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U.S. Nuclear Regulatory Commission
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SUSQUEHANNA STEAM ELECTRIC STATION
APPLICATION FOR RENEWED OPERATING LICENSES
NUMBERS NPF-14 AND NPF-22
FOLLOW-UP TO ENVIRONMENTAL AUDIT DOCUMENT
REQUESTS FOR SUPPLEMENTAL INFORMATION **Docket Nos. 50-387**
PLA-6253 **and 50-388**

Reference: 1) Letter from Mr. A. L. Stuyvenberg (USNRC) to Mr. B. T. McKinney (PPL), "Environmental Site Audit Regarding Susquehanna Steam Electric Station, Units 1 and 2 Nuclear Power Plant License Renewal Application (TAC NOS. MD3021 and MD3022)," dated April 18, 2007.

2) PLA-6219, Mr. B. T. McKinney (PPL) to Document Control Desk (USNRC), "Application for Renewed Operating Licenses Numbers NPF-14 and NPF-22 Environmental Audit Document Requests Supplemental Information," dated June 20, 2007.

The attachment to this letter is a copy of the document "Environmental Studies in the Vicinity of the Susquehanna Steam Electric Station – 2006 Water Quality and Fishes," originally requested in Reference 1 as Document Request 56. This document is provided as a follow-up to PPL's response in Reference 2.

If you have any questions, please contact Mr. Duane L Filchner at (610) 774-7819.

for B.T. McKinney

B. T. McKinney

Attachment: "Environmental Studies in the Vicinity of the Susquehanna Steam Electric Station – 2006 Water Quality and Fishes"

Copy: NRC Region I
Ms. E. H. Gettys, NRC Project Manager, License Renewal, Safety
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Attachment to PLA-6253
Environmental Studies in the Vicinity of the Susquehanna Steam Electric Station
2006
Water Quality and Fishes

ENVIRONMENTAL STUDIES
IN THE VICINITY OF THE
SUSQUEHANNA STEAM ELECTRIC STATION

2006
WATER QUALITY AND FISHES

Prepared by

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July 2007

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INTRODUCTION

PPL Susquehanna, LLC (PPL) contracted Ecology III, Inc. to conduct nonradiological monitoring of the Susquehanna River in the vicinity of the Susquehanna Steam Electric Station (Susquehanna SES) in 2006. The Susquehanna SES is a nuclear power station with two boiling water reactors, each with a net electrical generating capacity of approximately 1,220 megawatts. It is located on a 1,700-acre site in Salem Township, Luzerne County, 5 miles northeast of Berwick, Pennsylvania. Approximately 700 acres of mostly undeveloped and recreational lands owned by PPL are located on the east side of the Susquehanna River in Conyngham and Hollenback Townships. PPL owns 90 percent of the station and the Allegheny Electric Cooperative, Inc. owns 10 percent.

The objective of the nonradiological environmental monitoring program is to assess the impact of operating the Susquehanna SES on the Susquehanna River water quality and relative abundance of fishes. This was accomplished in 2006 by comparing data at control and indicator stations and by evaluating results of preoperational (1971-1982) and operational (1983-2006) studies (Ichthyological Associates 1972-1985, Ecology III 1986-2007). Monitoring was done at sites within a control station (SSES) upriver from the Susquehanna SES river intake structure and indicator station (Bell Bend) downriver from the discharge diffuser.

To more objectively assess the impact of operating the Susquehanna SES on the Susquehanna River, a statistical procedure called BACI (Before-After:Control-Impact) analysis was applied to preoperational and operational fishes monitoring data.

This report presents results of water quality and fishes studies.

WATER QUALITY

PROCEDURES

Water quality of the Susquehanna River relative to operation of the Susquehanna SES was monitored throughout 2006 at two control sites, the Susquehanna SES Environmental Laboratory and SSES; and one indicator site, Bell Bend. River flow and temperature were monitored continuously at the Environmental Laboratory located on the west river bank, 1,620 feet upriver from the nuclear power plant river intake. The SSES river site is located 750 feet upriver from the intake. The Bell Bend river site is 2,260 feet downriver from the blowdown discharge (Fig. 1).

A cooling tower blowdown sample and SSES and Bell Bend river samples were collected quarterly in 2006. These samples were analyzed by the Chemical Laboratory at the PPL System Facilities Center, Hazleton, Pennsylvania. Temperature and dissolved oxygen were measured by Ecology III. Blowdown is river water used in the nuclear power plant cooling cycle and is discharged back to the river. It has high conductivity and dissolved solids concentrations because of evaporative loss in the cooling towers (13,000 gallons/minute/tower evaporation during operation). In 2006, the daily average blowdown ranged from 4.4 to 17.3 cubic feet per second (cfs). Blowdown samples have been collected as part of this program since 1991. They were originally collected at the Susquehanna SES sewage treatment plant automatic composite sampler (ACS; location code 6S7). Since November 1996, they have been collected at the 2S7 ACS (6S7 ACS is

a backup site). The 2S7 ACS site is about 750 feet downstream from the cooling tower basin and the 6S7 ACS site is about 2,130 feet farther down the blowdown line (Fig. 1).

RESULTS AND DISCUSSION

River Flow and Temperature

In 2006, Susquehanna River flow was above average in January, February, and June through November (Fig. 2). The annual precipitation at Avoca, PA (about 30 miles upriver from the Susquehanna SES) was 45.56 inches. This was the third highest annual total on record since 1955, and closely follows the highest total (49.45 inches) set in 2003.

Monthly precipitation was above average for January, June, and August through November. January precipitation was 1.8 inches above normal, but February through May precipitation was 3.9 inches below normal. This changed in June with 9.00 inches of precipitation, making it the wettest June on record with the greatest 24-hour (25-26 June) total of 3.20 inches. From 24 through 28 June, 7.10 of the record 9.00 inches fell, causing the river to flood in late June and early July. The summer (June-August) precipitation total of 16.42 inches was the third greatest since 1955. The precipitation remained above average from August through November. November, with 6.06 inches, was the second wettest November on record.

There were 20 occurrences in 2006 when daily mean river flow exceeded 50,000 cfs. Daily mean river flow ranged from 3,000 to 191,000 cfs (Table 1). The 191,000 cfs was a result of the record rainfall in June. The July and November monthly mean flows were the highest recorded for those respective months in our 46-year database. The January and June flows were the second highest, only January 1996 and June 1972 were

higher. An estimated 643 billion cubic feet of water passed by the Environmental Laboratory in 2006 (Fig. 3). This was the sixth highest flow in the last 46 years.

River temperature was monitored throughout the year. River temperature ranged from 0.3 C at 0500 hours on 4 March to 29.3 C at 1600 hours on 3 August. Daily mean river temperature ranged from 0.8 C on 3 and 4 March to 28.7 C on 3 August (Table 2). Monthly mean temperature was above average every month except June, September, and October. The monthly mean temperature for January and April were the warmest recorded for those respective months in our 32-year database. December was the second warmest, only December 2001 was warmer.

River Water Quality at the Susquehanna SES

Control and indicator data were compared to PADEP water quality criteria (2005; Table 3). The parameters encompassed by the criteria were alkalinity, ammonia nitrogen, chloride, dissolved oxygen, fluoride, total and dissolved iron, manganese, nitrate, pH, sulfate, temperature, and total dissolved solids. Data for all parameters fell within the criteria for the year at both the control and indicator river sites (Table 4).

The basic quality of this section of the Susquehanna River continues to improve. The most significant change noticed in this water quality program has been the decrease of total iron in the Susquehanna River (Table 5). The source of iron to the river is drainage from abandoned coalmines in northeast Pennsylvania. In the 1980's concentrations began to decrease. Of the 59 samples collected in the 1970's only 34% met the criterion. In the 1980's and 90's, 56% of 119 samples and 85% of 95 samples met the criterion,

respectively. Of the 24 samples collected in the past 6 years, 92% have met the criterion. The annual mean concentration of total iron has been <1.5 mg/L since 1994.

Control and Indicator Site Comparisons

Control and indicator water quality data were similar in many respects. Data for sulfate and total mineral solids (tms) were usually slightly higher at the indicator site than the control site in a majority of samples (Table 4). Higher values at the indicator site are possibly due in part to the high concentrations of solids in the blowdown. Most of the water taken from the river for plant operation is evaporated in the cooling process and the remaining cooling water returned to the river subsequently contains concentrated mineral solids. This relationship is suggested in the quarterly tms samples collected at SSES, Bell Bend, and the blowdown (Table 6). However, when linear regression analysis was used to discover the best predictor of tms at Bell Bend, it was clear that the SSES tms measurements accounted for greater than 99% of the variability in the tms measurements at Bell Bend, indicating little influence of the power plant discharge on Bell Bend tms samples (Fig. 4).

The dilutive effect of high river flow decreases tms values at the control and indicator sites (Fig. 5). In 2006, the measured tms at the Bell Bend indicator site was within 1.5 mg/L of the SSES samples (Table 6). Since 1991, the average tms at Bell Bend has exceeded SSES by 3.4 mg/L (Table 7). However, a Mann-Whitney Rank Sum Test indicated that the difference in the median values between the two sites was not statistically different (P=0.86).

Conclusion

Susquehanna River flow was above average in 2006; it was the sixth highest flow in the last 46 years. Control and indicator data were similar throughout the year. Indicator data relative to the mineral concentrations in the Susquehanna SES blowdown were somewhat higher. The higher indicator values were within PADEP criteria for the river.

FISHES

PROCEDURES

Electrofishing

Electrofishing samples were collected once each month in May, July, and October in 2006. High water during some months decreased the number of samples from five to three samples this year. Sampling was done at four sites, and each site was approximately 1,100-yards long and parallel to the river shoreline. These sites have been consistently sampled by boat electrofishing since 1976. Two sites were located upriver from the Susquehanna SES river intake structure along each bank of the river, and two sites were downriver from the intake (referred to as SSES and Bell Bend locations, respectively; Table 8, Fig. 1).

Our electrofishing boat was operated with a 5-KW generator (direct current) controlled by a variable-voltage pulsator. The electrofishing unit was outfitted on an 18-foot flat-bottomed boat, similar to the design of Novotny and Priegel (1974). In the interest of continuity, this same electrofishing unit has been used since the inception of the sampling program.

During sampling, the boat was driven parallel to the shoreline usually within 30 feet of the riverbank. For purposes of safety and sampling efficiency, all sampling was done at river levels less than 493.1 feet above mean sea level (msl; equivalent to 10.1 feet) as measured at the Environmental Laboratory. Electrofishing was done only in the evening and sampling began about one hour after sunset. Two observers stood in the bow of the

boat and identified and counted fish during each sample. Data were recorded using a cassette tape recorder.

Seining

Shoreline fishes were collected by seine during August and October. Sampling was done when river levels were less than 490.2 feet above msl (equivalent to 7.2 feet at the Environmental Lab). High water prevented seining in June. Similar to the electrofishing sampling sites, two seine sites were above the Susquehanna SES river intake structure along each shoreline and two were below (Table 8, Fig. 1).

To sample, one end of a 25-foot bag seine (0.25-inch mesh) was kept stationary on the riverbank while we extended the other end about 20 feet into the river or as far as depth of the water allowed. The seine was then pulled upriver and onto shore. Two hauls were made in the same location at each site and the catches from both hauls were combined and considered one unit of effort. Captured fish were placed in 10% formalin in the field and returned to the laboratory. After at least two weeks in the formalin, the fish were rinsed with water, identified, enumerated, and finally preserved in 40% isopropanol.

Statistical Analysis

A statistical analysis known as the Before-After:Control-Impact (BACI), was applied to the electrofishing (1976-2006) and seining data (1978-2006; Ecology III, Inc. 1990). Twenty species or categories of fish were analyzed from the electrofishing data, as were 12 species from the seining data. These species or groups were chosen based on their abundance during the years before Susquehanna SES operation.

Two different electrofishing data sets were analyzed. The first set included all months sampled by electrofishing through the years, and is referred to as the All-Data Set. The second set, named the Summer-Data Set, included only the months from June through October, to reflect the reduced monitoring effort in place since 1986. The seining data set analyzed by the BACI represents all of the months sampled by this method through the years.

Additionally, in 1990 Williams and Thórarinsson recommended that the BACI analyses eventually be re-run to use February 1985 as the beginning of operation data. This reflects the time period between startup of Unit 1 (September 1982) and Unit 2 (February 1985), and replaces the existing beginning date of September 1982. For the purposes of this report, the electrofishing data sets were analyzed using both the traditional September 1982 date, as well as the extended time period (the 19 months between the startup dates were not used in the second BACI analysis).

RESULTS AND DISCUSSION

Electrofishing

Electrofishing at the SSES and Bell Bend locations in 2006 resulted in the observation of 533 fish of 17 species (Tables 9 through 11). The total numbers of fish collected above and below the SSES intake and discharge for the year were generally similar, as were most of the monthly totals. The range of sample sizes (differences between minima and maxima) among the months at SSES was 83 fish, while the range at Bell Bend was 109. Maximum monthly sample sizes occurred during May at both SSES (131) and Bell Bend (160).

Smallmouth bass was the most abundant species observed at SSES and Bell Bend in 2006 (25% and 42% of the totals, respectively). Smallmouth bass and walleye together represented 45% of the fish observed at SSES and 62% of those at Bell Bend. Smallmouth bass was the most abundant species during most months at both SSES and Bell Bend, with the exception of the May sample at SSES where walleye was the most abundant species.

Fifteen species were observed at both SSES and Bell Bend this year. Species richness per month ranged from 9 to 12 at SSES and 8 to 13 at Bell Bend. Maximum species richness at SSES and Bell Bend occurred in May (12 and 13 species, respectively). Sucker and sunfish species dominated richness in all months during 2006.

Seining

Seining at the SSES and Bell Bend locations in 2006 resulted in the capture of 670 fish of 10 species (Tables 9 and 12). Spotfin shiner was the most abundant species captured at SSES (65%), and equally abundant with spottail shiner at Bell Bend (49%). Spotfin shiner and spottail shiner comprised 94% and 99% of the fishes collected at SSES and Bell Bend, respectively.

Similar to previous years, the number of fishes captured at SSES was a fraction (36%) of those collected at Bell Bend. This difference in fish numbers was largely accounted for in the October sample where more than four times the number of fishes were captured at Bell Bend than were captured at SSES. This may reflect the growing disparity between the upriver and downriver sites, particularly the SSES location on the west bank of the river. In the past few years, the SSES West site has become overgrown

with vegetation, including the exotic invasive plant, purple loosestrife. Thick vegetation during higher water levels at this site sometimes presents obstacles that can affect sampling efficiency. Furthermore, it is also the deepest of the four sites.

Eight species were collected at SSES and five species were captured at Bell Bend. Five species were observed in most months at both sites. At both stations, species in the minnow and sunfish families predominated.

BACI Results: Electrofishing

Of the 20 species or categories of fish that were tested with the BACI analysis with the 1982 operational start date, nine species from the All-Data and eight species from the Summer-Data set showed significant or marginally significant differences in the numbers of fishes above versus below the power plant discharge ($P \leq 0.10$, Table 13). Species in the All-Data set that indicated declines in their numbers at the downstream locations included quillback, white sucker, northern hog sucker, shorthead redhorse, muskellunge, rock bass, smallmouth bass, and unidentified fish. Brown bullhead was also significantly different. However, its numbers showed significant increase at Bell Bend compared to the upriver sites. The Summer-Data set demonstrated decline or increase in all of the same species, except white sucker.

Changing the time period demarcating preoperational and operational data from 1982 to 1985 made little difference in the outcome of the BACI analysis. Both data sets indicated the same basic differences between upriver versus downriver fish numbers.

BACI Results: Seining

The results of the 12 seined species tested by BACI analysis indicated that spotfin shiner were marginally significant in both the 1982 operational data set and the 1985 data set (P=0.09). The point estimates for these test results indicate that more spotfins were collected at the downriver sites. Additionally, rock bass showed marginal significance in the 1985 operational data set (P=0.08), indicating fewer specimens at the downriver locations.

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Table 1

Daily mean flow (cfs) of the Susquehanna River at the Susquehanna SES Environmental Laboratory, 2006.

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	38000	28800	7120	8470	14900	8470	94200	17200	35900	18200	40200	14400
2	32600	30600	7120	8470	13500	10300	80400	15300	21300	16700	31900	19200
3	33200	30600	6490	8470	11900	18700	67600	11900	18700	14000	28100	22300
4	38700	38000	6490	9180	10700	30600	43100	9540	52600	12300	24600	22300
5	38700	47800	6180	9540	9540	50200	33200	8470	41600	11500	21800	19700
6	36600	58600	6490	10700	8820	41600	28800	8120	24600	10300	19200	17200
7	33900	50200	6490	10700	8470	31300	23500	8820	17200	10300	17200	15300
8	28100	39500	6180	11500	8120	24000	19700	9540	14000	10300	16200	14000
9	24000	32600	5880	11500	7780	19200	18200	7780	12300	9180	17700	12300
10	20700	26900	5880	13100	6800	17700	16700	6490	11100	8120	16700	11900
11	20200	23500	6490	12300	6490	18200	14900	5880	9540	7450	16200	11500
12	21800	21300	12300	11100	6490	17700	14000	5020	8470	6800	16200	10700
13	25200	19700	16200	9910	8120	17700	16200	5020	7450	6490	28100	10300
14	31300	17700	18700	9180	11500	15800	20700	4480	7120	5880	33900	10300
15	43900	16200	43900	9180	11900	13500	24000	4210	8120	5880	28800	9910
16	56800	14900	47000	11100	11900	11900	20700	3960	10700	5880	31300	9910
17	44600	14400	37300	12300	12300	10700	16200	3710	14000	5590	92000	9910
18	46200	14900	27500	11500	11500	9910	13100	3230	13100	6180	116000	9540
19	103000	16200	22900	10300	11100	8820	11100	3000	11100	6800	87700	8820
20	97500	15300	19200	9180	10700	8120	9910	3000	9180	8120	64800	8820
21	73400	13100	16200	8120	11500	8120	8470	3000	7780	34600	48500	8470
22	56800	11500	14400	8120	11500	8470	9540	6180	6490	61200	38700	8120
23	45400	10700	13100	14000	10300	7780	14000	7780	5880	48500	33900	8470
24	38700	10300	11900	22300	10300	7120	20700	6180	5880	35900	31300	10300
25	33900	9910	11500	33900	9910	7120	21800	5020	5590	26900	26300	11900
26	28100	9540	11100	35900	9180	11900	18200	4210	5300	21300	24000	14000
27	24600	8820	11100	28800	8120	17200	14000	4210	5300	18200	21300	17700
28	20700	8120	11100	22300	7780	189000[a]	11500	7450	5300	22300	19200	23500
29	19700		10300	18200	7780	191000[a]	10300	13500	7780	37300	17700	21300
30	19700		9910	15800	8470	115000	12300	19200	11500	49300	15300	18200
31	21800		9180		9180		17700	46200		48500		16200
MEAN	38600	22800	14400	13800	9890	31600	24000	8630	13800	19000	34200	13800

[a] Calculated from U.S. Geological Survey data.

Table 2

Daily mean temperature (C) of the Susquehanna River at the Susquehanna SES Environmental Laboratory, 2006.

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	2.0	3.1	1.4	11.1	14.3	25.0	20.7	27.3	19.9	15.6	8.8	9.5
2	2.1	3.1	1.3	11.8	15.0	24.8	21.0	27.9	19.2	15.4	9.2	9.5
3	2.6	3.7	0.8	11.7	15.7	23.3	21.5	28.7	18.8	15.6	8.6	8.3
4	2.8	4.3	0.8	11.3	16.5	20.5	22.1	28.5	17.9	16.2	7.7	6.9
5	3.1	4.5	1.3	10.7	17.8	18.3	22.3	27.8	17.6	16.5	7.2	5.7
6	3.2	4.0	2.1	10.3	18.2	18.3	22.4	27.4	18.0	15.7	6.9	4.9
7	2.7	3.5	2.6	9.7	17.6	18.6	22.4	27.0	18.6	14.8	6.9	4.5
8	2.5	2.9	3.2	9.0	17.5	18.4	22.4	26.6	19.5	14.7	7.4	3.1
9	2.5	2.4	4.1	8.3	17.5	18.4	22.8	26.2	20.3	15.4	8.5	2.0
10	2.9	1.9	5.6	8.8	18.0	18.2	23.1	25.8	20.5	16.2	9.0	2.0
11	3.3	1.7	7.0	9.8	18.5	17.6	24.0	25.5	19.9	16.4	9.4	2.5
12	3.9	1.6	7.1	11.0	18.4	17.5	24.6	24.8	19.6	16.2	9.9	3.3
13	4.2	1.3	7.4	12.2	18.8	17.8	24.3	24.4	19.2	14.4	9.2	4.2
14	5.1	1.5	8.0	12.7	18.6	18.7	24.5	24.3	18.4	13.4	9.0	4.8
15	3.8	2.0	6.4	13.3	17.6	19.0	24.7	25.0	18.4	12.1	9.2	5.3
16	2.2	2.9	5.2	14.2	16.7	19.6	24.7	25.2	18.7	11.6	10.1	5.6
17	1.1	4.0	4.6	14.3	16.6	20.7	25.8	25.5	19.2	11.5	11.8	5.6
18	1.8	3.6	4.3	14.8	17.1	22.3	26.9	25.7	19.9	12.2	11.1	6.0
19	1.9	2.1	3.8	15.4	16.6	23.8	27.4	25.3	20.4	13.1	10.1	5.7
20	1.9	1.7	3.6	16.1	15.9	24.4	27.9	25.7	19.6	13.6	9.1	5.1
21	2.5	1.7	3.5	16.6	15.4	24.5	28.2	25.7	18.7	12.6	8.0	4.9
22	2.8	1.8	3.3	15.5	14.9	24.9	27.1	25.5	18.2	11.3	7.0	4.6
23	2.7	2.2	3.6	13.1	14.6	25.2	26.4	25.5	18.3	10.6	6.5	5.1
24	2.8	2.2	3.7	12.7	15.3	24.8	25.2	25.1	18.4	9.8	6.2	5.6
25	2.9	2.1	3.9	13.0	16.0	24.5	24.6	24.5	18.7	9.2	6.0	5.2
26	2.4	1.9	4.4	12.0	16.3	24.0	25.1	23.9	18.4	9.0	5.8	5.2
27	1.7	1.1	5.1	11.6	17.4	23.4	25.8	22.9	18.2	8.2	5.9	4.9
28	1.7	1.0	6.1	12.2	18.8	-- [a]	25.7	22.4	18.1	8.4	6.2	4.4
29	1.9		7.3	12.8	20.3	--	25.8	22.5	17.8	8.1	6.9	4.2
30	2.5		8.5	13.5	22.1	20.5	26.6	21.8	16.4	7.8	7.9	4.3
31	3.2		9.8		23.8		27.1	20.8		8.1		4.1
MEAN	2.7	2.5	4.5	12.3	17.3	21.3	24.6	25.3	18.8	12.7	8.2	5.1

[a] Equipment failure

Table 3

Pennsylvania Department of Environmental Protection specific water quality criteria for the Susquehanna River in the vicinity of the Susquehanna Steam Electric Station, 2006.

PARAMETER	UNIT	PERIOD	CRITERIA		AVERAGE
			Minimum	Maximum	
Alkalinity as CaCO3	mg/L		20		
Ammonia Nitrogen	mg/L			4.56	
Chloride	mg/L			250	
Dissolved Oxygen	mg/L		4.0		
		Daily Average	5.0		
Fluoride	mg/L	Daily			2.0
Iron Total	mg/L	30-Day			1.5
Dissolved	mg/L			0.3	
Manganese	mg/L			1.0	
	ug/L			1000	
Nitrite plus Nitrate as N	mg/L			10	
pH			6.0	9.0	
Sulfate	mg/L			250	
Temperature	C	January 1-31		4.4	
		February 1-29		4.4	
		March 1-31		7.8	
		April 1-15		11.1	
		April 16-30		14.4	
		May 1-15		17.8	
		May 16-31		22.2	
		June 1-15		26.7	
		June 16-30		28.9	
		July 1-31		30.6	
		August 1-15		30.6	
		August 16-31		30.6	
		September 1-15		28.9	
		September16-30		25.6	
		October 1-15		22.2	
		October 16-31		18.9	
		November 1-15		14.4	
		November 16-30		10.0	
		December 1-31		5.6	
Total Dissolved Solids	mg/L	Monthly		750	500

Table 4

Water quality data collected quarterly from the Susquehanna River and the Susquehanna SES blowdown, 2006. River sites were SSES (control) and Bell Bend (indicator). Analyses were performed by the PPL Chemical Laboratory, Hazleton, PA. N.D. = Not Detected

PARAMETER	UNITS	SSES	BLOW DOWN	BELL BEND	SSES	BLOW DOWN	BELL BEND
Date		2/23/2006	2/23/2006	2/23/2006	5/18/2006	5/18/2006	5/18/2006
Time		845	733	851	722	832	716
River level	ft	489.4			489.6		
Temperature	C	2	18.8	2	16.1	19.8	15.7
Dissolved oxygen	mg/L	12.8	7.3	12.8	10.2	8.2	10.5
pH, lab		7.61	8.8	7.64	8.04	8.93	7.98
Conductivity, lab	µmho	248	932	248	243	874	243
Total alkalinity	mg/L	56	223	56	62	230	61
Phenolphthalein alkalinity	mg/L	0.0	14.0	0.0	0.0	16.0	0.0
Total suspended solids	mg/L	4.3	27.3	4	8	32	7
Ammonia as N	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Silicon dioxide	mg/L	3.9	15.4	3.9	0.2	2.3	0.2
Bicarbonate as CaCO3	mg/L	68.3	238	68.3	75.6	242	74.4
Carbonate by calculation	mg/L	0	16.8	0	0	19.2	0
Chloride	mg/L	23.1	105	23.2	22.6	99.7	22.7
Fluoride	mg/L	0.05	0.21	0.06	0.06	0.21	0.06
Nitrate as NO3	mg/L	3.4	15.4	3.4	1.2	5.4	1.3
Nitrate ion as N	mg/L	0.8	3.5	0.8	0.3	1.2	0.3
Phosphorus as PO4	mg/L	0.092	3.006	0.092	0.135	3.175	0.147
Sulfate	mg/L	23.7	97.5	23.7	21.6	87	21.7
Aluminum, dissolved	ug/L	N.D.	N.D.	N.D.	N.D.	<100	N.D.
Aluminum, total	ug/L	<100	533	<100	104	378	110
Barium, total	ug/L	25	110	25	30	105	30
Calcium, dissolved	mg/L	25.9	103	25.6	24.4	93.1	24.3
Calcium, total	mg/L	25.6	105	25.5	24.3	93.3	24.3
Copper, dissolved	ug/L	N.D.	N.D.	N.D.	<20	<20	N.D.
Copper, total	ug/L	N.D.	N.D.	N.D.	N.D.	<20	N.D.
Iron, dissolved	mg/L	0.17	0.39	0.18	0.07	0.31	0.06
Iron, total	mg/L	0.56	2.48	0.55	0.51	1.76	0.5
Magnesium, dissolved	mg/L	5.56	21.4	5.49	5.15	19.9	5.15
Magnesium, total	mg/L	5.52	21.8	5.49	5.19	20.1	5.18
Manganese, dissolved	ug/L	88	30	92	26	36	23
Manganese, total	ug/L	95	159	94	113	347	112
Nickel, total	ug/L	N.D.	<10	N.D.	N.D.	<10	N.D.
Potassium, dissolved	mg/L	1.13	4.78	1.07	1.28	5.33	1.26
Potassium, total	mg/L	1.1	4.87	1.08	1.31	5.4	1.29
Silver, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Sodium, dissolved	mg/L	13.3	59.6	13.3	13	57.4	13.1
Sodium, total	mg/L	13.3	60.1	13.2	12.9	57.1	12.9
Strontium, total	ug/L	88	335	88	79	321	79
Vanadium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Zinc, dissolved	ug/L	<20	N.D.	<20	<20	N.D.	<20
Zinc, total	ug/L	N.D.	<20	N.D.	N.D.	<20	N.D.
Beryllium, total	ug/L	N.D.	<0	N.D.	N.D.	N.D.	N.D.
Cadmium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Chromium, total	ug/L	N.D.	<10	N.D.	N.D.	<10	N.D.
Lead, total	ug/L	N.D.	N.D.	N.D.	N.D.	<5	N.D.
Thallium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Arsenic, total	ug/L	<1.0	1.9	<1.0	<1.0	2.2	<1.0
Selenium, total	ug/L	N.D.	<2.0	N.D.	N.D.	N.D.	N.D.
Antimony, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Total mineral solids	mg/L	133.55	556.06	133.17	126.68	508.06	126.29
Calcium hardness (C)	mg/L	64.7	257.2	63.9	60.9	232.5	60.7
Total hardness (C)	mg/L	86.7	352	86.3	82	316	82

Table 4 (cont.)

PARAMETER	UNITS	SSES	BLOW DOWN	BELL BEND	SSES	BLOW DOWN	BELL BEND
Date		8/16/2006	8/16/2006	8/16/2006	11/16/2006	11/16/2006	11/16/2006
Time		609	719	615	725	845	730
River level	ft	487.4			493.3		
Temperature	C	23.80	25.20	23.70	9.50	24.70	9.50
Dissolved oxygen	mg/L	7.50	7.40	7.40	10.70	8.10	10.90
pH, lab		7.9	8.71	7.88	7.72	8.91	7.70
Conductivity, lab	µmho	366	1030	366	172	733	173
Total alkalinity	mg/L	94	218	94	44	201	46
Phenolphthalein alkalinity	mg/L	0.0	10.0	0.0	0.0	15.0	0.0
Total suspended solids	mg/L	7.6	27.3	6.4	14.0	84.0	15.2
Ammonia as N	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Silicon dioxide	mg/L	3.77	11.06	3.69	4.69	18.73	4.75
Bicarbonate as CaCO3	mg/L	94.0	198	94.0	44.0	171	46.0
Carbonate by calculation	mg/L	0.0	12.0	0.0	--	--	--
Chloride	mg/L	30.5	98.6	31.4	13.4	72.8	13.3
Fluoride	mg/L	0.09	0.23	0.11	0.06	0.22	0.07
Nitrate as NO3	mg/L	1.8	5.9	1.8	2.0	9.4	2.0
Nitrate ion as N	mg/L	0.4	1.3	0.4	0.4	2.1	0.4
Phosphorus as PO4	mg/L	0.104	2.929	0.101	0.353	4.175	0.310
Sulfate	mg/L	35.7	185	35.8	14.8	9.4	15.1
Aluminum, dissolved	ug/L	N.D.	<100	N.D.	N.D.	<100	N.D.
Aluminum, total	ug/L	124	489	113	308	1860	338
Barium, total	ug/L	34	113	34	25	112	24
Calcium, dissolved	mg/L	38.5	120	38.7	19.1	85.9	19.2
Calcium, total	mg/L	38.5	120	38.8	19.0	88.8	18.9
Copper, dissolved	ug/L	N.D.	N.D.	N.D.	N.D.	<20	N.D.
Copper, total	ug/L	N.D.	N.D.	N.D.	N.D.	<20	N.D.
Iron, dissolved	mg/L	0.07	0.17	0.07	0.11	0.37	0.11
Iron, total	mg/L	0.61	1.87	0.59	0.81	4.59	0.86
Magnesium, dissolved	mg/L	8.52	25.7	8.53	3.82	16.9	3.86
Magnesium, total	mg/L	8.56	25.8	8.60	3.89	18.0	3.84
Manganese, dissolved	ug/L	48	28	44	37	41	34
Manganese, total	ug/L	120	274	118	53	250	55
Nickel, total	ug/L	N.D.	<10	<10	<10	<10	N.D.
Potassium, dissolved	mg/L	1.69	5.64	1.68	1.50	6.13	1.42
Potassium, total	mg/L	1.73	5.68	1.72	1.54	6.34	1.38
Silver, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Sodium, dissolved	mg/L	18.8	59.3	18.7	8.60	45.3	8.64
Sodium, total	mg/L	18.7	59.3	18.7	8.48	46.3	8.45
Strontium, total	ug/L	152	450	152	56	280	55
Vanadium, total	ug/L	N.D.	N.D.	N.D.	N.D.	<10	N.D.
Zinc, dissolved	ug/L	<20	N.D.	N.D.	<20	<20	<20
Zinc, total	ug/L	N.D.	<20	N.D.	<20	24	<20
Beryllium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Cadmium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Chromium, total	ug/L	N.D.	N.D.	N.D.	N.D.	<10	N.D.
Lead, total	ug/L	N.D.	N.D.	N.D.	N.D.	<5	N.D.
Thallium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Arsenic, total	ug/L	<1.0	2.8	<1.0	<1.0	3.2	<1.0
Selenium, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Antimony, total	ug/L	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Total mineral solids	mg/L	195.74	642.13	196.79	94.28	385.13	95.78
Calcium hardness (C)	mg/L	96.1	299.6	96.6	47.7	214.5	47.9
Total hardness (C)	mg/L	131	406	132	63.5	296	63.0

Table 5

Total iron concentrations from the Susquehanna River at the SSES sampling site, 1975-2006. Samples were collected monthly from 1975 through 1996 and quarterly from 1997 through 2006. Analyses were performed by the PPL Chemical Laboratory, Hazleton, PA.

YEAR	NO. SAMPLES Collected	NO. SAMPLES <1.50 mg/L	% SAMPLES <1.50 mg/L	ANNUAL MEAN
1975	12	2	16.7	3.55
1976	12	3	25.0	3.08
1977	11	5	45.5	1.71
1978	12	5	41.7	1.48
1979	12	5	41.7	3.13
1980	12	5	41.7	1.74
1981	12	9	75.0	1.31
1982	12	7	58.3	2.37
1983	11	6	54.5	1.41
1984	12	4	33.3	1.71
1985	12	5	41.7	1.61
1986	12	7	58.3	1.82
1987	12	8	66.7	1.96
1988	12	7	58.3	1.28
1989	12	9	75.0	1.45
1990	12	10	83.3	1.41
1991	12	10	83.3	0.98
1992	12	12	100.0	0.92
1993	12	8	66.7	1.55
1994	11	8	72.7	1.46
1995	12	12	100.0	0.89
1996	12	9	75.0	1.42
1997	4	4	100.0	0.55
1998	4	4	100.0	0.65
1999	4	4	100.0	0.60
2000	4	4	100.0	0.70
2001	4	4	100.0	0.74
2002	4	4	100.0	0.62
2003	4	3	75.0	1.43
2004	4	3	75.0	0.94
2005	4	4	100.0	0.57
2006	4	4	100.0	0.62

Table 6

Comparison of total mineral solids (tms) concentrations from the Susquehanna River and the Susquehanna SES blowdown, 2006. River sites were SSES (control) and Bell Bend (indicator).

DATE	SSES		BLOWDOWN		BELL BEND	DIFFERENCE
	Flow (cfs)	tms (mg/L)	Flow (cfs)	tms (mg/L)	tms (mg/L)	SSES - BELL BEND tms (mg/L)
23 Feb	10700	133.6	7.7	556.1	133.2	0.4
18 May	11500	126.7	11.9	508.1	126.3	0.4
16 Aug	3960	195.7	17.3	642.1	196.8	-1.0
16 Nov	31300	94.3	9.3	385.1	95.8	-1.5

Table 7

Comparison of annual average total mineral solids (tms) concentrations from the Susquehanna River and the Susquehanna SES blowdown, 1991-2006. River sites were SSES (control) and Bell Bend (indicator).

DATE	SSES		BLOWDOWN		BELL BEND	DIFFERENCE
	Flow (cfs)	tms (mg/L)	Flow (cfs)	tms (mg/L)	tms (mg/L)	SSES - BELL BEND tms (mg/L)
1991	12600	197.3	14.6	711.8	203.7	-6.4
1992	13400	155.3	7.5	600.3	156.4	-1.1
1993	23700	202.8	13.1	636.2	204.4	-1.6
1994	19200	174.9	13.9	660.9	175.3	-0.4
1995	10200	196.7	12.9	643.9	198.8	-2.1
1996	24000	151.8	19.5	438.4	152.6	-0.8
1997	6490	239.0	16.9	787.7	248.6	-9.6
1998	11200	242.2	19.2	649.3	247.9	-5.7
1999	19300	181.6	14.8	594.8	182.8	-1.2
2000	15000	190.6	15.8	632.7	193.8	-3.2
2001	7190	180.2	20.8	572.5	183.9	-3.7
2002	12200	136.2	17.7	523.4	142.5	-6.3
2003	26900	131.3	18.7	459.0	132.5	-1.2
2004	12200	134.1	18.3	446.6	136.3	-2.2
2005	13500	157.0	16.2	583.9	165.4	-8.4
2006	14400	137.6	11.6	522.8	138.0	-0.4
MEAN	15100	175.1	15.7	591.5	178.9	-3.4

Table 8

Descriptions of electrofishing (EL) and seining (SN) sites at SSES and Bell Bend on the Susquehanna River, 2006.

SITE	LOCATION
	SSES (Control)
EL-1	East bank, 426 feet upriver from gas-line crossing to 1,082 feet upriver from a point opposite the center of the Susquehanna SES intake structure
EL-2	West bank from gas-line crossing to a point 820 feet upriver from the center of the Susquehanna SES intake structure
SN-1	East bank, 1,837 feet upriver from a point opposite the center of the Susquehanna SES intake structure (33 feet upriver from the mouth of Little Wapwallopen Creek)
SN-2	West bank, 1,312 feet upriver from the center of the Susquehanna SES intake structure (328 feet downriver from the boat dock at the Susquehanna SES Environmental Laboratory)
	BELL BEND (Indicator)
EL-3	East bank, 1,279 feet downriver from a point opposite the Susquehanna SES intake structure to a point 1,640 feet upriver from the mouth of Wapwallopen Creek
EL-4	West bank, 1,246 feet downriver from the Susquehanna SES intake structure (558 feet downriver from the discharge diffuser) to a point near the southeastern boundary of PPL's Wetlands Nature Area
SN-3	East bank, 8,528 feet (1.6 miles) downriver from a point opposite the Susquehanna SES intake structure, at the launching ramp of the Berwick Boat Club
SN-4	West bank, 4,264 feet (0.8 miles) downriver from the Susquehanna SES intake structure, near the southeastern boundary of PPL's Wetlands Nature Area

Table 9

Fish species that were observed while electrofishing or collected by seining at SSES and Bell Bend on the Susquehanna River, 2006. Names of fishes and order of listing conform to Nelson et al. (2004).

COMMON NAME	SCIENTIFIC NAME
Herrings	Clupeidae
Gizzard shad	*Dorosoma cepedianum*
Carps and Minnows	Cyprinidae
Spotfin shiner	*Cyprinella spiloptera*
Common carp	*Cyprinus carpio*
River chub	*Nocomis micropogon*
Spottail shiner	*Notropis hudsonius*
Bluntnose minnow	*Pimephales notatus*
Fallfish	*Semotilus corporalis*
Suckers	Catostomidae
Quillback	*Carpiodes cyprinus*
White sucker	*Catostomus commersonii*
Northern hog sucker	*Hypentelium nigricans*
Shorthead redhorse	*Moxostoma macrolepidotum*
North American Catfishes	Ictaluridae
Yellow bullhead	*Ameiurus natalis*
Channel catfish	*Ictalurus punctatus*
Pikes	Esocidae
Northern pike	*Esox lucius*
Muskellunge	*Esox masquinongy*
Sunfishes	Centrarchidae
Rock bass	*Ambloplites rupestris*
Redbreast sunfish	*Lepomis auritus*
Green sunfish	*Lepomis cyanellus*
Bluegill	*Lepomis macrochirus*
Smallmouth bass	*Micropterus dolomieu*
Black crappie	*Pomoxis nigromaculatus*
Perches	Percidae
Tessellated darter	*Etheostoma olmstedi*
Walleye	*Sander vitreus*

Table 10

Number, mean, and percent total of fish observed while electrofishing at SSES on the Susquehanna River, 2006.

SPECIES	31 May				25 Jul				26 Oct				OVERALL	
	East	West	Mean	% Total	East	West	Mean	% Total	East	West	Mean	% Total	Mean	% Total
Gizzard shad	1	0	0.5	0.8	0	0	0.0	0.0	0	0	0.0	0.0	0.2	0.4
Common carp	2	3	2.5	3.8	2	0	1.0	3.3	1	0	0.5	2.1	1.3	3.3
Fallfish	0	0	0.0	0.0	0	0	0.0	0.0	1	0	0.5	2.1	0.2	0.4
Quillback	4	0	2.0	3.1	0	1	0.5	1.6	0	0	0.0	0.0	0.8	2.1
White sucker	1	0	0.5	0.8	1	0	0.5	1.6	0	2	1.0	4.2	0.7	1.7
Northern hog sucker	15	1	8.0	12.2	7	0	3.5	11.5	0	0	0.0	0.0	3.8	9.6
Shorthead redhorse	1	2	1.5	2.3	8	3	5.5	18.0	8	0	4.0	16.7	3.7	9.2
Channel catfish	6	4	5.0	7.6	0	0	0.0	0.0	6	0	3.0	12.5	2.7	6.7
Northern pike	0	0	0.0	0.0	1	0	0.5	1.6	1	0	0.5	2.1	0.3	0.8
Muskellunge	2	0	1.0	1.5	0	0	0.0	0.0	1	0	0.5	2.1	0.5	1.3
Pike spp.	1	0	0.5	0.8	0	0	0.0	0.0	0	0	0.0	0.0	0.2	0.4
Rock bass	7	2	4.5	6.9	2	0	1.0	3.3	0	0	0.0	0.0	1.8	4.6
Redbreast sunfish	1	0	0.5	0.8	0	0	0.0	0.0	0	0	0.0	0.0	0.2	0.4
Bluegill	0	0	0.0	0.0	0	0	0.0	0.0	0	1	0.5	2.1	0.2	0.4
Smallmouth bass	15	7	11.0	16.8	17	8	12.5	41.0	9	5	7.0	29.2	10.2	25.4
Sunfish spp.	0	1	0.5	0.8	0	0	0.0	0.0	0	0	0.0	0.0	0.2	0.4
Walleye	10	21	15.5	23.7	5	0	2.5	8.2	5	5	5.0	20.8	7.7	19.2
Fish (unidentified)	15	9	12.0	18.3	4	2	3.0	9.8	3	0	1.5	6.3	5.5	13.8
TOTAL	81	50	65.5		47	14	30.5		35	13	24.0		40.0	

Table 11

Number, mean, and percent total of fish observed while electrofishing at Bell Bend on the Susquehanna River, 2006.

SPECIES	31 May				25 Jul				26 Oct				OVERALL	
	East	West	Mean	% Total	East	West	Mean	% Total	East	West	Mean	% Total	Mean	% Total
Gizzard shad	0	0	0.0	0.0	0	0	0.0	0.0	1	0	0.5	2.0	0.2	0.3
Common carp	3	0	1.5	1.9	4	2	3.0	7.3	4	4	4.0	15.7	2.8	5.8
River chub	1	0	0.5	0.6	0	0	0.0	0.0	0	0	0.0	0.0	0.2	0.3
Quillback	1	0	0.5	0.6	3	2	2.5	6.1	2	0	1.0	3.9	1.3	2.7
White sucker	1	0	0.5	0.6	0	0	0.0	0.0	0	0	0.0	0.0	0.2	0.3
Northern hog sucker	1	0	0.5	0.6	1	2	1.5	3.7	0	0	0.0	0.0	0.7	1.4
Shorthead redhorse	2	0	1.0	1.3	1	4	2.5	6.1	2	0	1.0	3.9	1.5	3.1
Sucker spp.	1	0	0.5	0.6	0	0	0.0	0.0	1	0	0.5	2.0	0.3	0.7
Channel catfish	8	4	6.0	7.5	0	0	0.0	0.0	2	0	1.0	3.9	2.3	4.8
Muskellunge	0	0	0.0	0.0	0	0	0.0	0.0	2	1	1.5	5.9	0.5	1.0
Rock bass	2	6	4.0	5.0	2	1	1.5	3.7	0	0	0.0	0.0	1.8	3.8
Redbreast sunfish	1	1	1.0	1.3	0	0	0.0	0.0	0	0	0.0	0.0	0.3	0.7
Green sunfish	0	1	0.5	0.6	0	0	0.0	0.0	0	0	0.0	0.0	0.2	0.3
Bluegill	0	1	0.5	0.6	1	2	1.5	3.7	0	0	0.0	0.0	0.7	1.4
Smallmouth bass	45	19	32.0	40.0	15	28	21.5	52.4	9	6	7.5	29.4	20.3	41.6
Sunfish spp.	2	0	1.0	1.3	0	0	0.0	0.0	0	0	0.0	0.0	0.3	0.7
Walleye	24	16	20.0	25.0	2	4	3.0	7.3	6	8	7.0	27.5	10.0	20.5
Fish (unidentified)	11	9	10.0	12.5	3	5	4.0	9.8	3	0	1.5	5.9	5.2	10.6
TOTAL	103	57	80.0		32	50	41.0		32	19	25.5		48.8	

Table 12

Number, mean, and percent total of fish captured by seining at SSES and Bell Bend on the Susquehanna River, 2006.

SPECIES	23 Aug				11 Oct				OVERALL	
	East	West	Mean	% Total	East	West	Mean	% Total	Mean	% Total
SSES										
Spotfin shiner	28	31	29.5	69.4	42	15	28.5	60.6	29.0	64.8
Spottail shiner	1	20	10.5	24.7	11	20	15.5	33.0	13.0	29.1
Fallfish	0	0	0.0	0.0	1	0	0.5	1.1	0.3	0.6
Redbreast sunfish	1	1	1.0	2.4	0	0	0.0	0.0	0.5	1.1
Bluegill	0	0	0.0	0.0	0	3	1.5	3.2	0.8	1.7
Smallmouth bass	1	0	0.5	1.2	0	0	0.0	0.0	0.3	0.6
Black crappie	0	0	0.0	0.0	0	2	1.0	2.1	0.5	1.1
Tessellated darter	1	1	1.0	2.4	0	0	0.0	0.0	0.5	1.1
TOTAL	32	53	42.5		54	40	47.0		44.8	
BELL BEND										
Spotfin shiner	36	30	33.0	85.7	136	41	88.5	42.8	60.8	49.5
Spottail shiner	10	1	5.5	14.3	221	13	117.0	56.5	61.3	49.9
Bluntnose minnow	0	0	0.0	0.0	1	0	0.5	0.2	0.3	0.2
Yellow bullhead	0	0	0.0	0.0	0	1	0.5	0.2	0.3	0.2
Smallmouth bass	0	0	0.0	0.0	1	0	0.5	0.2	0.3	0.2
TOTAL	46	31	38.5		359	55	207.0		122.8	

Table 13

P-values for fish species deemed significant by the BACI analysis, 1976-2006 ($\alpha = 0.05$). Columns depict the p-values associated with the four temporal categories of data analyzed; All Data represents all months sampled, Summer Data denotes samples collected from June through October; annual dates represent the beginning operation of SSES (*ns* indicates that a species was not significant in that data set).

SPECIES	ALL DATA 1982	SUMMER DATA 1982	ALL DATA 1985	SUMMER DATA 1985
Quillback	0.015	0.005	0.021	0.004
White sucker	0.029	*ns*	0.027	*ns*
Northern hog sucker	0.002	0.020	0.007	0.038
Shorthead redhorse	<0.001	<0.001	<0.001	<0.001
Brown bullhead*	0.005	0.046	0.015	0.067
Muskellunge	<0.001	0.006	0.003	0.006
Rock bass	0.005	0.017	0.002	0.012
Smallmouth bass	0.065	0.004	0.065	0.005
Unidentified fish	0.017	<0.001	0.023	0.002

*Brown bullhead numbers increased at Bell Bend relative to those collected at SSES.

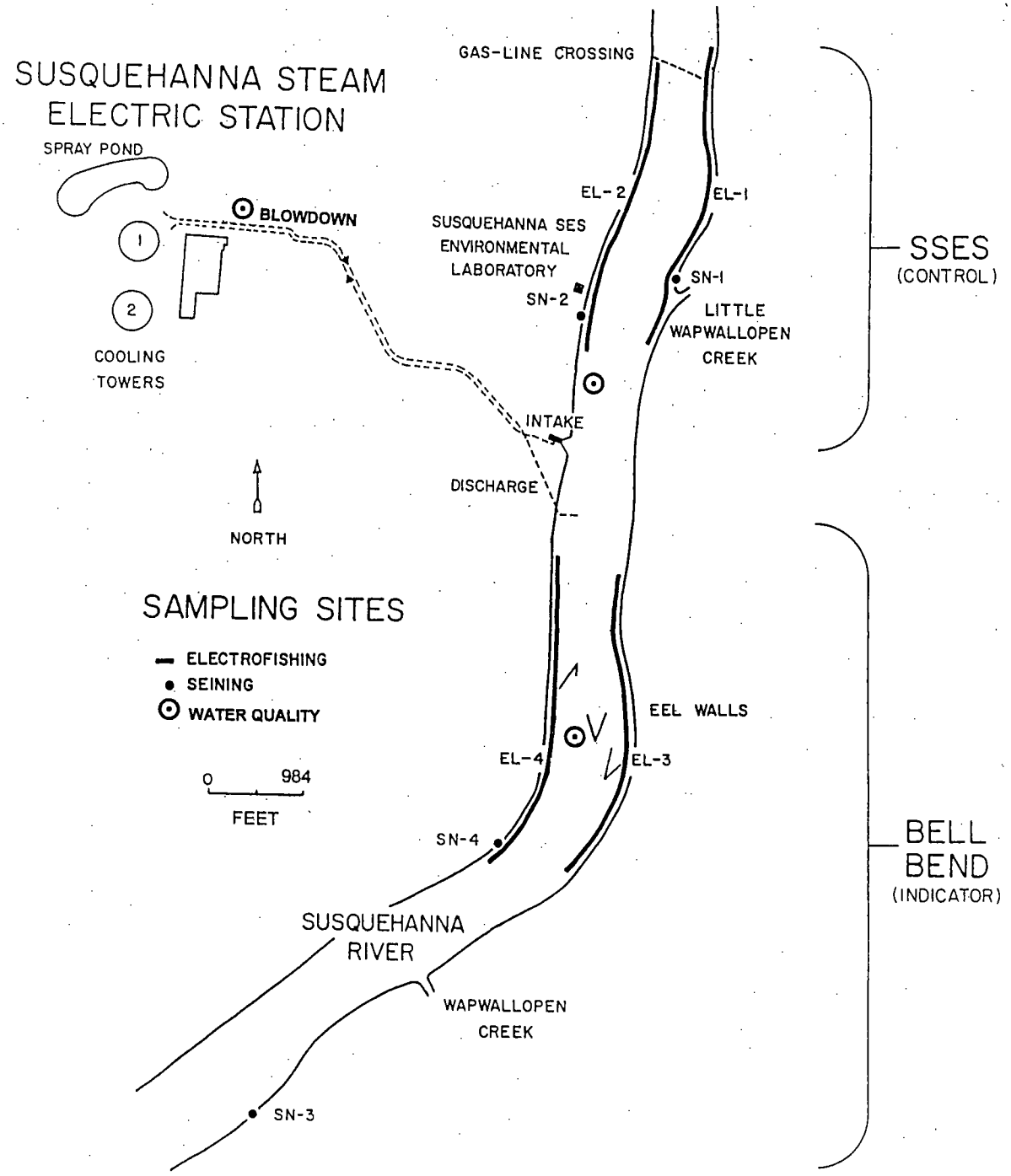

Fig. 1

Sampling sites for water quality, electrofishing (EL), and seining (SN) at SSES and Bell Bend on the Susquehanna River, 2006.

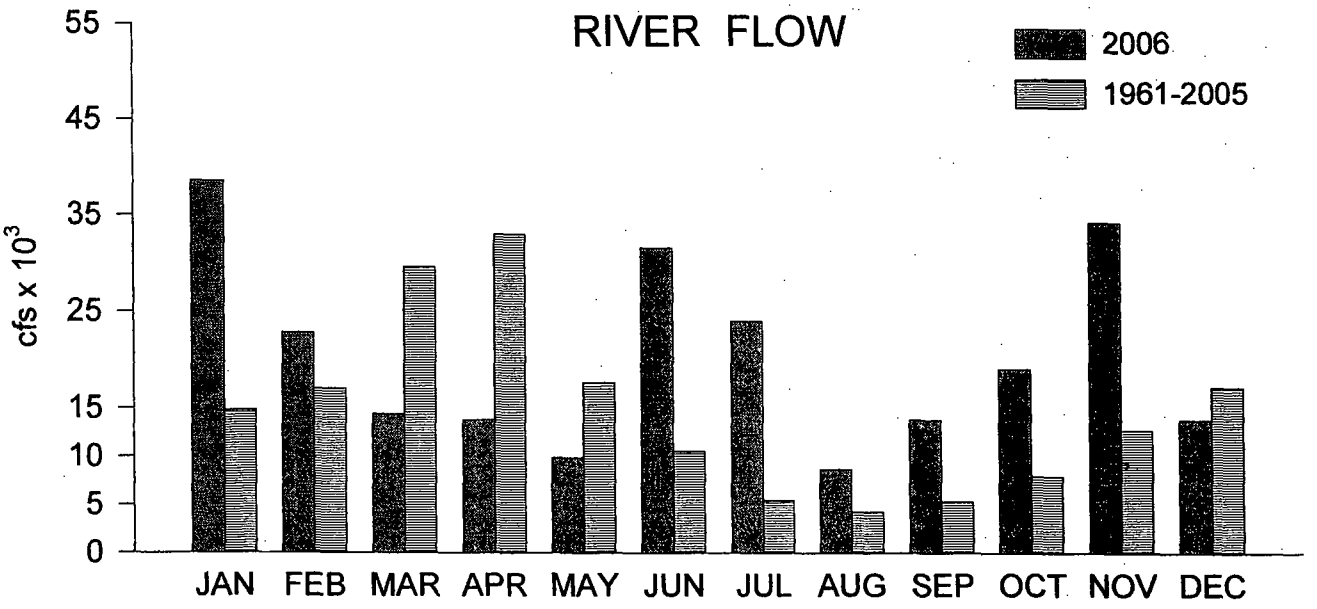

Fig. 2

The 2006 monthly mean flow of the Susquehanna River at the Susquehanna SES Environmental Laboratory compared to the forty-five year (1961-2005) mean. The means were calculated from U.S. Geological Survey and Environmental Laboratory data.

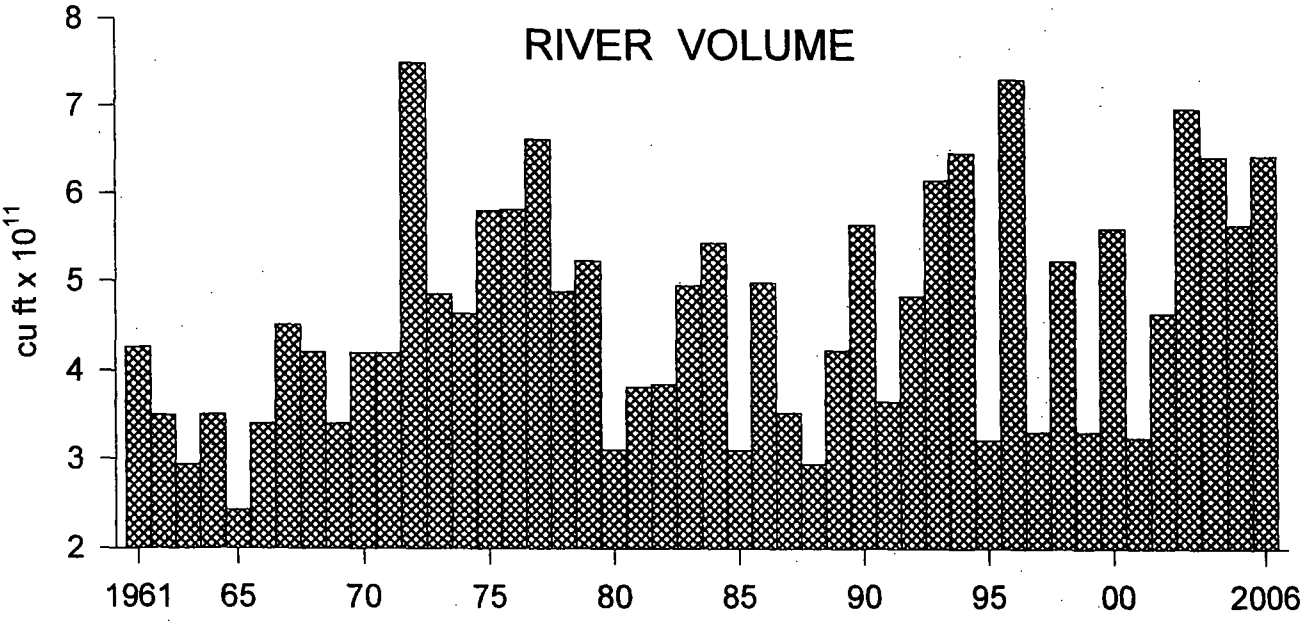

Fig. 3

Volume of Susquehanna River flow at the Susquehanna SES Environmental Laboratory, 1961-2006. The volumes were calculated from U.S. Geological Survey and Environmental Laboratory data.

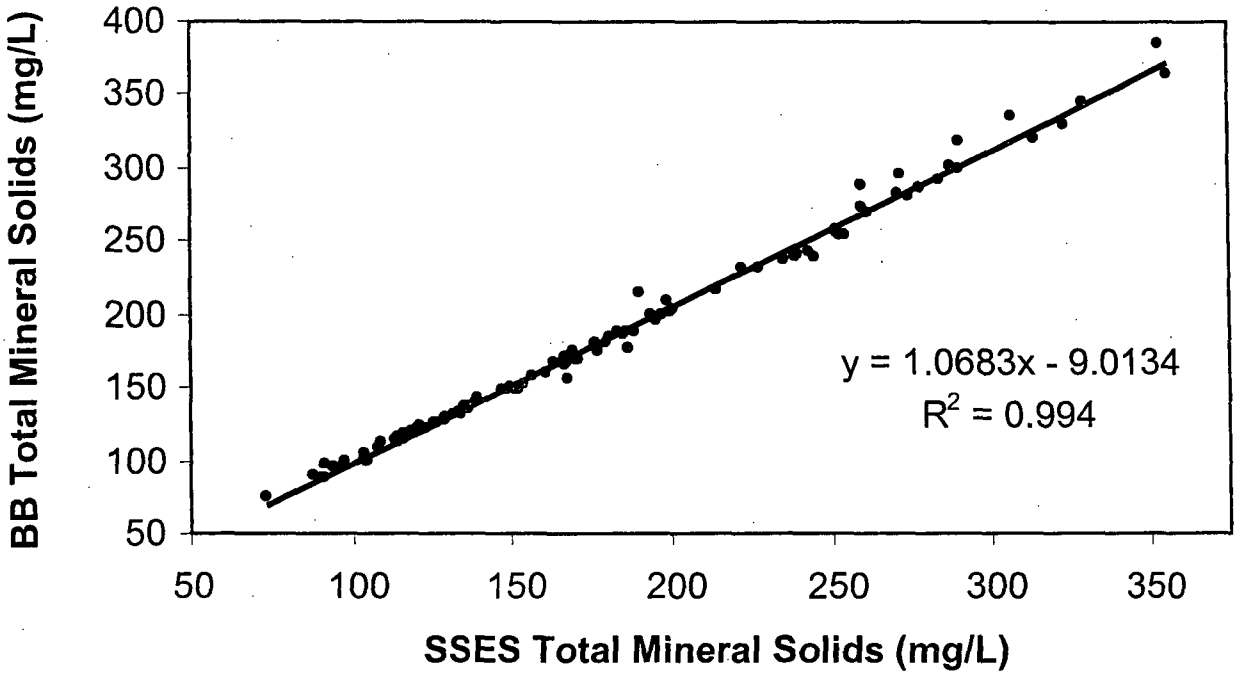

Fig. 4

Linear regression analysis of total mineral solids measurements at SSES vs. Bell Bend (BB) on the Susquehanna River, 1991-2006.

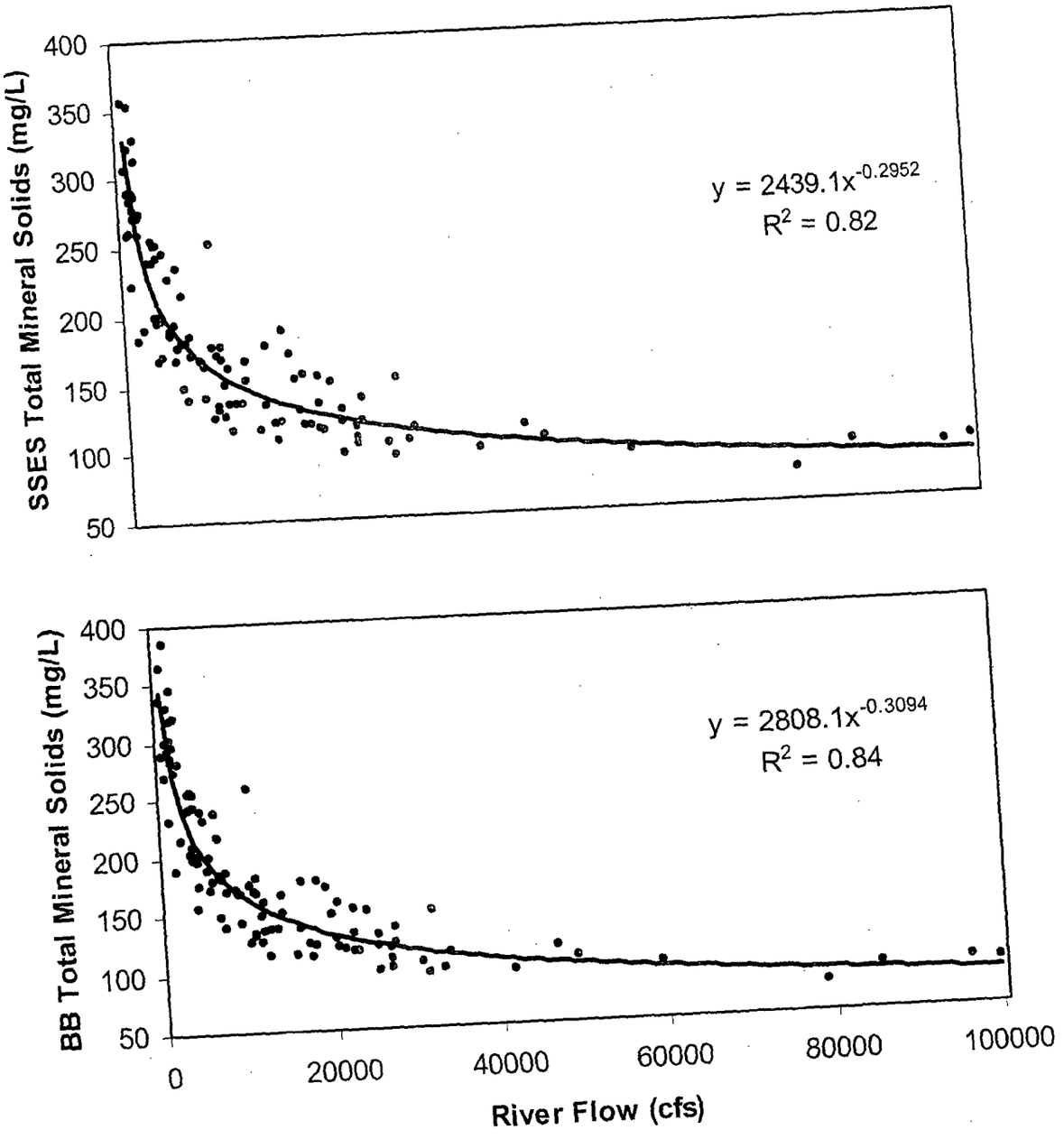

Fig. 5

Negative curvilinear relationships between river flow and measurements of total mineral solids at SSES and Bell Bend (BB) on the Susquehanna River, 1991-2006.