SUSQUEHANNA STEAM ELECTRIC STATION
316(b) ENTRAINMENT DEMONSTRATION PROGRAM

FOR

NATIONAL POLLUTION DISCHARGE ELIMINATION
SYSTEM PERMIT NO. PA. 0047325
SPECIAL CONDITION C, PART C

BY

PENNSYLVANIA POWER & LIGHT CO
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I. INTRODUCTION

Special Condition C of the NPDES Permit No. PA. 0047325, requires a 316(b) study program for impingement and entrainment at the Susquehanna SES. To meet this requirement, a predictive model for impingement and entrainment was submitted to the Pennsylvania Department of Environmental Resources (Pa. DER) by the Pennsylvania Power and Light Company (PP&L) on January 9, 1980 (Appendix A). Additional discussions were held between the Pa. DER and PP&L on March 4, 1980 to elaborate on this model. At this meeting, it was agreed that a 316(b) demonstration program should be only conducted for entrainment. A proposed sampling program for the demonstration was submitted to the Pa. DER on April 9, 1980 (Appendix B). Both the Pa. DER and U.S. Environmental Protection Agency approved the proposed program in a letter dated April 29, 1980 (Appendix C). The objective of this 316(b) demonstration was to evaluate the estimated annual number of larval fish that would be entrained by the Susquehanna SES as calculated by the predictive model.

The predictive model was based on specific design information for the Susquehanna SES intake structure and larval fish entrainment data from other power plants with similar intakes on the Delaware and Susquehanna Rivers. In addition, the model also incorporated ecological data from a survey conducted in the vicinity of the Susquehanna SES in 1974 (Ref. 1). Results of the model indicated that few larval fish would be entrained by the Susquehanna SES as compared to those in the river. It was, therefore, concluded that no adverse impact would occur to the river fishes. The following conservative assumptions were used to design the predictive model: (1) highest number of larval fish collected per unit volume based on data in the vicinity of the Susquehanna SES, (2) maximum intake flows, and (3) 100% mortality of entrained larval.

The demonstration program submitted to the Pa. DER (Appendix B) was revised after the program was in place. Comparisons between the proposed demonstration program and the actual 316(b) demonstration are listed as follows:

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II. PROCEDURES

All samples and associated field data for the 316(b) demonstration were collected by Ichthyological Associates, in the Susquehanna River at the Susquehanna SES intake structure. The intake is of a standard design (Ref. 2) with two 11 x 11-ft bays (Fig. 1). River water which is drawn into either the North or South bay, passes beneath a skimmer wall and then through 1-inch vertical bar screens followed by 3/8-inch mesh traveling screens before entering a wet pit area which houses four make-up section pumps A through D (Fig. 2). Only three of these pumps are necessary to produce a maximum intake flow of 8,880 m^3/s (39,100 gpm). During sample collection intake flows were limited to about one-third maximum because of other preoperational testing activities and pumps C and D located in the South bay were operated. Therefore, to simulate more representative intake velocities, all sampling was done directly in front of the skimmer wall of the South intake bay. Since it was not possible to isolate both bay channels before sampling, some flow could have entered via the North intake bay. To evaluate the amount of flow which bypassed the South intake, water velocities were measured with a Gurley Pygmy Current Meter (Model No. 625) in the first three sampling periods. Replicate measurements of water velocity were taken in the center of each bay at depths where samples were collected.

Larval fish samples were collected during four, 24-hour sampling periods on 20-21 May, 28-29 May, 11-12 June, and 16-17 July 1981. Sets of replicate samples were taken at 3-hour intervals throughout each sampling period. In each set, three replicate surface (within 1/2 meter below base of skimmer wall) and bottom (within 1/2 meter of river bottom beneath base of skimmer wall) samples were collected. In all, 48 replicates (24 surface, 24 bottom) were obtained during each of the four sampling period.

Each replicate was collected by pumping water through a 216-μ mesh net for 5 minutes with a high capacity (500 gal/min) trash pump mounted on a pontoon boat as described by Gale and Mohr (Ref. 3). The 4-inch intake pipe of this sampler was modified by dividing it into two, 4-inch sample collection pipes so that surface and bottom samples could be collected without major adjustments for depth while sampling was in progress. This was accomplished by attaching the pump's intake pipe to a polyvinyl chloride (PVC) "t-fitting" affixed to the bow of the boat. From this fitting, two 4-inch pipes were directed downward with 90° elbows and then equipped with gate valves. Prior to each sampling period, the length of each of these sample collection pipes was adjusted with various sizes of PVC pipe to within 1/2 meter of the sampling depth as determined by river level. The collection of either surface or bottom samples was controlled with the gate valves. For example, the change from surface to bottom collections, the gate valve on the bottom collection pipe was opened

Proposed Demonstration	Actual Demonstration
1. Samples collection three times per 24 hour period	1. Samples collection eight times per 24 hour period
2. Two replicate 5 minute samples	2. Three replicate 5 minute samples
3. Six sampling periods -- two in May, June and July	3. Four sampling periods -- twice in May, once each in June and July.
4. Samples collected near skimmer wall and near bottom of intake opening	4. Samples collected near skimmer wall and near bottom of intake opening
5. Identify larvae	5. Identify larvae

The actual demonstration criteria were the same or exceeded the proposal with the exception of four sampling periods versus six. Activities associated with station pre-operational testing limited the number of sampling periods, but the total number of samples collected was greater than originally proposed.

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III. RESULTS AND DISCUSSION

Temperature and flow of the river, and pumping rate and velocity in the intake were measured while collecting entrainment samples (Table 1). Seasonal warming of the river occurred throughout the four sampling periods and mean river flow decreased continuously until on the last sampling period in July, it was only 15% of the flow measured in the first period in May. The maximum pumping rate of intake pumps C and D was 0.82 m^3/s (13,000 gal/min). These pumps created velocities up to 0.15 m/s (0.5 ft/s) in the South bay and no measurable velocity in the North bay. It was concluded from these data that essentially all of the river water was drawn through the South bay when entrainment samples were collected.

At least 18 species of larval fish were collected in the entrainment samples (Table 2). Six species composed 82% of the total number captured. Quillback was the most numerous (37%) followed in abundance by carp (22%), tessellated darter (11%), spottail shiner (8%), and spotfin shiner (4%). Game fish larvae such as bullhead catfishes, sunfishes, and walleye composed less than 3% of the total.

A total of 3,374 larval fish (86% prolarvae) was collected in the four sampling periods (Tables 3 through 7). In each sampling period, over 70% of the larvae were captured at night in collections from 0900 through 0300 hours. Numbers were always greatest at midnight or 0300 hours. Gale and Mohr (1976) documented similar diel variations in the abundance of drifting larval fish nearby in the river channe (Ref. 1). After 5 June, the densities of larval fish in the river decreased substantially (Ref. 40) suggesting that the sampling period 20 May through 17 July was adequate even though the demonstration program initially was to include sampling in August.

Large fluctuations in the density of larval fish occurred among the four sampling periods (Table 8). In the first period, 24% of the total catch was collected followed by 48% in the second, 26% in the third, and 2% in the last period. As expected, the majority of the larvae, about 60%, were captured in surface samples (Table 9 and 10). The maximum mean density at the intake (35.1 fish/10 m^3) was found in the second sampling period on 28-29 May which was similar to the peak density (34.4 fish/10 m^3) found at a routine monitoring station located 190 m upriver near the channel on 27 May (Ref. 40). In general, fluctuations in mean density were similar to those in the river (Fig. 3). The density, however, was always greater in the intake ($\bar{x}$ = 34%). This was due in great part to the fact that common carp, one of the most numerous fishes in the intake samples, was seldom taken in the river samples. In addition, Gale and Mohr (1976) found that drifting larvae tended to move shoreward at night.

while simultaneously closing the valve on the surface collection pipe.

The volume sampled in each replicate was determined by multiplying pumping duration (5 min) by pumping rate. The pumping rate was measured once in May and once in July by timing the filling of a 1,280-liter trough.

During these tests, the pumping rate was checked with a hand-held tachometer (Stewart-Warner Model 757-W). These tachometer readings were compared to those taken at 3-hour intervals during each sampling period to assure that the pump was functioning at near-maximum capacity.

Each sample was preserved in the field with 10% formalin containing rose bengal stain, and transported to the laboratory where larvae were sorted. Identifications and life stages (prolarva or postlarva) of all larvae were determined using a dissecting microscope (10-70X). Prolarvae were defined according to Hubbs, as fish with yolk and postlarvae were those without yok (Ref. 4). After scalation began, fish were considered juveniles and not reported. Catfishes were considered juveniles when morphometrics, meristics, and pigmentation patterns resembled those of adults.

Larvae were identified to the lowest taxon possible by comparing them to our reference series of 31 species of laboratory-reared specimens and with developmental information given in Buynak and Mohr (Refs. 5 through 17). We also used keys and descriptions for larval fish identification in Ref. 18 through 39). Severely damaged fish which could not be identified were tabulated as fragments. All specimens were stored in 10% formalin.

Larval fish data were calculated in terms of mean density and mean number.

The mean density of each species of larval fish was expressed as the number collected per $10_3 m^3$ in the raw data tables. The mean number of fish entrained per m^3 during the entire demonstration period was the mean density of the four sampling periods May through July. The mean number of fish entrained per day during the demonstration period was calculated by multiplying the mean number of entrained fish per m^3 by the total volume of water withdrawn from the river for 24 hours at maximum intake flow (0.82 m^3/s). The projected mean number of fish entrained per day was calculated in the same manner after adjusting for maximum intake flow (2.46 m^3/s). Daily estimates of entrained larval fish using the demonstration data were then compared and evaluated relative to daily estimates generated by the predictive model.

The estimate of the mean number of fish entrained per m^3 derived from data collected in demonstration program agreed closely with the predictive model estimate (Table 11). The projected demonstration that 389,000 larvae could be entrained per day from May through July compared to the predictive model estimate of 350,000 larvae per day from May through August. The projected demonstration estimate was slightly higher (11%) partially because August data were not included as they were in the predictive model estimate. Moreover, it should be emphasized that even under conditions of maximum design intake flow (Table 13), less than 1.5% of the overall river flow would have been withdrawn for cooling purposes for the Susquehanna SES during the demonstration program sampling period. It is fortunate for the fishery that natural river flow is usually high during the period of greatest larval fish abundance.

IV. CONCLUSION

To meet Special Condition C of the NPDES Permit No. PA. 0047325, the Pennsylvania Power and Light Co. developed a predictive model (Appendix A) and conducted this demonstration program to determine the magnitude of larval fish entrainment at the Susquehanna SES. Results of the demonstration program favorably support the estimated values of the predictive model. Therefore, if the magnitude of larvae fish entrainment, as derived from the model (based on entrainment studies at other power generating stations with similar intakes and flows) was acceptable to regulatory agencies, it seems reasonable to conclude that the projected entrainment of larval fishes would also be acceptable at this station. There should be no adverse impact from entrainment to the fish population in the Susquehanna SES from operation of this station.

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Table 1

Mean river temperature and flow, intake pumping rate, and current velocity for entrainment sampling periods in 1981.

Sampling Period	20-21 May	28-29 May	11-12 Jun	16-17 Jul
Mean river temperature (C)[a]	15.4	21.8	22.6	25.6
Mean river flow (m^3/s)[b]	440	169	136	66
Pumping rate of intake pumps C & D (m^3/s)	0.82 (13,000 g/m)	0.82	0.73 (11,500 g/m)	0.73
Intake Velocity				
Time[c]	1540 h	1545 h	1500 h	--
South Bay (m/s)				
Surface[d]	0.12 (0.4 ft/s)	0.12	0.15 (0.5 ft/s)	--
Bottom[e]	0.12	0.12	0.15	--
North Bay				
Surface	0	0	0	--
Bottom	0	0	0	--

[a]Measured by continuous recording thermometer 465 m upriver at Susquehanna SES Biological Laboratory.

[b]Calculated from continuously recorded river level data at the Biological Laboratory.

[c]Time velocity measurements were initiated on first sampling date.

[d]Within ½ m below base of skimmer wall.

[e]Within ½ m of river bottom beneath base of skimmer wall.

Table 2

Larval fishes collected in entrainment samples at the Susquehanna Steam Electric Station in 1981. Names and order of listing conform to Robins et al. (1980).

Cyprinidae - Carps and Minnows
- *Cyprinus carpio* - common carp
- *Notropis hudsonius* - spottail shiner
- *N. spilopterus* - spotfin shiner
- *Semotilus corporalis* - fallfish
- Unidentified Cyprinidae - minnow spp.

Catostomidae - Suckers
- *Carpiodes cyprinus* - quillback
- *Catostomus commersoni* - white sucker
- *Moxostoma macrolepidotum* - shorthead redhorse

Ictaluridae - Bullhead Catfishes
- *Ictalurus catus* - white catfish
- *I. punctatus* - channel catfish

Centrarchidae - Sunfishes
- *Ambloplites rupestris* - rock bass
- *Lepomis gibbosus* - pumpkinseed
- *L. macrochirus* - bluegill
- *Micropterus dolomieui* - smallmouth bass
- *Pomoxis* spp. - crappie spp.

Percidae - Perches
- *Etheostoma olmstedi* - tessellated darter
- *E. zonale* - banded darter
- *Percina peltata* - shield darter
- *Stizostedion vitreum* - walleye

Table 3

Number of larval fish captured with a pump sampler in the mouth of the South Bay channel of the river water intake of the Susquehanna Steam Electric Station, 20-21 May 1981.

SAMPLING TIME	0901-0935						1156-1230					
M^3/REPLICATE	9.8			9.4			9.8			9.4		
LOCATION	SURFACE [a]			BOTTOM [b]			SURFACE			BOTTOM		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
COLLECTION NO. TVJ-81-	055	056	057	058	059	060	064	065	066	061	062	063
SPECIES												
SPOTTAIL SHINER												
PROLARVA	0	0	0	0	1	0	0	0	0	0	1	0
QUILLBACK												
PROLARVA	4	11	5	2	0	1	4	3	4	0	2	0
WHITE SUCKER												
POSTLARVA	0	0	0	0	1	0	2	0	0	1	1	0
TESSELLATED DARTER												
PROLARVA	1	0	0	1	0	1	1	1	0	1	0	0
BANDED DARTER												
PROLARVA	0	0	2	0	1	0	0	1	1	3	0	0
POSTLARVA	0	0	2	0	0	0	0	0	0	2	0	1
SHIELD DARTER												
PROLARVA	0	1	2	1	0	0	0	0	1	1	0	0
POSTLARVA	0	0	0	0	0	0	0	0	1	0	0	0
WALLEYE												
PROLARVA	0	0	0	0	1	0	0	0	0	0	0	0
POSTLARVA	0	1	0	0	0	0	0	0	0	0	1	0
TOTAL	5	13	11	4	4	2	7	5	7	8	5	1

SAMPLING TIME	1500-1533						1802-1837					
M^3/REPLICATE	9.8			9.4			9.8			9.4		
LOCATION	SURFACE			BOTTOM			SURFACE			BOTTOM		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
COLLECTION NO. TVJ-81-	067	068	069	070	071	072	076	077	078	073	074	075
SPECIES												
SPOTTAIL SHINER												
PROLARVA	0	2	1	0	0	0	0	0	0	0	0	0
QUILLBACK												
PROLARVA	2	2	3	2	1	1	1	2	4	1	0	1
WHITE SUCKER												
PROLARVA	0	0	0	0	2	0	0	0	0	0	0	0
POSTLARVA	0	0	0	0	13	0	0	1	2	0	0	0
TESSELLATED DARTER												
PROLARVA	0	0	0	1	0	0	1	0	0	2	0	2
BANDED DARTER												
PROLARVA	0	0	1	0	0	0	0	0	0	0	0	1
POSTLARVA	0	0	1	0	0	0	0	0	2	0	0	0
SHIELD DARTER												
PROLARVA	0	0	0	0	0	0	2	0	0	0	0	0
WALLEYE												
POSTLARVA	0	1	1	0	0	0	0	0	0	0	0	1
FISH (FRAGMENTS)	0	0	0	0	0	1	0	0	0	0	0	0
TOTAL	2	5	7	3	16	2	4	3	8	3	0	5

Table 3 (cont.)

SAMPLING TIME	2109-2207						2356-0035					
M^3/REPLICATE	9.8			9.4			9.8			9.4		
LOCATION	SURFACE			BOTTOM			SURFACE			BOTTOM		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
COLLECTION NO TVJ-81-	079	080	081	082	083	084	088	089	090	085	086	087
SPECIES												
SPOTTAIL SHINER												
PROLARVA	0	1	2	1	0	1	0	0	1	0	1	0
POSTLARVA	1	0	0	0	0	0	0	0	0	0	0	0
FALLFISH												
POSTLARVA	0	0	0	0	0	1	0	0	0	0	0	0
QUILLBACK												
PROLARVA	14	33	22	17	7	13	23	48	34	2	10	7
WHITE SUCKER												
PROLARVA	2	0	1	0	0	1	2	0	0	0	0	0
POSTLARVA	10	8	3	4	1	2	1	2	0	1	1	3
TESSELLATED DARTER												
PROLARVA	10	15	17	9	10	15	5	9	9	5	7	7
POSTLARVA	0	0	2	1	0	0	0	0	0	0	1	0
BANDED DARTER												
PROLARVA	1	0	0	0	0	0	0	0	1	0	0	0
POSTLARVA	0	0	1	0	0	0	0	0	0	0	0	0
FISH (FRAGMENTS)	0	1	0	0	0	0	0	0	0	0	0	0
TOTAL	38	58	48	32	18	33	31	59	45	8	20	17

SAMPLING TIME	0303-0337						0557-0631					
M^3/REPLICATE	9.8			9.4			9.8			9.4		
LOCATION	SURFACE			BOTTOM			SURFACE			BOTTOM		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
COLLECTION NO. TVJ-81-	091	092	093	094	095	096	100	101	102	097	098	099
SPECIES												
SPOTTAIL SHINER												
PROLARVA	0	1	1	0	0	1	1	0	0	0	1	1
FALLFISH												
POSTLARVA	1	0	0	0	0	0	0	0	0	0	0	0
QUILLBACK												
PROLARVA	60	38	29	11	14	8	3	2	4	1	1	0
WHITE SUCKER												
PROLARVA	9	2	2	0	0	0	0	0	0	0	0	1
POSTLARVA	6	8	3	1	2	1	0	0	0	1	0	0
TESSELLATED DARTER												
PROLARVA	6	8	5	2	5	0	0	1	1	3	3	2
BANDED DARTER												
PROLARVA	2	1	0	1	0	0	0	0	0	0	0	1
POSTLARVA	0	1	1	0	0	0	1	0	1	0	1	1
SHIELD DARTER												
PROLARVA	0	1	0	0	0	0	0	0	0	0	0	1
POSTLARVA	0	0	0	0	0	0	0	0	0	2	0	0
TOTAL	84	60	41	15	21	10	5	3	6	7	6	7

[a]Within ½ m below base of skimmer wall.

[b]Within ½ m of river bottom beneath base of skimmer wall.

Table 4

Number of larval fish captured with a pump sampler in the mouth of the South Bay channel of the river water intake of the Susquehanna Steam Electric Station, 28-29 May 1981.

SAMPLING TIME	1203-1237						1504-1537					
M^3/REPLICATE	9.8			9.4			9.8			9.4		
LOCATION	SURFACE[a]			BOTTOM[b]			SURFACE			BOTTOM		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
COLLECTION NO. TVJ-81-	106	107	108	103	104	105	109	110	111	112	113	114
SPECIES												
CARP												
PROLARVA	5	7	2	0	6	6	4	2	0	0	4	0
SPOTTAIL SHINER												
PROLARVA	0	1	0	0	0	2	1	0	0	0	0	1
QUILLBACK												
PROLARVA	4	1	1	1	2	6	4	2	3	1	2	1
TESSELLATED DARTER												
PROLARVA	0	0	0	1	0	0	0	0	0	1	0	0
POSTLARVA	0	0	0	0	1	0	0	0	0	0	0	0
BANDED DARTER												
PROLARVA	0	0	0	0	0	0	0	0	0	0	0	2
POSTLARVA	1	0	0	0	0	0	0	0	0	0	0	0
WALLEYE												
POSTLARVA	0	0	0	0	0	0	1	0	0	0	0	0
TOTAL	10	9	3	2	9	14	10	4	3	2	6	4

SAMPLING TIME	1805-1839						2101-2134					
M^3/REPLICATE	9.8			9.4			9.8			9.4		
LOCATION	SURFACE			BOTTOM			SURFACE			BOTTOM		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
COLLECTION NO. TVJ-81-	118	119	120	115	116	117	121	122	123	124	125	126
SPECIES												
CARP												
PROLARVA	4	4	1	3	2	0	4	7	15	5	9	6
SPOTTAIL SHINER												
PROLARVA	0	0	1	0	0	1	6	3	15	1	5	9
POSTLARVA	0	0	0	0	0	0	2	0	0	0	0	0
SPOTFIN SHINER												
PROLARVA	0	0	0	0	0	0	0	1	0	0	0	0
MINNOW SPP.												
PROLARVA	0	0	0	0	0	0	0	0	0	1	1	0
QUILLBACK												
PROLARVA	3	1	5	5	3	3	15	14	21	12	9	9
POSTLARVA	0	0	0	0	0	0	1	0	3	0	0	0
WHITE SUCKER												
POSTLARVA	0	0	0	0	0	0	0	0	1	0	0	0
SHORTHEAD REDHORSE												
PROLARVA	0	0	0	0	0	1	3	0	2	0	1	0
POSTLARVA	0	0	0	0	0	0	0	1	0	1	0	0
TESSELLATED DARTER												
PROLARVA	0	0	0	0	1	2	4	13	16	10	10	8
POSTLARVA	0	1	0	0	0	0	0	1	1	0	2	0
BANDED DARTER												
PROLARVA	0	0	0	1	0	0	3	0	1	1	0	3
POSTLARVA	0	0	0	1	0	1	2	0	0	0	0	0
SHIELD DARTER												
POSTLARVA	0	0	0	0	0	1	0	0	0	0	0	0
FISH (FRAGMENTS)	0	0	0	0	0	0	0	0	1	0	0	0
TOTAL	7	6	7	10	6	9	40	40	76	31	37	35

Table 4 (cont.)

SAMPLING TIME	0034-0108						0303-0338					
M^3/REPLICATE	9.8			9.4			9.8			9.4		
LOCATION	SURFACE			BOTTOM			SURFACE			BOTTOM		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
COLLECTION NO. TVJ-81-	130	131	132	127	128	129	133	134	135	136	137	138
SPECIES												
CARP												
PROLARVA	22	34	28	14	14	19	33	44	30	22	15	28
SPOTTAIL SHINER												
PROLARVA	17	15	26	21	13	14	7	15	16	16	10	4
POSTLARVA	0	1	1	2	0	1	0	0	0	1	0	1
SPOTFIN SHINER												
PROLARVA	0	0	0	0	0	1	0	0	0	0	0	0
QUILLBACK												
PROLARVA	37	48	51	29	19	25	18	28	29	16	12	13
WHITE SUCKER												
PROLARVA	0	1	0	0	0	0	0	1	0	0	1	0
POSTLARVA	3	0	0	0	0	1	1	0	0	0	0	1
SHORTHEAD REDHORSE												
PROLARVA	0	2	2	1	1	0	1	2	0	1	0	0
CRAPPIE SPP.												
PROLARVA	0	0	0	0	0	0	0	2	0	0	0	0
POSTLARVA	0	0	0	1	0	0	0	0	0	0	0	0
TESSELLATED DARTER												
PROLARVA	6	6	11	7	7	10	2	1	0	4	0	2
POSTLARVA	0	0	0	1	0	1	0	0	0	0	0	0
BANDED DARTER												
PROLARVA	2	1	0	1	0	2	0	0	0	0	0	0
POSTLARVA	0	0	0	0	0	0	0	0	0	0	0	1
SHIELD DARTER												
PROLARVA	0	0	0	0	0	0	0	1	0	0	0	0
FISH (FRAGMENTS)	0	0	3	1	0	0	0	1	0	1	0	1
TOTAL	87	108	122	78	54	74	62	95	75	61	38	51

SAMPLING TIME	0600-0635						0900-0940					
M^3/REPLICATE	9.8			9.4			9.8			9.4		
LOCATION	SURFACE			BOTTOM			SURFACE			BOTTOM		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
COLLECTION NO. TVJ-81-	142	143	144	139	140	141	145	146	147	148	149	150
SPECIES												
CARP												
PROLARVA	16	26	20	30	14	10	26	26	36	21	12	16
SPOTTAIL SHINER												
PROLARVA	0	0	2	1	5	2	1	3	0	1	0	1
POSTLARVA	0	0	0	1	0	0	0	0	0	0	0	0
QUILLBACK												
PROLARVA	2	3	1	4	6	4	1	0	1	1	1	1
WHITE SUCKER												
POSTLARVA	0	0	0	1	0	0	0	0	0	0	0	0
SHORTHEAD REDHORSE												
PROLARVA	1	2	2	0	0	0	0	0	0	0	0	0
TESSELLATED DARTER												
PROLARVA	1	0	0	6	1	1	0	0	0	0	0	0
POSTLARVA	0	0	0	0	1	1	0	0	0	0	0	0
BANDED DARTER												
PROLARVA	0	1	1	3	5	3	1	0	0	0	0	0
POSTLARVA	0	0	1	2	3	3	0	0	0	0	0	0
SHIELD DARTER												
POSTLARVA	0	1	0	0	0	0	0	0	0	0	0	0
FISH (FRAGMENTS)	0	0	0	0	1	0	0	0	0	0	1	1
TOTAL	20	33	27	48	36	24	29	29	37	23	14	19

[a]Within ½ m below base of skimmer wall.

[b]Within ½ m of river bottom beneath base of skimmer wall.

Table 5

Number of larval fish captured with a pump sampler in the mouth of the South Bay channel of the river water intake of the Susquehanna Steam Electric Station, 11-12 June 1981.

SAMPLING TIME	1459-1538						1806-1840					
M^3/REPLICATE	9.8			9.4			9.8			9.4		
LOCATION	SURFACE[a]			BOTTOM[b]			SURFACE			BOTTOM		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
COLLECTION NO. TVJ-81-	151	152	153	154	155	156	160	161	162	157	158	159
SPECIES												
CARP												
PROLARVA	0	0	1	0	0	0	0	0	0	0	1	0
SPOTTAIL SHINER												
PROLARVA	1	0	1	0	0	0	0	0	0	0	0	1
SPOTFIN SHINER												
PROLARVA	2	0	0	2	0	3	0	0	1	0	0	2
QUILLBACK												
PROLARVA	2	3	0	2	3	5	1	0	0	0	0	2
POSTLARVA	0	0	0	0	0	0	1	0	0	0	0	0
ROCK BASS												
POSTLARVA	0	0	1	0	0	0	0	0	0	0	0	0
BLUEGILL												
POSTLARVA	0	0	0	0	0	0	0	0	0	0	1	0
CRAPPIE SPP.												
POSTLARVA	1	1	1	0	0	1	0	0	0	0	1	1
TESSELLATED DARTER												
PROLARVA	0	0	0	0	0	1	0	0	0	0	0	0
BANDED DARTER												
PROLARVA	0	0	0	1	0	1	0	0	0	1	0	0
POSTLARVA	0	0	0	0	0	1	0	1	0	0	1	1
TOTAL	6	4	4	5	3	12	2	1	1	1	4	7

SAMPLING TIME	2100-2133						0008-0043					
M^3/REPLICATE	9.8			9.4			9.8			9.4		
LOCATION	SURFACE			BOTTOM			SURFACE			BOTTOM		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
COLLECTION NO. TVJ-81-	163	164	165	166	167	168	172	173	174	169	170	171
SPECIES												
CARP												
PROLARVA	0	0	1	0	0	0	8	5	8	2	4	1
SPOTTAIL SHINER												
PROLARVA	0	0	1	0	0	0	0	2	2	0	1	0
POSTLARVA	1	0	0	0	0	1	0	0	1	1	0	0
SPOTFIN SHINER												
PROLARVA	0	0	3	2	1	0	3	7	5	3	2	1
POSTLARVA	0	1	0	0	0	1	3	5	7	1	1	0
MINNOW SPP.												
POSTLARVA	0	0	0	1	0	0	0	0	0	0	0	0
QUILLBACK												
PROLARVA	1	1	0	1	3	2	55	25	50	20	47	33
POSTLARVA	4	2	1	1	0	6	3	2	8	1	1	1
SHORTHEAD REDHORSE												
POSTLARVA	0	0	2	0	0	1	1	7	0	2	1	0
ROCK BASS												
PROLARVA	0	1	0	0	0	0	0	0	0	0	0	0
POSTLARVA	1	1	1	1	1	3	4	6	4	4	1	0
SMALLMOUTH BASS												
POSTLARVA	0	0	0	0	0	0	1	0	0	0	0	0
CRAPPIE SPP.												
PROLARVA	0	0	0	0	1	2	0	0	0	0	0	1
POSTLARVA	1	0	1	2	0	0	0	0	0	0	0	0
TESSELLATED DARTER												
PROLARVA	4	1	1	7	8	7	7	10	3	6	9	8
POSTLARVA	3	6	8	3	3	7	5	0	3	4	5	5
BANDED DARTER												
PROLARVA	0	0	0	1	0	1	1	0	2	1	0	0
POSTLARVA	1	3	1	1	0	0	1	0	1	0	0	0
SHIELD DARTER												
POSTLARVA	0	0	0	1	0	0	0	0	0	0	0	0
FISH (FRAGMENTS)	0	0	0	0	0	0	2	1	0	0	0	1
TOTAL	16	16	20	21	17	31	94	70	94	45	72	51

Table 5 (cont.)

SAMPLING TIME	0301-0336						0557-0631					
M^3/REPLICATE	9.8			9.4			9.8			9.4		
LOCATION	SURFACE			BOTTOM			SURFACE			BOTTOM		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
COLLECTION NO. TVJ-81-	175	176	177	178	179	180	184	185	186	181	182	183
SPECIES												
CARP												
PROLARVA	6	6	3	3	2	3	2	2	5	7	3	4
SPOTTAIL SHINER												
PROLARVA	1	0	1	0	0	1	0	0	0	0	0	0
POSTLARVA	1	1	0	0	0	0	0	2	1	1	0	0
SPOTFIN SHINER												
PROLARVA	10	8	11	4	0	6	2	1	0	2	0	0
POSTLARVA	0	0	0	0	1	0	0	0	0	0	1	0
QUILLBACK												
PROLARVA	18	7	9	10	2	7	0	1	1	0	0	2
POSTLARVA	5	6	3	4	1	2	0	1	0	0	0	0
WHITE SUCKER												
POSTLARVA	0	0	0	0	2	0	0	0	0	0	0	0
SHORTHEAD REDHORSE												
POSTLARVA	2	0	1	1	0	2	1	0	1	0	1	0
ROCK BASS												
POSTLARVA	7	4	5	0	0	0	2	2	3	0	0	0
BLUEGILL												
POSTLARVA	0	0	0	0	0	0	1	0	0	0	0	0
CRAPPIE SPP.												
POSTLARVA	0	0	0	1	0	0	0	1	0	0	0	0
TESSELLATED DARTER												
PROLARVA	3	3	4	2	1	1	0	0	0	1	1	0
POSTLARVA	2	2	2	1	1	1	0	0	0	1	2	0
BANDED DARTER												
PROLARVA	0	1	0	1	0	0	0	0	0	2	0	1
POSTLARVA	0	0	0	0	0	0	0	0	0	2	0	0
SHIELD DARTER												
POSTLARVA	0	0	0	0	0	0	0	0	0	0	1	0
FISH (FRAGMENTS)	0	1	0	1	1	1	0	0	0	0	0	0
TOTAL	55	39	39	28	11	24	8	10	11	16	9	7

SAMPLING TIME	0855-0932						1205-1238					
M^3/REPLICATE	9.8			9.4			9.8			9.4		
LOCATION	SURFACE			BOTTOM			SURFACE			BOTTOM		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
COLLECTION NO. TVJ-81-	187	188	189	190	191	192	196	197	198	193	194	195
SPECIES												
CARP												
PROLARVA	2	2	1	0	1	0	1	0	0	0	0	0
SPOTFIN SHINER												
POSTLARVA	0	0	0	0	0	0	0	0	1	0	0	0
QUILLBACK												
PROLARVA	1	0	1	1	1	1	0	0	0	0	0	0
POSTLARVA	0	1	0	1	0	0	0	0	0	0	0	1
CRAPPIE SPP.												
POSTLARVA	0	0	0	0	0	1	0	0	0	0	0	0
TESSELLATED DARTER												
PROLARVA	0	0	0	0	0	0	0	0	0	1	0	0
BANDED DARTER												
POSTLARVA	0	0	0	0	0	1	0	0	0	0	0	0
TOTAL	3	3	2	2	2	3	1	0	1	1	0	1

[a]Within ½ m below base of skimmer wall.

[b]Within ½ m of river bottom beneath base of skimmer wall.

Table 6

Number of larval fish captured with a pump sampler in the mouth of the South Bay channel of the river water intake of the Susquehanna Steam Electric Station, 16-17 July 1981.

SAMPLING TIME	1200-1232						1500-1534					
M^3/REPLICATE	10.1			10.1			10.1			10.1		
LOCATION	SURFACE [a]			BOTTOM [b]			SURFACE			BOTTOM		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
COLLECTION NO. TVJ-81-	202	203	204	199	200	201	205	206	207	208	209	210
SPECIES												
PUMPKINSEED POSTLARVA	0	0	0	0	0	0	0	1	0	0	0	0
TOTAL	0	0	0	0	0	0	0	1	0	0	0	0

SAMPLING TIME	1800-1833						2100-2132					
M^3/REPLICATE	10.1			10.1			10.1			10.1		
LOCATION	SURFACE			BOTTOM			SURFACE			BOTTOM		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
COLLECTION NO. TVJ-81-	214	215	216	211	212	213	217	218	219	220	221	222
SPECIES												
SPOTFIN SHINER PROLARVA	0	1	1	0	0	0	1	0	0	1	0	1
SPOTFIN SHINER POSTLARVA	0	0	0	0	0	0	3	2	2	1	0	0
WHITE CATFISH POSTLARVA	0	0	0	0	0	0	1	0	1	0	0	1
CHANNEL CATFISH POSTLARVA	0	0	0	0	0	0	1	0	0	0	0	0
BLUEGILL POSTLARVA	0	0	0	0	0	0	0	1	0	0	0	0
BANDED DARTER POSTLARVA	0	0	0	0	0	0	0	0	0	0	0	1
FISH (FRAGMENTS)	0	0	0	0	0	1	0	0	1	0	0	0
TOTAL	0	1	1	0	0	1	6	3	4	2	0	3

Table 6 (cont.)

SAMPLING TIME	0000-0032						0300-0332					
M^3/REPLICATE	10.1			10.1			10.1			10.1		
LOCATION	SURFACE			BOTTOM			SURFACE			BOTTOM		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
COLLECTION NO. TVJ-81-	226	227	228	223	224	225	229	230	231	232	233	234
SPECIES												
CARP												
PROLARVA	0	0	1	0	0	0	0	0	0	0	1	0
POSTLARVA	0	0	0	0	0	0	0	0	0	1	0	0
SPOTFIN SHINER												
PROLARVA	5	4	1	0	1	0	5	3	2	4	1	4
POSTLARVA	0	0	0	0	0	0	1	0	0	1	0	0
WHITE CATFISH												
POSTLARVA	1	1	0	0	0	0	0	0	0	0	0	0
CHANNEL CATFISH												
POSTLARVA	0	0	1	0	0	1	0	0	0	0	0	0
PUMPKINSEED												
PROLARVA	0	0	0	1	0	0	0	0	0	0	0	0
BLUEGILL												
POSTLARVA	0	0	0	0	0	0	0	0	0	0	1	0
BANDED DARTER												
PROLARVA	0	0	1	0	0	0	0	0	0	0	0	0
FISH (FRAGMENTS)	0	0	0	1	0	0	0	0	0	0	0	0
TOTAL	6	5	4	2	1	1	6	3	2	6	3	4

SAMPLING TIME	0600-0633						0900-0932					
M^3/REPLICATE	10.1			10.1			10.1			10.1		
LOCATION	SURFACE			BOTTOM			SURFACE			BOTTOM		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
COLLECTION NO. TVJ-81-	238	239	240	235	236	237	241	242	243	244	245	246
SPECIES												
SPOTFIN SHINER												
PROLARVA	0	1	0	1	1	1	1	0	0	0	0	0
PUMPKINSEED												
PROLARVA	0	0	0	0	0	0	0	0	0	0	0	2
BLUEGILL												
PROLARVA	0	0	1	1	0	0	0	0	0	0	0	0
BANDED DARTER												
PROLARVA	0	0	0	1	0	0	0	0	0	0	0	0
TOTAL	0	1	1	3	1	1	1	0	0	0	0	2

[a]Within ½ m below base of skimmer wall.

[b]Within ½ m of river bottom beneath base of skimmer wall.

Table 7

Total number of larval fish collected during four diel sampling periods at the river water intake of the Susquehanna Steam Electric Station in 1981.

SPECIES	20 MAY	28 MAY	11 JUN	16 JUL	TOTAL	% TOTAL
CARP						
PROLARVA	0	652	84	2	738	21.9
POSTLARVA	0	0	0	1	1	0.0
SPOTTAIL SHINER						
PROLARVA	18	236	12	0	266	7.9
POSTLARVA	1	10	10	0	21	0.6
SPOTFIN SHINER						
PROLARVA	0	2	81	40	123	3.6
POSTLARVA	0	0	22	10	32	0.9
FALLFISH						
POSTLARVA	2	0	0	0	2	0.1
MINNOW.SPP.						
PROLARVA	0	2	0	0	2	0.1
POSTLARVA	0	0	1	0	1	0.0
QUILLBACK						
PROLARVA	457	478	318	0	1253	37.1
POSTLARVA	0	4	56	0	60	1.8
WHITE SUCKER						
PROLARVA	22	3	0	0	25	0.7
POSTLARVA	79	8	2	0	89	2.6
SHORTHEAD REDHORSE						
PROLARVA	0	22	0	0	22	0.7
POSTLARVA	0	2	23	0	25	0.7
WHITE CATFISH						
POSTLARVA	0	0	0	5	5	0.1
CHANNEL CATFISH						
POSTLARVA	0	0	0	3	3	0.1
ROCK BASS						
PROLARVA	0	0	1	0	1	0.0
POSTLARVA	0	0	51	0	51	1.5
PUMPKINSEED						
PROLARVA	0	0	0	3	3	0.1
POSTLARVA	0	0	0	1	1	0.0
BLUEGILL						
PROLARVA	0	0	0	2	2	0.1
POSTLARVA	0	0	2	2	4	0.1
SMALLMOUTH BASS						
POSTLARVA	0	0	1	0	1	0.0
CRAPPIE SPP.						
PROLARVA	0	2	4	0	6	0.2
POSTLARVA	0	1	13	0	14	0.4
TESSELLATED DARTER						
PROLARVA	166	131	89	0	386	11.4
POSTLARVA	4	10	64	0	78	2.3
BANDED DARTER						
PROLARVA	17	31	14	2	64	1.9
POSTLARVA	15	15	15	1	46	1.4
SHIELD DARTER						
PROLARVA	10	1	0	0	11	0.3
POSTLARVA	3	2	2	0	7	0.2
WALLEYE						
PROLARVA	1	0	0	0	1	0.0
POSTLARVA	5	1	0	0	6	0.2
FISH (FRAGMENTS)	2	11	8	3	24	0.7
TOTAL	802	1624	873	75	3374	

Table 8

Total mean density of larval fish/10 m^3 collected during four diel sampling periods at the river water intake of the Susquehanna Steam Electric Station in 1981.

SPECIES	20 MAY	28 MAY	11 JUN	16 JUL	MEAN	% TOTAL
CARP						
PROLARVA	0.00	14.09	1.81	0.04	3.99	21.9
POSTLARVA	0.00	0.00	0.00	0.02	0.01	0.0
SPOTTAIL SHINER						
PROLARVA	0.39	5.11	0.26	0.00	1.44	7.9
POSTLARVA	0.02	0.22	0.22	0.00	0.11	0.6
SPOTFIN SHINER						
PROLARVA	0.00	0.04	1.75	0.83	0.65	3.6
POSTLARVA	0.00	0.00	0.47	0.21	0.17	0.9
FALLFISH						
POSTLARVA	0.04	0.00	0.00	0.00	0.01	0.1
MINOW SPP.						
PROLARVA	0.00	0.04	0.00	0.00	0.01	0.1
POSTLARVA	0.00	0.00	0.02	0.00	0.01	0.0
QUILLBACK						
PROLARVA	9.81	10.33	6.89	0.00	6.76	37.1
POSTLARVA	0.00	0.09	1.21	0.00	0.32	1.8
WHITE SUCKER						
PROLARVA	0.47	0.06	0.00	0.00	0.13	0.7
POSTLARVA	1.71	0.17	0.04	0.00	0.48	2.6
SHORTHEAD REDHORSE						
PROLARVA	0.00	0.47	0.00	0.00	0.12	0.6
POSTLARVA	0.00	0.04	0.50	0.00	0.13	0.7
WHITE CATFISH						
POSTLARVA	0.00	0.00	0.00	0.10	0.03	0.1
CHANNEL CATFISH						
POSTLARVA	0.00	0.00	0.00	0.06	0.02	0.1
ROCK BASS						
PROLARVA	0.00	0.00	0.02	0.00	0.01	0.0
POSTLARVA	0.00	0.00	1.09	0.00	0.27	1.5
PUMPKINSEED						
PROLARVA	0.00	0.00	0.00	0.06	0.02	0.1
POSTLARVA	0.00	0.00	0.00	0.02	0.01	0.0
BLUEGILL						
PROLARVA	0.00	0.00	0.00	0.04	0.01	0.1
POSTLARVA	0.00	0.00	0.04	0.04	0.02	0.1
SMALLMOUTH BASS						
POSTLARVA	0.00	0.00	0.02	0.00	0.01	0.0
CRAPPIE SPP.						
PROLARVA	0.00	0.04	0.09	0.00	0.03	0.2
POSTLARVA	0.00	0.02	0.28	0.00	0.08	0.4
TESSELLATED DARTER						
PROLARVA	3.60	2.85	1.94	0.00	2.10	11.5
POSTLARVA	0.09	0.22	1.39	0.00	0.42	2.3
BANDED DARTER						
PROLARVA	0.37	0.68	0.31	0.04	0.35	1.9
POSTLARVA	0.32	0.33	0.33	0.02	0.25	1.4
SHIELD DARTER						
PROLARVA	0.22	0.02	0.00	0.00	0.06	0.3
POSTLARVA	0.07	0.04	0.04	0.00	0.04	0.2
WALLEYE						
PROLARVA	0.02	0.00	0.00	0.00	0.01	0.0
POSTLARVA	0.11	0.02	0.00	0.00	0.03	0.2
FISH (FRAGMENTS)	0.04	0.24	0.17	0.06	0.13	0.7
TOTAL	17.27	35.14	18.89	1.55	18.21	

Table 9

Mean density of larval fish/10 m^3 collected in bottom samples during four diel sampling periods at the river water intake of the Susquehanna Steam Electric Station in 1981.

SPECIES	20 MAY	28 MAY	11 JUN	16 JUL	MEAN	% TOTAL
CARP						
PROLARVA	0.00	11.35	1.37	0.04	3.19	21.6
POSTLARVA	0.00	0.00	0.00	0.04	0.01	0.1
SPOTTAIL SHINER						
PROLARVA	0.35	4.74	0.13	0.00	1.31	8.9
POSTLARVA	0.00	0.27	0.13	0.00	0.10	0.7
SPOTFIN SHINER						
PROLARVA	0.00	0.04	1.24	0.62	0.48	3.2
POSTLARVA	0.00	0.00	0.22	0.08	0.08	0.5
FALLFISH						
POSTLARVA	0.04	0.00	0.00	0.00	0.01	0.1
MINNOW SPP.						
PROLARVA	0.00	0.09	0.00	0.00	0.02	0.2
POSTLARVA	0.00	0.00	0.04	0.00	0.01	0.1
QUILLBACK						
PROLARVA	4.52	8.20	6.29	0.00	4.75	32.2
POSTLARVA	0.00	0.00	0.84	0.00	0.21	1.4
WHITE SUCKER						
PROLARVA	0.18	0.04	0.00	0.00	0.06	0.4
POSTLARVA	1.46	0.13	0.09	0.00	0.42	2.9
SHORTHEAD REDHORSE						
PROLARVA	0.00	0.22	0.00	0.00	0.06	0.4
POSTLARVA	0.00	0.04	0.35	0.00	0.10	0.7
WHITE CATFISH						
POSTLARVA	0.00	0.00	0.00	0.04	0.01	0.1
CHANNEL CATFISH						
POSTLARVA	0.00	0.00	0.00	0.04	0.01	0.1
ROCK BASS						
POSTLARVA	0.00	0.00	0.44	0.00	0.11	0.8
PUMPKINSEED						
PROLARVA	0.00	0.00	0.00	0.12	0.03	0.2
BLUEGILL						
PROLARVA	0.00	0.00	0.00	0.04	0.01	0.1
POSTLARVA	0.00	0.00	0.04	0.04	0.02	0.1
CRAPPIE SPP.						
PROLARVA	0.00	0.00	0.18	0.00	0.04	0.3
POSTLARVA	0.00	0.04	0.31	0.00	0.09	0.6
TESSELLATED DARTER						
PROLARVA	3.37	3.15	2.35	0.00	2.22	15.0
POSTLARVA	0.09	0.31	1.46	0.00	0.47	3.2
BANDED DARTER						
PROLARVA	0.31	0.93	0.44	0.04	0.43	2.9
POSTLARVA	0.22	0.49	0.31	0.04	0.27	1.8
SHIELD DARTER						
PROLARVA	0.13	0.00	0.00	0.00	0.03	0.2
POSTLARVA	0.09	0.04	0.09	0.00	0.06	0.4
WALLEYE						
PROLARVA	0.04	0.00	0.00	0.00	0.01	0.1
POSTLARVA	0.09	0.00	0.00	0.00	0.02	0.2
FISH (FRAGMENTS)	0.04	0.27	0.18	0.08	0.14	1.0
TOTAL	10.95	30.36	16.53	1.24	14.77	

Table 10

Mean density of larval fish/10 m^3 collected in surface samples during four diel sampling periods at the river water intake of the Susquehanna Steam Electric Station in 1981.

SPECIES	20 MAY	28 MAY	11 JUN	16 JUL	MEAN	% TOTAL
CARP						
PROLARVA	0.00	16.84	2.25	0.04	4.78	22.1
SPOTTAIL SHINER						
PROLARVA	0.43	5.48	0.38	0.00	1.57	7.3
POSTLARVA	0.04	0.17	0.30	0.00	0.13	0.6
SPOTFIN SHINER						
PROLARVA	0.00	0.04	2.25	1.03	0.83	3.8
POSTLARVA	0.00	0.00	0.72	0.33	0.26	1.2
FALLFISH						
POSTLARVA	0.04	0.00	0.00	0.00	0.01	0.0
QUILLBACK						
PROLARVA	15.09	12.46	7.48	0.00	8.76	40.4
POSTLARVA	0.00	0.17	1.57	0.00	0.44	2.0
WHITE SUCKER						
PROLARVA	0.77	0.09	0.00	0.00	0.21	1.0
POSTLARVA	1.96	0.21	0.00	0.00	0.54	2.5
SHORTHEAD REDHORSE						
PROLARVA	0.00	0.72	0.00	0.00	0.18	0.8
POSTLARVA	0.00	0.04	0.64	0.00	0.17	0.8
WHITE CATFISH						
POSTLARVA	0.00	0.00	0.00	0.17	0.04	0.2
CHANNEL CATFISH						
POSTLARVA	0.00	0.00	0.00	0.08	0.02	0.1
ROCK BASS						
PROLARVA	0.00	0.00	0.04	0.00	0.01	0.0
POSTLARVA	0.00	0.00	1.74	0.00	0.44	2.0
PUMPKINSEED						
POSTLARVA	0.00	0.00	0.00	0.04	0.01	0.0
BLUEGILL						
PROLARVA	0.00	0.00	0.00	0.04	0.01	0.0
POSTLARVA	0.00	0.00	0.04	0.04	0.02	0.1
SMALLMOUTH BASS						
POSTLARVA	0.00	0.00	0.04	0.00	0.01	0.0
CRAPPIE SPP.						
PROLARVA	0.00	0.09	0.00	0.00	0.02	0.1
POSTLARVA	0.00	0.00	0.26	0.00	0.06	0.3
TESSELLATED DARTER						
PROLARVA	3.83	2.55	1.53	0.00	1.98	9.1
POSTLARVA	0.09	0.13	1.32	0.00	0.38	1.8
BANDED DARTER						
PROLARVA	0.43	0.43	0.17	0.04	0.27	1.2
POSTLARVA	0.43	0.17	0.34	0.00	0.23	1.1
SHIELD DARTER						
PROLARVA	0.30	0.04	0.00	0.00	0.09	0.4
POSTLARVA	0.04	0.04	0.00	0.00	0.02	0.1
WALLEYE						
POSTLARVA	0.13	0.04	0.00	0.00	0.04	0.2
FISH (FRAGMENTS)	0.04	0.21	0.17	0.04	0.12	0.5
TOTAL	23.60	39.92	21.26	1.86	21.66	

Table 11

Comparison of a Predictive Model to a 316(b) Demonstration for entrainment of larval fishes at the Susquehanna Steam Electric Station in 1981.

Study	Sampling Period	Mean River Flow		Max Intake Flow		Max % River Flow Withdrawn	Mean No. Fish Entrained		Mean No. Fish Entrained/day
		m^3/s	cfs	m^3/s	cfs		m^3	ft^3	
Predictive Model	May-Aug 1974	199.5	7,047	2.46	87[a]	1.23	1.64	0.0465	349,531
Demonstration	May-Jul 1981	170.2	6,010	0.82	29	0.48	1.83	0.0518	129,790
Projected Demonstration (2 units)	May-Jul 1981	170.2	6,010	2.46	87[a]	1.44	1.83	0.0518	389,370

[a]Maximum design intake flow, 8,880 m (39,100 gpm), at full load with two cooling towers operational. Evaporation losses calculated at 73 F wet bulb and 65% relative humidity.

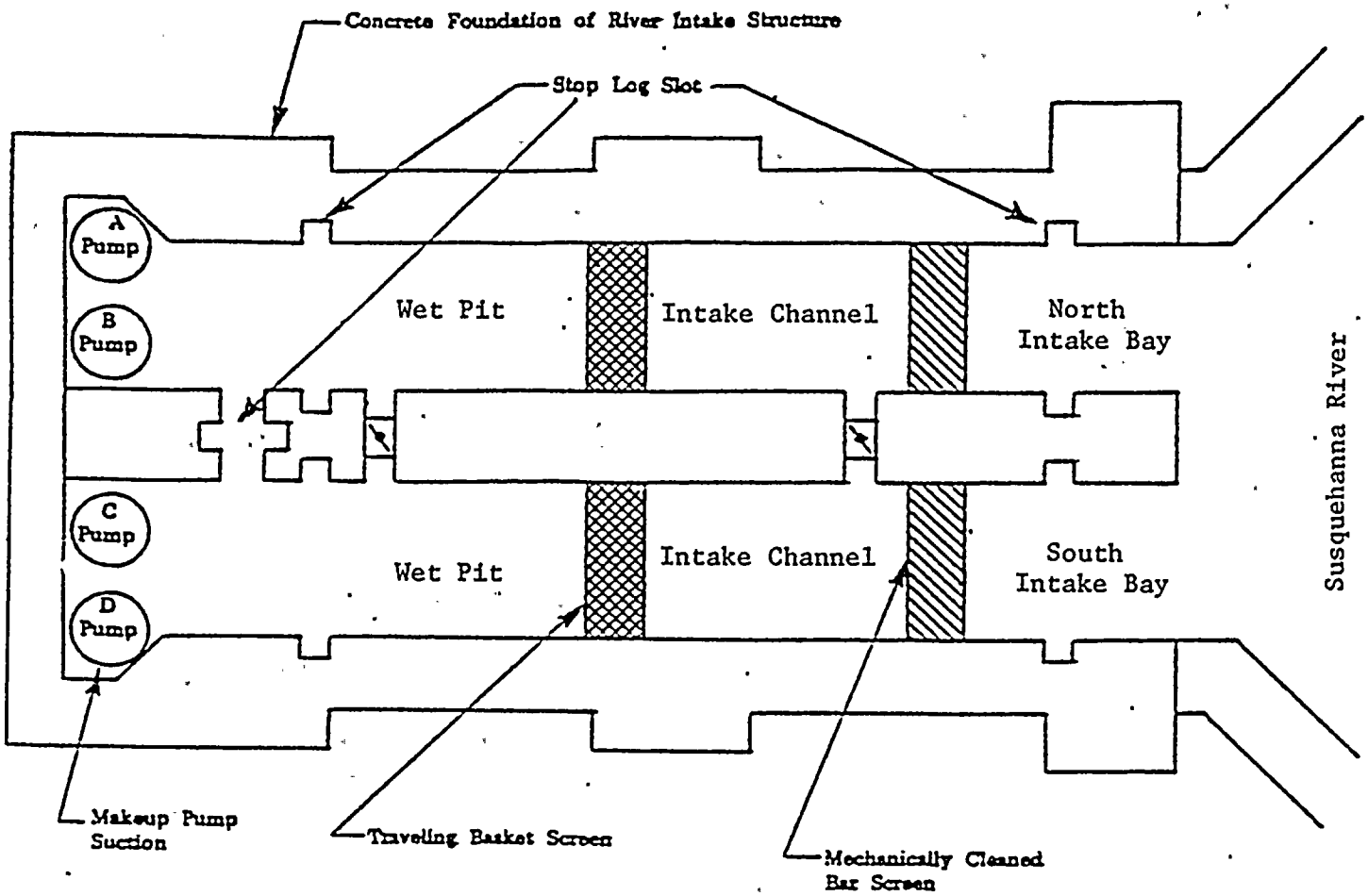

Fig. 1

Plane view of river intake structure.

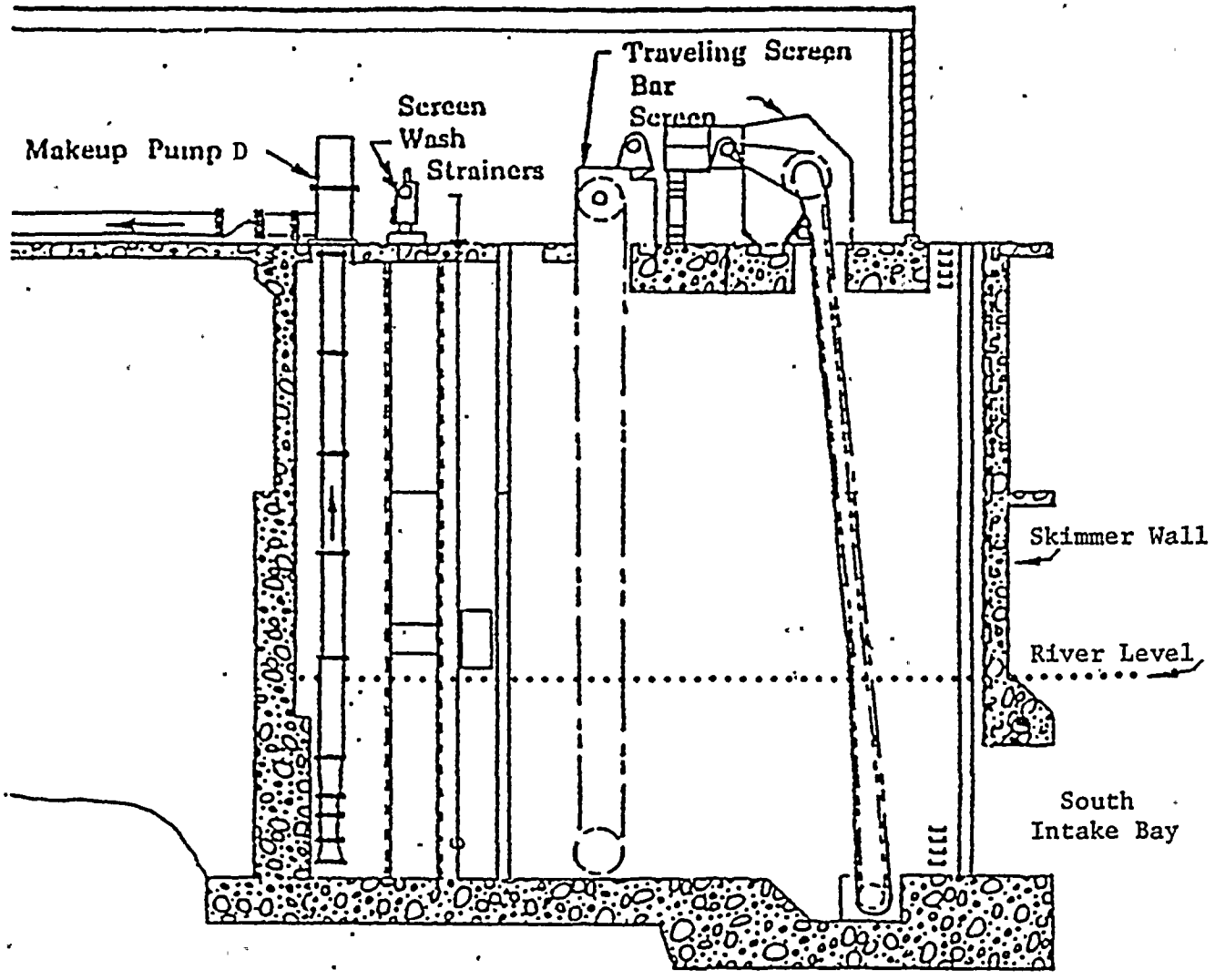

Fig. 2

Cross-section of river intake structure.

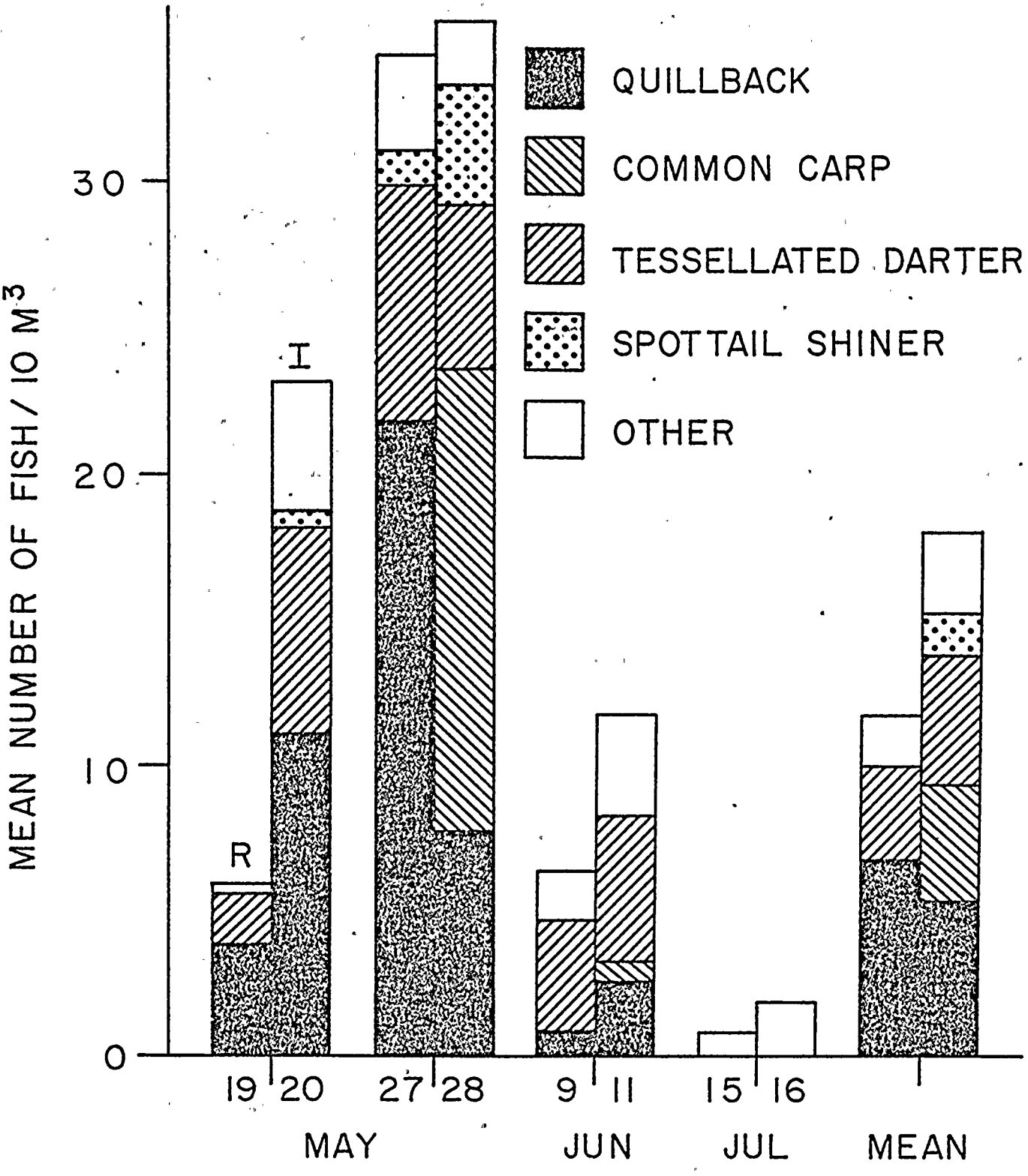

Fig. 3

Mean density (fish/10 m^3) of larval fish collected at 0900 and 2100 hours at the Susquehanna SES intake (I), and 190 m upriver, near the river channel (R), 1981. Fishes which occurred in densities of less than 0.5 fish/10 m^3 during a sampling period, or which composed less than 5% of the overall mean were categorized as "other."

APPENDIX A

Correction

1. Section V., paragraph 2, pg. 4 Hunlock SES mean river flow withdrawn was 1% and not 0.7% as originally listed. Also, the ratio of fish impinged is 1% for Hunlock SES to 0.6% for the Susquehanna SES or 1:0.6 and not 1:0.86.

2. Table 1; the max. % river flow is 1% (see above). The estimated no. of impinged fish per day for the Susquehanna SES is 13.68 and not 19.5. Also, the weight is 0.84 pounds per day and not 1.18.

Revised
July 1982

Copy to:
W.L.Bohner - N-4
L.I.Ratzell - A3-3
C.H.Fretz - A3-3
R.G.Johnson - Susq. SES
M.R.Buring - A3-3
J.S.Fields - A3-3
File

APPENDIX A

January 9, 1980

Mr. Lawrence A. Pawlush
Regional Water Quality Manager
Bureau of Water Quality Management
Wilkes Barre Regional Office
90 East Union St.-2nd Floor
Wilkes Barre, PA 18701 File 100450-012

Dear Mr. Pawlush:

Special Condition C of our recently issued NPDES Permit for the Susquehanna SES (Permit No. PA0047325 July 31, 1979) requires submission of a specific study program for monitoring impingement and entrainment effects at the plant intakes. In preparing such a study program, studies conducted at other stations by PP&L and other utilities were reviewed for similarities of aquatic environs, design and operation. Programs reviewed would then be used as a basis for a similar study to be conducted at the Susquehanna SES. Those programs reviewed included:

1) Hunlock SES - for similarity of river conditions and intake flows.

2) Martins Creek SES - for similarity of river intake structure design.

(Note: However, there is an intake canal prior to the intake structure).

3) Brunner Island - similarity of intake structure and flows.

4) Three Mile Island Nuclear Station - similarity of intake structure and flows.

Comparisons of results of studies at these four stations and projected impingement and entrainment for the Susquehanna SES are summarized in the attachment to this letter. (Impingement and Entrainment Studies for Susquehanna SES).

Analysis of data from the various stations reviewed indicates there was not an adverse impact to the aquatic environs from impingement and entrainment. The projected rates for the Susquehanna SES are similar to data collected at these four other stations. The projection of impingement and entrainment based on intake structure, location, design, operation, and river water withdrawal rates indicates the adverse impact from the Susquehanna SES will also be negligible.

PP&L would like to meet with DER personnel to discuss this study program and any additions or changes you may request, and answer any questions at your convenience. Please contact Michael R. Buring of my staff at 215-821-4655 for any questions or to arrange the meeting referred to above.

Very truly yours,

(Signed) G. H. GOCKLEY

Gene H. Gockley
Mgr.-Environmental Mgmt.

Attachment

c-Mr. Richard L. Constriciano

MRB:EJM

IMPINGEMENT AND ENTRAINMENT STUDIES FOR THE SUSQUEHANNA STEAM ELECTRIC STATION

I. Purpose

In response to Special Condition C of the National Pollutant Discharge Elimination System Permit No. PA-0047325, the Pennsylvania Power & Light Co. (PP&L). is providing a study for projection of impingement and entrainment effects at the Susquehanna Steam Electric Station (Susquehanna SES) intake. The purpose of this study was to determine impingement and entrainment monitoring requirements for the Susquehanna SES.

II. Study Area

The Susquehanna SES consists of two boiling water reactors, each with an electrical generating capacity of 1,050 MWe. It is located on a 1075 acre site in Salem Township, Luzerne County, about 5 miles northeast of Berwick, Pennsylvania. Commercial operation of Unit 1 is scheduled to begin in 1982 and Unit 2 in 1983. Aquatic studies have been conducted on the Susquehanna River near the Susquehanna SES by Ichthyological Associates, Inc. since 1971. The Susquehanna River will be the source of make-up water for the station cooling system. The overall objective of these studies has been to establish an ecological baseline of existing conditions in the river and on the site prior to operation of the Susquehanna SES (Ref. 1).

Most of the aquatic studies were conducted within 1.25 miles of the intake structure and discharge diffuser of the Susquehanna SES. The slope of the river bed in this stretch of the Susquehanna River is 1.6 ft/mi and the average width is about 984 ft. Depth is relatively shallow in most areas (less than 6.6 ft.), but some pools may exceed 16.4 ft. even during low river flow. During periods of low flow, which normally occur in late summer and early autumn, abandoned eel walls help maintain pools, some of which are several kilometers long.

In times of high flow the river level commonly increases 9.84 ft. or more, and its flow characteristics resemble those of an open channel. Upriver from the site, the "Wyoming Region" of the northern anthracite coal field lies beneath or adjacent to the river. Acid mine drainages from this Area, which enter from abandoned strip and shaft mines, degrade the water quality at the site.

III. River Water Intake

The river intake structure, as shown on Figure 1, River Intake Structure-Velocity Profile, consists of a structural steel superstructure above the operating floor and a reinforced concrete substructure that extend into rock below the level of the river bottom. The superstructure houses the makeup water pumps and

associated equipment including switchgear, automatic operating equipment for trash handling screens, motor control centers, screen wash strainers and a debris handling facility. (Ref. 2)

The substructure contains two water entrance chambers that house the traveling screens and two pump chambers. The two intake openings are formed by the floor and sides of the entrance chambers. The top of the intake openings is formed by an inverted weir that extends one foot below the minimum river water level, elevation 484.0 ft., to intercept floating oil and debris. The front of the intake is at the river bank with flared wing walls extending down the natural slope of the bank to provide for an even and gradual water approach velocity. (See Figure 2, River Intake Structure Wing Walls).

A cost-benefit analysis was used in determining the best intake structure type for this station. The standard intake structure was selected for the Susquehanna SES over the alternate infiltration system (Ranney Collector) since the altnerate could not provide the required water supply for station operation. The standard intake has also been used without adverse environmental impacts at other PP&L and utility stations. Based on environmental impact, location on the river and economic costs the standard intake structure was considered to be the best technology available (BTA) for the Susquehanna SES by PP&L.

The intake flow velocity (0.37 fps, max) is perpendicular to, and considerably less than, the mean river velocity (1.22 fps mean, July 1974 through April 1975), which tends to move submerged aquatic life and floating debris past the intake (Ref. 1, 1974, 1975, 1976). Figure 1 shows the average horizontal velocity of the water flowing from the river to the intake pumps.

Four nominal 33.33% capacity intake pumps that have a capacity of 13,500 gpm (30 cfs) each are installed in the intake structure. At 100% station load operation of both units maximum intake flow under the least favorable (1%) meteorological conditions is 39,100 gpm (87 cfs).

The two water entrance chambers are each equipped with automatically operated trash bar screens and traveling screens. A trash bar screen is provided behind each of the inverted weir intake openings to prevent large debris from impeding operation of the automatic traveling screen located downstream. The trash bar screens and traveling screens are operated automatically by differential pressure sensors or by a timer for periodic cleaning. Water spray systems wash debris from the screens into a basin for disposal whenever the trash bar screens or traveling screens operate. The trash bar screens consist of vertical bars with a 1 in. opening between bars. The traveling screens have 3/8 in. mesh wire openings. (Ref. 2).

The velocity of water through both intake structure passages when three pumps are operating (39,100 gpm maximum) is as follows:

- Through the entrance openings (i.e. under inverted weir) is independent of river level: 0.37 fps.
- Through the clean bar screen openings at minimum river level 484 ft. above msl: 0.58 fps.
- Through the clean traveling screen openings at the minimum river level 484 ft. above msl: 0.64 fps.

Under the worst case anticipated (general maintenance and repair) with three pumps operating at a flow of 39,100 gpm and with only one passage open, the inlet velocity would be 0.75 fps (Ref. 2). The worst case situation should occur less than once per year and be of short duration since maintenance of this type is normally scheduled during outages.

After passing through the intake structure river water goes through the stations circulating water system. There are two hyperbolic natural draft cooling towers for cooling heated condenser cooling water. Cold air enters the bottom of the tower, mixes with the circulating water in the tower fill (water dispersal material), removes heat from the water and the warm air-water vapor mixture rises to leave the tower at the top. The towers are suitable for year-round operation. (Ref. 2). The maximum volume of water withdrawn by the Susquehnna SES from the Susquehanna River as indicated previously will be 39,100 gpm (87 cfs) while the annual average will be 32,365 gpm (72 cfs).

IV. Methods for Determining Impingement and Entrainment Calculations

The equation used for calculating entrainment is as follows:

$$\frac{\#\text{ larval fish}}{\text{ft}^3}(X)\ \frac{\#\text{ max. intake flow ft}^3}{\text{sec}}(X)\ 60\ \text{sec/min}(X)\ 60\ \text{min/hour}\ (X)\ 24\ \text{hour/day} = \frac{\#}{}\ \text{larval fish entrained/day}$$

NOTE: (X) = multiply

An example of entrainment at Hunlock SES is as follows:

$$0.03\ \text{larval fish/ft}^3\ (X)\ 145\ \text{ft}^3/\text{s}\ (X)\ 60\ \text{s/m}\ (X)\ 60\ \text{m/hr}\ (X)\ 24\ \text{h/d} = 375{,}840\ \text{larval fish entrained/day}$$

The equation used for calculating weight of impinged fish is as follows:

$$\frac{\text{lbs. fish}}{\text{sampling time}} = \frac{\text{lbs. fish}}{\text{day}}$$

An example of an impingement calculation for Three Mile Island Nuclear Station can be shown as follows:

$$\frac{5.4 \text{ lbs}}{480 \text{ hr}} = \frac{\text{lbs fish}}{24 \text{ hr/day}} = 0.3 \text{ lb. fish impinged/day}$$

To facilitate comparisons of data collected from the various impingement and entrainment studies the data was normalized. See Table 1, Impingement and Entrainment Data from Power Stations, for the appropriate parameters. The calculation for impingement at the Susquehanna SES however, is based on a direct ratio with Hunlock SES impingement data.

V. Assumptions used in Determining Impingement and Entrainment Projection for the Susquehanna SES

Since the Susquehanna SES has a closed cycle heat dissipation system, PP&L conservatively assumes that the mortality of all entrained organisms is 100%. The critical months for development of fish eggs and larvae in 1974 were May through August. The year 1974 was selected since three separate methods (fixed net, push net, and pump) of larval fish collection were used at the Susquehanna SES (Ref. 1, 1974). By using these methods both drifting and swimming larvae were collected. The most larval fish were collected with the push net technique (0.0465 larval fish/ft^3), and this data was used in determining entrainment for the station.

Impingement studies between July 1974 and April 1975 at the nearby Hunlock Steam Electric Station, (Hunlock SES) indicated that fish were considered to be the critical organism (Ref. 3). During this period approximately 1.0% of the mean river flow was withdrawn by Hunlock SES. This is similar to the flow to be withdrawn by the Susquehanna SES of 0.6% (87 cfs). Based on Hunlock SES impingement data a direct ratio of 1.0% to 0.6% (1:0.6) was used in projecting estimates for the Susquehanna SES.

VI. Impingement and Entrainment Study Data

1. Susquehanna Steam Electric Station, Units 1 & 2

Susquehanna SES, Units 1 and 2 are two-1050 MWe boiling water reactors operated by PP&L. The station will utilize a closed cooling system with a maximum flow of 87 cfs of Susquehanna River water with an intake velocity of 0.37 fps.

Larval fish data have been collected for over seven years in the vicinity of the Susquehanna SES intake structure (Ref. 1). Larval fish data collected between May and July of 1974 were used for this analysis. There were 275 push net samples (0.0465

larval fish/ft^3) average about five minutes each, 276 fixed net samples (0.0277 larval fish/ft^3), and 343 five minute pump samples (0.0177 larval fish/ft^3). Larvae of 22 species of fish were collected with a majority being suckers, minnows and carp, and perches. The push net data of 0.0465 larval fish/ft^3 was used in projecting that approximately 350,000 larval fish/day would be entrained. About 1.23% of the mean river flow will be withdrawn by the station during the spawning season. (See Table 1, for additional information.)

Projected impingement data for the Susquehanna SES are based on the nearby data collected at the Hunlock SES between July 1974 and April 1975 (Ref. 3). Seventy six fish were collected during an 80 hour sampling period and it is estimated that approximately 23 fish were impinged per day. Also, the estimated weight per day of these impinged fish was 1.4 lbs. Since the Susquehanna SES withdraws about 86% as much water from the Susquehanna River as does Hunlock SES (0.6% vs. 0.7%) the projected number of fish impinged per day was approximately 20 with a weight of about 1.2 lbs.

2. Hunlock Steam Electric Station

The Hunlock SES is a small one unit coal-fired station (46 MWe) operated by the Luzerne Electric Division of UGI Corporation. It is located about 9.3 miles up river from the Susquehanna SES, and utilizes a once through cooling system that draws in about 145 cfs of Susquehanna River water through two intake canals with velocities up to 0.75 ft/s.

Larval fish were also sampled at the Hunlock SES once per month in May through July 1974 to determine entrainment losses. Mean densities of entrained larvae were less than 0.03 larval fish/ft^3 or about 375,000 larval fish/day. This was concluded to be an acceptable loss because less than 2% of the mean river flow was drawn into the station during the sampling period.

Once each month, from July 1974 through April 1975, impingement samples were collected. Seventy-six fish were collected in an 80 hour period. Extrapolation of results from these samples showed that 23 fish were impinged per day and approximately 1.4 lbs. of fish were impinged per day. It was concluded that impingement losses would have a negligible affect on the sport fishery of the Susquehanna River (Ref. 3).

3. Martins Creek Steam Electric Station Units, 1 & 2

Martins Creek SES is located about 6 miles north of Easton, Pa. on the Delaware River (Ref. 4). Martins Creek SES Units 1 & 2 are two-150 MWe coal fired units and Units 3 & 4 are two-800 MWe

oil fired units operated by PP&L. Units 1 & 2 utilize a combined maximum of 268 cfs of Delaware River Water for once through cooling with an intake velocity of 0.8 fps. Units 3 & 4 utilize 80 cfs for cooling tower makeup and station service water. Since Units 3 & 4 are used only for cycling, impingement and entrainment studies were monitored only on Units 1 & 2.

The water withdrawn by Units 1 & 2 during the entrainment sampling period of April through June 1976 was 3.5% of the mean river flow. The number of larval fish entrained was $0.0012/ft^3$. About 28,000 larval fish were entrained at Martins Creek per day and the impact of entrainment was not considered adverse for the aquatic environs.

The impingement program was conducted from March 1976 through February 1977. During a sampling period (26 hours) it was projected that about 3 fish per day would be impinged or about 4 lbs. per day. Impingement was not considered an adverse impact since so few fish were impinged.

4. Brunner Island Steam Electric Station.

The Brunner Island SES located on the Susquehanna River about 8 miles north of York, Pa. is owned and operated by PP&L. Unit 1 is rated at 300 MWe, Unit 2 at 350 MWe and Unit 3 is rated at 790 MWe (Ref. 5). This station has a once through cooling system with a maximum intake flow of 1,154 cfs.

The entrainment survey was conducted between April and July of 1976. The river water withdrawn during the entrainment study was about 3.7% of the mean river flow. The number of larval fish entrained per day was about 500,000 and this was not considered to be an adverse environmental impact on the Susquehanna River.

The impingement study was conducted between March 1976 and February 1977. The data collected for this study was limited however 47 fish were impinged over a 267 hour sampling period. The number of fish impinged per day was 43 or 7.88 lbs. per day.

It was evident that impingement losses on the traveling screens were not substantial (Ref. 5).

5. Three Mile Island Nuclear Station (Unit 1)

The Three Mile Island Nuclear Station (Three Mile Island NS) is located on Three Mile Island about 10 miles Southeast of Harrisburg, Pa. and is owned and operated by Metropolitan Edison Company (Ref. 6). Unit 1 is 792 MWe pressurized water reactor with an intake flow of 60 cfs and a velocity of 0.2 fps. This station used a closed cooling system with two natural draft cooling towers.

An entrainment survey of larval fish was conducted between April and August 1977. About 0.2% of the mean river flow was used for station, cooling (two natural draft cooling towers). The number of larval fish entrained was 0.075 larval fish/ft^3. The number of larvae estimated to be entrained per day was 388,800 and was not considered an adverse environmental impact.

The impingement studies indicated that mainly diseased or dead fish are impinged while healthy fish avoid the screens. During the period March through December 1977, 168 fish were impinged per day (0.27 lbs./day). This was not considered to be an adverse impact to the aquatic environs.

VII. Summary

Impingement and entrainment surveys have been conducted at several power stations including those mentioned in this study. In all cases with the exception of the Martins Creek SES the projected estimate for fish impinged and entrained at the Susquehanna SES is similar to the data collected at the other stations. At Martins Creek which is on the Delaware River the number of organisms entrained 0.0012/ft^3 was very low and this may be due to a very small number of larval fish in the vicinity of the station or the period in which the larval fish were sampled. Samples collected at Martins Creek were April through June while at other stations the entrained samples were collected in July and some also in August. Table 1, lists both the appropriate impingement and entrainment data.

The intake structure design selected for the Susquehanna SES was based on environmental as well as economic costs meeting BTA requirements (Ref. 7 & 8). The Susquehanna SES intake structure location and type were based on availability of water and topography in the vicinity surrounding the station. The location of the intake on the river is in an area which has tended to limit the types and quantities of organisms present (Ref. 1, 1974).

Comparisons of flow volume, available organisms, flow rates, design of the intake structure, river conditions and sampling data indicate that the Susquehanna SES intake is not unique. The projected estimates of impingement and entrainment values for the Susquehanna SES are similar to data collected for studies at Hunlock SES, Martins Creek SES, Brunner Island SES and Three Mile Island NS. Based on data collected from field impingement and entrainment studies at similar electric generating stations which indicated that the impacts are not adverse, an impingement and entrainment field study at the Susquehanna SES should not be required as part of the National Pollutant Discharge Elimination System Permit.

VIII References

1. Ecological Studies of the North Branch Susquehanna River in the vicinity of the Susquehanna Steam Electric Station, Progress Reports 1972-1978, Ichthyological Associates, Inc. for the Pennsylvania Power & Light Co.

2. Susquehanna Steam Electric Station Units 1 & 2, Environmental Report Operating License Stage, Pennsylvania Power & Light Co., Volume 2, Subsection 3.4, May 1978.

3. Hunlock Steam Electric Station Ecological Study, Progress Report for the Period May 1974 - April 1975, by Ichthyological Associates Inc. for Luzerne Electric Division of UGI Corporation, September 1975.

4. An Ecological Study of the Effects of the Martins Creek S.E.S. Cooling Water Intake, for Pennsylvania Power & Light Co., Roy F. Weston, November 18, 1977.

5. An Ecological Study of the effects of the Brunner Island SES Cooling Water Intakes, for Pennsylvania Power & Light Co., Roy F. Weston, November 18, 1977.

6. An ecological study of the Susquehanna River in the vicinity of the Three Mile Island Nuclear Station, Annual Report for 1977, Ichthyological Associates, Inc., for Metropolitan Edison Co., April 1978.

7. USEPA, 1976. Development document for best technology available for the location, design, construction and capacity of cooling water intake structures for minimizing adverse environmental impact Washington, D.C.

8. Review of Best Technology Available for Cooling Water Intakes, NUS Corporation, for the Department of Water and Power City of Los Angeles, March 1978.

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TABLE 1

Impingement and Entrainment
Data From Power Stations

Station	Sampling Period	Mean River Flow cfs	Max Intake Flow cfs	Max Intake Velocity fps	Max % River Flow Withdrawn	No. Organisms Entrained per ft	No. of Fish Entrained Per Day	No. of Fish Impinged Per Day	Lbs. of Fis Impinged Per Day
1. Susquehanna Steam Electric Station (Units 1 & 2)[a]	E-May - August 1974	7,047	87	0.37	1.23	0.0465	349,531	-	-
	I-July 1974 - April 1975	14,519	87	0.5	0.6	-	-	13.68	0.84
1. Hunlock Steam Electric Station	E-May - July 1974	8,574	145	0.75	1.7	0.03	375,840	-	-
	I-July 1974-April 1975	14,519	145	0.75	1.0	-	-	22.8	1.4
3. Martins Creek Steam Electric Station (Units 1 & 2)	E-April - June 1976	7,733	268	0.8	3.5	0.0012	27,786	-	-
	I-March 1976 - February 1977	9,286	268	0.8	2.9	-	-	2.8	4
4. Brunner Island Steam Electric Station (Units 1, 2, 3)	E-April - July 1976	31,353	1,154	2.2	3.7	0.005	498,528	-	-
	I-March 1976 February 1977	31,716	1,154	2.2	3.6	-	-	43.4	7.88[b]
5. Three Mile Island Nuclear Sta. (Unit 1)	E-April - August 1977	29,148	60	0.2	0.21	0.075	388,800	-	-
	I-March - December 1977	39,118	60	0.2	0.15	-	-	168	0.27

Key:

E - Entrainment
I - Impingement

Notes:

a. Projected impingement & entrainment values based on far field studies at Susquehanna SES & Hunlock SES data.

b. Weights were not measured as part of this study; therefore they were assigned to the 47 fish collected in a 26 hour period between March 1976 - February 1977. Ten of the fish longer than 10 cm were given estimated weights of largest fish collected (white sucker 30 cm - 380 g). The 37 fish less than 10 cm in length were assigned the weight of the most common fish impinged (14 out of 37) the blue gill (5 cm - 2 g). The weight of fish impinged per day may be an overestimated by a factor of 2 high.

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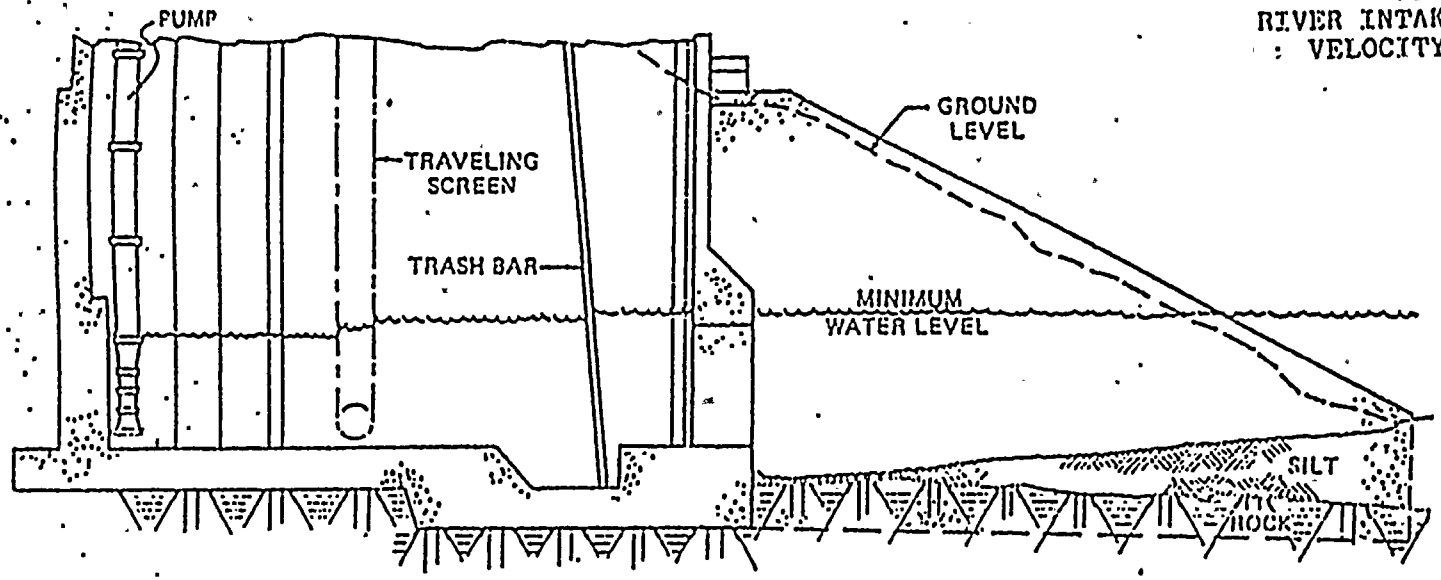
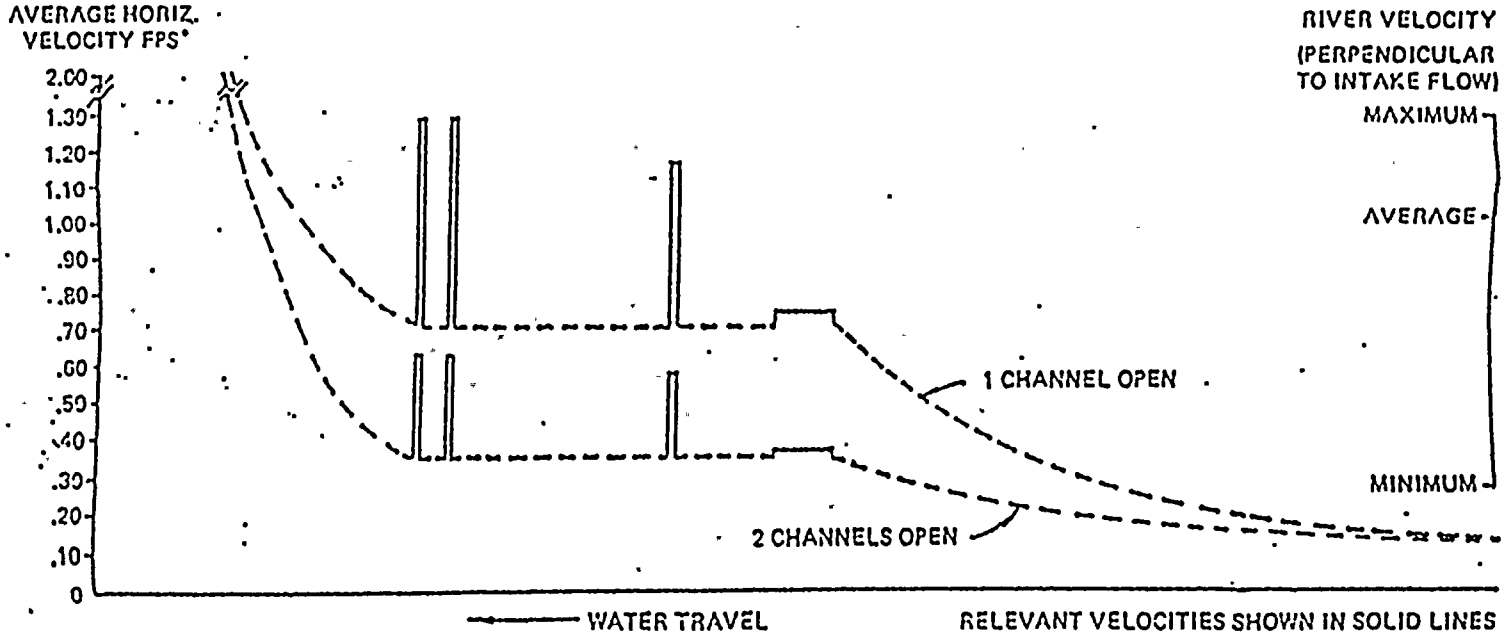
Revised
July 1982

FIGURE 1
RIVER INTAKE STRUCTURE
: VELOCITY PROFILE



SECTION A-A



*AT MINIMUM WATER LEVEL—39,100 GPM TOTAL FLOW

APPENDIX B

Copies to:

S.J.Berger	TW2
R.J.Shovlin	N4
G.H.Gockley	A3-3
W.E.Barberich	N4
J.S.Fields	A3-3
S.H.Cantone	N4
R.P.Janoso	A3-3
R.A.Webster	Susq. SES
J.P.Mahony	Susq. SES
R.H.Featenby	Susq. SES

April 9, 1980

Jim Ulanowski

SUSQUEHANNA SES IMPINGEMENT/ENTRAINMENT
File 100450 012

Dear Mr. Ulanowski:

During our meeting of March 4, 1980 at Wilkes Barre we discussed our submittal of January 9, 1980 regarding Special Condition C of our NPDES Permit #0047325. Our submittal included a predictive model to satisfy this condition. During this meeting you requested that PP&L submit a program for confirmation of predicted organism entrainment values. You also concurred with our conclusion that impingement losses would be negligible and that further monitoring would not be required. Accordingly, we are submitting a proposed verification program for entrainment values for fish larvae which we feel certain will verify our predictive model. This program is as follows:

I. Sampling Frequency -

- o Fish larvae will be sampled at the intake bay at which two pumps are operating:*
  1. Three times per 24 hour day (including daylight and nighttime) at approximately 8 hour intervals).**
  2. Approximately five minutes duration per replicate.
  3. Two sample days per month.

II. Sampling Level -

- o Samples will be withdrawn at two levels
  1. Near the botton of the skimmer wall.
  2. Near the botton of the intake aperture.

*There are two bays with two full capacity pumps per bay. Normal two unit station operation requires three of these four pumps to operate. These tests will be conducted with three pumps operating.

**Current plans are to conduct sampling at 0200, 1400, 2200 hrs.

III. Sample Volume -

- A calibrated volume delivery pump with a discharge collection filter will be used which delivers approximately 500 gallons per minute. Since the sample will be of about 5 minutes duration, each sample volume will be about 2500 gallons.

IV. Identification -

- Fish larvae collected will be identified to the lowest feasible taxon.

V. Program Duration -

- This program will be conducted for a period of three months during the spawning season which at the Susq. SES is May, June and July.

VI. Reporting -

We will supply you copies of the draft report upon review and completion.

- Final results will be reported to you as an addendum to our routine annual report which is completed prior to May 1st of the year following data collection. Copies will be supplied to your office after preparation.

Although you suggested a sampling frequency of four hours rather than the eight hour frequency described above, we have determined that this cannot be accomplished without significant adverse impact on the intake pumps. Since the cooling towers will not be in operation during this sampling period there will be no evaporation and the intake rate will exceed the blowdown rate. As a result it will be necessary to cycle these pumps on and off to permit blowdown of water accumulated in the cooling tower basins between sampling periods. These pumps are designed for continuous operation and a limited number of cycles are permitted. We have therefore proposed a eight hour interval between sampling periods.

You suggested also in our meeting that we should consider sampling at bottom, middle and surface levels. We cannot at this time determine a practical method for sampling at three different levels. We have determined however from our data on existing river concentrations of fish larvae that these organisms tend to group at either the bottom or surface level. We consider that there will be no loss of confidence in verification of the program with the described sampling.

Since this is not normal operational mode as described in our NPDES permit and application we also request your approval for this pumping and release concept.

We trust that this verification program as described will serve to verify our initial program submittal of January 9, 1980. We request your approval of this program as described at your earliest convenience since we fully intend to proceed during May of 1980.

If you have any questions please do not hesitate to call me at 215-281-4785.

Very truly yours,

Michael R. Buring

Michael R. Buring

MRB:NLF
MRB#]03:6

Copies to:
Ed Kupski PA DER Wilkes Barre
Paul Swerdon PA DER Wilkes Barre

APPENDIX C

APPENDIX C

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
P.O. Box 2063
Harrisburg, Pennsylvania 17120
(717) 787-9614

April 29,1980

Mr. Michael R. Buring
Pennsylvania Power and Light Company
2 North 9th Street
Allentown, PA 18101

Dear Mr. Buring:

Ed Kupsky, myself, and Jim LaBuy, U.S. EPA have reviewed your proposed impingement/entrainment study plan for the Susquehanna Steam Electric Station as contained in your letter dated April 9, 1980. We find the proposal to be acceptable.

Paul Swerdon, Facilities Engineer, Wilkes-Barre Office, has approved your request for the pumping and release operational mode.

Sincerely,

James T. Ulanoski

James T. Ulanoski
Aquatic Biology Section
Division of Water Quality