2	<5	<5
	LH16	07/10/2001	36	<0.1	<3	1.102	<0.01	0.06	0.2	<2	<5	<5
	LH17	07/10/2001	34	<0.1	<3	0.69	<0.01	<0.05	0.1	<1	<5	<5
8	LH1	07/16/2001	8	<0.1	<2	0.1	<0.005	<0.05	0.06	<1	<5	<5
	LH2	07/16/2001	8	0.2	<2	0.1	<0.005	<0.05	0.12	<1	<5	<5
	LH3	07/16/2001	8	<0.1	<2	0.2	0.007	<0.05	0.08	<1	<5	<5
	LH4	07/16/2001	4	0.1	<2	0.2	<0.005	<0.05	0.07	1.3	<5	<5
	LH5	07/16/2001	<1	0.1	<2	0.2	<0.005	<0.05	0.08	1.7	<5	<5
	LH6	07/16/2001	2	0.1	<2	0.4	<0.005	0.12	0.36	3	<5	<5
	LH7	07/16/2001	3	0.1	<2	0.2	<0.005	<0.05	<0.05	1.3	<5	<5
	LH8	07/16/2001	5	0.1	<2	0.1	<0.005	<0.05	0.05	1.3	<5	<5
	LH9	07/16/2001	43	0.2	<2	0.4	<0.005	0.09	0.29	3.2	5	<5
	LH10	07/16/2001	8	<0.1	<2	0.2	<0.005	<0.05	0.1	1.4	<5	<5
	LH11	07/16/2001	31	0.1	7	1.1	0.122	0.42	1.28	1.7	<5	<5
	LH12	07/16/2001	13	0.1	<2	0.3	0.005	<0.05	0.07	1.9	<5	<5
	LH13	07/16/2001	32	<0.1	<2	0.5	0.005	<0.05	0.08	1.4	<5	<5
	LH14	07/16/2001	54	0.3	<2	0.5	0.046	0.07	0.22	1.4	6	<5
	LH15	07/16/2001	16	<0.1	<2	0.4	0.005	<0.05	0.08	1.1	<5	<5
	LH16	07/16/2001	38	<0.1	<2	0.6	0.005	0.07	0.2	<1	<5	<5
	LH17	07/16/2001	21	<0.1	<2	0.8	0.005	<0.05	0.11	<1	<5	<5

Table 3-2. (Continued)

TRIP	STATION	DATE	ALKALINITY	NH3-N	BOD-5	NITRATE	NITRITE	P, diss	PO4, diss	SIO2-diss	TIC	TOC
9	LH1	07/24/2001	10	<0.1	<2	<0.1	<0.005	0.08	0.24	<1	<5	<5
	LH2	07/25/2001	7	0.11	<2	0.133	<0.005	<0.05	0.11	<1	<5	<5
	LH3	07/24/2001	7	<0.1	<2	<0.1	<0.005	0.41	1.24	<1	<5	<5
	LH4	07/24/2001	4	<0.1	<2	0.138	<0.005	<0.05	0.08	1.14	<5	<5
	LH5	07/24/2001	<1	0.248	<2	0.13	<0.005	<0.05	0.06	<1	<5	<5
	LH6	07/24/2001	<1	<0.1	<2	0.185	<0.005	0.05	0.16	1.47	<5	<5
	LH7	07/24/2001	<1	0.136	<2	0.128	<0.005	1.15	3.53	1.35	<5	<5
	LH8	07/24/2001	40	0.151	<2	<0.1	<0.005	<0.05	0.07	1.69	<5	<5
	LH9	07/24/2001	42	0.174	<2	0.141	<0.005	0.11	0.34	<1	<5	<5
	LH10	07/24/2001	7.86	0.116	<2	<0.1	<0.005	0.72	2.22	1.19	<5	<5
	LH11	07/24/2001	14	0.974	<2	0.756	0.077	0.32	0.99	1.12	<5	<5
	LH12	07/24/2001	22	0.142	<2	0.101	<0.005	0.08	0.26	1.06	<5	<5
	LH13	07/24/2001	32	0.158	<2	0.12	<0.005	<0.05	0.09	1.62	<5	<5
	LH14	07/24/2001	48	0.147	<2	0.179	0.028	0.09	0.29	3.13	<5	<5
	LH15	07/24/2001	17	<0.1	<2	0.123	<0.005	<0.05	0.08	2.39	<5	<5
	LH16	07/24/2001	38	0.149	<2	0.312	<0.005	0.07	0.2	<2	<5	<5
	LH17	07/24/2001	18	<0.1	<2	0.151	0.005	0.09	0.26	1.13	<5	<5
10	LH1	07/31/2001	8	<0.1	<2	<0.1	<0.005	<0.05	<0.05	<1	<5	<5
	LH2	08/01/2001	9	<0.1	<2	0.113	<0.005	0.39	1.2	<1	<5	<5
	LH3	07/31/2001	9	<0.1	<2	0.232	0.007	<0.05	0.09	<1	<5	<5
	LH4	07/31/2001	4	<0.1	<2	0.184	<0.005	<0.05	<0.05	1.26	<5	<5
	LH5	07/31/2001	<1	<0.1	<2	0.119	<0.005	0.16	0.48	2.48	<5	<5
	LH6	07/31/2001	<1	<0.1	<2	0.199	<0.005	<0.05	0.06	2.93	<5	<5
	LH7	07/31/2001	<1	<0.1	<2	0.333	<0.005	<0.05	0.13	2.51	<5	<5
	LH8	07/31/2001	5	<0.1	<2	0.176	<0.005	0.39	1.2	<1	<5	<5
	LH9	07/31/2001	44	0.105	<2	0.219	<0.005	0.07	0.23	1.74	6.6	<5
	LH10	07/31/2001	7	<0.1	<2	0.107	<0.005	<0.05	0.06	<1	<5	<5
	LH11	07/31/2001	26	<0.1	<2	1.04	0.092	0.35	1.09	<1	<5	<5
	LH12	07/31/2001	12	0.85	<2	0.176	<0.005	<0.05	0.09	<1	<5	<5
	LH13	07/31/2001	34	<0.1	<2	1.09	<0.005	<0.05	0.07	<1	<5	<5
	LH14	07/31/2001	55	0.178	<2	0.34	0.057	0.05	0.15	<1	<5	<5
	LH15	07/31/2001	18	<0.1	<2	0.119	0.009	<0.05	0.09	1.18	<5	<5
	LH16	07/31/2001	35	0.137	<2	0.247	0.006	0.06	0.17	<1	<5	<5
	LH17	07/31/2001	19	<0.1	<2	0.162	0.006	<0.05	0.05	<1	<5	<5

Table 3-2. (Continued)

TRIP	STATION	DATE	ALKALINITY	NH3-N	BOD-5	NITRATE	NITRITE	P, diss	PO4, diss	SIO2-diss	TIC	TOC
11	LH1	08/06/2001	13	<0.1	<2	0.164	<0.01	<0.05	0.09	<1	<5	<5
	LH2	08/06/2001	8	<0.1	<2	0.179	<0.01	<0.05	0.07	<1	<5	<5
	LH3	08/06/2001	10	<0.1	<2	0.223	<0.01	3.14	9.63	<1	<5	<5
	LH4	08/06/2001	6	<0.1	<2	0.139	<0.01	<0.05	<0.05	1.39	<5	<5
	LH5	08/06/2001	4	<0.1	<2	0.248	<0.01	<0.05	<0.05	2.19	<5	<5
	LH6	08/06/2001	4	<0.1	<2	0.699	<0.01	<0.05	0.09	2.2	<5	<5
	LH7	08/06/2001	5	<0.1	<2	0.355	<0.01	<0.05	0.05	<1	<5	<5
	LH8	08/06/2001	9	<0.1	<2	0.2	<0.01	<0.05	<0.05	1.35	<5	<5
	LH9	08/06/2001	32	<0.1	<2	0.519	0.067	0.11	0.33	1.52	<5	<5
	LH10	08/06/2001	14	<0.1	<2	0.219	<0.01	<0.05	0.05	1.25	<5	<5
	LH11	08/06/2001	40	0.43	3	2.194	0.554	0.29	0.89	1	<5	<5
	LH12	08/06/2001	16	<0.1	<2	0.737	<0.01	<0.05	0.06	<1	<5	<5
	LH13	08/06/2001	10	<0.1	<2	1.01	<0.01	<0.05	0.08	1.25	<5	<5
	LH14	08/06/2001	60	<0.1	<2	0.771	<0.01	0.05	0.15	1.03	<5	<5
	LH15	08/06/2001	18	<0.1	<2	0.472	<0.01	<0.05	0.09	<1	<5	<5
	LH16	08/06/2001	36	<0.1	<2	0.496	<0.01	<0.05	0.09	<1	<5	<5
	LH17	08/06/2001	20	<0.1	<2	0.584	<0.01	0.06	0.18	<1	<5	<5
12	LH1	08/16/2001	9	<0.1	<2	0.093	<0.01	<0.05	0.07	<1	<1	6
	LH2	08/16/2001	10	<0.1	<2	0.144	<0.01	<0.05	0.09	<1	<1	6
	LH3	08/16/2001	10	<0.1	<2	0.177	<0.01	<0.05	0.11	<1	<1	6
	LH4	08/16/2001	4	<0.1	<2	0.134	<0.01	<0.05	0.07	<1	<1	3
	LH5	08/16/2001	<1	<0.1	<2	0.198	<0.01	<0.05	0.07	<1	1	2
	LH6	08/16/2001	<1	<0.1	<2	0.531	<0.01	<0.05	0.06	<1	<1	4
	LH7	08/16/2001	2	<0.1	<2	0.413	<0.01	<0.05	0.05	<1	<1	3
	LH8	08/16/2001	2	<0.1	<2	0.209	<0.01	<0.05	0.07	<1	<1	3
	LH9	08/16/2001	34	<0.1	<2	0.318	<0.01	0.09	0.27	<1	6	1
	LH10	08/16/2001	6	<0.1	<2	0.225	<0.01	<0.05	0.07	<1	<1	3
	LH11	08/16/2001	28	0.43	3	2.142	0.441	0.3	0.91	<1	<1	5
	LH12	08/16/2001	14	<0.1	<2	0.836	<0.01	<0.05	0.11	<1	<1	2
	LH13	08/16/2001	34	<0.1	<2	0.509	<0.01	<0.05	0.07	<1	<1	3
	LH14	08/16/2001	57	<0.1	<2	1.065	<0.01	0.12	0.36	<1	1	2
	LH15	08/16/2001	14	<0.1	<2	0.419	<0.01	<0.05	0.07	<1	<1	2
	LH16	08/16/2001	32	<0.1	<2	0.73	<0.01	0.05	0.15	<1	<1	3
	LH17	08/16/2001	11	<0.1	<2	0.625	0.49	<0.05	0.08	<1	<1	3

Table 3-2. (Continued)

TRIP	STATION	DATE	ALKALINITY	NH3-N	BOD-5	NITRATE	NITRITE	P, diss	PO4, diss	SIO2-diss	TIC	TOC
13	LH1	08/20/2001	9	0.42	<3	0.116	<0.01	<0.05	0.07	<1	<5	6
	LH2	08/20/2001	8	0.31	<3	0.113	<0.01	<0.05	0.05	<1	<5	6
	LH3	08/20/2001	10	0.18	<3	0.139	<0.01	<0.05	0.08	<1	<1	5
	LH4	08/20/2001	4	<0.1	<3	0.116	<0.01	<0.05	0.06	<1	<1	2
	LH5	08/20/2001	<1	0.27	<3	0.15	<0.01	<0.05	0.05	<1	<1	2
	LH6	08/20/2001	<1	0.14	<3	0.459	<0.01	<0.05	<0.05	<1	<1	2
	LH7	08/20/2001	1	0.47	<3	0.299	<0.01	<0.05	0.07	<1	<1	2
	LH8	08/20/2001	2	<0.1	<3	0.148	<0.01	<0.05	0.06	<1	<1	2
	LH9	08/20/2001	33	0.17	<3	0.585	<0.01	0.11	0.35	<1	<1	2
	LH10	08/20/2001	6	<0.1	<3	0.191	<0.01	<0.05	0.05	<1	<1	2
	LH11	08/20/2001	30	0.45	<3	1.939	0.313	0.47	1.44	<1	1	5
	LH12	08/20/2001	16	0.25	<3	0.59	<0.01	<0.05	0.05	<1	<1	3
	LH13	08/20/2001	37	0.17	<3	0.284	<0.01	<0.05	0.05	<1	<1	3
	LH14	08/20/2001	61	<0.1	4	0.523	<0.01	0.07	0.22	<1	2	2
	LH15	08/20/2001	12	0.22	<3	0.257	<0.01	<0.05	<0.05	<1	<1	2
	LH16	08/20/2001	32	0.11	<3	0.68	<0.01	0.09	0.27	<1	1	4
	LH17	08/20/2001	12	<0.1	<3	0.274	<0.01	<0.05	0.07	<1	<1	2
14	LH1	08/29/2001	8	<0.1	<2	0.093	<0.01	<0.05	0.07	<1	<5	<5
	LH2	08/29/2001	8	<0.1	<2	0.117	<0.01	<0.05	0.09	<1	<5	<5
	LH3	08/29/2001	10	<0.1	<2	0.15	<0.01	<0.05	0.13	<1	<5	<5
	LH4	08/29/2001	4	<0.1	<2	0.091	<0.01	<0.05	0.07	<1	<5	<5
	LH5	08/29/2001	<1	<0.1	<2	0.182	<0.01	<0.05	0.05	<1	<5	<5
	LH6	08/29/2001	<1	<0.1	<2	0.505	<0.01	<0.05	0.07	<1	<5	<5
	LH7	08/29/2001	<1	<0.1	<2	0.311	<0.01	<0.05	0.07	<1	<5	<5
	LH8	08/29/2001	6	<0.1	<2	0.169	<0.01	<0.05	0.07	<1	<5	<5
	LH9	08/29/2001	50	<0.1	<2	0.469	<0.01	0.13	0.4	<1	6	<5
	LH10	08/29/2001	16	<0.1	<2	0.144	<0.01	<0.05	0.07	<1	<5	<5
	LH11	08/29/2001	44	0.4	<2	0.337	<0.01	0.33	1.02	<1	5	<5
	LH12	08/29/2001	16	<0.1	<2	0.571	<0.01	<0.05	0.08	<1	<5	<5
	LH13	08/29/2001	50	<0.1	<2	0.393	<0.01	<0.05	0.11	<1	6	<5
	LH14	08/29/2001	86	<0.1	<2	0.761	<0.01	0.12	0.36	<1	6	<5
	LH15	08/29/2001	20	0.18	<2	0.25	<0.01	<0.05	0.07	<1	<5	<5
	LH16	08/29/2001	70	<0.1	<2	1.491	<0.01	0.16	0.48	<1	7	<5
	LH17	08/29/2001	20	<0.1	<2	0.219	<0.01	<0.05	0.06	<1	<5	<5

Table 3-2. (Continued)

TRIP	STATION	DATE	ALKALINITY	NH3-N	BOD-5	NITRATE	NITRITE	P, diss	PO4, diss	SIO2-diss	TIC	TOC
15	LH1	09/04/2001	8	<0.1	<2	0.128	<0.01	<0.05	0.09	<1	<5	<5
	LH2	09/04/2001	10	<0.1	<2	0.088	<0.01	<0.05	0.08	<1	<5	<5
	LH3	09/04/2001	12	<0.1	<2	0.139	<0.01	0.05	0.15	<1	<5	<5
	LH4	09/04/2001	4	<0.1	<2	0.11	<0.01	<0.05	0.08	<1	<5	<5
	LH5	09/04/2001	<1	<0.1	<2	0.163	<0.01	<0.05	0.06	<1	<5	<5
	LH6	09/04/2001	<1	<0.1	<2	0.528	<0.01	<0.05	0.07	<1	<5	<5
	LH7	09/04/2001	<1	<0.1	<2	0.292	<0.01	<0.05	0.07	<1	<5	<5
	LH8	09/04/2001	6	<0.1	<2	0.101	<0.01	<0.05	0.08	<1	<5	<5
	LH9	09/04/2001	42	0.1	<2	0.81	<0.01	0.12	0.37	<1	5.5	<5
	LH10	09/04/2001	8	0.26	<2	0.084	<0.01	<0.05	0.07	<1	<5	<5
	LH11	09/04/2001	30	1.62	7	1.651	0.345	0.38	1.17	<1	6.8	<5
	LH12	09/04/2001	12	<0.1	<2	0.485	<0.01	<0.05	0.08	<1	<5	<5
	LH13	09/04/2001	42	<0.1	<2	0.242	<0.01	<0.05	0.12	<1	5.3	<5
	LH14	09/04/2001	62	<0.1	<2	0.77	<0.01	0.12	0.37	<1	8.7	<5
	LH15	09/04/2001	18	<0.1	<2	0.193	<0.01	<0.05	0.08	<1	<5	<5
	LH16	09/04/2001	38	<0.1	<2	0.592	<0.01	0.16	0.5	<1	<5	<5
	LH17	09/04/2001	18	<0.1	<2	0.212	<0.01	<0.05	0.07	<1	<5	<5
16	LH1	09/12/2001	8	<0.1	<2	0.3	<0.005	<0.05	0.13	4	<5	<5
	LH2	09/12/2001	10	<0.1	<2	0.3	<0.005	0.35	1.09	<1	<5	<5
	LH3	09/12/2001	12	<0.1	<2	0.2	0.006	0.09	0.27	3	6	<5
	LH4	09/12/2001	10	<0.1	<2	0.2	<0.005	0.06	0.18	4	<5	<5
	LH5	09/12/2001	10	<0.1	<2	0.8	<0.005	<0.05	0.05	6	<5	<5
	LH6	09/12/2001	12	<0.1	<2	0.3	<0.005	<0.05	0.07	10	<5	<5
	LH7	09/12/2001	10	<0.1	<2	0.3	<0.005	0.64	1.96	8	<5	<5
	LH8	09/12/2001	8	<0.1	4	0.2	<0.005	<0.05	<0.05	3	<5	<5
	LH9	09/12/2001	42	<0.1	10	0.3	<0.005	0.09	0.27	15	<5	<5
	LH10	09/12/2001	24	<0.1	10	0.2	<0.005	<0.05	0.08	5	<5	<5
	LH11	09/12/2001	32	0.6	13	2.1	0.108	<0.05	0.1	6	<5	<5
	LH12	09/12/2001	22	<0.1	9	0.4	<0.005	<0.05	0.06	2	<5	<5
	LH13	09/12/2001	46	<0.1	9	0.3	<0.005	<0.05	0.06	2	<5	<5
	LH14	09/12/2001	72	<0.1	11	0.5	0.041	<0.05	0.08	5	<5	<5
	LH15	09/12/2001	20	<0.1	9	0.3	<0.005	<0.05	0.08	3	<5	<5
	LH16	09/12/2001	46	<0.1	8	0.6	<0.005	<0.05	0.09	6	<5	<5
	LH17	09/13/2001	18	<0.1	11	0.3	0.006	<0.05	0.05	3	<5	<5

Table 3-2. (Continued)

TRIP	STATION	DATE	ALKALINITY	NH3-N	BOD-5	NITRATE	NITRITE	P, diss	PO4, diss	SIO2-diss	TIC	TOC
17	LH1	09/17/2001	8	<0.1	<2	0.046	<0.01	0.06	<0.05	3	<5	<5
	LH2	09/17/2001	12	<0.1	<2	0.075	<0.01	0.05	<0.05	3	<5	<5
	LH3	09/17/2001	8	<0.1	<2	0.059	<0.01	<0.05	0.08	2	<5	<5
	LH4	09/17/2001	6	<0.1	<2	0.05	<0.01	0.07	<0.05	5	<5	<5
	LH5	09/17/2001	2	<0.1	<2	0.198	<0.01	0.07	<0.05	8	<5	<5
	LH6	09/17/2001	2	<0.1	<2	0.308	<0.01	<0.05	0.05	9	<5	<5
	LH7	09/17/2001	2	<0.1	<2	0.165	<0.01	0.07	<0.05	9	<5	<5
	LH8	09/17/2001	4	<0.1	<2	0.132	<0.01	<0.05	0.16	4	<5	<5
	LH9	09/17/2001	36	<0.1	<2	0.361	<0.01	0.37	0.12	13	7	<5
	LH10	09/17/2001	12	<0.1	<2	0.09	<0.01	<0.05	0.07	5	<5	<5
	LH11	09/17/2001	26	0.4	7	1.583	0.058	1.69	0.55	8	<5	5
	LH12	09/17/2001	16	<0.1	<2	0.23	<0.01	0.06	<0.05	5	<5	<5
	LH13	09/17/2001	52	<0.1	<2	0.184	<0.01	0.07	<0.05	3	<5	<5
	LH14	09/17/2001	56	0.1	<2	0.409	<0.01	0.05	0.16	6	7	<5
	LH15	09/17/2001	36	<0.1	3	0.147	<0.01	0.07	<0.05	4	<5	<5
	LH16	09/17/2001	32	<0.1	<2	0.302	<0.01	0.06	0.18	4	6	<5
	LH17	09/17/2001	14	<0.1	<2	0.123	<0.01	0.07	<0.05	4	<5	<5
18	LH1	09/24/2001	12	<0.1	2	0.06	<0.01	<0.05	0.06	<1	<5	<5
	LH2	09/24/2001	8	<0.1	2	0.063	<0.01	<0.05	0.05	1	<5	<5
	LH3	09/24/2001	12	<0.1	2	0.101	<0.01	<0.05	<0.05	1	<5	<5
	LH4	09/24/2001	6	<0.1	<1	0.075	<0.01	<0.05	<0.05	4	<5	<5
	LH5	09/24/2001	2	<0.1	<1	0.237	<0.01	<0.05	<0.05	6	<5	<5
	LH6	09/24/2001	2	<0.1	<1	0.571	<0.01	<0.05	0.05	7	<5	<5
	LH7	09/24/2001	2	<0.1	<1	0.337	<0.01	<0.05	0.05	7	<5	<5
	LH8	09/24/2001	8	<0.1	<1	0.086	<0.01	<0.05	0.05	3	<5	<5
	LH9	09/24/2001	32	0.1	<1	0.676	<0.01	0.1	0.31	7	<5	<5
	LH10	09/24/2001	10	<0.1	5	0.157	<0.01	<0.05	0.05	3	<5	<5
	LH11	09/24/2001	40	0.7	8	1.796	0.155	0.54	0.17	5	6	<5
	LH12	09/24/2001	12	<0.1	<1	0.499	<0.01	<0.05	0.05	11	<5	<5
	LH13	09/24/2001	38	0.1	3	0.436	<0.01	<0.05	0.05	4	<5	<5
	LH14	09/24/2001	40	0.2	1	1.129	<0.01	0.06	<0.05	5	<5	<5
	LH15	09/24/2001	18	0.1	<1	0.375	<0.01	<0.05	0.07	4	<5	<5
	LH16	09/24/2001	42	0.1	5	0.86	<0.01	0.06	0.18	6	<5	<5
	LH17	09/24/2001	22	0.1	2	0.436	<0.01	<0.05	0.05	3	<5	<5

Table 3-2. (Continued)

TRIP	STATION	DATE	ALKALINITY	NH3-N	BOD-5	NITRATE	NITRITE	P, diss	PO4, diss	SIO2-diss	TIC	TOC
19	LH1	10/02/2001	8	<0.1	<2	<0.01	<0.01	<0.05	0.07	<1	<5	<5
	LH2	10/02/2001	18	<0.1	<2	0.039	<0.01	<0.05	0.06	<1	<5	<5
	LH3	10/02/2001	8	<0.1	<2	0.07	<0.01	<0.05	<0.05	<1	<5	<5
	LH4	10/02/2001	4	<0.1	<2	0.052	<0.01	<0.05	0.05	3	<5	<5
	LH5	10/02/2001	<1	<0.1	<2	0.144	<0.01	<0.05	0.06	5	<5	<5
	LH6	10/02/2001	2	<0.1	<2	0.61	<0.01	<0.05	0.05	6	<5	<5
	LH7	10/02/2001	2	<0.1	<2	0.326	<0.01	<0.05	0.07	6	<5	<5
	LH8	10/02/2001	4	<0.1	<2	0.118	<0.01	<0.05	<0.05	2	<5	<5
	LH9	10/02/2001	26	<0.1	4	0.668	<0.01	0.11	0.34	6	<5	<5
	LH10	10/02/2001	4	<0.1	<2	0.149	<0.01	<0.05	0.09	3	<5	<5
	LH11	10/02/2001	34	0.5	3	1.518	<0.01	0.56	1.71	4	<5	<5
	LH12	10/02/2001	12	<0.1	<2	0.516	<0.01	<0.05	0.07	9	<5	<5
	LH13	10/02/2001	26	<0.1	3	0.948	<0.01	<0.05	0.06	3	<5	<5
	LH14	10/02/2001	36	<0.1	<2	1.384	<0.01	<0.05	0.08	5	<5	<5
	LH15	10/02/2001	18	<0.1	4	0.471	<0.01	<0.05	0.08	5	<5	<5
	LH16	10/02/2001	30	<0.1	<2	0.871	<0.01	0.08	0.24	5	<5	<5
	LH17	10/02/2001	14	<0.1	4	0.567	<0.01	<0.05	0.08	3	<5	<5
20	LH1	10/09/2001	14	<0.1	<2	<0.01	<0.01	<0.05	0.05	<1	<5	<5
	LH2	10/09/2001	10	<0.1	<2	<0.01	<0.01	<0.05	0.07	1	<5	5
	LH3	10/09/2001	16	<0.1	<2	0.079	<0.01	<0.05	0.07	<1	<5	<5
	LH4	10/09/2001	6	<0.1	<2	<0.01	<0.01	<0.05	0.07	3	<5	<5
	LH5	10/09/2001	2	<0.1	<2	0.116	<0.01	<0.05	0.07	5	<5	<5
	LH6	10/09/2001	2	<0.1	<2	0.568	<0.01	<0.05	0.05	6	<5	<5
	LH7	10/09/2001	2	<0.1	<2	0.265	<0.01	<0.05	0.06	6	<5	<5
	LH8	10/09/2001	4	<0.1	<2	0.142	<0.01	<0.05	0.07	2	<5	<5
	LH9	10/09/2001	50	0.1	<2	0.927	<0.01	0.1	0.32	5	9	<5
	LH10	10/09/2001	6	<0.1	<2	0.16	<0.01	<0.05	0.08	4	<5	<5
	LH11	10/09/2001	46	0.7	<2	1.581	<0.01	0.32	0.99	3	8	<5
	LH12	10/09/2001	14	<0.1	<2	0.461	<0.01	<0.05	0.07	5	<5	<5
	LH13	10/09/2001	32	<0.1	<2	0.634	<0.01	<0.05	0.07	4	8	<5
	LH14	10/09/2001	44	0.1	<2	1.155	<0.01	0.7	0.23	3	10	<5
	LH15	10/09/2001	36	0.1	<2	0.434	<0.01	<0.05	0.7	3	5	<5
	LH16	10/09/2001	38	0.1	<2	0.909	<0.01	0.1	0.3	5	9	<5
	LH17	10/09/2001	18	0.3	<2	0.452	<0.01	<0.05	0.07	4	<5	<5

Table 3-2. (Continued)

TRIP	STATION	DATE	ALKALINITY	NH3-N	BOD-5	NITRATE	NITRITE	P, diss	PO4, diss	SIO2-diss	TIC	TOC
21	LH1	10/18/2001	8	0.4	<2	0.066	<0.01	<0.05	0.07	1	<5	5
	LH2	10/18/2001	12	0.4	<2	0.023	<0.01	<0.05	0.08	1	<5	<5
	LH3	10/18/2001	10	0.4	<2	0.043	<0.01	<0.05	0.07	<1	<5	<5
	LH4	10/18/2001	8	0.3	<2	0.052	<0.01	0.05	0.15	3	<5	<5
	LH5	10/18/2001	2	0.3	<2	0.109	<0.01	<0.05	<0.05	6	<5	<5
	LH6	10/18/2001	4	0.3	<2	0.394	<0.01	<0.05	0.08	6	<5	<5
	LH7	10/18/2001	4	0.4	<2	0.18	<0.01	<0.05	0.08	6	<5	<5
	LH8	10/18/2001	10	0.6	<2	0.054	<0.01	<0.05	0.07	3	<5	<5
	LH9	10/18/2001	36	0.9	<2	0.424	<0.01	0.1	0.31	6	<5	<5
	LH10	10/18/2001	10	0.8	<2	0.071	<0.01	<0.05	0.07	5	<5	<5
	LH11	10/18/2001	10	1	8	0.92	<0.01	0.35	1.06	4	<5	5
	LH12	10/18/2001	14	0.6	<2	0.444	<0.01	<0.05	0.07	5	<5	<5
	LH13	10/18/2001	34	0.3	<2	0.391	<0.01	0.09	0.27	5	<5	<5
	LH14	10/18/2001	48	0.7	2	0.752	<0.01	<0.05	0.07	3	5	<5
	LH15	10/18/2001	16	0.4	<2	0.23	<0.01	<0.05	0.08	3	<5	<5
	LH16	10/18/2001	38	0.7	<2	0.353	<0.01	0.11	0.32	6	<5	<5
	LH17	10/18/2001	20	1.1	<2	0.239	<0.01	<0.05	0.07	5	<5	<5
22	LH1	10/23/2001	8	<0.1	<2	0.049	<0.01	<0.05	0.07	1	<5	6
	LH2	10/23/2001	10	<0.1	<2	0.028	<0.01	<0.05	0.05	1	<5	6
	LH3	10/23/2001	8	<0.1	<2	0.049	<0.01	<0.05	0.06	1	<5	5
	LH4	10/23/2001	6	<0.1	<2	0.044	<0.01	<0.05	0.06	3	<5	<5
	LH5	10/23/2001	2	<0.1	<2	0.147	<0.01	<0.05	0.07	6	<5	<5
	LH6	10/23/2001	2	<0.1	<2	0.505	<0.01	<0.05	0.06	6	<5	<5
	LH7	10/23/2001	2	<0.1	<2	0.256	<0.01	<0.05	0.07	7	<5	<5
	LH8	10/23/2001	4	<0.1	<2	0.083	<0.01	<0.05	0.07	3	<5	<5
	LH9	10/23/2001	32	<0.1	<2	0.655	<0.01	0.09	0.29	6	6	<5
	LH10	10/23/2001	10	0.1	<2	0.116	<0.01	<0.05	0.07	5	<5	<5
	LH11	10/23/2001	34	1.1	<2	0.868	0.095	0.35	1.08	4	5	6
	LH12	10/23/2001	12	<0.1	<2	0.365	<0.01	<0.05	0.07	5	<5	<5
	LH13	10/23/2001	34	<0.1	3	0.486	<0.01	0.09	0.27	4	5	<5
	LH14	10/23/2001	50	<0.1	<2	0.856	0.069	<0.05	0.07	3	8	<5
	LH15	10/23/2001	20	<0.1	<2	0.26	<0.01	<0.05	0.07	3	<5	<5
	LH16	10/23/2001	38	<0.1	<2	0.515	<0.01	0.1	0.31	6	<5	<5
	LH17	10/23/2001	18	<0.1	<2	0.279	<0.01	<0.05	0.06	5	<5	<5

Table 3-2. (Continued)

TRIP	STATION	DATE	ALKALINITY	NH3-N	BOD-5	NITRATE	NITRITE	P, diss	PO4, diss	SIO2-diss	TIC	TOC
23	LH1	10/29/2001	8	0.1	<2	0.078	<0.01	<0.05	0.09	<1	<5	<5
	LH2	10/29/2001	8	0.1	10	0.039	<0.01	<0.05	0.09	<1	<5	<5
	LH3	10/29/2001	10	0.1	<2	0.046	<0.01	<0.05	0.09	<1	<5	<5
	LH4	10/29/2001	4	0.1	<2	0.063	<0.01	<0.05	0.08	3	<5	<5
	LH5	10/29/2001	2	0.1	<2	0.147	<0.01	<0.05	0.09	6	<5	<5
	LH6	10/29/2001	2	0.1	<2	0.536	<0.01	<0.05	0.09	6	<5	<5
	LH7	10/29/2001	2	0.2	<2	0.248	<0.01	<0.05	0.1	6	<5	<5
	LH8	10/29/2001	8	0.2	<2	0.091	<0.01	<0.05	0.1	3	<5	<5
	LH9	10/29/2001	30	0.3	<2	0.979	<0.01	0.08	0.25	6	7	<5
	LH10	10/29/2001	14	0.2	<2	0.128	<0.01	<0.05	0.11	5	<5	<5
	LH11	10/29/2001	32	0.4	4	1.824	0.118	0.55	1.67	4	6	8
	LH12	10/29/2001	12	0.2	<2	0.332	<0.01	<0.05	0.09	5	<5	<5
	LH13	10/29/2001	38	0.3	<2	0.399	<0.01	0.08	0.24	4	7	<5
	LH14	10/29/2001	54	0.4	<2	0.735	0.096	<0.05	0.09	3	9	<5
	LH15	10/29/2001	16	0.1	<2	0.294	<0.01	<0.05	0.11	4	<5	<5
	LH16	10/29/2001	48	0.1	<2	0.498	<0.01	0.12	0.37	6	9	6
	LH17	10/29/2001	18	0.3	<2	0.26	<0.01	0.06	0.17	5	<5	<5
24	LH1	11/05/2001	16	<0.1	<2	0.091	<0.01	<0.05	0.09	1	<5	<5
	LH2	11/05/2001	12	<0.1	<2	0.011	<0.01	<0.05	0.08	1	<5	<5
	LH3	11/05/2001	14	<0.1	<2	0.13	<0.01	<0.05	0.08	1	<5	<5
	LH4	11/05/2001	8	<0.1	<2	0.081	0.098	<0.05	0.09	3	<5	<5
	LH5	11/05/2001	2	<0.1	<2	0.208	<0.01	<0.05	0.09	3	<5	<5
	LH6	11/05/2001	6	<0.1	<2	0.586	<0.01	<0.05	0.09	6	<5	<5
	LH7	11/05/2001	2	<0.1	<2	0.283	0.027	<0.05	0.1	6	<5	<5
	LH8	11/05/2001	8	<0.1	<2	0.146	<0.01	<0.05	0.12	3	<5	<5
	LH9	11/05/2001	48	<0.1	<2	0.912	0.042	0.08	0.25	7	9	<5
	LH10	11/05/2001	10	<0.1	<2	0.192	<0.01	<0.05	0.09	5	<5	<5
	LH11	11/05/2001	48	1.1	9	1.511	0.092	0.55	1.68	4	10	<5
	LH12	11/05/2001	18	<0.1	<2	0.405	0.046	<0.05	0.08	5	<5	<5
	LH13	11/05/2001	54	<0.1	<2	0.522	<0.01	0.08	0.25	4	10	<5
	LH14	11/05/2001	24	<0.1	<2	0.795	0.079	<0.05	0.06	4	11	<5
	LH15	11/05/2001	24	<0.1	<2	0.652	<0.01	<0.05	0.1	4	6	<5
	LH16	11/05/2001	60	<0.1	<2	0.375	<0.01	0.13	0.4	5	12	<5
	LH17	11/05/2001	28	0.1	<2	0.3	<0.01	0.05	0.17	4	5	<5

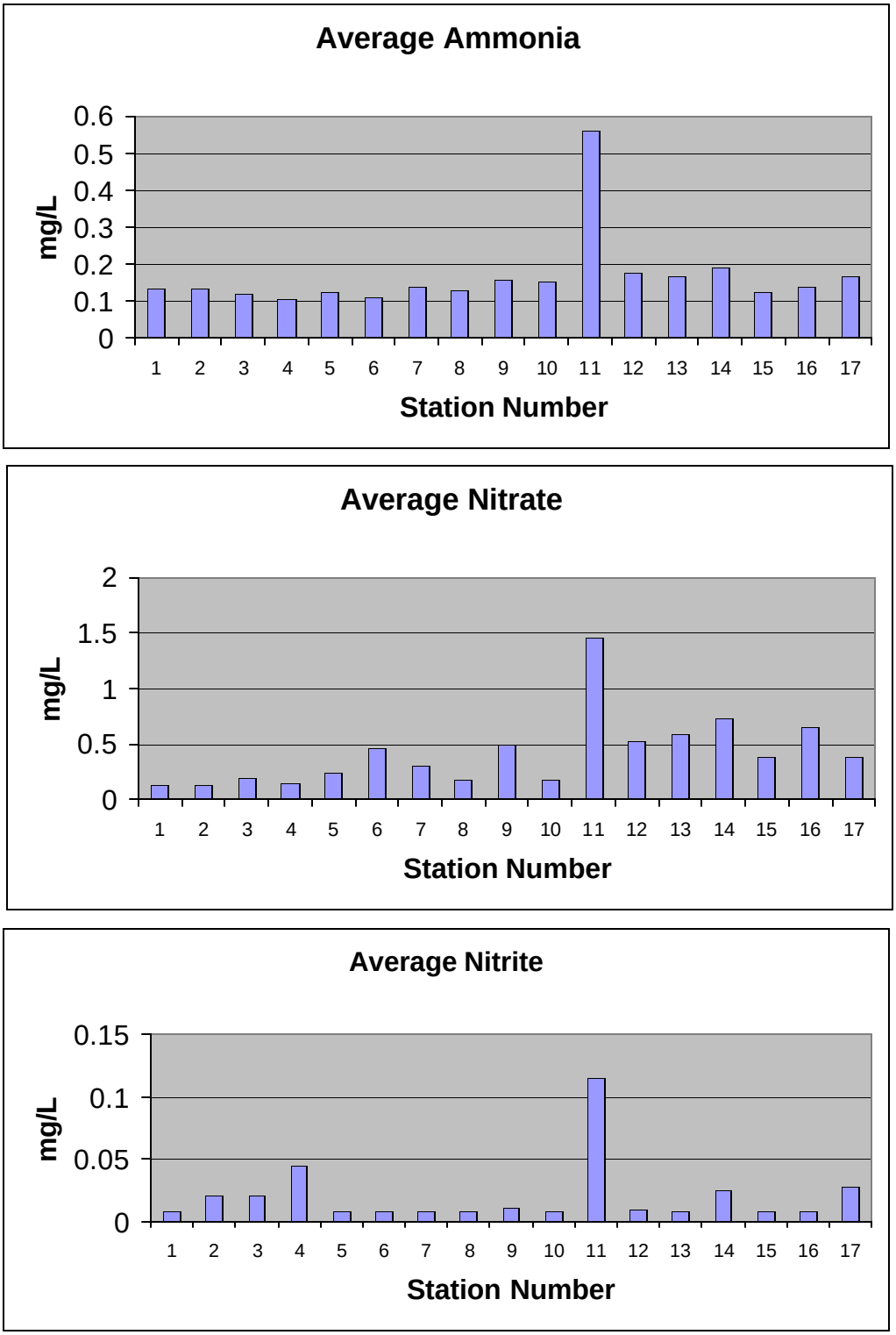
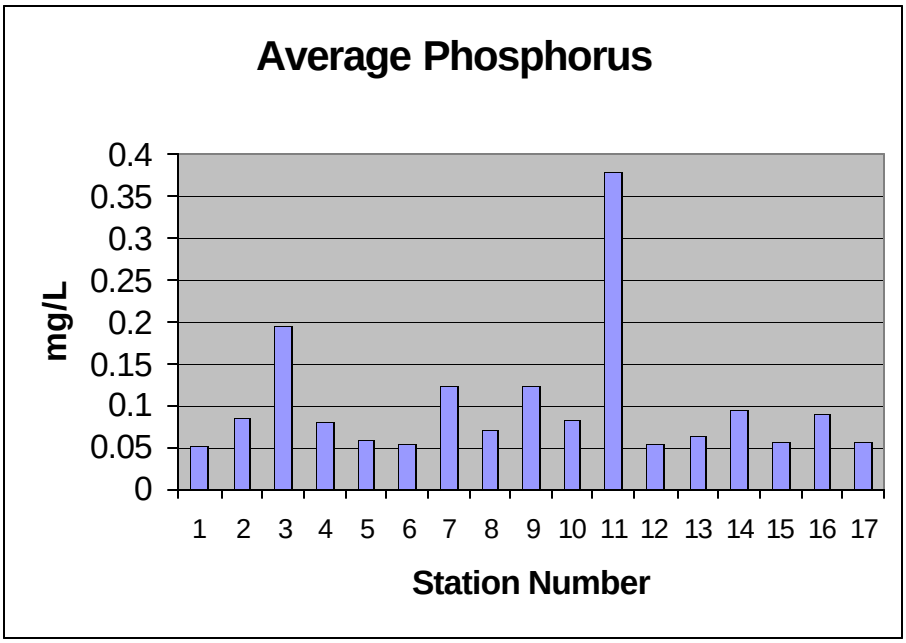


Figure 3-21. Average nitrate, nitrite, and ammonia concentrations observed at stations LH1 to LH17 during the Lehigh River water quality monitoring study conducted between May and November 2001.

Table 3-3. PADEP chronic ammonia criteria for specific temperatures and pH levels

Temperature C	pH	6.00	6.20	6.40	6.60	6.80	7.00	7.20	7.40	7.60	7.80	8.00
0.00		7.41	6.58	5.84	5.18	4.60	4.08	3.62	3.22	2.87	2.15	1.37
2.00		7.41	6.58	5.84	5.18	4.60	4.08	3.62	3.22	2.87	2.15	1.37
4.00		7.41	6.58	5.84	5.18	4.60	4.08	3.62	3.22	2.87	2.15	1.37
6.00		7.41	6.58	5.84	5.18	4.60	4.08	3.62	3.22	2.87	2.15	1.37
8.00		7.41	6.58	5.84	5.18	4.60	4.08	3.62	3.22	2.87	2.15	1.37
9.90		7.41	6.58	5.84	5.18	4.60	4.08	3.62	3.22	2.87	2.15	1.37
10.00		7.41	6.58	5.83	5.18	4.59	4.08	8.49	5.37	3.40	2.15	1.37
12.00		6.34	5.63	4.99	4.43	3.93	3.49	7.27	4.60	2.91	1.85	1.17
14.00		5.44	4.83	4.28	3.80	3.37	3.00	6.24	3.95	2.50	1.59	1.01
16.00		4.68	4.15	3.68	3.27	2.90	2.58	5.37	3.40	2.15	1.37	0.87
18.00		4.03	3.57	3.17	2.82	2.50	2.22	4.63	2.93	1.86	1.18	0.75
20.00		3.48	3.09	2.74	2.43	2.16	1.92	4.00	2.53	1.61	1.02	0.65
22.00		3.01	2.67	2.37	2.10	1.87	1.66	3.46	2.19	1.39	0.89	0.57
24.00		2.61	2.31	2.05	1.82	1.62	1.44	3.00	1.90	1.21	0.77	0.50
26.00		2.26	2.01	1.78	1.58	1.41	1.25	2.61	1.66	1.05	0.67	0.43
28.00		1.97	1.75	1.55	1.38	1.22	1.09	2.27	1.44	0.92	0.59	0.38



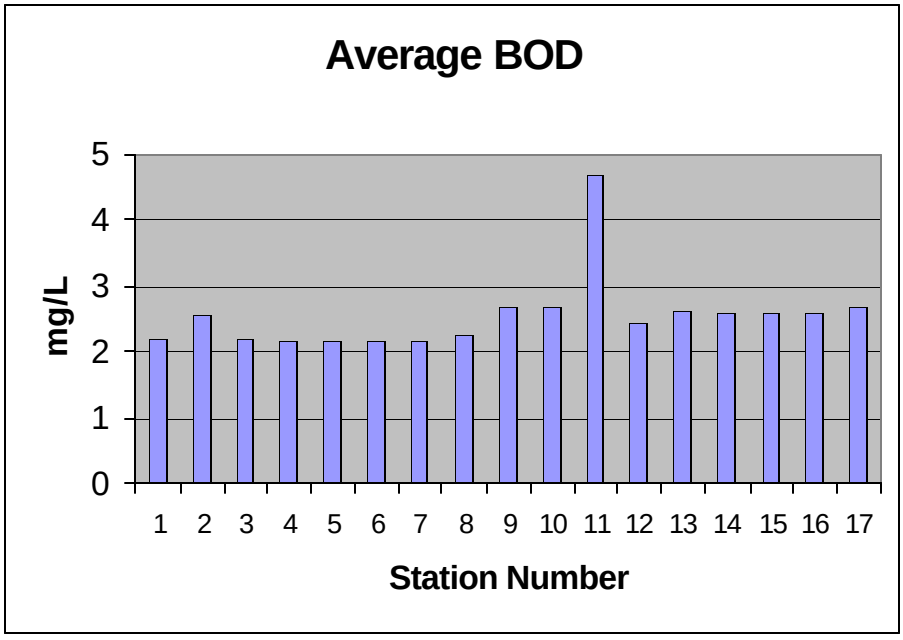


Figure 3-22. Average phosphorus concentrations and BOD levels observed at stations LH1 to LH17 during the Lehigh River water quality monitoring study conducted between May and November 2001.

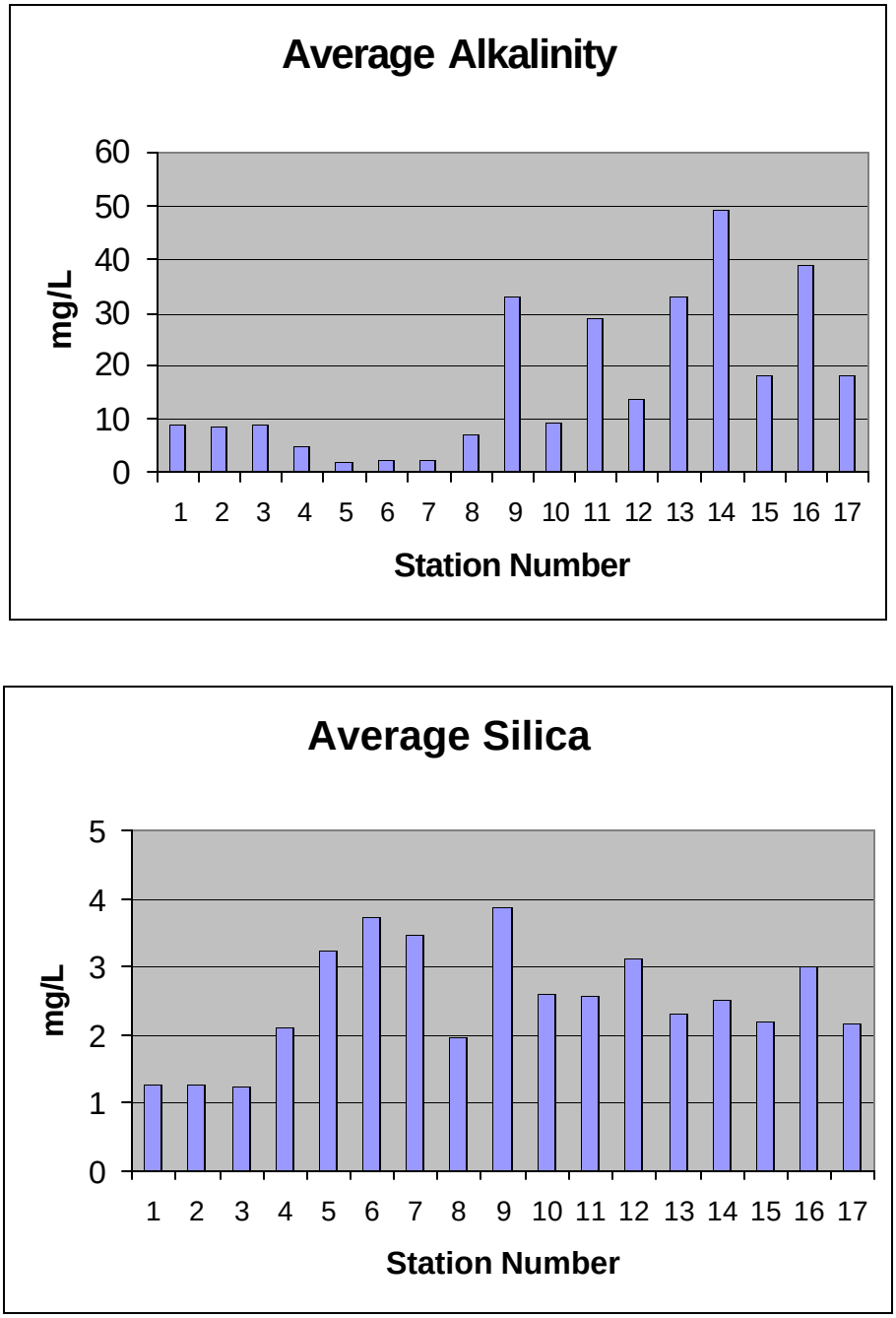


Figure 3-23. Average alkalinity and silica concentrations observed at stations LH1 to LH17 during the Lehigh River water quality monitoring study conducted between May and November 2001.

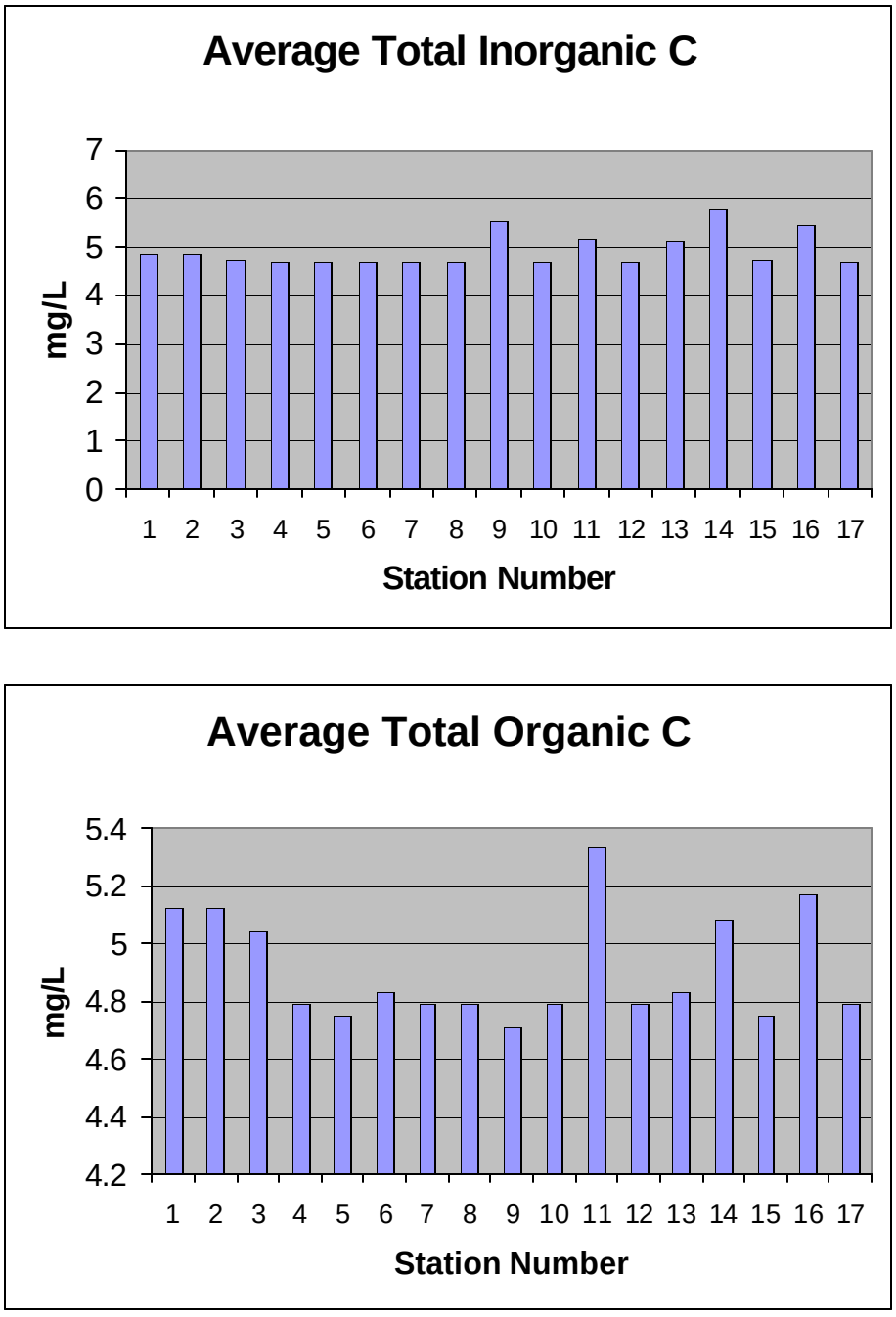


Figure 3-24. Average inorganic and organic carbon concentrations observed at stations LH1 to LH17 during the Lehigh River water quality monitoring study conducted between May and November 2001.

3.6 CHLOROPHYLL CONCENTRATIONS

Table 3-4 summarizes the chlorophyll concentrations observed in weekly grab sampling at all 17 stations during the 24-week monitoring period. The data indicate that chlorophyll levels were relatively low throughout the study period averaging only about 1.5 µg/L. No seasonal increasing or decreasing trends are indicated in the data as very few differences were observed in weekly mean concentration among the seventeen mainstem and tributary stations (Table 3-4). In addition, no one particular station showed consistently higher levels despite the fact that some stations showed higher nutrient loadings (e.g., LH11 downstream of Lehighton sewage treatment plant outfall). The lack of seasonal trends in the chlorophyll data may be a function of the riverine nature of the Lehigh, where residence time may be too short for any significant build up of phytoplankton biomass in the water column (attached algal biomass was not measured). The low chlorophyll concentrations measured in the water samples were similar to those monitored by the YSI units (deployed at LH1, LH2, and LH10), however probe fouling and other optical obstructions resulted in occasional high readings that are likely spurious. These high ranging values should be eliminated from the YSI dataset (see the electronic appendix), if the data are to be used in future modeling efforts.

3.7 METALS CONCENTRATIONS

Whole water samples were collected at a subset of mainstem and tributary stations in May, June, August, and September 2001. Samples were analyzed for five total metals including aluminum, cadmium, iron, manganese, and zinc. Both total and dissolved metals were analyzed in the June sampling. These data are presented in Tables 3-5 and 3-6 and are compared to DRBC, PADEP, New Jersey Department of Environmental Protection, and U.S EPA chronic freshwater criteria to evaluate potential toxic conditions in the system using the DRBC recommended hardness of 74 mg/L (a conservative approach for hardness based criteria since our observed hardness was lower). Samples collected in May and June 2001 resulted in aluminum concentrations above DRBC's chronic criteria of 0.087 mg/L (Table 3-5). Aluminum concentrations were generally lower in the August and September samples and fewer values were over the DRBC chronic criteria. Cadmium was not detected in any of the samples at 0.005 mg/L detection limit, however DRBC chronic criteria for cadmium are 0.001 mg/L which is below the detection levels achieved during the study (Table 3-5). Observed concentrations of iron were all below PADEP water quality criteria for CWF and TSF (1.5 mg/L). As observed for aluminum, iron concentrations were higher throughout the study area in May and June when concentrations averaged 0.3 mg/L relative to August and September where concentrations dropped to about 0.05 mg/L. In addition, many of the August samples had no detectable levels of total iron at a method detection limit of 0.005 mg/L. Only one sample collected in August 2001 at station LH6 (Buck Mountain) resulted in a manganese concentration over PADEP water quality criteria of 1.0 mg/L. Manganese concentrations were generally higher (averaging 0.19 mg/L) in May, June, and August collections relative to the September samples where concentrations among the stations averaged only 0.05 mg/L (Table 3-5). Total zinc concentrations showed no increasing or decreasing pattern among the sampling months, averaging about 0.05 mg/L throughout the study period among all stations. A total of seven

Table 3-4. Summary of chlorophyll concentrations observed each week at 17 stations in the Lehigh River watershed between May and November 2001

TRIP	STATION	DATE	Chl a Avg (µg/L)	TRIP	STATION	DATE	Chl a Avg (µg/L)	TRIP	STATION	DATE	Chl a Avg (µg/L)
1	LH1	05/31/2001	3.2	2	LH1	06/05/2001	4.0	3	LH1	06/13/2001	1.1
	LH2	05/30/2001	2.7		LH2	06/06/2001	2.2		LH2	06/13/2001	1.0
	LH3	05/30/2001	2.0		LH3	06/06/2001	3.5		LH3	06/13/2001	0.7
	LH4	05/30/2001	0.3		LH4	06/06/2001	0.6		LH4	06/13/2001	0.2
	LH5	05/30/2001	0.6		LH5	06/05/2001	0.9		LH5	06/13/2001	1.3
	LH6	05/30/2001	0.3		LH6	06/05/2001	0.4		LH6	06/13/2001	0.2
	LH7	05/30/2001	1.5		LH7	06/05/2001	1.0		LH7	06/13/2001	3.5
	LH8	05/30/2001	1.4		LH8	06/05/2001	2.0		LH8	06/13/2001	0.8
	LH9	05/31/2001	0.8		LH9	06/05/2001	0.8		LH9	06/14/2001	0.7
	LH10	05/30/2001	1.8		LH10	06/05/2001	2.8		LH10	06/14/2001	1.0
	LH11	05/30/2001	0.9		LH11	06/05/2001	1.1		LH11	06/14/2001	1.8
	LH12	05/30/2001	1.3		LH12	06/05/2001	1.7		LH12	06/14/2001	2.1
	LH13	05/30/2001	0.6		LH13	06/05/2001	0.6		LH13	06/14/2001	1.1
	LH14	05/30/2001	0.3		LH14	06/05/2001	0.9		LH14	06/15/2001	2.2
	LH15	05/30/2001	2.7		LH15	06/05/2001	1.5		LH15	06/15/2001	2.1
	LH16	05/31/2001	1.9		LH16	06/05/2001	5.0		LH16	06/15/2001	8.5
	LH17	05/31/2001	2.7		LH17	06/05/2001	3.4		LH17	06/15/2001	1.8
		Ave.	**1.5**			**Ave.**	**1.9**			**Ave.**	**1.8**
4	LH1	06/21/2001	1.0	5	LH1	06/26/2001	1.3	6	LH1	07/02/2001	1.2
	LH2	06/21/2001	0.9		LH2	06/26/2001	1.2		LH2	07/02/2001	1.5
	LH3	06/21/2001	1.3		LH3	06/25/2001	0.6		LH3	07/02/2001	0.6
	LH4	06/21/2001	0.3		LH4	06/25/2001	0.2		LH4	07/02/2001	0.6
	LH5	06/20/2001	1.8		LH5	06/25/2001	1.0		LH5	07/02/2001	0.5
	LH6	06/20/2001	0.5		LH6	06/25/2001	0.3		LH6	07/02/2001	0.3
	LH7	06/20/2001	0.5		LH7	06/25/2001	0.6		LH7	07/02/2001	0.9
	LH8	06/20/2001	0.9		LH8	06/25/2001	0.8		LH8	07/02/2001	0.8
	LH9	06/20/2001	0.6		LH9	06/25/2001	0.4		LH9	07/02/2001	0.4
	LH10	06/20/2001	0.9		LH10	06/25/2001	0.9		LH10	07/02/2001	0.5
	LH11	06/20/2001	1.0		LH11	06/25/2001	0.6		LH11	07/02/2001	1.0
	LH12	06/20/2001	2.6		LH12	06/25/2001	1.5		LH12	07/02/2001	1.1
	LH13	06/20/2001	0.7		LH13	06/25/2001	0.7		LH13	07/02/2001	1.7
	LH14	06/20/2001	1.6		LH14	06/25/2001	1.9		LH14	07/02/2001	2.4
	LH15	06/20/2001	1.8		LH15	06/25/2001	1.1		LH15	07/02/2001	2.0
	LH16	06/20/2001	3.8		LH16	06/25/2001	0.8		LH16	07/02/2001	3.1
	LH17	06/20/2001	3.0		LH17	06/25/2001	1.0		LH17	07/02/2001	0.9
		Ave.	**1.4**			**Ave.**	**0.9**			**Ave.**	**1.1**

Table 3-4. (Continued)

TRIP	STATION	DATE	Chl a Avg (µg/L)	TRIP	STATION	DATE	Chl a Avg (µg/L)	TRIP	STATION	DATE	Chl a Avg (µg/L)
7	LH1	07/10/2001	1.3	8	LH1	07/16/2001	0.6	9	LH1	07/24/2001	1.9
	LH2	07/10/2001	1.2		LH2	07/16/2001	1.5		LH2	07/25/2001	1.2
	LH3	07/10/2001	0.3		LH3	07/16/2001	0.5		LH3	07/24/2001	0.6
	LH4	07/10/2001	0.6		LH4	07/16/2001	0.2		LH4	07/24/2001	0.2
	LH5	07/10/2001	1.1		LH5	07/16/2001	0.4		LH5	07/24/2001	0.2
	LH6	07/10/2001	0.3		LH6	07/16/2001	0.0		LH6	07/24/2001	0.2
	LH7	07/10/2001	1.0		LH7	07/16/2001	0.8		LH7	07/24/2001	0.5
	LH8	07/10/2001	0.6		LH8	07/16/2001	0.6		LH8	07/24/2001	0.8
	LH9	07/10/2001	1.7		LH9	07/16/2001	0.3		LH9	07/24/2001	0.2
	LH10	07/10/2001	1.1		LH10	07/16/2001	0.9		LH10	07/24/2001	1.1
	LH11	07/10/2001	1.1		LH11	07/16/2001	1.1		LH11	07/24/2001	1.4
	LH12	07/10/2001	1.1		LH12	07/16/2001	0.7		LH12	07/24/2001	0.7
	LH13	07/10/2001	0.7		LH13	07/16/2001	0.3		LH13	07/24/2001	0.4
	LH14	07/10/2001	2.5		LH14	07/16/2001	3.0		LH14	07/24/2001	8.4
	LH15	07/10/2001	3.0		LH15	07/16/2001	1.0		LH15	07/24/2001	2.1
	LH16	07/10/2001	3.2		LH16	07/16/2001	1.9		LH16	07/24/2001	2.4
	LH17	07/10/2001	1.1		LH17	07/16/2001	0.8		LH17	07/24/2001	1.7
		Ave.	**1.3**			**Ave.**	**0.9**			**Ave.**	**1.4**
10	LH1	07/31/2001	0.4	11	LH1	08/06/2001	0.9	12	LH1	08/16/2001	0.6
	LH2	08/01/2001	0.9		LH2	08/06/2001	0.9		LH2	08/16/2001	1.6
	LH3	07/31/2001	0.4		LH3	08/06/2001	0.4		LH3	08/16/2001	0.6
	LH4	07/31/2001	0.1		LH4	08/06/2001	0.3		LH4	08/16/2001	0.1
	LH5	07/31/2001	0.1		LH5	08/06/2001	0.3		LH5	08/16/2001	0.3
	LH6	07/31/2001	0.0		LH6	08/06/2001	0.3		LH6	08/16/2001	0.1
	LH7	07/31/2001	0.7		LH7	08/06/2001	1.2		LH7	08/16/2001	0.2
	LH8	07/31/2001	0.7		LH8	08/06/2001	1.0		LH8	08/16/2001	0.2
	LH9	07/31/2001	0.2		LH9	08/06/2001	0.5		LH9	08/16/2001	0.3
	LH10	07/31/2001	0.7		LH10	08/06/2001	1.3		LH10	08/16/2001	0.4
	LH11	07/31/2001	1.1		LH11	08/06/2001	1.2		LH11	08/16/2001	0.8
	LH12	07/31/2001	0.5		LH12	08/06/2001	1.6		LH12	08/16/2001	0.5
	LH13	07/31/2001	0.6		LH13	08/06/2001	0.9		LH13	08/16/2001	0.8
	LH14	07/31/2001	6.0		LH14	08/06/2001	3.8		LH14	08/16/2001	2.8
	LH15	07/31/2001	1.9		LH15	08/06/2001	2.2		LH15	08/16/2001	1.1
	LH16	07/31/2001	1.6		LH16	08/06/2001	3.9		LH16	08/16/2001	3.7
	LH17	07/31/2001	1.5		LH17	08/06/2001	1.7		LH17	08/16/2001	1.0
		Ave.	**1.0**			**Ave.**	**1.3**			**Ave.**	**0.9**

Table 3-4. (Continued)

TRIP	STATION	DATE	Chl a Avg (µg/L)	TRIP	STATION	DATE	Chl a Avg (µg/L)	TRIP	STATION	DATE	Chl a Avg (µg/L)
13	LH1	08/20/2001	0.8	14	LH1	08/29/2001	0.7	15	LH1	09/04/2001	0.6
	LH2	08/20/2001	0.9		LH2	08/29/2001	0.9		LH2	09/04/2001	1.1
	LH3	08/20/2001	0.6		LH3	08/29/2001	0.5		LH3	09/04/2001	0.6
	LH4	08/20/2001	0.2		LH4	08/29/2001	0.2		LH4	09/04/2001	0.4
	LH5	08/20/2001	0.6		LH5	08/29/2001	1.2		LH5	09/04/2001	0.8
	LH6	08/20/2001	0.0		LH6	08/29/2001	0.2		LH6	09/04/2001	0.5
	LH7	08/20/2001	0.6		LH7	08/29/2001	0.8		LH7	09/04/2001	0.7
	LH8	08/20/2001	0.1		LH8	08/29/2001	0.2		LH8	09/04/2001	0.6
	LH9	08/20/2001	0.1		LH9	08/29/2001	0.4		LH9	09/04/2001	0.3
	LH10	08/20/2001	0.3		LH10	08/29/2001	0.9		LH10	09/04/2001	0.9
	LH11	08/20/2001	1.5		LH11	08/29/2001	2.5		LH11	09/04/2001	0.8
	LH12	08/20/2001	0.7		LH12	08/29/2001	0.9		LH12	09/04/2001	0.7
	LH13	08/20/2001	0.6		LH13	08/29/2001	0.8		LH13	09/04/2001	0.5
	LH14	08/20/2001	4.5		LH14	08/29/2001	4.3		LH14	09/04/2001	4.0
	LH15	08/20/2001	1.5		LH15	08/29/2001	4.3		LH15	09/04/2001	1.5
	LH16	08/20/2001	2.6		LH16	08/29/2001	1.2		LH16	09/04/2001	2.0
	LH17	08/20/2001	1.1		LH17	08/29/2001	1.9		LH17	09/04/2001	1.5
		Ave.	**1.0**			**Ave.**	**1.3**			**Ave.**	**1.0**
16	LH1	09/12/2001	0.3	17	LH1	09/17/2001	0.5	18	LH1	09/24/2001	0.8
	LH2	09/12/2001	1.4		LH2	09/17/2001	1.7		LH2	09/24/2001	0.6
	LH3	09/12/2001	0.5		LH3	09/17/2001	0.5		LH3	09/24/2001	1.1
	LH4	09/12/2001	0.0		LH4	09/17/2001	0.1		LH4	09/24/2001	1.3
	LH5	09/12/2001	0.2		LH5	09/17/2001	0.2		LH5	09/24/2001	0.0
	LH6	09/12/2001	0.1		LH6	09/17/2001	0.0		LH6	09/24/2001	0.1
	LH7	09/12/2001	0.2		LH7	09/17/2001	0.2		LH7	09/24/2001	0.2
	LH8	09/12/2001	1.0		LH8	09/17/2001	0.6		LH8	09/24/2001	0.4
	LH9	09/12/2001	0.2		LH9	09/17/2001	0.2		LH9	09/24/2001	0.1
	LH10	09/12/2001	0.5		LH10	09/17/2001	0.8		LH10	09/24/2001	1.0
	LH11	09/12/2001	1.8		LH11	09/17/2001	1.4		LH11	09/24/2001	2.2
	LH12	09/12/2001	0.7		LH12	09/17/2001	0.7		LH12	09/24/2001	1.1
	LH13	09/12/2001	0.6		LH13	09/17/2001	0.5		LH13	09/24/2001	0.4
	LH14	09/12/2001	2.6		LH14	09/17/2001	2.1		LH14	09/24/2001	0.5
	LH15	09/12/2001	1.9		LH15	09/17/2001	2.1		LH15	09/24/2001	1.4
	LH16	09/12/2001	2.6		LH16	09/17/2001	2.8		LH16	09/24/2001	1.9
	LH17	09/13/2001	1.5		LH17	09/17/2001	1.2		LH17	09/24/2001	1.0
		Ave.	**1.0**			**Ave.**	**0.9**			**Ave.**	**0.8**

Table 3-4. (Continued)

TRIP	STATION	DATE	Chl a Avg (µg/L)	TRIP	STATION	DATE	Chl a Avg (µg/L)	TRIP	STATION	DATE	Chl a Avg (µg/L)
19	LH1	10/02/2001	1.6	20	LH1	10/09/2001	2.5	21	LH1	10/18/2001	2.5
	LH2	10/02/2001	5.0		LH2	10/09/2001	5.2		LH2	10/18/2001	5.2
	LH3	10/02/2001	2.5		LH3	10/09/2001	1.4		LH3	10/18/2001	1.4
	LH4	10/02/2001	0.1		LH4	10/09/2001	0.1		LH4	10/18/2001	0.1
	LH5	10/02/2001	0.2		LH5	10/09/2001	0.3		LH5	10/18/2001	0.3
	LH6	10/02/2001	0.1		LH6	10/09/2001	0.1		LH6	10/18/2001	0.1
	LH7	10/02/2001	0.2		LH7	10/09/2001	0.2		LH7	10/18/2001	0.2
	LH8	10/02/2001	0.7		LH8	10/09/2001	0.5		LH8	10/18/2001	0.5
	LH9	10/02/2001	0.2		LH9	10/09/2001	0.1		LH9	10/18/2001	0.1
	LH10	10/02/2001	0.7		LH10	10/09/2001	0.3		LH10	10/18/2001	0.3
	LH11	10/02/2001	1.8		LH11	10/09/2001	1.2		LH11	10/18/2001	1.2
	LH12	10/02/2001	0.7		LH12	10/09/2001	1.1		LH12	10/18/2001	1.1
	LH13	10/02/2001	0.4		LH13	10/09/2001	0.9		LH13	10/18/2001	0.9
	LH14	10/02/2001	0.3		LH14	10/09/2001	0.9		LH14	10/18/2001	0.9
	LH15	10/02/2001	0.6		LH15	10/09/2001	0.8		LH15	10/18/2001	0.8
	LH16	10/02/2001	1.3		LH16	10/09/2001	1.5		LH16	10/18/2001	1.5
	LH17	10/02/2001	0.5		LH17	10/09/2001	0.9		LH17	10/18/2001	0.9
	Ave.		**1.0**		**Ave.**		**1.1**		**Ave.**		**1.1**
22	LH1	10/23/2001	1.6	23	LH1	10/29/2001	2.1	24	LH1	11/05/2001	2.2
	LH2	10/23/2001	3.5		LH2	10/29/2001	3.3		LH2	11/05/2001	5.3
	LH3	10/23/2001	1.2		LH3	10/29/2001	1.7		LH3	11/05/2001	2.3
	LH4	10/23/2001	0.1		LH4	10/29/2001	0.1		LH4	11/05/2001	0.1
	LH5	10/23/2001	0.3		LH5	10/29/2001	0.1		LH5	11/05/2001	0.3
	LH6	10/23/2001	0.0		LH6	10/29/2001	0.1		LH6	11/05/2001	0.1
	LH7	10/23/2001	0.2		LH7	10/29/2001	0.9		LH7	11/05/2001	0.1
	LH8	10/23/2001	0.9		LH8	10/29/2001	0.3		LH8	11/05/2001	0.5
	LH9	10/23/2001	0.1		LH9	10/29/2001	0.2		LH9	11/05/2001	0.4
	LH10	10/23/2001	0.8		LH10	10/29/2001	0.5		LH10	11/05/2001	0.6
	LH11	10/23/2001	0.9		LH11	10/29/2001	0.9		LH11	11/05/2001	0.7
	LH12	10/23/2001	1.1		LH12	10/29/2001	1.1		LH12	11/05/2001	0.9
	LH13	10/23/2001	0.3		LH13	10/29/2001	0.5		LH13	11/05/2001	0.6
	LH14	10/23/2001	1.9		LH14	10/29/2001	1.9		LH14	11/05/2001	2.6
	LH15	10/23/2001	1.4		LH15	10/29/2001	1.0		LH15	11/05/2001	1.7
	LH16	10/23/2001	3.5		LH16	10/29/2001	4.5		LH16	11/05/2001	3.0
	LH17	10/23/2001	1.4		LH17	10/29/2001	1.7		LH17	11/05/2001	1.7
	Ave.		**1.1**		**Ave.**		**1.2**		**Ave.**		**1.4**

occurrences of zinc concentrations above the hardness based criteria was observed in the time series. Station L17 was over the zinc criteria in May and June while L14 exceeded the criteria in the June and August collections. Station L6 had zinc concentrations over criteria in June and August as well. Zinc concentration at station L7 was above criteria once during the June sampling.

Table 3-5. Total metals concentrations (mg/L) observed in grab samples collected in May, June, August, and September 2001 at selected tributary and mainstem stations in the Lehigh River watershed. Shaded values are above the lowest water quality criteria available.

STATION	DATE	AL	CD	FE	MN	ZN	Hardness
LH2	05/30/2001	0.12	<0.005	0.292	0.065	0.016	21
LH3	05/30/2001	0.11	<0.005	0.249	0.069	0.013	20
LH6	05/30/2001	0.17	<0.005	0.23	0.08	0.01	34
LH7	05/30/2001	0.19	<0.005	0.273	0.087	0.028	36
LH8	05/30/2001	0.22	<0.005	0.184	0.082	0.017	22
LH10	05/30/2001	0.24	<0.005	0.304	0.111	0.024	31
LH14	05/30/2001	0.23	<0.005	0.297	0.105	0.025	62
LH17	05/31/2001	0.25	<0.005	0.342	0.113	0.08	34
LH2	06/21/2001	0.16	<0.005	0.227	0.101	< 0.005	11
LH3	06/21/2001	0.14	<0.005	0.232	0.063	< 0.005	12
LH6	06/20/2001	1.26	<0.005	0.237	0.54	0.158	11
LH7	06/20/2001	0.81	<0.005	0.225	0.404	0.116	11
LH8	06/20/2001	0.26	<0.005	0.23	0.077	< 0.005	12
LH10	06/20/2001	0.26	<0.005	0.246	0.084	< 0.005	16
LH14	06/20/2001	0.35	<0.005	0.435	0.121	0.072	21
LH17	06/20/2001	0.29	<0.005	0.331	0.097	0.047	25
LH2	08/20/2001	<0.02	<0.005	0.139	0.112	< 0.005	24
LH3	08/20/2001	<0.02	<0.005	<0.005	0.041	< 0.005	27
LH6	08/20/2001	4.74	<0.005	<0.005	1.0	0.276	50
LH7	08/20/2001	1.64	<0.005	<0.005	0.584	0.057	46
LH8	08/20/2001	0.38	<0.005	<0.005	0.207	< 0.005	26
LH10	08/20/2001	0.06	<0.005	<0.005	0.196	< 0.005	32
LH14	08/20/2001	0.08	<0.005	<0.005	0.13	0.771	102
LH17	08/20/2001	<0.02	<0.005	<0.005	0.095	< 0.005	42
LH2	09/13/2001	0.14	<0.005	0.037	0.026	0.034	40
LH3	09/12/2001	0.13	<0.005	0.037	0.034	0.01	44
LH6	09/12/2001	<0.02	<0.005	0.095	0.036	< 0.005	44
LH7	09/12/2001	0.06	<0.005	0.282	0.095	0.026	30
LH8	09/12/2001	0.14	<0.005	0.028	0.062	0.015	22
LH10	09/12/2001	0.13	<0.005	0.025	0.078	0.027	30
LH14	09/12/2001	0.03	<0.005	0.008	0.008	0.009	30
LH17	09/12/2001	<0.02	<0.005	0.053	0.023	< 0.005	20
DRBC Chronic		0.087	0.001	none	none	0.082	
PADEP		0.750 (acute)	hardness based	1.5	1	hardness based	
NJDEP Chronic		none	none	none	none	0.1	
EPA Chronic		none	0.002	none	none	0.12	

Table 3-6. Dissolved metals concentrations (mg/L) observed in grab samples collected in June 2001 at selected tributary and mainstem stations in the Lehigh River watershed. Shaded values are above the lowest water quality criteria available.

STATION	DATE	Al-dissolved	Cd-dissolved	Fe-dissolved	Mn-dissolved	Zn-dissolved
LH2	06/21/2001	0.03	<0.005	<0.005	0.084	<0.005
LH3	06/21/2001	<0.02	<0.005	<0.005	0.023	<0.005
LH6	06/20/2001	0.21	<0.005	0.014	0.064	<0.005
LH7	06/20/2001	0.22	<0.005	0.046	0.067	<0.005
LH8	06/20/2001	0.03	<0.005	<0.005	0.033	<0.005
LH10	06/20/2001	0.03	<0.005	<0.005	0.042	<0.005
LH14	06/20/2001	<0.02	<0.005	<0.005	0.116	0.629
LH17	06/20/2001	<0.02	<0.005	<0.005	0.027	0.037
DRBC Chronic		0.087	0.001	none	none	0.082
PADEP		0.750 (acute)		1.5	1	
NJDEP Chronic		none	none	none	none	0.1
EPA Chronic		none	0.002	none	none	0.12

Dissolved metals analyzed in the June 2001 sampling (collected during higher water flows) had much lower concentration relative to the total metals measured for the month (Table 3-6). Dissolved aluminum exceeded criteria at stations LH6 and LH7. None of the other dissolved metals concentrations exceeded its respective water quality criteria, with the exception of zinc at station LH14. Dissolved zinc levels at Aquashicola Creek were measured at 0.629 mg/L and were over 19 times higher that the PADEP hardness based criteria of 0.032 mg/L (at a hardness of 21). Dissolved zinc concentrations at LH17 (Northampton were slightly over the 0.037 mg/L criteria for a hardness of 25.

4.0 SUMMARY AND CONCLUSIONS

Water quality monitoring in the Lehigh River in the year 2001 has provided the data set that was needed to develop a water quality model for the system. If sufficient funding is found to continue with the overall program goals, this model can be used to evaluate the effects of operational changes at Walters and Beltzville reservoirs and input changes from other point and non-point sources on Lehigh River water quality. Currently, Wildlands Conservancy, DRBC, and the US Army Corps of Engineers are investigating potential funding sources to continue the program initiated in the spring of 2001.

The data collected in 2001 suggest that water quality was generally within PADEP and DRBC recommended levels with some exceptions. Temperature conditions upstream and immediately downstream of Walters dam were too high to support a Cold Water Fishery according to PADEP guidelines. While most of the tributary water temperatures were within recommended levels, mainstem stations just below the Lehigh Gorge State Park were above HQ-CWF requirements. Ambient water temperature in the lower portion of the Lehigh (between Mahoning Creek and Northampton) typically met the temperature requirement for TSF critical use. Dissolved oxygen monitoring by the in-situ meters revealed that apart from a few minor exceptions, oxygen levels were within acceptable ranges, even in the stream reach directly below Walters dam. Overall pH levels remained between the required 6 to 9 range, accept for a few short-term low pH events. Nutrient levels were not excessive and with the exception of aluminum in May and June 2001, few water quality violations for metals were observed during the monitoring period. Chlorophyll levels monitored by weekly grab samples indicated that concentrations were consistently low (1.5 mg/L) throughout the entire monitoring period suggesting that very little if any seasonal changes in water column phytoplankton biomass occurred in 2001. Sampling for total and dissolved metals suggest that aluminum concentrations are typically above the lowest criteria available for comparison (DRBC chronic) and that zinc concentrations are occasionally higher than PADEP hardness based criteria.

5.0 REFERENCES

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