Indian Point Generating Station

a 316(a) Demonstration

APPENDIX D

Procedures and Analyses-
Biological and Hydrothermal Studies

Consolidated Edison Company of New York, Inc.
Power Authority of the State of New York

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SECTION 1 - HYDROTHERMAL ANAYLSES Section 1 - Engineering, Hydrological and Hydrothermal Data

1.1 General Plant Information

The Indian Point Generating Station is located on the east bank of the Hudson River in the Village of Buchanan in northern Westchester County, New York, The plant is situated about 25 miles north of the New York City limits and some 43 river miles above the Battery at 41°16'20" latitude and 73°57'10" longitude (discharge coordinates). Significant points of reference include the City of Peekskill (2.5 miles to the northeast), the West Point Military Academy (8.3 miles to the north) and the Lovett and Bowline Point Generating Stations located across the river at mile points (MP) 41.0 and 37.5, respectively.

The Indian Point Sation consists of three generating units, numbers 1, 2, and 3, which are situated on a site with an area of about 239 acres. Unit No. 2 is the northernmost (upstream) unit followed by Units Nos. 1 and 3 going south (downstream).

Indian Point Units Nos. 2 and 3 are nuclear power plants with net rated capacities of 873 MWe (906 MWe gross) and 965 MWe (1000 MWe gross), respectively. Generation statistics for Units Nos. 1, 2, and 3 are summarized in Table 1-1 for the period 1972 through 1977. This table indicates that Units Nos. 2 and 3 operated during 1977 at 68.1 and 72.2% of their dependable output, respectively. Gross power generation in MW(e) is shown on Figures 1-1 through 1-13.

On September 28, 1973, Con Edison received a Facility Operating License from the Nuclear Regulatory Commission (NRC) (formerly, the Atomic Energy Commission) authorizing the full-term, full-power operation of Indian Point Unit No. 2. Indian Point Unit No. 3 began commercial operation on August 30, 1976. Unit No. 3 is currently licensed to operate at a 91% power level with an output of 873 MWe. Unit No. 1 has not operated since October 31, 1974.

1.2 Plant Operating Characteristics

1.2.1 Cooling Water System

Cooling water from the Hudson river enters the Indian Point Station through the Units Nos. 2 and 3 intakes, is pumped through the condensers and returns to the river via a common discharge canal located south of Unit No. 3.

Table 1-1. Historical Operation of the Indian Point Station Generation Statistics

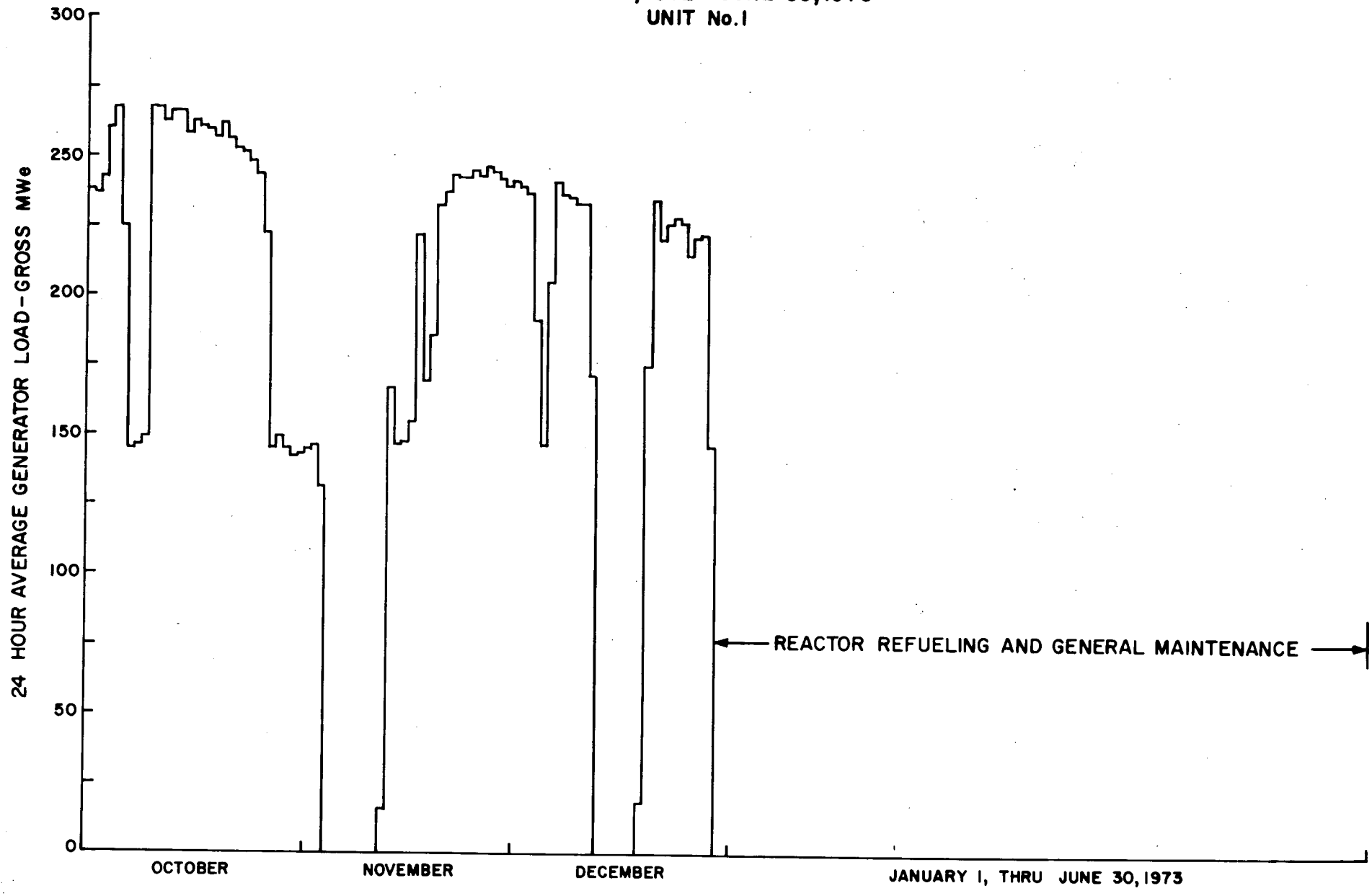
	Unit No. 1	Unit No. 2	Unit No. 3*
Gross Output Mw(e)	285	906	1,000
Net Output Mw(e)	265	873	965
Dependable Net Output in Mw(e)	-	865	873
1972	1,127,511 [1] 128 [2] 48.4 [3]	-	-
1973	-	248,151 28 3.3	-
1974	1,226,560 140 52.8	3,324,048 379 43.9	-
1975	-	4,867,119 556 64.2	-
1976	-	2,267,654 258 29.8	1,872,947 213 24.4
1977	-	5,210,299 595 68.1	5,518,432 630 72.2

[1] Net generation MW-hrs
[2] Average hourly net load MW
[3] Plant Capacity Factor(%) = Net generation/Dependable output x hours in year

*Unit 3 is currently licensed at 873 Mw(e) net.

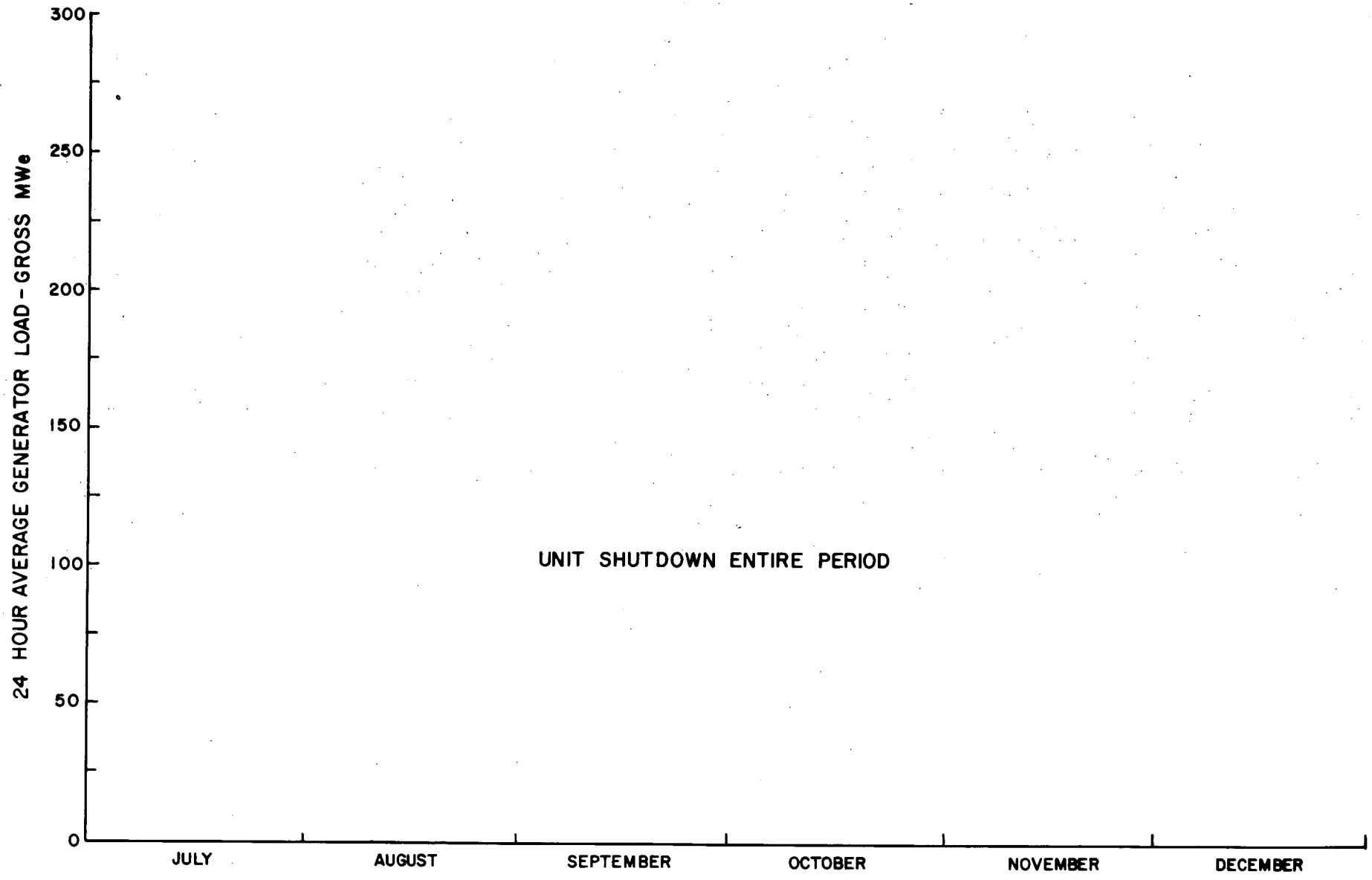
Source: Con Edison 1977f.

Figure 1-1. INDIAN POINT STATION
POWER GENERATION HISTORY
OCTOBER 1, 1972 - JUNE 30, 1973
UNIT No. 1



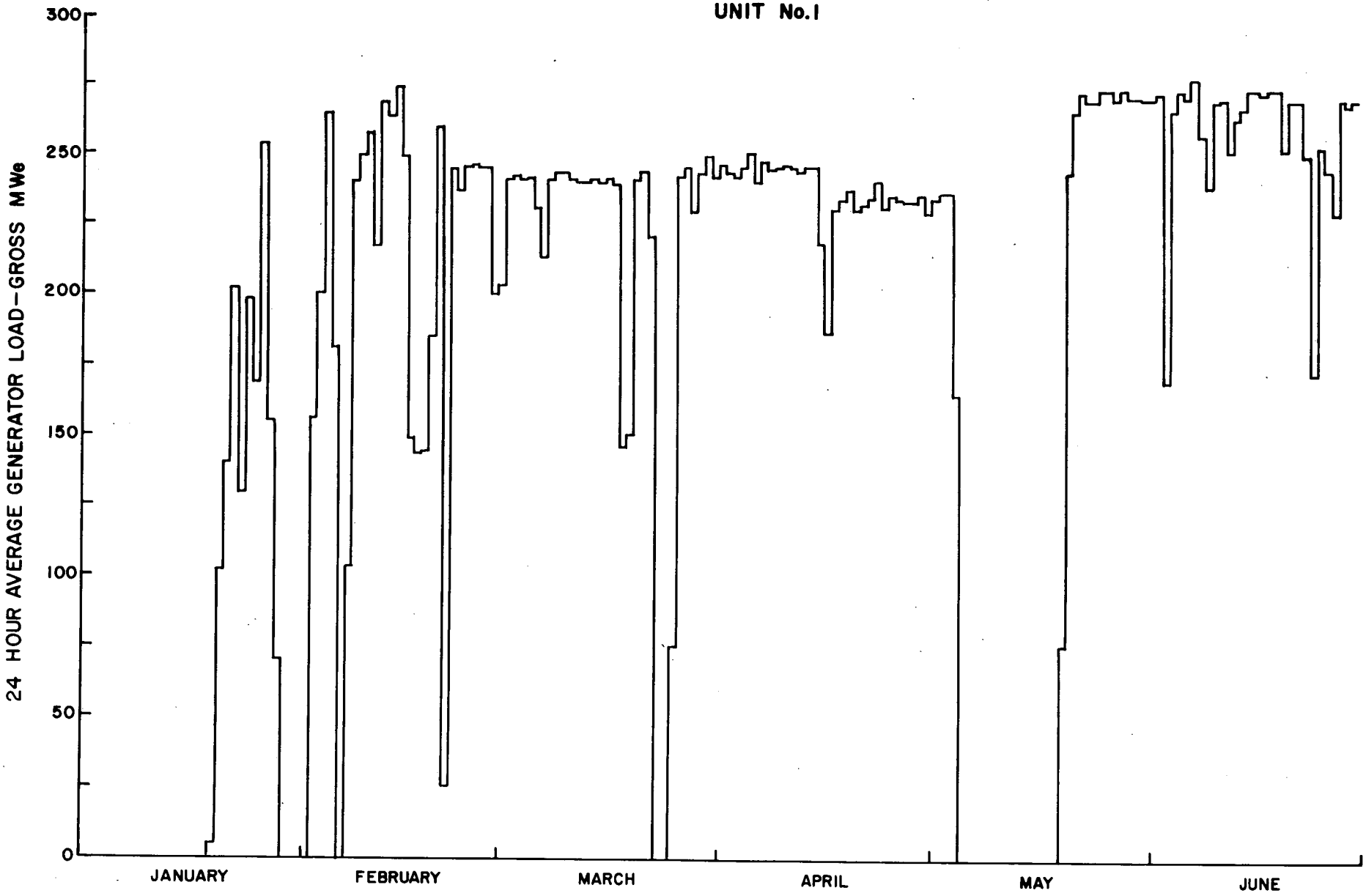
Source: Con Edison 1973-1977

Figure 1-2. **INDIAN POINT STATION POWER GENERATION HISTORY JULY 1973 - DECEMBER 1973 UNIT No. 1**



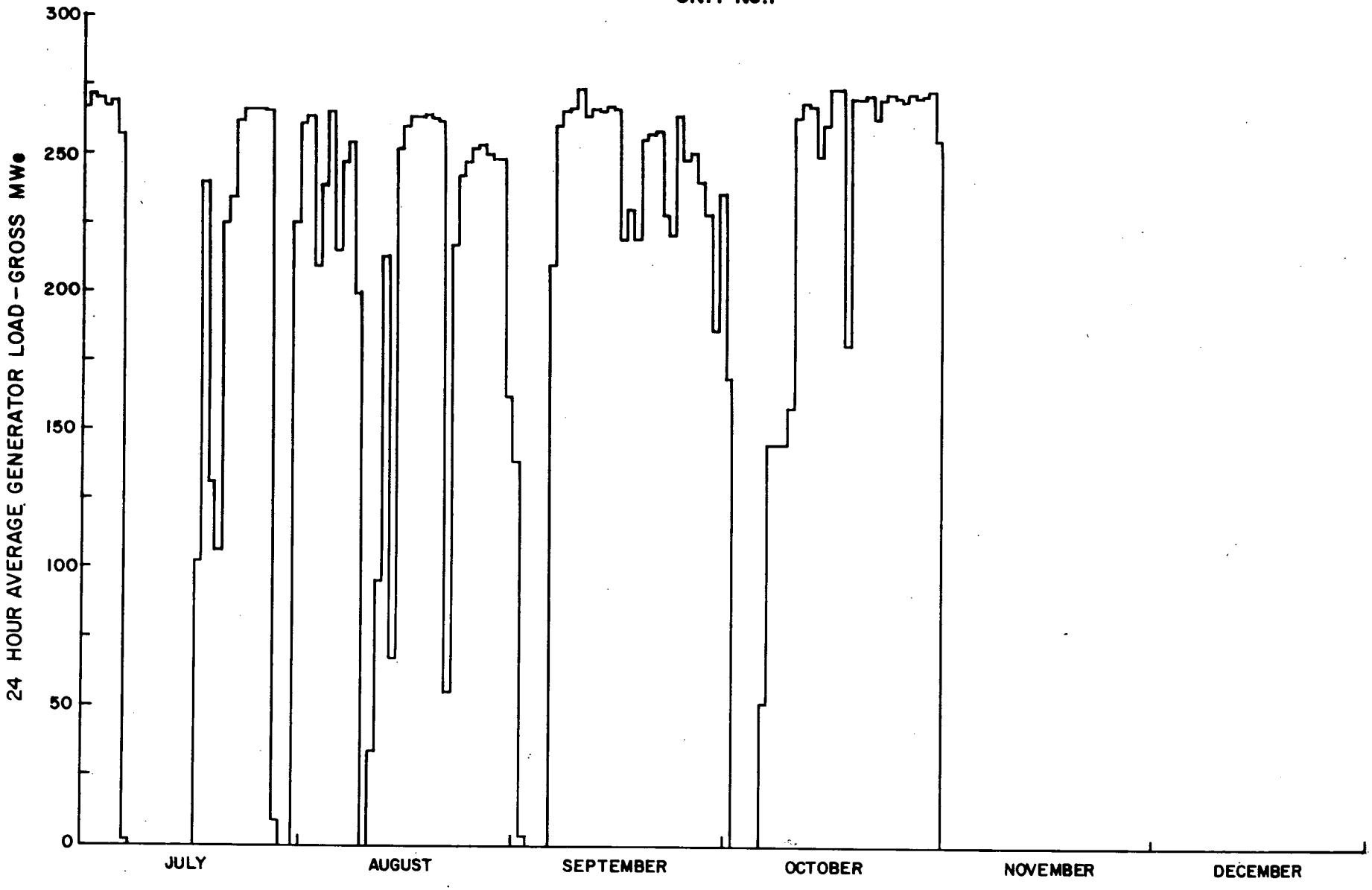
Source: Con Edison 1973-1977

Figure 1-3. INDIAN POINT STATION
POWER GENERATION HISTORY
JANUARY 1974 – JUNE 1974
UNIT No. 1



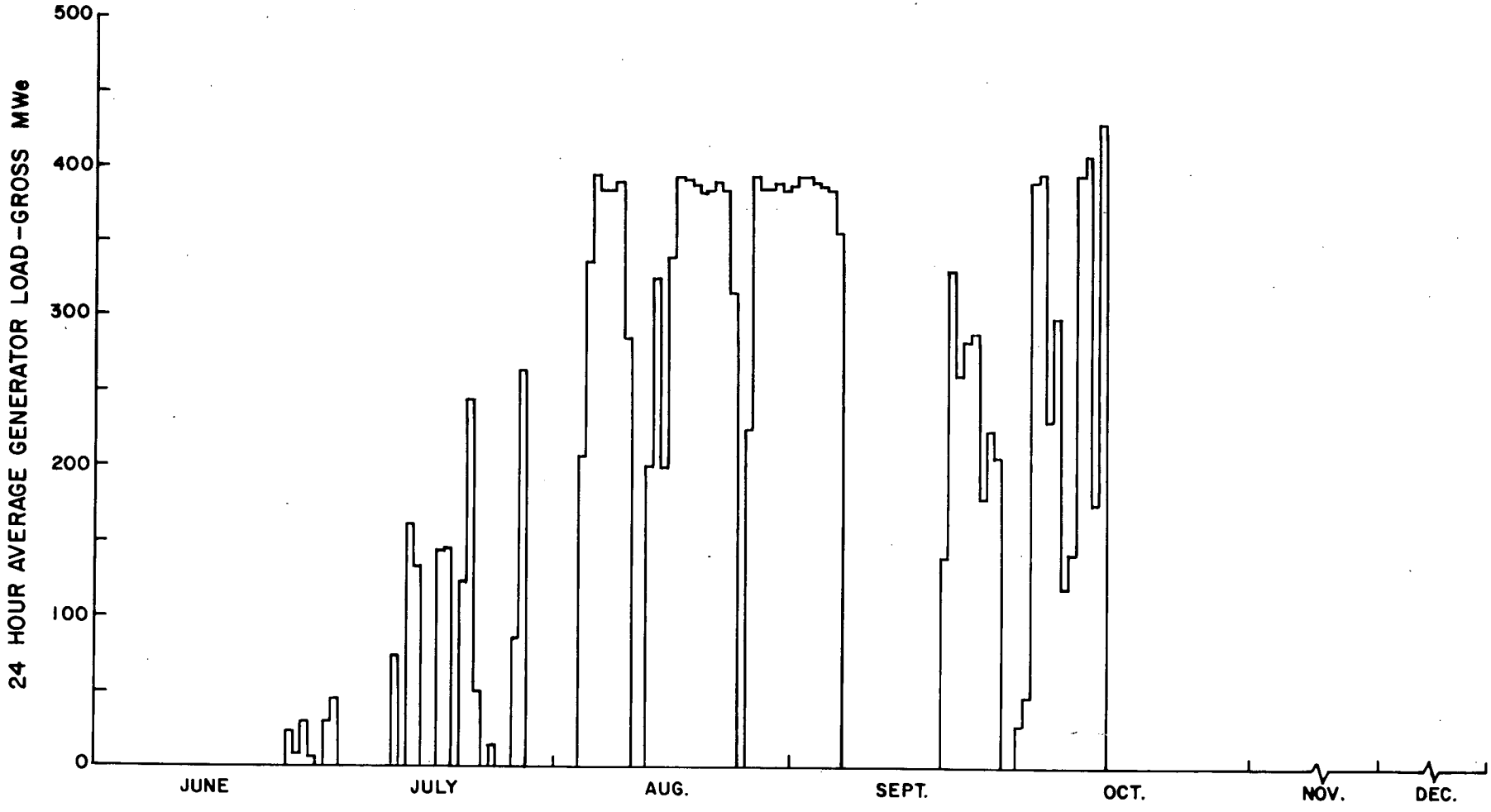
Source: Con Edison 1973-1977

Figure 1-4. INDIAN POINT STATION
POWER GENERATION HISTORY
JULY 1974 – DECEMBER 1974
UNIT No.1



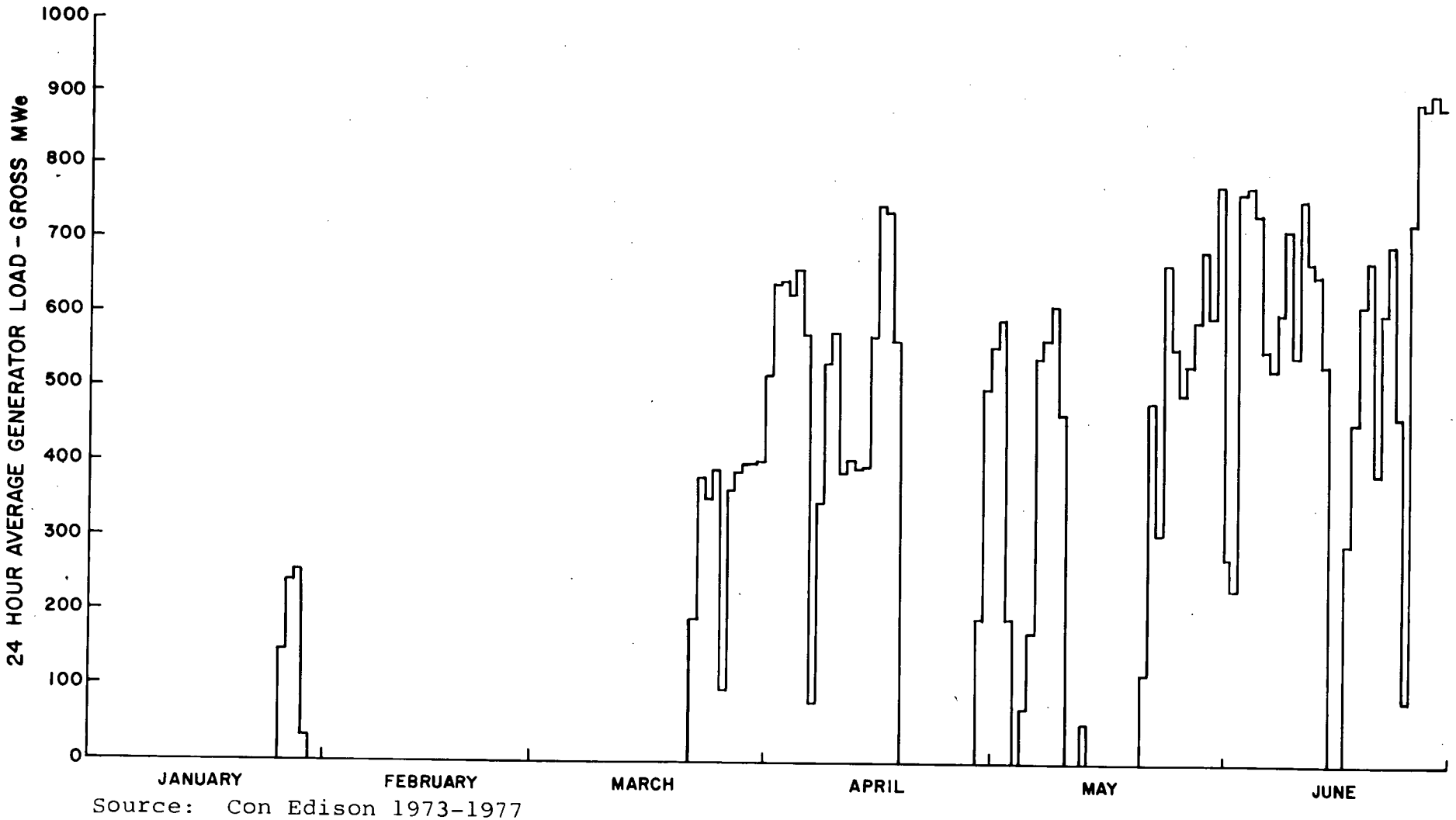
Source: Con Edison 1973-1977

Figure 1-5. INDIAN POINT STATION
POWER GENERATION HISTORY
JUNE 1973 - DECEMBER 1973
UNIT No.2



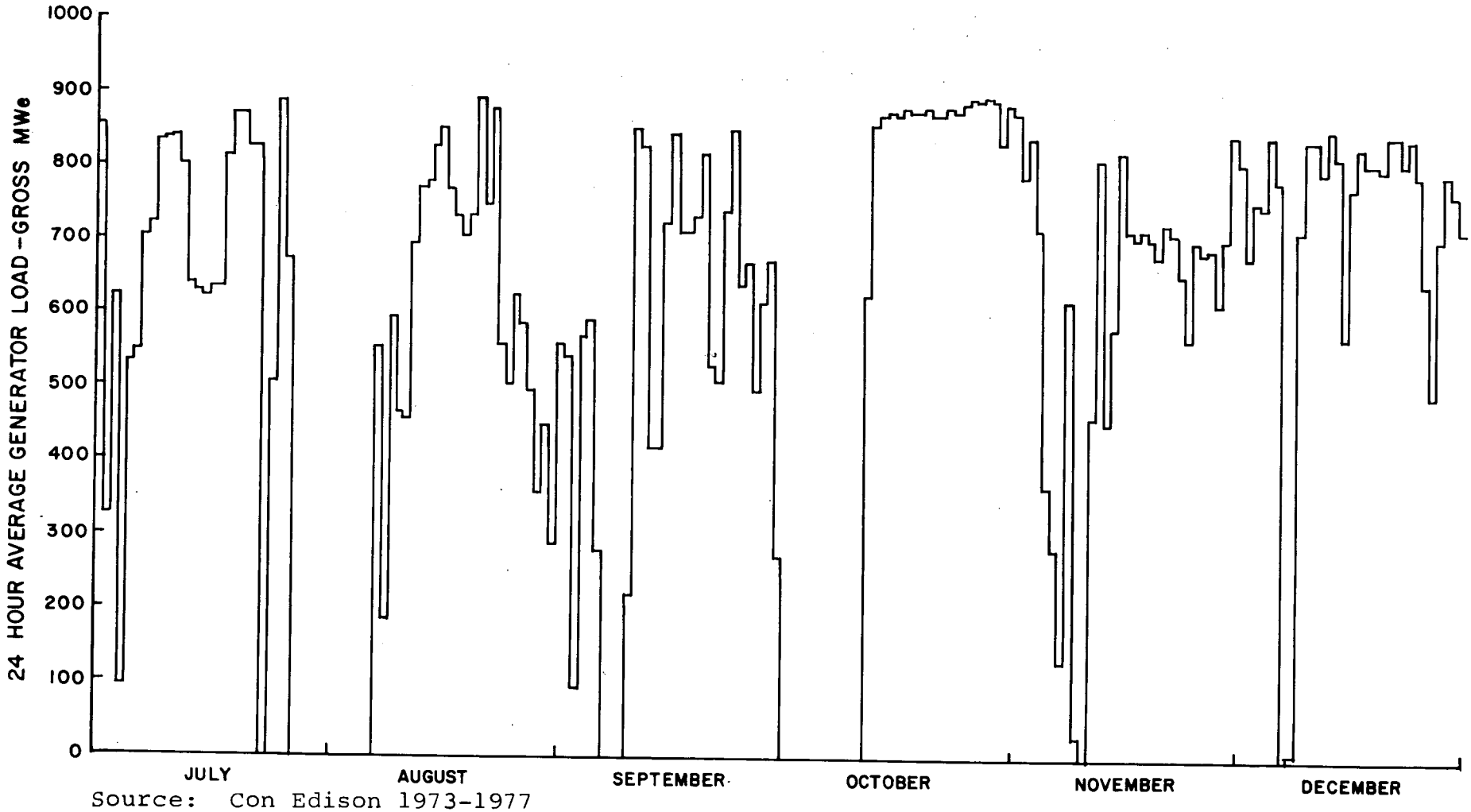
Source: Con Edison 1973-1977

Figure 1-6. **INDIAN POINT STATION**
POWER GENERATION HISTORY
JANUARY 1974 – JUNE 1974
UNIT No.2



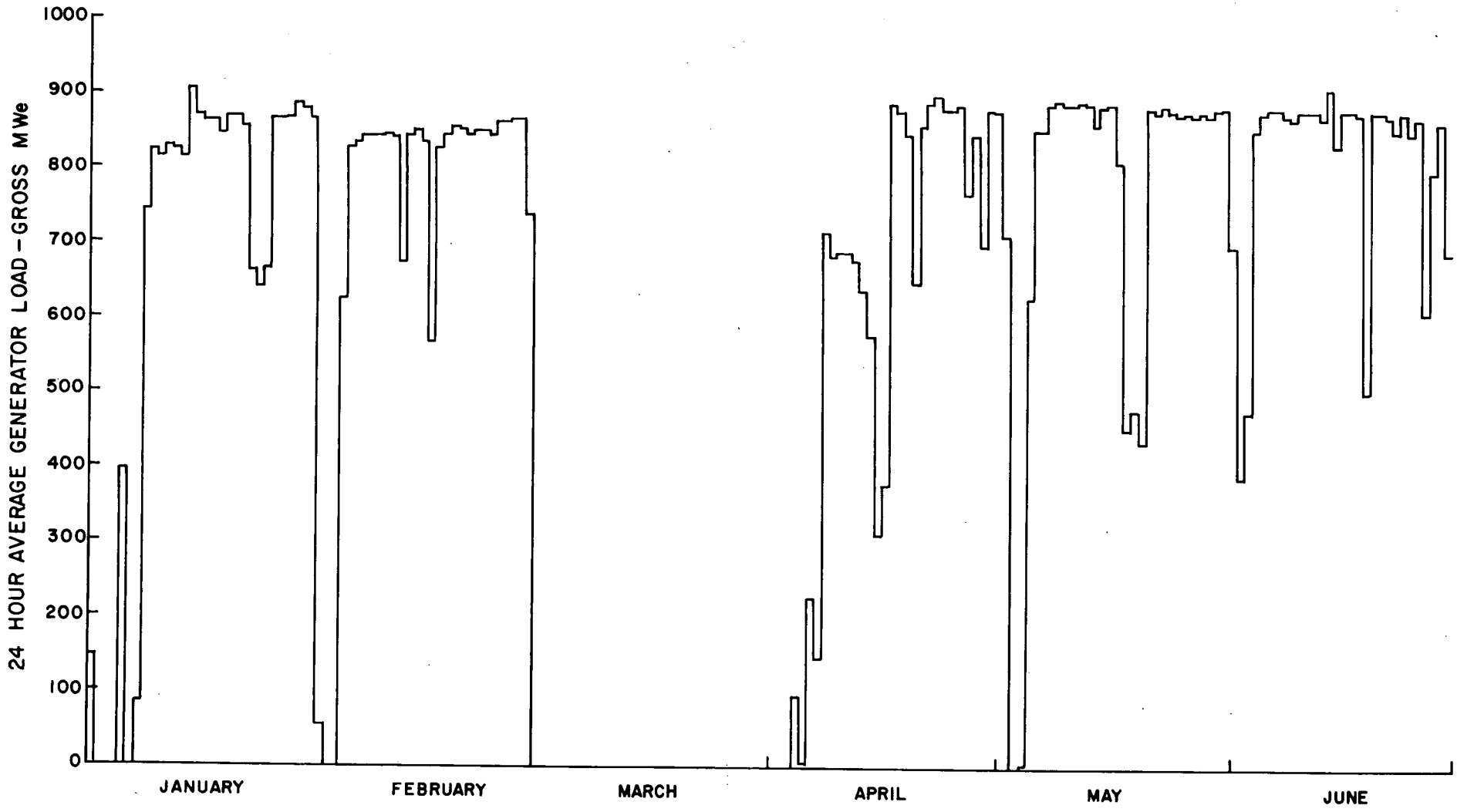
Source: Con Edison 1973-1977

Figure 1-7. **INDIAN POINT STATION POWER GENERATION HISTORY JULY 1974 - DECEMBER 1974 UNIT No.2**



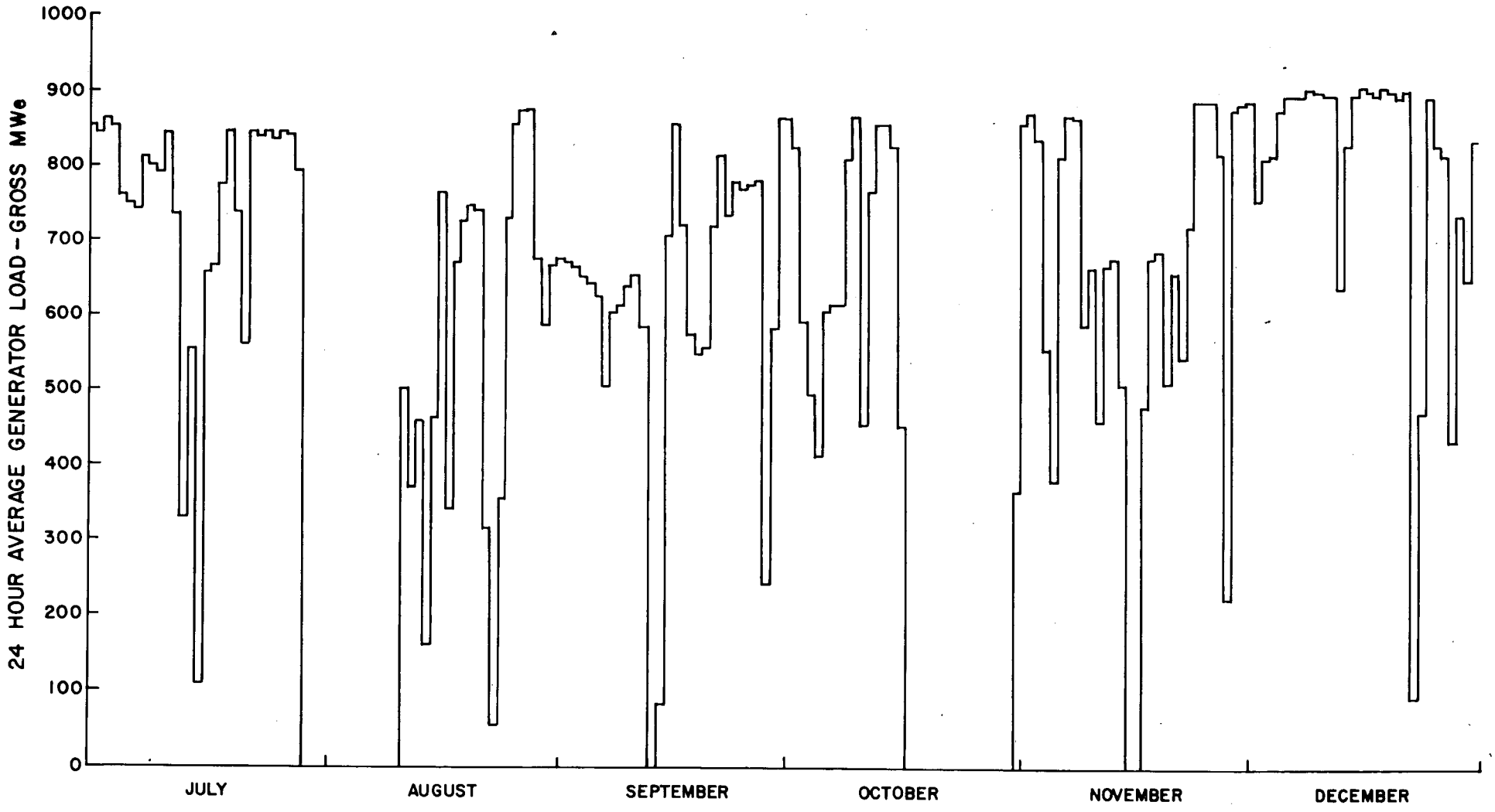
Source: Con Edison 1973-1977

Figure 1-8. **INDIAN POINT STATION POWER GENERATION HISTORY JANUARY 1975 – JUNE 1975 UNIT No. 2**



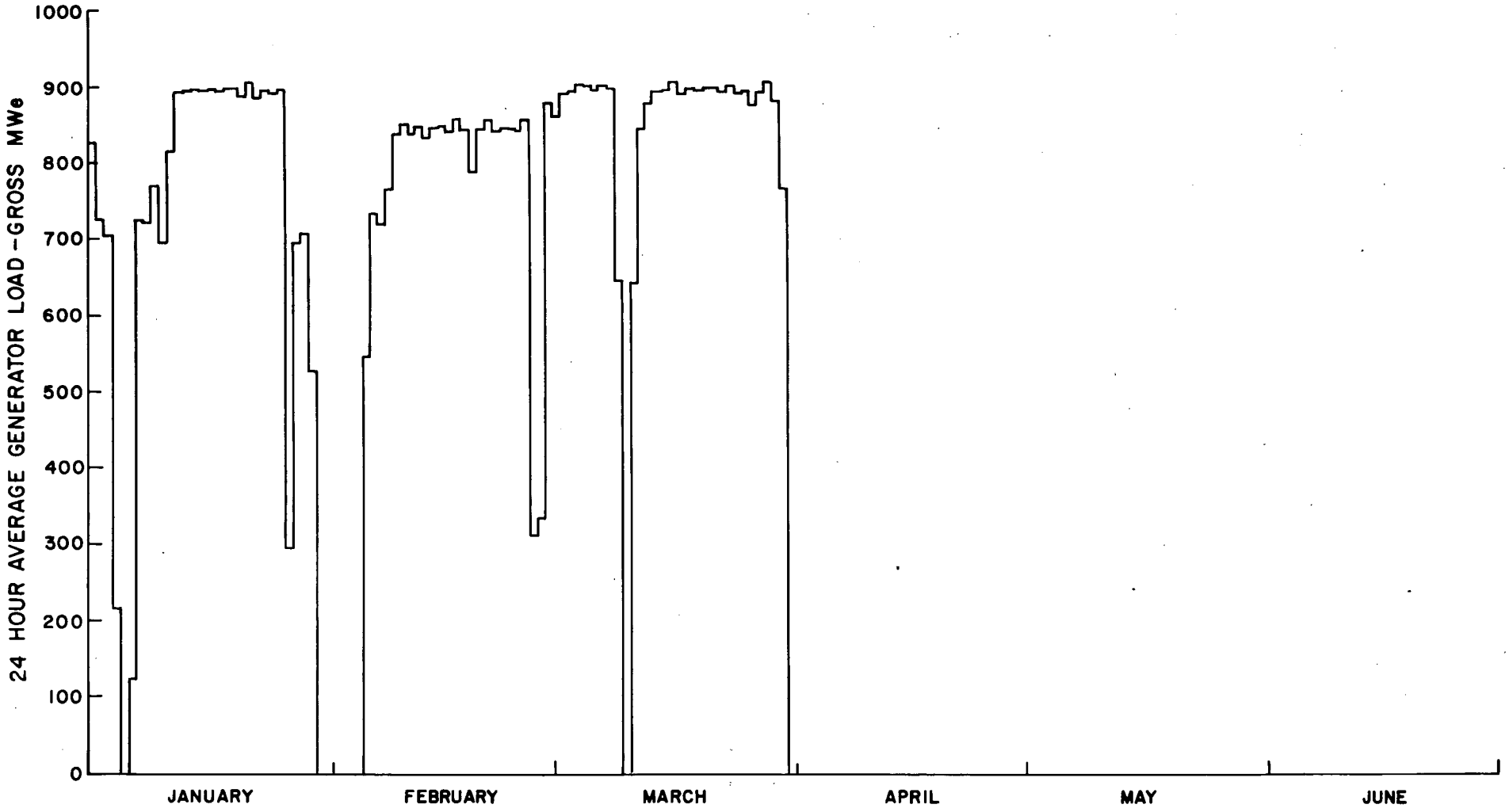
Source: Con Edison 1973-1977

Figure 1-9. **INDIAN POINT STATION POWER GENERATION HISTORY JULY 1975 - DECEMBER 1975 UNIT No.2**



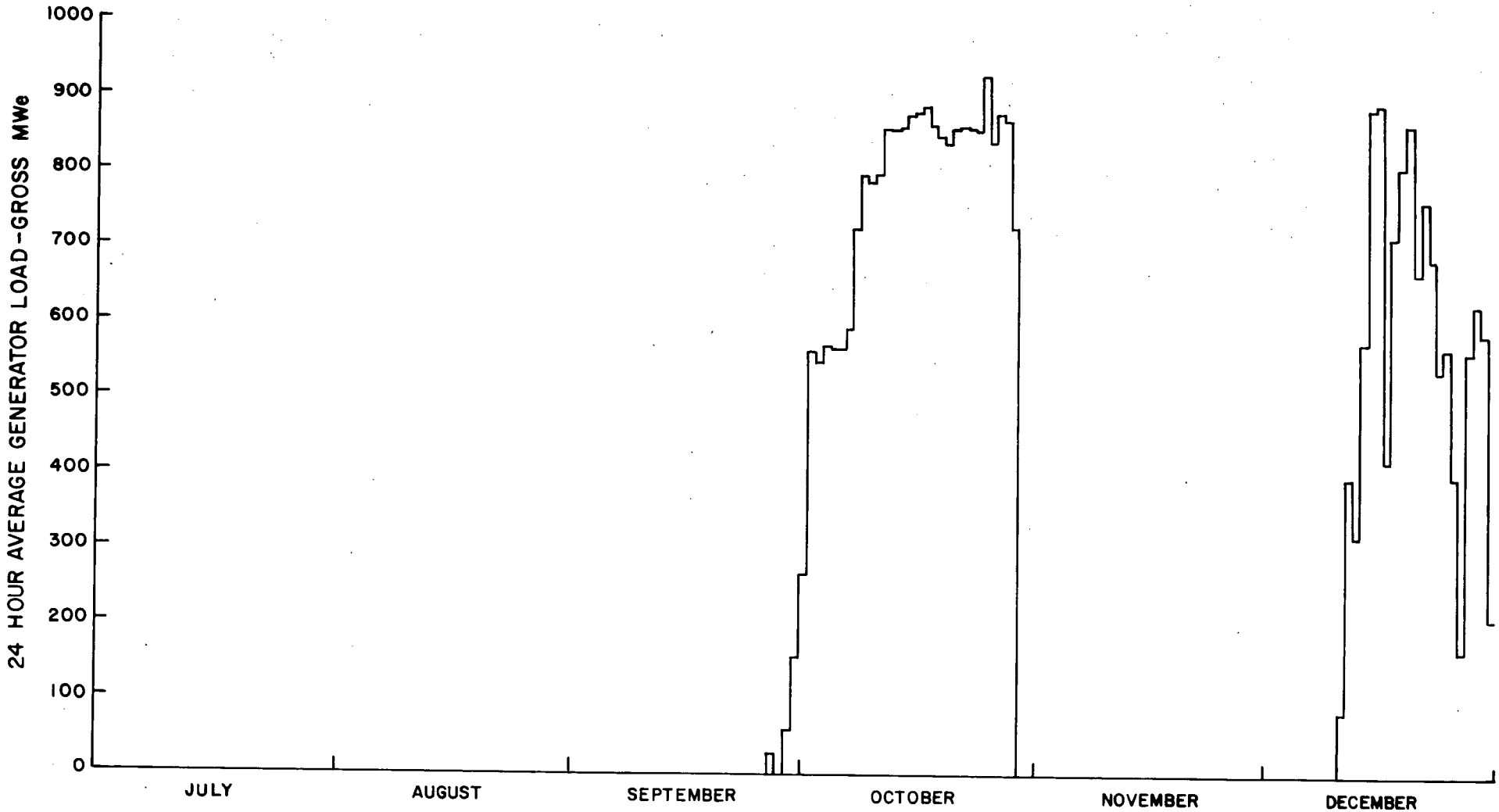
Source: Con Edison 1973-1977

Figure 1-10. **INDIAN POINT STATION POWER GENERATION HISTORY JANUARY 1976 – JUNE 1976 UNIT No.2**



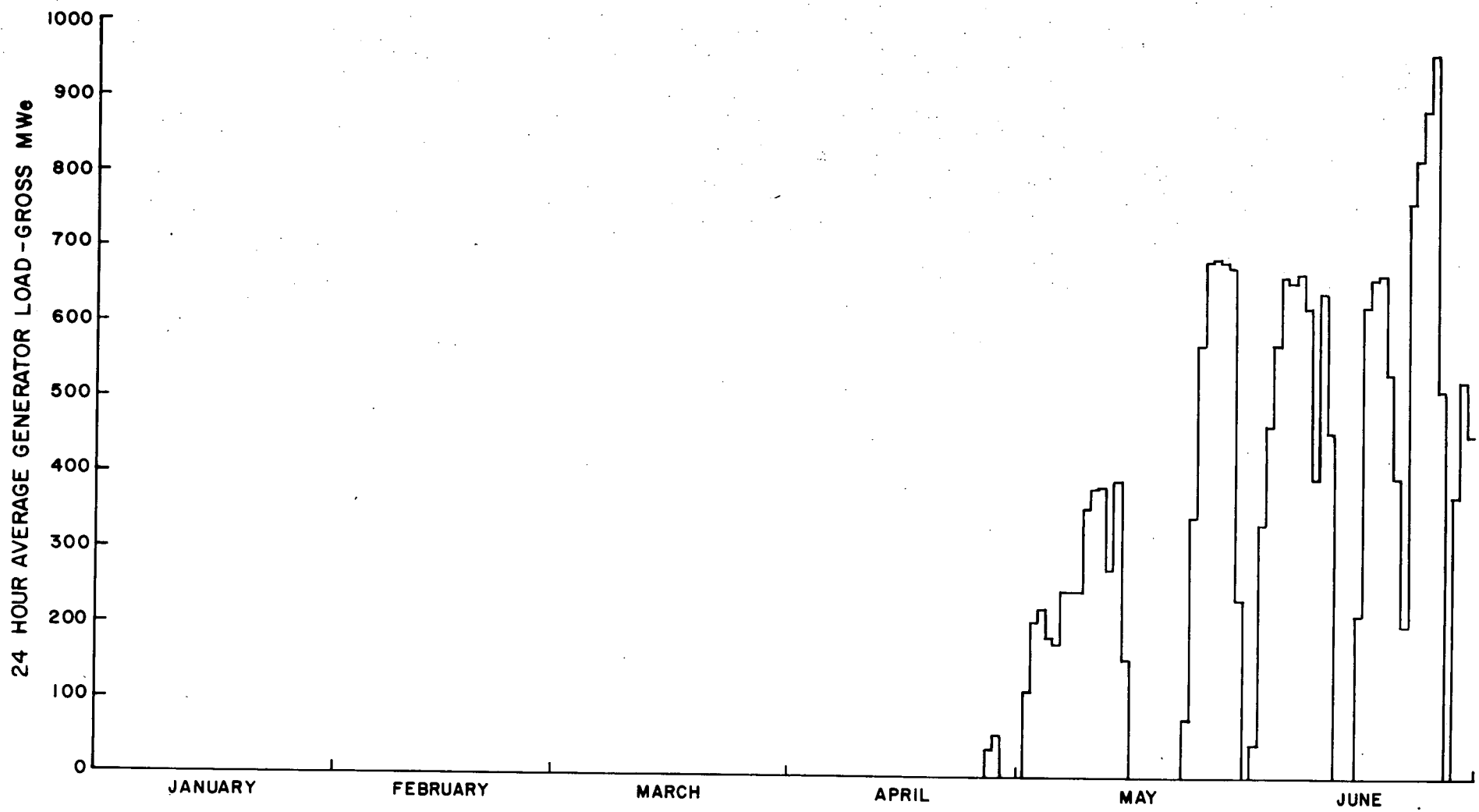
Source: Con Edison 1973-1977

Figure 1-11. INDIAN POINT STATION
POWER GENERATION HISTORY
JULY 1976 - DECEMBER 1976
UNIT No. 2



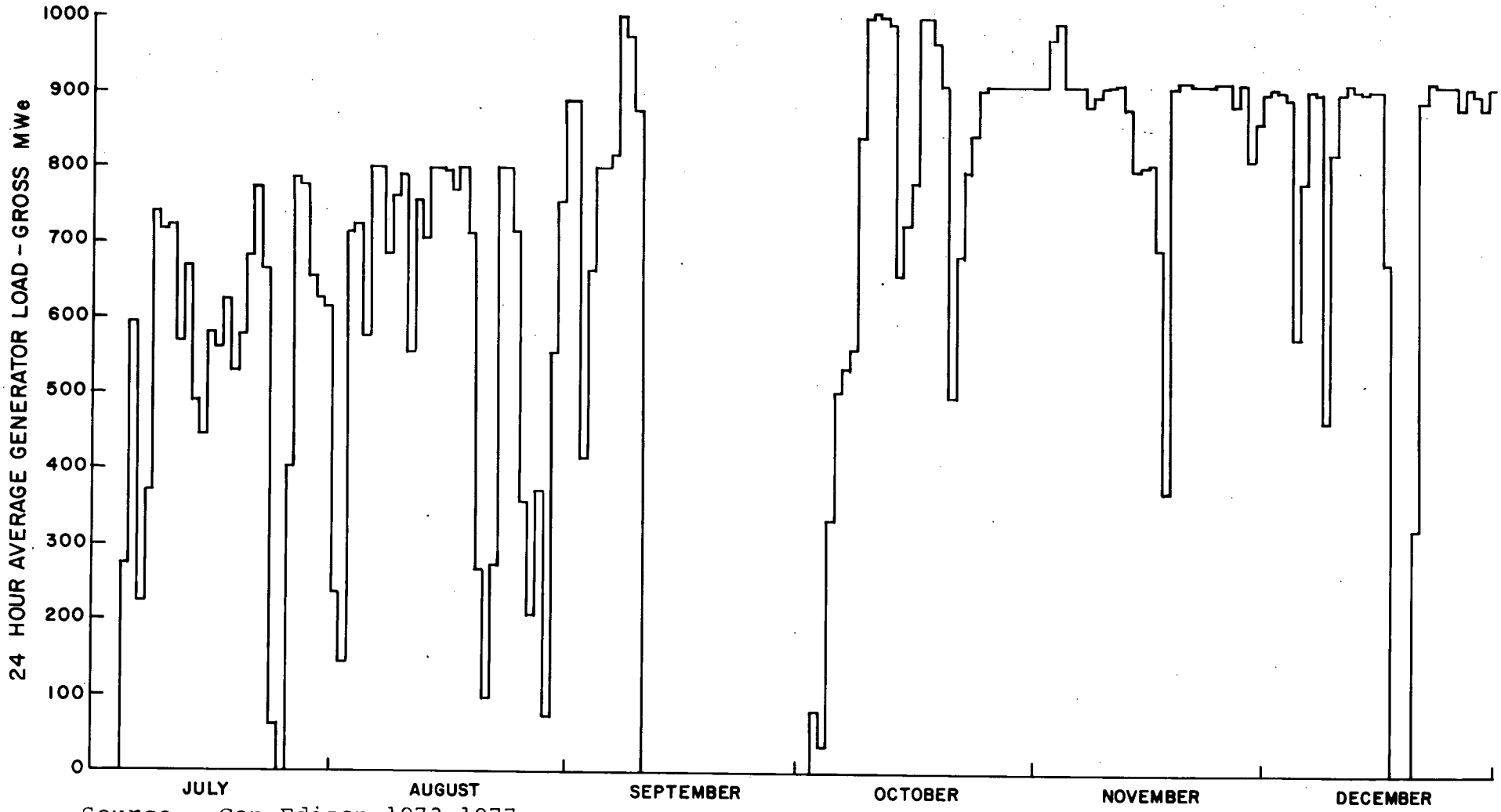
Source: Con Edison 1973-1977

Figure 1-12. INDIAN POINT STATION
POWER GENERATION HISTORY
JANUARY 1976 – JUNE 1976
UNIT No.3



Source: Con Edison 1973-1977

Figure 1-13. INDIAN POINT STATION
POWER GENERATION HISTORY
JULY 1976 – DECEMBER 1976
UNIT No.3



Source: Con Edison 1973-1977

Each unit has six circulating water pumps and six service water pumps. The circulating water system is designed to operate at either 100% flow or at 60% flow. When the ambient water temperature is above 40°F (non-winter condition) the pumps operate so that the maximum cooling water flow for each unit is 840,000 gpm (1871.5 cfs). During the winter, 40% of the cooling water is returned to the intakes without passing through the condensers thereby reducing the maximum intake for each unit to 504,000 gpm (1123 cfs). This reduced flow condition occurs when the water temperature is 40°F or less and results in a decrease in intake volume which mitigates impingement during the winter months.

Service water is drawn through a separate intake forebay in the center of each intake and, after utilization is discharged into the common canal. The maximum total service water flow for each unit is 30,000 gpm (67 cfs) making the combined maximum (cooling water + service water) flow for Units Nos. 2 and 3 together 1,740,000 gpm (3877 cfs).

Cooling water flow rates for Units Nos. 2 and 3 for both non-winter and winter operating conditions are summarized below.

Non-Winter Condition

Unit No.	Max. Cooling Water Flow gpm (cfs)	Max. Service Water Flow gpm (cfs)	Total gpm (cfs)
2	840,000 (1871.5)	30,000 (67)	870,000 (1938.5)
3	840,000 (1871.5)	30,000 (67)	870,000 (1938.5)
2&3	1,680,000 (3743)	60,000 (134)	1,740,000 (3877)

Winter Condition

2	504,000 (1123)	30,000 (67)	534,000 (1190)
3	504,000 (1123)	30,000 (67)	534,000 (1190)
2&3	1,008,000 (2246)	60,000 (134)	1,740,000 (3877)

1.2.2 Condenser and System Temperature Rise

The condenser temperature rise is dependent upon the rate of condenser cooling water flow and the amount of waste heat rejection to the condenser. Predicted condenser temperature rises based on condenser performance analysis, for various operating conditions and river temperatures are presented in Tables 1-2 and 1-3, for Units No. 2 and 3, respectively.

The daily average temperature rise across the circulating water system (from intakes through discharge canal), including daily

Table 1-2. Condenser Temperature Rise (F) Predictions Indian Point Unit No. 2

Plant Capacity MW	River Temperature °F	Pumps Operated with No Recirculation 6 pumps	5 pumps	4 pumps	3 pumps	Pumps Operated with 40% Recirculation 6 pumps	5 pumps	4 pumps	3 pumps
906 (100% load)	40	-	-	-	-	26.2	31.6		
	50	15.8	18.8	23.5	32.2	26.5	31.8		
	60	15.9	18.9	23.6	32.5	-	-	**	**
	70	16.0	19.0	23.8	*	-	-		
	80	16.1	19.2	24.3	*	-	-		
766	40	-	-	-	-	22.6	27.4	34.4	
	50	13.5	16.3	20.6	27.5	22.9	27.5	34.5	
	60	13.6	16.4	20.7	27.8	-	-	-	**
	70	13.7	16.5	20.8	28.2	-	-	-	
	80	13.8	16.6	21.0	*	-	-	-	
510	40	-	-	-	-	15.8	19.3	24.2	31.
	50	9.4	11.5	14.5	19.4	16.1	19.4	24.3	31.
	60	9.5	11.6	14.6	19.5	-	-	-	-
	70	9.6	11.7	14.7	19.8	-	-	-	-
	80	9.7	11.8	14.8	20.2	-	-	-	-

*Turbine backpressure higher than 3.5 "Hg
** Plant would be derated

Source: Derived from Con Edison 1977b

Table 1-3. Condenser Temperature Rise (F) Predictions Indian Point Unit No. 3

Plant Capacity MW	River Temperature °F	Pumps Operated with No Recirculation 6 pumps	5 pumps	4 pumps	3 pumps	Pumps Operated with 40% Recirculation 6 pumps	5 pumps	4 pumps	3 pumps
1000 (100% load)	40	-	-	-	-	28.8	34.7		
	50	17.1	20.7	25.8	35.3	29.1	34.9		
	60	17.2	20.8	25.9	35.6	-	-	**	**
	70	17.3	20.9	26.1	*	-	-		
	80	17.4	21.1	26.6	*	-	-		
766	40	-	-	-	-	22.6	27.4	34.4	
	50	13.5	16.3	20.6	27.5	22.9	27.5	34.5	
	60	13.6	16.4	20.7	27.8	-	-	-	**
	70	13.7	16.5	20.8	28.2	-	-	-	
	80	13.8	16.6	21.0	*	-	-	-	
510	40	-	-	-	-	15.8	19.3	24.2	33.
	50	9.4	11.5	14.5	19.4	16.1	19.4	24.3	33.
	60	9.5	11.6	14.6	19.5	-	-	-	-
	70	9.6	11.7	14.7	19.8	-	-	-	-
	80	9.7	11.8	14.8	20.2	-	-	-	-

* Turbine backpressure higher than 3.5 "Hg
** Plant would be derated

Source: Derived from Con Edison 1977b

intake and discharge temperatures, for October, 1973 through December 1977 are given in Annual Environmental Operating Reports (Con Edison 1973-77) and are included as Attachment 1 of this Appendix.

1.2.3 Heat Rejection Rates

The amount of heat rejected to the condenser is primarily dependent upon the electrical output of the power plant. Since the turbine performance is sensitive to exhaust steam temperature, the condenser waste heat is also dependent upon the inlet temperature and flow rate of the condenser cooling water. Tables 1-4 and 1-5 present heat rejection rates based on turbine performance analysis versus plant capacity and river temperature for Indian Point Units Nos. 2 and 3, respectively. It is apparent that the plant load decreases with decreasing steam flow which results in a lower heat rejection rate. Also, a higher river temperature and/or lower cooling water flow can reduce turbine efficiency which in turn may increase condenser waste heat per unit of generation.

Total heat rejected to the river on a daily basis for the period October 1973 through December 1976 is presented in Attachment 1 of this Appendix.

1.3 Time-Temperature Profiles

Transit times for cooling water traveling through the intake structures, condensers, discharge canal and dispersing into the Hudson River are presented below. Time-temperature correlations, as shown in Figures 1-14, 1-15 and 1-16, respectively, for the flood, ebb and slack tidal phases were evaluated for the case when both Indian Point Units Nos. 2 and 3 operate at maximum generating capacity with maximum cooling water flow.

As shown in Figures 1-14 through 1-16, the time-temperature profiles can be characterized by four stages. 1) Water temperature increases rapidly through the condensers (Point A to Point B), 2) water from both units mixes in the discharge canal where the temperature remains relatively constant to the discharge ports (Point B to Point C), 3) temperature decreases rapidly as the submerged jet is entrained rising to the water surface (Point C to Point D), and 4) the thermal plume gradually disperses into the ambient receiving water body (Point D to Point E).

The time-temperature profiles indicate that during a complete tidal cycle, the total transit time to the 4°F excess temperature isotherm (Pt.A to Pt.E) of the slack phase is the longest while that of ebb is the shortest, because for an estuary such as the

Table 1-4. Condenser Waste Heat (10^9 Btu/hr) Indian Point Unit No. 2

Plant Capacity MW (gross)	River Temperature °F	Pumps Operated with No Recirculation				Pumps Operated with 40% Recirculation			
		6 pumps	5 pumps	4 pumps	3 pumps	6 pumps	5 pumps	4 pumps	3 pumps
906 (100% load)	40	-	-	-	-	6.6	6.6		
	50	6.5	6.6	6.6	6.8	6.7	6.7		
	60	6.6	6.6	6.6	6.8	-	-	**	**
	70	6.6	6.7	6.7	*	-	-		
	80	6.7	6.7	6.8	*	-	-		
766	40	-	-	-	-	5.7	5.8	5.8	
	50	5.7	5.7	5.8	5.8	5.8	5.8	5.8	
	60	5.7	5.7	5.8	5.8	-	-	-	**
	70	5.8	5.8	5.8	5.9	-	-	-	
	80	5.8	5.8	5.9	*	-	-	-	
510	40	-	-	-	-	4.0	4.1	4.1	4.4
	50	3.9	4.0	4.1	4.1	4.1	4.1	4.1	4.4
	60	4.0	4.1	4.1	4.1	-	-	-	-
	70	4.0	4.1	4.1	4.2	-	-	-	-
	80	4.1	4.1	4.1	4.2	-	-	-	-

* Turbine backpressure higher than 3.5" Hg

** Plant would be derated

Source: Derived from Con Edison 1977b

Table 1-5. Condenser Waste Heat (10^9 Btu/hr) Indian Point Unit No. 3

Plant Capacity MW (gross)	River Temperature °F	Pumps Operated with No Recirculation				Pumps Operated with 40% Recirculation			
		6 pumps	5 pumps	4 pumps	3 pumps	6 pumps	5 pumps	4 pumps	3 pumps
1000	40	-	-	-	-	7.3	7.3		
(100% load)	50	7.2	7.2	7.2	7.4	7.3	7.3		
	60	7.3	7.3	7.3	7.5	-	-	**	**
	70	7.3	7.3	7.3	*	-	-		
	80	7.3	7.4	7.5	*	-	-		
766	40	-	-	-	-	5.7	5.8	5.8	
	50	5.7	5.7	5.8	5.8	5.7	5.8	5.8	
	60	5.7	5.7	5.8	5.8	-	-	-	**
	70	5.8	5.8	5.8	5.9	-	-	-	
	80	5.8	5.8	5.9	*	-	-	-	
510	40	-	-	-	-	4.0	4.1	4.1	4.4
	50	3.9	4.0	4.1	4.1	4.1	4.1	4.1	4.4
	60	4.0	4.1	4.1	4.1	-	-	-	-
	70	4.0	4.1	4.1	4.2	-	-	-	-
	80	4.1	4.1	4.1	4.2	-	-	-	-

* Turbine backpressure higher than 3.5" Hg

** Plant would be derated

Source: Derived from Con Edison 1977b

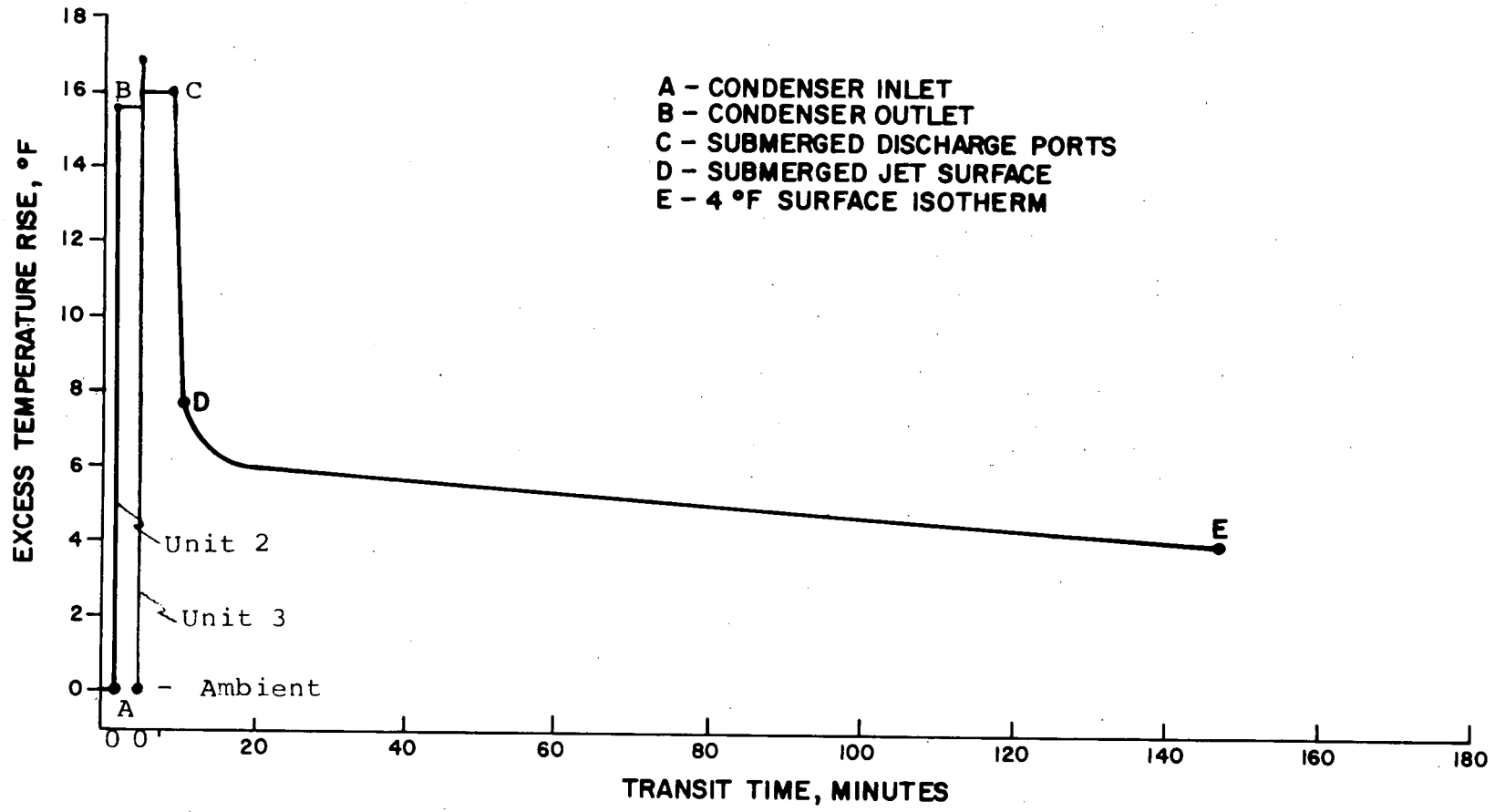


Figure 1-14. Predicted Transit Time vs. Temperature for Indian Point at 100% Rated Capacity. Flood Tide.

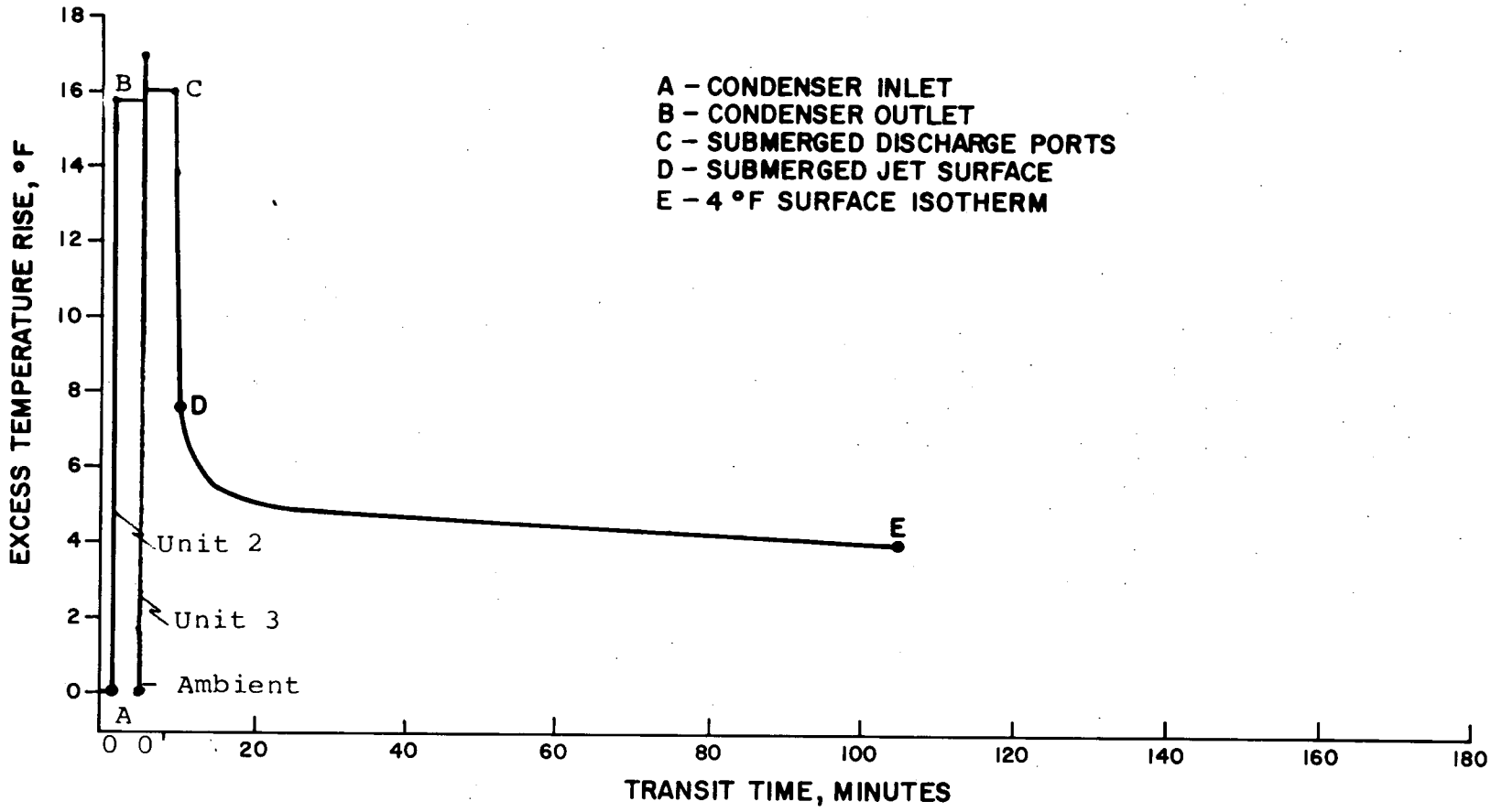


Figure 1-15. Predicted Transit Time vs. Temperature for Indian Point at 100% Rated Capacity. Ebb Tide

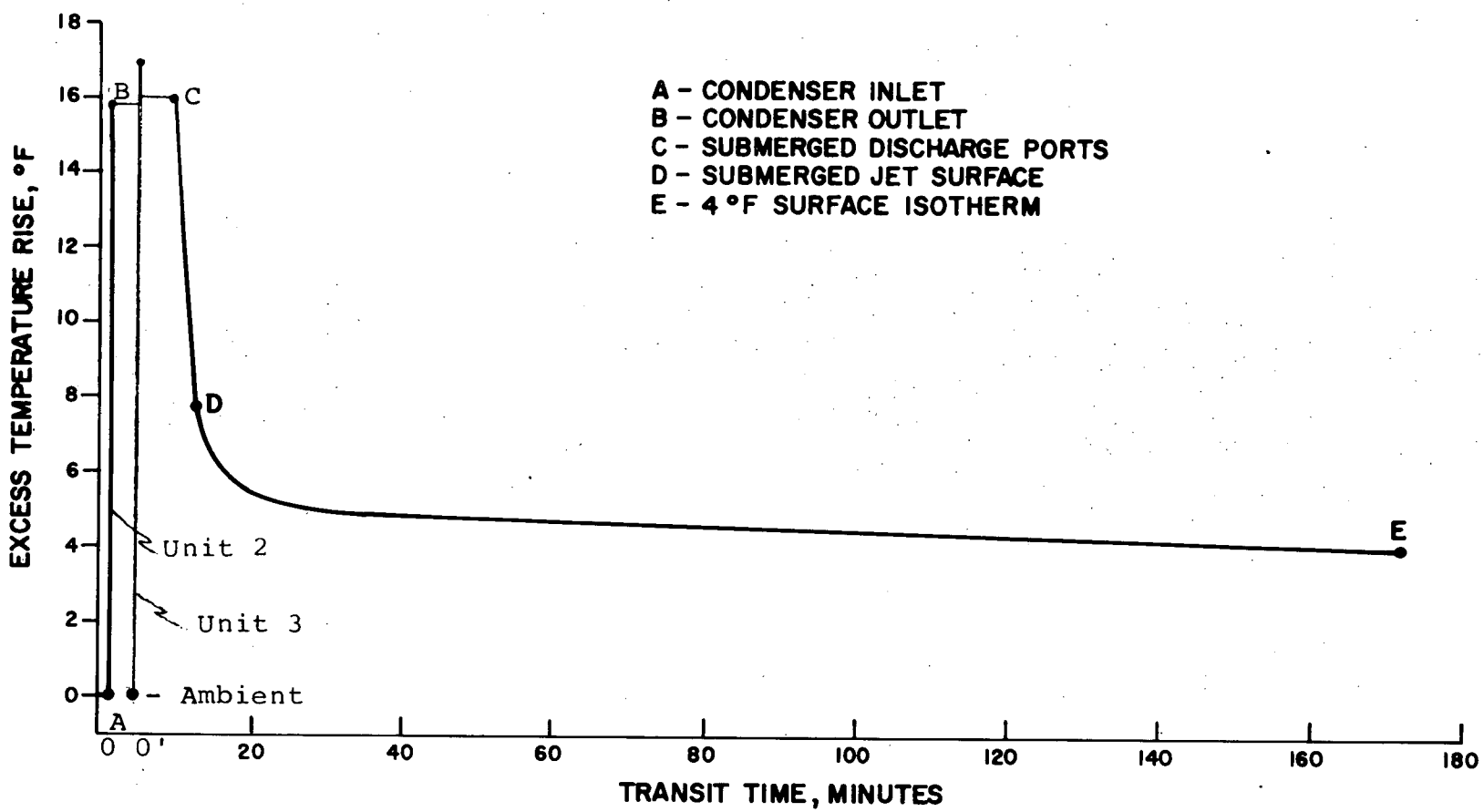


Figure 1-16. Predicted Transit Time vs. Temperature for Indian Point at 100% Rated Capacity. Slack Tide.

Hudson River, the ebb current is generally greater than the flood current. Maximum heat transfer occurs when the cooling water is absorbing heat from the condenser. However, the transit time during this particular process is very short (approximately 0.14 minutes for each unit). The next highest transfer of heat is observed during the period when the submerged jet mixes with the ambient receiving body resulting in a moderate thermal dilution. Due to high initial jet momentum, this dilution process is completed within a short period. The final thermal plume diffusion might take as much as three hours, but the thermal effect during this period is considered insignificant.

The data presented in Figures 1-14 through 1-16 are evaluated on the basis of both analytical work and actual field survey data. The hydro-thermal data for the nearfield submerged jet are predicted by a slot jet model developed by Koh and Fan (1970), while the far field thermal plume characteristics are established by field surveys.

The Koh and Fan submerged jet model was developed to deal with the case of merging adjacent plumes discharging into a stagnant water body. The effects of both ambient density and thermal stratification on the plumes were incorporated into this model. At the point of discharge, the individual jets are separate and the axisymmetric case is solved. At the point where the jets begin to merge the two-dimensional solution is applied. The transition from one jet to the other occurs in an intermediate zone but is assumed to be instantaneous. Koh and Fan applied two different transition criteria. The first is based on the geometry of the jet in which the two-dimensional analysis starts when the width of the round jet is equal to the jet spacing. The second criterion is based on the entrainment concept to define transition when the entrainment as calculated by round jet theory equals that calculated in the slot jet theory. However, these two criteria give essentially the same solution.

1.4 Chlorine

Sodium hypochlorite is used in the condenser cooling system to control biological fouling.

In accordance with the Environmental Technical Specification Requirements (ETSR) (U.S. NRC 1975b) for Indian Point Units Nos. 1, 2 and 3, the maximum frequency of chlorination of the circulating water system is three (3) times per week when the intake water temperature is 45°F or higher, and the maximum concentration of the total residual chlorine in the cooling water discharge to the Hudson River cannot exceed 0.5 ppm nor an average of 0.2 ppm during a maximum of 2 one-hour periods a day.

Assuming chlorination would be required from mid-April through early December when the river water is warmer than 45°F, and the frequency of chlorination is three times per week, the total number of chlorination periods become approximately 100 times a year. During the last few years, however, the actual chlorination frequency has been much lower than that estimated above. The record indicates that the Indian Point cooling water system was chlorinated only 16 times in 1974, 13 times in 1975 and none in 1976 and 1977. The new chlorination procedure adopted for the Indian Point station calls for physical examination of the condenser to determine whether chlorination is necessary or not.

In addition to the reduction in chlorination frequency, the daily average total residual chlorine concentration in the discharge canal was found to be practically undetectable (0.05 ppm whereas the accuracy of a residual chlorine analysis is ±0.05 ppm) during 11 of the 13 chlorination days in 1975. Average chlorine concentrations on the remaining two days were 0.10 and 0.24 ppm. (See Attachment 2, chlorination data for 1975.) These low residual chlorine values together with the infrequency of chlorination lead to the conclusion that chlorination at Indian Point does not cause any significant adverse environmental impact.

1.5 Other Chemicals

In addition to sodium hypochlorite which is used in the circulating water system, normal operation of Indian Point necessitates the use of chemicals in the primary (reactor core coolant) and secondary (steam generation) systems of the plant. Consequently, releases of certain chemicals to the Hudson River from plant operations occur. The most common chemicals used are:

(1) Phosphates (trisodium and disodium), used in combination with sodium hydroxide in the treatment of plant service boilers;

(2) Hydrazine, used in the secondary system to control oxygen in the steam generators;

(3) Cyclohexylamine or morpholine, used in the secondary system to adjust feedwater and steam pH;

(4) Lithium hydroxide, used in primary system for pH control;

(5) Boric acid, used in the primary system to control the neutron reactivity;

(6) Potassium chromate, used in the core coolant water system as a corrosion inhibitor;

(7) Sodium hydroxide, used in the primary system demineralizers;

(8) Detergent, used in the plant laundry; and

(9) Sulfuric acid which is used as a chemical regenerant in the water treatment process.

Chemical discharge concentrations are regulated by the NPDES permits (USEPA 1975), 401 Certifications (NYSDEC 1973, 1975) and USNRC Environmental Technical Specification Requirements (ETSR) (U.S. NRC 1975b) for the Indian Point Station. These documents specify the limits of the various chemical discharges and require a monitoring program to assure that chemical discharges do not exceed the established limits.

Water from the once-through condenser system or service water system is used to dilute any discharged chemicals. During normal plant operation, dilution of effluent results in chemical concentrations which are insignificant. Even when less water is used during shutdowns or outages dilution factors are high. Discharges are diluted further due to tidal dispersion in the river (Con Ed 1973). The results of the 1975 chemical monitoring program submitted to the USNRC in March, 1976, indicate clearly that the actual chemical discharge concentrations are much less than the maximum permitted levels specified by the ETSR. Similar findings are reported for 1976 and 1977. Maximum concentration levels given in the ETSR and monthly monitoring data for the year 1975 are presented in Tables 1-6 and 1-7, respectively. Monthly monitoring data for 1976 and 1977 have been submitted to the NYSDEC.

1.6 Dissolved Oxygen

Analytical studies and field surveys conducted during the last five years have indicated that operation of the Indian Point Station results in no discernible difference between dissolved oxygen levels measured at the intake and those measured at the discharge (Lawler 1972; 1973; Con Edison 1977e).

In 1974 and 1975, Con Edison conducted a series of D.O. surveys across the cooling water systems of both Indian Point Unit No. 1 and No. 2 pursuant to requirements specified in the 401 Certification issued by the NYSDEC for Indian Point Unit No. 2. Summary results of each survey were submitted to both the NYSDEC and the USNRC.

Table 1-6. LIQUID EFFLUENT MONITORING SURVEY PER ENVIRONMENTAL TECHNICAL SPECIFICATION REQUIREMENTS

Parameter Analyzed for	Max. Conc. (ppm)	Collection and Analyses Frequency *
Phosphate (Orthophosphate)	1.5	WK
Hydrazine	0.1	WK
Cyclohexylamine	0.1	WK
pH - (units)	6.0 - 9.0	DD
Lithium Hydroxide	0.01	D
Boron	1.0	D
Chromium (total)	0.05	WK
Residual Chlorine (free and combined)	0.5	D
Chlorine Demand	(Not Applicable)	WK
Sodium Hydroxide	(Not Applicable)	DD
Specified Conductance (Salinity)	(Not Applicable)	WK
Soda Ash	(Not Applicable)	D
Sulfuric Acid	(Not Applicable)	DD
Turbidity (Suspended Solids)	(Not Applicable)	WK
Dissolved Oxygen	(Not Applicable)	WK
Detergent	1.0	MO
Drewgard 100	2.5	MO

* WK (weekly), MO (monthly), D (during discharge), DD (continuously during discharge of regenerant wastes from neutralization facility).

Source: Con Edison 1977c.

Table 1-7. EFFLUENT MONITORING DATA

1975 (1)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
pH	7.2-7.8	7.3-7.8	7.1-7.8	7.3-7.8	7.4-7.7	7.6-7.7	7.4-8.1	7.6-7.7	7.5-7.9	7.4-7.9	7.6-7.8	7.4-7.9
Phosphate mg/l	<0.1-0.2	<0.1	<0.1	<.1-0.6	<0.1-0.2	<0.1	<.1-0.2	<.1	<.1	<.1-.2	<.1	<.1
Hydrazine, mg/l	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Cyclohexylamine mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Boron, mg/l	≤0.2	≤0.2	≤0.2	≤0.2	≤0.2	≤.2	≤.2-.9	≤.2-.3	≤.2	≤.2-.3	≤.2	≤.2-.6
Chromium, mg/l	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003	<.003
Detergent, mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Free Residual Chlorine, ppm	— (2)	(2)	(2)	(2)	<.05-.27	<.05-.16	<.05	<.05	<.05	(2)	(2)	(2)
Total Residual Chlorine, ppm	— (2)	(2)	(2)	(2)	<.05-.49	<.05-.18	<.06	<.05	<.05	(2)	(2)	(2)
Dissolved Oxygen, mg/l	9.8-15.0	14.8-15.0	13.8-14.8	12.8-14.4	9.4-11.8	7.1-8.7	6.2-7.6	6.3-7.7	5.7-7.9	6.6-10.3	9.5-13.0	12.-15

(1) Data taken from "Annual Environmental Operating Report - 1975," submitted to NRC on 3/30/76.

(2) No Chlorination

Source: Con Edison 1977c.

Examination of the 1974-75 data confirms the analytical findings that plant operation causes no discernible difference between the dissolved oxygen measurements obtained at the intake of Indian Point Unit No. 2 and those obtained in the discharge canal. The NYSDEC concurred with this conclusion and consequently amended the Section 401 D.O. survey requirements from 30 days of measurements four times a year (a total of 120 days per year) to five days of measurements to be conducted at the time of each thermal survey.

During August 1974, Con Edison conducted a series of dissolved oxygen measurements in the Hudson River in the vicinity of Indian Point to investigate the validity of the speculation of the Nuclear Regulatory Commission that the plant operation may reduce ambient D.O. levels. However, these river D.O. surveys indicated that the operation of the Indian Point station has no discernible impact on ambient river D.O. concentrations.

A series of twelve dissolved oxygen river surveys were conducted. The month of August was selected because it had been speculated by the NRC staff that the impact of plant operation on ambient dissolved oxygen levels would be most severe in late summer and early fall. The lowest ambient D.O. levels occur in late summer, because the maximum solubility of D.O. decreases with water temperature, and the highest river water temperatures occur in August.

Each river survey consisted of a sequence of D.O. and temperature measurements versus depth at over 50 locations, distributed in a ray-like fashion emanating from the Indian Point discharge canal in upstream, downstream, and cross-river directions. The following figures show the results of four representative surveys conducted on July 31 (Figure 1-17), August 1st (Figure 1-18), August 7th (Figure 1-19), and August 13th (Figure 1-20), 1974. Both Unit Nos. 1 and 2 were off-line from July 28th to mid-day of July 30th; from then until August 5th only Unit No. 1 operated at an average gross generation of 250 MWe. On August 7th and 13th both Units Nos. 1 and 2 operated at a combined electrical generation of approximately 1050 MWe gross, therefore, Figures 1-17 and 1-18 would represent the impact under minimal influence from the station, while Figures 1-19 and 1-20 represent the impact under almost 90% of the site's maximum generation. Clearly, from these figures there is no discernible difference between the D.O. patterns, save that D.O. levels in the immediate vicinity of the discharge canal are slightly higher than the rest of the river. This suggests that the turbulence created by the effluent from the discharge structure may slightly aerate the discharge region.

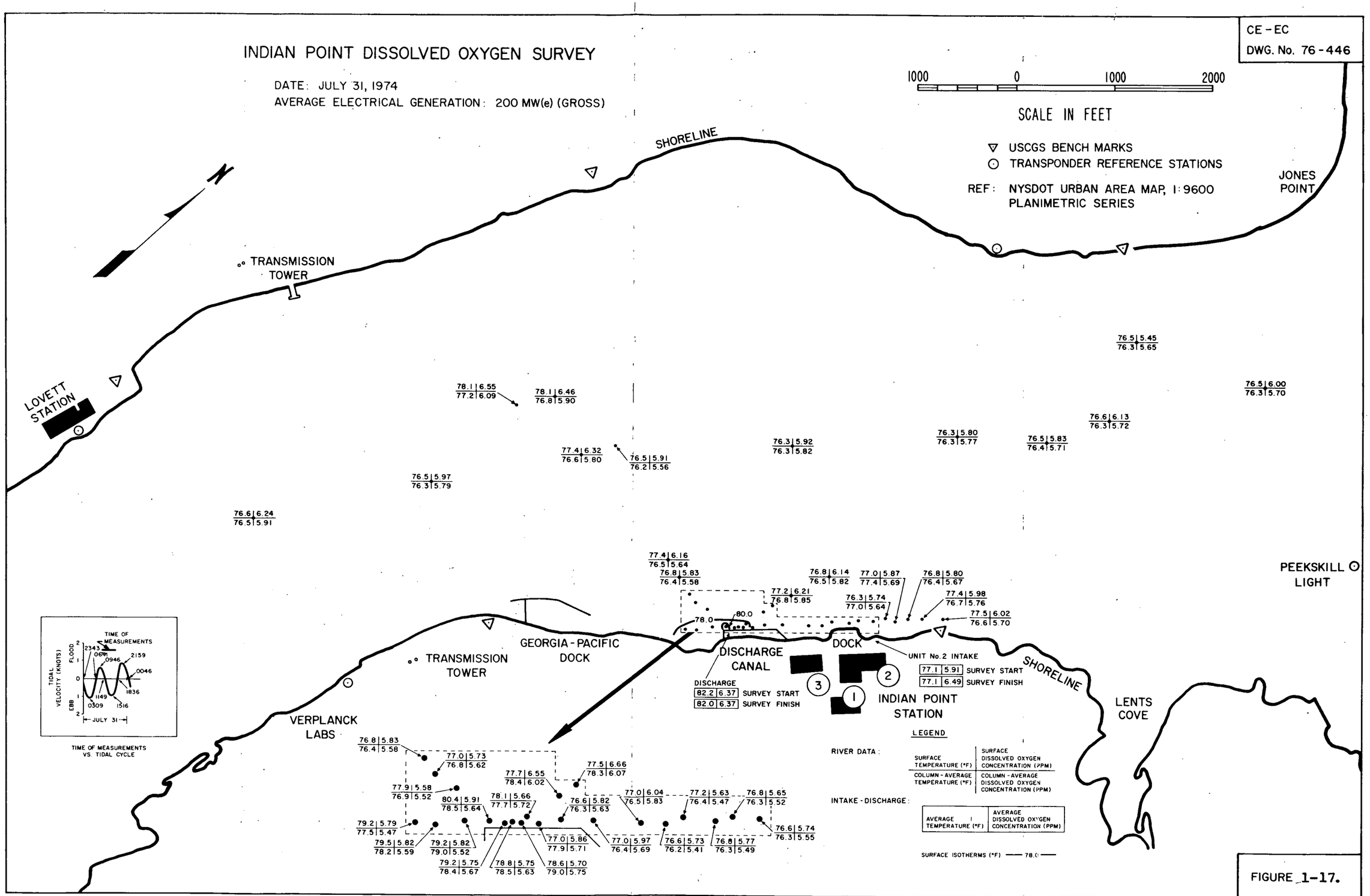


FIGURE 1-17.

Source: Con Edison 1977e

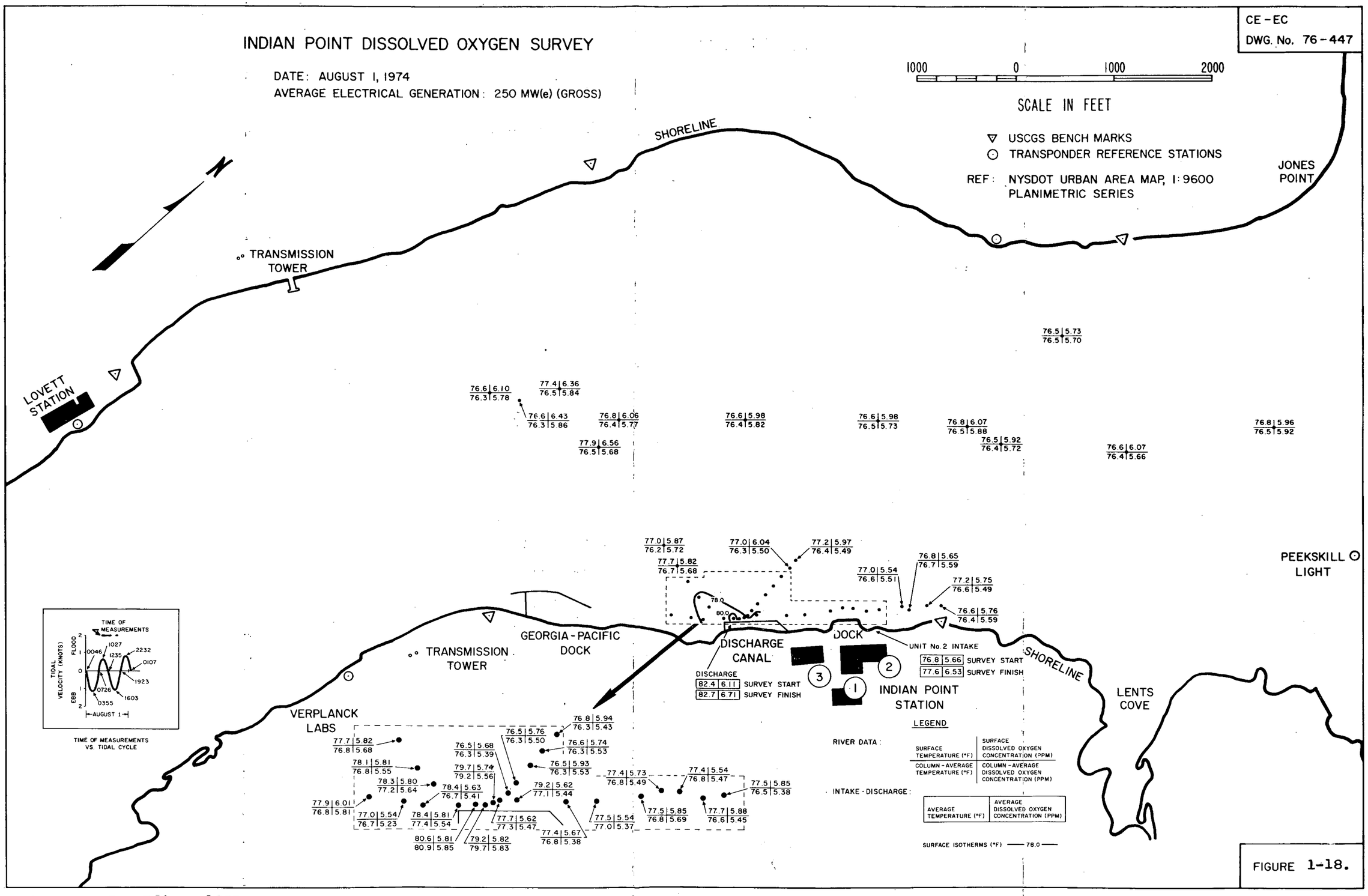


FIGURE 1-18.

Source: Con Edison 1977e

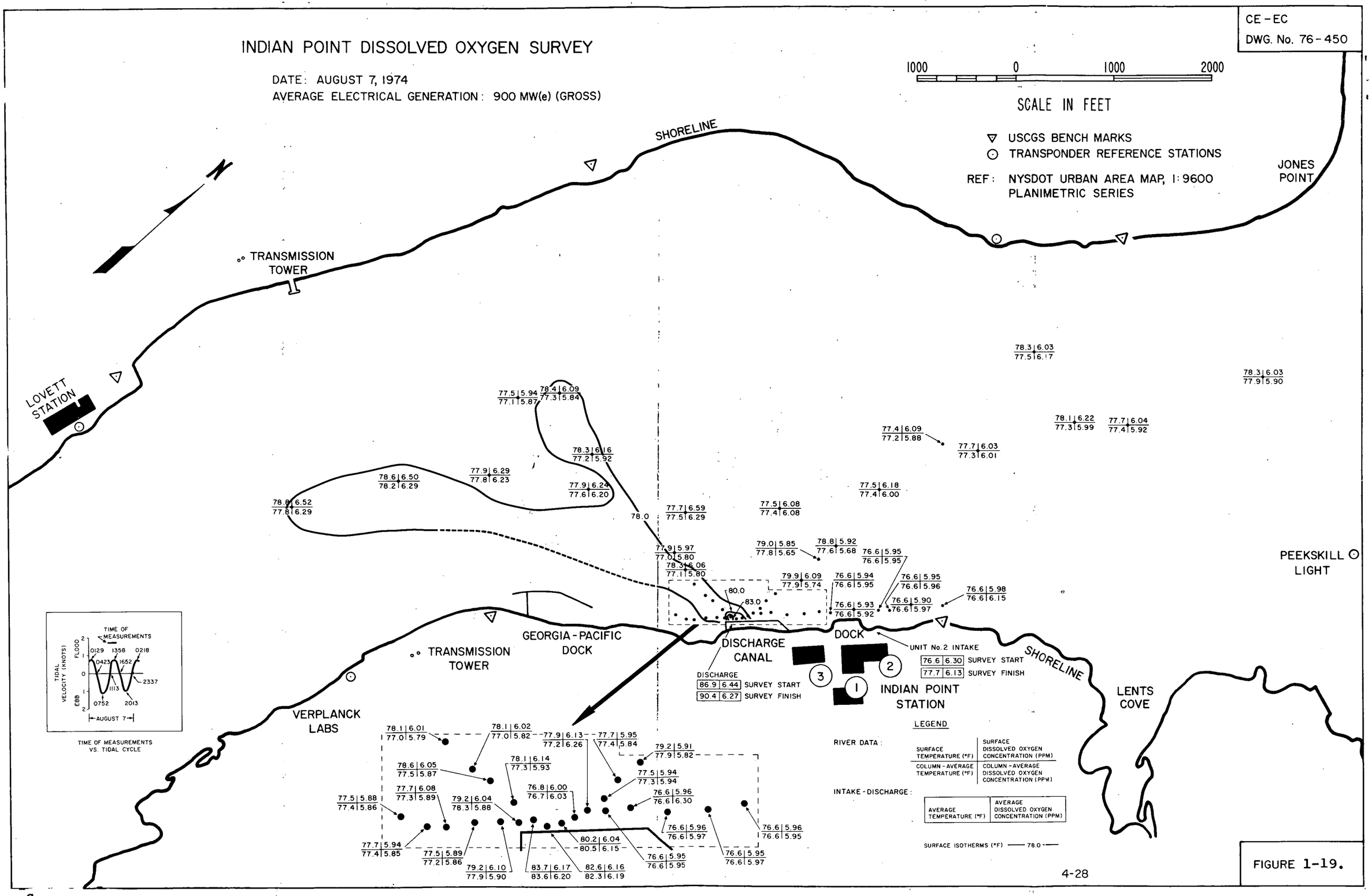


FIGURE 1-19.

Source: Con Edison 1977e

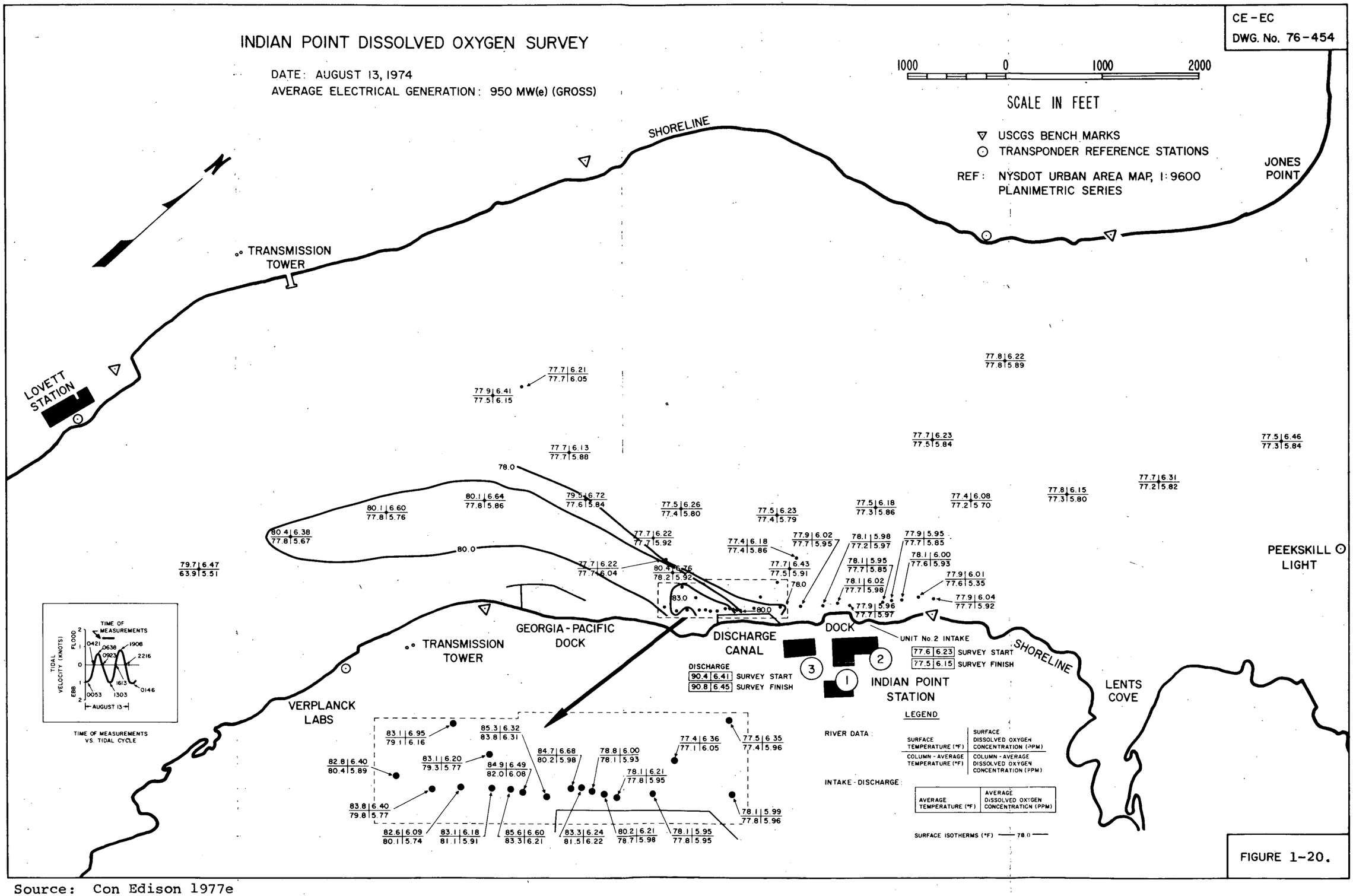


FIGURE 1-20.

Source: Con Edison 1977e

Table 1-8. Monthly Mean Freshwater Flow(cfs) at Green Is.,N.Y.

1947-1975

Month	Maximum	Minimum	Average
January	33,970	4,187	13,844
February	31,970	6,259	14,062
March	36,280	9,123	20,957
April	51,670	15,630	31,519
May	40,520	9,431	19,229
June	29,630	3,573	10,239
July	18,380	3,131	6,788
August	8,929	2,912	5,533
September	16,980	3,724	6,197
October	10,140	2,967	6,761
November	26,150	3,270	11,001
December	27,010	6,096	14,290

Source: TI 1976f.

Table 1-9. Monthly Freshwater Flow (cfs) at Green Island, N. Y.

For Years 1971 through 1975

	1971	1972	1973	1974	1975
January	9002	13410	26210	22010	19070
February	12110	10930	20460	18640	19370
March	20220	26860	29410	20730	23680
April	37270	37960	30960	30170	25580
May	35240	40520	27600	22960	20000
June	7334	29630	13050	8791	12970
July	6223	18380	10390	11780	7464
August	8929	7616	5591	6359	8966
September	9315	6309	4791	10390	17030
October	7811	7291	5650	9049	23360
November	7291	26150	8280	17180	22420
December	17000	27010	26420	19380	18647

Source: TI 1976 f.

1.7 Hydrologic Information

1.7.1 Flow

1.7.1.1 Freshwater Input

The major portion of the freshwater flow in the Hudson River Estuary enters at its head at Troy, about 150 miles north of the mouth. Because of the inability to directly measure freshwater flow in tidal waters due to masking by the larger tidal flows, the USGS gauging station at Green Island just above Troy is used to establish freshwater discharges into the estuary (LMS 1975). The freshwater flow near Indian Point may be estimated by multiplying measured flows at Green Island by seasonal flow factors developed from United States Geological Survey (USGS) data. These factors account for the flow from the drainage area between Green Island and Indian Point and average about 1.2 (Con Ed 1972a; Dames & Moore and Con Ed 1976). Long-term monthly mean, minimum and maximum freshwater flows at Green Island for the period 1947 to 1975 are presented in Table 1-8 (TI 1976f). Freshwater flow varies during the year with maximum flows occurring predominately during the spring months and low flows occurring generally in the late summer and early fall. Discharge at Green Island during the high flow month of April averaged 31, 519 cfs during the period 1947 to 1975, while discharge during August, the low flow month, averaged 5533 cfs. The minimum average seven consecutive day flow which may be expected once in ten years is approximately 3000 cfs (USNRC 1975a; Con Ed 1977a).

Monthly average freshwater discharge data at Green Island for the period 1971 through 1975 are presented in various reports (TI 1976; Con Ed 1977). The recent data follow the historical trend, with, generally, the highest flows occurring during April and the lowest, during August (Table 1-9).

1.7.1.2 Tidal Flow

The Hudson River is tidal from its mouth at the Battery up to the Federal Dam at Troy. The magnitude of tidal flow at any section is determined by such factors as ocean tide, channel friction, wave reflection and freshwater flow. Mean tidal flow over any period represents the average of mean ebb and mean flood flows. Average tidal flow near Indian Point is approximately 140,000 cfs based on low summer freshwater flows of about 6000 cfs. Higher freshwater flows into the estuary generally decrease tidal flood velocities and flows and increase ebb velocities and flows in the estuary (LMS 1975). Maximum tidal flow generally ranges from 200,000 to 300,000 cfs (USNRC 1975a).

Generally, due to density differences between salt and freshwater, a two-layer flow system exists in the Hudson River in

the vicinity of Indian Point under conditions of low to medium freshwater discharge (summer, fall and winter months). These layers are not separated by any distinct boundary since vertical mixing occurs between them (USNRC 1975a). The net flow in the upper layer which is predominantly freshwater is in the downstream direction, while the lower layer, predominantly salt water, has a net upstream flow. For a freshwater flow range between 6,000 and 12,000 cfs, the net upper layer flow at Indian Point has been reported at a relatively constant 35,400 cfs (QLM 1974). During periods of high freshwater flow (spring season), the estuary is characterized by a one-layer flow system with net flow in the downstream direction.

Units Nos. 2 and 3 circulate a maximum of 1,740,000 gallons per minute (3877 cfs) of Hudson River water for condenser cooling (1,680,000 gpm) and other plant operational needs (60,000 gpm). This represents only 2.8% of the tidal flow of the Hudson River (average tidal flow 140,000 cfs under low freshwater flow conditions). Essentially all of this water is returned to the river. Generally, when freshwater flows of more than 20,000 cfs are present near Indian Point, salt intrusion is not evident and the river water is completely fresh from top to bottom (one-layered). Under this condition, the water circulated by the plant represents less than 20% cf the fresh water flow in the river. However, during periods of salt intrusion a two-layered system generally exists in the river due to density differences between salt and fresh water. Under this condition, estimation of freshwater usage is extremely difficult since the water available for use includes both upper and lower layer net flows, which are mixtures of saltwater and freshwater. Since the river flow used for cooling is continuously returned to the river, the plant has no impact on the amount of flow in the Hudson River.

1.7.2 Currents

Tidal currents were measured on August 26, 1974 at a transect located at the Indian Point station as part of the 1974 intensive thermal survey program (Dames & Moore and Con Ed 1976). Current measurements were also taken on September 25, 1974 at a transect located approximately one-half mile south of the station. The measurements are shown on Figs. 1-21 and 1-22 along with predicted values from the National Ocean Survey (US Dept. of Commerce 1975).

The results indicate that the measured tidal currents are generally close to the predicted tidal currents for both tidal times and magnitudes.

Generally, the ebb and flow currents at the surface were higher than those at the bottom. Channel (mid-transect) surface velocities at maximum ebb were approximately 1.4 and 1.6 feet per

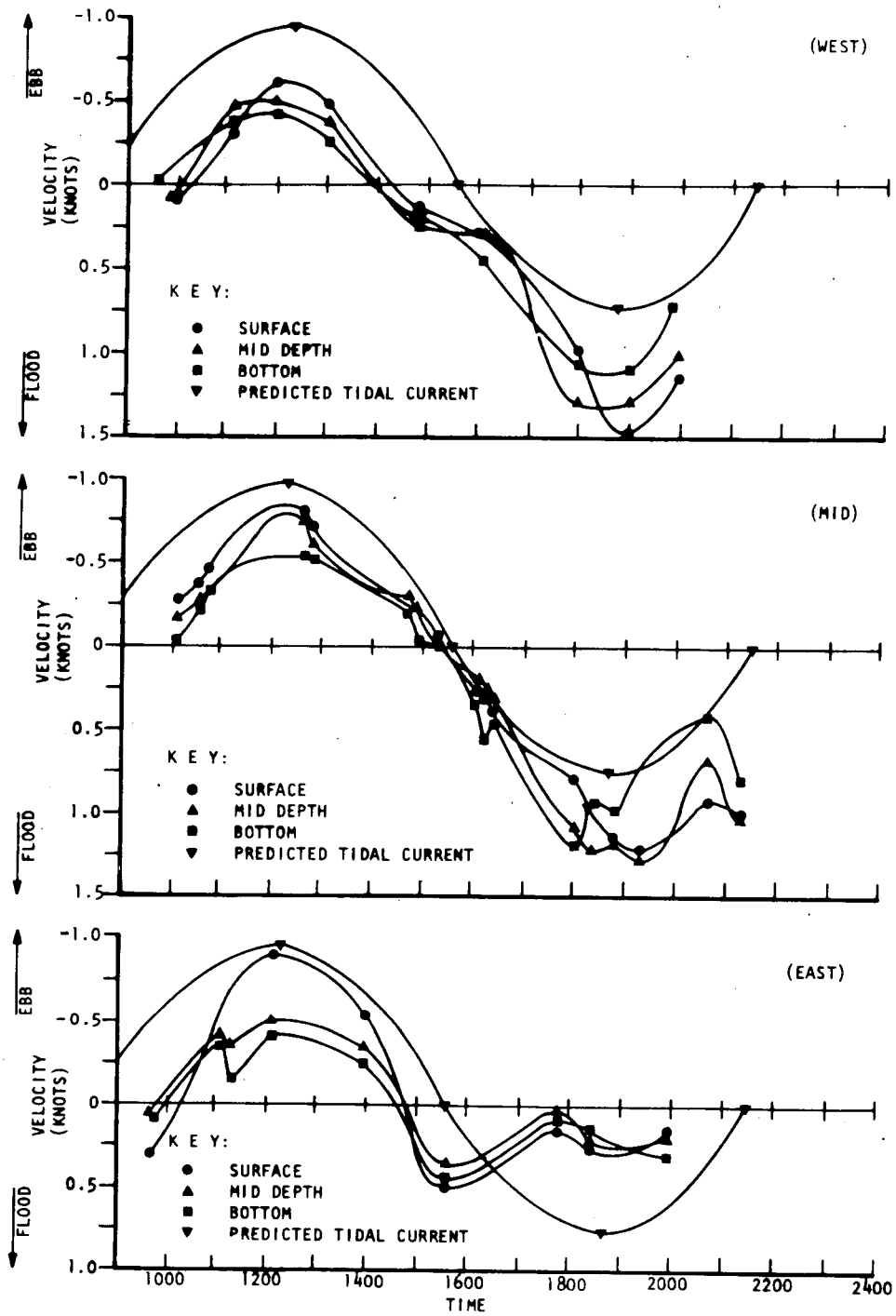


Figure 1-21.

CURRENT VELOCITY VS TIME AT 3 STATIONS AUGUST 26, 1974

Source: Dames & Moore and Con Edison 1976.

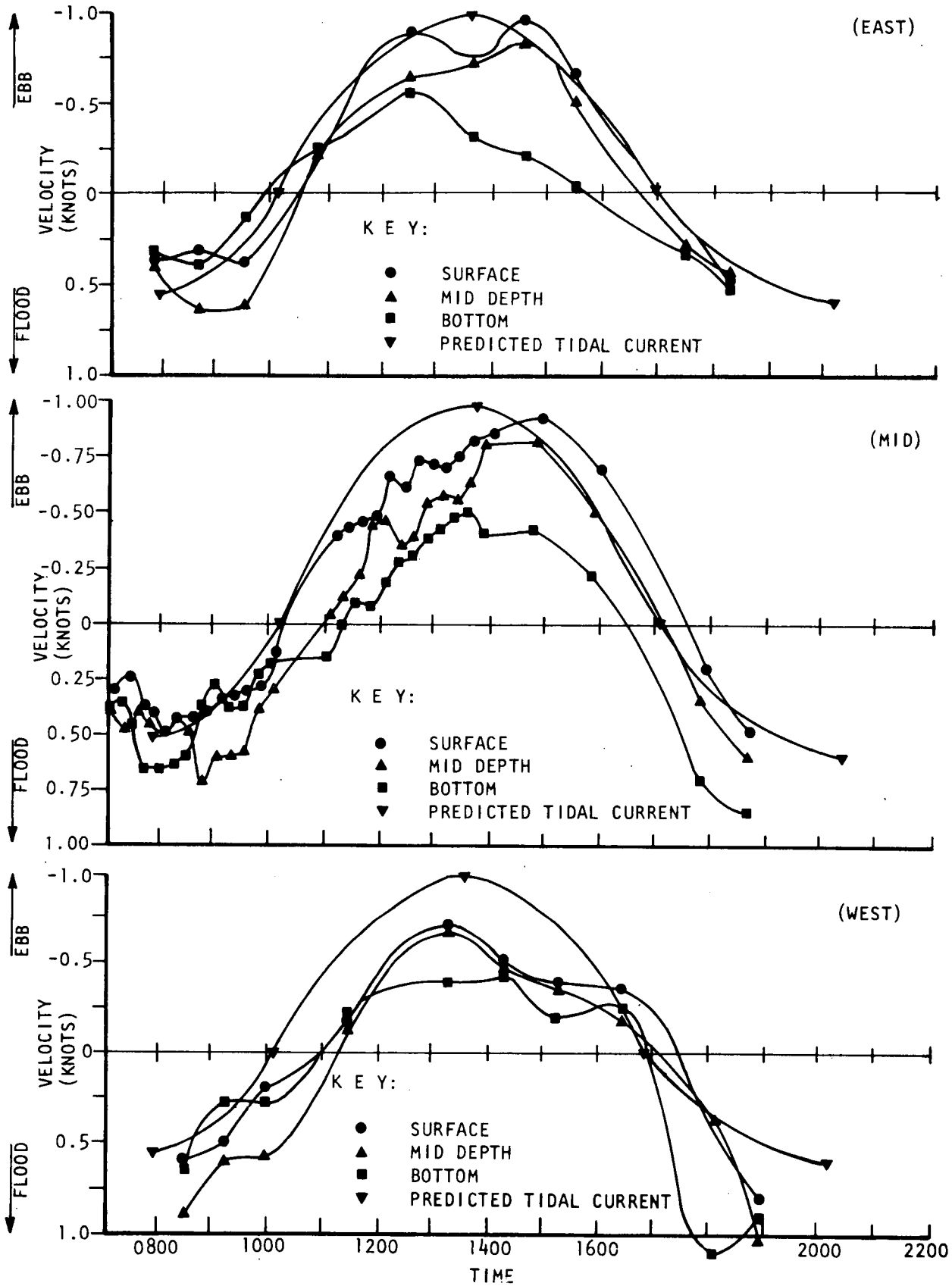


Figure 1-22. **CURRENT VELOCITY VS TIME SEPTEMBER 26, 1974**

Source: Dames & Moore and Con Edison 1976.

second for the August and September dates, respectively. These velocities correspond to maximum tidal flows of 230,000 and 257,000 cfs for a cross-sectional area of 160,000 square feet. These values lie within the reported range for maximum tidal flows.

1.7.3 Stratification

The degree of mixing of saltwater and freshwater in an estuary may be represented by a vertical stratification factor (VSF) which is the ratio of the tidal flow to the freshwater flow. When the VSF of an estuary is less than 10, between 20 and 200, or over 2,000, the estuary is classified as highly stratified, partially stratified, or well mixed, respectively (QLM 1971). Under normal conditions, the salt-intruded reach of the lower Hudson River has a VSF of greater than 10 and may be considered as a partially stratified estuary. The VSF of the Hudson River near Indian Point varies seasonally and is approximately 10 during fall and winter and 23 during the summer months. Generally, during the spring, mixing of salt and fresh water is not evident since the salt front is below Indian Point (LMS 1975).

At Indian Point, the lighter freshwater which is flowing downstream in the upper layer of the River mixes downward, while the heavier ocean-derived salt water flowing upstream beneath mixes upward. This mixing, which results from turbulent eddies produced by tidal motion, is incomplete and results in a vertical salinity gradient which generally increases from top to bottom (Fig. 1-23). The salinity in the upper and lower layers decreases steadily from the ocean entrance to the head of the estuary (LMS 1975). In addition, salinity varies with tidal phase in a sinusoidal fashion, increasing with incoming tide and generally reaching a maximum at High Water Slack. Concentrations decrease during ebb tide to minimum levels at Low Water Slack (Dames & Moore and Con Ed 1976). Generalized mean salinity profiles have been presented for freshwater flow ranges observed at Indian Point in various reports (QLM 1974; LMS 1975). Dissolved solids at Indian Point are generally less than 100 ppm (defined here as the salt front concentration) for freshwater flows greater than 20,000 cfs. For extremely low freshwater flows in the range of 2,000 to 3,000 cfs, mean salinities may reach near 10,000 ppm (LMS 1975).

1.8 Ambient Temperature of Receiving Water

The ambient (natural) water temperature is the temperature that would exist without the influence of any artificial heat source. The ambient water temperature varies spatially and temporally and is influenced by local meteorological and hydrological factors,

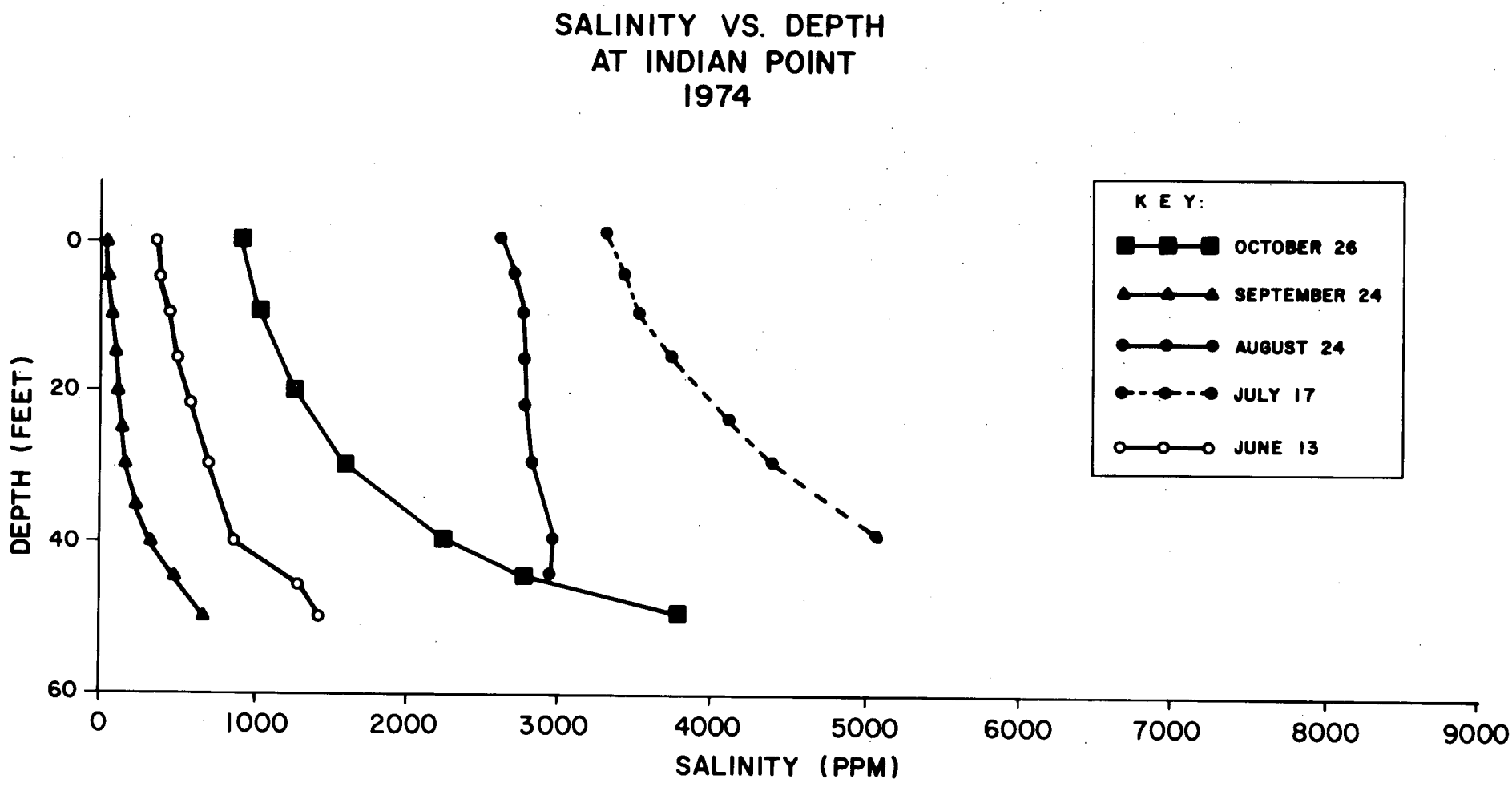


Figure 1-23.
Source: Dames & Moore and Con Edison 1976.

the morphology of the river and the topography of the surroundings. This natural variation can be considerable in the Indian Point reach with temperature changes of about 2°F within a 3 hour period, not an uncommon occurrence.

Seasonal changes in ambient water temperature at Indian Point reflect changes in air temperature and range from freezing during late December to late February, to water temperatures of almost 80°F during August, the month in which the river water characteristically reaches its highest ambient temperature.

The difference between the thermal plume temperature due to artificial sources such as an electric generating station and the ambient temperature defines the intensity and extent of the thermal plume. If the ambient natural temperature were spatially and temporally isothermal, one could go a sufficient distance either upstream or downstream outside the influence of the thermal discharge and determine the ambient temperature in the plume region. However, in the Indian Point reach (and for that matter most of the Hudson) the ambient temperature is a spatially and temporally varying quantity.

Since operation of Indian Point Unit No. 2 began in 1973, a continuous thermal survey program has been conducted by Con Edison. The ambient temperature in the plume region has been obtained from an analysis of ambient reference temperatures measured outside the region of the plume.

Ambient reference temperatures for the thermal surveys have been obtained from a northern transect at Bear Mountain Bridge during ebb and LWS and from a southern transect at Croton Point during flood and HWS. Bear Mountain Bridge is located approximately 22,000 feet upstream (north) of the Indian Point Station while the Croton Point transect is approximately 50,000 feet downstream of the station. These transects are located out of the influence of the thermal plume.

Two separate measuring procedures have been employed to obtain ambient reference temperatures. The first involved the use of fixed transects, located at Bear Mountain and Croton Point. Several stations representative of the cross-section of the river at these locations were selected, and temperatures at various depths were obtained. This static profiling pattern produced a grid-like representation of the temperature at the cross-section. The second method employed involved the use of mobile monitoring instumentation, whereby a temperature scan was made from shore to shore at the transect. This technique produced a continuous (data sampling and recording as frequently as every three seconds) band of temperatures along the path of the vessel. Data for all tidal phases were generally obtained using a thermistor

assembly deployed at the surface and at depths of approximately three, six, ten, thirteen, sixteen, nineteen and twenty-two feet.

The determination of an ambient temperature at Indian Point was made from an evaluation of all information available, including the temporal changes in temperature at the transects taken at the base line positions, a consideration of temperature well below the surface, estimation of the natural changes in temperature as the river water flows downstream from the upstream baseline position at Bear Mountain, and variations during the day from solar heating and atmospheric cooling. Considering the location of the Croton Point transect and the tidal excursion (distance traveled by a particle of water from one slack tide to the next), water that is measured at Croton Point will never reach the Indian Point area. Water that is measured at the Bear Mountain Bridge during maximum ebb will, depending upon the prevailing tidal characteristics, pass Indian Point at LWS during the same tidal cycle or on the succeeding tidal cycle. Stated differently, water that is at Indian Point during the maximum ebb and the LWS thermal plume measurements was at the Bear Mountain Bridge during the early ebb of this tidal cycle or some previous tidal cycle. There is, therefore, a logistic problem in the sense of translating ambient temperature measurements conducted at Bear Mountain Bridge and Croton Point to an Indian Point ambient temperature. That is

$$Ta\,[p,\ t(1)] = Ta\,[r,\ t(2)] + \theta\,(x,t)$$

where

$Ta\,[p,\ t(1)]$ = ambient temperature in the plume region at time $t(1)$

$Ta\,[r,\ t(2)]$ = ambient temperature in the reference region at time $t(2)$

$\theta\,(x,t)$ = ambient temperature spatial and temporal variations between plume regions and reference regions

As previously indicated, the factors that influence θ include local river hydrology and meteorology, and the morphological configuration of the river and its surroundings. The primary influence on θ (in the salt intrusion region) would be the water temperature difference between the ocean water and the water over the dam at Troy. Under salt intrusion conditions the water in the Indian Point reach is a mixture of ocean and fresh water, with the actual temperature distribution determined by the relative proportions of each, and by localized influences.

Relationships are available in the literature that permit one to relate the temperature distribution in an estuary to the salinity gradient. Using the relationship presented by Edinger (1971),

$$\frac{T(x) - Tr}{To - Tr} \propto \frac{S(x)}{So}$$

where T(x), Tr and To are the intermediate, upstream river, and ocean temperatures, respectively, and S(x) and So are the intermediate and ocean salinities, respectively. One can relate the Bear Mountain (BM) and Croton Point (CP) area-average salinity and temperature accordingly:

$$\frac{T(CP) - T(BM)}{To - Tr} = \frac{K\,[\,S(CP) - S(BM)\,]}{So}$$

and the Indian Point and Bear Mountain area-average temperatures and salinities as:

$$\frac{T(IP) - T(BM)}{To - Tr} = \frac{K\,[\,S(IP) - S(BM)\,]}{So}$$

where K is a proportionality constant. Therefore,

$$T(IP) - T(BM) = [\,T(CP) - T(BM)\,]\,\frac{[\,S(IP) - S(BM)\,]}{S(CP) - S(BM)}$$

This enables one to compute the Indian Point area-average temperature from the Indian Point salinity and the Bear Mountain and Croton Point area-average temperatures and salinities. Setting

$$\Delta\theta(CP-BM) = T(CP) - T(BM)$$
$$\Delta S(IP-BM) = S(IP) - S(BM)$$
$$\Delta S(CP-BM) = S(CP) - S(BM)$$

the Indian Point area-average temperature becomes

$$T(IP) = T(BM) + \frac{\Delta\theta(CP-BM)\;\Delta S(IP-BM)}{\Delta S(CP-BM)}$$

The Indian Point area-average temperature is obtained with the above equation and the following:

-The Indian Point area-average temperature for ebb can be approximated by taking the average of the Bear Mountain ebb and the Croton Point flood temperatures, weighted for salinity.

-The Indian Point area-average temperature for LWS can be approximated by the ebb area-average temperature at Bear Mountain Bridge.

-The Indian Point area-average temperature for maximum flood, because of the convective nature of the plume, is approximated as the average of the Bear Mountain Bridge ebb and the Grassy Point (or Croton Point) flood temperature, weighted for salinity.

-The Indian Point area-average temperature for HWS can be approximated as the average of the flood area-average temperature at Croton Point and the ebb area-average temperature at Bear Mountain Bridge, weighted for salinity. That is:

$$T(IP, Ebb) = T(BMB, Ebb) + \left(\Delta\theta[(CP, Flood) - (BMB, Ebb)] \times \left\{\frac{\Delta S[(IP, Ebb) - (BMB, Ebb)]}{\Delta S[(CP, Flood) - (BMB, Ebb)]}\right\}\right)$$

$$T(IP, LWS) = T(BMB, Ebb)$$

$$T(IP, Flood) = T(BMB, Ebb) + \left(\Delta\theta[(CP, Flood) - (BMB, Ebb)] \times \left\{\frac{\Delta S[(IP, Flood) - (BMB, Ebb)]}{\Delta S[(CP, Flood) - (BMB, Ebb)]}\right\}\right)$$

$$T(IP, HWS) = T(BMB, Ebb) + \left(\Delta\theta[(CP, Flood) - (BMB, Ebb)] \times \left\{\frac{\Delta S[(IP, Flood) - (BMB, Ebb)]}{\Delta S[(CP, Flood) - (BMB, Ebb)]}\right\}\right)$$

It should be noted that the flood and ebb temperature and salinity values are used, because the "HWS and LWS water" would not reach Indian Point. Furthermore, the area-average temperatures at the baselines are determined from the measurements conducted at 6 foot depths and below, thus minimizing surface and upper depth spatial perturbations.

The aforementioned procedures have been employed (in generally the above form) since the August 1974 survey. Previous surveys, because of a more limited data base, employed Bear Mountain and/or Roa Hook measurements as an Indian Point ambient for ebb and LWS and Grassy Point measurements for a flood and HWS Indian Point ambient.

It must be noted that there will be some departure from the area average temperature due to factors such as solar stratification. This departure can be expressed as

$$Ts = T + \delta$$

where Ts is the surface temperature, T is the area average temperature, and δ is the surface excess temperature. This surface stratification, i.e. the tendency for the surface to be warmer than the deeper layers, is due primarily to short wave solar radiation. It is also influenced by factors such as wind induced mixing, vertical mixing and local river morphology. Solar stratification is greater in shallow areas (i.e., Peekskill and Haverstraw Bays) and least in the deeper areas (i.e., Bear Mountain Bridge). The temperature rise due to solar stratification decreases with increasing depth. During daylight hours one could theoretically extrapolate the solar stratification at Bear Mountain or Croton Point to Indian Point. The Bear Mountain value would be too conservative (i.e., underestimate the temperature rise), while the Croton Point value would tend to approximate the Indian Point rise.

Empirical techniques to compute the degree of solar stratification have been employed. However, it has been shown, utilizing mathematical model data from the Alden Research Laboratories physical model of the Hudson River in the vicinity of Indian Point and appropriate equations that describe the influence of solar radiation on solar stratification that in the vicinity of the thermal plume, utilization of the three foot depth temperature measurements can remove the effects of solar stratification. (Dames & Moore and Con Ed, 1974)

The employment of the three foot datum as an index to evaluate the intensity and extent of the plume with regards to the state thermal criteria pending final resolution of the factors that influence the natural temperature patterns was concurred with by the New York State Department of Environmental Conservation with the provision that the surface isotherms also be presented (Quinn 1975). This procedure has been followed during the thermal survey program commencing with the August 1974 survey.

Indian Point ambient temperature data, as summarized in Table 1-10, shows a strong seasonal variation. The ambient water temperatures established for each tidal phase are tabulated in

TABLE 1-10.

SUMMARY OF FIELD DATA ON AMBIENT WATER TEMPERATURE AT INDIAN POINT

	1974	1975	1976
APRIL	A*: 44.5	-	-
	B*: 44-45	-	-
MAY	A: 62.5	A: 55.3	-
	B: 62.0-63.5	B: 54.9-56.1	-
JUNE	A: 68.5	-	-
	B: 67.9-69.1	-	-
JULY	A: 76.5	-	-
	B: 76.1-76.8	-	-
AUGUST	A: 78.8	-	-
	B: 77.9-79.3	-	-
SEPTEMBER	A: 71.0	-	-
	B: 71.0-71.0	-	-
OCTOBER	A: 57.9	-	A: 61.5
	B: 56.9-59.3	-	B: 60.7-62.3
NOVEMBER	A: 49.6	-	-
	B: 49.6-49.6	-	-

*A: mean temperature, °F
B: range, °F

Source: Dames & Moore and Con Edison 1974-76, Con Edison 1977d.

TABLE 1-11.

AREA AVERAGE
AMBIENT WATER TEMPERATURE
OF THE HUDSON RIVER AT INDIAN POINT

Date	Tidal Phase	Temperature, °F
5/31/74	First Flood	62.5
	HWS	62.5
	Ebb	61.8
	LWS	61.8
	Second Flood	63.5
6/13/74	First HWS	68.4
	Ebb	67.9
	LWS	68.1
	Flood	69.1
	Second HWS	69.1
7/17/74	Flood	76.8
	HWS	76.8
	Ebb	77.2
	LWS	77.2
8/20/74	LWS	77.9
	Flood	78.4
	HWS	79.0
	Ebb	78.7

Source: Dames & Moore and Con Edison 1974-1976, Con Edison 1977d.

TABLE 1-11 (Continued)

Date	Tidal Phase	Temperature, °F
8/21/74	LWS	78.2
	Flood	78.8
	HWS	79.4
	Ebb	79.1
8/23/74	Ebb	79.0
	LWS	78.9
	Flood	78.7
	HWS	78.7
8/24/74	Ebb	78.9
	LWS	79.3
	Flood	78.7
	HWS	78.7
9/24/74	First HWS	71.0
	Ebb	71.0
	LWS	71.0
	Flood	71.0
	Second HWS	71.0
10/22/74	Ebb	58.9
	LWS	58.9
	Flood	59.0
	HWS	59.3

TABLE 1-11(Continued)

Date	Tidal Phase	Temperature, °F
10/23/74	HWS	57.9
	Ebb	57.8
	LWS	57.6
	Flood	57.6
10/24/74	HWS	58.0
	Ebb	57.9
	LWS	57.8
	Flood	57.8
10/25/74	HWS	57.4
	Ebb	57.2
	LWS	56.9
	Flood	56.9
11/20/74	First HWS	49.6
	Ebb	49.6
	LWS	49.6
	Flood	49.6
	Second HWS	49.6
4/23/75	First Flood	44.5
	HWS	44.8
	Ebb	44.2
	LWS	44.0
	Second Flood	45.0

TABLE 1-11(Continued)

Date	Tidal Phase	Temperature, °F
5/13/75	First LWS	54.4
	Flood	54.5
	HWS	54.5
	Ebb	54.9
	Second LWS	54.9
5/14/75	First Ebb	55.0
	LWS	55.1
	Flood	54.5
	HWS	55.0
	Second Ebb	56.1
5/15/75	First Ebb	55.8
	LWS	55.9
	Flood	55.9
	HWS	55.9
	Second Ebb	56.6
10/13/76	Ebb	62.3
	LWS	62.3
	Flood	62.3
	HWS	62.3
10/14/76	Ebb	61.5
	LWS	61.5
10/15/76	Ebb	61.1
	LWS	60.7
	Flood	60.7
	HWS	60.8

Table 1-11. During the thermal surveys, Indian Point ambient temperatures ranged from 44 to 79.4°F, the latter representing the maximum area-average ambient at Indian Point. On a tidal average basis, the maximum area average ambient temperature at Indian Point did not exceed 78.9°F.

Ten-year statistics of ambient water temperature at the Indian Point site are not available. Monthly mean, minimum and maximum water temperatures measured near Indian Point were taken by the USGS during the period 1959 through 1969 and are presented in Table 1-12. However, these USGS measurements are not considered accurate representations of ambient temperatures at the Indian Point station since they were taken in the shallow waters of Lents Cove (1959-1966) and near the west bank of the river (1966-1969) near Jones Point, regions in which temperatures may be influenced significantly by solar heating and reduced mixing. Furthermore, in collecting their data, the USGS was not specifically preparing for thermal surveys. This is reflected in the accuracy of their measurements. USGS data were measured to the nearest degree F with a thermometer (1959-1966) or, after 1966, with a thermister.

1.9 Recirculation

The extent of recirculation of discharge water to the intakes was determined using dye studies during the October, 1974 intensive thermal survey (Dames & Moore and Con Edison 1976). Dye was injected into the discharge canal and discrete water samples were taken in the canal upstream of the dye release point. Table 1-13 presents the results of the study. Recirculation ranged from 0% during ebb and LWS, to 5 and 6% during flood and HWS, respectively. During these measurements, Units Nos. 1 and 2 were operating at an average electrical generation of 275 MW(e) and 875 MW(e), respectively.

The extent of recirculation with the combined operation of Units Nos. 2 and 3 was obtained from the October 1976 thermal survey (Con Edison 1977d). Using intake and discharge temperature measurements with a calculated Indian Point ambient temperature, an estimation of recirculation was obtained. Per cent recirculation was classified for this case as:

$$\% \text{ Recirculation} = \frac{\text{intake temp - ambient temp.}}{\text{discharge temp - intake temp}} \times 100$$

As expected, recirculation is greater during flood and HWS, and combined operation of Units Nos. 2 and 3 produces a greater percent recirculation than the combined operation of Units Nos. 1 and 2. Also, the above ratio includes indirect recirculation, which the dye studies did not. Since the above ratio is

Table 1-12.

Hudson River Water Temperature (°F) in the Vicinity of I.P.

(U.S.G.S. 1959-1969)

Month	Maximum	Minimum	Average
January	42.0	32.0	34.0
February	38.0	32.0	33.2
March	43.0	32.0	35.0
April	57.0	37.0	44.6
May	67.0	48.0	57.3
June	78.0	60.0	68.2
July	81.0	71.0	75.9
August	81.0	73.0	76.9
September	80.0	64.0	73.0
October	73.0	57.0	64.2
November	61.0	43.0	52.9
December	51.0	32.0	40.8

Source: Con Edison 1972b.

TABLE 1-13.

RECIRCULATION - UNIT NOS. 1 AND 2

DYE SAMPLES - DISCHARGE CANAL OCTOBER, 1974 SURVEY

	TIME	PARTS PER BILLION	PERCENT RECIRCULATION
29 October	1130	0.0	0
	1145	0.0	0
Ebb	1200	0.3*	0.6
	1215	0.0	0
	1515	0.0	0
	1545	0.0	0
LWS	1600	0.0	0
	1620	5.0*	10.2
30 October	0810	2.2	4.5*
	0820	0.0	0.0
Flood	0830	2.8	5.7
	0840	1.4	2.9
	0850	1.5	3.1
	0900	1.6	3.2
	1030	2.6	5.3
	1040	1.7	3.5
HWS	1050	2.1	4.3
	1100	2.4	4.9
	1110	3.3	6.7
	1120	2.2	4.5

Station operating characteristics:

	MW(e) gross	Flow Rate (gpm)
Unit No. 1	275	302,000
Unit No. 2	800 to 900 MW(e)	715,000

*It is very doubtful that there was actually any dye in these samples. They were most likely contaminated by dye washing off the hands of the sampler during closure of the bottles. It is believed that none of the October 30 samples were so contaminated.

Source: Dames & Moore and Con Edison 1976.

TABLE 1-14.

INDIAN POINT INTAKE AND DISCHARGE TEMPERATURES
OCTOBER 13, 1976

Tidal Phase	Unit No. 2 Intakes Time	Temperature (°F) North Bay	Temperature (°F) South Bay	Unit No. 3 Intakes Time	Temperature (°F) North Bay	Temperature (°F) South Bay	Discharge Canal Time	Temperature (°F) East Wall	Temperature (°F) Mid Canal	Temperature (°F) West Wall
Ebb	0800	64.1	63.9	0720	64.6	64.6	0705	86.5	86.2	85.9
	0928	63.3	63.3	0941	63.8	63.8	0800	85.9	85.8	85.9
							0900	84.9	85.0	85.0
LWS	1040	63.3	63.1(1)	1000	63.3	63.3	1015	84.4	84.3	84.3
	1205	65.5	64.2	1124	63.1	63.1	1115	85.8	86.2	86.5
							1215	86.5	86.9	87.0
Flood	1340	65.6	65.4	1300	64.4	64.7	1305	85.5	85.5	89.1
	1500	66.0	65.8	1420	64.8	64.6	1410	85.4	85.4	85.1
							1510	86.2	85.9	85.2
HWS	1630	65.4	65.2	1550	65.3	65.1	1605	85.3	85.9	85.7
	1750	65.2	65.1	1710	65.1	65.3	1705	86.6	85.8	85.5
							1805	88.8	88.1	88.2

Note: Intake temperatures above were obtained at the north and south bays of both units and are the average of the values obtained at the surface, bottom and at least three intermediate depths (i.e., approximately 1/4 depth, 1/2 depth and 3/4 depth). Discharge canal temperatures were obtained at one cross section, near the west wall, east wall and mid-channel, at approximately the same depth intervals.

(1) Surface measurement only.

Source: Con Edison 1977d.

TABLE 1-15

RECIRCULATION, FLOW, AND GENERATION STATISTICS
OCTOBER 13, 1976

	Unit No. 2					Unit No. 3								
Tidal Phase	Time	Discharge Minus Intake Temp. Rise °F	Recirculation (1) (°F)	Recirculation (2) (°F)	Range, % Recircu-lation	Time	Discharge Minus Intake Temp Rise (°F)	Recirculation (1)	Recirculation (2)	Range % Recircu-lation	Flow (GPM) Unit No. 2	Flow (GPM) Unit No. 3	MW(e) Unit No. 2	MW(e) Unit No. 3
Ebb	800	21.9	1.7	0.9	7.8-4.1	720	21.6	2.3	1.5	10.7-6.9	720,000	715,000	870	1000
	928	21.7	1.0	0.2	4.6 -0.9	941	21.2	1.5	0.7	7.1-3.3				
LWS	1040	21.1	0.9	0.1	4.27-0.5	1000	21.0	1.0	0.2	4.8-1.0	(1027) 580,000			
	1205	21.9	2.6	1.6	11.9-7.31	1124	23.1	0.8	0.0	3.5-0.0				
Flood	1340	19.8	2.2	1.4	11.1-7.1	1300	22.1	2.3	1.5	10.4-6.8	(1300) 720,000			
	1500	12.9	3.6	2.8	18.1-11.1	1420	20.6	2.4	1.6	11.7-7.8			(1501) 865	
HWS	1630	20.3	2.0	1.2	9.9-5.9	1500	20.4	2.9	2.1	14.2-10.3		(1707) 515,000		
	1750	23.1	2.9	2.1	12.5-9.1	1710	20.8	2.9	2.1	13.9-10.1				

Recirculation (1) Survey Indian Point area - average temperature - 62.3°F
Recirculation (2) Lowest recorded average intake temperature - 63.1°F

Source: Con Edison 1977d.

TABLE 1-16.

AVERAGE PERCENT RECIRCULATION
COMBINED OPERATION OF UNIT NOS. 2 & 3

Tidal Phase	Average % Recirculation Unit No. 2	Unit No. 3
Ebb	4.4	7.0
LWS	6.0	2.3
Flood	12.6	9.2
HWS	9.4	12.1

Source: Con Edison 1977d.

extremely sensitive to the choice of ambient, a range of ambient temperatures were selected. The first (recirculation (1) in Table 1-15) is the area-average ambient utilized for evaluating the extent of the plume. For reasons elaborated upon in the survey report, it tends to be overly conservative, for example, it does not account for natural vertical stratification. Ambient (2), the lowest observed average intake temperature, is more realistic. It, as expected, occured during LWS. The results are presented in Table 1-14, 1-15 and 1-16. Average station electric generation during these measurements was above 1870 MW(e) (gross).

1.10 Intake and Receiving Water Features

1.10.1 Topography

River Cross-Sections and Surface Width Each Half Mile, Within Local Zone

In the river segment near Indian Point, from Verplanck north to Peekskill Bay, the surface width of the Hudson River ranges from 3500 to 6300 feet, and the cross-sectional areas based on mean depth are on the order of from 160,000 to 180,000 square feet. The surface width and cross-sectional area at the discharge canal are 5000 feet and 160,000 square feet, respectively. Approximate river cross-sections and surface widths at half-mile intervals at locations within the Indian Point vicinity are as follows:

General Location	River Mile	Width ft	Cross-Sectional Area ft^2
Peekskill Bay	44.0	6300	180,000
Jones Point	43.5	4800	174,000
Indian Point	43.0	4400	175,000
Unit 2 Intake	42.8	4500	165,000
Discharge Canal	42.5	5000	160,000
Overhead Cables	42.0	3800	160,000
Verplanck	41.5	3500	165,000

1.10.2 Bottom Contours Near Intake and Discharge

River depths in the vicinity of the station range from about 10 feet below mean sea level (MSL) on either side of each intake structure to about 40 feet below MSL within 200 feet of the plant. The river bottom immediately in from of the intakes is slightly more than 27 feet below MSL while depths in front of the discharge canal are near 20 feet. Bottom contours near the intakes, and discharge are shown in Fig. 1-24.

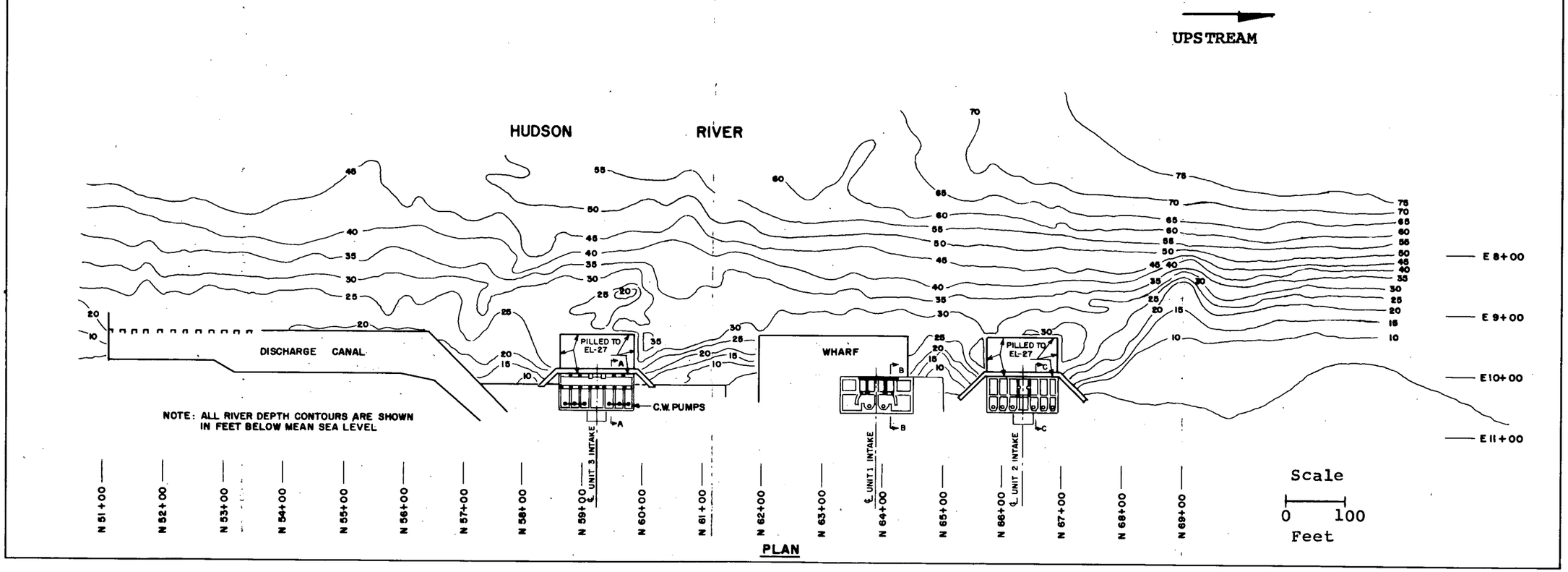


Figure 1-24. BOTTOM CONTOURS NEAR INDIAN POINT INTAKES AND DISCHARGE

Source: Stone & Webster 1976

1.10.3 Characterization of Bottom Sediments

The substrate characteristic of the river region near Indian Point is composed primarily of extremely fine particles. A Wentworth sediment particle analysis was conducted during October and November 1973 at Indian Point and on the opposite shore at Jones Point. Results of analyses of samples from 12 locations indicated that sediments in the Jones Point region were characterized by slightly higher percentages of sand than the sediments at Indian Point, but that at both locations particles of very fine sand, silt and clay comprised the majority of the total weight of the samples (TI 1974).

The fine particle composition of the sediments in this region of the Hudson varies appreciably only in restricted areas which receive occasional deposition of organic detritus due to eddy effects and in those in which high current veolocity scours finer particles leaving higher percentages of coarse sands (TI 1973a).

1.11 Outfall Configuration and Operation

The outfall or discharge structure for the Indian Point facility is designed to enhance mixing of cooling water and river water in such a way as to minimize thermal impact in the river. It can accommodate the combined cooling water flow from all three Indian Point units (about 2,058,000 gpm including service water).

After passing through the plant, the circulating water from the station enters a discharge canal. The portion of the canal exclusively serving Indian Point Unit No. 2 is about 18 feet wide with an elevation varying from 12 to 17 feet below mean low water. The water from Unit No. 2 joins the water discharged from Unit No. 3 in a 40 foot wide discharge canal. The cooling water from the discharge channel is released to the Hudson River via an outfall structure located south of Indian Point Unit No. 3. The outfall structure, as depicted schematically in Fig. 1-25 and 1-26 consists of twelve submerged rectangular ports equipped with adjustable gates which are in line and parallel to the river axis. The ports, 4 feet high by 15 feet wide and spaced 21 feet apart (center to center), are submerged to a depth of 12 feet (center to surface) at mean low water. The first upstream port is approximately 600 feet from the Indian Point Unit No. 3 intake and the length of total port section is approximately 252 feet.

The entire structure of ports described above are equipped with adjustable gates (permitting port heights from 4 feet to fully closed) such that the discharge velocity can be adjusted. Normal full flow operation is with a head differential of about 1-3/4

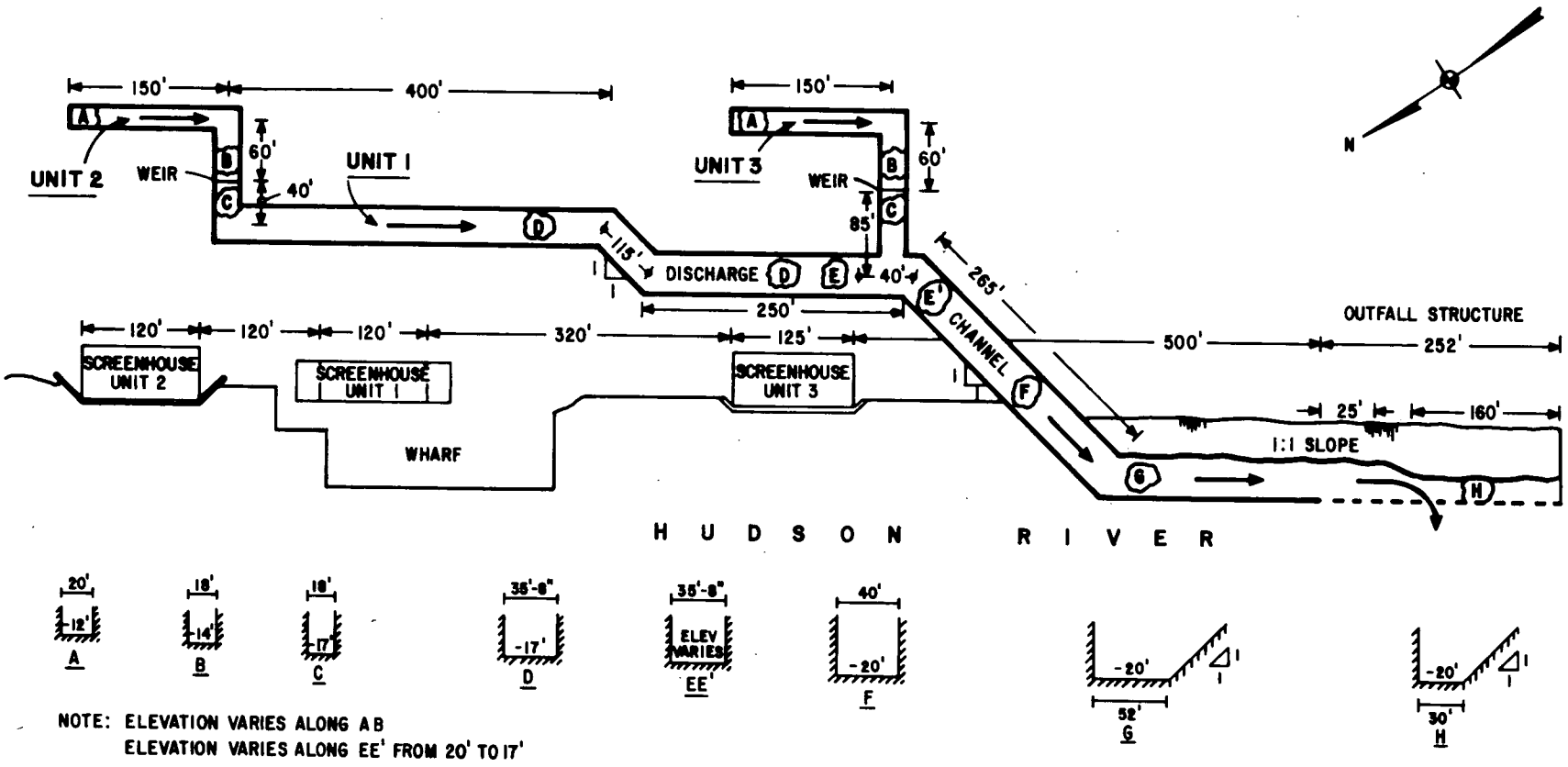
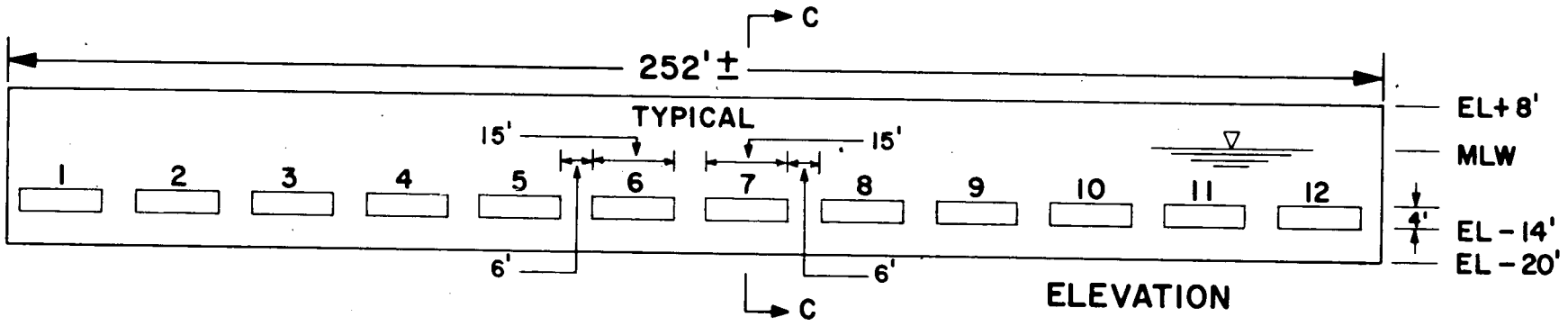
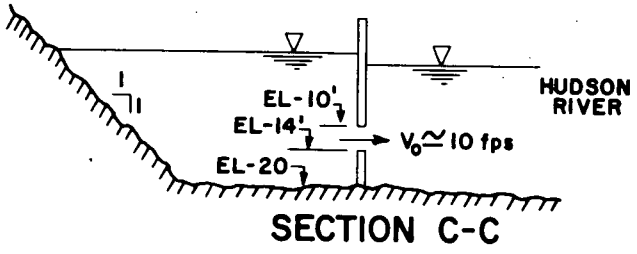


Figure 1-25. Indian Point Discharge Canal.

Source: Con Edison 1977b.





DETAILS OF DISCHARGE STRUCTURE

FIGURE 1-26

feet across the structure, thus producing a discharge velocity of about 10 feet per second.

1-12 Plume Data

1.12.1 Sources

The following is a listing of reports which contain the plume data collected and analyzed during each of the Consolidated Edison surveys conducted from May 1974 through May 1977. These reports have previously been submitted to the various regulatory agencies.

"Indian Point No. 2 Routine Monthly Thermal Monitoring For May 1974, Report No. 1", prepared by Dames & Moore and Consolidated Edison Company of New York, Inc.

"Indian Point No. 2 Routine Monthlyy Thermal Monitoring For June 1974, Report No. 2", Prepared by Dames & Moore and Consolidated Edison Company of New York, Inc., February 1975.

"Indian Point No. 2 Routine Monthly Thermal Monitoring For July 1974, Report No. 3", Prepared by Dames & Moore and Consolidated Edison Company of New York, Inc., March, 1975.

"Indian Point No. 2 Routine Monthly Thermal Monitoring For July 1974, Report No. 3 Supplement", Prepared by Dames & Moore and Consolidated Edison Company of New York, Inc., May, 1975.

"Indian Point No. 2 Routine Monthly Thermal Monitoring For September 1974, Report No. 4," Prepared by Dames & Moore and Consolidated Edison Company of New York, Inc., March, 1976.

"Indian Point No. 2 Routine Monthly Thermal Monitoring For November 1974, Report No.5", Prepared by Dames & Moore and Consolidated Edison Company of New York, Inc., June, 1976.

"Indian Point No. 2 Routine Monthly Thermal Monitoring For April 1975, Report No. 6", Prepared by Dames & Moore and Consolidated Edison Company of New York, Inc., August, 1976.

"Indian Point Nuclear Generating Station Intensive Thermal Survey Program, August and October 1974" (in two volumes), Prepared by Dames & Moore and Consolidated Edison Company of New York, Inc., March, 1976.

"Indian Point Nuclear Generating Station, Intensive Thermal Survey Program, May 1975 Survey, Report No. 7", Prepared by Dames & Moore and Consolidated Edison Company of New York, Inc., December 1976.

"Indian Point Nuclear Generating Station, Thermal Survey Program, Routine Monthly Thermal Monitoring October 1976 Survey, Report No. 1" Consolidated Edison Company of New York, Inc., January 1977.

"Indian Point Nuclear Generating Station Thermal Survey Program, Routine Monthly Thermal Monitoring May 1977 Survey Report. Consolidated Edison Company of New York, Inc. March 1978.

SECTION 2 - PHYTOPLANKTON

2.1. Laboratory Procedures

Samples were preserved immediately after collection with Lugol's solution. Appropriate samples for cell counts and identification were filtered on gridded Millipore filters, cleared and fixed with Permount (APHA 1971; NYU 1974, 1976a). Counts and identifications of phytoplankton were made with a Zeiss photomicroscope at 1560 x magnification. Individual diatoms and green algal cells and colonies were counted as single units. Filaments of blue-green and green algae occupying an entire microscope field were counted as two units. The usual practice was to count and identify approximately 300 units per slide; enumeration of more than 300 units per slide did not increase the sensitivitiy of the population analysis. Abundances of phytoplankton per liter (X) were calculated according to the formula $X = \frac{C}{FxP}$ where

C = specimens counted
F = fraction of filter counted
P = portion of sample filtered

Chlorophyll a content and light intensity values were measured weekly at the seven river locations adjacent to Indian Point in 1975 & monthly in 1974. (Fig. 4-1, Summary). Photometric readings were taken on each chlorophyll sampling date to delineate the euphotic zone and levels of incident solar radiation. Collection techniques and chlorophyll extraction procedures are described in NYU (1976a). Data were anlyzed using two-way factoral ANOVA.

2.2. Photosynthetic & Chlorophyll a Measurements.

The following are procedures used to determine the effects of laboratory thermal exposures, as discussed in Section 4-4, Summary. Photosynthetic measurements required two 300 ml aliquots of Hudson River water. These were distributed into glass bottles and then innoculated with 10 microcuries of $NaH^{14}CO_3$. The bottles were incubated in a trough maintained at ambient temperature with flowing river water. The measurement of the photosynthetic rate of phytoplankton requires at least two hours of incubation with carbon-14. Therefore, the exposure to heat was two hours. These experiments were carried out in closed bottles. The temperature in the closed bottles decayed to 1°C above ambient in 15 minutes and remained at this temperature.

Three aliquots of 50 milliliters each were filtered for chlorophyll a analysis. The filters were extracted with 90%

acetone. The flouorescence of the extract was measured on a Turner Model 111 Fluorometer.

The results of photosynthetic and chlorophyll a measurements of Hudson River phytoplankton exposed to laboratory thermal and chlorine exposures during 1975 are given in Table 2-3.

2.3 Temperature Results

On 7/31/75 the 2°C rise in temperature reduced primary productivity, chlorophyll a content, and only a small reduction in metabolic ratio. This indicated a biomass rather than a metabolic change had occurred in the test. Abundance (cells/liter) were similar for the control and test populations but there was a reduction in the diatom population in the total population. This change may have affected the primary productivity of the test population (on 7/31/75) while the metabolic capacity of the individuals remained unchanged. On 9/11/75 a 2°C rise showed increased primary productivity with an unchanged chlorophyll a value and an increased metabolic ratio (Table 2-3).

A 5°C thermal increase inhabited photosynthesis on 7/31/75 had increases on 6/26/75 and 9/11/75. The 7/31 reduction of photosynthesis was concurrent with a chlorophyll a content reduction. Since there was little change on 7/31/75 of metabolic ratio (capacity) the effect on the 5°ΔT was consistent with deductions made at the lower ΔT of 2°C (Table 2-3).

2.4 Phytoplankton Species Composition

The species composition of the phytoplankton as discussed in the Summary, Section 4.3, Community Structure, in the vicinity of Indian Point during the years 1972, 1974, and 1975 is given in Table 2-1. The relative dominance of common forms of phytoplankton during 1971 is listed in Table 2-2.

The typical nuisance algae as indicated by Palmer (1962) which have occurred in the Indian Point vicinity are given in Table 2-4. As discussed in Summary Section 4.5, these species did not comprise a major portion of the phytoplankton community indicated in Table 2-1.

2.5 Energy Inputs into Hudson River

Energy inputs are introduced into the Hudson River estuary from both man-made and natural sources. Table 2-5 lists the various sources and kilocalorie estimates of their respective energy inputs.

Table 2-1. Phytoplankton Species Collected in the Indian Point Vicinity 1972, 1974, 1975. The numbers shown are the number of collections in which the species were found.

Species	1972	1974	1975
Bacillariophyta			
Achnanthes			
exigua Grun		1	
lanceolata (Breb.) Grun.	5	4	2
linearis (W. Sm.) Grun.			4
linearis var. curta H.L. Sm.		2	4
minutissima Kuetz	5	4	
sp.	5	2	1
Actinoptychus			
undulatus (Bail.) Ralfs	1		
Amphiprora			
ornata Bailey	3		
paludosa W. Sm.		3	2
paludosa subsaline Cleue	50	1	
Amphora			
ovalis Kuetz		1	3
ovalis var. pediculus Kuetz		1	2
Asterionella			
bleakeleyi W. Sm.	5	6	
formosa Hass	137	62	47
Bacillaria			
paradoxa Gmelin	27		
Campylodiscus			
echeneis Ehr.	3		
Cocconeis			
fluviatilis Wall.	1		
placentula Ehr.	14	7	2
placentula var. euglypta Ehr.		4	1
Coscinodiscus			
excentricus Ehr.	197	69	52
lacustris Grun.	3		7
lineatus Ehr.		7	

Table 2-1. (Cont'd)

Species	1972	1974	1975
Coscinodiscus (Cont'd.)			
perferatus type		90	64
rothii (Ehr.) Grun.	71	9	
sublineatus Grun.	13	1	
sp. a.	98	12	
sp. b.		2	
sp.	59		7
Cyclotella			
bodanica Eulenst		1	
comta (Ehr.) Kuetz.	9	1	7
glomerata Bachm.	229	154	83
kuetzingiana Thw.	107	76	18
meneghiniana Kuetz.	179	127	54
stelligera Cl. & Grun.		33	4
striata (Kuetz.) Grun.	86	17	2
stylorum Brightw.	2		
sp.	4	27	16
Cymatopleura			
solea (Breb.) W. Sm.	2		
Cymbella			
affinis Keutz.		1	
sinuata Greg.		1	
tumida (Breb.) V.H.	1		
ventricosa Kuetz.	1	3	
sp.	1		
Diatoma			
tenue Ag.	7	4	4
tenue var. elongatum Lyngb			3
vulgare Bory	3	5	5
Diploneis			
puella (Schum.) Cl.	5	2	
smithii dilatata (M. Perag.) Boyer	2		6
Eunotia			
incisa W. Sm. ex Greg.	1		
sp.		1	
Fragilaria			
brevistriata Grun.		2	
capucina Desm.			7

Table 2-1. (Cont'd)

Species	1972	1974	1975
Fragilaria (Cont'd.)			
construens (Ehr.) Grun.	21	8	1
construens var. venter (Ehr.) Grun		5	2
crotonensis Kitton	61	10	9
leptostauron (Ehr.) Hust	2	4	
pinnata Ehr.			2
vaucheriae (Kuetz.) Peters	3	2	
sp.	12	5	17
Frustulia			
rhomboides var. capitata (A. Mayer) Patr.			1
Gomphonema			
olivaceum (Lyng.) Kuetz		2	
parvulum Kuetz		5	2
sp.	1	1	2
Gyrosigma			
acuminatum (Kuetz.) Rabh.	4		
attenuatum (Kuetz.) Rabh.		1	
macrum (W. Sm.) Griff & Henfr	2		3
modiferum (Grun.) Reim.	1		
obscurum (W. Sm.) Griff.	2		
spencerii (Quek.) Griff & Henfr	9	6	1
strigilis (W. Sm.) Cl.		1	
wormleyi (Sulliv.) Boyer	3		2
sp.	4		
Melosira			
ambigua (Grun.) Muell.	147	54	44
ambigua var. distans (Ehr.) Kuetz	3	6	
distans var. alpigena Grun.		83	59
granulata (Ehr.) Ralfs	112	17	11
granulata var. angustissima Muell.	73	2	12
italica (Ehr.) Kuetz	114	14	30
varians Ag.	55	6	11
sp. auxospore		13	1

Table 2-1. (Cont'd)

Species	1972	1974	1975
Meridion			
circulare (Greg.) Ag.	1	1	2
Navicula			
capitata Ehr.	87	80	49
cryptocephala Kuetz.	3	12	16
decussis Oestr.		2	
graciloides A. Mayer			1
hustedtii Krass.	1		
lanceolata (Ag.) Kuetz.	10	5	
menisculus var. upaliensis (Grun.) Grun.			1
mournei Patr.			1
notha Wallace		1	
odiosa Wallace			1
peregrina (Ehr.) Kuetz.		5	8
pupula Kuetz.	1		1
pygmaea Kuetz.	1		
radiosa Kuetz.	6		
rhynchocephala Kuetz.		10	
rhynchocephala var. germainii (Wall.) Patr.	55	33	24
salinarum var. intermedia (Grun.) Cl.		2	
symmetrica Patr.	1	1	
tripunctata var. schizonemoides (V.H.) Patr.	2	2	
viridula Kuetz.	4	1	
viridula var. avenacea (Breb. ex Grun.) V.H.	12	7	13
sp.	5		23
Nitzschia			
accomodata Hust.	38	43	26
acicularis W. Sm.	15	23	4
amphibia Grun.	21	5	11
angustata (W. Sm.) Grun.	6	4	
apiculata (Greg.) Grun.		2	
bremensis Hust.	2	1	
capitellata Hust.		18	13
closterium (Ehr.) W. Sm.	1	2	3
commutata Grun.			11
dissipata (Kuetz) Grun.	1	7	2

Table 2-1. (Cont'd)

Species	1972	1974	1975
Nitzschia (Cont'd.)			
fasciculata Grun.			2
filiformis (W. Sm.) Hust.		1	
fonticola Grun.	5	74	76
frustulum Kuetz.		2	1
holsatica Hust.		26	6
hungarica Grun.		1	2
kuetzingiana Hilse	67	28	4
linearis W. Sm.	2		1
lorenziana Grun.			1
microcephala Grun.		6	
palea (Kuetz.) W. Sm.	13	47	7
parvula Levis	2	2	
romana Grun.		10	1
sigma (Kuetz.) W. Sm.	113	28	27
stegnii		2	
sublinearis Hust.	3		
tryblionella Hantz.	25	41	
tryblionella var. debilis (Arn.) A. Mayer	40	45	32
tryblionella var. levidensis (W. Sm.) Grun.	11	11	33
tryblionella var. Victoriae Grun.	9	7	2
sp. 1	13	22	3
sp.	27	89	72
Pinnularia			
sp.	1		1
Pleurosigma salinarum Grun			4
Rhoicosphenia			
curvata (Kuetz.) Grun. ex. Rabh.		1	2

Table 2-1. (Cont'd)

Species	1972	1974	1975
Skeletonema			
costatum (Grun.) Cl.		1	
Stephanodiscus			
astraea (Ehr.) Grun.	114	51	38
astraea var. minutula (Kuetz.)			70
hantzschia Grun.	6	4	
niagarae Ehr.	12	4	
sp.	26	4	4
Surirella			
biseriata var. constricta. Grun.	2	2	
elegans Ehr.	17		
ovalis Breb.	102	9	
ovalis var. Minor ?	10	8	
ovata Kuetz	3	50	30
ovata var. crumena (Breb.) U.H.	1	2	
ovata var. salina (W. Sm.)	1		
robusta Ehr.	7	1	1
sp.	9	2	1
Synedra			
acus Kuetz.		1	
fasciculata var. truncata (Ag.) Kuetz.			1
filiformis Grun		1	
parasitica (W. Sm.) Hust.	1		
parasitica var. subconstricta Grun.	5	1	

Table 2-1. (Cont'd)

Species	1972	1974	1975
Synedra			
pulchella Ralfs. ex. Kuetz	4	5	1
rumpens Kuetz.	56	10	1
ulna (Nitz.) Ehr.	69	9	2
ulna var. *longissima* (W. Sm.) Brun.	8	8	6
sp.	3	12	6
Tabellaria			
fenestrata (Lyngb.) Kuetz.	20	9	11
Thalassionema			
nitzchioides Grun	52	20	
unidentified form.		1	
Thalassiosira			
fluviatilis Hust	88	5	13
sp.		15	10
Unidentified			
Forms.	125	95	61
Chrysophyta			
Dinobryon			
sp.	83	71	7
Mallomonas			
sp.	8	1	
Synura			
sp.	6	1	
Euglenophyta			
Euglenoids		42	7
Flagellate colonies		2	

Table 2-1. (Cont'd)

Species	1972	1974	1975
Euglenophyta (Cont'd)			
Phacus			
longicauda (Ehr.) Dujardin	5	7	2
Unidentified Forms	22		
Chlorophyta			
Actinastrum			
hantzschii Lagerh.	68	23	38
Ankistrodesmus			
falcatus (Corda) Ralfs	19	17	42
Characium		4	
sp.			
Cladophora			
sp.	1		
Closteriopsis			
longissima Lemm.	30	11	6
Closterium			
sp.	2	4	
Cosmarium			
sp.	2		
Crucigenia			
apiculata (Lemm.) Schmidle			1
fenestrata Schmidle	4	1	2
tetrapedia (Kirch.) West & West	16	59	39
Kirchneriella			
lunaris (Kirch.) Moebius			9
obesa (W. West) Schmidle		1	
sp.			1
Micractinium			
pusillum Fres.		4	
sp.		7	
Pandorina			
sp.	29	5	1
Pediastrum			
biradiatum Meyen		49	
boryanum (Turp.) Mene.		1	
duplex Meyen		56	

Table 2-1. (Cont'd)

Species	1972	1974	1975
Pediastrum (Cont'd			
simplex (Meyen) Lemm.		15	
tetras (Ehr.) Ralfs.		7	
Quadrigula			
lacustris (Chod.) G.M. Smith		1	
Scenedesmus			
abundans (Kirch.) Chodat.		10	
acuminatus (Lag.) Chodat.		12	2
acutus Meyen		6	
arcuatus Lemm.		3	1
artistatus Chod.		2	
bernardi G.M. Smith		9	
bijuga (Turp.) Lager		9	
denticulatus Lager			2
dimorphus		28	12
dispar Breb			3
opolinensis P. Richter		1	1
quadricauda (Turp.) Breb		137	59
2 cell - sp.			47
sp.		107	61
Schroederia			
sp.		5	
Selenastrum			
gracile Reinsch		5	
Staurastrum			
sp.		2	4
Tetraedron			
caudatum (Corda) Hansgirg		5	15
hastatum (Reinsch) Hansgirg		3	
trigonum var. gracile (Reinsch) DeToni		16	14
sp.			11
Treubaria			
setigerum (Archer.) G.M. Smith		1	
Unidentified green coccoid unicells cells			84
Green colonies (4 cells)			73
Green colonies (8 cells)			47
Green colonies (≥ 10 cells)			49
Green filaments			44
Unidentified green algae			80

Table 2-1. (Cont'd)

Species	1972	1974	1975
Cyanophyta			
Anabaena			
circinalis Rahen	8	1	7
sp.		2	9
Anacystis			
sp.	5		
Aphanothece sp.	1		
Coelosphaerium	5		
Gloeocapsa			
sp.			2
Merismopedia sp.	4		
Microcoleus sp.	4		
Schizothrix			
sp.	3		
Unidentified forms			
blue-green trichomes	99	37	51
blue-green colonies	152	40	40
Other Algal Forms:			
Ceratium			
hirundinella (Muell.) Dujardin	3		
Gonyaulax, *Gymnodinium*, and/or *Peridinium*	37	9	1
Unidentified flagellate colonies	19		
Total Number of Collections in which species were found.	4,819	3,444	2,234

Source: Derived from NYU 1974, 1976a, 1977a

Table 2-2. Relative dominance by common forms of the phytoplankton at stations A through G, 1971. Nannoplankton Net Collection

	10%							25%							50%						
	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G
Diatoms																					
Fragilaria construens			x																		
Coscinodiscus rothii						x															
Thalassiosira fluviatilis	x	x	x	x		x	x														
Surirella ovalis							x														
Nitzschia fonticola		x																			
Synedra rumpens	x	x	x	x	x				x	x		x									
Fragilaria crotonensis	x	x																			
Amphiprora paludosa	x	x		x	x																
Coscinodiscus excentricus	x	x	x	x	x	x	x														
Coscinodiscus sp. (perf.)						x															
Asterionella formosa	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Fragilaria vaucheriae					x	x															
Melosira ambigua	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Skeletonema costatum			x			x	x							x							
Cyclotella meneghiniana	x	x	x	x	x	x															
Cyclotella glomerata	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Melosira granulata	x	x		x																	
Green algae																					
Actinastrum hantzchii	x	x	x	x	x	x	x	x	x	x	x	x	x	x							
Crucigenia tetrapedia	x	x	x	x		x	x	x													
Filamentous types		x	x	x	x	x	x														
Pediastrum duplex	x	x	x	x	x	x	x														
Scenedesmus quadricauda	x	x	x	x	x	x	x			x		x									
8-Celled colonies	x	x			x																
Unidentified coccoids	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Kirchneriella obesa	x	x	x						x												
Blue-green algae																					
Colonies	x	x	x	x	x	x	x	x		x	x	x	x								
Trichomes	x	x	x	x	x	x	x	x			x			x							

Source: NYU 1973

Table 2-3. The photosynthetic rate, chlorophyll a and photosynthesis per molecule of chlorophyll a of Hudson River phytoplankton exposed to thermal and chlorine additions, for 1975.

Date	Temp. °C	mg Carbon / m^3/hr	$S_{\bar{X}}$	df	mg Chl a / m^3	$S_{\bar{X}}$	n	mgC/m^3/hr / mg Chl a/m^3	$S_{\bar{X}}$	df
6/26	23.4	30.19	1.50	6	3.55	0.12	3	8.50	0.51	5
	28.4	41.41	2.59	6	3.35	0.16	3	12.36	1.10	5
	27.4	44.12	4.32	6	3.87	0.07	3	11.40	1.14	5
	27.8	37.42	3.93	6	3.24	0.17	3	11.59	2.09	5
	28.3	67.71	2.75	6	3.47	0.24	3	19.51	1.56	5
	32.6	51.93	3.56	6	3.29	0.10	3	15.78	1.26	5
	32.6	62.93	2.06	6	3.35	0.09	3	18.79	0.75	5
	32.6	26.11	3.43	6	3.03	0.23	3	8.60	1.29	5
	32.6	50.87	4.84	6	3.26	0.13	3	15.60	1.56	5
	35.0	58.30	2.28	6	3.05	0.08	3	19.11	0.96	5
	33.6	38.76	2.08	6	3.66	0.11	3	10.59	0.64	5
	36.0	43.61	3.36	6	2.45	0.03	3	17.80	1.42	5
	36.0	53.42	3.27	6	5.59	1.29	3	9.56	2.29	5
7/31	26.2	137.28	5.94	6	9.92	0.23	3	13.84	0.69	5
	28.8	108.23	4.90	6	8.88	0.92	3	12.19	1.34	5
	28.8	154.18	4.63	6	8.39	0.58	3	18.38	1.47	5
	28.8	122.77	5.49	6	8.42	0.48	3	14.58	1.02	5
	28.8	112.13	2.28	6	9.79	2.01	3	11.45	2.40	5
	31.0	103.38	2.12	6	6.98	0.23	3	14.81	0.59	5
	32.0	127.82	3.50	6	7.69	0.16	3	16.62	0.499	5
	31.0	121.77	5.53	6	12.00	1.96	2	10.15	1.93	4
	31.0	94.91	4.48	6	8.10	0.14	3	11.72	0.59	5
9/11	22.5	22.17	5.49	6	1.74	0.18	3	12.74	3.42	5
	22.5	19.64	1.80	6	1.20	0.09	3	16.44	1.95	5
	22.5	27.45	5.16	6	1.31	0.03	3.	20.95	3.98	5
	22.5	19.89	2.97	6	1.39	0.06	3	14.31	2.22	5
	24.8	27.14	2.53	6	1.73	0.13	3	15.69	1.88	5
	24.8	29.01	3.22	6	1.59	0.05	3	18.25	2.11	5
	24.8	25.40	1.42	6	1.54	0.10	3	16.49	1.48	5
	24.8	31.48	4.30	6	1.42	0.07	3	17.27	3.33	5
	27.5	24.53	2.20	6	1.37	0.18	3	17.95	3.95	5
	27.5	29.51	1.88	6	1.35	1.09	3	21.86	17.71	5
	27.5	35.27	1.23	6	1.44	0.12	3	24.49	2.20	5
	27.5	21.09	4.12	6	0.93	0.11	3	22.67	5.21	5

ND - Not detectable, < 0.03 mg/l

Source: Derived from NYU 1976b

Table 2-4

Nuisance Algae - Indian Point Vicinity

I. Toxic Algae

Cyanophyta

a) Anacystis (Microcystis) spp.
b) Gomphosphaeria lacustrus (kuetzingianum type)
c) Anabaena spp.
d) A. circinalis

II. Taste and Odor Producing Algae

1 - Diatoms (Bacillariophyceae)

a) Cyclotella comta
b) Diatoma vulgare
c) Fragilaria construens
d) Stephanodiscus niagarae
e) Synedra ulna
f) Tabellaria fenestrata

2 - Green Algae (Chlorophyceae)

a) Pediastrum tetras
b) Scenedesmus abundans

III. Filter Clogging Algae

1 - Diatoms

a) Asterionella formosa
b) Cyclotella meneghiniana
c) Cymbella ventricosa
d) Diatoma vulgare
e) Fragilaria crotonensis
f) Melosira granulata
g) Melosira varians
h) Navicula graciloides
i) Navicula lanceolata
j) Nitzschia palea
k) Stephanodiscus hantzschia
l) Synedra acus
m) Synedra pulchella
n) Tabellaria fenestrata

Source: Derived from Table 2-1 and Palmer, 1962

Table 2-5. Energy Inputs into Hudson River

Source		kcal $yr^{-1} x10^9$	% of Total
Benthic plants	Primary	40	.000488
Phytoplankton	Production	200	.2440
Upstream watershed		620	.756
Lower watershed		80,000	97.6
Human effluents		1,100	1.342
Marine		0.17	.0002
Total		81,960.17	100.0%

Source: Derived from Con Edison 1977a

SECTION 3 - MICROZOOPLANKTON

3.1 Field Studies

In general, microzooplankton samples were collected once every two weeks from May through August. During April, September, October, November, and December samples were generally collected once per month (Table 3-1). The plankton collected in each vertical tow were washed into a jar and preserved in 10% Formalin (NYU, 1973, 1974, 1976a 1977a, and 1977b).

In the laboratory, replicate 1 ml samples were examined by scanning two Sedgwick-Rafter counting cells at a magnification of 100X. The average number of organisms in the two aliquots was used in calculating the concentration of organisms in the river by the following formula:

$$\text{number of organisms} = \frac{AV}{RC}$$

where

A = average of two 1 ml counts
V = volume of sample
R = revolutions recorded by flowmeter
C = volume factor for flowmeter
(R) (C) = volume of water filtered by net

3.2 Community Structure

The following table (Table 3-2) indicates the composition of the microzooplankton collected at the seven river stations from 1971-1976, excluding 1973.

3.3 Analysis of Variance

Microzooplankton data were analyzed by a two-way factorial analysis of variance (ANOVA). Numbers per liter were transformed logarithmically for variance stabilization prior to analysis. Where ANOVA indicated significant differences between stations, a Scheffe test ($a<0.10$) was performed to locate the differences.

The following tables (Tables 3-3 through Table 3-8) contain the ANOVA results for the years 1974, 1975 and 1976. The 1971-72 ANOVA data are not included because they were tabulated in a different manner which was not suitable for inclusion in this report. However, the data can be found in the appendices to the NYU 1971-72 Annual Report (NYU 1973).

Table 3-1. Frequency of Microzooplankton Collections at the Indian Point Standard Stations

	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1971									
Day	0	2	4	2	4	2	3	2	0
Night	0	1	1	1	1	1	1	1	0
1974									
Day	1	2	2	3	2	1	1	1	1
Night	0	1	1	1	1	1	1	1	1
1975									
Day	1	2	2	2	1	1	1	1	1
Night	1	2	2	2	1	1	1	1	1
1976									
Day	0	2	3	2	2	2	2	2	0
Night	0	2	2	3	2	2	2	2	0

Source: Derived from NYU, 1973, 1976a, 1976b, 1977b.

Table 3-2 Microzooplankton Species List

	1971-72	1974	1975	1976
Crustacea				
Copepoda				
Acartia tonsa Dana	X	X	X	X
Canthocamptid	X	X	X	X
Canuella sp.	X	X	X	X
Diacyclops bicuspidatus Claus	X	X	X	X
Ectinosoma curticorne Boeck	X	X	X	X
Epischura sp.	X	X	X	
Ergasilus sp.	X	X	X	X
Eurytemora affinis (Poppe)	X	X	X	X
Halicyclops fosteri M.S. Wilson	X	X	X	X
Nauplii	X	X	X	X
Copepodids	X	X	X	X
Mesocyclops edax	X			X
Cladocera				
Bosmina longirostris (O.F. Muller)	X	X	X	X
Chydorid	X	X	X	X
Daphnia pulex Leydig	X	X	X	X
Diaphanosoma brachyurum (Lieven)	X	X	X	X
Leptodora kindtii (Focke)	X	X	X	X
Moina sp.	X		X	
Ostracoda (no further identification)	X	X	X	X
Cirripedia				
Nauplii	X	X	X	X
Rotifera				
Asplanchna sp.	X	X	X	X
Brachionus angularis Grosse	X	X	X	X
Brachionus calyciflorus Pallas	X	X	X	X
Brachionus quadridentata Herman	X	X	X	X
Filinia longiseta (Ehrenberg)	X	X	X	X
Kellicottia longispina (Kellicott)	X	X	X	X
Keratella cochlearis (Grosse)	X	X	X	X
Keratella quadrata (Muller)	X	X	X	X
Keratella serrulata Ahlstrom	X	X	X	
Lecane sp.		X	X	
Monostyla	X			
Notholca accuminata (Ehrenberg)	X	X	X	X
Philodina sp.	X	X	X	X
Platyias patulus Ahlstrom		X	X	X
Platyias quadricornis Ahlstrom		X	X	
Pleosoma trunctatum (Levander)	X	X	X	X
Polyarthra sp.	X	X	X	X
Synchaeta sp.	X	X	X	
Trichocerca sp.	X	X	X	X
Unidentified sp. # 1	X	X	X	X
Unidentified sp. # 3		X	X	X
Unidentified sp. # 2			X	

Table 3-2 (Cont'd)	1971-72	1974	1975	1976
Protozoa				
Plasmodroma				
Mastigophora				
Arcella sp.	X	X	X	
Centropyxis sp.	X	X	X	X
Ceratium hirundinella (Muller)	X	X	X	X
Coelastrum sp.	X	X	X	
Difflugia sp.	X	X	X	X
Dinobryon sp.	X	X	X	
Errerella sp.		X	X	
Eudorina sp.	X	X	X	X
Euglypha sp.	X	X	X	
Pandorina sp.	X	X	X	
Pleodorina sp.	X	X	X	X
Volvox sp.	X	X	X	X
Ciloiphora				
Ciliate				
Carchesium sp.	X	X	X	X
Codonella cratera (Leidy)	X	X	X	
Epistylis sp.	X	X	X	X
Tintinnopsis sp.	X	X	X	
Vorticella sp.	X	X	X	
Eutintinnus sp.	X			
Suctorid				
Metacineta sp.	X	X	X	
Staurophrys sp.	X	X	X	
Miscellaneous				
Gastropod veliger	X	X	X	X
Polecypod veliger	X	X	X	
Annelid larvae	X	X	X	X
Nematode	X	X	X	X
Tardigrade	X	X	X	X

Source: NYU 1973, 1974, 1977a, 1977b.

Table 3-3. Results of analyses of variance of day abundances of microzooplankton, 1974.

Analysis	F-value	Station Effect	Scheffe Test ($\alpha < .10$)
Total	1.03	N.S.	---
Copepoda-Adults	1.57	N.S.	---
Copepoda-Copepodids	0.79	N.S.	---
Copepoda-Nauplii	2.37	*	F>B
Eurytemora affinis	2.23	*	N.S.
Acartia tonsa	1.43	N.S.	---
Diacyclops bicuspidatus	1.95	N.S.	---
Halicyclops fosteri	0.80	N.S.	---
Diaphanosoma brachyurum	1.26	N.S.	---
Bosmina longirostris	2.17	N.S.	---
Daphnia pulex	1.06	N.S.	---
Crustacea	1.24	N.S.	---
Rotifera	0.28	N.S.	---
Protozoa	1.66	N.S.	---

* $P < 0.05$

Source: NYU 1976a

Table 3-4. Results of analyses of variance of night abundances of microzooplankton, 1974.

Analysis	F - Value	Station Effect	Scheffe Test ($\alpha < .10$)
Total	2.78	*	G > D
Copepoda - Adults	2.80	*	G > A, C, D, & E
Copepoda - Copepodids	1.81	N.S.	------
Copepoda - Nauplii	1.99	N.S.	------
Eurytemora affinis	1.26	N.S.	------
Acartia tonsa	3.51	*	G > B, C, D & E
Diacyclops bicuspidatus	2.18	N.S.	------
Halicyclops fosteria	1.36	N.S.	------
Diaphanosoma brachyurum	0.90	N.S.	------
Bosmina longirostris	2.06	N.S.	------
Crustacea	2.00	N.S.	------
Rotifera	0.79	N.S.	------
Protozoa	1.03	N.S.	------

* $P < 0.05$

Source: NYU 1976a

Table 3-5 Results of analysis of variance of day abundances of microzooplankton, 1975.

Analysis	F - Value	Station Effect	Scheffe Test ($\alpha < 0.10$)
Total	0.9630	N.S.	------
Copepoda - Adults	1.5664	N.S.	------
Copepoda - Copepodids	1.5167	N.S.	------
Copepoda - Nauplii	0.2604	N.S.	------
Eurytemora affinis	1.8006	N.S.	------
Acartia tonsa	1.5773	N.S.	------
Diacyclops bicuspidatus	1.0515	N.S.	------
Halicyclops fosteri	0.4111	N.S.	------
Diaphanosoma brachyurum	0.8800	N.S.	------
Bosmina longirostris	1.2740	N.S.	------
Daphnia pulex	1.0000	N.S.	------
Crustacea	0.6605	N.S.	------
Rotifera	1.7702	N.S.	------
Protozoa	0.8000	N.S.	------

* $P < 0.05$

Source: NYU 1977a

Table 3-6. Results of analysis of variance of night abundance of microzooplankton, 1975.

Analysis	F - Value	Station Effect	Scheffe Test (α <0.10)
Total	2.3974	*	N.S.
Copepoda - Adults	1.4474	N.S.	------
Copepoda - Copepods	0.2275	N.S.	------
Copepoda - Nauplii	2.1532	N.S.	------
Eurytemora affinis	0.3069	N.S.	------
Acartia tonsa	1.5405	N.S.	------
Diacyclops bicuspidatus	1.1866	N.S.	------
Halicyclops fosteri	1.3096	N.S.	------
Diaphanosoma brachyurum	1.8919	N.S.	------
Bosmina longirostris	2.3970	*	D > G
Daphnia pulex	0.2857	N.S.	------
Crustacea	3.1005	*	N.S.
Rotifera	0.8316	N.S.	------
Protozoa	0.5306	N.S.	------

* $P < 0.05$

Source: NYU 1977a

Table 3-7 Results of analysis of variance of day abundances of microzooplankton, 1976.

Analysis	F - Value	Station Effect	Scheffe Test ($\alpha < 0.10$)
All species	0.15	N.S.	
Crustacea	0.33	N.S.	
Rotifera	0.32	N.S.	
Protozoa	1.98	N.S.	
Copepoda - Adults	1.39	N.S.	
Copepoda - Copepodids	2.07	N.S.	
Copepoda - Nauplii	0.63	N.S.	
Acartia tonsa	0.01	N.S.	
Eurytemora affinis	1.25	N.S.	
Diacyclops bicuspidatus	1.60	N.S.	
Halicyclops fosteri	2.95	*	D, E > All; C>A; All>F
Total Copepoda	0.39	N.S.	
Total Calanoida	0.95	N.S.	
Total Cyclopoida	3.41	*	D, E>A, B; All>F
Total Harpacticoida	1.39	N.S.	
Bosmina longirostris	4.17	*	All>F
Diaphanosoma brachyurum	0.93	N.S.	
Total Cladocera	5.01	*	All>F

* $P < 0.05$

Source: NYU 1977b

Table 3-8. Results of analysis of variance of night abundances of microzooplankton, 1976.

Analysis	F - Value	Station Effect	Scheffe Test ($\alpha < 0.10$)
All species	1.31	N.S.	
Crustacea	1.06	N.S.	
Rotifera	1.49	N.S.	
Protozoa	0.46	N.S.	
Copepoda-Adults	1.02	N.S.	
Copepoda-Copepodids	0.56	N.S.	
Copepoda-Nauplii	1.54	N.S.	
Acartia tonsa	2.32	N.S.	
Eurytemora affinis	1.18	N.S.	
Diacyclops bicuspidatus	0.76	N.S.	
Halicyclops fosteri	1.99	N.S.	
Total Copepoda	0.56	N.S.	
Total Calanoida	1.38	N.S.	
Total Cyclopoida	1.50	N.S.	
Total Harpacticoida	2.07	N.S.	
Bosmina longirostris	1.02	N.S.	
Diaphonosoma brachyurum	1.02	N.S.	
Total Cladocera	0.36	N.S.	

Source: NYU 1977b

3.4 Laboratory Tolerance Studies

For the experiments conducted from 1971-1973 organisms were collected at the plant intakes and in the river using 571 um mesh and 76 um mesh plankton nets (NYU 1973, 1974).

Collected organisms were maintained in ambient-temperature water baths for 1 to 7 days prior to thermal tolerance studies. Two milliliters of river water, containing between 5 and 50 organisms, depending on the species being tested, were pipetted into 2-ml microanalyzer beakers and capped.

Thermal exposures were conducted by submerging the test containers in constant-temperature water baths. This was done by placing the microanalyzer beakers containing the organisms in netted dishes, which were then lowered into the water bath. Submersion helped to minimize the effects of air temperature during tests. Temperature was monitored continuously with a thermister telethermometer. Irrespective of ambient temperature, the test temperature in the vial was reached after 5 minutes of submersion in the water bath. After selected exposure times, the test containers were allowed to cool in ambient-temperature water baths. Control organisms were placed in test containers and maintained at ambient water temperature.

Approximately 1 hour after being held in ambient water temperature, organisms were examined for viability under 50X magnification. Organisms were observed for response to probing or twitching after addition of a drop of formalin. Organisms not responding to probing but responding to a drop of formalin were classified at stunned. Organisms that showed no response to either stimulus were classified as dead. The organisms were then preserved in 10% formalin and the total number per vial was counted at a later date. Three to five vials per exposure time per test temperature were used in each experiment.

In general, the test procedures used in 1975 were very similar to those used in the previous years. Organisms were collected the day before or the morning of the test using 76 um mesh plankton nets. Test containers were polystyrene cylinders (2.0 cm diameter; 2.2 cm high) with 76 um mesh nylon net bottoms. Organisms were examined for immediate effects (one hour after exposure) and at various times up to 24 hours for latent effects. Observations were made with a steroscopic microscope at a magnification of 30X. In the majority of experiments, nine replicate test containers were prepared for each control and test group. No fewer than three replicate test containers were used in any of the experiments (NYU 1976b).

SECTION 4 - MACROZOOPLANKTON

4.1 Macrozooplankton

4.1.1. Thermal Tolerance

All organisms used by New York University for the short-term thermal tolerance tests were collected from the plant intakes with 571 um mesh plankton nets, and maintained in water baths at ambient temperature for 48 hours before use in experiments. Each test group consisted of 25 organisms selected to approximate the size composition of the river population at the time samples were taken. Test organisms were sorted into 125 ml methylpentene polymer containers with bottoms of 571 um mesh nylon netting (NYU 1973).

The experimental procedure consisted of immersing containers with test organisms in constant-temperature water baths filled with aerated Hudson River water to obtain thermal exposures of desired temperatures and durations. Temperature was monitored continuously with a thermister telethermometer. At the end of the selected exposure time, the test containers were transferred immediately to an ambient temperature bath. Control groups were placed in the test containers and maintained at ambient temperature.

Test organisms were examined for viability 1 hour after thermal exposure. During summer ambient temperatures, test organisms were held at ambient temperature in the laboratory for examination 24 hours after thermal tolerance tests.

Amphipods lacking pleopodal movement were classified as dead. Other behavioral characteristics such as locomotor ability, stimulus response, and spatial orientation were also noted throughout the tests.

The results of these studies are presented in Figures 4-1, 4-2, 4-14 and 4-15 and in Table 4-1.

4.2 Macrozooplankton Latent Mortality

Gammarus spp. used for latent mortality were collected from the Indian Point Unit 1 intakes bays by 571 um mesh nylon plankton nets. Test organisms were sorted into 3-liter battery jars and maintained in aerated Hudson River water for at least 48 hours prior to experimentation. The thermal tolerance tests were conducted during maximum summer ambient temperatures and declining fall ambient temperatures. All experimental ΔT's represented a temperature increase (NYU 1974).

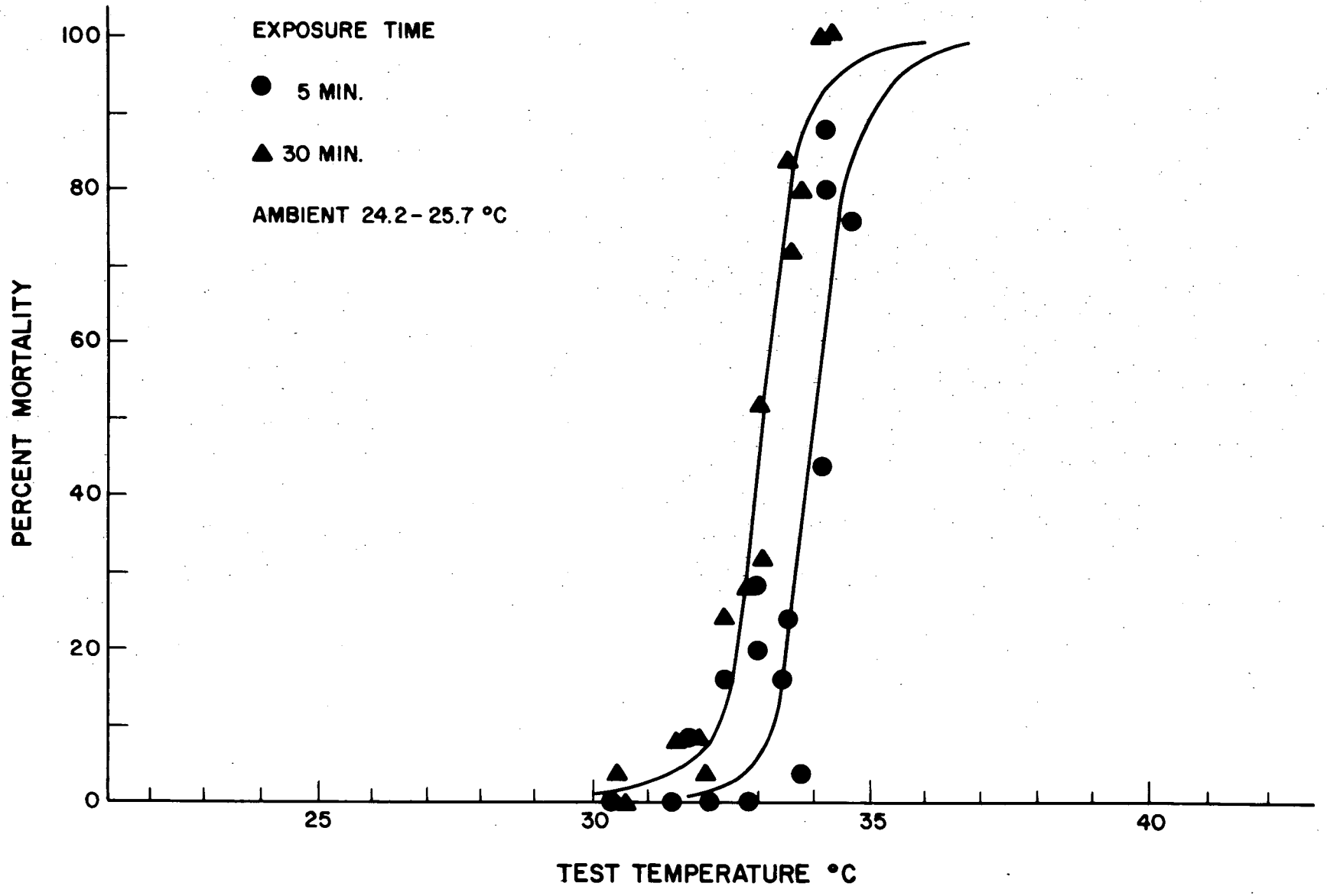


Figure 4-1. Temperature tolerance of Neomysis americana.

Source: NYU 1973.

Table 4-1. TL95 and TL50 (^{o}C) of *Gammarus* spp. in 5-minute and 30-minute exposures at summer ambient temperatures. ($25^{o}C$).

TL95*		TL50*	
5 min	30 min	5 min	30 min
38.0	37.2	38.7	37.8

Source: Derived from NYU 1973.

* after initial exposure organisms were held for 24 hours at the ambient temperature ($25^{o}C$), then mortalities were tabulated.

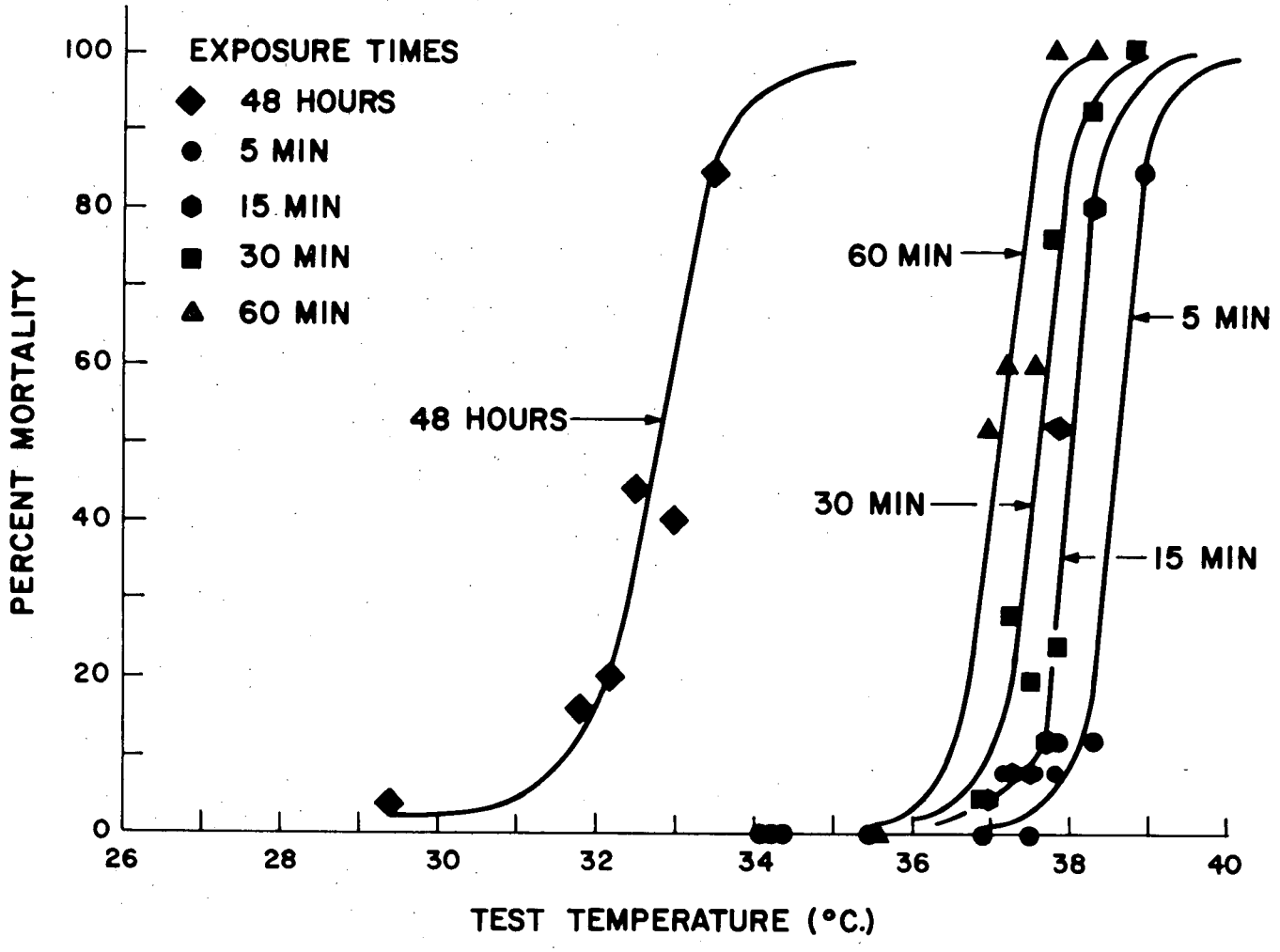


Figure 4-2. Temperature tolerance of Gammarus spp. at an ambient temperature of 24.7 to 25.8 C.

Source: NYU 1973.

The aquatic plants Cabomba sp. and Myriophyllum sp. and assorted green algae served as substrate and food in all experiments involving culturing of Gammarus spp. This diet was supplemented with finely ground commercial fish food and presoaked maple leaves.

Twenty Gammarus spp. were placed in 125 ml methylpentene polymer containers with bottoms of 571 um mesh nylon netting. In latent mortality tests, the procedure for thermal exposure was identical to that used for the determination of acute temperature tolerances. Temperature was monitored continuously with a thermister telethermometer. At the end of the selected exposure time, the test containers were transferred immediately to an ambient water table, resulting in a rapid return to ambient temperature. Control groups of Gammarus spp. were placed in the test containers and maintained continuously at ambient temperature.

Test groups of 80 and 100 Gammarus spp. (20 organisms per replicate) were exposed to selected ΔT's and exposure times and examined for mortality immediately and at 5 and 10 days after exposure. Following thermal exposure, the test organisms were put in battery jars (20 per jar) containing 800 ml of Hudson River water. All test organisms were held for 10 days after thermal exposure in Freas Model-818 incubators at Hudson River ambient temperature at the time of collection. The photoperiod was 14 hours in summer and reduced to 12 hours in the fall. The water in each jar was replaced with fresh river water during the 5-day examination.

4.3 Gammarus Cold Shock

The effects of long-term exposures to potential Indian Point discharge temperatures during declining ambient temperatures were also examined for Gammarus spp. Four replicates of 20 organisms each served as controls and were maintained at Hudson River ambient temperature. An equal number of test organisms was exposed to an immediate 15.6°C ΔT and maintained at that temperature for 17 days. The temperature of the test group was reduced to ambient immediately. The groups were then maintained in culture for another 7 days. The numbers of ovigerous females, amplectic pairs, and young were recorded for each group at 17 and 24 days (Ginn, 1977).

4.4. Gammarus Reproductive Studies

Gammarus spp. used for reproductive experiments were collected from the Indian Point Unit 1 intake bays by 571 u-mesh nylon plankton nets. Test organisms were sorted into 3-liter battery jars maintained in aerated Hudson River water for at least 48

hours prior to experimentation. The thermal tolerance tests were conducted during maximum summer ambient temperatures and declining fall ambient temperatures. All experimental ΔT's represented a temperature increase (NYU 1976a, 1977a).

The aquatic plants Cabomba sp. and Myriophyllum sp. and assorted green algae served as substrate and food in all experiments involving culturing of Gammarus spp. This diet was supplemented with finely ground commercial fish food and presoaked maple leaves.

Ovigerous female G. daiberi were subjected to 5 and 60-minute exposures to 8.3°C ΔT and 5 and 30-minute exposures to an 11.0°C ΔT. Ovigerous females first were isolated into groups of approximately the same size and them randomly sorted into test groups composed of 10 individuals. After thermal exposure the test organisms were maintained individually in culture dishes containing 200 ml of Hudson River water at ambient temperature. Ninety-five percent of the young were released by the females and counted with 5 days after temperature exposure. The remaining young were released within 6 days after exposure.

Reproduction of G. daiberi following exposure to increased temperatures was tested by exposing test groups composed of half males and half females (non-ovigerous). A total of 40 G. daiberi in each test group were exposed to 8.3°C ΔT over an ambient temperature of 26.0°C for 5 and 60 minutes. Groups of males and females were maintained in 1.5-liter culture dishes. The organisms were examined at 5, 10, and 15 days. Any ovigerous females were isolated and maintained individuallly in 200-ml culture dishes. The total number of your produced was recorded for all but four females at 15 days. The young of these were released and counted by the 17th day.

The results and analysis of these studies are presented in Tables 4-2 and 4-3.

4.5. Gammarus Plume Transit Studies

Test organisms were collected at the Indian Point Unit No. 2 intake station and maintained in the laboratory for at least 96 hours prior to experimentation. Following test exposures, all living organisms were placed into 800 ml battery jars (20 per jar) and maintained for 120 hours in Freas Model 818 incubators which were set at Hudson River ambient temperature. A 12 hour photoperiod was maintained throughout the holding and experimental periods (NYU 1976b).

The experimental procedure involved the simultaneous exposure of amphipods to a test condition (discharge plume) and to a control

Table 4-2. Number of young produced by ovigerous female *Gammarus* spp. exposed to 8.3C° and 11.0C° ΔT's at an ambient temperature of 26.0C°. Test organisms exposed to an 11.0C° ΔT were larger than those exposed to an 8.3C° ΔT.

	8.3C° ΔT			11.0C° ΔT		
	Exposure Time (min)					
	0 (Control)	5	60	0 (Control)	5	30
Total Young	77	99	90	143	153	3
$\bar{X}$ (from surviving females)	9.6	9.9	10.0	14.3	15.3	0.3
95% C.I.	7.7-11.6	7.7-12.1	8.3-11.7	8.4-20.2	9.9-20.7	0.0-0.8

Source: Ginn 1977.

Table 4-3. Reproduction of Gammarus spp. following 8.3C°ΔT at an ambient temperature of 26.0C°.

Time after Exposure (Days)		Control 1	Control 2	5 minute 1	5 minute 2	60 minute 1	60 minute 2
5	Number alive	20	20	18	18	20	18
	Amplectic pairs	8	9	7	6	8	6
10	Number alive	18	20	16	17	14	17
	Amplectic pairs	1	0	1	1	0	1
	Ovigerous Females	7	10	6	7	9	6
15-17	Total number of young	141		118		115	
	$\bar{X}$ (for surviving females)	8.29		8.43		8.21	
	95% C.I.	6.34-10.24		5.91-10.95		6.54-9.88	

Source: Ginn 1977.

condition. Two floatation devices (Figure 4-3), one in the discharge canal and one in the control area, each with a total of forty amphipods contained in submerged cages, were simultaneously allowed to drift for one hour under the influence of local tidal and current conditions.

The plume transit rack was lowered into the plume at a point near the highest observed surface ΔT (Figure 4-4). The control rack was placed into a non-plume area of the river near Jones Point, approximately 1500 m north of Indian Point. the location of each transit rack and the surface water temperatures were recorded at five minute intervals. After the test, plume exposed and control test organisms were immediately examined for viability and then returned to the laboratory where they were maintained for latent survival analysis.

The plume transit locations for control and experimental groups on July 17 and September 4, 1975 are presented in Figures 4-5 and 4-6. In July the exposures were initiated during a low slack tide which began to flood during the transit. The control transit rack drifted inshore to position E (Fig 4-5) and was consequently transported offshore to position F where it was allowed to again drift freely. The exposure on September 4 was conducted entirely during an ebbing tide. The highest plume temperatures during the one-hour transit were recorded during the 20 minutes following immersion (Fig 4-4).

4.6 Macrozooplankton Field Studies

Replicate samples were collected by towing a series of plankton nets against the prevailing current. Each net rig was attached to the towing cable by three bridle lines secured at a common eye to a cable clamp. The towing cable was routed from a winch through a gantry pulley and then outboard through a davit pulley. There was approximately 250 feet of 1/8 inch stainless steel cable with a 50 pound net depressor on the end. Secured in the mouth opening of each net (during the 1974, 1975 and 1976 collections) was a General Oceanic digital flowmeter, model 1031, from which flow volumes were computed for each tow (NYU 1973, 1974, 1976a, 1977a, 1977b).

Samples were collected by ten minute tows of the plankton net from the seven standard stations at three depths; surface (6-12 inches below the water surface); mid-depth (net set on cable at 1.5 - 2 times the mean depth for that station); and bottom (less than five feet from the bottom in 1971, 1972, and 1974; approximately two feet from the bottom in 1975; and approximately one foot from the bottom in 1976 (Figure 4-7).

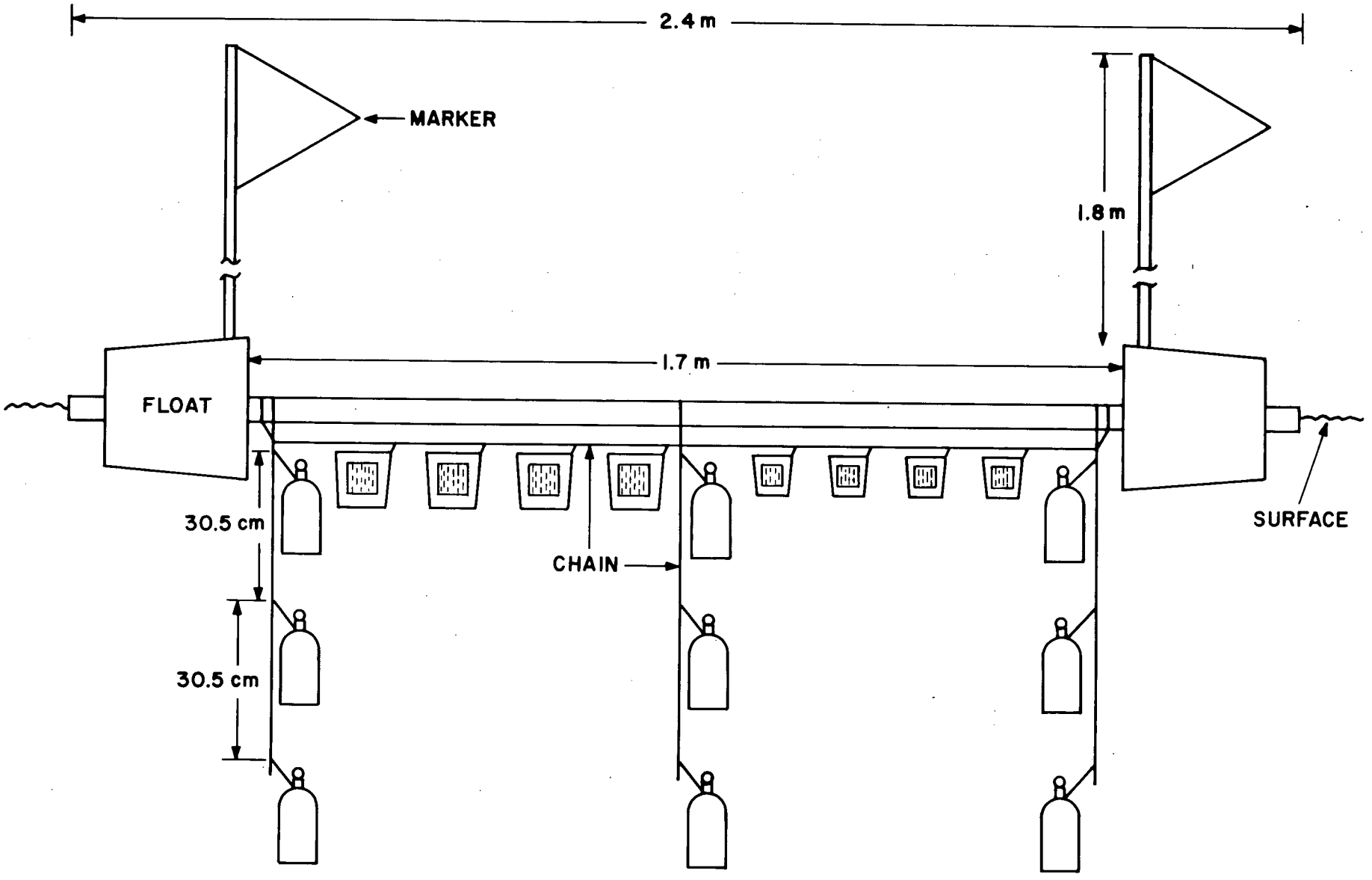


Figure 4-3. Organism exposure rack-simulated plume entrainment.

Source: NYU 1976b.

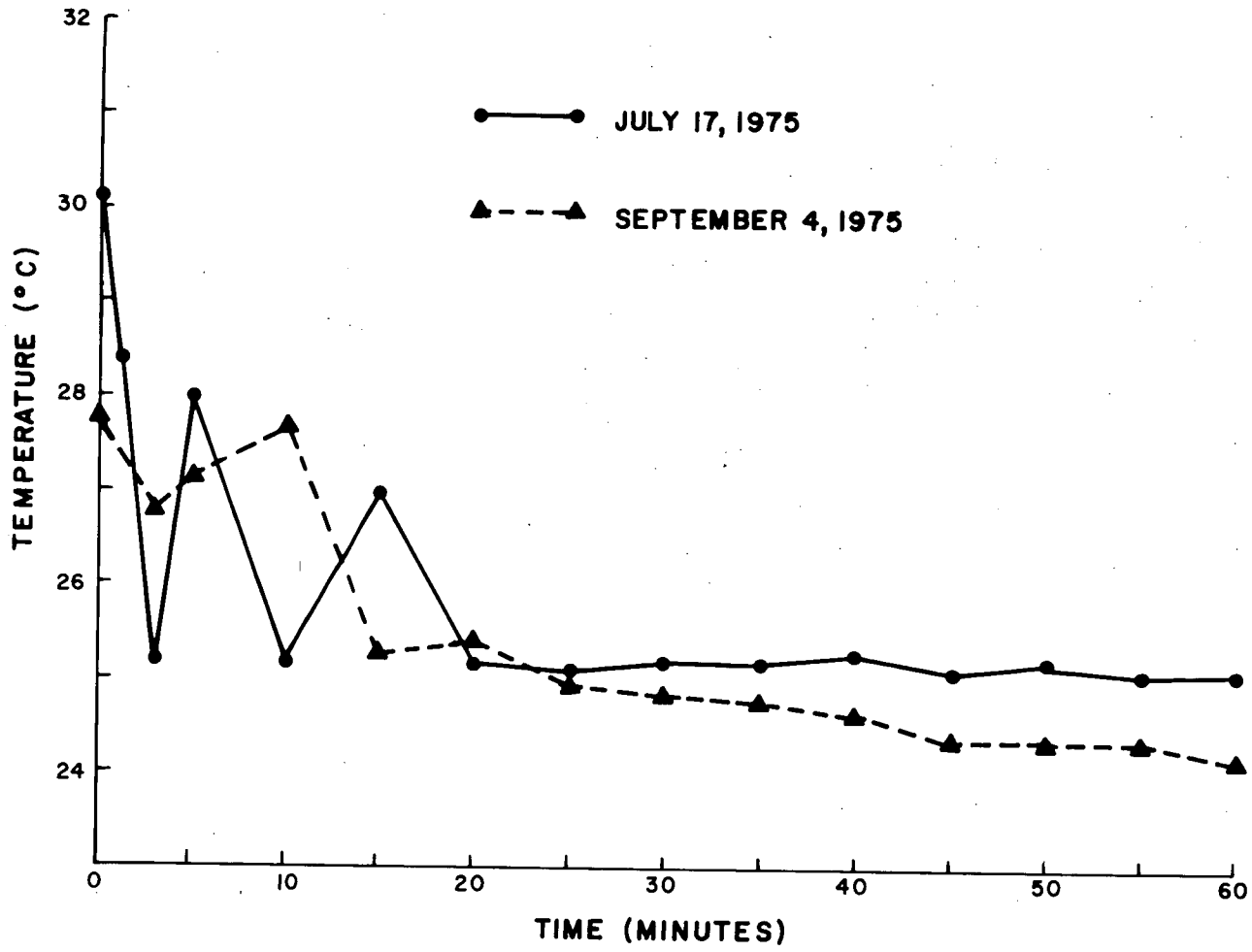


Fig. 4-4. Indian Point Plume Temperatures during plume transit study, 1975.

Source: NYU 1976b.

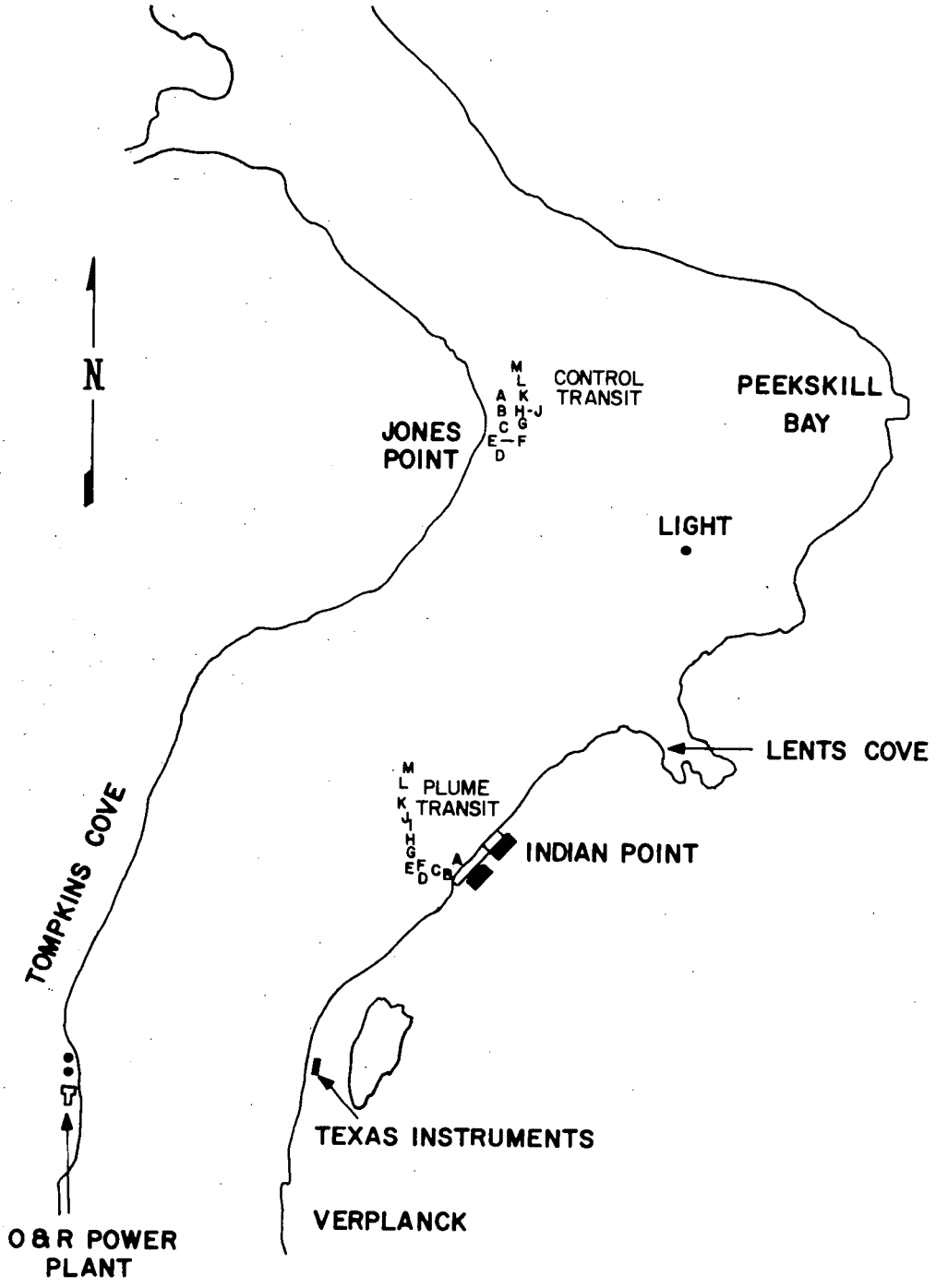


Fig. 4-5. **LOCATIONS A-M OF CONTROL AND PLUME TRANSIT RIGS DURING *IN SITU* PLUME CHLORINATION ON 7-17-75**

Source: NYU 1976b

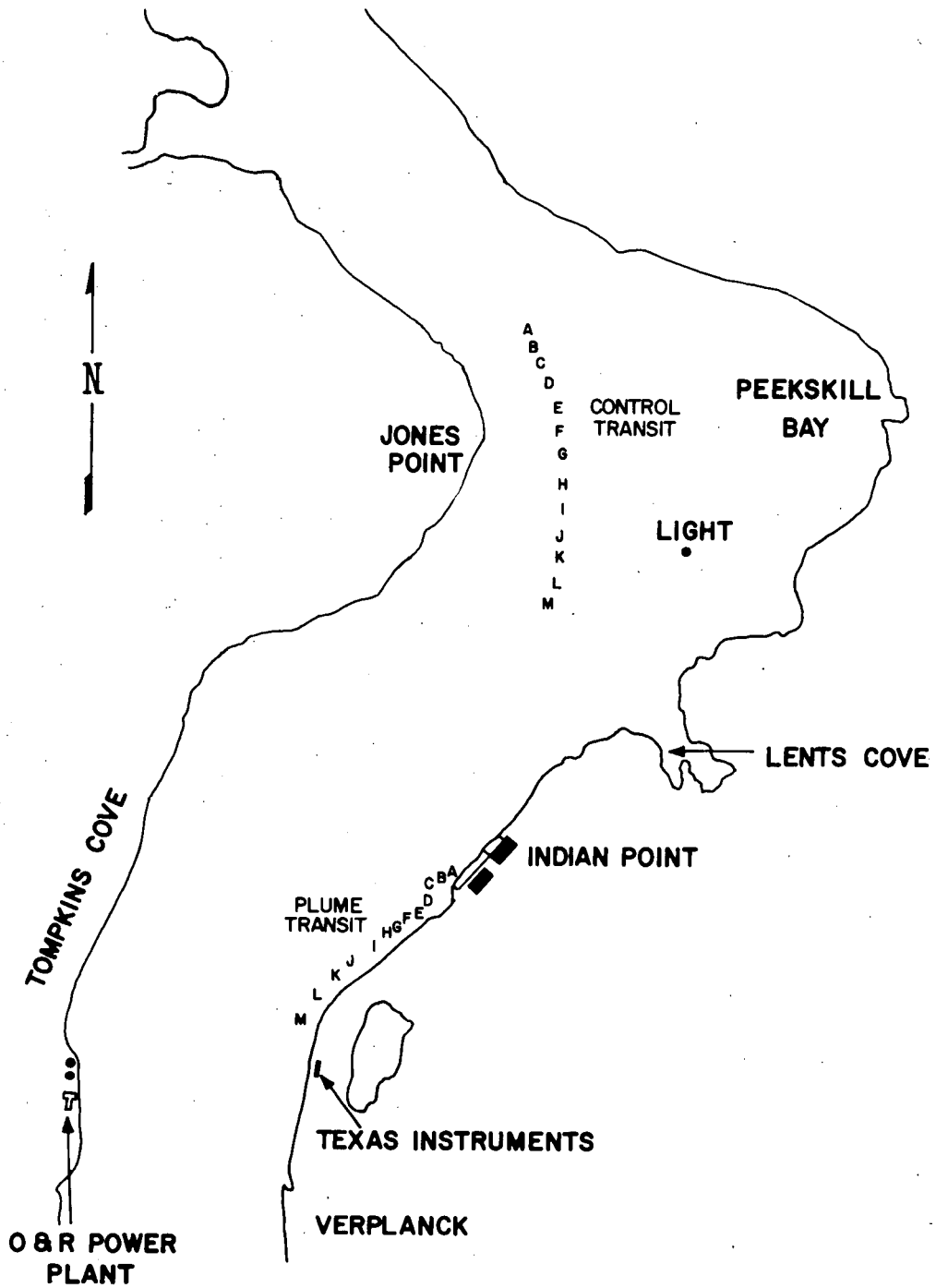


Fig. 4-6. **LOCATIONS (A-M) OF CONTROL AND PLUME TRANSIT RIGS DURING IN SITU PLUME CHLORINATION ON 9-4-75**

Source: NYU 1976b

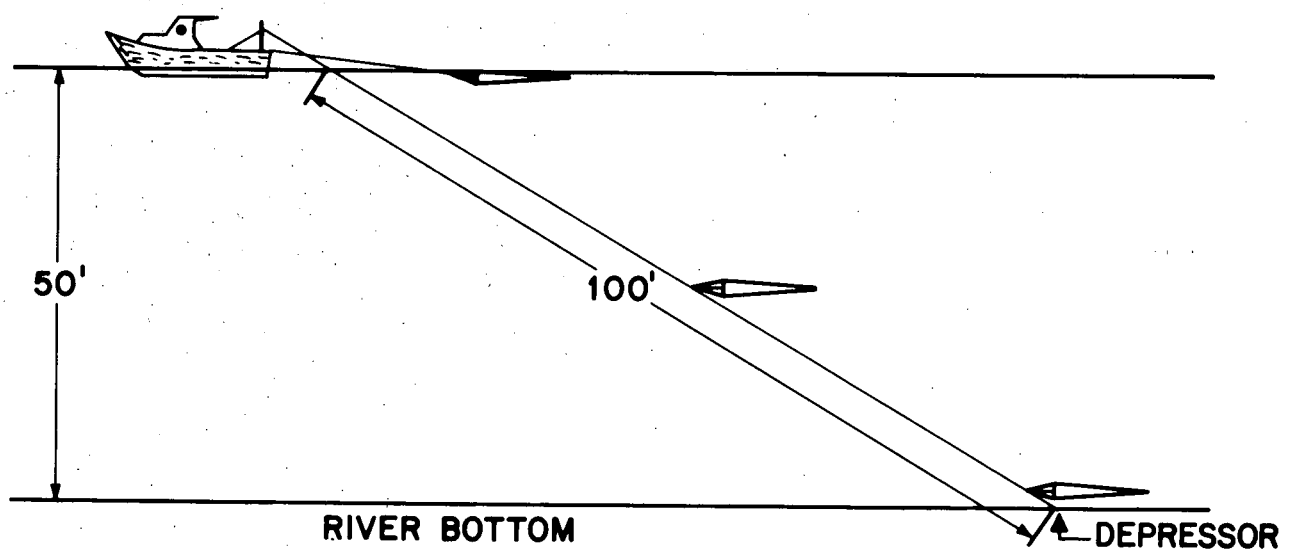


Figure 4-7. Deployment of 0.5 meter and 1.0 meter plankton nets.
Source: NYU 1976a.

The organisms collected in the tows included both macrozooplankton and ichthyoplankton. All ichthyoplankton were sorted out and analyzed separately for species composition, numerical abundance and life stages (see Section 5.1.2).

The macrozooplankton were examined in a glass sorting tray against a black background, and each species was sorted out for counting. When a sample contained a very large number of organisms (macrozooplankton only) of a single species, the sample was divided and successively subdivided, using a Folsom plankton splitter to obtain a representative subsample in which the number of organisms was small enough to be counted individually. That number was then multiplied by the appropriate divisor of the original sample to obtain the number in the whole sample.

All macroinvertebrates were sorted from the samples, identified to species (when possible) and enumerated. The data were analyzed by analysis of variance to determine whether significant differences existed in the temporal and spatial distribution of river macrozooplankton relative to macrozooplankton sampled at the plant intakes.

The results and analysis of these studies are presented in Tables 4-4 through 4-16 and in Figures 4-8 through 4-13.

4.7. Benthic Field Studies

Benthic samples were collected monthly, using an Emory type bottom grab, at regular trawl and plankton stations from August 1969 through October 1970 (except during January and February when river ice conditions limited sampling) (Fig. 4-16). The grab covered an area of 250 cm^2 and had a capacity of 250 cm^3. Each sample was fixed in neutral formalin and then washed on a 0.3 mm x 0.5 mm mesh screen. The organisms were retained and later identified and counted with the aid of a binocular microscope (Raytheon 1970, 1971).

Field Studies (Texas Instruments)

Preliminary investigations during 1972 employed five replicate samples taken while the vessel was anchored at the respective stations (Fig. 4-17). The 1973-1974 sampling comprised three replicate grabs taken at random within a 100m diameter circle. Samples were transferred to individual containers and transported to the field laboratory for washing and preservation. Samples were washed on U.S. Standard sieves (mesh sizes 250 and 500 um) and perserved in 4% formaldehyde solution to which Rose Bengal stain had been added. A small portion of each sample was placed in a petri dish and organisms were sorted from the debris with the aid of a dissecting microscope. Each aliquot was sorted

Table 4-4. Macrozooplankton taxa in Indian Point collections, 1971, 1972, 1974, 1975 and 1976. X denotes the presence of that organism for the given year.

Taxa	1971	1972	1974	1975	1976
Annelida					
Oligochaeta	X	X	X	X	X
Polychaeta	X	X	X	X	X
Hirudinea		X	X	X	X
Arthropoda					
Crustacea					
Copepoda					
Caligus sp.			X		
Branchyura					
Argulus sp.			X	X	X
Malacostraca					
Cumacea		X	X	X	X
Mysidacea					
Neomysis americana	X	X	X	X	X
Isopoda					
Chiridotea almyra	X	X	X	X	X
Cyathura polita	X	X	X	X	X
Edotea sp.	X	X	X	X	X
Cirolana sp.			X	X	X
Cassidinidae lunifrons					X
Amphipoda					
Gammarus spp.	X	X	X	X	X
Monoculodes edwardsi	X	X	X	X	X
Leptocheirus plumulosus	X	X	X	X	X
Corophium sp.	X	X	X	X	X
Decapoda					
Crangon septemspinosa	X	X	X	X	X
Decapod larva (zoea)		X	X	X	X
Palaemonetes sp.				X	X
Insecta					
Odonata (nymph)			X	X	X
Odonata (adult)	X	X		X	
Diptera (larvae)					
Chaoborus sp.	X	X	X	X	X
Chironomus sp.	X	X	X	X	X
Diptera (pupae)	X	X	X	X	X
Diptera (adult)	X	X	X	X	X
Plecoptera (nymph)				X	
Tricoptera (larva)					X

Table 4- 4. (cont.).

Taxa	1971	1972	1974	1975	1976
Arachnida					
Hydracarina	X	X	X	X	X
Coelenterata					
Medusae	X	X	X	X	X
Ctenophora			X	X	X
Mollusca					
Gastropoda	X	X			
Pelecypoda	X	X		X	

Source: NYU 1977b

Table 4-5 Analysis of Variance of Daylight Collections in 1971 of Macrozooplankton with Student-Newman-Keuls Analysis

Total Macrozooplankton (Days)

Surface

Source of Variation	(n-1) d.f.	Sum of Squares	Mean Square	F Stations / Error	F (.05)
Dates	31	261.5124	8.4358		
Stations	6	7.7379	1.2896		
Error	186	322.4055	1.7333	F = 0.74	F(6,120) = 2.52 F(6,00) = 2.41

Middle

Dates	31	462.0124	14.9036		
Stations	6	25.4664	4.2444		
Error	186	717.0027	3.8548	F = 1.10	F(6,120) = 2.52 F(6,00) = 2.41

Bottom

Dates	31	411.6480	13.2789		
Stations	6	165.7189	27.6198		
Error	186	398.0384	2.1399	F = 12.90	F(6,120) = 2.52 F(6,00) = 2.41

B G F D E C A*

Surface vs. Middle vs. Bottom

Dates	31	89.5928	2.8901		
Depth	2	314.2617	157.1308		
Error	62	58.1817	0.9384	F = 167.44	F(2,40) = 4.05 F(2,60) = 3.93

Surface < Middle < Bottom

* Stations A through G listed in ascending order. The difference between any two means is insignificant if the two stations are included within any one line below them. Significance was determined by the Student-Newman-Keuls procedure (Q<.05).

Source: NYU 1973

Table 4-6. Analysis of Variance of Night Collections in 1971 of Macrozooplankton with Student-Newman-Keuls Analysis

Total Macrozooplankton (Night)

Surface

Source of Variation	(n-1) d.f.	Sum of Squares	Mean Square	F Stations / Error	F (.05)
Dates	10	181.4286	18.1429		
Stations	6	19.2490	3.2082		
Error	60	105.3614	1.7560	F = 1.83	2.63

Middle

Dates	10	65.7362	6.5736		
Stations	6	11.8070	1.9678		
Error	60	39.2551	.6543	F = 3.01	2.63

Bottom

Dates	10	59.4473	5.9447		
Stations	6	.9756	0.1626		
Error	60	28.3353	.4722	F = 0.34	2.63

Surface vs. Middle vs. Bottom

Dates	10	31.9389	3.1939		
Depth	2	21.6902	10.8451		
Error	20	7.0580	0.3529	F = 30.73	4.46

Surface < Middle Bottom

* Stations A through G listed in ascending order. The difference between any two means is insignificant if the two stations are included within any one line below them. Significance was determined by the Student-Newman-Keuls procedure (Q<.05).

Source: NYU 1973

Table 4-7 Analysis of Variance of Daylight Collections in 1971 of *Monoculodes edwardsi* with Student-Newman-Keuls Analysis

Monoculodes edwardsi (Day)

Surface

Source of Variation	(n-1) d.f.	Sum of Squares	Mean Square	F Stations / Error	F (.05)
Dates	34	8.4421	0.2483		
Stations	6	1.0808	0.1801		
Error	204	45.5837	0.2234	F = 0.81	F(6,120) = 2.52 F(6,00) = 2.41

Middle

Dates	34	271.3543	7.9810		
Stations	6	18.5047	3.0841		
Error	204	547.5854	2.6842	F = 1.15	F(6,120) = 2.52 F(6,00) = 2.41

Bottom

Dates	34	675.2502	19.8603		
Stations	6	213.8183	35.6364		
Error	204	623.1710	3.0547	F = 11.67	F(6,120) = 2.52 F(6,00) = 2.41

B G F D E A C*

Surface vs. Middle vs. Bottom

Dates	34	128.7061	3.7855		
Depth	2	448.3196	224.1598		
Error	68	132.2880	1.9454	F = 115.23	F(2,60) = 3.93 F(2,120) = 3.80

Surface < Middle < Bottom

* Stations A through G listed in ascending order. The difference between any two means is insignificant if the two stations are included within any one line below them. Significance was determined by the Student-Newman-Keuls procedure (Q<.05).

Source: NYU 1973

Table 4-8 Analysis of Variance of Night Collections in 1971 of *Monoculodes edwardsi* with Student-Newman-Keuls Analysis

Monoculodes edwardsi (Night)

Surface

Source of Variation	(n-1) d.f.	Sum of Squares	Mean Square	F (Stations) (Error)	F (.05)
Dates	10	214.7657	21.4766		
Stations	6	21.8761	3.6460		
Error	60	175.8014	2.9300	F = 1.24	2.63

Middle

Dates	10	106.9716	10.6972		
Stations	6	6.1203	1.0201		
Error	60	111.1847	1.8530	F = 0.55	2.63

Bottom

Dates	10	147.6959	14.7696		
Stations	6	13.4147	2.2358		
Error	60	66.2870	1.1047	F = 2.02	2.63

Surface vs. Middle vs. Bottom

Dates	10	47.8106	4.7811		
Depth	2	38.6420	19.3210		
Error	20	7.6659	0.3832	F = 50.41	4.46

Surface < Middle < Bottom

* Stations A through G listed in ascending order. The difference between any two means is insignificant if the two stations are included within any one line below them. Significance was determined by the Student-Newman-Keuls procedure ($Q<.05$).

Source: NYU 1973

Table 4-9 Analysis of Variance of Daylight Collections in 1971 of *Neomysis americana* with Student-Newman-Keuls Analysis

Neomysis americana (Day)

Surface

Source of Variation	(n-1) d.f.	Sum of Squares	Mean Square	F Stations / Error	F (.05)
Dates	23	8.9942	0.3911		
Stations	6	1.9402	0.3234		
Error	138	46.9360	0.3401	F = .95	F(6,120) = 2.52 F(6,00) = 2.41

Middle

Dates	23	158.4653	6.8898		
Stations	6	23.6587	3.9431		
Error	138	364.7113	2.6428	F = 1.49	F(6,120) = 2.52 F(6,00) = 2.41

Bottom

Dates	23	865.4695	37.6291		
Stations	6	108.5037	18.0840		
Error	138	509.3430	3.6908	F = 4.90	F(6,120) = 2.52 F(6,00) = 2.41

B G A F D C E*

Surface vs. Middle vs. Bottom

Dates	23	170.7824	7.4253		
Depth	2	155.5380	77.7690		
Error	46	147.1748	3.1991	F = 24.31	F(2,40) = 4.05 F(2,60) = 3.93

Surface < Middle Bottom

* Stations A through G listed in ascending order. The difference between any two means is insignificant if the two stations are included within any one line below them. Significance was determined by the Student-Newman-Keuls procedure ($Q<.05$).

Source: NYU 1973

Table 4-10. Analysis of Variance of Night Collections in 1971 of *Neomysis americana* with Student-Newman-Keuls Analysis

Neomysis americana (Night)

Source of Variation	(n-1) d.f.	Sum of Squares	Mean Squares	F (Stations)/(Error)	F(.05)
Surface					
Dates	8	455.3108	56.9139		
Stations	6	5.7243	0.9541		
Error	48	68.1281	1.4193	F = 0.67	F(6,40)=2.74 F(6,60)=2.63
Middle					
Dates	8	484.9531	60.6191		
Stations	6	27.0657	4.5110		
Error	48	79.9745	1.6661	F = 2.71	F(6,40)=2.74 F(6,60)=2.63
Bottom					
Dates	8	462.4637	57.8080		
Stations	6	16.8344	2.8057		
Error	48	45.3133	0.9940	F = 2.82	F(6,40)=2.74 F(6,60)=2.63
Surface vs. Middle vs. Bottom					
Dates	7	210.2038			
Depth	2	11.7562	5.8781		
Error	14	16.6774	1.1912	F = 4.93	4.86

Surface < Middle < Bottom

* Stations A through G listed in ascending order. The difference between any two means is insignificant if the two stations are included within any one line below them. Significance was determined by the Student-Newman-Keuls procedure (Q<.05).

Source: NYU 1973

Table 4-11 Analysis of Variance of Daylight Collections in 1971 of *Gammarus* sp. with Student-Newman-Keuls Analysis

Gammarus sp. (Day)

Surface

Source of Variation	(n-1) d.f.	Sum of Squares	Mean Square	F Stations/Error	F (.05)
Dates	31	271.3064	8.7518		
Stations	6	16.2416	2.7069		
Error	186	243.4296	1.3087	F = 2.06	F(6,120) = 2.52 F(6,00) = 2.41

C B D A E G F*

Middle

Dates	31	600.2910	19.3642		
Stations	6	25.9436	4.3239		
Error	186	657.1988	3.5333	F = 1.22	F(6,120) = 2.52 F(6,00) = 2.41

Bottom

Dates	31	604.0494	19.4854		
Stations	6	167.6353	27.9392		
Error	186	400.2495	2.1518	F = 12.15	F(6,120) = 2.52 F(6,00) = 2.41

B G F E D C A*

Surface vs. Middle vs. Bottom

Dates	31	174.5157	5.6295		
Depth	2	341.2734	170.6367		
Error	62	73.8757	1.1915	F = 143.21	F(2,40) = 4.05 F(2,60) = 3.93

Surface < Middle < Bottom

* Stations A through G listed in ascending order. The difference between any two means is insignificant if the two stations are included within any one line below them. Significance was determined by the Student-Newman-Keuls procedure (Q<.05).

Source: NYU 1973

Table 4-12. Analysis of Variance of Night Collections in 1971 of *Gammarus* sp. with Student-Newman-Keuls Analysis

Gammarus sp. (Night)

Surface

Source of Variation	(n-1) d.f	Sum of Squares	Mean Squares	F (Station)/(Error)	F(.05)
Dates	10	186.0533	18.6053		
Stations	6	20.2770	3.3795		
Error	60	121.8541	2.0309	F = 1.66	2.63

Middle

Dates	10	80.5468	13.4599		
Stations	6	25.0332	2.5077		
Error	60	95.7919	1.5965	F = 1.57	2.63

F G B A C E D*

Bottom

Dates	10	55.0648	5.5064		
Stations	6	4.4992	0.7498		
Error	60	39.7661	0.6627	F = 1.13	2.63

Surface vs. Middle vs. Bottom

Dates	10	35.4543	3.3966		
Depth	2	28.8293	14.4146		
Error	20	9.0538	0.4526	F = 31.84	4.46

Surface<Middle = Bottom

* Stations A through G listed in ascending order. The difference between any two means is insignificant if the two stations are included within any one line below them. Significance was determined by the Student-Newman-Keuls procedure (Q<.05).

Source: NYU 1973

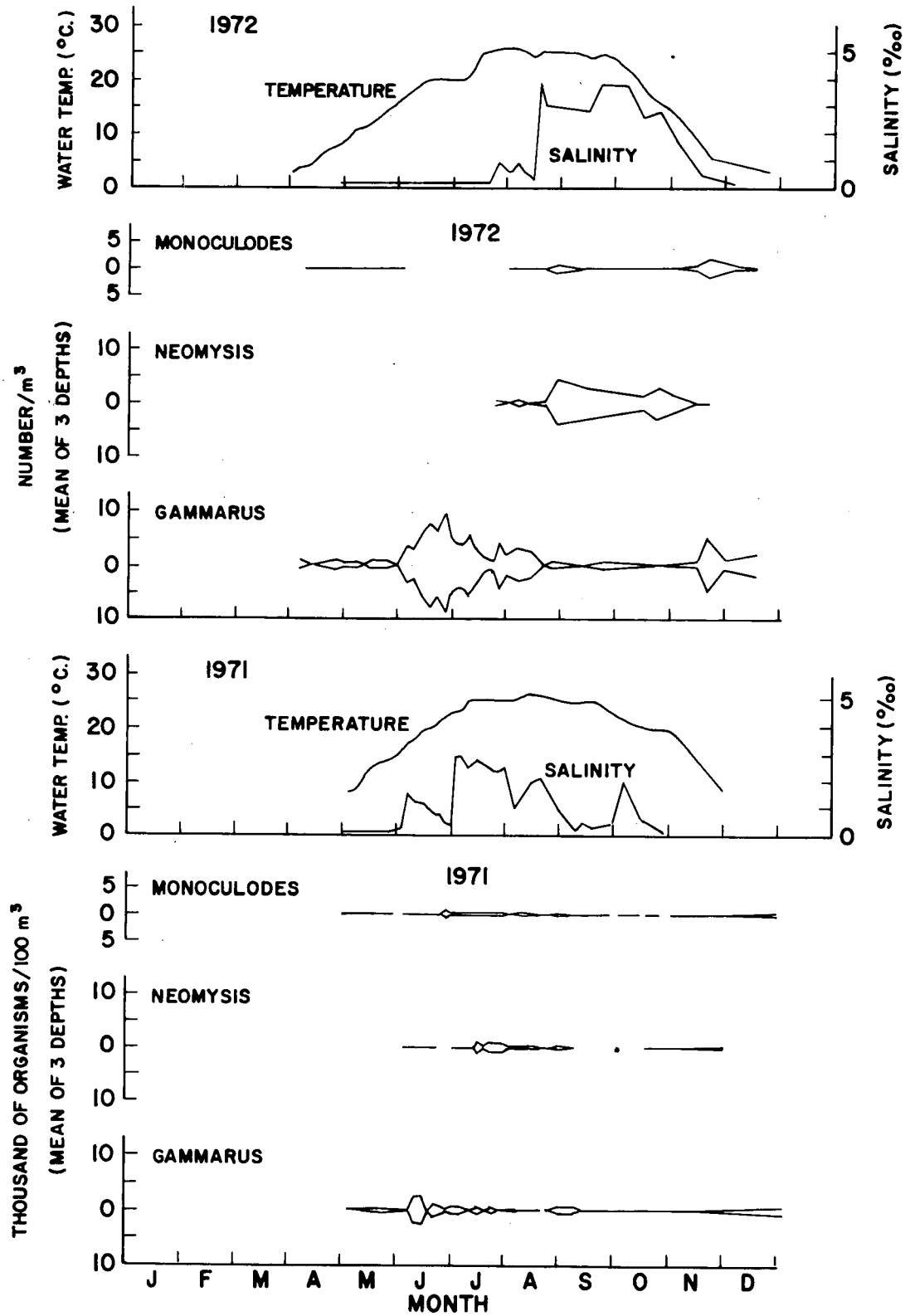


Figure 4-8. SEASONAL ABUNDANCE OF MONOCULODES EDWARDSI, NEOMYSIS AMERICANA, AND GAMMARUS SP. IN THE HUDSON RIVER AT INDIAN POINT IN RELATION TO WATER TEMPERATURE AND SALINITY IN 1971 AND 1972. (ABUNDANCES ARE REPRESENTED BY VERTICAL DISTANCE BETWEEN GRAPH LINES, I.E., VALUES ABOVE AND BELOW ZERO LINE SHOULD BE ADDED.)

Source: NYU 1974

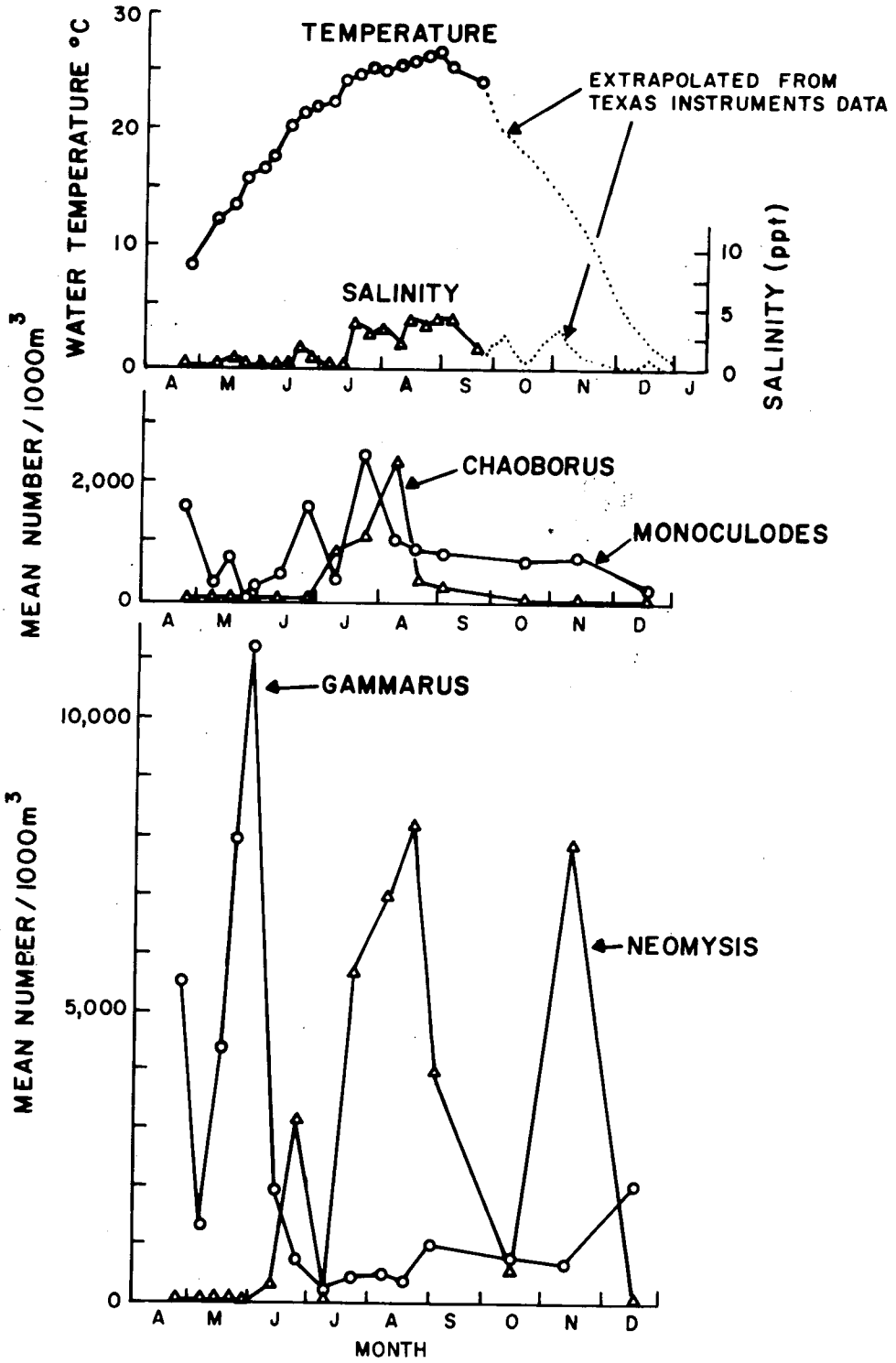


Figure 4-9. ABUNDANCE OF MACROZOOPLANKTON BY MONTH FOR DAYTIME SAMPLES TAKEN IN THE HUDSON RIVER AT INDIAN POINT, 1974

Source: NYU 1976a

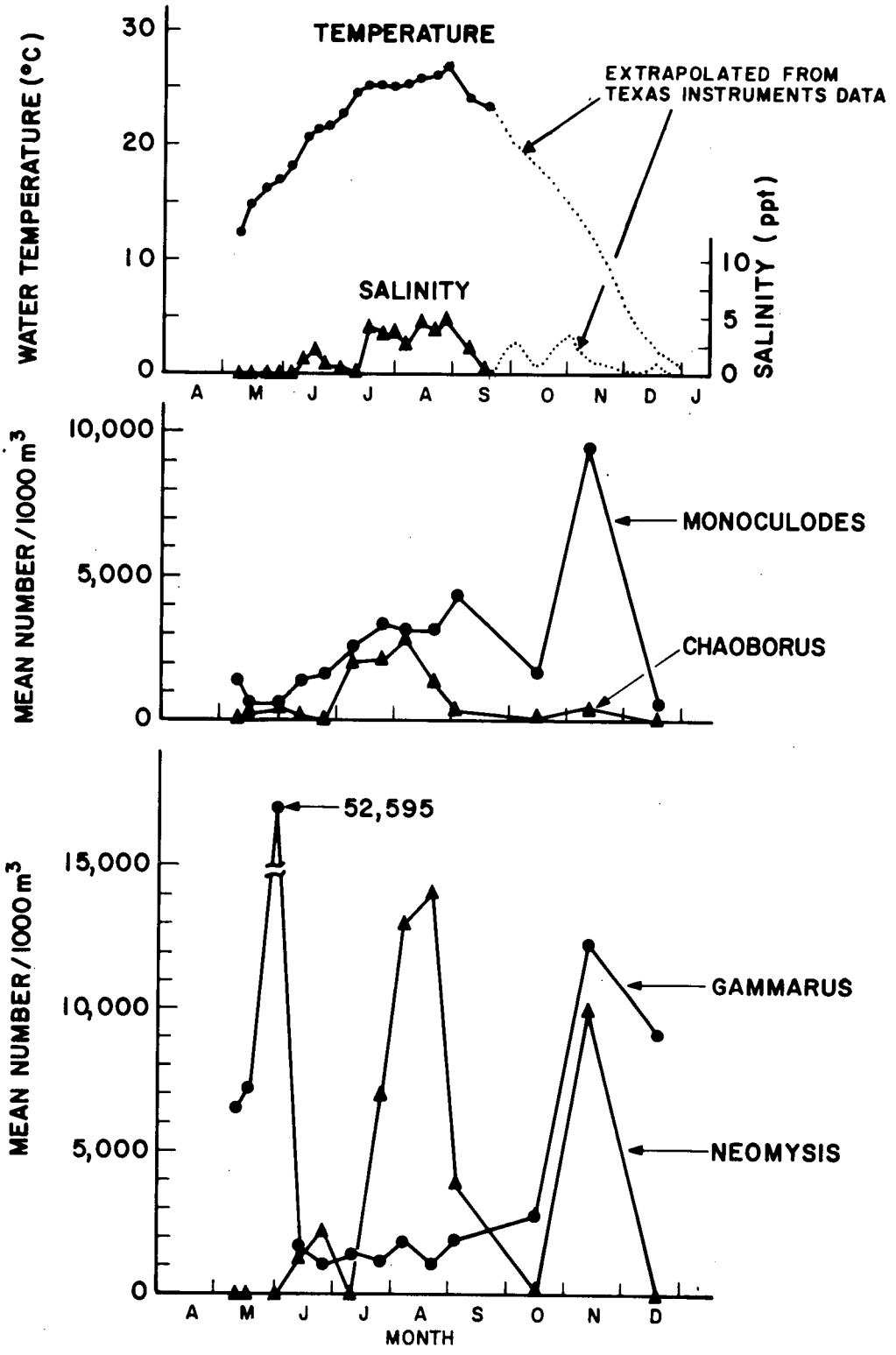


Figure 4-10. **ABUNDANCE OF MACROZOOPLANKTON BY MONTH FOR NIGHTTIME SAMPLES TAKEN IN THE HUDSON RIVER AT INDIAN POINT, 1974.**

Source: NYU 1976a

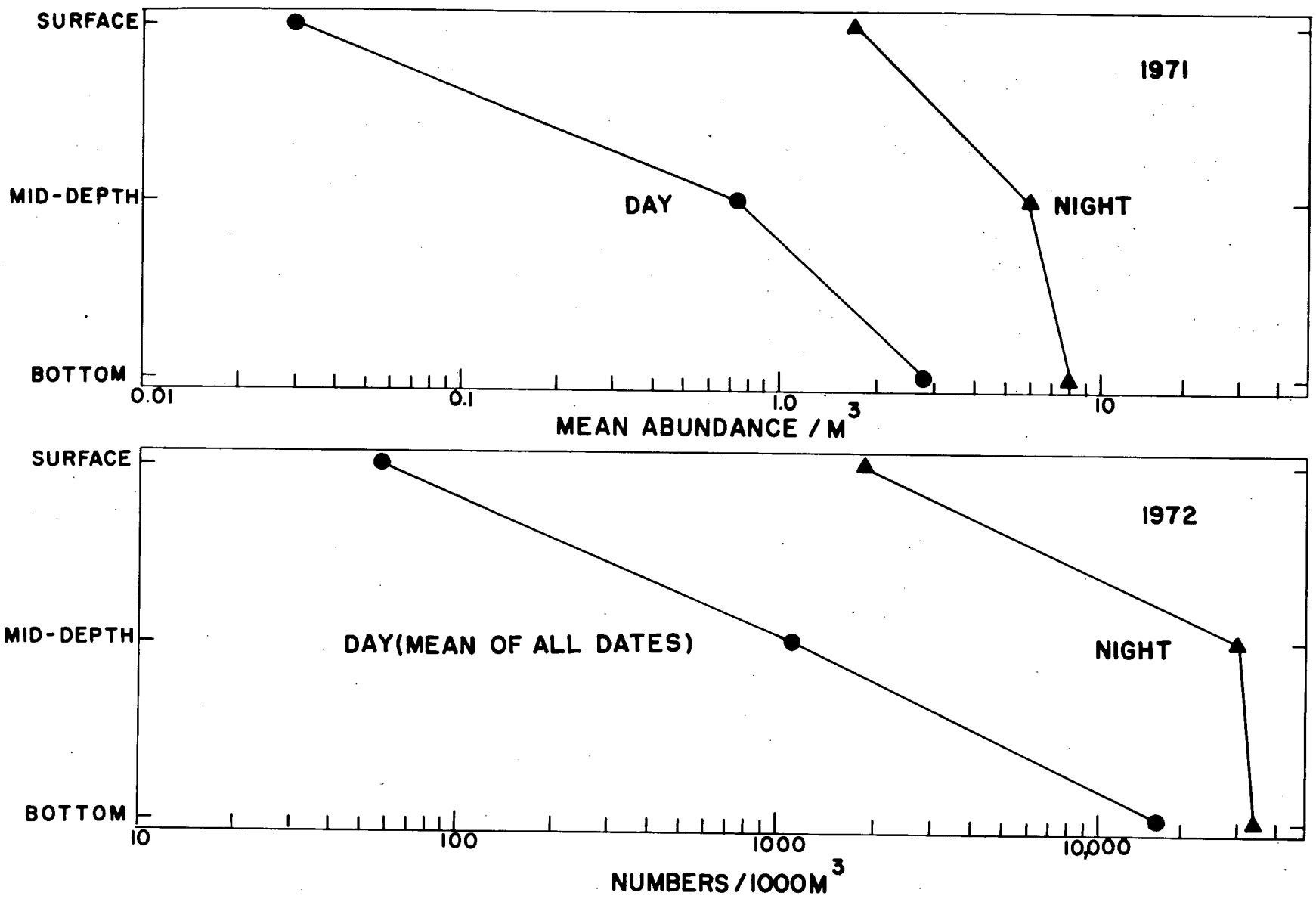


Figure 4-11. Vertical abundance patterns of total macrozooplankton in day and night samples for 1971 and 1972.

Source: NYU 1974.

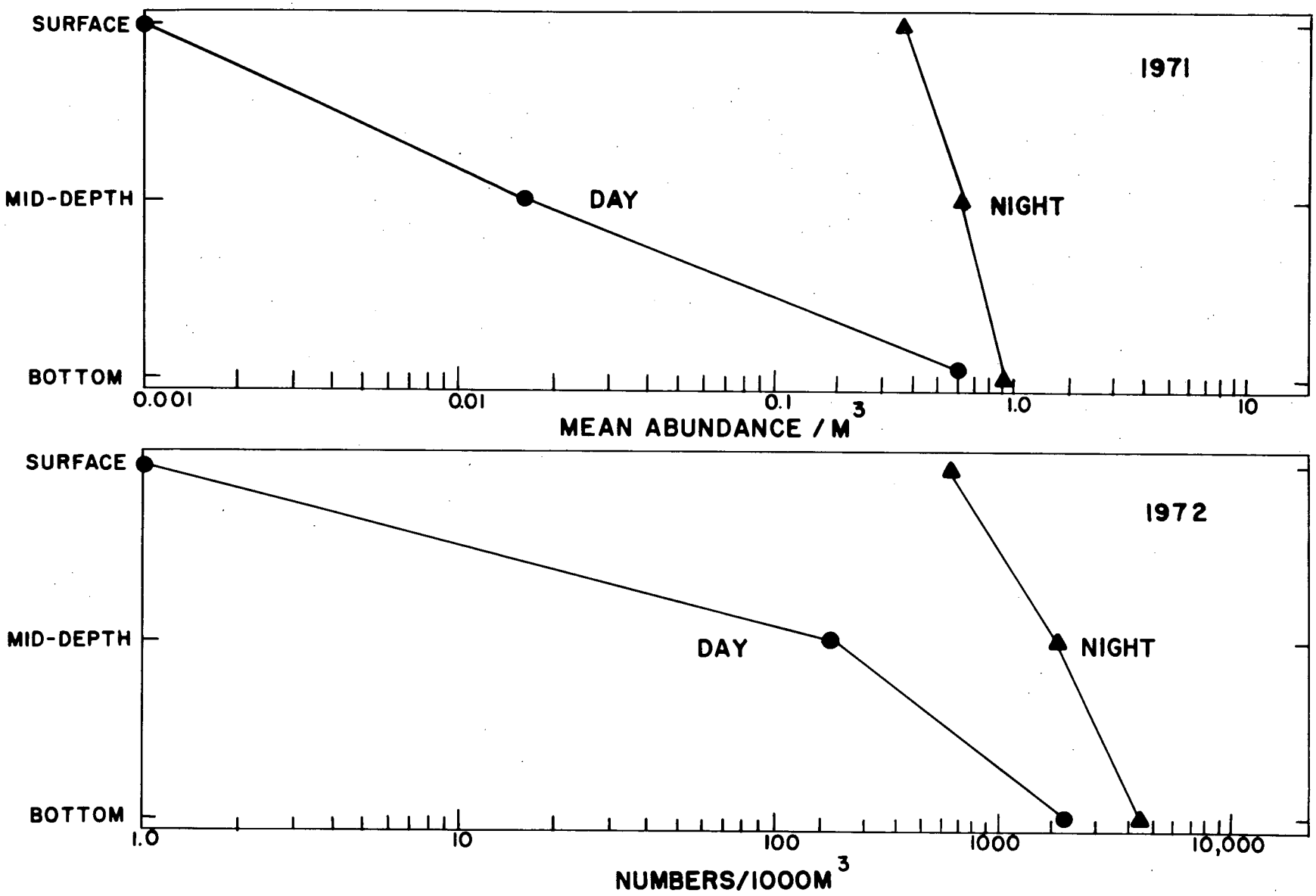


Figure 4-12. Vertical abundance patterns of *Neomysis* [illegible] in day and night samples for 1971 and 1972.

Source: Derived from NYU 1974.

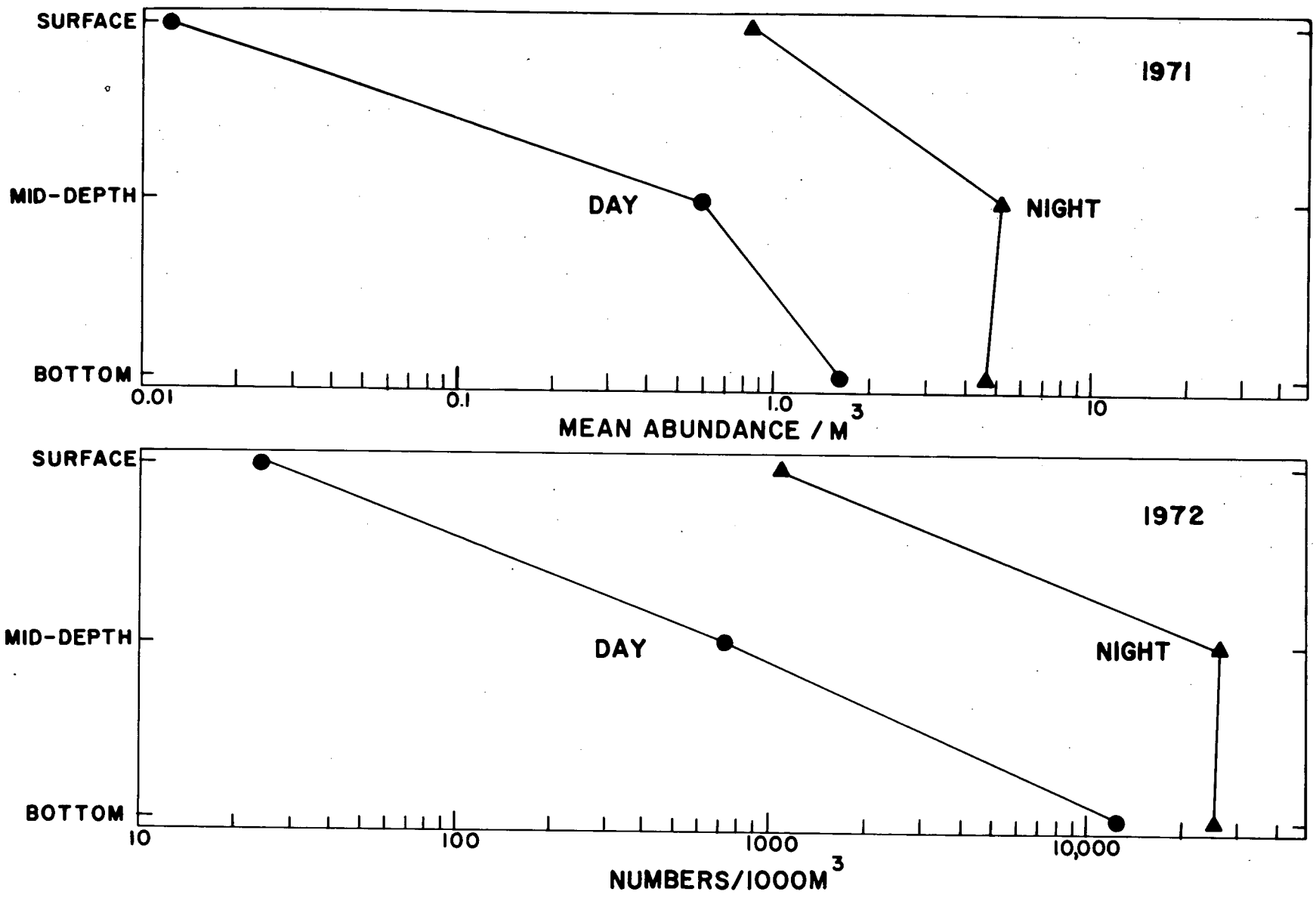


Figure 4-13. Vertical abundance patterns of Gammarus sp. in day and night samples for 1971 and 1972.

Source: Derived from NYU 1974.

Table 4-13

Differences in Macrozooplankton river abundance among stations in 1972. Comparisons were made using the Student-Newman-Keuls test. Letters refer to the respective river station locations.

Taxa, depth tested	Significant differences among stations ($\alpha \leq .05$)	Significant differences among stations ($\alpha \leq .10$)
Day		
all species; all depths	none	none
all species; bottom	A > D	A > D, E, F, G, C > D
all species; middle	none	none
Gammarus sp.; all depths	none	none
Gammarus sp.; bottom	A > D, F	A > D, E, F, G
Gammarus sp.; middle	none	none
Night		
all species; all depths		none
all species; bottom		none
all species; middle		none
Gammarus sp.; all depths		none
Gammarus sp.; middle		none
M. edwardsi; middle		none
N. americana; all depths		none

Source: NYU 1974

Table 4-14. Differences in macrozooplankton river abundance among stations 1974. Letters refer to the respective river station locations.

Taxa	Significant Differences Among Stations ($\alpha < 0.05$)
Day	
Total	A>I, B>I, C>I
Gammarus	None
Monoculodes	None[1]
Neomysis	None
Night	
Total	A>G; B>G; E>G; E>(F,G); (A,B)>(F,G)
Gammarus	A>F; A>G; B>G; C>G; D>G; E>G; (C,D)>(F,G); E>(F,G); (A,B)>(F,G)
Monoculodes	None
Neomysis	None[1]

[1] The analysis of variance resulted in a difference among stations. However, the Scheffe test ($\alpha < .10$) did not show any difference among stations for meaningful contrasts.

Source: NYU 1976a

Table 4-15. Differences in macrozooplankton river abundance among stations 1975. Letters refer to the respective river station locations.

Taxa	Significant Differences Among Stations (α<0.05)
Day	
Total	A>G
Gammarus	A>(F,G)
Monoculodes	None[1]
Neomysis	None
Night	
Total	(B,C,D,E,F)>G
Gammarus	A>G; B>(C,E,F,G); C>(F,G); D>(B,C,G); E>(C,G)
Monoculodes	A>G; B>D; C>(B,D,E,G); E>(B,D,G); F>(B,C,D,E,G) G>(B,D)
Neomysis	E>(B,G); F>B

[1] The analysis of variance resulted in a difference among stations. However, the Scheffe test (α<0.10) did not show any differences among stations for meaningful contrasts.

Source: NYU 1977a

Table 4-16. Differences in macrozooplankton river abundance among stations in 1976. Letters refer to the respective river station locations.

Taxa	Significant Difference Among Stations ($\alpha < 0.05$)
Day	
Total	C>G
Gammarus	A>G
Monoculodes	none[1]
Neomysis	none
Chaoborus	none
Night	
Total	none[1]
Gammarus	none[1]
Monoculodes	none
Neomysis	none[1]
Chaoborus	E>F

[1] The analysis of variance ($\alpha < .05$) indicated a difference among stations. However, the Scheffe test ($\alpha < 0.10$) was unable to locate the difference.

Source: NYU 1977b

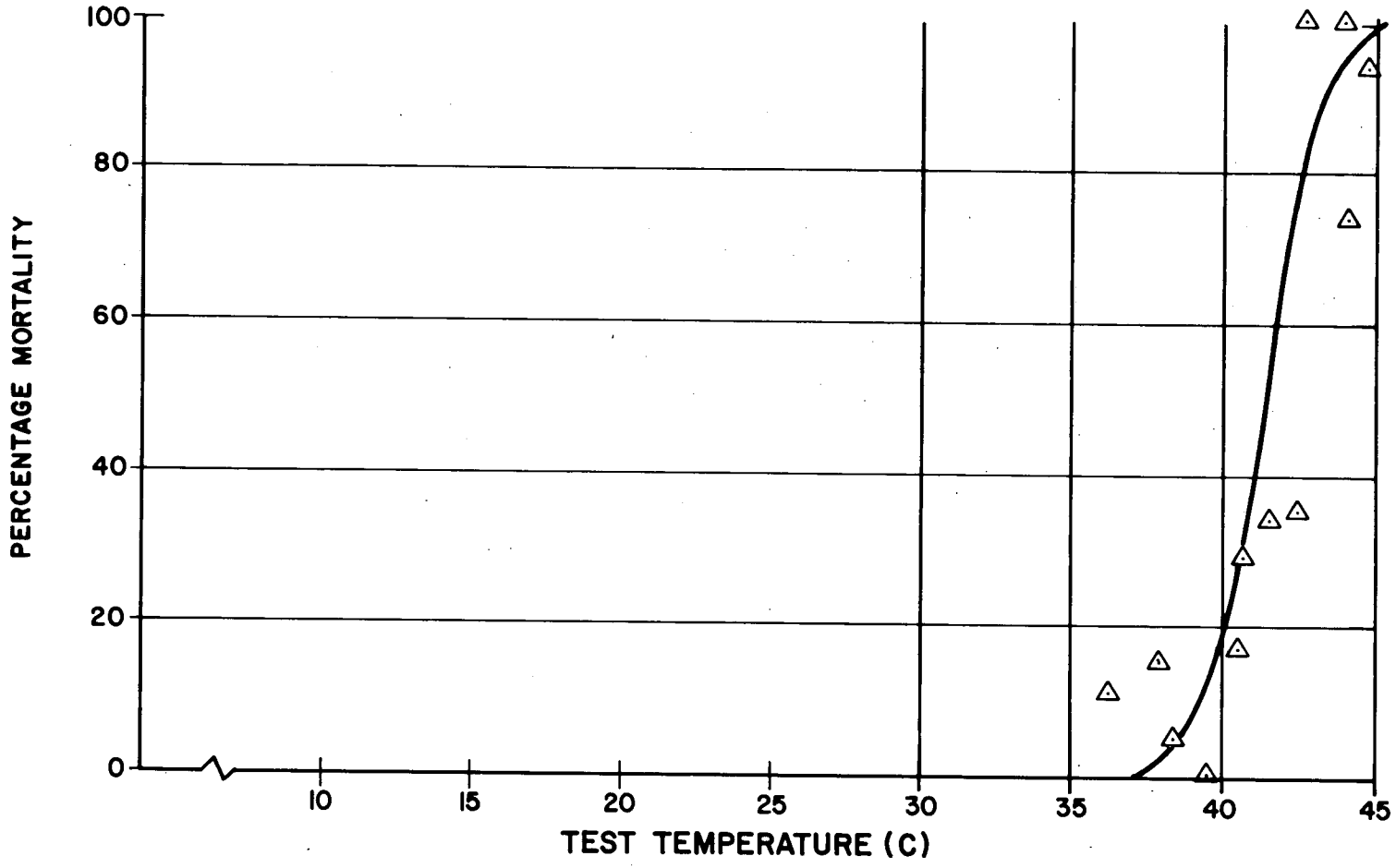


Fig. 4-14. PREDICTED THERMAL MORTALITY CURVE FOR CHAOBORUS PUNCTIPENNIS. CURVE DERIVED FOR EXPOSURE DURATION OF 10 MINUTES AND ACCLIMATION TEMPERATURE OF 25 C. ALSO SHOWN ARE EMPIRICAL DATA FROM LABORATORY THERMAL TOLERANCE TESTS WHERE DURATION = 10 MINUTES AND ACCLIMATION TEMPERATURE = 24 - 26 C.

Source: Derived from EA 1977

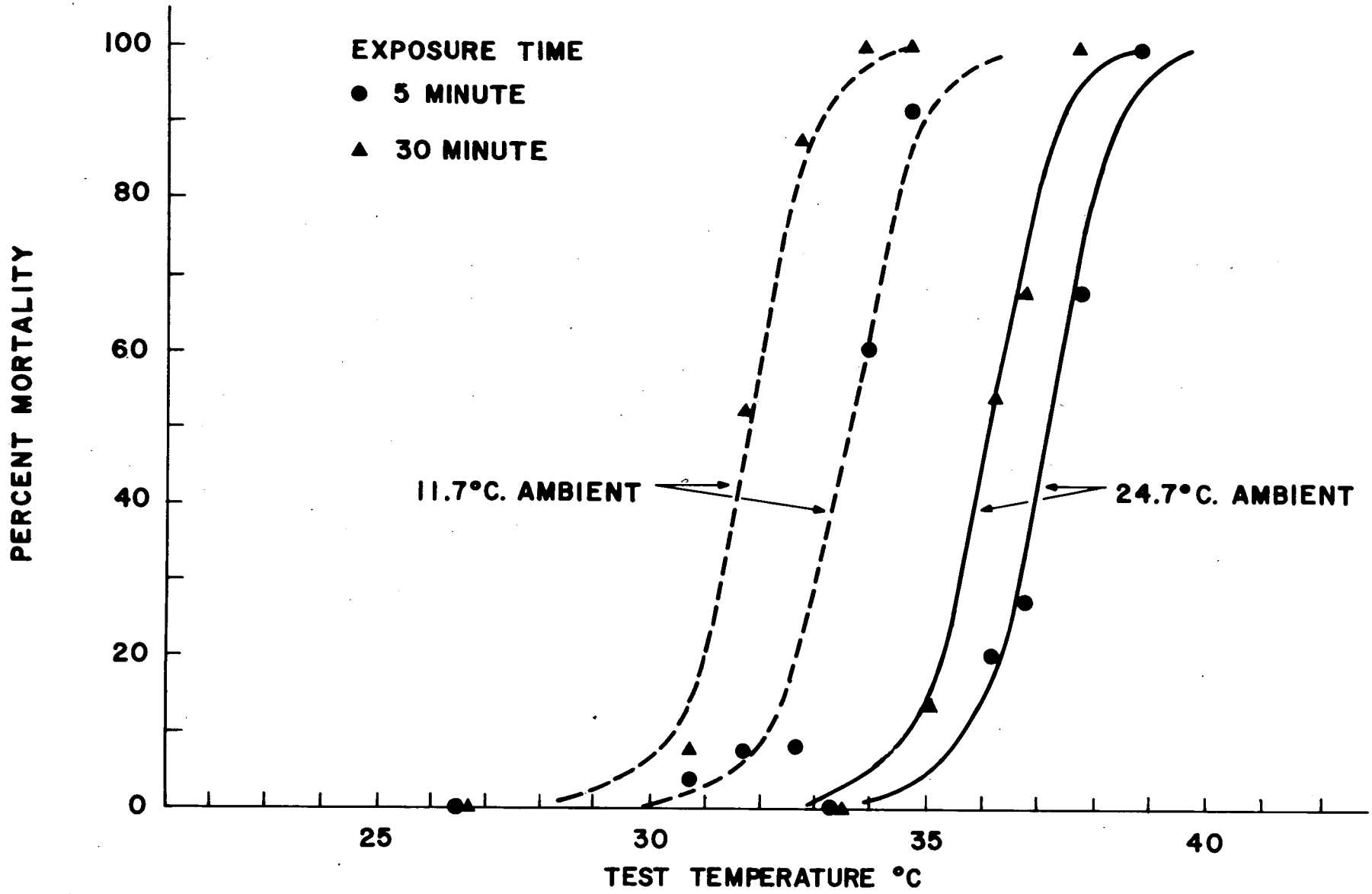


Figure 4-15. Temperature tolerance of Monoculodes edwardsi.
Source: NYU 1973.

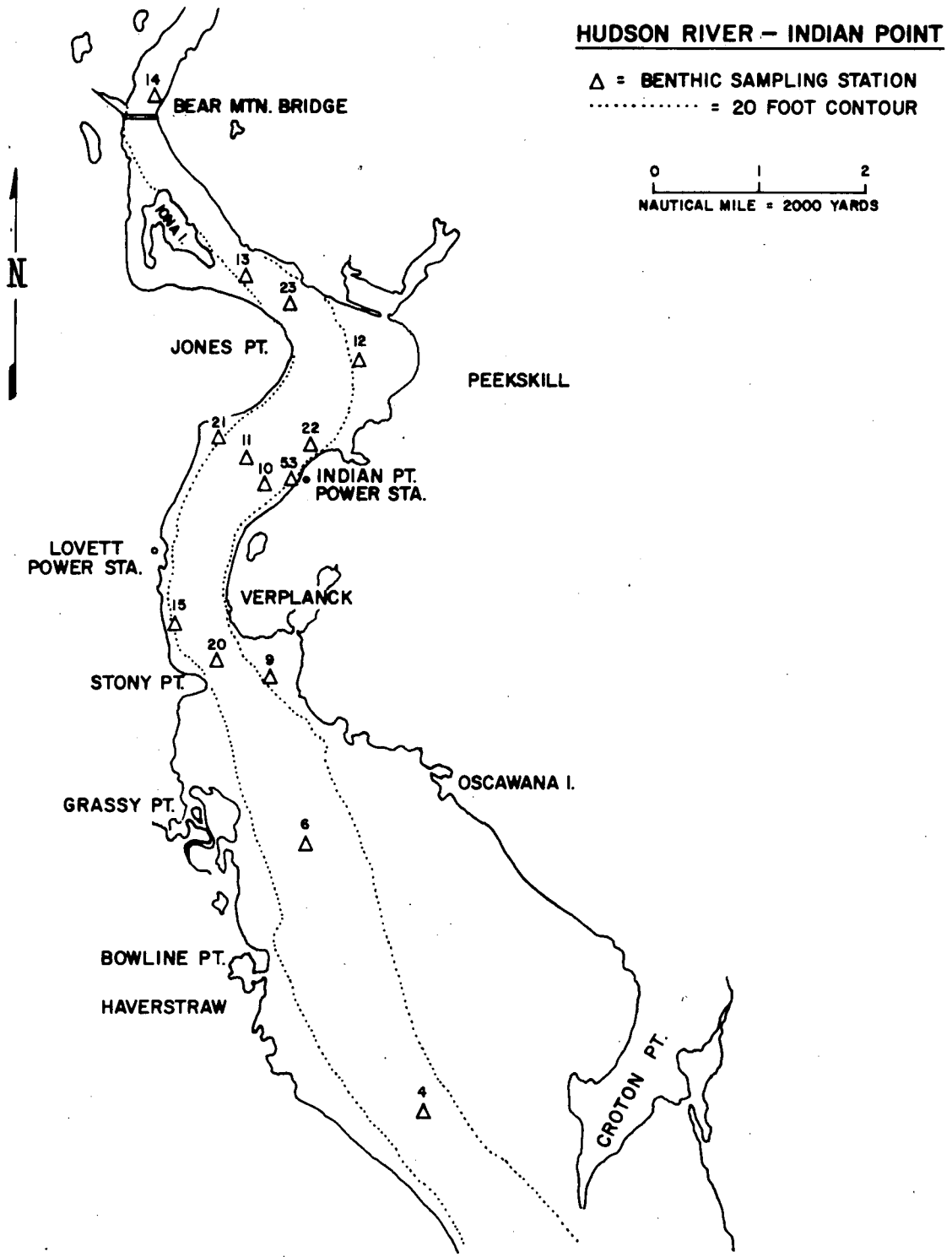


Fig. 4-16. **RAYTHEON'S BENTHIC STATION LOCATIONS**

Source: Raytheon 1971

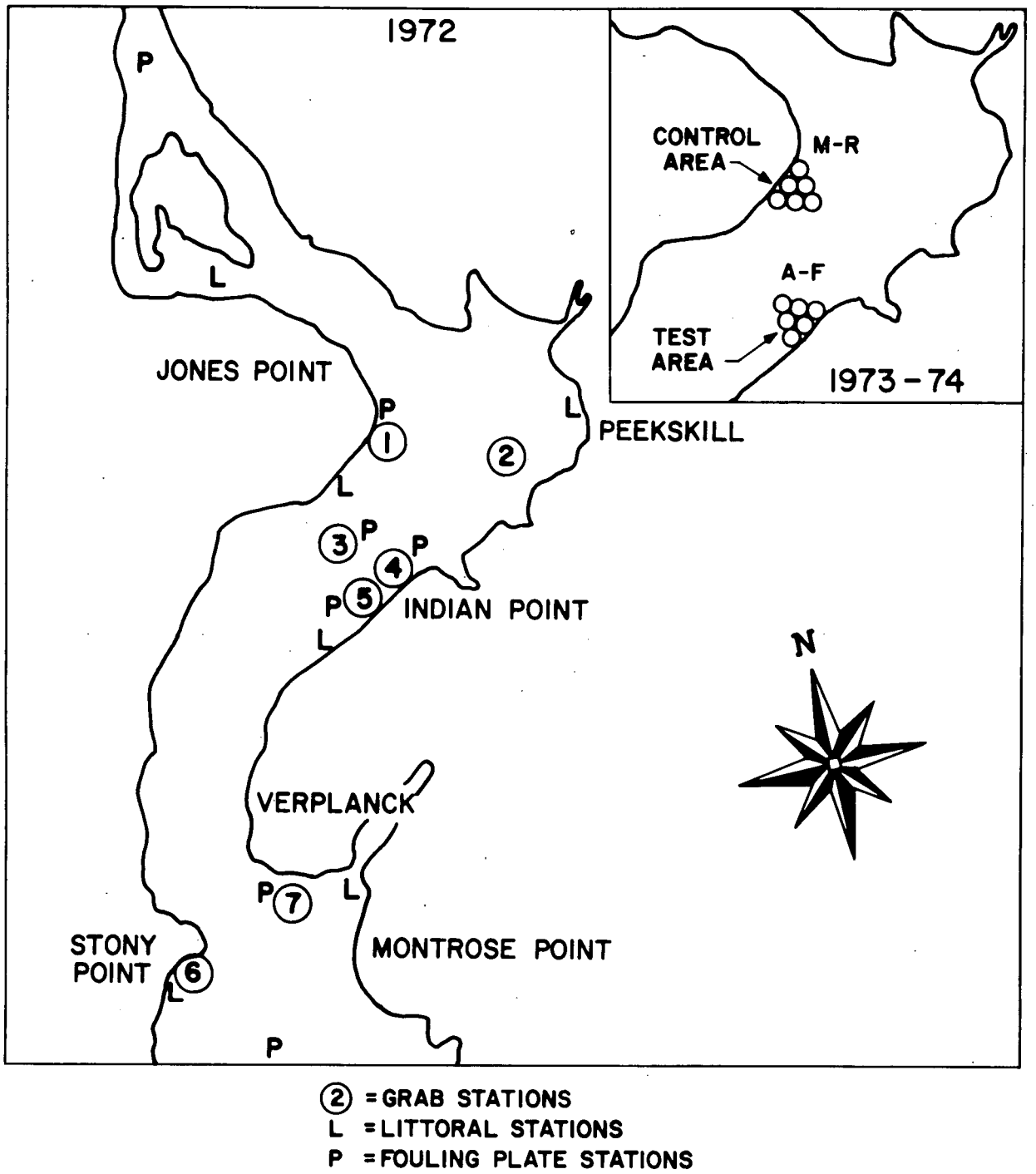


Figure 4-17. Location of Benthic Sampling Stations in Hudson River near Peekskill, New York during 1972, 1973 and 1974.

Source: TI 1976b.

twice to assure completeness of the procedure. Specimens were then separated by taxa and enumerated (TI 1976c).

Wet weight and wet volume biomass were determined for all grab samples. After being picked, the samples were placed on preweighed filter papers in a Buchner funnel to be air-dried without dessication. A sample's total weight was determined to the nearest 0.1 g. The samples were then placed in a graduated cylinder containing a measured amount of 70% ethanol, and the volume of the sample was determined as the difference between initial and final volume in the graduated cylinder (TI, 1976c).

The results and analysis of these studies are presented in Tables 4-17 through 4-25 and in Figure 4-18.

4.8. Sediment Analysis

Sediment samples from the test and control areas were collected with a Phleger corer for the 1973-74 studies. A detailed analysis of handling techniques are found in TI 1972. Essentially, each sediment sample was washed through a nested series of U.S. Standard sieves (8, 4, 2, 1, 0.5, 0.25, 0.125, and 0.064 mm mesh sizes) to determine particle size distribution. All sediment fractions were dried in a dessicating oven and weighed to the nearest 0.1 gram (TI 1976c).

4.9. Sediment-Temperature Studies

Simultaneously with monthly sampling during 1974, temperatures of the sediments and overlying water were determined for each station in the test and control areas. *In situ* apparatus designed and built for this application permitted simultaneous measurement of sediment temperature 1 cm below the bottom water interface and water temperature 2.5 and 30 cm above the interface (TI 1976c).

Table 4-17

Taxon List for Hudson River Ecological Survey Benthic Collections (Raytheon) at Indian Point, August, 1969 - October, 1970

PLATYHELMINTHES
- *Planocera* sp.

NEMERTEA
- *Nemertea*, unidentified
- *Amphiporous* sp.

ANNELIDA
- Polychaeta
  - *Spio setosa*
  - *Prionospio* sp.
  - *Hypaniola grayi*
  - *Nereis succinea*
- Oligochaeta
  - *Tubifex tubifex*

ARTHROPODA
- Crustacea
  - Decapoda
    - *Rhithropanopeus harrisii*
  - Amphipoda
    - *Gammarus fasciatus*
    - *Leptocheirus pinguis*
    - *Corophium volutator*
    - *Monoculodes* sp.
  - Isopoda
    - *Edotea montosa*
    - *Cyathura polita*
  - Cirripedia
    - *Balanus improvisus*
  - Insecta
    - *Tendipes tentans*, larva
    - *Tendipes tentans*, pupa
    - *Chaoborus albipes*
    - *Pentaneura* sp.

MOLLUSCA
- *Congeria leucophaeta*
- *Bithinia tentaculata*

ECTOPROCTA
- *Electra crustulenta*

Source: Raytheon 1971

Table 4-18. Taxon list for Hudson River ecological survey benthic collections at Indian Point, April 1972 - December 1974.

CNIDARIA
- Cordylophora lacustris
- Hydra americana

PLATYHELMINTHES
- Planaridae
- Dugesia sp.
- Dugesia tigrina

NEMERTEA
- Paleonemertea

NEMATHELEMENTHES
- Unidentified Nematoda

ACANTHOCEPHALA
- Sipunculida

ANNELIDA
- Polychaeta
  - Scolecolepides viridis
  - Boccardia hamata
  - Hypaniola sp
  - Nereis larvae
  - Nereis succinea
  - Serpulidae
- Oligochaeta
  - Limnodrilus sp
  - Peloscolex sp
  - Stylaria sp
  - Unidentified
  - Naididae
- Hirudinea
  - Hirudinia
  - Glossiphoniidae
  - Piscicola sp

ARTHROPODA
- Crustacea
  - Decapoda
    - Crangon septemspinosa
    - Rhithropanopeus harrisi
    - Orconectes limosus
    - Palaemonetes pugio
    - Callinectes sapidus
  - Mysidacea
    - Neomysis americana
  - Amphipoda
    - Gammurus sp
    - Monoculodes sp
    - Corophium sp
    - Leptocheirus sp
    - Unidentified
    - Crangonyx sp
  - Isopoda
    - Livoneca ovalis
    - Cassidina lunifrons
    - Cyathura polita
    - Edotea sp.
    - Chiridotea almyra
    - Asellus sp.
  - Cumacea
    - Unidentified
  - Cirripedia
    - Balanus improvisus
  - Copepoda
    - Harpacticoida
    - Cyclopoida
    - Calanoida
  - Ostracoda
    - Unidentified
  - Cladocera
    - Cladoceran ephippium
    - Microthricidae
    - Daphnia sp
    - Bosmina sp
    - Latona sp
    - Leptodora kindti
- Insecta
  - Phloethripidae
  - Isotomidae-Collembola
  - Unidentified insect larvae
  - Agraylea sp
  - Leptoceridae
  - Trichopteran adult
  - Limnophora sp
  - Amphiagrion sp
  - Enallagma sp
  - Ischnura sp
  - Odonata larvae
  - Cryptochironomous sp
  - Palpomyia sp
  - Chironomid larvae
  - Chironomid pupae
  - Chaoborus sp
  - Trichopteran larvae
  - Ephemeropteran larvae
  - Dipteran pupae
  - Ceratopogonidae larvae
- Arachnida
  - Hydracarina

MOLLUSCA
- Gastropoda
  - Amnicola sp
  - Nudibranchia
  - Unidentified juvenile
  - Ferrissia sp
- Pelecypoda
  - Lamsilinae
  - Sphaeridae
  - Congeria leucophaeta
  - Pisidium sp
  - Ellipto sp

ECTOPROCTA
- Cristatella mucedo
- Hyalinella sp
- Pectinatella magnifica
- Lophopodella carteri

Source: TI 1976b.

Table 4-19. Diversity Indices Calculated from 1973 Test - and Control-Area Data

Month	Diversity Index	Test Area Stations						Control Area Stations					
		A	B	C	D	E	F	M	N	O	P	Q	R
Apr	SW	0.67	0.61	0.53	0.73	0.42	0.73	-	-	-	-	-	-
	H	2.80	1.93	1.22	3.69	0.67	3.89	-	-	-	-	-	-
	J	0.60	0.53	0.49	0.67	0.34	0.66	-	-	-	-	-	-
May	SW	0.60	0.64	0.75	0.80	0.45	0.69	-	-	-	-	-	-
	H	2.23	2.29	4.37	4.59	0.92	2.89	-	-	-	-	-	-
	J	0.63	0.61	0.72	0.77	0.42	0.69	-	-	-	-	-	-
Jun	SW	0.73	0.42	0.71	0.65	0.60	0.71	0.46	0.14	0.10	0.27	0.26	0.24
	H	3.65	0.71	3.34	2.89	2.15	3.31	0.96	0.14	0.09	0.39	0.35	0.33
	J	0.77	0.37	0.64	0.68	0.63	0.71	0.44	0.14	0.11	0.27	0.26	0.28
Jul	SW	0.50	0.26	0.32	0.68	0.68	0.66	0.38	0.33	0.15	0.47	0.46	0.32
	H	1.60	0.34	0.46	2.95	3.05	2.47	0.79	0.46	0.15	0.94	0.97	0.59
	J	0.53	0.27	0.29	0.65	0.61	0.66	0.40	0.33	0.15	0.45	0.42	0.36
Aug	SW	0.26	0.30	0.49	0.29	0.56	0.65	0.57	0.39	0.28	0.37	0.42	0.14
	H	0.35	0.46	1.29	0.44	1.98	3.19	3.37	0.73	0.44	1.12	1.04	0.18
	J	0.25	0.30	0.51	0.30	0.52	0.60	0.81	0.44	0.34	0.53	0.50	0.15
Sep	SW	0.59	0.67	0.67	0.58	0.47	0.58	0.51	0.57	0.12	0.57	0.48	0.10
	H	2.24	2.55	2.94	1.88	1.56	1.94	1.62	1.88	0.13	1.91	1.34	0.10
	J	0.57	0.62	0.62	0.58	0.60	0.51	0.57	0.53	0.13	0.55	0.42	0.12
Oct	SW	0.73	0.10	0.85	0.83	0.42	0.84	0.42	0.47	0.31	0.44	0.42	0.52
	H	2.62	0.12	4.35	4.24	0.95	4.30	0.79	1.35	0.53	0.70	0.79	1.42
	J	0.63	0.12	0.72	0.67	0.39	0.66	0.39	0.43	0.30	0.39	0.35	0.43
Nov	SW	0.81	0.70	0.65	0.93	0.77	0.96	0.88	0.61	0.30	1.01	0.64	0.75
	H	4.12	2.01	1.45	5.31	2.93	5.45	4.50	1.35	0.38	7.22	1.95	2.35
	J	0.66	0.58	0.54	0.75	0.59	0.72	0.69	0.49	0.25	0.73	0.49	0.57
Dec	SW	0.71	0.58	0.71	0.89	0.92	0.35	0.37	0.56	0.48	0.43	0.41	0.33
	H	2.28	1.17	2.05	4.12	4.88	0.47	1.30	1.06	1.13	0.77	0.57	0.47
	J	0.60	0.45	0.58	0.71	0.70	0.30	0.34	0.44	0.37	0.37	0.31	0.27

SW = Shannon-Weaver
H = Hurlbert
J = Pielou

Source: TI 1976c.

Table 4-20. Diversity Indices Calculated from 1974 Test - and Control-Area Data

Month	Diversity Index	Test Area Stations						Control Area Stations					
		A	B	C	D	E	F	M	N	O	P	Q	R
Apr	SW	0.85	0.79	0.80	0.42	0.66	0.32	0.50	0.43	0.32	0.45	0.66	0.54
	H	4.31	3.76	3.67	0.76	2.28	0.67	1.49	1.33	0.57	0.92	3.25	1.74
	J	0.63	0.60	0.6	0.33	0.49	0.25	0.45	0.41	0.29	0.38	0.66	0.47
May	SW	0.66	0.47	0.47	0.38	0.40	0.49	0.65	0.43	0.46	0.55	0.51	0.41
	H	2.21	1.78	1.43	1.35	0.97	1.29	2.14	0.99	1.45	1.70	1.55	1.24
	J	0.55	0.44	0.36	0.37	0.37	0.38	0.62	0.38	0.46	0.42	0.49	0.36
Jun	SW	0.61	0.60	0.61	0.48	0.71	0.53	0.61	0.63	0.62	0.66	0.49	0.41
	H	1.78	1.99	2.14	1.40	3.03	1.65	2.12	2.21	2.21	2.42	1.45	1.23
	J	0.49	0.50	0.47	0.39	0.54	0.41	0.51	0.51	0.53	0.64	0.37	0.35
Jul	SW	0.51	0.61	0.65	0.71	0.75	0.62	0.46	0.55	0.56	0.63	0.38	0.50
	H	0.96	1.95	2.39	2.63	3.25	2.06	1.02	1.57	1.27	1.73	0.61	1.56
	J	0.41	0.44	0.49	0.52	0.56	0.46	0.38	0.46	0.45	0.49	0.32	0.43
Aug	SW	0.58	0.80	0.75	0.65	0.34	0.36	0.67	0.74	0.49	0.48	0.62	0.25
	H	2.09	3.36	3.03	2.06	0.63	0.89	2.87	3.02	1.39	1.42	2.44	0.47
	J	0.52	0.56	0.55	0.47	0.27	0.27	0.53	0.58	0.39	0.35	0.48	0.20
Sep	SW	0.57	0.71	0.68	0.65	0.50	0.46	0.67	0.67	0.60	0.55	0.54	0.39
	H	1.91	3.15	2.52	2.23	1.23	1.19	2.55	1.94	2.39	1.20	1.36	1.09
	J	0.49	0.59	0.52	0.50	0.42	0.39	0.51	0.53	0.49	0.45	0.40	0.33
Oct	SW	0.79	0.83	0.77	0.32	0.36	0.58	0.81	0.63	0.72	0.65	0.47	0.46
	H	3.44	3.84	3.09	0.40	0.52	1.35	3.37	1.37	2.29	2.22	1.11	1.29
	J	0.63	0.60	0.58	0.25	0.27	0.44	0.61	0.46	0.56	0.50	0.38	0.38
Nov	SW	0.75	0.39	0.84	0.58	0.59	0.68	0.65	0.51	0.62	0.65	0.72	0.59
	H	2.92	0.86	4.38	1.25	1.34	1.99	2.27	1.42	2.26	2.77	3.49	1.77
	J	0.56	0.30	0.66	0.44	0.44	0.52	0.50	0.44	0.51	0.53	0.59	0.46
Dec	SW	0.73	0.55	0.71	0.53	0.66	0.36	0.60	0.76	0.67	0.60	0.58	0.42
	H	2.39	1.71	2.23	0.92	1.57	0.59	2.08	3.00	2.66	1.88	1.80	1.23
	J	0.56	0.41	0.54	0.40	0.51	0.28	0.51	0.58	0.54	0.50	0.51	0.35

*SW = Shannon-Weaver log 10
H = Hurlbert
J = Pielou

Source: TI 1976c.

Table 4-21. Comparison of Benthic Diversity Values in Indian Point Test and Control Areas in 1972, 1973, and 1974

	Year	T vs C	Stations**
Heip Evenness	1972	-	NS
	1973	NS*	DFA > O D>R
	1974	NS	A>FR
Shannon-Weaver	1972	-	NS
	1973	NS	ACDF>O DF>R
	1974	NS	AC>R

* NS = not significant (P =< 0.05)
** See Figure

Source: TI 1976c

Table 4-22. Comparison of Relative Abundance of Dominant Taxa During August-December Periods of 1969, 1972, 1973, and 1974.

Taxon	Mean No./m^2 1969*	1972	1973 Test	1973 Control	1974 Test	1974 Control
Congeria leucophaeta	56	192	124	64	521	134
Gammarus sp	104	72	320	137	189	76
Cyathura polita	160	192	280	138	555	654
Leptocheirus sp	384	2	3	< 1	24	10
Balanus improvisus	1408	227	86	197	1803	1486
Monoculodes sp	0	< 1	< 1	3	9	7
Nemertea	16	< 1	< 1	2	6	44
Rhithropanopeus harrisi	0	8	9	< 1	31	22
Corophium sp	0	27	94	48	236	285
Edotea	16	5	11	45	23	58

* From Raytheon, 1971

Table 4-23. Comparison of Relative Abundance of Dominant Taxa during January-October Periods of 1970, 1972, 1973, and 1974

Taxon	Mean No./m^2 1970*	1972	1973 Test	1973 Control	1974 Test	1974 Control
Congeria leucophaeta	560	107	89	45	239	83
Gammarus sp	320	83	353	211	287	181
Cyathura polita	316	162	260	139	448	411
Leptocheirus sp	224	1	2	< 1	16	6
Balanus improvisus	116	130	62	141	816	943
Monoculodes sp	52	< 1	< 1	2	2	2
Nemertea	36	< 1	< 1	1	4	3
Rhithropanopeus harrisi	24	7	9	1	16	12
Corophium sp.	8	66	72	34	94	195
Edotea sp	< 1	3	8	32	14	40

* From Raytheon, 1971

Source: TI 1976c.

Table 4-24. Annual Mean Numbers of Individuals per Square Meter in Indian Point Test and Control Areas, 1972, 1973, and 1974.

Dominant Taxa	1972 Survey	1972 Test	1972 Control	1973 Test	1973 Control	1974 Test	1974 Control
Limnodrilus sp.	547.7	324.7	415.7	1349.5	2870.8	2730.9	3601.6
Cyathura polita	162.0	201.3	219.9	244.6	137.8	467.5	434.6
Boccardia hamata	215.0	132.2	783.9	221.4	767.1	133.6	955.0
Scolecolepides viridis	74.6	89.9	69.1	212.4	244.0	2824.5	2086.8
Gammarus sp.	82.8	156.1	93.0	442.4	219.1	287.4	154.4
Amnicola sp.	992.1	662.8	486.9	15.7	3.5	4008.3	975.8
Balanus improvisus	133.4	240.9	22.9	47.8	108.9	1016.9	825.8
Congeria leucophaeta	123.9	290.2	11.0	97.6	35.4	295.9	74.3
Chironomid larvae	191.1	129.3	43.4	121.7	26.2	226.9	52.0
Corophium sp.	56.8	48.8	15.2	57.8	27.2	150.2	158.7
Chaoborus sp.	2.6	5.1	1.6	26.8	12.1	46.2	43.4
Peloscolex sp.	56.8	85.9	62.1	23.5	13.8	8.2	3.6
Chiridotea almyra	2.6	2.3	6.3	2.9	12.2	21.9	30.1
Edotea sp.	2.6	1.1	5.3	6.3	25.1	12.8	32.1
Nematoda	25.7	18.4	21.2	7.6	0.9	12.5	4.0
Rhithropanopeus harrisi	6.3	17.5	1.2	10.9	1.1	18.7	18.9
Hypaniola sp.	4.8	2.7	5.1	5.1	4.4	10.7	2.0
Nudibranchia	2.8	1.1	1.1	1.7	1.8	21.0	4.6
Monoculodes sp.	0.2	0.3	0.2	1.9	2.2	5.4	4.0
Paleonemertea	0.4	0.4	0.2	0.5	0.9	3.8	2.8
Hydracarina	0.7	1.1	0.2	0.1	0.1	0.3	0.3
Piscicola sp.	0.3	0.5	1.0	0.2	0.2	0.5	0.1
Trichoptera - adult	0.1	0.1	0.3	0.2	0.1	0.7	1.0
Leptocheirus sp.	1.4	0.9	-	2.0	0.7	18.9	5.8
Planaridae	8.9	13.3	2.9	-	-	0.4	0.2
Sphaerium sp.	0.3	-	0.2	-	-	4.5	1.6
Collembola	0.1	-	0.2	-	-	0.3	0.2
Chironomid pupae	0.1	-	0.2	-	-	3.1	0.4
Hydra americana	0.1	-	-	-	0.6	0.2	-
Daphnia sp.	0.1	0.1	-	-	-	0.1	1.2
Cassidina lunifrons	0.1	0.1	-	-	-	0.2	0.4
Acanthocephala	0.1	0.1	-	0.1	-	-	-
Nereis succinea	0.1	0.1	-	-	-	-	0.2
Sipunculida	0.1	0.1	-	-	-	-	-
Dugesia sp.	0.1	0.2	-	-	-	-	-
Palpomyia sp.	0.1	0.1	-	-	-	-	-
Enallagma sp.	0.1	-	-	-	-	-	-
Decapod - larva	0.1	0.1	-	-	-	-	-
Turbellaria	0.1	0.3	-	-	-	-	-
Neomysis americana	-	-	-	0.1	0.1	0.2	-
Odonata - larva	-	-	-	0.1	-	-	0.1
Agraylea sp.	-	-	-	0.1	-	-	-
Glossiphoniidae	-	-	-	-	0.1	-	-
Elliptio sp.	-	-	-	-	-	0.2	-
Ceratopogonidae	-	-	-	-	-	0.1	0.2
Ferrissia sp.	-	-	-	-	-	0.1	0.1
Crangonyx sp.	-	-	-	-	-	0.1	-
Crangon septemspinosa	-	-	-	-	-	-	0.3
Ephemeroptera - adult	-	-	-	-	-	-	0.2
Naididae	-	-	-	-	-	-	0.1
Leptodora sp.	-	-	-	-	-	-	0.1
Harpacticoida	4344.1	7836.7	2527.2	0.2	0.1	52.5	10.3
Ostracoda	208.3	198.8	82.9	-	-	0.1	0.1
Cyclopoida	17.6	23.6	11.4	0.4	-	34.5	18.9
Calanoida	1.0	1.2	1.3	0.2	-	11.1	0.3
Macrothricidae	0.3	-	2.0	-	-	-	0.3
Total No. of Taxa	44	38	32	31	28	40	43
Mean Total No/m^2	7268.5	10488.5	4895.1	2901.7	4516.5	12409.2	9500.7

Source: TI 1976c

Table 4-25. Benthic Grabs-Average Number Organisms Collected per 2500 cc Sample-All Stations.

Species	1969					1970									
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct
Polychaeta															
Spio setosa	11	19	19	8	13	14	5	15	82	47	37	74	74	19	25
Prionospio sp.			7	4	17		11	1	4	5	1		9	11	1
Hypaniola gravi													P	P	P
Nereis succinea														1	1
Cirripedia															
Balanus improvisus	1	25	63	87		40*		4		P		32	3	33	4
Amphipoda															
Gammarus fasciatus	P	4	P		9	55*	P	2	P	4	2	12	3	2	P
Leptocheirus pinquis	P		35	5	8		15	2	7	2	2	3	17	5	3
Corophium volutator							P					2	P	P	
Monoculoides sp.												P	P	13	
Mollusca															
Congeria leucophaeta		1	2	4		20*	P	9	1	P		P	16	74	20
Bithinia tentaculata												1	1	13	P
Decapoda															
Rhithropanopeus harrisii										P		5			1
Isopoda															
Edotea montosa	P		1		1	P		P	P	P	P	P	P	P	P
Cyathura polita	3	2	7	2	6	20*	1	2	7	6	5	9	14	6	9
Diptera															
Tendipes tentans larva			2	2	4	1	1	3	2	5	P				
Tendipes tentans pupa										P					
Chaoborus albipes			P	P	P			1	1	P			P		P
Pentaneura sp.				0								P	P	P	1
Nemertea															
Nemertea, unident.	1	P	1	P	P				P	1	1	1	2	2	2
Amphiporous										P					
Ectoprocta															
Electra crustulenta			P												
Oligochaeta															
Tubifex tubifex												12	3	20	P
Platyheiminthes															
Planocera sp.														P	P

P = Present but average less than 1

Blank - species not present

* Unusually high averages may be due to small number of stations sampled (2) in January. Not truly representative.

Source: Raytheon 1971

Table 4-26. Comparison of Means and Standard Deviations between Test and Control Areas, Indian Point, 1973-1974, Showing Probability of Area Variations and Station Differences.

		MEAN		STANDARD DEVIATION	
Species	Months Analyzed	Test vs Control	Pairwise Station Differences (0.05 level) Stations	Test vs Control	Pairwise Station Differences (0.05 level) Stations
Gammarus	Apr-Dec Apr-Dec	Test P=0.02	A,B,C,E > R▲ A,C,E > O C,E > D,M,N,P C > F,Q	Test P=0.07	A > O,R
Cyathura	Apr-Dec Apr-Dec	Test P=0.03	B,C,E,Q > M,O▲ C,Q > R C > A,D,F,N,P	Test P=0.22	None
Limnodrilus	Apr-Dec Apr-Dec	Control P=0.002	O,R > A,C,D,E,M,N▲ R > F,P,Q	Control P=0.003	Q,R > E R > D
Chironomid	Apr-Dec Apr-Dec	Test P=0.001	A,B,C,D,E,F > M,N,O,P,Q,R▲	Test P=0.001	A,B,C,D,F > P B,D > M,N,O A,B,D,F > Q
Balanus	Oct-Dec Jul-Dec	Test P=0.5	C > M,P,R	Test P=0.46	A,B,C > R
Congeria	Sep-Dec Sep-Dec	Test P=0.004	None*	Test P=0.004	None*
Scolecolepides	Apr-Dec Apr-Dec	Test P=0.13	C,D,E,F,P,Q,R > A▲ C,D,E,F,R > B, M F > N,O	Test P=0.31	None*
Boccardia	Sep-Dec Apr-Dec	Control P=0.02	Q > D,F,N,O	Control P=0.007	Q > O
Hypaniola	Nov-Dec Nov-Dec	Test P=0.06	None*	Test P=0.06	None
Corophium	Sep-Dec Aug-Dec	Control P=0.33	None*	Test P=0.29	A,C > R C > O
Chirodotea	Jul-Sep Apr-Aug	Control P=0.004	N > A	Control P=0.004	None*
Edotea	Oct-Dec Aug-Nov	Control P=0.05	P > A	Control P=0.04	P > A

*Nonparametric 2-way analysis of variance considering all stations was significant at 0.05 level, but no pairwise station difference was significant.

▲Larger area reported and associated significance level. Analysis uses all three replicates, not the mean.

Source: TI 1976c.

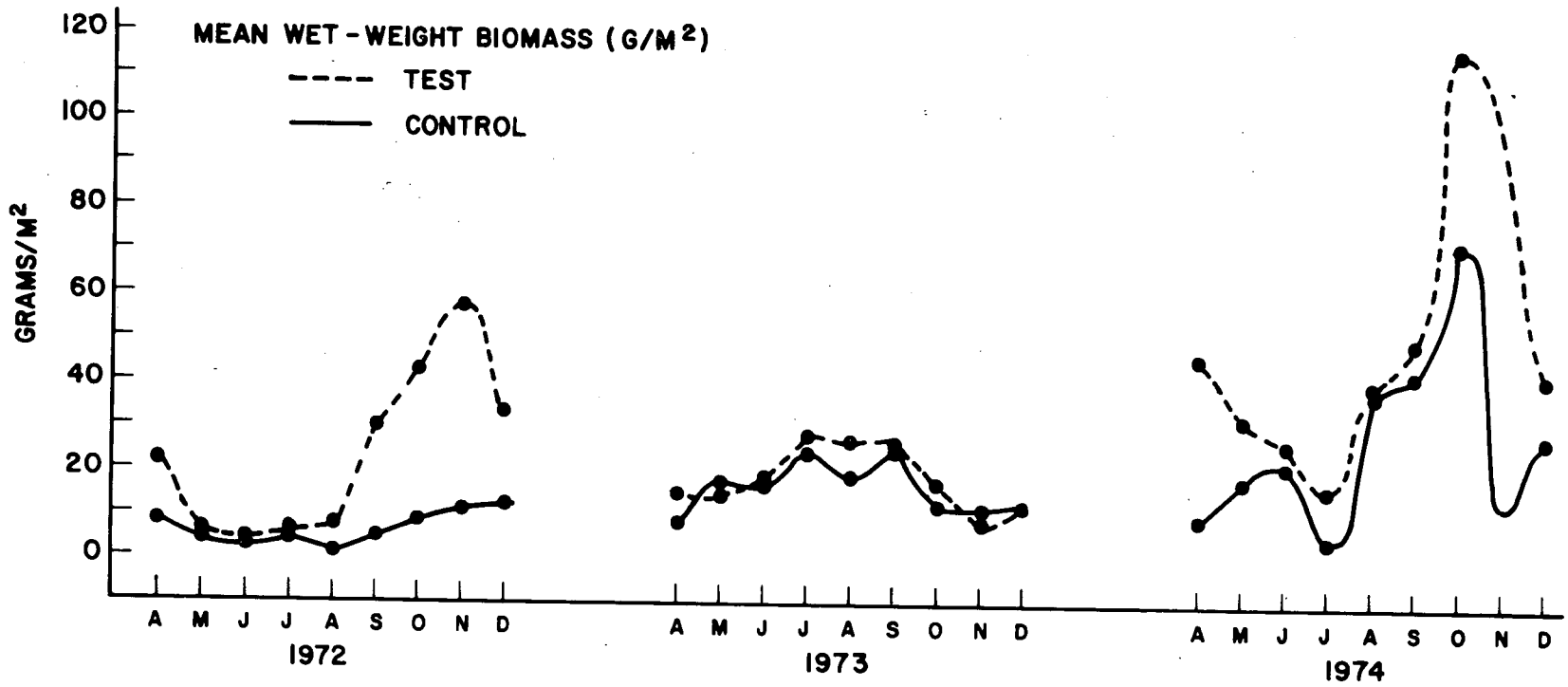


Fig. 4-18. **MEAN WEIGHT BIOMASS PER SQUARE METER IN INDIAN POINT TEST AND CONTROL AREAS IN 1972, 1973, AND 1974**

Source: Derived from TI 1976c.

SECTION 5

5.1. Ichthyoplankton Methods

5.1.1 Field Collections

During the 1971-1976 sampling period ichthyoplankton and macrozooplankton were collected in the same samples. Sampling methodology for ichthyoplankton and macrozooplankton samples is given in Section 4.1, Appendix D.

During 1973 sampling for ichthyoplankton was not conducted at stations A-G, the standard ichthyoplankton/macrozooplankton stations (Fig. 7-1, Summary Section). The Indian Point plant was off-line for most of 1973 and the desing of the sampling program was changed to examine the spatial distribution of ichthyoplankton in the Hudson River to those enhained in the intakes of the plant (NYU 1974).

Four longitudinal transects, R-1 through R-4 (Fig. 5-1), were sampled to coincide with 50 minute intake sampling conducted every 2 hours over a 24 hour period. Sampling began at R-1 prior to commencement of the 50 minute sample at the intake and proceeded to R-2, R-3, and R-4 in order that the 50 minute plant sample was collected approximately mid-way in the 2 hour river sampling segment. There 24 hr sampling cycles were begun on May 29, 1973 and were conducted weekly through the striped bass larvae season which ended in mid-July. Sampling was conducted every other week after mid-July until October (NYU 1974).

5.1.2 Laboratory Methods

Fish eggs, larvae, and juveniles were sorted from the samples and identified to the lowest taxa possible and enumerated. Abundance data (no./1000 m^3) were analyzed by ANOVA and *a posteriori* tests to determine whether differences occurred between stations or sampling depths (NYU 1976, 1977).

5.2 Standard Station Fisheries Methods

5.2.1 Beach Seine Sampling

The shoreline in the vicinity of Indian Point on both east and west sides of the river is predominantly rocky; however, beach seining sites are available. Five stations were sampled between 1972-73 and two additional sites were added during the 1974-76 sampling periods (Figure 8-1, Summary). The frequency of beach seine sampling from 1972-1976 is given in Table 5-1. The

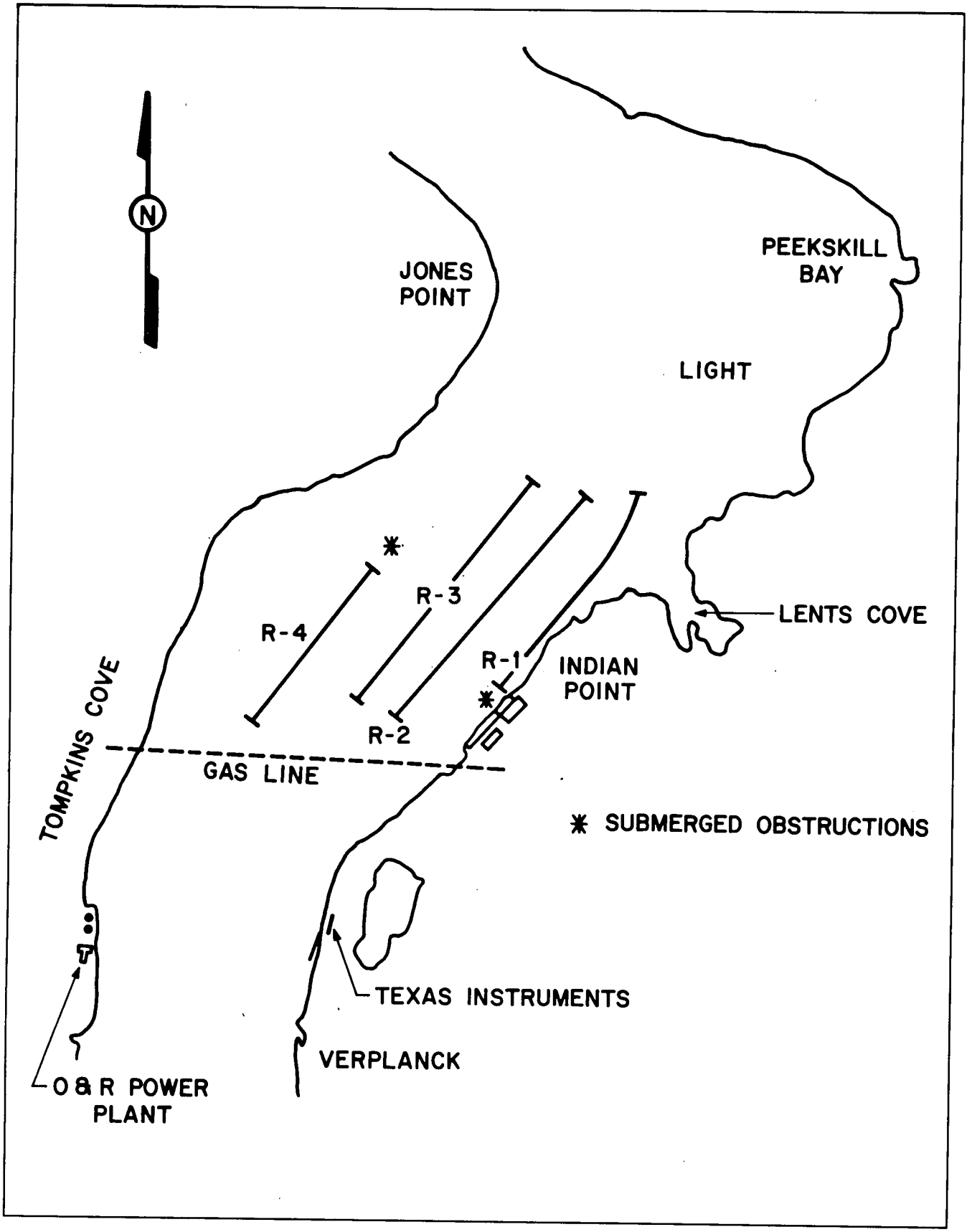


Figure 5-1. Sampling Stations in the Indian Point vicinity during 1973.
Source: NYU 1976a.

Table 5-1 Beach seine sampling frequency, 1972-1976

Year	Stations Sampled	Sampling Frequency
1972	Standard Stations 8-12 (5 Stations)	Weekly during day (late Apr.-Dec.) Once every 2 weeks, every 6 hrs. for 24 hrs. (late Apr.-May) Once per month every 6 hrs. for 24 hrs. (Jun.-Dec.)
1973	Standard Stations 8-12 (5 Stations)	Weekly during day (late Mar.-Dec.) Monthly every 6 hrs. for 24 hrs. (late Mar.-Dec.)
1974	Standard Stations 8-12 (5 Stations)	Weekly during day (late Mar.-Dec.)
	Standard Stations 20-21 (2 Stations)	Weekly during day (May-Dec.)
1975-76	Standard Stations 8-12, 20-21 (7 Stations)	Weekly during day (late Mar.-Dec.)

Sources: TI 1976b, 1977a.

Table 5-2. Description of 100 ft. (30.5 m) beach seine used for standard station sampling, Indian Point Region, 1972-1976.

Element	Dimensions	Mesh Size
Wings	40 ft x 8 ft (12.1 m x 2.4 m)	3/8-in (9mm) stretch
Bay	20 ft x 10 ft (6.1 m x 3 m)	3/16-in (4.5 mm) delta
End jacks	2 in x 4 in x 8 ft (5 cm x 10 cm x 1.3 m)	
Tow line	16 ft x 3/8 in (4.8 m x 1 cm)	

Table 5-3. Descriptions of standard station beach seine sites, Indian Point Region, 1972-1976.

Station	Location	Description
8	In Peekskill Bay (RM 43, east side) immediately south of public launching ramp	Mud but beach covered with accumulation of glass; maximum depth, 1.5 m; covered with heavy aquatic vegetation during summer
9	South of Jones Point (RM 42, west side) and adjacent to former reserve fleet headquarters	Medium-sized rocks and mud changing to gravel farther out; maximum depth, 1.5 m; heavily vegetated during summer
10	Gas line 100 m south of Con Edison Indian Point discharge canal (RM 42, east side)	Sand and gravel changing to mud at greater depths; maximum depth, 2 m; small stream enters river immediately south of sampling site
11	35 m south of Trap Rock Corp. barge mooring area (RM 40, west side)	Sand; drops off steeply to depth of 2.5 m
12	South of Green's Cove (RM 40, east side) 100 m south of Cortlandt Yacht Club	Gravel and crushed brick; drops off to maximum depth of 2 m; very dense aquatic vegetation during summer
20*	Verplanck Point (RM 40, east side) 10 m south of pier	Sand; drops steeply to maximum depth of 2 m
21*	Verplanck Point (RM 40, east side) 50 m south of trailer park	Sand changing to mud; maximum depth, 2 m

* Two stations added in May 1974

Source for Table 5-2, 5-3: TI 1976b.

Table 5-4. Descriptions of surface and bottom trawls used in standard station sampling, Indian Point Region, 1972-1976.

Surface Trawl

Element	Length Ft.	Length (m)	Stretch Size In.	Stretch Size (cm)
1st section	6.9	(2.1)	1.7	(4.3)
2nd section	10.9	(3.3)	1.4	(3.5)
3rd section	9.9	(3.0)	1.2	(3.0)
4th section	8.9	(2.7)	1.0	(2.5)
Cod end	9.6	(2.9)	0.16	(0.4)
Head rope	17.5	(5.3)		
Foot rope	17.5	(5.3)		
Spreader bars	10.8	(3.3)		
Total	49.5	(15.0)		

Bottom Trawl

Element	Length Ft.	Length (m)	Stretch Mesh Size In.	Stretch Mesh Size (cm)
Total	44.3	(13.5)		
Body	33	(10)		
Body mesh			1.5	(3.8)
Cod end	11.6	(3.5)		
Cod-end mesh			1.25	(3.1)
Head rope	25.7	(7.8)		
Foot rope	30.7	(9.3)		
Door	1.3 x 2.6	(0.4 x 0.8)		
Cod-end liner mesh			0.25 0.6	(0.6)* (1.6)†

*Used from April through June 1972.

†Used from July 1974 through December 1975 for repetitive samples. No liner used from July 1972 through June 1974.

Sources: TI 1976b, 1977a.

Table 5-5. Sampling Frequency for surface and bottom trawls at standard stations 1-7 in the Indian Point Region, 1972-1976.

Year	Gear	Sampling Frequency
1972	surface and bottom trawls	weekly during day (April-December) biweekly during night (April-December)
1973	surface and bottom trawls	biweekly during day (late March-December)
1974-76	surface trawls	biweekly during day (July-December)
1974-76	bottom trawls	biweekly during day (April-December)

Sources: TI 1976b, 1977a.

stations varied with respect to bottom type and the presence or absence of aquatic vegetation during the summer (Table 5-3).

Detailed dimensions of the 100 ft (30.5 m) seine net are given in Table 5-2. The deployment of the net consisted of holding one end on shore and extending the net perpendicular to shore at which point the net was towed in a clockwise manner.

After forming a semicircle with a diameter of approximately 60 ft (18.3 m), both wings of the net were pulled in simultaneously and the catch was withdrawn from the central, or bag, portion of the net.

5.2.2 Surface Trawl Sampling

The net used in surface trawling was a modified mid-water trawl net. The dimensions of the net are given in Table 5-4. The net is equipped with spreader bars and floats which insures that the net remains on the surface.

The mouth of the net was deployed to its maximum extent by towing the net with two boats. An angle of 45° was maintained between tow direction and the tow lines which are attached to the spreader bars. The duration of tows were 10 min and a towing speed of 1.0 m/sec was maintained throughout the tow.

5.2.3 Bottom Trawl Sampling

Bottom trawling utilized an otter-type bottom trawl whose dimensions are given in Table 5-4. The bottom net was towed by one vessel for 10 min. at a speed of 1.0 m/sec.

The locations of trawl stations are shown in Figure 8-1, Summary Section. The approximate water depths at the stations were as follows: Station 1 (9 m), Station 2 (5 m), Station 3 (5 m), Station 4 (16 m), Station 5 (12 m), Station 6 (12 m), and Station 7 (5 m). Both bottom and surface tows were conducted against the direction of the tide and along fixed direction as indicated in Figure 8-1, Summary Section. Further details on all fish sampling methods used are described in TI (1976b).

5.2.4 Laboratory Methods

Fish were identified to species and sorted each year into the following size classes:

1972	1973-74 Jan-Mid-July	1973-74 Mid-July-Dec.
0.49mm	0-100mm	0-Xmm
50.125mm	101-150mm	X+1-150mm
126-250mm	151-250mm	151-250mm
251+mm	251+mm	251+mm

where X = upper young-of-the-year limit and is species and date specific. In the years 1975-76 the size categories were the same as mid-July - Dec., 1973-74. Catch-per-unit-effort (C/f) were calculated biweekly for each gear type to assess the distribution and relative abundance of fishes commonly collected in the Indian Point area. The C/f values for most common species were plotted graphically by gear type. In addition, 1972-75 data for striped bass, white perch, and Atlantic tomcod were evaluated using an non-parametric 2-way ANOVA and a posteriori tests (TI, 1976b).

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Attachment 1

Intake Temperature, Discharge Temperature, T, and Total Heat Release to the Hudson River by the Indian Point Station from October 1973-December 1976 (Con Edison 1973-1977).

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE October, 1973

LOCATION

PREPARED BY

SUBJECT Part "C"

Total Heat Release to River

Oct.

Day	Intake Avg	Intake Max T	Intake Min T	Effluent Max T	Effluent Min T	Effluent Avg	Avg. ΔT		Total	BTU Release x 10^3	
1	70.1	71.0	69.8	89.2	90.0	89.6	4.9		26	449	416
2	70.2	71.0	70.1	77.0	70.0	73.5	0.8		5	728	907
3	70.7	72.0	70.2	79.9	78.8	78.9	8.2		75	314	737
4	70.5	71.0	70.2	83.0	83.0	83.0	12.5		80	067	963
5	70.2	70.9	69.9	70.6	70.6	70.6	0.4		2	562	175
6	69.6	70.0	69.2	83.0	70.0	79.9	10.3		65	976	001
7	68.9	69.0	68.9	82.5	68.0	71.3	2.4		16	671	408
8	68.8	69.2	68.8	83.2	67.8	75.7	6.9		44	197	515
9	69.0	69.5	68.8	83.0	77.5	80.0	11.0		84	696	909
10	68.8	69.0	68.7	79.0	77.0	78.5	9.7		82	145	527
	-	-	-	-	-	-	-		423	810	558
11	68.1	68.5	68.0	81.0	68.0	70.0	1.9		12	170	330
12	69.0	70.0	67.5	88.0	68.0	83.0	14.0		89	676	118
13	71.0	71.1	70.0	68.1	67.8	68.0	3.0		19	216	311
14	67.1	67.1	67.1	67.9	67.1	67.5	0.4		2	562	175
15	67.0	67.1	66.0	67.3	66.9	67.0	0.0				0
16	66.3	67.0	66.2	67.0	66.2	66.5	0.2		1	389	524
17	65.5	66.1	65.0	65.6	65.2	65.5	0.0				0
18	65.1	65.1	65.1	65.2	65.2	65.2	0.1			546	981
19	64.0	64.2	63.8	64.8	64.1	64.3	0.3		1	430	788
20	63.5	64.0	63.0	65.0	63.8	64.0	0.5			675	930
	-	-	-	-	-	-	-		127	668	137
21	63.0	63.3	63.0	65.0	65.0	65.0	2.0		1	391	444
22	62.5	63.0	62.2	65.0	64.3	64.5	2.0		1	391	444
23	62.5	63.0	62.3	64.4	62.1	63.4	0.9		3	906	957
24	62.4	62.9	62.4	62.9	62.1	62.4	0				0
25	62.1	62.1	62.0	62.8	62.0	62.5	0.4		1	507	077
26	61.8	62.0	61.7	62.0	61.7	61.8	0.0				0
27	61.6	61.7	61.5	62.0	61.2	61.8	0.2			945	222
28	61.0	61.4	60.8	61.2	60.8	61.0	0.0				0
29	60.1	60.8	59.9	60.9	60.0	60.1	0.0				0
30	60.0	60.0	60.0	60.0	60.0	60.0	0.0				0
31	60.0	60.0	59.8	60.5	60.0	60.2	0.2			545	302
							Total		621	166	161

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO. _____

DATE November, 1973

LOCATION _____

PREPARED BY _____

SUBJECT Part "C"

Total Heat Release to River

Nov.

Day	Intake Avg T	Intake Max T	Intake Min T	Effluent Max T	Effluent Min T	Effluent Avg T	Avg. ΔT		Total BTU Release x 10^3		
1	59.8	60.0	59.4	60.1	59.9	60.0	0.2			340	664
2	59.0	59.2	58.6	59.9	59.0	59.5	0.5			713	115
3	58.2	59.0	57.0	59.4	58.0	59.2	1.0		1	643	343
4	57.0	57.3	56.0	59.9	57.0	58.6	1.6		2	725	309
5	56.3	56.8	55.8	57.9	6.4	57.2	0.9		1	919	472
6	55.4	56.0	55.0	56.7	55.8	56.0	0.6		1	720	112
7	55.2	55.5	55.0	55.9	55.1	55.5	0.3			795	282
8	54.5	55.0	54.0	55.0	54.5	55.0	0.5		1	325	470
9	54.0	54.0	53.1	55.0	54.0	54.6	0.6		1	590	564
10	53.5	54.0	53.0	53.0	52.0	52.5	1.0		2	650	740
	-	-	-	-	-	-	-		15	424	271
11	52.5	53.0	51.3	52.0	50.6	51.5	1.0		3	215	913
12	52.0	52.3	51.0	51.5	50.2	51.0	1.0		4	986	405
13	52.0	55.0	51.0	52.1	50.4	51.0	1.0		5	483	206
14	52.0	53.0	52.0	52.0	51.0	51.7	0.3			473	930
15	52.0	52.0	52.0	51.7	51.0	51.5	0.5			749	700
16	52.0	52.0	52.0	51.8	51.0	51.2	0.4			673	650
17	51.0	51.0	50.0	52.0	51.9	52.0	1.0		2	450	617
18	50.4	50.5	50.2	52.0	51.1	51.8	1.4		3	484	606
19	50.4	50.9	50.2	51.3	51.0	51.1	0.7		1	742	303
20	50.3	50.5	50.0	51.0	50.8	51.0	0.3			746	701
	-	-	-	-	-	-	-		24	006	
21	50.0	50.0	49.5	50.5	50.0	50.8	0.8		1	991	203
22	50.0	50.0	49.9	50.0	50.0	50.0	0.0				0
23	49.9	50.0	49.5	50.4	50.4	50.4	0.5		1	205	518
24	49.8	50.0	49.8	50.3	50.3	50.3	0.5		1	176	729
25	49.7	50.0	49.4	50.3	50.0	50.0	0.3			784	486
26	49.6	49.6	49.6	50.0	50.0	50.0	0.4			728	708
27	50.0	50.0	49.8	50.2	50.0	50.0	0.0				0
28	50.0	51.0	49.8	50.8	50.2	50.3	0.3			728	348
29	49.0	49.0	49.0	50.4	50.4	50.4	1.4		3	316	673
30	49.0	49.1	48.9	49.9	49.5	49.7	0.7		1	784	286
	-	-	-	-	-	-	-		11	715	951
								Total	51,	147	055

2 2 (PAD) 5 72 CONSL.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE December, 1973

LOCATION

PREPARED BY

SUBJECT Part "C"

Total Heat Release to River

Dec.

Day	Intake Avg T	Intake Max T	Intake Min T	Effluent Max T	Effluent Min T	Effluent Avg T	Avg. ΔT		Total BTU Release x 10^3		
1	48.0	49.0	47.3	49.7	48.2	49.0	1.0		2	548	980
2	47.0	47.3	47.0	48.2	48.0	48.0	1.0		2	522	591
3	47.3	47.5	47.0	48.0	48.0	48.0	0.7		1	784	860
4	47.5	47.9	47.5	48.0	48.0	48.0	0.5		1	274	490
5	47.9	48.0	47.8	48.1	48.0	48.0	0.1			254	898
6	48.0	48.0	48.0	48.5	48.0	48.5	0.5		1	274	490
7	116.5	47.0	46.2	47.9	47.0	47.2	0.7		1	284	286
8	46.0	46.3	46.0	47.0	46.4	46.5	0.5		1	274	490
9	46.0	46.0	45.9	46.5	46.5	46.5	0.5		1	387	245
10	45.9	46.0	45.0	46.5	45.5	46.1	0.2			418	247
	-	-	-	-	-	-	-		14	524	577
11	45.0	45.0	44.0	46.7	44.5	45.1	0.1			272	771
12	43.6	44.0	43.6	44.5	44.0	44.0	0.4		1	023	910
13	43.3	43.6	43.0	44.0	43.0	43.5	0.2			471	411
14	42.5	42.5	42.0	43.0	43.0	43.0	0.5		1	178	529
15	41.5	42.0	41.3	43.0	42.0	42.3	0.8		1	885	646
16	39.8	41.3	38.0	42.0	39.9	41.0	1.2		2	264	214
17	37.0	38.9	34.5	40.0	37.0	38.0	1.0		1	229	508
18	36.5	37.0	36.0	38.0	37.0	37.5	1.0		1	229	508
19	36.0	36.5	36.0	37.5	37.0	37.3	1.3			854	537
20	36.3	36.3	36.3	37.5	37.5	37.5	1.2		2	082	847
	-	-	-	-	-	-	-		12	492	881
21	36.9	37.7	36.0	38.8	37.2	38.0	1.1		2	298	520
22	35.2	36.0	35.0	38.0	37.0	37.0	1.8		2	174	251
23	35.0	35.0	34.9	37.0	35.9	36.5	1.5		1	655	337
24	34.2	34.9	33.1	35.7	34.3	35.0	0.8			882	846
25	32.7	33.0	32.5	34.3	33.5	33.5	0.8		1	031	587
26	32.9	33.0	32.8	33.7	33.5	33.6	0.7			902	639
27	32.4	32.8	32.2	34.0	33.2	33.5	1.1		1	409	196
28	32.3	32.3	32.0	33.3	33.3	33.3	1.0		1	271	491
29	32.0	32.0	32.0	33.3	33.3	33.3	1.3		2	987	764
30	32.0	32.0	31.8	33.5	33.2	33.3	1.3		2	395	207
31	32.4	32.6	32.0	33.0	33.0	33.3	0.9		2	121	351
								Total	46	147	642

2-2 (PAD) 5-72 CONSOL.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE Jan, 1974

LOCATION Indian Point

PREPARED BY

SUBJECT Part "C" TABLE IX-4

Total Heat Release to River

Date	Intake Avg T	Intake Max T	Intake Min T	Effluent Max T	Effluent Min T	Effluent Avg T	Avg. Δ T		Total	BTU Release x 10^3	
1	32.2	32.4	32.0	33.0	33.0	33.0	0.8		1	556	497
2	32.2	32.2	32.2	33.5	33.1	33.2	1.0		1	336	265
3	32.2	32.2	32.2	33.5	33.5	33.5	1.3		1	849	420
4	32.0	32.0	32.0	34.5	33.5	33.5	1.5		1	934	226
5	32.0	32.0	32.0	33.8	33.5	33.6	1.6		1	999	840
6	32.0	32.0	32.0	33.8	33.6	33.7	1.7		2	090	164
7	32.2	32.5	32.0	34.0	34.0	34.0	1.8		2	234	705
8	32.2	32.5	32.1	34.0	33.5	33.6	1.4		2	124	350
9	32.0	32.0	32.0	33.5	33.5	33.5	1.5		1	898	241
10	31.9	31.9	31.9	33.5	33.5	33.5	1.6		1	967	220
							Subtotal		18	990	928
11	31.9	31.9	31.9	33.9	33.5	33.7	1.8		2	213	114
12	31.7	31.8	31.6	33.8	33.6	33.7	2.0		2	459	016
13	31.5	31.7	31.3	33.6	33.2	33.4	1.9		2	336	065
14	31.3	31.3	31.3	33.3	33.1	33.2	1.9		2	361	136
15	31.5	31.7	31.3	33.3	33.2	33.2	1.7		2	750	858
16	31.8	32.0	31.6	52.0	33.1	40.5	8.7		18	732	301
17	31.7	32.0	31.4	36.5	33.0	33.2	1.5		4	136	544
18	31.0	31.0	31.0	33.8	32.8	38.1	7.1		20	473	887
19	31.2	31.4	31.0	44.1	33.0	35.6	4.4		14	171	128
20	31.8	32.1	31.4	52.5	34.3	45.0	13.2		34	232	378
							Subtotal		101	866	427
21	32.1	32.9	31.7	61.0	34.1	48.0	15.9	*	37	439	046
22	32.4	33.1	32.0	51.0	47.8	49.5	17.1	*	53	022	979
23	32.2	32.4	32.0	49.0	33.7	41.3	9.1		27	452	816
24	32.0	32.2	31.9	46.3	33.6	40.5	8.5		28	630	142
25	31.9	32.0	31.8	44.0	38.0	40.5	8.6		48	866	284
26	31.8	32.0	31.5	30.2	44.0	46.4	14.3		117	035	848
27	32.1	33.5	31.9	50.2	50.2	50.2	18.1	*	130	680	389
28	32.1	32.4	32.0	50.3	34.0	45.5	13.4		72	716	815
29	32.1	32.1	32.1	45.5	34.0	36.5	4.4		19	992	641
30	32.1	32.1	32.1	34.2	34.0	34.1	2.0		6	767	894
31	32.5	32.5	32.5	33.6	33.6	33.6	1.1		4	379	328
							Subtotal		546	979	182
							Total		667	836	537

* Within Δ T specification for reduced flow conditions.

2-2 (PAD) 5-72 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE Feb, 1974

LOCATION Indian Point

PREPARED BY

SUBJECT Part "C"

Total Heat Release to River

Date	Intake Avg T	Intake Max T	Intake Min T	Effluent Max T	Effluent Min T	Effluent Avg T	Avg. ΔT		Total BTU Release x 10^3
1	31.8	32.0	31.5	33.3	33.1	33.2	1.4		4 792 802
2	31.5	31.5	31.5	40.9	33.2	38.8	7.3		30 428 824
3	31.5	31.5	31.5	41.0	37.5	39.0	7.5		31 262 490
4	31.6	31.7	31.5	45.8	40.8	43.3	11.7		43 001 349
5	31.5	31.5	31.5	44.8	33.2	40.9	9.4		30 274 683
6	31.5	31.5	31.5	33.2	33.0	33.2	1.7		5 475 209
7	31.6	32.0	31.2	40.8	33.0	37.5	5.9		21 995 837
8	31.7	32.0	31.4	45.8	40.0	42.2	12.5		38 339 049
9	31.4	31.5	31.1	44.7	43.3	44.0	12.6		40 580 959
10	31.4	31.8	31.1	44.7	43.5	44.0	12.6		40 580 959
								Subtotal	286 732 161
11	31.5	31.7	31.3	44.9	39.8	43.2	11.7		37 682 319
12	31.8	32.2	31.5	45.6	43.5	44.2	13.0		41 869 423
13	31.8	32.0	31.8	45.1	39.0	41.6	9.8		31 562 968
14	32.0	32.5	31.3	50.0	40.0	48.6	16.6	*	53 463 803
15	31.5	31.6	31.4	49.8	47.2	48.6	17.1	*	56 794 273
16	31.4	31.5	31.2	48.9	47.6	48.2	16.8	*	53 201 078
17	31.5	31.8	31.3	49.3	42.1	45.0	14.5		45 900 229
18	31.7	31.9	31.4	46.2	43.8	43.8	13.3		42 037 776
19	32.1	33.1	31.8	45.9	42.5	44.2	12.1		37 519 184
20	32.6	33.8	32.1	46.0	45.0	45.5	12.9		39 999 791
								Subtotal	440 030 864
21	32.0	32.3	31.8	42.0	33.1	34.9	2.9		8 999 158
22	32.1	33.6	31.7	54.3	42.0	46.8	14.7		40 908 424
23	31.9	33.0	31.5	54.0	51.7	52.0	20.1	*	42 072 556
24	32.1	33.1	31.5	54.1	54.7	52.6	20.4	*	42 700 505
25	32.5	33.0	32.0	54.0	52.2	53.0	20.5	*	42 909 821
26	32.2	32.5	31.9	52.8	50.0	51.3	19.1	*	43 645 143
27	32.1	32.9	31.9	52.0	50.0	50.8	18.7	*	46 409 791
28	32.1	32.3	31.8	52.1	34.5	49.2	17.1	*	42 664 534
							Total		1,037, 072, 957

* Within ΔT specifications for reduced flow conditions.

2-2 (PAD) 5-72 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE Mar, 1974

LOCATION Indian Point

PREPARED BY

SUBJECT Part "C"

Total Heat Release to River

Date	Intake Avg T	Intake Max T	Intake Min T	Effluent Max T	Effluent Min T	Effluent Avg T	Avg. Δ T		Total	BTU Release x 10^3	
1	32.0	32.2	31.9	50.1	42.5	47.3	15.3	*	36	246	496
2	32.0	32.2	31.9	51.6	49.9	50.8	18.8	*	39	689	714
3	32.4	32.6	32.1	51.8	51.0	51.4	19.0	*	40	111	945
4	32.9	33.1	32.6	52.2	51.4	51.8	18.9	*	40	467	603
5	33.6	34.4	33.0	54.3	52.0	53.1	19.5	*	42	337	055
6	34.1	35.0	33.3	75.0	52.7	60.8	26.7	**	59	058	131
7	34.7	35.5	34.0	62.0	50.5	57.0	22.3	*	45	447	043
8	35.3	36.0	34.8	58.2	56.5	57.0	21.7	*	47	113	543
9	35.3	36.3	34.8	58.8	57.1	57.4	22.1	*	47	981	995
10	35.1	36.0	34.8	58.6	56.9	57.5	22.4	*	47	289	872
							Subtotal		445	743	397
11	35.4	37.0	34.2	61.5	56.6	58.5	23.1	*	48	767	681
12	35.9	37.0	35.1	62.0	54.4	58.1	22.2	*	50	063	176
13	35.2	36.8	34.0	56.8	47.5	52.7	17.5	*	39	275	285
14	35.3	36.4	34.0	48.2	47.5	47.8	12.5		45	371	838
15	35.7	37.0	35.0	48.4	47.2	48.0	12.3		50	754	093
16	36.4	37.4	35.7	48.0	46.0	47.1	10.7		44	151	934
17	36.1	36.5	36.0	47.0	46.8	46.9	10.8		44	564	569
18	36.6	37.2	36.0	46.9	41.0	43.6	7.0		34	006	392
19	37.1	37.9	36.7	46.3	42.0	43.5	6.4		28	043	821
20	37.9	38.7	37.2	47.7	46.0	46.7	8.8		36	734	095
							Subtotal		421	732	884
21	37.9	38.3	37.7	47.0	44.0	45.3	7.4		50	462	605
22	38.1	39.0	37.5	54.0	45.0	50.1	12.0		86	509	380
23	38.3	39.8	37.6	58.0	53.8	56.6	18.3	*	129	292	666
24	38.7	40.0	37.9	59.5	54.4	57.3	18.6	*	127	730	887
25	38.1	39.5	37.3	57.0	51.8	53.6	15.5	*	104	508	781
26	38.7	42.0	37.8	58.5	44.1	48.2	9.5	*	67	506	582
27	39.4	41.5	38.1	60.3	55.0	57.4	18.0	*	120	954	798
28	39.1	40.2	38.2	58.8	53.0	56.5	17.4	*	117	215	170
29	38.5	40.3	37.0	63.0	54.7	58.5	20.0	*	118	032	760
30	38.7	40.0	37.8	59.9	56.3	57.2	18.5	*	115	060	954
31	39.1	40.7	38.0	59.0	56.3	57.3	18.2	*	113	959	191
							Total		2,018,	710,	055

* Within Δ T specifications for reduced flow conditions.

** Within Δ T specifications for reduced flow and circulating pump outage

2-2 (PAD) 5-72 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE Apr, 1974

LOCATION Indian Point

PREPARED BY

SUBJECT Part "C"

Total Heat Release to River

Date	Intake Avg T	Intake Max T	Intake Min T	Effluent Max T	Effluent Min T	Effluent Avg T	Avg. ΔT		Total BTU Release x 10^3
1	38.9	40.2	37.9	63.4	56.1	57.6	20.7	*	130 407 495
2	39.2	41.0	38.0	63.7	60.1	62.1	22.9	*	145 723 074
3	39.3	40.2	38.0	63.5	58.1	61.9	22.6	*	143 814 038
4	40.1	41.0	38.9	64.0	60.0	62.8	22.7	*	144 559 298
5	40.7	41.7	39.7	65.3	60.9	63.8	23.1	*	146 995 764
6	41.1	43.2	40.1	65.9	62.0	64.6	23.5	*	148 131 710
7	40.4	41.8	39.9	62.0	48.0	51.1	10.7		53 307 659
8	40.4	41.2	39.8	69.9	48.4	61.4	21.0	*	114 236 283
9	40.2	41.2	39.8	69.9	47.6	63.2	23.0	*	139 048 363
10	40.9	44.0	39.9	69.4	47.0	61.6	20.7	*	152 878 712
							Subtotal		1,323 102 326
11	41.3	42.6	40.2	59.0	52.0	56.7	15.4	*	119 129 857
12	41.8	42.2	41.0	62.5	57.0	59.4	17.6	*	121 855 870
13	42.2	42.5	41.7	59.3	58.2	59.0	16.8	*	121 113 132
14	43.2	43.9	42.4	60.1	59.0	59.6	16.4	*	118 229 486
15	44.4	45.5	43.8	66.5	60.0	63.3	18.9	*	136 252 274
16	45.4	46.8	44.2	69.0	64.3	66.4	21.0	*	157 562 937
17	45.0	46.1	44.0	68.0	63.0	65.8	20.8	*	149 949 592
18	44.8	46.4	44.3	65.8	49.7	60.5	15.7	*	116 874 270
19	44.7	45.1	44.1	53.2	49.3	50.5	5.8		43 607 810
20	44.8	45.5	44.1	53.8	51.8	52.9	8.1		27 205 089
							Subtotal		1,111, 780, 317
21	45.4	46.0	44.7	54.8	51.2	53.2	7.8		26 197 493
22	46.1	46.7	45.6	55.9	52.2	54.3	8.2		28 918 030
23	46.8	48.3	46.2	57.3	54.7	55.9	9.1		37 309 627
24	47.3	48.0	47.0	56.8	54.3	55.3	8.0		39 977 600
25	47.5	48.0	46.9	59.8	56.7	57.2	9.7		39 769 602
26	48.1	49.3	47.5	57.2	54.0	55.2	7.1		46 517 624
27	48.6	49.0	48.1	58.8	58.8	58.8	10.2		76 469 400
28	49.4	50.0	49.0	58.8	58.8	58.8	9.4		77 440 048
29	50.6	51.7	41.8	58.7	58.9	58.9	8.3		90 549 962
30	51.5	51.8	51.0	64.3	61.8	64.0	12.5		157 437 000
							Total		3,055, 469, 099

* Within ΔT specifications for reduced flow conditions.

2-2 (PAD) 5-72 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

No.

DATE May, 1974

LOCATION Indian Point

PREPARED BY

SUBJECT Part "C"

Total Heat Release to River

Date	Intake Avg T	Intake Max T	Intake Min T	Effluent Max T	Effluent Min T	Effluent Avg T	Avg. ΔT		Total BTU Release x 10^3
1	52.5	53.6	51.6	66.2	62.9	64.3	11.8		152 895 137
2	52.5	53.0	51.9	67.7	63.7	65.2	12.7		135 292 300
3	52.5	52.8	52.2	66.0	57.7	64.9	12.4		91 738 564
4	52.8	53.3	52.3	61.0	60.5	60.6	7.8		51 983 357
5	52.5	52.9	52.0	62.0	53.8	55.3	2.8		27 406 632
6	52.8	53.0	52.6	64.5	54.2	58.5	5.7		51 990 555
7	53.3	54.3	52.6	70.8	63.5	66.8	13.5		105 355 040
8	53.5	55.1	52.7	69.0	65.5	66.8	13.3		108 979 149
9	54.3	56.0	53.5	67.0	64.7	66.3	12.0		102 472 596
10	53.8	54.0	53.0	65.5	55.0	63.0	9.2		84 631 895
								Subtotal	912 745 223
11	53.2	53.5	53.0	55.0	54.9	55.0	1.8		9 392 242
12	53.8	54.0	53.5	55.3	55.0	55.1	1.6		8 367 851
13	54.1	54.8	53.8	59.0	55.2	56.9	2.8		24 551 775
14	54.6	55.1	54.0	56.8	55.8	56.2	1.6		6 891 962
15	55.7	56.1	55.0	57.2	56.8	57.0	1.3		5 379 847
16	56.5	57.0	56.0	57.2	57.0	57.1	.6		2 087 165
17	57.4	58.8	56.9	59.0	57.8	58.4	1.0		3 597 360
18	57.9	58.0	57.9	58.5	58.5	58.5	.6		3 632 387
19	58.5	59.0	58.0	61.0	58.8	59.9	1.4		18 939 462
20	59.0	59.8	58.5	63.0	61.0	61.9	2.9		38 675 163
								Subtotal	99 460 204
21	59.3	59.9	58.9	70.8	62.1	65.6	6.3		77 156 724
22	60.1	61.2	59.2	75.9	64.9	70.5	10.4		135 640 762
23	60.6	61.0	60.1	74.0	64.8	69.9	9.3		113 898 021
24	60.6	61.0	60.5	74.5	73.8	74.1	13.5		165 335 850
25	60.7	61.2	60.0	Pen Stopped		74.2	13.5		165 335 850
26	60.5	60.9	60.0	Pen Stopped		74.2	13.7		167 784 037
27	60.3	60.5	60.0	Pen Stopped		74.2	13.9		177 099 050
28	60.6	61.5	60.1	Pen Stopped		74.2	13.6		189 399 407
29	60.8	61.0	60.3	73.0	70.2	71.7	10.9		151 798 054
30	61.0	61.8	61.2	72.6	70.3	71.7	10.7		149 012 769
31	61.2	61.8	61.0	74.1	70.8	73.1	11.8		164 331 839
							Total		2,696, 997, 192

2-2 (PAD) 5-72 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE June, 1974

LOCATION Indian Point

PREPARED BY

SUBJECT Part "C"

Total Heat Release to River

Date	Intake Avg T	Intake Max T	Intake Min T	Effluent Max T	Effluent Min T	Effluent Avg T	Avg. Δ T		Total BTU Release x 10^3
1	61.3	61.8	61.0	71.8	65.1	69.5	8.2		87 354 083
2	61.1	61.3	62.9	73.1	65.0	68.1	7.0		97 443 010
3	64.6	62.9	61.0	77.3	71.0	74.2	12.6		164 847 879
4	62.5	64.0	61.5	77.2	76.2	76.7	14.2		174 675 308
5	63.3	63.9	62.7	77.3	73.8	75.7	12.4		172 791 818
6	61.0	65.0	63.0	76.3	68.3	73.7	9.7		151 317 653
7	64.4	64.9	63.9	76.5	72.0	73.3	8.9		149 737 765
8	64.4	64.9	63.7	74.0	72.4	73.2	8.8		152 055 957
9	64.9	67.0	64.0	77.0	73.0	74.8	9.9		171 062 951
10	66.3	67.2	65.2	77.3	69.8	74.8	8.5		146 872 231
									1,463, 158, 625
11	67.8	69.1	66.5	78.6	76.0	77.6	9.8		169 335 043
12	67.6	68.0	67.0	81.2	71.4	77.0	9.4		156 932 248
13	67.6	67.0	67.0	82.5	80.4	81.4	13.8		192 101 924
14	67.9	68.8	67.0	82.3	73.0	79.7	11.8		152 159 112
15	67.7	68.2	67.0	75.1	74.1	74.6	6.9		49 825 659
16	68.0	68.2	67.6	75.0	74.0	74.5	6.5		48 839 655
17	68.3	69.3	67.9	79.0	72.0	76.2	7.7		102 711 055
18	68.7	70.0	67.7	79.0	77.8	78.4	9.7		135 202 693
19	68.7	69.5	68.0	81.0	77.0	79.2	10.5		160 459 793
20	69.7	71.0	68.8	83.5	80.1	81.0	11.3		168 971 241
									1,342, 533, 533
21	69.8	70.0	69.5	80.0	73.9	77.7	7.9		123 863 515
22	70.3	71.0	69.8	82.0	80.2	80.8	10.1		161 385 941
23	70.0	70.4	69.5	87.5	84.0	85.8	15.8	*	179 687 854
24	70.2	71.1	69.8	87.8	73.6	80.7	10.5		108 341 835
25	69.9	70.0	69.5	79.8	73.2	75.5	5.6		63 848 047
26	69.9	70.2	69.8	84.5	78.5	82.4	12.5		162 534 963
27	69.9	70.0	69.8	83.5	81.8	82.9	13.0		175 180 304
28	69.7	70.5	69.2	86.8	83.0	84.0	14.3		190 434 115
29	69.9	70.5	69.2	87.0	84.0	85.5	15.6	**	191 279 291
30	70.2	71.0	69.5	87.3	83.8	84.9	14.7		196 436 306
							Total		4,363, 619, 359

* Within Δ T specifications for pump outage.

** Unit I at reduced flow, within Δ T specification for reduced flow.

2-2 (PAD) 5-72 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE July 1974

LOCATION

PREPARED BY

SUBJECT Part "C"

Table IX-4

Total Heat Release to River

Date	Inthke Avg T	Inthke Max T	Inthke Min T	Effluent Max T	Effluent Min T	Avg T	AvgΔT	Total BTU Release x 10^6
1	71.0	72.0	70.1	88.0	84.2	86.0	15.00	185,469
2	71.3	72.0	70.5	No		86.0	14.7	204,894
3	71.9	72.5	70.9	84.2	84.2	84.2	12.3	171,442
4	71.7	72.1	71.0	84.5	84.1	84.3	12.6	159,421
5	72.1	72.5	71.9	84.0	84.0	84.0	11.9	143,513
6	72.6	73.2	72.0	No		84.0	11.4	158,898
7	73.6	74.6	73.0	84.5	83.5	84.3	10.7	135,048
8	74.2	75.0	74.0	89.0	83.5	85.4	11.3	132,884
9	75.4	76.4	74.8	89.9	88.8	82.2	6.8	71,942
10	76.1	77.0	75.2	90.1	89.9	89.9	13.8	146,000
11	75.8	76.0	75.2	89.8	86.3	88.8	13.0	145,708
12	75.6	76.0	75.1	86.1	84.8	85.8	10.2	142,171
13	75.5	75.8	74.9	85.4	84.0	84.8	9.3	122,800
14	75.9	77.0	75.0	87.2	85.1	86.0	10.1	108,527
15	76.0	76.5	75.5	88.0	86.0	86.8	10.8	121,153
16	75.8	76.8	75.2	88.0	85.0	86.1	10.3	126,305
17	76.0	77.0	75.8	89.0	87.5	88.5	12.5	154,992
18	76.0	77.0	75.5	92.0	88.0	89.6	13.6	171,943
19	76.1	77.0	75.8	90.2	86.0	87.9	11.8	161,500
20	76.0	76.9	75.3	90.0	86.1	88.0	12.0	147,109
21	76.0	77.2	75.0	91.5	87.0	89.2	13.2	153,760
22	76.1	77.6	75.0	94.0	80.0	90.2	14.1	181,648
23	76.0	76.2	75.9	80.0	79.5	79.0	3.0	43,297
24	76.0	76.0	75.0	89.0	80.0	85.2	9.2	128,785
25	76.0	77.3	75.8	90.2	89.0	89.7	13.7	190,956
26	76.0	77.0	75.5	90.0	80.0	87.0	11.0	153,322
27	75.9	76.5	75.5	84.9	79.8	83.5	7.6	63,814
28	75.9	76.0	75.8	84.0	76.9	77.0	1.1	6,095
29	75.7	75.9	75.5	76.7	76.6	76.6	.9	5,041
30	76.0	76.9	75.5	81.2	76.2	79.2	3.2	17,[illegible]
31	75.8	75.9	75.2	81.0	80.8	80.9	5.1	28,568
								3,884,948

2 2 PADI 11/74 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

DATE August 1974

LOCATION

PREPARED BY

SUBJECT

Total Heat Release to River

Date	Intake Avg T	Intake Max T	Intake Min T	Effluent Max T	Effluent Min T	Effluent Avg T	Avg ΔT		Total BTU Release x 10^6
1	75.8	76.0	75.2	82.8	80.2	81.0	5.2		37,948
2		N/A		81.0	79.0	80.2	N/A		
3		N/A		82.5	79.0	81.1	N/A		
4		N/A		83.2	82.0	82.5	N/A		
5		N/A		82.8	79.0	81.2	N/A		
6		N/A			N/A		N/A		
7		N/A			N/A		N/A		
8	76.5	77.0	76.0	88.0	79.6	82.2	5.7		89,889
9	76.5	77.9	76.1	91.0	82.2	88.0	11.5		168,582
10	76.6	77.0	76.1	90.0	83.8	86.4	9.8		123,442
11	76.8	77.5	75.8	87.0	83.6	85.0	8.2		116,665
12	76.3	78.0	76.0	90.7	82.7	86.8	10.5		158,180
13	77.0	78.5	76.0	92.8	88.2	90.0	13.0		179,998
14	77.0	77.0	76.4	90.1	87.8	89.0	12.0		162,237
15	77.1	78.0	76.2	93.0	90.0	91.2	14.1		191,999
16	77.1	78.5	76.0	92.0	90.1	90.1	13.9		194,577
17	77.0	78.0	76.5	91.5	87.0	90.0	13.0		181,979
18	77.3	78.5	76.8	93.2	86.8	91.0	13.7		184,218
19	77.3	78.1	76.5	84.1	88.0	91.5	14.2		188,489
20	77.5	78.5	76.9	92.1	86.9	90.0	12.5		174,979
21	78.5	80.0	77.3		N/A				
22	78.6	80.0	77.9	92.0	84.8	89.0	10.4		145,583
23	78.7	79.6	77.9	92.5	89.5	92.5	13.8		193,177
24	78.8	80.0	77.9	91.0	89.0	90.0	11.2		155,223
25	79.0	80.0	77.8	91.0	88.3	89.8	10.8		147,995
26	78.4	80.0	77.1	91.1	88.8	89.9	11.5		160,981
27	79.0	80.0	78.0	91.0	89.0	90.0	11.0		153,982
28	78.5	79.0	78.0	90.0	88.2	89.2	10.7		149,782
29	78.2	79.9	77.5	92.0	90.0	90.8	12.6		176,379
30	78.0	79.9	77.2	91.2	81.2	85.8	7.8		108,187
31	77.8	78.0	77.0	87.0	80.1	84.2	6.4		89,589

2-2 (PAD) 11/74 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE September 1974

LOCATION

PREPARED BY

SUBJECT

Total Heat Release to River

Date	Intake Avg T	Intake Max T	Intake Min T	Effluent Max T	Effluent Min T	Avg T	Avg ΔT	Total BTU Release x 10^6
1	77.8	79.0	77.0	88.0	86.1	87.2	9.4	131,584
2	77.4	78.0	76.6	87.0	84.0	84.8	7.4	103,588
3	76.0	77.0	76.5	84.0	77.0	80.0	4.0	54,467
4	75.8	76.2	75.2	84.0	82.0	82.0	6.2	85,220
5	75.0	75.6	74.5	83.2	83.0	83.0	8.0	125,345
6	74.8	75.0	74.2	83.0	78.0	81.0	6.2	96,830
7	74.0	74.2	73.2	78.0	78.0	78.8	4.8	45,071
8	74.0	74.0	73.6	78.9	78.9	78.9	4.9	43,800
9	73.8	74.0	73.7	79.0	79.0	79.0	5.2	46,906
10	73.5	75.0	73.2	86.0	78.0	81.2	7.7	107,621
								840,435
11	73.7	74.2	73.1	87.0	86.0	86.0	12.3	171,442
12	74.5	76.0	74.0	90.0	85.0	87.0	12.5	171,486
13	74.8	75.0	74.0	88.0	78.0	85.0	10.2	142,783
14	74.0	75.0	73.2	85.2	79.0	83.0	9.0	125,985
15	73.8	74.0	73.0	87.0	83.0	85.0	11.2	156,782
16	73.8	74.0	73.0	88.0	85.0	87.8	14.0	183,987
17	73.5	73.2	72.6	88.0	84.1	88.0	14.5	170,677
18	73.5	74.0	73.0	87.0	83.3	86.0	12.5	149,235
19	73.5	74.3	73.0	88.5	83.0	87.0	13.5	157,643
20	73.5	74.0	73.0	88.9	84.0	87.5	14.0	172,466
								1,602,491
21	73.3	74.0	73.0	85.2	84.0	84.8	11.5	141,669
22	73.0	73.9	72.3	84.0	82.0	83.3	10.3	126,886
23	72.3	72.6	71.8	86.0	80.8	85.0	12.7	156,452
24	71.8	72.5	71.0	86.0	83.0	85.0	13.2	162,611
25	71.0	71.3	71.0	83.0	80.9	82.0	11.0	135,826
26	70.7	71.8	70.0	83.0	81.0	82.3	11.6	142,901
27	70.1	70.5	69.9	82.2	73.5	78.3	8.2	101,016
28	70.0	71.5	69.8	82.2	79.2	81.1	11.1	136,741
29	70.2	71.1	69.9	82.5	80.2	81.1	10.9	134,277
30	68.7	69.0	68.2	79.8	72.5	77.3	8.6	86,653
								1,325,036

2 2 PAD 11/74 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE October, 1974

LOCATION

PREPARED BY

SUBJECT

Total Heat Release to River

Date	Intake Avg.	Intake Max. T	Intake Min. T	Effluent Max. T	Effluent Min. T	Effluent Avg.	Avg. ΔT	Total BTU Release
1	68.0	68.5	67.9		NA		NA	NA
2	68.0	68.0	67.9	68.0	63.0	68.0	0	0
3	65.6	67.0	65.3	66.0	64.8	65.6	0	0
4	64.5	65.5	63.2	64.9	62.9	64.5	0	0
5	64.5	64.8	64.0	64.3	64.5	64.5	0	0
6	64.5	64.9	64.0	68.0	63.9	67.0	2.5	14004
7	64.5	64.9	64.2	67.8	67.0	67.5	3.0	16805
8	64.8	64.1	63.4	67.0	66.0	66.8	2.8	15684
9	63.9	64.0	63.7	66.4	65.5	66.0	2.1	13985
10	63.5	63.5	63.5	67.5	65.0	66.0	2.5	18052
11	63.4	63.4	63.4	67.1	65.1	65.5	2.1	24106
12	63.5	64.0	63.0	75.5	66.0	72.5	9.0	125866
13	63.0	63.0	62.5	75.6	74.0	75.0	12	167986
14	63.5	64.0	62.5	75.9	74.8	75.0	11.5	160981
15	63.5	64.2	62.5	78.0	74.9	76.0	12.5	162145
16	62.8	64.2	62.0	79.0	76.0	77.0	14.2	172937
17	62.4	62.8	62.0	74.0	74.0	74.0	11.6	142901
18	62.0	64.0	60.6	74.0	74.0	74.0	12.0	147368
19	60.5	61.2	60.0	75.1	74.0	74.5	14.0	172466
20	60.0	61.0	59.0	76.0	73.2	75.0	15.0	184786
21	59.0	60.0	58.8	74.5	73.0	74.0	15.0	184786
22	59.0	61.0	58.4	75.0	72.8	73.5	14.5	178626
23	59.0	60.3	58.2	74.0	73.0	73.8	14.8	182322
24	59.0	60.2	58.1	74.0	73.0	73.8	14.8	182322
25	59.0	60.0	58.0	72.5	72.0	73.0	14.0	172466
26	58.5	59.5	57.8	73.5	71.2	72.5	14.0	170502
27	58.3	59.2	57.8	73.0	71.0	72.5	14.2	174300
28	57.3	58.0	56.9	71.9	71.0	71.3	14.0	171627
29	56.8	57.0	56.5	72.2	71.0	71.5	14.7	180208
30	56.8	56.0	56.1	71.0	70.0	70.2	13.4	164271
31	56.5	57.0	56.1	70.0	70.0	70.0	13.5	165497

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

No.

DATE November, 1974

LOCATION

PREPARED BY

SUBJECT

Total Heat Release to River

Date	Intake - °F Min. T	Max. T	Avg. T	Effluent - °F Min. T	Max. T	Avg. T	Avg. ΔT	Total BTU Release	x10^6
1	56.0	57.8	56.1		NA		NA		NA
2	56.0	57.0	56.7	68.5	7.15	70.0	13.3	147	060
3	56.0	58.0	56.5	68.5	72.5	70.5	14.0	125	361
4	56.0	70.0	56.8	64.1	65.4	65.0	14.0	114	311
5	56.0	57.0	56.8	64.1	65.4	65.0	8.2	64	721
6	56.0	57.8	56.8	64.1	65.0	65.0	8.2	55	809
7	55.8	56.2	56.0	55.8	63.0	58.0	2.0	14	013
8	54.0	55.9	55.1	55.5	72.0	67.0	11.9	83	333
9	54.0	54.8	54.2	54.0	63.0	55.0	.8	2	559
10	53.5	54.0	53.5	53.0	53.5	53.5	0		
11	53.1	53.9	53.3	53.1	70.5	61.0	7.7	46	430
12	NA	NA		65.2	71.0	70.0	NA		NA
13	52.5	54.0	53.4	52.5	54.0	53.4	0		
14	52.0	52.9	52.6	52.0	67.9	64.0	11.4	98	292
15	51.0	52.8	51.9	63.8	67.0	66.0	14.1	122	417
16	50.1	51.8	51.0	63.0	64.9	63.5	12.5	108	526
17	50.0	51.1	50.4	63.0	65.0	63.5	13.1	109	995
18	50.0	51.0	50.4	58.0	64.0	62.2	11.8	110	856
19	49.6	50.4	50.3	62.0	69.0	65.8	15.5	112	075
20	49.7	50.1	49.8	69.0	70.8	70.5	20.7	117	197
21	49.6	50.0	49.7	70.2	70.9	70.5	20.6	116	631
22	48.4	49.0	48.2	70.3	70.9	70.6	22.4	126	822
23	47.8	48.4	48.1	71.0	72.8	72.4	24.3	115	252
24	47.8	48.3	48.0	71.5	725	722	24.2	127	870
25	46.5	47.6	47.0	60.0	64.5	60.1	13.1	113	091
26	47.1	47.4	47.2	58.2	58.9	58.5	11.3	105	617
27	45.8	46.5	46.0	56.2	58.1	57.6	11.6	108	087
28	45.5	46.2	45.8	50.0	56.6	57.5	11.7	109	019
29	44.8	45.4	45.2	57.0	56.3	57.2	12.0	111	325
30	43.8	45.1	45.0	56.8	57.2	57.1	12.1	110	656

2-2 (PAD) 5-73 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE December, 1974

LOCATION

PREPARED BY

SUBJECT

Total Heat Release to River

Date	Intake - °F Min. T	Max. T	Avg. T		Effluent - °F Min. T	Max. T	Avg. T	Avg. ΔT	Total BTU Release	x 10^6
1	NA	NA	41.2		NA	NA	62.3	21.1	206	908
2	NA	NA	41.2		NA	NA	62.1	20.9	103	490
3	NA	NA	40.9		NA	NA	60.8	19.9	165	613
4	40.0	40.8	40.0		58.5	61.0	59.7	19.3	146	266
5	39.9	40.9	40.5		59.5	61.8	60.7	20.2	141	504
6	40.2	41.2	40.9		62.0	63.0	62.6	21.7	142	590
7	40.5	41.1	40.8		62.8	63.0	62.9	22.1	145	218
8	40.2	41.5	41.0		62.8	62.8	62.8	21.8	143	247
9	40.6	41.0	40.5		62.8	66.9	64.5	24.0	136	774
10	40.0	40.9	40.5		65.0	67.0	66.1	25.6	125	226
11	38.0	39.6	38.7		65.0	66.5	66.0	27.3	134	655
12	37.2	40.0	38.5		NA	NA	NA	NA		NA
13	37.0	40.0	38.2		NA	NA	NA	NA		NA
14	35.8	39.9	37.3		62.8	64.1	63.1	25.8	126	204
15	35.8	38.2	37.7		37.0	65.5	54.5	17.8	87	071
16	36.0	39.5	37.1		55.8	64.0	60.5	23.4	114	464
17	36.0	39.4	37.0		56.0	65.0	61.4	24.4	128	692
18	35.5	35.5	35.5		57.0	60.5	57.9	22.4	150	817
19	NA	NA	NA		55.0	58.5	56.4	NA		NA
20	NA	NA	NA		54.5	58.0	55.3	NA		NA
21	35.5	38.5	37.2		55.1	56.8	56.3	19.1	120	533
22	35.0	37.4	35.9		54.9	57.5	55.6	19.7	124	320
23	34.9	37.0	35.5		53.0	57.9	55.3	19.8	124	951
24	35.2	37.0	36.0		55.0	57.9	56.2	20.2	127	475
25	35.4	37.0	36.0		52.4	59.0	56.5	20.5	129	368
26	35.0	37.0	35.8		50.4	58.0	54.2	18.4	116	116
27	35.0	36.2	35.6		49.0	52.0	50.4	14.8	99	984
28	35.0	36.0	35.6		48.0	56.9	52.6	17.0	136	258
29	35.0	37.0	35.9		50.5	67.0	55.7	19.8	153	190
30	35.2	36.8	36.0		53.0	6.20	57.8	21.8	137	572
31	37.5	39.0	38.3		NA	NA	NA	NA		NA
									3 468	506

2-2 (PAD) 5-73 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE

LOCATION

PREPARED BY

SUBJECT

January, 1975

Part D

Site Thermal Discharges

Date	Inlet Min.	Inlet Max.	Inlet Avg.	Outlet Min.	Outlet Max.	Outlet Avg.	
1	35.8	38.0	36.5	NA	NA	NA	Unit Off Line
2	34.0	36.2	35.7	NA	NA	NA	Unit Off Line
3	34.0	36.0	35.4	NA	NA	NA	Unit Off Line
4	34.5	36.0	35.5	NA	NA	NA	Unit Off Line
5	34.5	39.0	36.0	55.0	58.0	56.3	
6	34.7	37.0	35.8	NA	NA	NA	Unit Off Line
7	34.8	38.0	35.9	NA	NA	NA	
8	36.0	40.2	37.3	61.0	65.0	62.7	
9	35.8	39.0	37.0	62.0	65.0	63.3	
10	35.8	39.9	37.3	63.0	66.3	64.7	
11	35.8	39.8	37.4	63.0	65.0	64.0	
12	NA	NA	NA	55.0	58.8	58.6	
13	36.0	40.0	36.8	56.0	61.0	58.0	
14	34.0	39.0	35.6	56.0	61.0	57.8	
15	33.4	38.5	34.9	55.2	60.0	56.0	
16	33.0	38.0	34.3	48.0	60.5	55.7	
17	31.8	33.0	32.3	51.0	56.0	53.5	
18	32.0	35.5	33.3	52.0	58.5	55.3	
19	32.9	34.7	33.6	52.9	57.9	55.4	
20	31.6	34.1	32.7	51.6	57.1	54.4	
21	31.0	33.8	32.0	50.5	56.8	53.7	
22	32.0	33.6	32.5	50.0	50.8	50.4	
23	32.0	34.2	32.4	48.0	54.8	52.7	
24	32.0	34.5	33.1	49.0	56.0	50.8	
25	32.0	36.0	34.1	54.0	58.5	55.8	
26	32.5	35.0	33.4	53.2	56.0	54.3	
27	32.8	34.5	33.4	52.2	56.0	54.2	
28	33.0	35.8	34.1	54.1	57.6	55.2	
29	33.0	33.8	33.5	54.1	55.0	54.7	
30	32.0	35.0	34.0	55.0	57.0	56.0	
31	32.0	35.0	34.0	55.0	56.0	56.0	

NA - Charts out of service

2-2 (PAD) 5-73 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE January, 1975

LOCATION

PREPARED BY

SUBJECT

Part E

AVERAGE ΔT ACROSS CONDENSER AND TOTAL RELEASED HEAT TO RIVER

Date	Average ΔT °F	Total BTU Release x 10^3		
1	NA		NA	
2	NA		NA	
3	NA		NA	
4	NA		NA	
5	20.3	99	300	333
6	NA		NA	
7	NA		NA	
8	25.4	122	724	316
9	26.3	127	072	816
10	27.4	132	387	648
11	26.6	128	713	782
12	21.5	116	388	831
13	21.2	125	063	867
14	22.2	130	963	106
15	22.1	130	373	182
16	21.4	126	243	715
17	21.2	125	063	867
18	22.0	129	783	258
19	21.8	128	603	410
20	21.7	128	013	486
21	21.7	128	013	486
22	17.9	105	596	378
23	20.3	119	754	552
24	17.7	104	437	770
25	21.7	128	013	486
26	20.9	123	294	095
27	20.8	122	704	171
28	21.1	124	473	943
29	21.2	125	063	867
30	22.0	129	783	258
31	22.0	108	091	148

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE

LOCATION

PREPARED BY

SUBJECT

February, 1975

Part D

Site Thermal Discharges

Date		Inlet Min.	Inlet Max.	Inlet Avg.		Outlet Min.	Outlet Max.	Outlet Avg.			
1		33.5	34.2	33.8		33.5	35.2	34.7			
2		32.2	34.0	33.2		32.8	35.4	33.9			
3		33.9	34.0	34.0		34.9	35.5	35.2			
4		32.8	34.0	33.3		37.8	56.0	48.1			
5		32.5	35.0	33.4		53.5	56.0	54.7			
6		32.5	35.0	33.7		50.0	56.0	54.0			
7		33.0	34.0	33.9		54.0	57.0	55.1			
8		33.8	36.0	34.4		54.0	56.5	55.2			
9		33.0	37.0	34.3		54.5	59.0	55.3			
10		33.0	35.8	33.2		54.4	56.5	55.3			
11		32.5	36.0	34.1		53.5	57.0	55.1			
12		33.2	36.2	34.5		35.5	56.8	53.1			
13		32.5	36.0	34.0		54.0	59.0	56.0			
14		32.2	35.8	33.4		53.6	57.2	55.3			
15		32.1	34.0	33.1		54.2	56.8	55.1			
16		32.5	35.0	33.8		47.6	52.4	49.8			
17		33.5	36.0	34.1		53.6	58.7	55.4			
18		33.8	36.0	34.7		55.0	57.2	55.5			
19		32.2	34.0	33.1		54.0	56.0	54.8			
20		32.0	34.8	33.4		53.5	55.5	55.4			
21		32.3	34.5	33.5		54.1	59.6	56.5			
22		32.2	35.0	33.5		55.0	59.0	56.0			
23		34.0	35.3	34.6		55.9	58.4	57.2			
24		34.0	37.1	35.2		54.5	59.4	56.5			
25		33.0	36.0	34.4		55.6	58.5	56.7			
26		33.1	35.8	34.1		54.9	57.0	56.1			
27		32.5	36.0	34.1		55.0	58.0	56.1			
28		33.8	34.2	34.0		56.0	58.5	56.8			

2-2 (PAD) 5-73 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE February, 1975

LOCATION

PREPARED BY

SUBJECT

Part E

Date	Average ΔT °F	Total BTU Release x 10^3		
1	0.9	2	588	804
2	0.7	2	159	616
3	1.2	7	079	087
4	14.8	85	924	020
5	21.3	126	931	220
6	20.3	120	972	065
7	21.2	126	336	358
8	20.8	128	951	672
9	21.0	125	143	515
10	21.5	128	123	123
11	21.0	125	143	515
12	18.6	110	841	399
13	22.0	131	102	730
14	21.9	130	506	809
15	22.0	131	102	730
16	16.0	95	347	440
17	21.3	126	931	280
18	20.8	123	951	672
19	21.7	129	314	966
20	22.0	131	102	730
21	23.0	137	061	945
22	22.5	134	082	338
23	22.6	134	678	259
24	19.3	115	012	850
25	22.3	132	840	495
26	22.0	131	102	730
27	22.0	131	102	730
28	22.8	135	870	102

2-2 (PAD) 12/75 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

_____ NO. _____

DATE _____

LOCATION _____

PREPARED BY _____

SUBJECT

Part D

March, 1975

Site Thermal Discharges

Date	Inlet Min.	Inlet Max.	Inlet Avg.	Outlet Min.	Outlet Max.	Outlet Avg.
1	34.0	35.0	34.3	34.5	36.3	35.4
2	34.0	36.0	34.9	34.4	37.0	35.6
3	33.8	36.0	35.1	34.3	37.0	35.9
4	33.0	37.0	34.9	34.3	37.0	35.6
5	34.0	36.8	35.3	34.5	37.8	36.0
6	35.0	36.5	35.7	35.4	37.5	36.3
7	35.5	36.0	35.9	35.7	37.0	36.5
8	35.0	36.9	35.9	35.2	37.9	36.5
9	34.8	36.0	35.5	35.0	37.0	36.3
10	35.2	36.0	35.8	35.4	36.9	36.5
11	34.8	36.4	35.7	35.0	37.2	36.3
12	35.0	36.4	36.0	35.2	37.2	36.6
13	36.0	37.0	36.3	36.4	38.4	37.0
14	36.0	36.1	36.0	36.5	37.3	36.9
15	36.2	38.0	36.6	37.1	39.0	37.5
16	36.4	37.8	37.0	37.4	38.8	38.0
17	37.0	37.0	37.0	37.4	38.0	37.5
18	37.8	38.0	37.9	38.6	40.2	38.9
19	38.0	38.4	38.1	38.8	39.4	39.0
20	38.0	39.5	38.6	38.9	41.0	39.7
21	39.0	39.8	39.3	40.0	40.9	40.3
22	38.0	39.8	38.8	38.8	40.6	39.7
23	38.0	39.8	38.7	*	*	*
24	38.5	39.0	38.6	39.3	39.5	39.5
25	38.0	38.0	38.0	38.5	39.2	38.9
26	38.2	38.2	38.2	39.2	39.2	39.2
27	38.2	38.2	38.2	38.7	39.7	39.0
28	38.0	38.5	38.1	39.0	39.4	39.0
29	38.2	39.8	39.3	39.2	40.7	40.3
30	39.0	40.0	39.4	40.0	41.4	40.5
31	39.0	40.0	39.5	40.0	41.2	40.7

* - Not Available

2-2 (PAD) 8/74 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE March, 1975

LOCATION

PREPARED BY

SUBJECT

Part E

Date	Average ΔT °F	BTU Release x 10^3	Total	
1	1.1	6	555	137
2	.7	4	194	961
3	.8	4	671	410
4	.7	3	000	020
5	.7	2	676	849
6	.6	2	294	442
7	.6	2	294	442
8	.6	2	294	442
9	.8	3	059	256
10	.7	2	676	849
11	.6	2	295	161
12	.6	2	431	187
13	.7	1	971	531
14	.9	2	904	038
15	.9	2	534	826
16	1.0	2	824	870
17	.5	1	407	637
18	1.0	2	870	451
19	.9	3	513	993
20	1.1	4	358	215
21	1.0	3	926	028
22	.9	3	495	641
23	NA		NA	
24	.9	3	475	130
25	.9	3	511	835
26	1.0	3	935	625
27	.8	3	160	015
28	.9	3	569	052
29	1.0	3	861	255
30	1.1	4	217	033
31	1.2	4	692	522

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE April, 1975

LOCATION

PREPARED BY

SUBJECT

Part D

Site Thermal Discharges

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	39.0	39.0	39.0	39.4	40.0	39.6
2	39.0	40.2	39.7	40.0	41.0	40.7
3	39.0	40.0	39.6	40.0	41.6	40.5
4	39.0	40.0	39.8	40.2	55.2	45.0
5	40.0	40.0	40.0	41.0	45.0	42.2
6	38.0	40.0	39.5	40.6	54.0	48.1
7	38.0	39.5	38.7	39.0	56.0	46.5
8	38.5	40.0	39.5	55.8	64.4	60.5
9	38.0	41.0	39.2	53.5	63.0	56.4
10	39.0	40.0	39.5	55.5	58.0	56.9
11	40.0	40.0	40.0	56.0	58.0	57.2
12	39.0	41.0	39.9	56.8	58.6	57.5
13	40.0	42.0	40.7	50.9	62.6	57.4
14	40.0	42.0	41.3	54.2	61.0	57.1
15	41.0	42.0	41.4	41.5	56.8	49.4
16	41.0	43.0	41.8	41.8	65.4	54.3
17	42.0	48.0	44.4	63.8	66.2	64.8
18	42.5	51.0	45.4	59.0	67.5	63.0
19	43.8	53.0	44.9	59.0	68.0	63.3
20	44.0	45.5	44.8	46.0	64.0	58.3
21	44.0	46.0	44.9	58.5	62.0	60.7
22	43.8	47.0	44.7	59.0	66.6	62.5
23	44.0	47.0	45.4	64.8	68.0	66.5
24	43.0	44.0	43.5	62.0	64.0	63.0
25	44.0	44.0	44.0	63.0	64.0	63.5
26	45.5	48.0	47.1	63.0	68.2	66.2
27	46.0	48.0	46.9	61.0	67.8	64.8
28	47.0	48.0	47.8	66.4	68.0	67.1
29	48.0	48.0	48.0	61.8	68.1	65.1
30	48.0	49.0	48.2	67.8	69.5	68.4

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE April, 1975

LOCATION

PREPARED BY

SUBJECT

Part E

Date	Average ΔT °F	Total BTU Release x 10^3
1	.6	2 330 428
2	1.0	3 885 246
3	.9	3 456 777
4	5.2	31 640 093
5	2.2	14 321 547
6	8.6	55 994 548
7	7.8	50 972 953
8	21.0	128 796 066
9	17.2	98 495 938
10	17.4	137 064 272
11	17.2	135 096 660
12	17.6	138 238 443
13	16.7	131 160 432
14	15.8	124 100 421
15	8.0	62 835 656
16	12.5	97 176 113
17	20.4	157 637 083
18	17.6	151 246 274
19	18.4	163 245 720
20	13.5	122 423 009
21	15.8	164 127 919
22	17.8	185 714 965
23	21.1	221 511 788
24	19.5	189 043 160
25	19.5	171 663 902
26	19.1	175 199 143
27	17.9	158 029 559
28	19.3	170 389 413
29	17.1	150 966 786
30	20.2	178 335 033

2-2 (PAD) 12/75 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE May, 1975

LOCATION

PREPARED BY

SUBJECT

Part D Site Thermal Discharges

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	49.0	50.0	49.3	67.0	69.4	68.5
2	49.5	50.2	50.1	50.0	69.5	59.2
3	51.0	51.5	51.3	51.2	52.8	52.5
4	51.0	51.0	51.0	51.0	66.5	56.0
5	51.0	52.0	52.0	64.5	70.5	67.9
6	51.0	52.0	52.0	71.5	76.0	74.8
7	51.5	54.0	52.5	66.4	76.0	70.5
8	52.2	54.0	53.3	66.8	70.4	68.4
9	53.0	55.0	53.8	67.6	70.5	68.9
10	53.0	55.0	54.0	68.0	69.5	68.6
11	53.8	55.0	54.3	68.2	70.2	69.1
12	54.0	55.0	54.9	69.2	70.8	69.6
13	54.5	56.0	55.4	69.0	71.5	70.4
14	55.5	56.0	55.8	68.5	71.9	70.5
15	55.8	57.5	56.4	71.0	72.0	71.5
16	56.0	57.5	56.7	71.4	73.5	72.2
17	56.0	57.2	56.6	67.0	72.8	71.5
18	57.0	57.5	57.1	57.0	73.0	64.7
19	57.8	59.0	58.2	62.0	70.1	67.5
20	58.8	61.0	59.4	69.0	79.5	74.3
21	59.8	61.5	60.8	79.0	80.5	79.6
22	62.0	63.0	62.2	78.8	80.5	79.8
23	62.5	63.5	63.1	80.0	82.2	80.9
24	61.6	64.0	63.2	81.0	83.2	81.8
25	62.5	64.5	63.9	80.0	82.5	81.7
26	63.8	64.4	64.0	81.0	85.0	82.3
27	64.2	66.6	65.6	82.5	85.5	83.7
28	64.5	67.5	66.5	83.8	87.0	84.6
29	67.0	67.8	67.2	84.5	87.5	85.3
30	67.0	68.0	67.6	84.4	87.5	85.5
31	67.0	68.0	67.5	78.8	81.8	80.0

2-2 (PAD) 8/74 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE May, 1975

LOCATION

PREPARED BY

SUBJECT

Part E

Date	Average ΔT °F	BTU Release x 10^3	Total	
1	19.2	168	884	736
2	9.1	79	815	099
3	1.2	4	223	769
4	5.0	39	830	006
5	15.9	143	004	616
6	22.8	204	707	680
7	18.0	163	743	947
8	15.1	157	743	947
9	15.1	158	359	785
10	14.6	153	413	807
11	14.8	155	515	366
12	14.7	154	464	587
13	15.0	155	835	645
14	14.7	152	701	292
15	15.1	156	856	429
16	15.5	161	011	567
17	14.9	154	778	861
18	7.6	78	911	142
19	9.3	96	606	949
20	14.9	145	324	125
21	18.8	164	554	464
22	17.6	154	008	765
23	17.8	155	780	224
24	18.6	162	759	263
25	17.8	155	758	864
26	18.3	160	704	854
27	18.1	159	469	579
28	18.1	159	469	579
29	18.1	159	469	579
30	17.9	188	733	680
31	12.5	152	114	125

2-2 (PAD) 12/75 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE June, 1975

LOCATION

PREPARED BY

SUBJECT

Part D Site Thermal Discharges

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	68.0	69.8	69.0	74.0	81.8	78.6
2	69.0	70.0	69.8	67.0	81.8	76.0
3	68.0	69.8	69.1	67.0	83.8	73.2
4	68.0	70.0	69.0	80.0	84.6	82.1
5	68.0	69.5	68.8	80.3	84.0	82.1
6	68.0	70.0	68.8	80.8	83.5	81.9
7	67.5	70.2	68.6	80.0	83.8	81.6
8	68.0	70.0	68.4	81.0	82.5	81.4
9	67.8	70.0	68.7	80.8	83.0	81.9
10	67.8	70.0	68.9	79.0	84.5	82.2
11	68.0	70.0	68.8	80.0	84.2	82.4
12	68.2	69.8	69.0	82.0	83.4	82.6
13	68.2	69.8	68.9	82.2	86.6	83.9
14	69.0	70.0	69.7	84.6	86.4	85.7
15	70.0	70.8	70.2	84.0	85.0	84.5
16	69.0	70.5	70.0	80.5	85.5	84.8
17	69.0	72.0	69.9	81.0	89.0	84.6
18	70.0	72.0	71.3	84.0	85.0	84.5
19	72.0	72.0	72.0	84.0	85.0	84.5
20	71.0	73.0	72.0	82.0	86.0	84.0
21	71.5	73.0	72.1	84.0	86.0	85.0
22	71.5	73.0	72.3	84.0	86.0	85.0
23	72.5	73.0	72.8	85.0	87.0	85.7
24	72.5	75.0	73.8	86.0	90.0	87.2
25	73.5	75.0	74.6	87.0	90.0	88.5
26	74.0	75.0	74.8	86.0	88.0	86.3
27	74.0	75.0	74.6	79.0	87.0	84.9
28	73.5	75.0	74.3	82.0	86.0	84.0
29	74.0	75.0	74.5	83.0	85.0	84.0
30	75.0	75.0	75.0	85.0	85.0	85.0

2-2 (PAD) 11-71 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE June, 1975

LOCATION

PREPARED BY

SUBJECT

Part E

Date	Average ΔT °F	Total BTU Released x 10^3		
1	9.6	116	823	648
2	6.2	57	964	160
3	4.1	46	990	338
4	13.1	157	938	513
5	13.4	158	212	125
6	13.1	158	787	065
7	13.0	157	392	950
8	13.0	157	434	602
9	13.2	159	814	380
10	13.3	171	038	718
11	13.6	165	875	392
12	13.6	165	500	168
13	14.0	173	277	255
14	16.0	173	632	928
15	14.3	174	018	559
16	14.8	183	050	115
17	14.7	183	400	258
18	13.2	160	790	850
19	12.5	157	246	075
20	12.0	146	619	720
21	12.9	156	981	777
22	12.7	155	248	712
23	12.9	157	043	671
24	13.4	156	022	687
25	13.9	160	630	833
26	11.5	139	517	368
27	10.3	124	304	221
28	9.7	117	516	974
29	9.5	115	093	944
30	10.0	121	739	280

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE July, 1975

LOCATION Indian Point

PREPARED BY

SUBJECT

Part D Site Thermal Discharges

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	76.0	79.0	76.9	86.0	92.0	88.0
2	76.0	79.0	76.8	88.0	92.9	90.0
3	76.0	79.0	77.8	88.0	91.9	89.2
4	78.0	79.0	78.9	88.0	92.0	89.7
5	79.0	79.0	79.0	86.0	90.2	88.2
6	78.0	80.0	78.9	83.5	90.5	88.4
7	77.0	79.0	77.8	85.0	88.5	87.2
8	78.0	79.0	78.1	88.0	95.5	90.4
9	77.0	79.0	77.9	88.0	92.0	89.9
10	76.8	78.0	77.5	85.5	90.6	88.1
11	76.8	77.5	77.3	86.0	90.4	88.9
12	76.8	78.2	77.3	85.5	90.0	88.0
13	76.8	77.2	77.0	76.0	89.2	82.7
14	76.5	77.0	76.9	76.0	90.0	84.6
15	78.8	79.0	78.9	76.2	91.5	80.2
16	78.2	80.2	79.1	88.2	93.8	91.2
17	77.0	80.0	79.1	88.5	94.8	91.5
18	77.0	79.0	78.5	87.0	93.8	90.9
19	76.8	78.0	77.7	91.0	93.5	92.4
20	77.0	78.5	77.9	80.8	96.0	92.4
21	78.2	79.8	78.4	80.8	93.0	88.3
22	77.8	80.0	78.5	89.9	94.2	92.2
23	77.0	80.5	79.0	91.6	93.9	92.4
24	78.5	81.0	79.6	92.4	94.8	93.4
25	78.0	79.4	78.8	92.0	94.5	93.1
26	78.0	80.0	78.6	91.8	93.5	92.5
27	77.5	80.0	78.6	91.8	93.8	92.5
28	77.5	80.2	79.1	91.5	94.0	92.8
29	78.5	79.0	78.7	79.0	79.0	79.0
30	79.0	79.0	79.0	79.0	79.5	79.3
31	79.0	81.0	80.1	79.0	82.5	80.7

2-2 (PAD) 11-71 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE July, 1975

LOCATION

PREPARED BY

SUBJECT

Part E

Date	Average ΔT °F	Total BTU Released x 10^3		
1	11.1	135	157	230
2	13.2	150	938	146
3	11.4	139	056	277
4	10.8	114	585	043
5	9.2	96	969	674
6	9.5	105	772	468
7	9.4	114	953	596
8	12.3	145	608	163
9	12.0	146	087	136
10	10.6	125	307	024
11	11.6	143	916	978
12	10.7	132	507	142
13	5.7	70	366	848
14	7.7	95	096	987
15	1.3	13	947	059
16	12.1	129	248	885
17	12.4	137	986	543
18	12.4	153	053	956
19	14.7	181	390	091
20	14.5	167	981	978
21	9.9	114	584	263
22	13.7	179	469	425
23	13.4	165	702	417
24	13.8	170	417	014
25	14.3	176	763	072
26	13.9	171	568	548
27	13.9	171	568	548
28	13.7	168	327	571
29	0.3	2	293	362
30	0.3	1	292	243
31	0.6	2	411	035

2-2 (PAD) 12/75 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE September, 1975

LOCATION

PREPARED BY

SUBJECT

Part D Site Thermal Discharges

DATE		Inlet MIN.	Inlet MAX.	Inlet AVG.		Outlet MIN.	Outlet MAX.	Outlet AVG.			
1		78.5	79.8	79.0		91.0	92.6	91.8			
2		78.5	79.0	78.6		90.0	94.0	91.6			
3		78.0	78.8	78.3		92.0	96.0	93.5			
4		78.0	78.5	78.1		87.0	95.0	91.7			
5		74.3	78.0	76.0		85.0	92.0	88.9			
6		74.6	75.5	74.9		84.8	85.5	85.2			
7		74.0	75.0	74.5		74.0	86.0	84.8			
8		74.2	75.0	74.6		85.0	93.5	88.8			
9		74.0	75.4	74.6		84.0	86.4	84.9			
10		73.5	74.2	73.9		83.2	85.0	84.0			
11		73.0	74.9	73.8		83.5	90.1	85.5			
12		73.5	74.9	73.9		84.5	88.0	87.2			
13		72.6	73.5	73.1		78.0	83.0	81.3			
14		71.8	72.5	72.1		78.0	87.5	80.5			
15		71.5	72.0	71.6		82.0	92.0	86.9			
16		71.0	72.0	71.4		82.0	84.0	82.6			
17		71.1	72.0	71.5		74.0	88.5	80.0			
18		71.0	72.0	71.5		76.0	78.0	76.6			
19		71.0	72.0	71.4		74.0	84.0	80.1			
20		71.1	72.0	71.3		79.0	80.0	80.0			
21		71.0	72.0	71.4		77.0	86.8	84.1			
22		70.0	72.0	71.1		81.0	86.5	84.6			
23		70.0	72.0	71.1		81.8	83.0	82.0			
24		69.8	71.0	70.3		80.5	82.0	81.3			
25		69.0	70.5	69.9		79.5	84.0	81.0			
26		69.2	70.0	69.6		80.0	82.0	81.2			
27		67.5	69.1	68.4		79.0	81.8	80.4			
28		66.5	67.6	67.0		65.1	80.0	69.9			
29		66.0	66.6	66.1		64.8	82.0	76.6			
30		65.9	66.2	66.1		81.5	82.0	81.9			

2-2 PAD 11/74 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE September, 1975

LOCATION

PREPARED BY

SUBJECT

Part E

Date	Average ΔT °F	BTU Released	Total x 10^3
1	12.8	156 547	917
2	13.0	151 165	911
3	15.6	160 356	626
4	13.6	143 476	981
5	12.9	136 092	136
6	10.3	108 662	713
7	10.3	108 662	713
8	14.2	121 310	330
9	10.3	124 353	641
10	10.1	122 908	213
11	11.7	136 077	388
12	13.3	150 490	458
13	8.2	31 131	144
14	8.4	45 777	042
15	15.3	162 127	363
16	11.2	137 288	423
17	8.5	103 254	082
18	5.1	62 368	443
19	8.7	89 101	065
20	8.7	91 261	281
21	12.7	119 753	719
22	13.5	124 366	234
23	11.1	116 530	009
24	11.0	115 387	826
25	11.1	116 436	807
26	11.6	121 681	702
27	12.0	125 877	624
28	2.9	20 951	656
29	10.5	91 880	233
30	15.8	138 257	875

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE

LOCATION

PREPARED BY

SUBJECT

October, 1975

Part D

Site Thermal Discharges

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	66.0	67.0	66.2	77.5	83.0	80.8
2	65.0	66.5	65.8	75.0	81.0	79.1
3	64.0	65.0	64.5	73.5	74.8	74.0
4	63.9	64.5	64.2	62.8	75.0	71.9
5	63.8	64.3	64.0	62.7	73.5	69.6
6	63.9	64.8	64.3	73.2	75.0	73.8
7	63.9	64.8	64.2	73.2	74.0	73.7
8	64.0	65.2	64.4	78.0	81.0	78.8
9	64.0	64.5	64.2	78.0	82.5	80.5
10	63.9	64.3	64.0	77.0	83.0	78.8
11	63.8	64.0	64.0	62.4	78.0	70.4
12	63.7	64.0	63.9	72.0	78.0	76.0
13	63.6	64.5	64.0	76.0	78.0	76.9
14	62.6	63.5	63.0	76.0	79.0	78.1
15	62.6	63.3	63.1	78.0	79.8	79.1
16	62.4	64.2	63.0	NA	NA	NA
17	62.2	62.8	62.4	62.0	63.4	62.4
18	62.1	62.2	62.1	61.0	62.5	61.9
19	61.0	62.0	61.6	60.5	61.8	61.0
20	59.0	61.0	60.1	59.0	60.8	59.7
21	58.0	59.0	58.3	57.2	59.1	58.5
22	57.8	59.5	58.4	57.4	59.0	58.1
23	58.2	59.0	58.6	57.0	58.8	57.8
24	57.9	58.8	58.1	57.0	58.2	57.6
25	57.8	57.9	57.9	57.0	57.8	57.3
26	57.0	57.9	57.6	56.6	59.0	57.1
27	56.5	57.0	56.6	56.0	57.6	56.5
28	56.5	56.5	56.5	56.2	57.5	56.7
29	56.5	56.5	56.5	56.0	57.4	56.5
30	55.0	56.6	55.7	54.0	57.0	55.2
31	54.0	54.5	54.2	63.2	68.9	65.0

NA - Not available, charts out of service

2-2 PAD 11/74 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE October, 1975

LOCATION

PREPARED BY

SUBJECT

Part E

Date	Average ΔT °F	BTU Released	Total x 10^3
1	14.6	146 095	379
2	13.3	140 647	077
3	9.5	101 248	484
4	7.7	83 172	918
5	5.6	60 489	397
6	9.5	102 615	941
7	9.5	102 615	941
8	14.4	155 544	163
9	16.3	136 067	351
10	14.8	159 864	834
11	6.4	69 115	386
12	12.1	130 700	304
13	12.9	139 341	646
14	15.1	145 173	710
15	16.0	144 038	368
16	NA	NA	
17	0	0	
18	0.8	1 803	118
19	0	0	
20	0	0	
21	0.2	454	858
22	0	0	
23	0	0	
24	0	0	
25	0	0	
26	0	0	
27	0	0	
28	0.2	457	017
29	0	0	
30	0	0	
31	10.8	90 178	477

2

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE November, 1975

LOCATION Indian Point Station

PREPARED BY

SUBJECT

Part D Site Thermal Discharges

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG
1	53.6	54.6	54.1	68.5	70.5	70.0
2	53.9	54.5	54.2	70.3	71.0	70.6
3	54.0	54.6	54.4	70.1	80.9	74.0
4	54.0	58.0	55.0	66.1	81.8	74.9
5	54.0	56.0	54.9	67.0	76.0	68.7
6	53.9	54.6	54.2	67.5	68.0	67.8
7	54.0	55.0	54.5	52.5	68.0	63.9
8	54.1	56.0	54.9	51.5	53.0	52.4
9	54.5	55.0	54.8	50.0	51.5	50.6
10	54.8	55.5	55.2	50.0	64.1	60.0
11	54.8	55.4	54.9	63.9	65.0	64.3
12	51.0	51.5	51.4	62.5	64.8	64.1
13	51.0	51.8	51.4	61.5	68.0	63.6
14	51.5	52.0	51.6	61.8	68.5	65.6
15	50.8	52.0	51.8	56.2	67.8	62.5
16	50.0	51.0	50.7	63.5	68.0	65.1
17	50.0	51.5	50.5	66.5	69.8	67.0
18	49.8	51.0	50.3	66.6	67.5	67.0
19	46.5	49.8	48.0	65.4	69.0	66.0
20	46.0	48.9	47.1	65.2	66.2	65.9
21	45.0	46.0	45.9	65.2	65.5	65.4
22	44.8	45.0	45.0	56.8	60.0	57.8
23	45.0	45.0	45.0	68.0	69.0	68.5
24	45.0	45.2	45.1	68.5	69.5	69.0
25	45.0	45.0	45.0	68.5	68.5	68.5
26	44.0	44.0	44.0	68.0	68.0	68.0
27	NA	NA	NA	NA	NA	NA
28	44.0	44.0	44.0	55.0	61.0	58.6
29	44.0	44.0	44.0	61.0	62.0	61.5
30	44.0	47.5	45.9	60.0	65.5	63.7

N.A. - Not available, charts out of service

2-2 PAD 11/74 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE November, 1975

LOCATION

PREPARED BY

SUBJECT

Part E

Date	Average ΔT °F	BTU Released	Total x 10^3
1	15.9	142	154 510
2	16.4	146	655 721
3	19.6	152	731 471
4	19.8	71	560 249
5	13.8	72	619 657
6	13.6	111	013 182
7	9.4	84	442 127
8	0	0	
9	0	0	
10	4.5	40	240 899
11	9.4	84	058 767
12	12.7	113	568 759
13	12.2	109	097 548
14	13.9	83	033 179
15	11.1	24	818 546
16	14.4	69	990 552
17	16.5	147	549 963
18	16.7	149	358 471
19	18.1	161	922 962
20	18.8	154	293 781
21	19.5	156	857 630
22	12.8	114	463 002
23	23.5	210	146 917
24	23.9	213	723 886
25	23.5	210	146 917
26	24.0	214	618 128
27	18.0	160	963 596
28	14.6	131	453 603
29	17.5	156	492 305
30	17.8	159	175 112

2-2 (PAD) 12/75 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE December 1975

LOCATION Indian Point Station

PREPARED BY

SUBJECT

Part D Site Thermal Discharges (°F)

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	45.8	49.0	46.8	63.5	66.4	65.2
2	44.2	46.0	44.9	56.0	64.8	60.9
3	44.0	46.0	44.8	55.5	65.0	62.6
4	43.0	45.0	43.9	55.0	64.5	61.6
5	42.0	44.0	43.2	59.8	63.0	62.0
6	41.5	44.0	43.3	62.0	64.0	62.8
7	42.0	45.0	43.1	61.0	64.0	62.2
8	40.0	44.0	41.9	59.0	62.4	60.9
9	41.0	43.0	41.7	58.2	61.5	60.2
10	41.0	43.0	42.4	56.8	60.0	58.6
11	40.0	43.0	40.8	58.2	61.0	59.6
12	40.4	42.8	41.3	58.0	58.0	58.0
13	40.1	43.0	41.0	50.0	62.0	56.2
14	40.3	43.2	41.7	57.0	62.0	59.2
15	40.5	43.0	41.9	57.8	60.0	58.8
16	40.0	42.5	41.2	56.9	59.2	58.0
17	37.0	42.0	40.6	56.0	62.4	59.4
18	38.5	40.5	39.8	57.0	62.0	60.1
19	37.5	39.0	38.2	55.0	60.0	57.1
20	37.0	40.0	38.1	53.2	56.0	53.3
21	36.5	39.0	37.6	53.0	57.0	54.2
22	35.5	39.0	36.9	51.2	58.2	55.0
23	35.2	39.0	36.2	34.4	57.0	37.8
24	32.0	36.5	33.9	34.4	47.0	43.8
25	32.0	37.0	33.9	50.2	54.0	51.7
26	32.4	36.4	34.3	46.0	54.0	50.3
27	31.8	36.4	33.3	32.0	52.0	48.7
28	30.8	34.0	32.1	38.3	45.0	40.9
29	31.0	35.0	32.5	44.0	51.0	46.0
30	32.0	35.8	33.4	41.0	49.8	44.9
31	32.0	36.0	33.4	46.0	52.0	49.2

2-2 PAD 11 '74 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE December, 1975

LOCATION

PREPARED BY

SUBJECT

Part E

Date	Average ΔT °F	Total BTU Released x 10^3
1	18.4	164 739 193
2	16.0	143 078 746
3	17.8	159 175 112
4	17.7	158 280 869
5	18.8	168 117 534
6	19.5	174 377 229
7	19.1	170 800 260
8	19.0	169 906 018
9	18.5	169 185 099
10	16.2	160 218 687
11	18.8	175 311 287
12	16.7	149 338 447
13	15.2	135 924 814
14	17.5	167 470 985
15	16.9	168 155 311
16	16.8	167 160 302
17	18.8	176 326 081
18	20.3	163 925 923
19	18.9	156 588 100
20	16.2	143 409 813
21	16.4	144 039 321
22	18.1	142 578 186
23	1.6	9 903 237
24	9.9	72 284 635
25	17.8	142 264 751
26	16.0	126 381 427
27	15.4	121 642 121
28	8.8	69 509 783
29	13.5	106 634 327
30	11.5	70 836 649
31	15.0	124 801 656

2-2 (PAD) 12/75 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE January, 1976

LOCATION

PREPARED BY

SUBJECT

Site Thermal Discharges °F

Date		Inlet MIN.	Inlet MAX.	Inlet AVG.		Outlet MIN.	Outlet MAX.	Outlet AVG.			
1		32.0	34.5	33.0		47.0	51.5	48.1			
2		31.8	34.2	32.7		44.8	47.8	46.1			
3		32.0	34.0	33.1		48.6	48.6	48.6			
4		32.5	34.0	32.9		33.0	33.0	33.0			
5		32.0	33.2	32.6		33.0	33.0	33.0			
6		32.9	32.9	32.9		33.0	33.0	33.0			
7		32.9	32.9	32.9		48.4	48.4	48.4			
8		32.9	32.9	32.9		48.4	48.4	48.4			
9		31.5	32.0	31.9		43.5	45.0	44.4			
10		31.5	31.5	31.5		43.5	44.5	44.0			
11		31.5	32.5	31.8		43.5	47.0	45.2			
12		31.5	32.0	31.9		45.0	47.2	46.4			
13		31.5	34.0	32.3		46.5	52.0	48.1			
14		31.5	35.0	32.0		45.5	52.5	47.5			
15		31.5	33.5	32.0		46.0	52.4	47.7			
16		31.5	32.0	31.9		46.0	48.8	47.2			
17		31.5	34.0	32.1		46.5	52.0	47.8			
18		31.5	32.0	31.8		46.5	48.8	47.1			
19		31.0	33.5	32.2		46.0	53.0	50.5			
20		31.0	34.0	32.1		45.0	50.0	46.2			
21		31.0	34.0	32.0		45.0	50.0	46.5			
22		31.0	36.0	31.8		44.5	53.5	47.8			
23		30.0	32.5	31.1		50.5	54.0	51.6			
24		30.5	36.0	32.5		46.5	54.5	51.3			
25		30.0	34.0	32.5		50.5	55.0	51.4			
26		31.5	34.0	32.6		32.0	52.5	39.6			
27		31.0	32.0	31.7		43.6	47.5	45.4			
28		30.5	32.0	31.6		43.5	51.0	50.2			
29		31.0	32.0	31.5		32.0	52.0	44.8			
30		30.0	33.0	31.0		30.0	33.0	31.0			
31		31.0	31.0	31.0		31.0	31.0	31.0			

2-2 (PAD) 1/75 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE January, 1976

LOCATION

PREPARED BY

SUBJECT

AVERAGE ΔT AND TOTAL HEAT
RELEASED TO RIVER (BTU'S)

Date	Average ΔT °F	Total BTU Release x 10^3		
1	15.1	119	707	168
2	13.4	106	648	131
3	15.5	146	639	517
4	0.1		876	849
5	0.4	2	113	554
6	0.1		736	505
7	15.5	147	531	961
8	15.5	148	052	559
9	12.5	117	208	088
10	12.5	118	197	700
11	13.4	127	543	759
12	14.5	138	013	770
13	15.8	150	387	418
14	15.3	145	628	322
15	15.7	149	435	599
16	15.3	145	628	322
17	15.7	150	132	396
18	15.3	146	380	776
19	18.3	164	326	808
20	14.1	140	599	701
21	14.5	144	588	345
22	16.0	155	342	640
23	20.5	179	041	035
24	18.8	155	488	991
25	18.9	156	316	060
26	7.0	57	852	857
27	13.7	113	850	768
28	18.6	150	198	143
29	13.3	97	396	831
30	0		0	
31	0		0	

2-2 (PAD) 5-72 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

NO.

DATA SHEET

DATE February, 1976

LOCATION

PREPARED BY

SUBJECT

Site Thermal Discharges °F

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	30.0	30.0	30.0	30.0	30.0	30.0
2	30.0	30.5	30.2	30.0	30.5	30.3
3	30.0	30.5	30.2	30.0	31.0	30.6
4	30.0	30.0	30.0	30.5	31.0	30.5
5	30.0	32.0	30.8	36.0	47.0	42.2
6	31.0	33.0	31.6	41.0	48.5	44.1
7	30.5	32.0	31.1	41.5	53.0	47.7
8	30.5	32.0	31.3	45.0	61.0	49.2
9	31.0	32.5	31.5	46.5	60.5	48.7
10	31.0	33.5	32.0	32.0	53.0	44.2
11	31.0	33.5	32.0	43.0	61.0	49.5
12	31.0	34.0	31.9	42.0	53.5	47.3
13	32.0	35.0	33.1	43.5	54.5	48.6
14	32.5	34.4	33.3	43.2	47.2	45.0
15	32.6	35.0	33.6	44.5	49.0	46.3
16	33.0	35.5	34.0	44.5	50.0	46.6
17	33.6	35.9	34.7	44.0	50.5	47.1
18	32.0	36.0	34.2	45.0	52.0	47.6
19	31.0	34.0	32.3	43.5	51.0	45.4
20	31.5	34.0	32.4	33.0	51.5	44.0
21	31.0	34.0	32.5	43.5	52.5	47.0
22	31.0	34.0	32.2	41.0	48.0	43.9
23	31.0	32.5	31.4	40.5	53.5	45.8
24	31.0	38.0	32.3	47.0	54.0	51.1
25	31.0	34.5	32.6	46.5	57.5	52.2
26	31.0	35.0	32.7	53.0	57 0	55.0
27	31.0	34.0	32.5	54.0	57.0	55.9
28	31.5	34.5	32.1	32.0	60.0	38.9
29	32.0	37.0	34.5	52.0	61.0	57.0

2-2 (PAD) 1/75 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE February, 1976

LOCATION

PREPARED BY

SUBJECT

AVERAGE ΔT AND TOTAL HEAT RELEASED TO RIVER (BUT'S)

Date	Average ΔT °F	Total BTU Release x 10^3		
1	0			0
2	.1		530	788
3	.4	2	123	150
4	.5	2	705	518
5	11.4	94	285	877
6	12.5	118	842	450
7	16.6	146	950	803
8	17.9	146	971	799
9	17.2	140	708	504
10	12.2	100	317	062
11	17.5	163	797	463
12	15.4	151	050	530
13	15.5	137	640	729
14	11.7	115	713	503
15	12.7	125	603	546
16	13.0	128	570	559
17	12.4	128	437	414
18	13.4	138	409	498
19	13.1	135	907	902
20	11.6	128	068	443
21	14.5	143	353	438
22	11.7	117	341	488
23	14.4	120	842	539
24	18.8	151	632	754
25	19.6	146	400	456
26	22.5	146	956	208
27	23.4	140	596	466
28	6.8	39	054	454
29	22.5	148	332	668

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE March, 1976

LOCATION

PREPARED BY

SUBJECT

Site Thermal Discharges oF

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	34.0	38.0	35.9	53.5	61.5	57.5
2	35.0	39.0	36.5	54.0	58.0	55.7
3	35.0	39.0	36.5	49.0	57.5	52.0
4	34.5	39.0	36.5	53.5	58.0	56.4
5	36.5	39.0	38.8	53.5	57.0	55.7
6	37.0	40.3	37.7	53.5	60.3	56.9
7	37.0	39.9	38.1	55.5	58.2	56.8
8	34.6	40.8	38.5	56.2	59.8	57.7
9	37.0	40.1	38.8	55.0	60.0	58.4
10	37.0	38.0	37.5	38.0	44.5	40.1
11	36.5	40.0	38.2	47.5	60.0	55.6
12	36.0	40.0	38.0	52.0	61.5	57.0
13	37.0	39.5	38.3	55.3	59.0	56.9
14	37.3	40.0	38.3	56.5	66.0	58.5
15	38.0	40.2	38.9	56.8	66.1	58.5
16	38.0	40.0	38.8	57.0	59.0	57.7
17	35.6	40.0	38.1	56.0	63.5	59.1
18	37.0	40.5	38.9	61.5	64.5	62.7
19	38.0	40.6	39.7	57.5	67.5	60.2
20	38.0	40.8	39.7	55.5	60.0	58.3
21	38.0	41.0	39.7	55.5	60.0	58.1
22	38.0	40.5	39.1	57.0	59.5	57.9
23	37.0	38.5	37.7	53.0	60.0	57.2
24	38.0	42.0	40.0	59.0	66.0	62.3
25	39.5	42.0	40.7	58.0	67.5	63.8
26	41.0	44.0	42.3	59.0	70.0	64.2
27	39.7	42.0	41.2	60.0	60.0	60.0
28	40.5	43.5	42.2	61.0	61.0	61.0
29	41.2	43.2	42.4	60.5	60.5	60.5
30	42.0	45.0	43.1	56.0	71.5	65.6
31	42.0	43.0	42.2	42.5	45.5	43.4

2-2 (PAD) 12/75 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE March, 1976

LOCATION

PREPARED BY

SUBJECT

AVERAGE ΔT AND TOTAL HEAT
RELEASED TO RIVER (BTU'S)

Date	Average ΔT °F	Total BTU Release x 10^3		
1	21.6	164	992	550
2	19.2	158	797	267
3	15.5	152	049	963
4	19.9	171	270	484
5	16.9	139	774	678
6	19.2	159	027	571
7	18.7	154	661	922
8	19.2	158	843	328
9	19.6	159	825	025
10	2.6	21	503	797
11	17.4	144	431	815
12	19.0	158	282	673
13	18.6	154	950	406
14	20.2	166	656	040
15	19.6	163	304	593
16	22.7	187	717	446
17	21.0	172	928	805
18	23.8	180	940	880
19	20.5	147	418	001
20	18.6	152	228	464
21	18.4	152	180	714
22	18.8	155	488	991
23	19.5	161	278	475
24	22.3	184	436	409
25	23.1	175	258	868
26	21.9	181	128	133
27	18.8	155	488	991
28	18.8	155	466	431
29	18.1	149	395	554
30	22.5	164	931	008
31	1.2	5	888	683

2-2 (PAD) 5-72 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE April, 1976

LOCATION Indian Point Sta.

PREPARED BY

SUBJECT

Site Thermal Discharges °F

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	42.0	42.0	42.0	43.0	43.0	43.0
2	42.0	42.0	42.0	43.0	43.0	43.0
3	42.0	42.0	42.0	43.0	43.0	43.0
4	42.0	42.0	42.0	43.0	43.0	43.0
5	42.0	42.0	42.0	43.0	43.0	43.0
6	42.0	42.0	42.0	43.0	43.0	43.0
7	42.0	42.5	42.5	44.5	44.5	44.5
8	42.0	42.5	42.3	44.0	44.6	44.3
9	42.0	42.5	42.4	44.1	44.1	44.1
10	42.0	43.0	42.2	43.6	44.1	43.9
11	42.0	42.0	42.0	44.0	44.0	44.0
12	43.0	43.5	43.2	43.2	43.7	43.4
13	42.0	42.5	42.2	43.2	45.6	44.0
14	42.0	45.8	43.2	44.0	47.9	45.1
15	44.8	46.0	45.6	44.9	48.0	45.9
16	44.7	45.2	44.9	45.0	46.9	45.6
17	45.0	45.8	45.3	45.0	50.7	46.5
18	45.7	46.7	46.1	45.8	50.0	46.6
19	46.6	47.9	47.2	46.6	54.2	49.8
20	48.0	48.3	48.1	48.5	49.2	48.9
21	48.2	49.0	48.7	49.5	49.5	49.5
22	49.0	49.3	49.2	49.7	50.0	49.9
23	49.3	51.0	50.2	49.9	50.8	50.4
24	50.1	50.3	50.2	50.5	52.7	50.8
25	50.3	50.4	50.3	50.3	55.4	50.9
26	50.0	50.3	50.2	50.1	56.2	50.9
27	50.0	51.2	50.4	50.1	60.8	53.7
28	50.1	51.0	50.5	51.0	61.3	55.7
29	50.3	51.3	50.7	51.0	60.8	52.1
30	50.7	51.9	51.0	51.0	52.3	51.5

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE April, 1976

LOCATION

PREPARED BY

SUBJECT

AVERAGE ΔT AND TOTAL HEAT RELEASED TO RIVER (BTU'S)

Date	Average ΔT °F	BTU	Total Release x 10^3	
1	1.0	2	364	254
2	1.0	2	411	036
3	1.0	2	311	476
4	1.0	2	345	062
5	1.0	2	285	086
6	1.0	2	285	086
7	2.0	7	485	006
8	2.0	5	201	120
9	1.7	5	668	932
10	1.7	7	304	357
11	2.0	7	928	828
12	0.2		868	175
13	1.8	8	975	529
14	1.9	11	694	002
15	0.3	1	220	632
16	0.7	3	257	057
17	1.2	6	772	490
18	0.5	2	821	871
19	2.6	15	353	616
20	0.8	4	085	086
21	0.8	2	634	146
22	0.7	2	393	882
23	0.2	1	101	879
24	0.6	3	386	245
25	0.6	3	386	245
26	0.7	2	729	748
27	3.3	16	629	307
28	5.2	29	347	458
29	1.4	7	901	239
30	0.5	2	836	865

2-2 (PAD) 5 72 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE May, 1976

LOCATION

PREPARED BY

SUBJECT

Site Thermal Discharges °F

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	51.4	51.5	51.5	51.4	51.5	51.5
2	51.5	53.5	52.4	51.4	67.0	59.5
3	53.2	56.0	54.2	64.0	66.8	65.1
4	54.2	56.0	55.2	64.0	65.2	64.4
5	55.2	56.2	55.7	56.2	65.0	63.8
6	56.0	56.5	56.2	56.2	65.2	62.0
7	56.1	56.5	56.4	64.8	65.8	65.1
8	56.0	56.6	56.3	63.8	65.2	64.8
9	55.5	56.5	56.0	62.8	65.4	63.9
10	55.8	57.0	56.4	65.4	68.0	66.8
11	56.2	58.0	57.0	67.5	69.0	68.1
12	56.5	58.7	57.4	68.0	70.0	69.0
13	56.3	57.2	56.9	57.0	69.0	65.3
14	57.0	57.6	57.2	68.0	69.1	68.7
15	57.5	58.6	57.8	57.0	69.0	62.0
16	57.6	57.6	57.6	58.0	58.7	58.1
17	57.7	57.7	57.7	57.8	58.5	58.0
18	57.7	58.0	57.8	57.8	58.2	58.0
19	57.5	58.3	58.0	58.0	58.8	58.4
20	58.1	58.3	58.2	58.0	58.9	58.5
21	58.0	58.2	58.1	58.8	58.9	58.8
22	57.8	58.2	58.0	58.5	59.0	58.8
23	57.9	59.2	58.5	58.6	75.0	62.0
24	58.3	60.0	59.1	59.0	72.3	70.1
25	59.0	59.4	59.1	71.6	77.7	74.7
26	60.0	61.4	61.0	69.5	71.2	70.8
27	60.5	62.0	61.2	77.0	78.2	77.5
28	60.8	61.5	61.4	73.8	77.4	76.3
29	61.2	61.2	61.2	71.8	74.9	74.2
30	60.4	60.8	60.7	60.4	75.2	65.1
31	60.0	60.8	60.3	60.1	64.9	61.0

2-2 (PAD) 12/75 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE May, 1976

LOCATION

PREPARED BY

SUBJECT

AVERAGE ΔT AND TOTAL HEAT RELEASED TO RIVER (BTU'S)

Date	Average ΔT °F	Total BTU Release x 10^3		
1	0			0
2	7.1	40	496	398
3	10.9	69	492	394
4	9.2	67	924	023
5	8.1	59	802	673
6	5.8	42	884	284
7	8.7	64	754	291
8	8.5	63	265	687
9	7.9	58	799	874
10	10.4	77	419	909
11	11.1	83	016	989
12	11.6	85	671	162
13	8.4	62	017	586
14	11.5	84	905	029
15	4.2	31	079	324
16	0.5	3	691	523
17	0.3	1	572	571
18	0.2		472	131
19	0.4		938	025
20	0.3	1	309	516
21	0.7	1	683	527
22	0.8	3	240	623
23	3.5	20	760	695
24	11.0	81	912	831
25	15.6	116	111	143
26	9.8	72	941	616
27	16.3	120	715	143
28	14.9	119	783	827
29	13.0	118	621	737
30	4.4	33	250	694
31	.7	5	210	115

2-2 (PAD) 5-72 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE

LOCATION June, 1976

PREPARED BY

SUBJECT

Site Thermal Discharges - °F

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	58.9	59.7	59.3	59.0	65.2	61.8
2	58.6	59.5	59.2	59.2	74.6	67.6
3	58.8	59.8	59.3	60.5	75.2	72.1
4	58.8	59.9	59.4	72.1	76.1	74.8
5	59.0	60.8	59.8	73.4	75.8	74.6
6	59.2	61.1	60.2	72.9	75.8	74.7
7	59.7	61.3	60.6	73.9	77.8	75.5
8	59.9	62.0	60.8	73.0	81.0	76.2
9	60.2	63.0	61.5	62.8	77.5	72.8
10	61.0	63.3	62.3	69.5	77.7	76.4
11	61.9	63.1	63.1	64.0	78.5	75.1
12	62.5	63.9	63.2	62.8	64.3	63.4
13	62.9	63.3	63.1	63.0	63.7	63.3
14	63.0	63.5	63.3	63.3	64.5	63.7
15	63.2	65.2	63.7	63.9	78.0	74.6
16	64.2	67.8	67.1	78.0	85.0	83.4
17	67.7	67.8	67.8	84.1	86.0	85.0
18	67.7	67.9	67.8	85.1	86.6	85.6
19	67.7	67.9	67.8	81.6	87.0	83.6
20	67.8	68.2	67.9	79.0	82.2	82.0
21	68.0	69.0	68.2	68.8	89.0	76.9
22	68.1	69.0	68.6	88.0	91.6	89.3
23	68.4	69.1	68.8	87.6	93.2	89.0
24	68.6	69.1	68.8	88.0	90.6	89.0
25	69.0	69.2	69.1	90.0	91.8	90.7
26	69.4	70.3	69.9	72.1	92.0	81.8
27	70.1	72.0	71.5	71.9	72.6	72.2
28	71.2	72.8	72.3	72.2	85.1	81.0
29	72.4	73.2	72.6	79.9	85.0	84.6
30	72.9	73.2	73.0	74.0	85.5	84.0

2-2 (PAD) 12/75 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE June, 1976

LOCATION

PREPARED BY

SUBJECT

AVERAGE ΔT AND TOTAL HEAT RELEASED TO RIVER (BTU'S)

Date	Average ΔT °F	Total BTU Release x 10^3		
1	2.5	18	607	555
2	8.4	70	713	149
3	12.8	116	766	080
4	15.4	140	484	190
5	14.8	135	010	780
6	14.5	132	274	075
7	14.9	135	923	015
8	15.4	134	037	257
9	11.3	96	535	697
10	14.1	128	625	135
11	12.0	105	337	056
12	0.2	1	488	604
13	0.2	1	488	604
14	0.4	2	600	080
15	10.9	75	990	549
16	16.3	121	027	973
17	17.2	127	710	499
18	17.8	130	115	775
19	15.8	115	420	217
20	14.1	103	001	487
21	8.7	57	355	289
22	20.7	161	494	735
23	20.2	176	081	622
24	20.2	182	333	038
25	21.6	194	969	981
26	11.9	91	284	067
27	0.7	3	021	950
28	8.7	70	953	163
29	12.0	108	316	656
30	11.0	97	997	185

2-2 (PAD) 5-72 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE July, 1976

LOCATION

PREPARED BY

SUBJECT

Site Thermal Discharges °F

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	73.0	73.5	73.2	73.9	74.3	74.1
2	73.3	74.1	73.7	74.0	74.3	74.2
3	73.7	74.3	74.1	74.0	74.5	74.3
4	74.0	74.4	74.3	74.2	74.8	74.7
5	74.2	75.8	74.9	74.9	92.7	82.0
6	75.6	76.8	75.9	78.0	91.5	89.4
7	76.0	76.7	76.2	76.8	91.1	82.0
8	76.0	76.8	76.3	77.4	93.0	84.4
9	76.1	77.3	76.6	92.0	93.0	92.4
10	76.4	77.8	77.1	88.0	94.3	92.3
11	77.0	77.9	77.4	92.4	93.1	92.9
12	77.0	78.1	77.7	78.0	93.2	89.6
13	76.7	78.0	77.1	85.1	92.8	91.1
14	76.2	77.3	76.7	77.0	92.4	87.4
15	76.0	77.0	76.5	76.8	92.5	85.5
16	76.5	76.7	76.6	77.9	92.8	89.2
17	76.3	78.0	76.7	77.4	96.7	90.4
18	76.0	77.2	76.3	80.0	91.7	89.3
19	76.0	77.3	76.3	76.5	92.0	87.7
20	76.2	77.1	76.5	83.3	94.5	90.3
21	76.2	77.4	76.6	90.4	96.0	93.4
22	76.0	77.3	76.7	90.1	93.5	92.2
23	75.9	76.7	76.4	90.0	91.3	90.9
24	75.7	76.9	76.2	78.2	90.1	81.3
25	75.0	75.8	75.2	76.2	82.4	79.2
26	74.2	75.9	75.1	75.6	91.2	81.8
27	74.8	76.2	75.3	88.0	93.1	91.6
28	75.0	77.0	75.6	90.5	94.0	93.0
29	75.2	76.0	75.6	89.0	96.2	92.0
30	75.4	76.7	75.9	87.5	91.3	90.2
31	75.7	76.2	76.0	87.5	92.5	90.2

2-2 (PAD) 12/75 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE July, 1976

LOCATION

PREPARED BY

SUBJECT

AVERAGE ΔT AND TOTAL HEAT
RELEASED TO RIVER (BTU'S)

Date	Average ΔT °F	Total BTU Release x 10^3		
1	0.9	3	589	564
2	0.5	1	994	202
3	0.2		797	681
4	0.4	1	649	100
5	7.1	51	031	420
6	13.5	122	423	022
7	5.8	52	805	271
8	8.1	73	716	140
9	15.8	143	848	841
10	15.2	138	386	226
11	15.5	141	117	534
12	11.9	111	339	446
13	14.0	127	460	998
14	10.7	97	416	620
15	9.0	75	591	351
16	12.6	112	387	351
17	13.7	107	704	660
18	13.0	118	356	641
19	11.4	103	789	670
20	13.8	117	297	226
21	16.8	138	282	581
22	15.5	135	651	319
23	14.5	132	013	177
24	5.1	32	386	321
25	4.0	22	982	804
26	6.7	58	523	864
27	16.3	148	401	019
28	17.4	158	415	812
29	16.4	136	052	448
30	14.3	128	168	240
31	14.2	123	997	190

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE August, 1976

LOCATION Indian Point Sta.

PREPARED BY

SUBJECT

Site Thermal Discharges °F

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	75.7	76.3	75.9	75.7	93.0	80.6
2	75.0	75.6	75.2	75.3	88.4	78.7
3	75.0	76.4	75.4	88.4	94.0	91.0
4	75.0	76.9	75.6	90.2	93.0	91.5
5	75.4	76.3	76.0	77.7	97.2	90.9
6	75.7	76.8	76.1	93.2	97.8	96.0
7	75.4	76.2	75.7	92.0	92.9	92.5
8	75.3	75.8	75.5	87.0	92.7	91.0
9	75.2	75.7	75.5	87.2	92.0	91.0
10	74.4	76.0	75.2	88.8	92.2	91.1
11	74.1	74.8	74.5	87.0	93.0	90.9
12	74.3	75.2	74.7	84.5	91.3	89.9
13	74.1	75.1	74.5	85.2	91.2	89.0
14	74.6	75.3	74.8	90.4	91.6	91.0
15	74.4	75.9	75.5	91.0	92.3	91.7
16	74.8	75.8	75.2	88.0	92.2	91.5
17	75.0	76.0	75.6	87.1	91.6	90.7
18	74.4	75.6	74.9	90.5	91.4	91.0
19	74.3	75.3	74.9	83.3	92.3	89.8
20	74.0	74.9	74.6	74.5	91.0	80.6
21	74.0	75.4	74.7	74.0	88.5	76.4
22	74.1	75.7	74.7	74.1	92.3	80.8
23	74.1	75.4	74.9	90.8	93.1	92.0
24	74.1	75.5	74.9	91.3	93.2	92.3
25	74.3	76.0	75.2	89.7	92.7	91.2
26	74.9	75.7	75.2	75.5	88.0	84.3
27	75.1	75.8	75.3	75.5	88.5	81.2
28	75.0	75.4	75.2	82.0	86.4	85.0
29	75.0	75.4	75.2	75.5	85.0	78.2
30	73.2	75.5	74.3	76.0	89.9	86.3
31	73.1	75.0	73.9	87.5	94.0	89.0

2-2 (PAD) 5 72 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE

LOCATION August, 1976

PREPARED BY

SUBJECT

AVERAGE ΔT AND TOTAL HEAT RELEASED TO RIVER (BTU'S)

Date	Average ΔT °F	BTU	Total Release x 10^3
1	4.7	35	923 707
2	3.5	23	204 115
3	15.6	139	033 970
4	15.9	141	707 701
5	14.9	118	747 204
6	19.9	156	876 576
7	16.8	146	403 818
8	15.5	126	485 193
9	15.5	134	814 660
10	15.9	140	200 985
11	16.4	112	406 551
12	15.2	135	195 503
13	14.5	128	969 395
14	16.2	143	798 458
15	16.2	142	205 026
16	16.3	143	024 171
17	15.1	132	494 784
18	16.1	141	269 273
19	14.9	130	739 886
20	6.0	52	646 934
21	1.7	14	916 631
22	6.1	53	524 383
23	17.1	150	043 762
24	17.4	152	676 109
25	16.0	140	391 824
26	9.1	71	857 604
27	5.9	45	329 263
28	9.8	85	989 992
29	3.0	27	802 473
30	12.0	105	293 868
31	15.1	140	247 048

2-2 (PAD) 5-72 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE September, 1976

LOCATION Indian Point

PREPARED BY

SUBJECT

Site Thermal Discharges °F

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	74.0	74.4	74.2	88.6	90.0	89.0
2	73.8	74.6	74.3	86.5	89.6	88.9
3	74.1	75.0	74.4	74.1	86.9	81.3
4	74.0	75.0	74.2	74.0	86.9	83.8
5	74.2	74.8	74.4	85.4	86.6	85.9
6	73.7	74.6	74.3	85.0	86.0	85.5
7	73.8	74.5	74.1	82.9	87.9	85.1
8	73.8	74.5	74.2	86.6	88.4	87.5
9	74.1	75.0	74.5	85.9	88.1	87.1
10	73.5	73.8	73.7	74.0	87.0	85.5
11	72.4	73.0	72.8	72.4	73.0	72.8
12	71.9	72.8	72.6	71.9	72.8	72.6
13	72.2	73.2	73.0	72.2	73.2	73.0
14	72.3	73.2	73.0	72.3	73.2	73.0
15	72.0	72.2	72.1	72.0	72.2	72.1
16	71.7	71.9	71.8	71.7	71.9	71.8
17	71.5	71.5	71.5	71.5	71.5	71.5
18	71.2	71.5	71.3	71.2	71.5	71.3
19	70.9	71.3	71.2	70.9	71.3	71.2
20	70.9	71.4	71.2	70.9	71.4	71.2
21	71.0	71.1	71.0	71.0	71.1	71.0
22	70.2	70.8	70.5	70.2	70.8	70.5
23	69.8	70.0	69.9	69.8	70.0	69.9
24	69.7	70.1	69.9	69.7	70.1	69.9
25	69.2	69.9	69.4	69.2	69.9	69.4
26	69.0	69.5	69.2	69.0	69.5	69.2
27	69.0	69.2	69.1	69.0	74.9	71.8
28	68.6	69.1	68.9	68.6	69.1	68.9
29	68.2	68.7	68.4	68.8	77.0	71.5
30	68.1	68.5	68.3	68.2	78.5	75.1

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE September, 1976

LOCATION

PREPARED BY

SUBJECT

AVERAGE ΔT AND TOTAL HEAT
RELEASED TO RIVER (BTU'S)

Date	Average ΔT °F	Total BTU Release x 10^3
1	14.8	155 604 136
2	14.6	153 501 378
3	6.9	71 626 457
4	9.6	99 780 874
5	11.5	119 529 172
6	11.2	117 123 059
7	11.0	115 031 576
8	13.3	139 833 447
9	12.6	132 821 413
10	11.8	124 770 474
11	0	0
12	0	0
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
26	0	0
27	2.7	24 489 842
28	0	0
29	3.1	27 279 005
30	6.8	61 126 526

2-2 (PAD) 5-72 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE October, 1976

LOCATION Indian Point

PREPARED BY

SUBJECT

Site Thermal Discharges °F

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	68.0	68.3	68.1	69.0	83.0	74.6
2	67.7	68.3	67.9	76.0	81.0	79.1
3	67.3	68.1	67.6	75.0	80.0	77.8
4	67.0	68.1	67.3	74.0	80.0	77.2
5	66.4	67.9	66.9	73.0	83.3	77.6
6	66.4	68.0	66.9	80.4	83.2	81.3
7	66.5	67.5	67.0	80.0	81.9	80.6
8	66.6	68.0	67.0	80.0	82.0	81.1
9	66.5	67.6	67.0	81.1	84.0	82.7
10	64.7	66.7	65.5	82.0	84.2	83.7
11	63.8	65.6	64.7	81.5	84.8	83.8
12	63.2	64.0	63.8	85.0	88.0	86.8
13	61.9	64.8	63.5	85.0	87.8	86.2
14	60.4	64.0	61.8	81.6	87.8	83.9
15	60.6	62.0	61.5	79.7	85.8	83.2
16	60.0	61.7	60.8	77.6	85.0	81.4
17	59.1	61.4	60.5	78.7	81.2	79.9
18	58.1	60.2	59.3	80.0	82.6	81.4
19	58.0	59.8	58.8	78.8	82.5	81.1
20	58.0	59.8	58.8	78.8	81.8	79.9
21	56.4	61.0	59.0	69.7	82.1	76.0
22	55.3	57.8	56.4	72.0	84.0	79.9
23	55.0	58.0	55.7	81.0	83.3	82.8
24	53.9	55.8	55.0	77.2	82.8	80.8
25	53.9	55.5	54.9	72.2	78.0	75.7
26	51.9	54.8	53.7	70.3	74.8	73.0
27	50.9	53.1	52.0	71.7	75.7	73.5
28	49.8	52.7	50.8	73.6	76.0	74.7
29	49.0	51.5	50.2	61.7	75.5	73.3
30	48.8	50.0	49.5	59.5	66.0	63.1
31	48.8	50.5	49.6	62.9	66.0	64.5

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE October, 1976

LOCATION

PREPARED BY

SUBJECT

AVERAGE ΔT AND TOTAL HEAT
RELEASED TO RIVER (BTU'S)

Date	Average ΔT °F	Total BTU Release x 10^3
1	6.5	59 552 571
2	11.2	120 293 622
3	10.2	146 466 441
4	9.9	156 040 761
5	10.7	172 782 937
6	14.4	251 150 702
7	13.6	237 197 886
8	14.1	245 918 396
9	15.7	274 351 346
10	18.2	312 230 737
11	19.1	333 123 501
12	23.0	378 354 991
13	22.7	380 662 883
14	22.1	353 317 186
15	21.7	329 846 901
16	20.6	322 812 897
17	19.4	339 519 342
18	22.1	376 751 474
19	22.3	363 683 430
20	21.1	362 867 630
21	17.0	260 444 590
22	23.5	317 545 936
23	27.1	375 537 031
24	25.8	337 855 128
25	20.8	335 053 784
26	19.3	329 365 540
27	21.5	332 480 558
28	23.9	344 595 721
29	23.1	333 061 136
30	13.6	162 971 588
31	14.9	164 787 668

2-2 (PAD) 5 72 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE November, 1976

LOCATION Indian Point

PREPARED BY

SUBJECT

Site Thermal Discharges °F

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	49.2	52.0	50.6	61.5	65.8	63.0
2	48.5	49.9	49.2	59.5	65.0	61.3
3	46.8	47.3	47.0	59.5	62.5	60.8
4	46.5	47.4	47.1	60.5	62.9	61.4
5	46.2	47.2	46.8	59.0	61.0	59.8
6	45.0	47.1	46.2	57.7	60.0	58.9
7	45.0	46.0	45.6	57.5	60.0	58.5
8	43.8	46.0	45.0	53.2	60.0	57.5
9	43.4	45.0	44.1	56.8	61.4	58.4
10	43.0	46.9	44.1	58.0	68.7	64.5
11	43.0	45.1	43.7	65.8	67.8	66.9
12	42.6	44.2	43.4	65.5	67.2	66.5
13	42.0	44.7	43.2	61.0	67.2	65.9
14	42.0	43.9	43.0	61.0	65.0	63.7
15	42.2	43.9	43.0	62.8	64.7	63.8
16	42.0	44.0	43.2	63.0	70.5	66.5
17	42.0	44.1	43.5	42.4	65.0	58.8
18	42.9	43.8	43.0	43.0	65.8	52.4
19	42.8	43.7	43.2	65.5	69.0	67.1
20	42.5	43.5	43.0	66.7	69.7	68.0
21	42.2	43.2	42.7	66.8	69.0	68.0
22	41.5	43.0	42.0	66.8	69.2	68.1
23	41.2	42.0	41.7	67.5	70.0	68.7
24	39.9	42.3	40.9	67.5	70.1	68.6
25	40.0	42.1	41.0	68.0	70.0	69.0
26	40.0	42.7	41.2	68.0	70.1	69.1
27	40.6	42.2	41.5	64.0	70.2	69.0
28	40.9	42.2	41.6	59.0	70.2	69.0
29	41.0	44.2	42.0	62.0	69.7	68.1
30	40.0	42.0	40.7	62.0	70.0	67.7

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE November, 1976

LOCATION

PREPARED BY

SUBJECT

AVERAGE ΔT AND TOTAL HEAT
RELEASED TO RIVER (BTU'S)

Date	Average ΔT °F	Total BTU Release x 10^3		
1	12.4	137	763	430
2	12.1	144	183	987
3	13.8	175	986	861
4	14.3	182	166	313
5	13.0	165	605	739
6	12.7	161	784	068
7	12.9	164	331	849
8	12.5	159	236	288
9	14.3	159	524	165
10	20.4	177	653	726
11	23.2	178	661	321
12	23.1	177	891	229
13	22.7	174	810	861
14	20.7	159	409	023
15	20.8	160	179	115
16	23.3	159	811	322
17	15.3	112	777	080
18	9.4	69	186	388
19	23.9	167	997	569
20	25.0	175	729	675
21	25.3	177	838	431
22	26.1	183	649	649
23	27.0	189	788	049
24	27.7	194	708	480
25	28.0	196	817	236
26	27.9	196	114	317
27	27.5	193	302	643
28	27.4	198	975	896
29	26.1	184	776	699
30	27.0	191	439	801

2-2 (PAD) 5-72 CONST.

SITE THERMAL DISCHARGES °F

DECEMBER 1976

	INLET			OUTLET		
DATE	MINIMUM	MAXIMUM	AVERAGE	MINIMUM	MAXIMUM	AVERAGE
1	39.0	40.0	39.7	66.8	68.5	67.7
2	38.5	42.0	39.5	65.0	70.0	67.6
3	37.0	40.2	38.2	60.0	69.7	66.5
4	37.2	39.2	37.8	59.0	67.8	66.2
5	36.9	38.2	37.8	48.2	65.6	58.4
6	36.8	38.7	37.5	50.0	67.2	62.8
7	37.2	42.0	38.0	65.5	80.0	71.9
8	35.7	41.5	37.2	68.8	82.2	76.7
9	34.0	38.9	35.3	35.9	72.8	51.4
10	34.3	37.6	35.8	45.5	55.0	49.7
11	35.0	37.4	35.8	46.0	54.5	50.7
12	35.0	38.7	36.3	51.5	58.0	55.5
13	34.0	39.3	36.4	52.0	59.5	54.3
14	32.3	37.5	34.7	53.5	62.5	58.0
15	33.3	37.8	34.5	62.0	66.0	64.5
16	33.3	38.2	35.0	67.0	70.8	69.5
17	34.0	39.9	35.6	37.4	72.8	56.7
18	33.0	35.8	34.4	44.0	51.0	47.1
19	32.9	35.4	34.0	45.5	53.3	48.0
20	32.9	36.0	34.3	47.5	55.0	50.4
21	32.4	36.0	33.8	43.0	56.5	51.0
22	32.4	37.0	34.1	51.0	66.2	60.8
23	33.0	37.2	34.5	49.5	66.2	61.1
24	32.5	37.5	34.8	60.0	67.0	63.5
25	32.5	36.5	33.7	61.8	66.5	64.4
26	32.3	36.1	33.4	53.0	72.0	65.6
27	32.6	36.4	33.8	48.5	71.8	57.0
28	32.8	36.2	34.0	60.0	67.4	64.1
29	32.8	33.8	33.2	63.1	67.4	64.6
30	32.5	37.0	33.4	50.0	68.5	64.6
31	32.5	38.0	33.5	48.5	69.9	55.1

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE December, 1976

LOCATION

PREPARED BY

SUBJECT

AVERAGE ΔT AND TOTAL HEAT
RELEASED TO RIVER (BTU'S)

Date	Average ΔT °F	Total BTU Release x 10^3		
1	28.0	196	817	236
2	28.1	197	520	155
3	28.3	204	357	413
4	28.4	199	628	911
5	20.6	140	032	208
6	25.3	177	595	652
7	33.9	207	872	969
8	39.5	205	349	440
9	16.1	103	050	288
10	13.9	137	988	469
11	14.9	174	796	459
12	19.2	225	241	075
13	17.9	209	260	344
14	23.3	273	339	430
15	30.0	351	939	180
16	34.5	369	967	961
17	21.1	221	461	380
18	12.7	109	074	750
19	14.0	120	239	882
20	16.1	140	052	596
21	17.2	182	384	620
22	26.7	283	504	632
23	26.6	279	092	573
24	28.7	283	775	383
25	30.7	296	443	375
26	32.2	283	002	033
27	23.2	206	712	812
28	30.1	292	454	971
29	31.4	305	085	917
30	31.2	303	142	694
31	21.6	206	595	209

2-2 (PAD) 5-72 CONST.

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

DATE January 1977

LOCATION

PREPARED BY

SUBJECT

Site Thermal Discharges

DATE	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	31.8	39.0	34.5	64.7	74.7	68.5
2	31.5	38.8	34.0	67.2	78.0	72.3
3	31.5	38.0	33.3	69.5	77.2	71.8
4	32.0	37.5	33.8	51.5	74.4	65.7
5	32.0	36.2	33.0	69.7	78.1	72.0
6	31.9	36.2	33.3	63.8	73.5	68.2
7	31.5	37.0	33.0	62.0	74.0	66.8
8	31.5	37.6	32.7	59.9	73.6	66.4
9	31.3	36.5	32.8	60.4	72.4	66.7
10	31.8	37.8	33.2	48.8	72.0	65.1
11	31.8	36.9	33.1	49.0	73.5	65.6
12	31.3	36.2	32.7	54.0	70.1	68.4
13	31.4	37.1	33.0	46.0	49.0	47.2
14	31.5	37.1	32.8	69.3	72.1	70.0
15	31.5	35.5	32.7	51.0	56.2	54.1
16	31.3	36.0	32.3	52.2	57.1	55.0
17	31.0	33.8	31.9	51.8	56.8	55.9
18	31.0	32.8	31.8	52.5	57.0	55.8
19	31.0	33.4	31.7	50.5	56.5	54.3
20	31.3	34.0	32.1	45.0	52.0	49.2
21	31.4	34.0	32.1	46.8	52.0	49.0
22	31.0	32.5	31.8	47.6	51.5	49.5
23	31.0	33.8	31.9	47.5	52.5	49.4
24	31.3	36.0	32.2	47.5	52.8	49.6
25	31.8	36.2	32.8	46.2	55.8	51.3
26	31.5	34.0	32.1	52.0	70.0	56.9
27	31.2	37.2	32.5	52.8	79.5	69.1
28	31.2	36.3	32.4	46.4	70.4	62.1
29	31.2	34.4	31.7	50.5	68.2	65.3
30	31.0	37.3	32.0	50.5	76.8	61.6
31	31.2	37.0	32.9	71.8	80.8	74.6

Feb 1977

SITE THERMAL DISCHARGES

DATE	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	31.6	37.0	35.1	51.0	76.0	66.3
2	32.0	35.0	34.8	49.0	71.5	61.8
3	32.1	36.2	34.9	65.0	79.2	72.2
4	31.8	37.1	34.4	76.0	79.3	77.3
5	32.2	35.8	34.6	46.5	78.2	61.3
6	32.3	35.5	34.9	46.5	66.0	55.4
7	32.0	36.8	35.0	64.2	68.2	65.8
8	31.7	35.8	34.8	65.5	71.2	67.7
9	31.9	36.2	32.9	51.2	74.4	64.2
10	32.0	38.3	33.5	50.5	71.2	65.2
11	31.8	36.2	33.5	65.5	70.2	67.8
12	32.3	37.5	34.1	66.9	70.6	68.9
13	32.5	39.8	35.1	63.2	69.0	65.6
14	33.0	36.0	34.2	48.5	65.0	56.3
15	32.8	37.8	34.5	63.7	69.0	66.1
16	32.4	36.0	33.6	63.0	66.2	64.4
17	32.6	37.1	34.2	62.8	69.2	67.7
18	32.0	37.0	33.8	58.3	69.3	63.4
19	32.8	36.9	33.9	49.2	70.3	65.3
20	32.5	36.4	34.2	48.6	68.9	67.2
21	32.4	36.9	33.9	49.4	70.2	67.3
22	32.4	37.0	34.6	68.5	72.3	71.2
23	32.5	36.3	34.1	64.0	72.2	67.9
24	32.8	37.3	35.0	63.8	69.7	66.4
25	33.0	43.0	35.7	68.0	78.0	72.0
26	33.1	40.5	35.8	67.0	77.0	73.0
27	33.0	37.5	34.5	63.8	70.8	67.7
28	33.6	40.2	35.0	63.8	70.0	66.1

MAR. 1977

Site Thermal Discharges - ^{0}F

DATE	Inlet MIN.	Inlet MAX.	Inlet AVG.	Out MIN.	Out MAX.	Out AVG.
1	33.9	40.0	35.9	65.0	70.0	66.8
2	34.0	39.0	34.9	65.2	70.2	66.7
3	33.5	37.8	35.5	66.0	71.8	68.6
4	34.0	38.2	35.4	64.5	68.8	66.5
5	33.8	39.2	35.8	61.0	70.2	64.7
6	34.2	38.6	35.3	61.0	67.5	63.7
7	34.4	39.8	35.9	61.2	67.5	64.2
8	34.0	39.0	35.9	61.5	67.0	64.2
9	34.0	39.2	36.4	62.2	66.5	63.9
10	34.0	38.4	36.1	62.1	71.8	66.4
11	34.0	37.5	35.7	50.0	62.5	55.1
12	34.5	37.1	35.6	47.0	56.0	51.3
13	34.7	38.2	36.1	51.5	56.5	54.1
14	34.4	36.7	35.2	52.2	55.5	53.1
15	35.0	38.0	36.8	50.0	63.0	54.0
16	37.9	42.0	39.1	60.8	68.8	65.4
17	38.5	42.0	40.0	65.8	69.5	67.8
18	37.9	40.3	38.9	64.5	68.0	66.2
19	37.5	41.4	39.0	60.2	66.3	63.7
20	37.2	40.2	38.4	63.4	67.4	65.0
21	37.5	41.8	39.0	64.0	68.9	66.3
22	37.9	40.0	38.8	65.8	67.4	66.7
23	37.2	41.7	38.6	63.0	73.0	67.0
24	36.7	41.0	37.9	65.2	67.8	66.4
25	35.3	41.7	38.2	65.0	69.7	67.0
26	36.1	40.5	38.4	65.2	68.3	66.9
27	37.0	39.9	38.4	65.5	68.3	67.1
28	36.9	41.0	38.4	65.6	68.5	67.0
29	37.4	41.0	38.8	66.0	68.8	67.4
30	38.0	40.6	39.4	66.2	68.6	67.9
31	39.0	41.0	40.0	67.8	70.2	68.7

SITE THERMAL DISCHARGES - °F

DATE	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	39.3	42.8	40.8	68.0	71.7	70.1
2	39.6	42.0	40.6	69.5	71.0	70.2
3	41.0	45.1	42.8	69.9	73.9	72.1
4	42.5	44.1	43.2	72.0	78.8	73.7
5	43.0	45.1	43.8	62.5	80.2	73.7
6	43.2	45.0	44.1	59.5	71.5	66.0
7	42.5	45.0	43.8	61.3	66.0	64.2
8	42.9	46.8	43.9	60.1	66.8	63.9
9	41.5	45.1	43.4	60.0	62.1	60.9
10	42.9	44.5	43.6	45.1	61.0	54.3
11	42.8	43.7	43.0	44.0	44.8	44.5
12	43.0	44.2	43.6	44.2	56.6	50.4
13	43.6	45.5	44.5	55.9	62.2	59.7
14	44.5	46.6	45.6	60.4	72.0	66.6
15	44.7	47.0	45.6	64.8	69.0	66.6
16	45.2	46.9	46.2	63.1	66.5	64.4
17	45.8	47.0	46.5	63.7	65.2	64.4
18	46.0	46.9	46.6	64.2	65.5	64.8
19	46.1	47.0	46.7	65.0	69.0	65.9
20	46.5	47.8	47.2	64.8	65.5	65.2
21	47.0	48.0	47.6	65.1	65.9	65.6
22	47.3	48.9	48.3	65.7	66.9	66.3
23	48.5	49.1	48.9	66.4	67.4	67.0
24	48.7	49.1	49.0	67.0	67.4	67.2
25	48.5	50.8	49.3	66.9	67.6	67.2
26	49.3	50.8	50.0	67.0	67.9	67.3
27	50.2	52.7	51.2	67.9	70.3	68.9
28	50.0	53.2	52.1	70.0	71.0	70.4
29	51.8	53.1	52.5	70.0	73.0	70.9
30	52.0	53.0	52.6	69.7	70.2	70.1

May 1977

Site Thermal Discharges - °F

DATE	Inlet MIN	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	52.1	53.2	52.8	70.0	70.4	70.2
2	52.6	53.2	53.0	69.8	70.2	70.1
3	52.2	53.9	53.1	70.2	74.0	71.1
4	52.9	53.9	53.1	70.5	74.4	72.4
5	52.5	54.0	53.3	71.2	73.9	71.9
6	53.2	55.0	54.1	68.3	72.0	71.3
7	53.9	55.6	54.9	70.2	72.0	71.3
8	53.6	54.9	54.2	70.0	75.0	71.4
9	53.0	55.0	54.1	70.3	73.0	71.4
10	52.6	54.0	53.2	70.0	71.0	70.4
11	52.5	53.6	53.0	65.5	70.2	69.7
12	52.4	53.8	53.2	62.0	70.1	68.2
13	53.0	55.2	54.2	69.5	71.0	70.3
14	53.3	54.7	54.1	64.0	70.2	67.5
15	53.9	55.3	54.6	65.8	72.0	69.2
16	54.8	56.3	55.5	71.1	73.0	72.2
17	55.4	58.0	56.7	72.0	74.5	73.0
18	57.0	58.9	58.0	72.8	74.7	73.8
19	58.2	59.5	58.9	72.3	74.7	73.4
20	58.0	60.0	59.3	71.5	73.1	72.6
21	58.8	60.2	59.8	71.2	73.0	72.0
22	59.5	60.5	60.2	71.2	72.8	71.9
23	59.9	61.6	61.0	71.2	72.7	72.3
24	60.9	63.2	62.4	71.9	74.0	73.1
25	61.9	65.0	63.4	71.9	74.8	73.1
26	62.2	65.0	63.7	65.0	81.8	78.4
27	63.6	66.3	64.7	77.7	82.1	80.6
28	63.9	68.2	65.6	79.3	82.0	80.8
29	64.0	66.9	65.3	80.0	82.2	80.9
30	64.2	66.1	65.5	79.5	81.0	80.6
31	64.2	66.2	65.5	79.7	81.8	81.0

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

NO.

DATE JUNE 1977

LOCATION

PREPARED BY

SUBJECT

SITE THERMAL DISCHARGES - °F

DATE	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	65.0	66.7	65.8	78.8	81.0	80.1
2	65.5	67.2	66.4	80.2	83.5	81.7
3	65.0	67.5	66.4	81.0	83.1	82.4
4	65.0	68.0	66.3	81.5	84.6	83.4
5	66.0	68.0	66.9	81.8	83.8	82.8
6	66.0	67.8	66.9	81.6	83.0	82.4
7	65.9	67.9	66.6	81.0	83.0	81.9
8	65.0	68.2	66.3	80.7	82.5	81.6
9	65.5	67.3	66.3	80.9	82.3	81.6
10	64.9	66.8	65.4	76.7	81.9	80.1
11	65.0	66.8	65.7	74.0	76.8	75.6
12	65.1	67.8	66.3	78.0	81.8	80.3
13	65.1	68.0	66.3	78.7	82.9	80.7
14	65.1	67.4	66.1	74.5	83.3	79.4
15	65.3	68.4	66.7	77.4	82.0	80.5
16	66.0	68.9	67.4	80.3	82.8	81.7
17	66.8	68.9	67.8	81.1	83.1	82.2
18	67.2	69.7	68.6	81.6	85.0	83.0
19	68.1	70.8	69.3	82.4	84.8	83.8
20	68.6	71.4	69.8	83.0	85.2	84.2
21	68.8	71.3	70.0	83.1	86.0	84.6
22	68.8	71.1	69.8	83.3	86.2	84.8
23	69.0	71.8	70.2	84.4	87.5	85.6
24	70.2	72.2	71.1	84.8	88.0	86.2
25	70.3	72.5	71.6	85.2	93.0	88.1
26	70.9	72.9	71.9	90.7	95.0	92.1
27	71.0	73.0	72.1	87.0	92.7	88.8
28	71.0	73.3	72.4	87.0	88.8	88.2
29	71.7	73.9	72.8	86.2	89.0	87.8
30	71.8	74.0	73.0	87.0	89.8	88.1

July 1977

Site Thermal Discharges

Date	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	72.4	74.0	73.5	86.3	89.3	88.5
2	72.8	74.0	73.6	85.0	88.0	86.5
3	72.6	74.0	73.5	84.8	88.7	86.1
4	73.4	74.1	73.8	88.5	96.8	91.3
5	73.4	76.0	74.5	90.7	97.5	94.6
6	74.0	75.3	74.7	88.2	90.1	89.3
7	74.2	76.0	75.0	89.0	90.2	89.7
8	74.8	76.0	75.4	89.8	92.0	91.1
9	74.9	77.2	75.7	84.3	92.7	89.7
10	75.1	76.1	75.5	90.7	92.0	91.2
11	74.8	75.9	75.4	90.2	91.8	91.0
12	74.4	75.5	75.1	89.7	91.8	90.5
13	74.9	76.4	75.6	80.2	90.8	89.8
14	75.0	76.8	75.7	77.0	88.0	80.1
15	75.0	77.2	76.1	88.2	92.8	90.6
16	75.4	77.6	76.5	90.7	92.8	91.7
17	76.0	77.6	76.9	91.2	92.7	92.1
18	76.7	78.6	77.6	91.8	93.3	92.6
19	77.0	79.1	78.1	92.0	94.6	93.1
20	78.0	79.7	78.7	91.0	94.5	93.3
21	78.7	81.0	79.7	90.6	93.2	92.0
22	78.3	80.1	79.1	91.2	93.0	92.0
23	78.2	79.9	78.9	90.8	93.0	91.8
24	78.8	79.8	79.3	90.8	93.1	91.7
25	78.3	79.7	79.0	91.8	93.1	92.0
26	77.5	78.8	78.1	90.5	91.8	91.0
27	77.0	78.0	77.8	89.0	91.3	90.4
28	76.8	78.2	77.5	90.0	91.0	90.4
29	77.0	78.1	77.3	89.7	97.0	91.8
30	76.2	77.5	77.1	92.4	97.3	95.4
31	76.8	77.8	77.3	91.8	93.0	92.3

August 1977

Site Thermal Discharges

DATE	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	76.5	78.2	77.0	91.9	92.9	92.2
2	76.2	77.1	76.5	91.7	93.2	92.2
3	77.2	78.0	77.6	91.8	92.8	92.1
4	77.3	78.1	77.9	90.8	93.2	92.3
5	77.7	78.8	78.2	90.5	92.0	91.2
6	78.0	79.8	78.7	88.7	91.9	90.5
7	78.3	81.4	79.3	88.4	95.6	93.4
8	78.8	82.5	79.6	93.0	96.8	95.0
9	78.8	81.0	79.5	88.8	96.3	93.5
10	78.1	81.0	79.7	95.0	96.8	96.0
11	79.2	81.2	80.4	89.4	96.1	93.3
12	79.0	81.2	79.8	93.4	96.9	95.5
13	78.7	82.0	79.7	91.1	96.9	94.6
14	79.0	80.8	79.6	94.3	95.8	95.0
15	78.7	80.6	79.4	87.8	95.4	92.1
16	78.1	80.0	78.9	87.4	93.7	91.3
17	78.5	80.2	79.0	88.5	94.0	91.8
18	78.0	80.1	78.8	87.5	94.7	91.9
19	77.5	79.0	78.3	87.2	89.2	88.1
20	77.9	79.0	78.3	87.0	89.2	87.8
21	77.3	79.0	77.9	86.4	88.3	87.3
22	77.2	79.0	77.8	86.0	92.7	89.6
23	76.9	78.9	77.5	91.1	92.3	91.6
24	76.9	79.0	77.6	91.2	93.2	91.9
25	76.5	78.3	77.3	90.9	92.2	91.5
26	76.0	78.0	76.9	89.5	91.5	90.9
27	76.4	78.4	77.2	89.0	91.4	90.7
28	76.8	78.8	77.6	90.0	91.8	90.9
29	77.0	79.0	77.9	90.3	93.4	91.5
30	77.1	79.0	78.1	90.4	92.0	91.3
31	77.0	78.9	77.7	91.2	91.8	91.6

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

DATA SHEET

DATE SEPT. 1977

LOCATION

PREPARED BY

SUBJECT

SITE THERMAL DISCHARGES - °F

DATE	INLET MIN.	INLET MAX.	INLET AVG.	OUTLET MIN.	OUTLET MAX.	OUTLET AVG.
1	77.9	80.3	78.8	93.9	95.9	94.8
2	78.0	80.3	79.0	93.9	95.7	94.8
3	78.0	80.8	79.2	93.7	95.8	94.7
4	77.8	81.4	79.0	93.7	95.9	94.7
5	77.9	81.1	78.8	93.2	95.1	94.2
6	77.7	79.9	78.4	94.2	95.9	94.9
7	77.0	78.8	77.7	93.0	95.2	94.0
8	77.0	79.4	77.7	93.0	95.4	94.0
9	76.9	78.1	77.4	92.1	94.2	93.5
10	76.6	78.8	77.4	92.7	94.5	93.8
11	75.9	77.9	76.6	92.2	94.1	93.0
12	74.9	78.0	75.9	90.9	92.8	91.8
13	74.9	76.5	75.4	91.0	93.4	91.7
14	74.8	76.8	75.3	91.0	93.5	91.5
15	74.1	75.9	74.9	90.0	92.5	91.0
16	74.1	75.7	74.5	89.5	91.2	90.3
17	74.1	76.0	74.8	90.0	92.8	91.6
18	74.2	76.0	75.1	89.9	92.4	91.6
19	74.2	76.8	75.2	89.7	92.6	91.5
20	73.4	75.7	74.5	90.0	92.8	90.4
21	73.1	74.7	73.6	88.8	90.9	89.8
22	73.0	74.1	73.4	88.4	89.8	89.2
23	72.8	73.6	73.1	88.0	89.3	88.8
24	72.2	73.4	72.8	87.2	88.7	88.0
25	72.0	73.0	72.3	87.2	88.7	88.0
26	70.7	72.4	71.4	72.5	86.6	84.0
27	69.0	70.9	69.7	84.2	86.2	85.0
28	68.0	69.3	68.8	82.4	86.0	84.4
29	67.9	69.2	68.5	83.2	85.0	84.0
30	67.8	68.9	68.2	83.4	85.2	84.2

Site Thermal Discharges °F

October 1977

DATE	Inlet MIN.	Inlet MAX.	Inlet AVG.	Outlet MIN.	Outlet MAX.	Outlet AVG.
1	68.0	69.0	68.5	83.9	84.8	84.5
2	67.0	69.4	68.4	83.0	84.9	84.2
3	64.7	67.0	66.1	79.8	82.4	81.1
4	63.9	65.1	64.5	78.7	79.9	79.4
5	63.0	64.1	63.6	77.8	79.0	78.5
6	62.6	63.9	63.3	77.6	79.2	78.5
7	61.2	63.1	61.9	77.5	80.2	78.9
8	61.0	62.1	61.5	70.5	73.8	73.0
9	61.0	63.2	62.0	70.0	73.9	73.2
10	59.5	62.1	60.4	70.5	73.5	72.6
11	59.0	60.0	59.4	70.8	73.7	72.5
12	58.9	59.8	59.2	70.8	72.0	71.3
13	58.7	59.8	59.1	81.1	91.0	86.2
14	57.8	61.0	59.0	74.8	91.7	84.8
15	57.2	58.9	57.9	74.2	75.7	75.1
16	57.0	59.1	57.6	74.1	81.9	75.8
17	57.0	58.8	57.6	79.8	82.0	80.2
18	55.1	56.8	55.6	77.4	82.1	80.5
19	54.0	55.8	54.8	70.4	81.2	75.1
20	53.0	54.0	53.7	71.0	74.0	73.3
21	52.2	53.1	52.9	69.7	73.0	71.7
22	52.2	53.1	52.8	69.0	71.2	69.9
23	51.6	52.9	52.2	69.2	72.0	70.0
24	51.0	51.8	51.2	66.0	72.1	68.2
25	50.9	51.8	51.4	65.4	70.8	67.4
26	51.1	55.2	52.2	68.0	85.0	72.0
27	51.9	56.3	53.5	83.5	87.0	85.0
28	52.0	55.8	53.2	68.0	86.0	81.2
29	51.8	53.3	52.4	66.0	78.8	75.1
30	51.2	52.0	51.8	70.8	72.6	71.3
31	51.0	51.9	51.4	67.5	69.0	68.3

NOV 1977

SITE THERMAL DISCHARGES-^{o}F

DATE	INLET MIN.	INLET MAX.	INLET AVG.	OUTLET MIN.	OUTLET MAX.	OUTLET AVG.
1	51.0	52.0	51.5	68.0	71.3	69.5
2	51.3	51.9	51.7	68.6	70.3	69.9
3	51.3	53.0	52.2	69.5	71.2	70.4
4	51.8	54.0	52.5	69.2	71.0	70.6
5	52.0	54.0	53.0	69.4	71.1	70.8
6	52.7	55.3	53.7	69.8	72.1	71.2
7	52.9	55.0	53.7	69.7	74.9	72.0
8	52.3	55.0	53.4	69.5	79.3	75.0
9	51.8	53.1	52.1	69.2	80.1	76.2
10	51.8	52.6	52.0	72.5	78.1	76.5
11	51.3	52.0	51.5	74.2	78.1	76.6
12	51.0	52.0	51.3	74.6	78.6	76.6
13	50.6	52.3	51.3	74.5	78.2	76.3
14	49.3	51.4	50.6	75.0	77.2	76.6
15	49.0	50.8	49.7	74.3	77.2	75.5
16	49.1	50.2	49.7	70.0	77.2	71.4
17	48.5	50.0	49.2	69.2	71.3	70.1
18	48.0	49.8	48.7	68.5	70.4	69.7
19	48.2	49.4	48.7	69.0	73.0	70.7
20	48.0	49.1	48.4	72.4	73.6	72.8
21	48.0	49.1	48.4	73.0	74.3	73.6
21	48.0	49.1	48.4	73.0	74.3	73.6
22	48.5	50.2	49.0	73.6	74.8	74.0
23	49.0	50.1	49.2	73.5	74.6	74.2
24	48.5	49.8	49.3	73.2	74.8	74.0
25	48.0	49.3	48.7	72.0	74.1	73.0
26	47.0	51.0	48.5	73.0	74.2	73.5
27	46.5	48.0	47.2	70.0	73.0	72.6
28	42.5	46.7	44.5	68.8	71.0	70.0
29	43.1	45.6	44.5	68.9	71.0	70.2
30	43.0	44.8	43.7	67.5	69.7	68.7

Site Thermal Discharges

	Inlet			Outlet		
DATE	MIN.	MAX.	AVG.	MIN.	MAX.	AVG.
1	42.0	44.0	42.8	55.0	68.0	66.8
2	40.8	43.1	42.0	55.0	65.2	63.0
3	40.4	42.5	41.8	57.2	65.0	64.2
4	40.6	42.0	41.3	64.0	66.0	65.1
5	40.0	42.2	41.0	63.0	64.4	63.8
6	40.1	42.0	40.8	62.7	65.0	63.8
7	40.5	42.2	41.5	63.0	66.0	64.2
8	37.8	41.2	39.4	62.3	65.3	63.2
9	37.9	40.9	39.2	61.0	64.0	63.5
10	35.8	40.0	37.5	59.0	62.1	60.8
11	34.4	39.0	35.6	58.3	61.4	59.0
12	34.0	38.2	35.9	53.4	60.5	57.5
13	35.0	37.9	36.0	53.3	59.0	55.0
14	35.0	37.3	35.5	47.5	59.0	53.5
15	35.3	38.8	36.5	45.8	55.0	50.1
16	34.8	36.6	35.4	45.0	48.0	47.2
17	34.4	36.2	35.4	43.5	49.3	46.0
18	34.3	36.8	35.5	43.5	53.1	48.6
19	34.1	37.1	35.3	47.2	56.1	50.6
20	33.9	37.2	35.3	50.0	58.8	53.5
21	33.0	36.2	34.8	56.2	59.2	57.4
22	32.0	35.0	33.8	56.0	58.2	57.3
23	32.2	35.0	33.3	56.0	58.0	57.3
24	32.5	35.3	33.5	55.4	58.4	57.3
25	33.0	36.8	34.0	57.0	59.8	58.2
26	32.0	34.0	33.0	56.1	57.9	56.8
27	32.0	34.9	33.0	56.0	58.9	57.0
28	32.0	35.9	33.1	57.0	58.2	57.4
29	32.0	35.8	33.0	56.0	57.9	56.8
30	32.3	36.1	33.1	56.3	58.3	57.6
31	32.4	35.1	33.0	56.2	58.5	57.4

Attachment 2

Chlorination Records during 1975 for the Indian Point Station as Reported to the New York State Department of Environmental Conservation under Section 401 of FWPCA

INDIAN POINT STATION
CONSOLIDATED EDISON CO., INC.

DATE June 5, 1975

CHLORINATION TIME: START 1425, FINISH 1525

HYPOCHLORITE (NaOCl) % 7.9

HYPOCHLORITE FEED RATE gpm 3 & 4

HYPOCHLORITE VOLUME gallons 210

CHLORINE DEMAND ppm 1.1

CIRCULATION WATER FLOW CHLORINATED gpm 280,000 & 420,000

CIRCULATION WATER FLOW, TOTAL gpm 720,000

		RESIDUAL CHLORINE, FREE AND TOTAL CONDENSER SECTION						DISCHARGE CANAL	
		21	22	23	24	25	26	1 meter	3 meters
TIME 1420	FREE	O/S	<.05	<.05				<.05	<.05
	TOTAL	O/S	<.05	<.05				<.05	<.05
1430	FREE	O/S	<.05	.23				<.05	<.05
	TOTAL	O/S	0.4	0.31				<.05	<.05
1440	FREE	O/S	.53	.28				.06	.06
	TOTAL	O/S	.56	.33				.10	.10
1450	FREE	O/S	.58	.35				.06	.15
	TOTAL	O/S	.58	.32				.10	.16
1500	FREE	O/S			<.05	.60	.05	.08	.08
	TOTAL	O/S			<.05	.69	.06	.12	.14
1510	FREE	O/S			.05	.30	.13	.16	.14
	TOTAL	O/S			.05	.33	.16	.18	.16
1520	FREE	O/S			.63	<.05	.13	.14	.10
	TOTAL	O/S			.62	<.05	.15	.14	.12
1530	FREE	O/S			<.05	<.05	<.05	.05	.05
	TOTAL	O/S			.06	<.05	<.05	<.05	<.05
	FREE								
	TOTAL								

REMARKS: No visible Damage to Aquatic life

INDIAN POINT STATION
CONSOLIDATED EDISON CO., INC.

DATE 5/22/75

CHLORINATION TIME: START 1400, FINISH 1500

HYPOCHLORITE (NaOCl) % 8.5

HYPOCHLORITE FEED RATE gpm 8.3

HYPOCHLORITE VOLUME gallons 500

CHLORINE DEMAND ppm 0.8

CIRCULATION WATER FLOW CHLORINATED gpm 280,000 & 420,000

CIRCULATION WATER FLOW, TOTAL gpm 720,000

		RESIDUAL CHLORINE, FREE AND TOTAL CONDENSER SECTION						DISCHARGE CANAL	
		21	22	23	24	25	26	1 meter	3 meters
TIME									
1355	FREE	O/S	<.05	<.05				<.05	<.05
	TOTAL	O/S	<.05	<.05				<.05	<.05
1405	FREE	O/S	<.05	<.05				<.05	<.05
	TOTAL	O/S	<.05	<.05				<.05	<.05
1415	FREE	O/S	.40	.38				<.05	<.05
	TOTAL	O/S	.42	.42				.42	.40
1425	FREE	O/S	.53	.87				.18	.27
	TOTAL	O/S	.95	1.00				.42	.48
1435	FREE	O/S			.21	<.05	<.05	<.05	.13
	TOTAL	O/S			.26	<.05	<.05	.34	.38
1445	FREE	O/S			.54	1.51	<.05	<.05	<.05
	TOTAL	O/S			.62	1.62	.15	.20	.49
1455	FREE	O/S			<.05	1.70	.18	.10	.12
	TOTAL	O/S			.34	2.08	.21	.32	.39
1505	FREE	O/S			<.05	1.42	<.05	<.05	<.05
	TOTAL	O/S			<.05	1.89	<.05	.05	.05
1530	FREE					<.05		<.05	<.05
	TOTAL					<.05		<.05	<.05

REMARKS: No visible damage to the aquatic life.

INDIAN POINT STATION
CONSOLIDATED EDISON CO., INC.

DATE 5/29/75

CHLORINATION TIME: START 1400, FINISH 1500

HYPOCHLORITE (NaOCl) % 8.1

HYPOCHLORITE FEED RATE gpm 2.7

HYPOCHLORITE VOLUME gallons 170

CHLORINE DEMAND ppm 0.8

CIRCULATION WATER FLOW CHLORINATED gpm 280,000 & 420,000

CIRCULATION WATER FLOW, TOTAL gpm 720,000

		RESIDUAL CHLORINE, FREE AND TOTAL CONDENSER SECTION						DISCHARGE CANAL	
		21	22	23	24	25	26	1 meter	3 meters
TIME 1355	FREE	O/S						<.05	<.05
	TOTAL	O/S						<.05	<.05
1405	FREE	O/S	<.05	<.05				<.05	<.05
	TOTAL	O/S	<.05	<.05				<.05	<.05
1415	FREE	O/S	.19	.13				<.05	<.05
	TOTAL	O/S	.28	.16				<.05	<.05
1425	FREE	O/S	.19	.22				<.05	<.05
	TOTAL	O/S	.35	.29				.05	.06
1435	FREE	O/S			<.05	<.05	.19	<.05	<.05
	TOTAL	O/S			<.05	<.05	.26	.05	.06
1445	FREE	O/S			.12	<.05	.17	<.05	<.05
	TOTAL	O/S			.15	<.05	.19	<.05	<.05
1455	FREE	O/S			.05	<.05	.12	<.05	<.05
	TOTAL	O/S			.05	<.05	.15	.05	.05
1505	FREE	O/S			.12	<.05	<.05	<.05	<.05
	TOTAL	O/S			.15	<.05	<.05	<.05	<.05
	FREE								
	TOTAL								

REMARKS: No visible damage to the aquatic life.

INDIAN POINT STATION
CONSOLIDATED EDISON CO., INC.

DATE 6/26/75

CHLORINATION TIME: START 1400, FINISH 1500

HYPOCHLORITE (NaOCl) % 7.0

HYPOCHLORITE FEED RATE gpm 5.0

HYPOCHLORITE VOLUME gallons 300

CHLORINE DEMAND ppm 0.5

CIRCULATION WATER FLOW CHLORINATED gpm 420,000

CIRCULATION WATER FLOW, TOTAL gpm 995,000

		RESIDUAL CHLORINE, FREE AND TOTAL CONDENSER SECTION						DISCHARGE CANAL	
		21	22	23	24	25	26	1 meter	3 meters
TIME									
1355	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	<.05	<.05	<.05	<.05
1405	FREE				.19	<.05	<.05	<.05	<.05
	TOTAL				.28	.18	.08	<.05	<.05
1415	FREE				1.03	.92	<.05	<.05	<.05
	TOTAL				1.23	1.08	.09	<.05	<.05
1425	FREE				.96	.86	<.05	.05	.05
	TOTAL				1.02	.92	.08	<.05	<.05
1435	FREE	<.05	<.05	<.05				.05	.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
1445	FREE	<.05	.77	.19				.05	.07
	TOTAL	<.05	.80	.29				.05	.07
1455	FREE	.05	.50	.37				.05	.05
	TOTAL	.05	.55	.42				.05	.05
1505	FREE	<.05	<.05	<.05				<.05	<.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
	FREE								
	TOTAL								

REMARKS: Changes pump stroke for, 5.5 to 4.5
@ 1430 hrs. No visible damage to the aquatic life.

INDIAN POINT STATION
CONSOLIDATED EDISON CO., INC.

DATE 7-3-75

CHLORINATION TIME: START 1405 hrs, FINISH 1505 hrs

HYPOCHLORITE (NaOCl) % 6.0

HYPOCHLORITE FEED RATE gpm 4.0

HYPOCHLORITE VOLUME gallons 240

CHLORINE DEMAND ppm 1.8

CIRCULATION WATER FLOW CHLORINATED gpm 420,000

CIRCULATION WATER FLOW, TOTAL gpm 1,005,000

		RESIDUAL CHLORINE, FREE AND TOTAL CONDENSER SECTION						DISCHARGE CANAL	
		24	25	26	21	22	23	1 meter	3 meters
TIME 1400	FREE	<.05	<.05	<.05				<.05	<.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
1410	FREE	.29	<.05	.1				<.05	<.05
	TOTAL	.34	<.05	.14				<.05	<.05
1420	FREE	.18	<.05	.28				<.05	<.05
	TOTAL	.20	<.05	.31				.1	.1
1430	FREE	.14	.24	<.05				<.05	<.05
	TOTAL	.19	.29	<.05				.07	.07
1440	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	<.05	<.05	<.05	<.05
1450	FREE				<.05	.14	.48	<.05	<.05
	TOTAL				<.05	.24	.50	<.05	<.05
1500	FREE				<.05	.18	.22	<.05	<.05
	TOTAL				<.05	.22	.22	<.05	<.05
1510	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	<.05	<.05	<.05	<.05
	FREE								
	TOTAL								

REMARKS: No visible damage to the aquatic life.

INDIAN POINT STATION
CONSOLIDATED EDISON CO., INC.

DATE 7-10-75

CHLORINATION TIME: START 1400, FINISH 1500

HYPOCHLORITE (NaOCl) % 5.4

HYPOCHLORITE FEED RATE gpm 3.5

HYPOCHLORITE VOLUME gallons 210

CHLORINE DEMAND ppm 0.8

CIRCULATION WATER FLOW CHLORINATED gpm 420,000

CIRCULATION WATER FLOW, TOTAL gpm 1,010,000

		RESIDUAL CHLORINE, FREE AND TOTAL CONDENSER SECTION						DISCHARGE CANAL	
		21	22	23	24	25	26	1 meter	3 meters
TIME									
1355	FREE	<.05	<.05	<.05				<.05	<.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
1405	FREE	<.05	.25	.22				<.05	<.05
	TOTAL	<.05	.27	.25				<.05	<.05
1415	FREE	<.05	.35	.26				<.05	<.05
	TOTAL	<.05	.40	.29				<.05	<.05
1425	FREE	<.05	.23	.32				<.05	<.05
	TOTAL	<.05	.25	.42				<.05	<.05
1435	FREE				.16	<.05	<.05	<.05	<.05
	TOTAL				.16	.05	<.05	<.05	<.05
1445	FREE				.12	.18	<.05	<.05	<.05
	TOTAL				.12	.20	.05	<.05	<.05
1455	FREE				.08	<.05	.09	<.05	<.05
	TOTAL				.09	<.05	.13	<.05	<.05
1505	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	<.05	<.05	<.05	<.05
	FREE								
	TOTAL								

REMARKS: _____

INDIAN POINT STATION
CONSOLIDATED EDISON CO., INC.

DATE 7-17-75

CHLORINATION TIME: START 1400, FINISH 1500

HYPOCHLORITE (NaOCl) % 6.30

HYPOCHLORITE FEED RATE gpm 3.5

HYPOCHLORITE VOLUME gallons 200

CHLORINE DEMAND ppm 1.0

CIRCULATION WATER FLOW CHLORINATED gpm 840,000

CIRCULATION WATER FLOW, TOTAL gpm 867,000

		RESIDUAL CHLORINE, FREE AND TOTAL CONDENSER SECTION						DISCHARGE CANAL	
TIME		21	22	23	24	25	26	1 meter	3 meters
1355	FREE	<.05	<.05	<.05				<.05	<.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
1405	FREE	<.05	<.05	<.05				<.05	<.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
1415	FREE	<.05	.10	.10				<.05	<.05
	TOTAL	<.05	.28	.13				<.05	<.05
1425	FREE	<.05	.16	.17				<.05	<.05
	TOTAL	<.05	.23	.21				.06	<.05
1435	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	<.05	<.05	<.05	<.05
1445	FREE				<.05	<.05	.08	<.05	<.05
	TOTAL				.16	<.05	.10	<.05	<.05
1455	FREE				.10	<.05	.14	<.05	<.05
	TOTAL				.14	<.05	.16	<.05	<.05
1505	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	<.05	<.05	<.05	<.05
	FREE								
	TOTAL								

REMARKS: On next Chlor. #22 & 23 open to 1 Turn, 21 open
24 & 26 open 1 Turn, #25 open 3 turns.

INDIAN POINT STATION
CONSOLIDATED EDISON CO., INC.

DATE 7-24-75

CHLORINATION TIME: START 1400, FINISH 1500

HYPOCHLORITE (NaOCl) % 5.49

HYPOCHLORITE FEED RATE gpm 3.5

HYPOCHLORITE VOLUME gallons 200

CHLORINE DEMAND ppm 1.2

CIRCULATION WATER FLOW CHLORINATED gpm 840,000

CIRCULATION WATER FLOW, TOTAL gpm 1,029,000

		RESIDUAL CHLORINE, FREE AND TOTAL CONDENSER SECTION						DISCHARGE CANAL	
		21	22	23	24	25	26	1 meter	3 meters
TIME									
1355	FREE	<.05	<.05	<.05				<.05	<.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
1405	FREE	<.05	<.05	<.05				<.05	<.05
	TOTAL	<.05	.08	<.05				<.05	<.05
1415	FREE	<.05	.09	<.05				<.05	<.05
	TOTAL	<.05	.12	.13				.05	.05
1425	FREE	<.05	.14	.12				<.05	<.05
	TOTAL	<.05	.19	.20				<.05	<.05
1435	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	<.05	<.05	<.05	<.05
1445	FREE				<.05	.1	.08	<.05	<.05
	TOTAL				<.05	.14	.13	<.05	<.05
1455	FREE				<.05	.11	.08	<.05	<.05
	TOTAL				<.05	.18	.12	.05	.05
1505	FREE				<.05	.1	<.05	<.05	<.05
	TOTAL				<.05	.2	<.05	<.05	<.05
1510	FREE					<.05			
	TOTAL					<.05			

REMARKS: 1500 #24 .06 F .06T

No visible damage to Aquatic life.

INDIAN POINT STATION
CONSOLIDATED EDISON CO., INC.

DATE August 14, 1975

CHLORINATION TIME: START 1400 hrs, FINISH 1500 hrs

HYPOCHLORITE (NaOCl) % 4.25

HYPOCHLORITE FEED RATE gpm 4.0

HYPOCHLORITE VOLUME gallons 240

CHLORINE DEMAND ppm 1.4

CIRCULATION WATER FLOW CHLORINATED gpm 420,000

CIRCULATION WATER FLOW, TOTAL gpm 1,040,000

		RESIDUAL CHLORINE, FREE AND TOTAL CONDENSER SECTION						DISCHARGE CANAL	
		21	22	23	24	25	26	1 meter	3 meters
TIME									
1355	FREE	<.05	<.05	<.05				<.05	<.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
1405	FREE	<.05	<.05	<.05				<.05	<.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
1415	FREE	<.05	.19	.05				<.05	<.05
	TOTAL	<.05	.24	.07				<.05	<.05
1425	FREE	<.05	.14	.10				<.05	<.05
	TOTAL	<.05	.22	.15				<.05	<.05
1435	FREE				<.05	<.05	.09	<.05	<.05
	TOTAL				<.05	<.05	.10	<.05	<.05
1445	FREE				.07	<.05	.15	<.05	<.05
	TOTAL				.12	<.05	.18	<.05	<.05
1455	FREE				.07	<.05	.15	<.05	<.05
	TOTAL				.12	<.05	.21	<.05	<.05
1505	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	<.05	<.05	<.05	<.05
	FREE								
	TOTAL								

REMARKS: No visible damage to aquatic Life

INDIAN POINT STATION
CONSOLIDATED EDISON CO., INC.

DATE August 21, 1975

CHLORINATION TIME: START 1400, FINISH 1500

HYPOCHLORITE (NaOCl) % 3.63

HYPOCHLORITE FEED RATE gpm 4.0

HYPOCHLORITE VOLUME gallons 240

CHLORINE DEMAND ppm 1.3

CIRCULATION WATER FLOW CHLORINATED gpm 420,000

CIRCULATION WATER FLOW, TOTAL gpm 1,005,000

		RESIDUAL CHLORINE, FREE AND TOTAL CONDENSER SECTION						DISCHARGE CANAL	
TIME		21	22	23	24	25	26	1 meter	3 meters
1355	FREE	<.05	<.05	<.05				<.05	<.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
1405	FREE	<.05	<.05	<.05				<.05	<.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
1415	FREE	.14	<.05	.04				<.05	<.05
	TOTAL	.19	<.05	.10				<.05	<.05
1425	FREE	<.05	.18	.06				<.05	<.05
	TOTAL	<.05	.23	.11				<.05	<.05
1435	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	<.05	<.05	<.05	<.05
1445	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	.13	.05	<.05	<.05
1455	FREE				<.05	.25	<.05	<.05	<.05
	TOTAL				<.05	.30	<.05	<.05	<.05
1505	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	<.05	<.05	<.05	<.05
	FREE								
	TOTAL								

REMARKS: No visible damage to aquatic Life.

INDIAN POINT STATION
CONSOLIDATED EDISON CO., INC.

DATE August 28, 1975

CHLORINATION TIME: START 1400, FINISH 1500

HYPOCHLORITE (NaOCl) % 4.0

HYPOCHLORITE FEED RATE gpm 5

HYPOCHLORITE VOLUME gallons 300

CHLORINE DEMAND ppm 1.4

CIRCULATION WATER FLOW CHLORINATED gpm 420,000

CIRCULATION WATER FLOW, TOTAL gpm 1,005,000

		RESIDUAL CHLORINE, FREE AND TOTAL CONDENSER SECTION						DISCHARGE CANAL	
TIME		21	22	23	24	25	26	1 meter	3 meters
1355	FREE	<.05	<.05	<.05				<.05	<.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
1405	FREE	<.05	<.05	<.05				<.05	<.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
1415	FREE	<.05	.18	.08				<.05	<.05
	TOTAL	<.05	.25	.14				<.05	<.05
1425	FREE	<.05	.11	.10				<.05	<.05
	TOTAL	<.05	.21	.13				<.05	<.05
1435	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	<.05	<.05	<.05	<.05
1445	FREE				<.05	<.05	.25	<.05	<.05
	TOTAL				<.05	<.05	.36	<.05	<.05
1455	FREE				.13	<.05	.20	<.05	<.05
	TOTAL				.22	<.05	.24	<.05	<.05
1505	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	<.05	<.05	<.05	<.05
	FREE								
	TOTAL								

REMARKS: No visible damage to aquatic Life.

INDIAN POINT STATION
CONSOLIDATED EDISON CO., INC.

DATE 9/4/75

CHLORINATION TIME: START 1400, FINISH 1500

HYPOCHLORITE (NaOCl) % 3.70

HYPOCHLORITE FEED RATE gpm 4.0

HYPOCHLORITE VOLUME gallons 240

CHLORINE DEMAND ppm 1.5

CIRCULATION WATER FLOW CHLORINATED gpm 420,000

CIRCULATION WATER FLOW, TOTAL gpm 1,005,000

		RESIDUAL CHLORINE, FREE AND TOTAL CONDENSER SECTION						DISCHARGE CANAL	
		21	22	23	24	25	26	1 meter	3 meters
TIME									
13:55	FREE	<.05	<.05	<.05				<.05	<.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
14:05	FREE	<.05	<.05	<.05				<.05	<.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
14:15	FREE	<.05	<.05	.05				<.05	<.05
	TOTAL	<.05	.05	.08				<.05	<.05
14:25	FREE	<.05	.05	.06				<.05	<.05
	TOTAL	<.05	.06	.08				<.05	<.05
14:35	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	<.05	.05	<.05	<.05
14:45	FREE				<.05	.20	<.05	<.05	<.05
	TOTAL				<.05	.29	<.05	<.05	<.05
14:55	FREE				<.05	.26	<.05	<.05	<.05
	TOTAL				<.05	.31	<.05	<.05	<.05
15:05	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	<.05	<.05	<.05	<.05
	FREE								
	TOTAL								

REMARKS: No visible damage to Aquatic Life.

INDIAN POINT STATION
CONSOLIDATED EDISON CO., INC.

DATE 9-18-75

CHLORINATION TIME: START 1400, FINISH 1500

HYPOCHLORITE (NaOCl) % 3.4

HYPOCHLORITE FEED RATE gpm 4.0

HYPOCHLORITE VOLUME gallons 240

CHLORINE DEMAND ppm 1.0

CIRCULATION WATER FLOW CHLORINATED gpm 420,000

CIRCULATION WATER FLOW, TOTAL gpm 1,005,000

		RESIDUAL CHLORINE, FREE AND TOTAL CONDENSER SECTION						DISCHARGE CANAL	
		21	22	23	24	25	26	1 meter	3 meters
TIME									
13:55	FREE	.05	.05	.05				<.05	<.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
14:05	FREE	<.05	<.05	<.05				<.05	<.05
	TOTAL	<.05	<.05	<.05				<.05	<.05
14:15	FREE	<.05	.13	.11				<.05	<.05
	TOTAL	<.05	.17	.13				<.05	<.05
14:25	FREE	.12	<.05	.16				.05	.05
	TOTAL	.15	<.05	.20				.05	.05
14:35	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	<.05	<.05	<.05	<.05
14:45	FREE				.19	<.05	.05	<.05	<.05
	TOTAL				.24	<.05	.07	<.05	<.05
14:55	FREE				.21	<.05	.05	<.05	<.05
	TOTAL				.27	<.05	.05	<.05	<.05
15:05	FREE				<.05	<.05	<.05	<.05	<.05
	TOTAL				<.05	<.05	<.05	<.05	<.05
	FREE								
	TOTAL								

REMARKS: No visible damage to Aquatic Life

Attachment 3

Thermal Plume Evaluation Program of Indian Point Nuclear Power Plant

by

H. Moy, L. Paretsky, R. Navarrete, and J. Szeligowski

THERMAL PLUME EVALUATION PROGRAM OF INDIAN POINT NUCLEAR POWER PLANT

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ABSTRACT

A thermal plume study has been formulated by Con Edison to demonstrate that plant thermal discharges from the Indian Point Unit No. 2 station to the Hudson River will satisfy all applicable water quality criteria. This program consists of physical modelling, mathematical analysis and field surveys. Two distinct physical models were used: a 1/75 scale, undistorted model for obtaining detailed temperature patterns in the vicinity of the discharge structure, and an overall distorted scale model for obtaining far field temperature patterns. A one-dimensional, tidal average hydrothermal mathematical model in which the Hudson River is separated into 28 longitudinal segments was developed; therefore, space-variable parameters, such as river geometry, dispersion coefficient and thermal stratification, can be introduced for computation. The field surveys provided field data for assessing the predictive capabilities of the physical and mathematical model. Model-prototype comparisons indicate that both the physical and analytical models tend to be conservative; that is, predict greater than measured extents for the thermal plume.

INTRODUCTION

Indian Point Unit No. 2 is a 906 MWe (unit gross rating) pressurized water reactor power plant located on the east shore of the Hudson River estuary, about 43 miles north of the Battery, near the Village of Buchanan, New York. (The station consists of three units, Indian Point Unit Nos. 1, 2 and 3). The condenser heat load, which is about 6.25 billion Btu/hr., is rejected to a once-through cooling system with a submerged multiport discharge structure (Figure 1).

The New York State thermal discharge criteria applicable to the Hudson River estuary are as follows:

> The water temperature at the surface of an estuary shall not be raised to more than 90°F at any point provided further, at least 50 percent of the cross sectional area and/or volume of the flow of the estuary including a minimum of one third of the surface as measured from water edge to water edge at any stage of tide, shall not be raised to more than 4°F over the temperature that existed before the addition of heat of artificial origin or to a maximum of 83°F, whichever is less. However, during July through September if the water temperature at the surface of an estuary before the addition of heat or artificial origin is more than 83°F, an increase in temperature not to exceed 1.5°F, at any point of the estuarine passageway as delineated above, may be permitted.

Prior to full power operation of Indian Point Unit No. 2 in 1973, both physical and analytical models were developed as predictive tools for describing the hydrothermal response of the Hudson River to the thermal effluent of Unit No. 2 and other neighboring power plants. The results of the model studies have been incorporated into the Indian Pint 2 Environmental Report and its supplements which have been reviewed by various governmental agencies, incuding the United States Nuclear Regulatory Commission (NRC), United States Environental Protection Agency, and the New York State Department of Enviromental Conservaton (DEC). In 1973, Con Edison received from NRC a facility operating license and from EPA a discharge permit (pursuant to Section 402 of the FWPCA) for Indian Point Unit No. 2. The provisions contained in these regulatory documents required Con Edison conduct a thermal monitoring program to evaluate the thermal effluent from Indian Point Unit No. 2 for purposes of comparision with both the thermal dishcarge criteria and the predictions from the physical and mathematical models.

This paper discusses the technical aspects of the physical and mathematical models, field study and model-prototype comparision.

PHYSICAL MODEL

A physical model is a small scale physical structure simulating the geometry and hydrology of both the thermal

effluent and the receiving water body. The basic dynamic and kinematic similitude of physical modeling is based on the relative magnitude of inertial to gravity forces, which is represented by the Froude number for flow with a constant density fluid, and by the densimetric Froude number for stratified flow. The Froude numbers should be equal between model and prototype for both free surface and internal density phenomena occur simultaneously.

Two distinct physical models were developed by Alden Research Laboratories (ARL):

1. Near field hydrothermal characteristics of the thermal effluent were investigated using an undistorted 1/75 scale model which simulated an area 4000 feet long by 2000 feet wide centered about the dishcarge. Currents ranging 0.5 to 2.0 feet per second can be simulated in both ebb and flood directions.

2. Far field thermal plume phenomena were investigated by a distorted scale model, 1/80 vertical and 1/400 horizontal, covering 17 miles of the river as shown in Figure 2. In this model, near field jet mixing phenomena were adjusted by modification of the outfall configuration to duplicate temperature patterns obtained from the undistorted scale model.

The physical models are located inside a building for control of atmospheric conditions to assure constant ambient temperature. However, water-atmosphere interface heat exchange could not be independently controlled. Since fresh water was employed in all tests, salinity variations could not be simulated. Temperature measurements were made with thermocouple sensors, and digital computer controlled data sampling and data processing. Temperature patterns were recorded at one-hour (prototype time scale) intervals for several complete tidal cycles.

MATHEMATICAL MODEL

The Hudson is an estuary which might probably be best described by a multi-dimensional transient mathematical model. However, seeking a numerical solution to such a set of differential equations governing the mass and energy

transport phenomena of estuarine thermal dispersion is difficult.

A simple, practical analytical model was developed for the Indian Point study. This is a multi-segment one-dimensional steady-state model capable of accepting multiple thermal discharges. The river is mathematically separated into 28 segments; therefore, space-variable parameters, such as river geometry, dispersion coefficient and thermal stratification, can be realistically introduced for computation.

The differental equation resulting from the energy balance on a river element is as follows:

$$E_i \cdot \frac{d^2\Delta\bar{T}_i}{dx^2} - \frac{Q_i}{A_i} \cdot \frac{d\Delta\bar{T}_i}{dx} - \frac{\bar{K}_i B_i (TSF)_i}{\rho C_p A_i} \cdot \Delta\bar{T}_i = 0$$

where

$\Delta\bar{T}$ = tidal-smoothed, area-averaged temperature rise, °F

E = longitudinal dispersion coefficient, Ft²/day
Q = river freshwater flow, feet³/day
A = cross-sectional area of the estuary, feet²
$\bar{K}$ = heat transfer coefficient, BTU/feet²/day/°F
B = top width of the estuary, feet
TSF = thermal stratification factor, $\Delta\bar{T}s/\Delta\bar{T}$
$\Delta\bar{T}_s$ = surface average temperature rise, °F
ρ = water density, lb/feet³
C_p = heat capacity, BTU/lb/°F
i = segment subscript; i = 1,2,3,....,n and n=28
L = segment length, feet
x = distance along river

The general solution of the ordinary differential equation above is:

$$\Delta\bar{T}_i = C_i \exp(J_i x) + D_i \exp(k_i x)$$

in which

$$\begin{matrix} J_i \\ k_i \end{matrix} = \frac{Q_i}{2A_iE_i} \left\{ 1 \pm \left[1 + \frac{4\bar{k}_i B_i (TSF)_i E_i A_i}{\rho C_p Q_i^2} \right]^{1/2} \right\}$$

The integration constants, Ci and Di can then be determined by the boundary conditions.

B.C. 1: $\Delta\bar{T}(\chi=0) = 0$

B.C. 2: $\Delta\bar{T}(\chi=\sum_{i=1}^{n}\chi_i)=0$

B.C. 3: $\Delta\bar{T}_i(\chi=\sum_{i=1}^{i}\chi_i) = \Delta\bar{T}_{i+1}(\chi=\sum_{i=1}^{i}\chi_i)$; $i=1,2,\cdots,(n-1)$

B.C. 4: $H_i=\rho C_p\left\{E_iA_i\frac{d\Delta\bar{T}_i}{d\chi} - E_{i+1}A_{i+1}\frac{d\Delta\bar{T}_{i+1}}{d\chi}\right\}_{\chi=\sum_{i=1}^{i}\chi_i}$; $i=1,2,\cdots(n-1)$

The first two boundary conditions represent zero excess temperature at the upper and lower ends of the Hudson River. Boundary Conditons 3 and 4 state equality of temperature and a conservation of enegy (Hi) at intermediate sections, respectively.

Once the tidal-averaged, area averaged temperture rise ($\Delta\bar{T}$) is calculated, the surface average temperature rise ($\Delta\bar{T}_S$) can then be computed by

$$(\Delta\bar{T}_S)_i = (\Delta\bar{T})_i \cdot (TSF)_i$$

Two empirical equations were developed to predict the cross-sectional areas (α_χ) and surface width (β_χ) of the river bounded by an isotherm representing a specific temperature rise (ΔT_χ).

$$\alpha_\chi = \frac{1}{\hat{K}_1}\cdot \ln\left(\frac{\Delta\hat{T}_A}{\Delta T_\chi}\right)$$

$$\beta_\chi = \frac{1}{\hat{K}_2}\cdot \ln\left(\frac{\Delta\hat{T}_S}{\Delta T_\chi}\right)$$

where the decay parameters $\hat{K}1$ and $\hat{K}2$ can be evaluated by the equations:

$$\frac{\Delta T}{\Delta\hat{T}_A} = \left[\frac{1}{\hat{K}_1 A}\right]^{(1-\exp\{-\hat{K}_1 A\})}$$

$$\frac{\Delta T_S}{\Delta\hat{T}_S} = \left[\frac{1}{\hat{K}_2 B}\right]^{(1-\exp\{-\hat{K}_2 B\})}$$

and A and B are the river cross-sectional area and surface width, and $\Delta\hat{T}_A$ and $\Delta\hat{T}_S$ are the maximum cross-sectional area and maximum surface temperature rises at a specific cross plane of the river.

FIELD PROGRAM

The field program was geared to satisfy two complementary objectives. (1) provide data in describing the spatial and temporal characteristics of the thermal plume, and (2) provide data for estimating the physical parameters used in the aforementioned hydrothermal models to enable a model-prototype comparison.

The Indian Point Unit No. 2 field survey program, which was conducted from May 1974 to may 1975, consisted of nine thermal surveys: six routine and three intensive surveys.

A routine thermal survey consists of measurements of the intensity and extent of the Indian Point plume over five successive tidal phases - that is 1 1/4 tidal cycles (i.e., maximum ebb, low water slack, maximum flood, high water slack and maximum ebb again). Data from a routine survey was sufficient to describe the general pattern of the thermal plume and thus could be used for comparison with the thermal critiera.

An intensive thermal survey consists of similar measurements conducted over four or five successive tidal phases for three or four days. Also more detailed measurements (than in a routine survey) of ancillary hydrological and meteorological parameters are acquired. Therefore, data from an intensive survey are utilized for model analysis.

Summary data from the Indian Point Unit No. 2 thermal survey program are shown in Table 1.

The methodology used to acquire thermal plume temperature information was common to both routine and intensive surveys, and is based upon the fact that plume behavior varies with distance from the discharge. A thermal plume is usually divided into near field, intermediate field, and far field regions. The near field is the region in the immediate vicinity of the discharge, where the initial momentum of the effluent jet governs the temperature distribution of the plume. The far field is the region wherein the effect of jet momentum is negligible; and the resultant temperature patterns are determined by the ambient currents of the receiving waterbody and atmospheric heat transfer. In the intermediate field, both the momentum of the effluent jet and ambient waterbody currents influence the plume pattern. Figure 3 depicts these regions.

Recalling that Indian Point has a submerged multiport discharge structure, the actual plume measurements can therefore be divided into those conducted in the near and

intermediate field, and those obtained in the far field; because the plume in the near and intermediate field extends to a greater depth than in the far field. During the surveys, at least two boats were used, one for the near and intermediate region and the other for the far field. Near field measurements were obtained via a string of thermistors extending to a depth of about 20 feet, attached to a vessel making a criss-cross pattern over the near and intermediate field. The far field was mapped through the use of thermistors concentrated near the surface (up to a depth of six feet), with the vessel making many transects across the river. Vessel speed ranged from 2 to 8 knots, with the temperature being continuously recorded. This pattern was repeated over each phase of the tidal cycle. An electronic navigation system (a Motorola Mini-Ranger) on each vessel gave the location of each temperature measurement with respect to the shore based transponders. The temperatures, location and time of each measurement was recorded either on magnetic tape of by a printer as the boat scans the plume. Figure 4 depicts the scanning arrangements.

The plume measurements from the near and far field patterns were both combined to present the total temperature pattern. Figures 5 to 9 illustrate typical ebb and flood patterns. The decrease in temporal with depths as well as the buoyant behavior of the plume can be noted from comparison the surface flood pattern (Figure 5) with the 3-foot depth (Figure 6) and 14-foot depth flood patterns (Figure 7). The surface and 3-foot ebb patterns are shown in Figures 8 and 9 respectively. Station output during this survey was approximately 270 MWe (net) and 770 MWE (net) for Unit Nos. 1 and 2, respectively.

The acquisition of the hydrogical and meteorological data necessary for comparison with the models can best be described by reference to the specific parameters: **

(a) fresh water flow: the fresh water flow past Indian Point is obtained by multiplying the recorded fresh water flow at the upstream head of the Hudson (at Troy Dam) by a factor obtained from historical records;

(b) meteorological data: The meteorological data, including air temperature, relative humidity, wind speed and solar radiation is obtained from a meteorological station located at the site. This data is necessary to evalute the heat transfer coefficient for model analysis;

** Calculations and analyses of these parameters appears in Dames&Moore and Con Edison 1974.

HCM

(c) longitudinal dispersion coefficient: this parameter is estimated from the measured salinity distribution in the river;

(d) thermal stratification factor: this parameter is evaluated from the three dimensional isotherm patterns constructed from the plume temperature data.

MODEL-PROTOTYPE COMPARSION

The physical and mathematical models described previously were tested for conditions similar to the prototype on the 20 through 24 August, 1974, and 22 through 24 October, 1974. Input parameters for model testing include plant heat load, fresh water flow, surface heat exchange, thermal stratification factors and longitudinal dispersion coefficients. To avoid repetition, model-prototype comparision for the August 1974 thermal survey is selected for presentation.

Analyses on Physical Modeling

A total of three tests series were conducted using the physical models:

August, 1974 Survey Simulation

Test Series No.	Fresh Water Flow, cfs		Heat Transfer Coeff. Btu/ft.^{2}-day-°F	
	Model	Prototype	Model	Prototype
2	6,400	6,400	149	178-200
7	35,000	6,400	145	178-200
13	20,800	6,400	149	178-200

Isotherms representing flood and ebb conditions are shown in Figures 10 and 11.

A comprehensive analysis reveals that, in general, the surface isotherm pattern predicted by the model bears a remarkable similarity to the prototype result; however, the former is found to be highly conservative when recorded freshwater runoff values were directly simulated (i.e., the model prediction for a specific isotherm pattern is exaggerated). As illustrated in Figure 12 the overall surface isotherm patterns from both the model and the

prototype are similar, yet by comparing individual isotherms of identical strength (temperature rise), the field conditions have been over-estimated by the model.

The conservatism of the model is primarily due to the lack of similitude in physical modelling. The most severe limitation of the existing model is its incapability in simulating in an estuary the natural phenomena of net non-tidal flow as a result of salinity intrusion due to upstream moving seawater coupled with a counter current flow of fresh water.

This two layer counterflow would result in a vertical mixing, and, thus, the effective water available for thermal dilution is much higher than the freshwater runoff. The physical model is not equipped to simulate such a two-layer flow. In an attempt to account for the added dilution due to the two-layer flow, the freshwater flow rate used in the model tests was increased in accordance with the hydrological analysis for the Hudson River. Figures 13A and 13B presented the physical model surface isotherm pattern for flood for the August survey with freshwater flow of 20,800 cfs and 35,000 cfs, respectively. By comparing Figure 13 to Figure 12 it is observed that the magnitude of the surface isotherms were underestimated by a freshwater flow rate higher than 20,800 cfs. A freshwater flow between 6,400 cfs and 20,800 cfs could probably be the best value in order to duplicate flood data of the August survey. However, the optimum freshwater flow for duplicating the ebb data of the August survey was between 20,800 cfs and 35,000 cfs.

The second "lack of similitude" of the ARL's distorted scale model involves the modelling of the outfall structure of the Lovett power plant. Because of insufficient field data, the Lovett outfall has not been satisfactorily calibrated. Basically, the lateral spread of the Lovett thermal plume employed in the model was larger than indicated by the field data. As a result of this modelling shortcoming, the thermal impact attributable to the operation of the Lovett power plant has been grossly exaggerated as shown in Figure 14. It is noticed that by incrasing the model freshwater flow from 6,400 cfs, which is the estimated freshwater flow, to 35,000 cfs, the 4°F temperature rise isotherm attributable to the operation of Indian Point power plant was forced to duplicate the prototype data. The thermal plume emanating from the Lovett discharge appeared to be insensitive to the adjustment of freshwater flow. Nevertheless, the exaggeration of the Lovett thermal plume, laterally and longitudinally, is obvious by comparing Figure 14A to Figures 14B and 14C.

Other modelling limitations which cannot be ignored include:

(1) the inability to simulate the surface heat exchange rate,

(2) the difficulty of duplicating the tide state and velocities, and

(3) the loss of heat due to warm water transfer through the downstream boundaries.

Analysis on Mathematical Model

Figure 15 presents the comparisin between the analytical model prediction and the field data, using August 20, 1974 conditon. Included in the simulation are the heat discharge from two downstream facilities, Lovett and Bowline Generating Stations. As can be seen, the model prediction is conservative, for it overestimates the intensity of the thermal plume. This conservative behavior is probably due to the difficulty in using a steady state, analytical model to predict the transient behavior of a thermal plume. In addition, the steady state model cannot describe the intra-tidal variation in hydrological and meteorological conditions, and the unsteady operation conditions of the power plants. Nevertheless, the model can predict, conservatively, the intensity and extent of a given perturbation on the estuary, for example, what effect a reduction in fresh water flow will have on the intensity and extent of the thermal effluent.

CONCLUSION

Three methods; physical modelling, analytical modelling and field measurements have been utilized to quantify the intensity of the thermal plume from Indian Point Unit No. 2.

In general, the Indian Point Unit No. 2 thermal plume evaluation program has achieved its primary objectives. It provided data necessary for preparing various environmental statements and other official documents (including input to biological studies), and satisified various licensing conditions imposed by government agencies.

GENERAL REFERENCES

1. Consolidated Edison Company of New York, Indian Point Unit No. 2 Environmental Report, Appendix K: Effect of Indian Point Cooling Water Discharge on Hudson River Temperature Distribution, prepared by Lawler, Matusky & Skelly Engineers, February, 1969.

2. Indian Point Nuclear Generating Station Intensive Thermal Survey Program, August and October, 1974, prepared by Dames & Moore and Consolidated Edison Company of New York, March 1976.

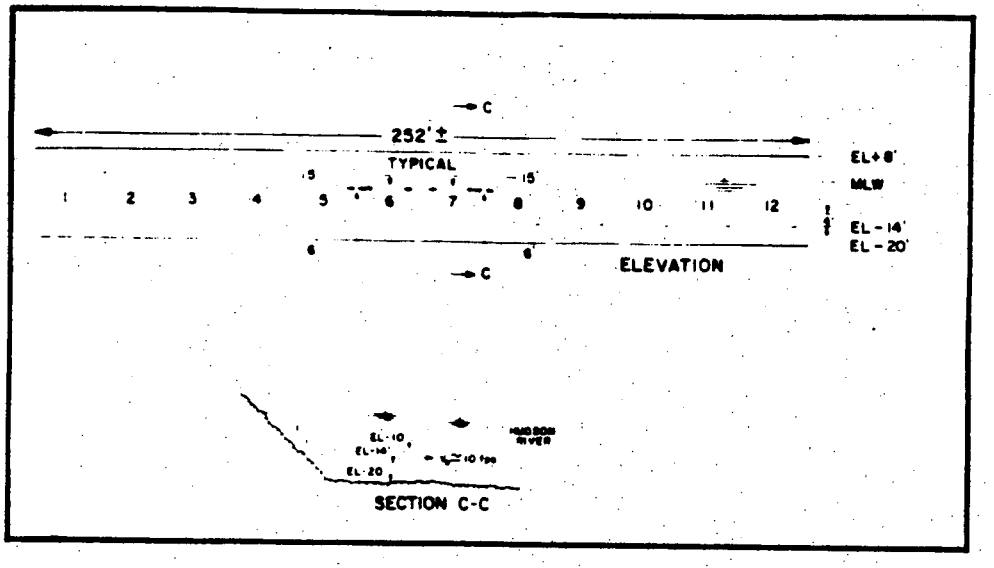


Figure 1. Details of Discharge Structure

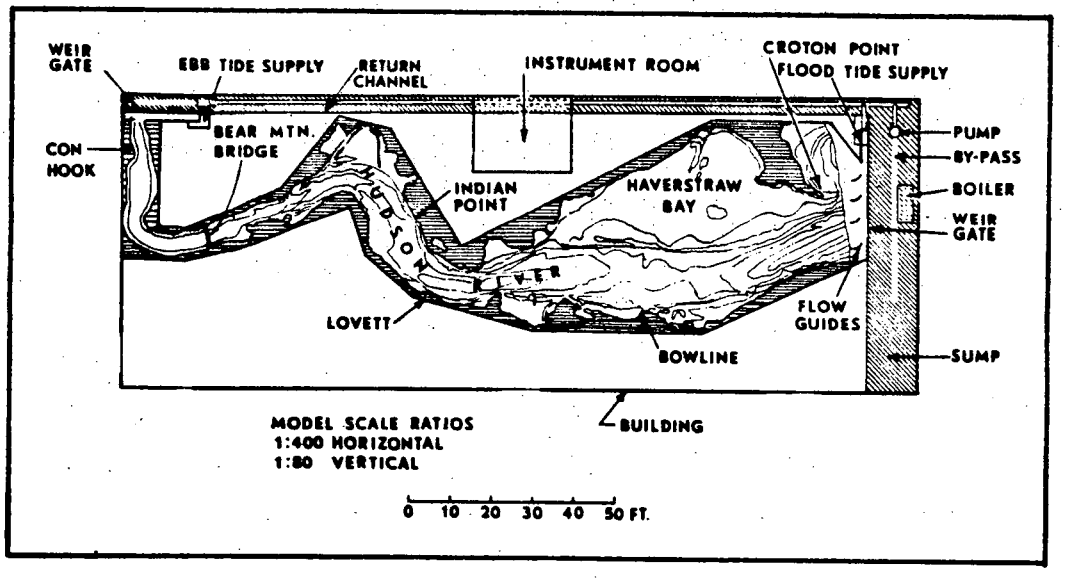


Figure 2. Distorted Physical Model

Hcm

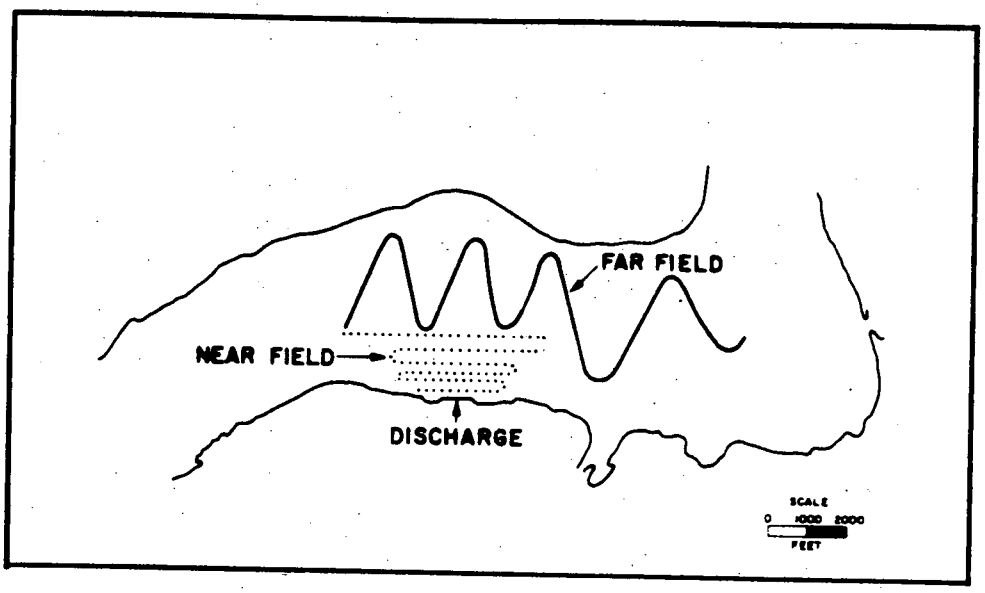


Figure 3. Typical Near & Far Field Scans

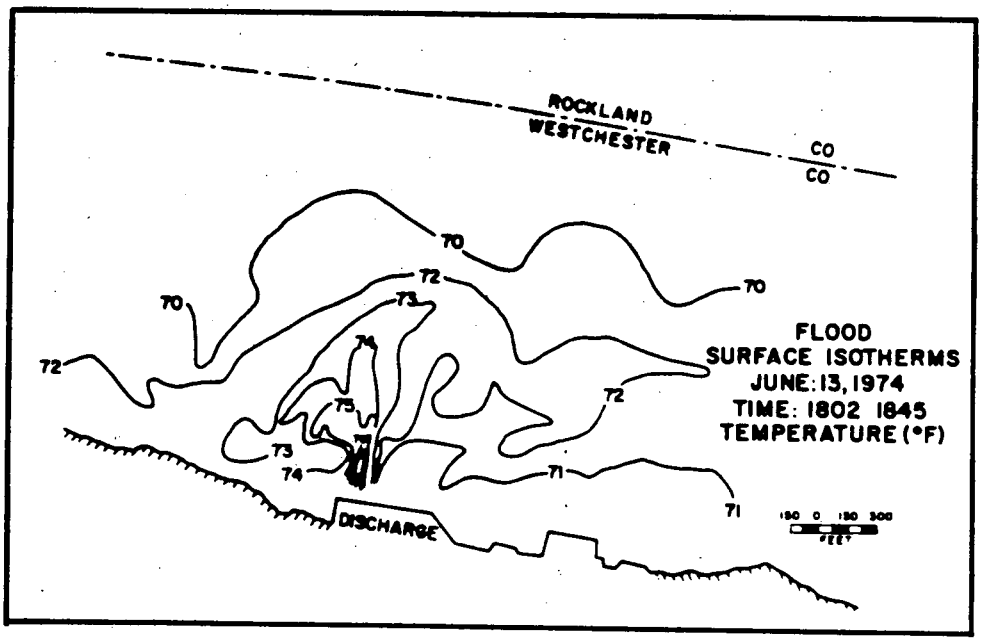


Figure 5. Flood Surface Isotherms

Hcm

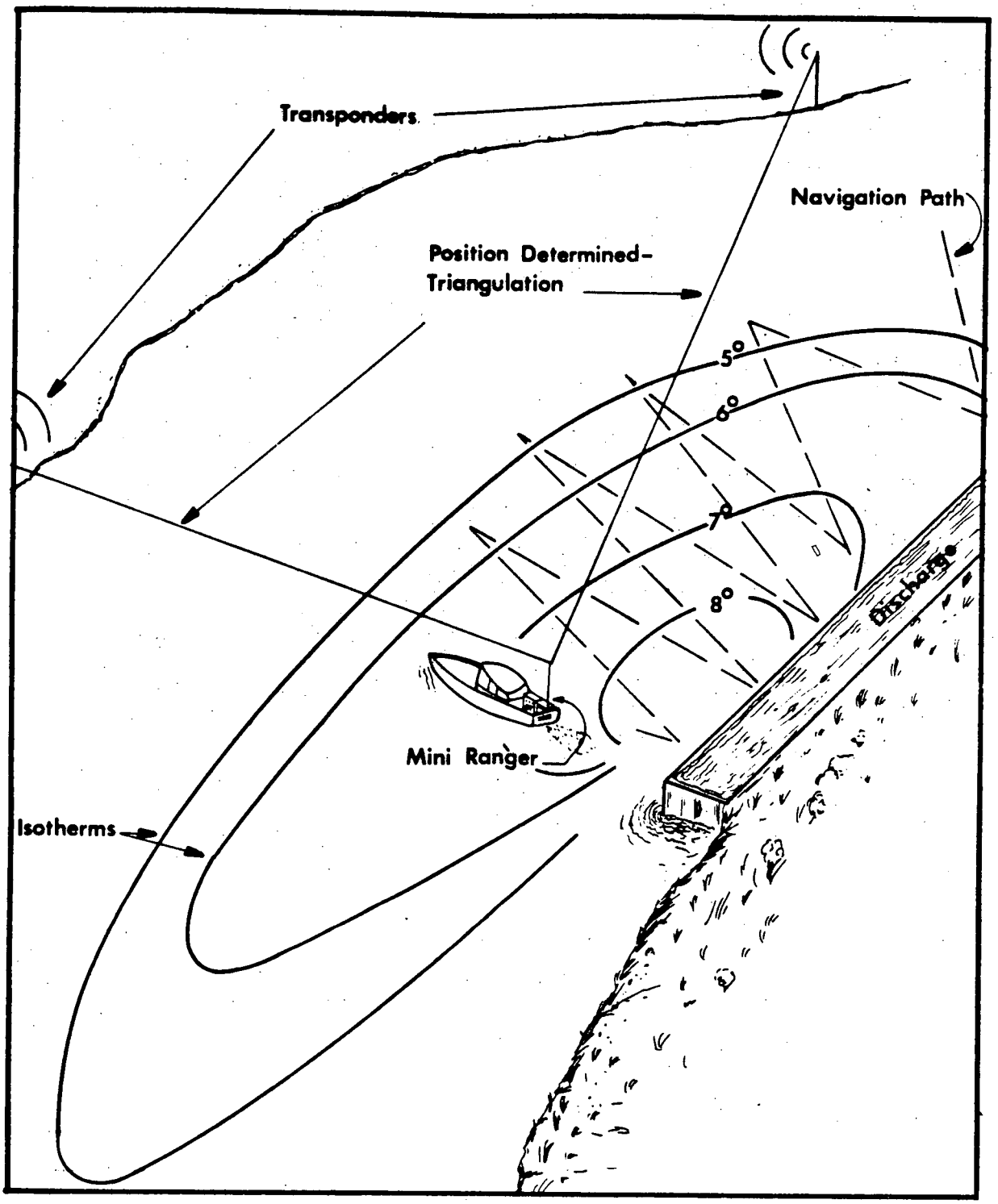


Figure 4. Schematic of Thermal Scanning

Hcm

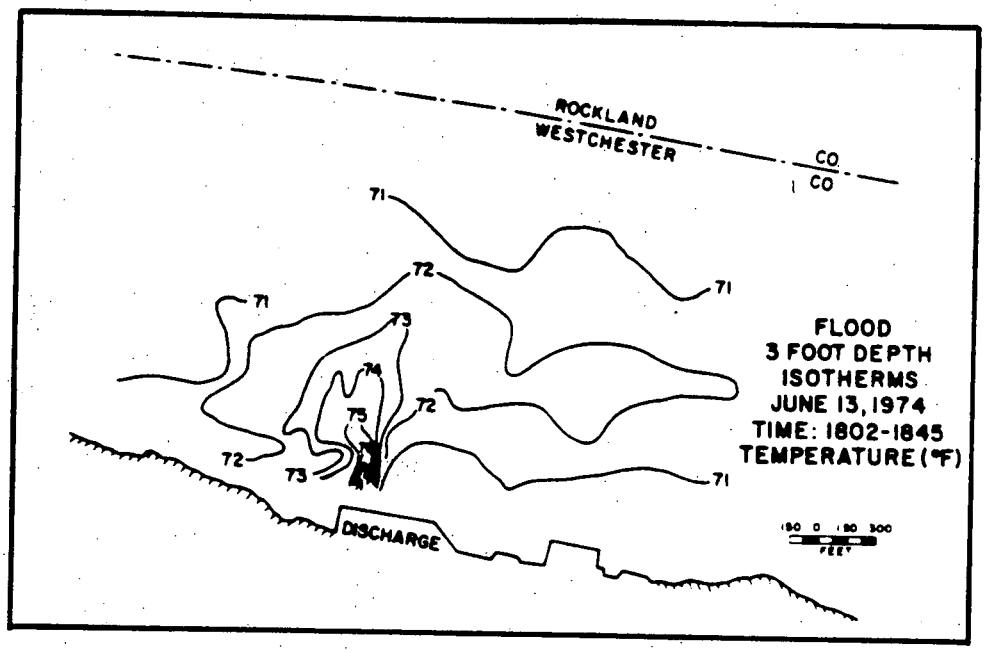


Figure 6. Flood 3-Foot Depth Isotherms

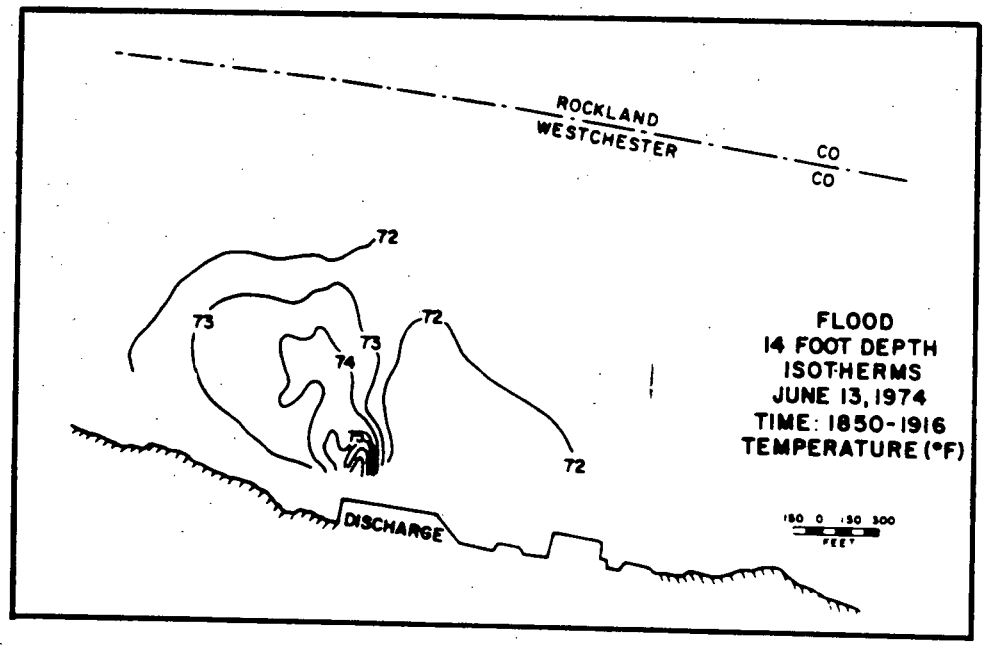


Figure 7. Flood 14-Foot Depth Isotherms

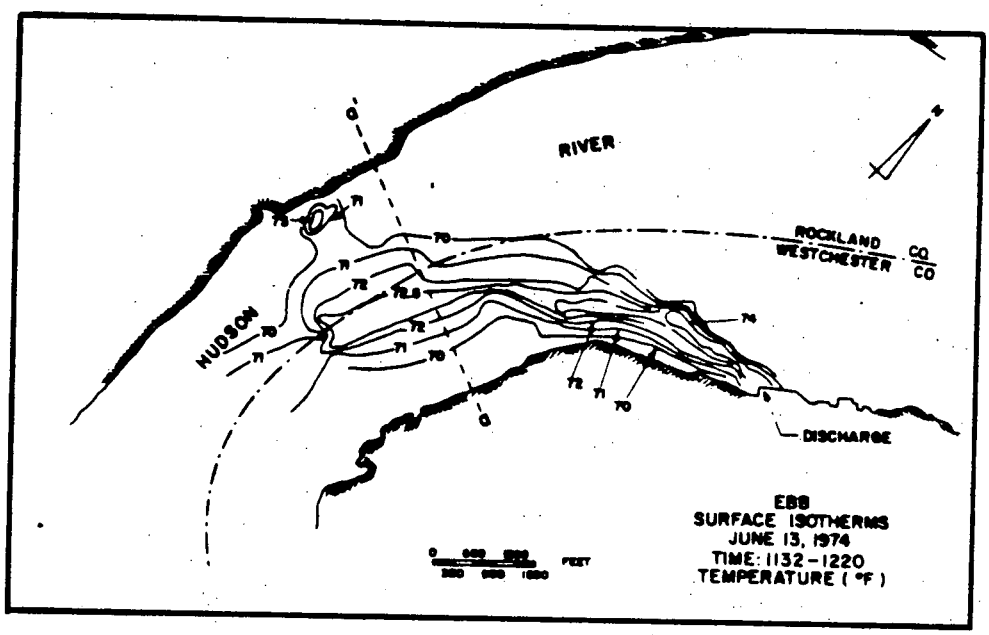


Figure 8. Ebb Surface Isotherms

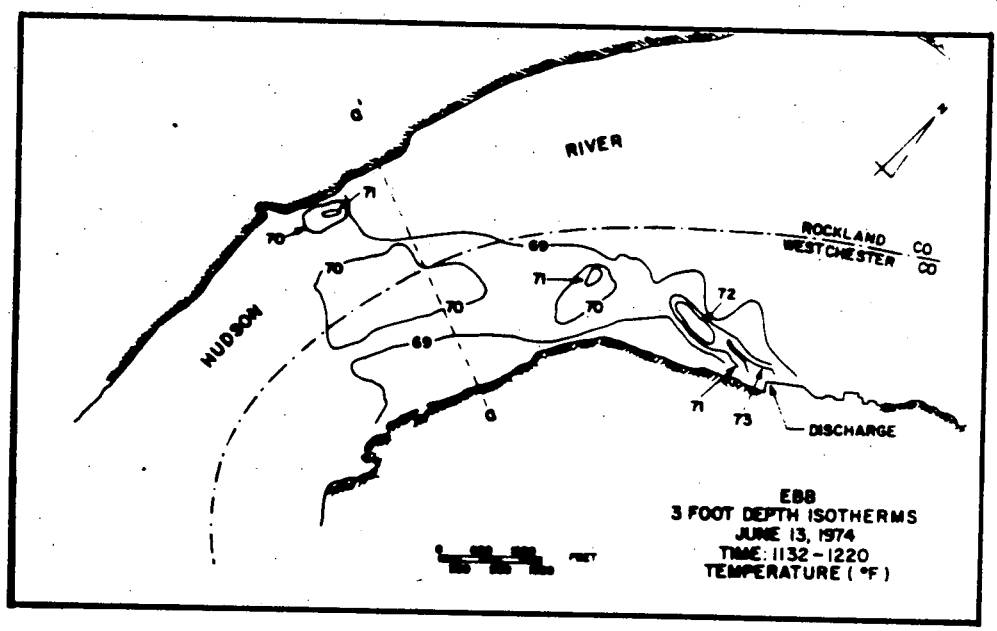


Figure 9. Ebb 3-Foot Depth Isotherms

Hcm

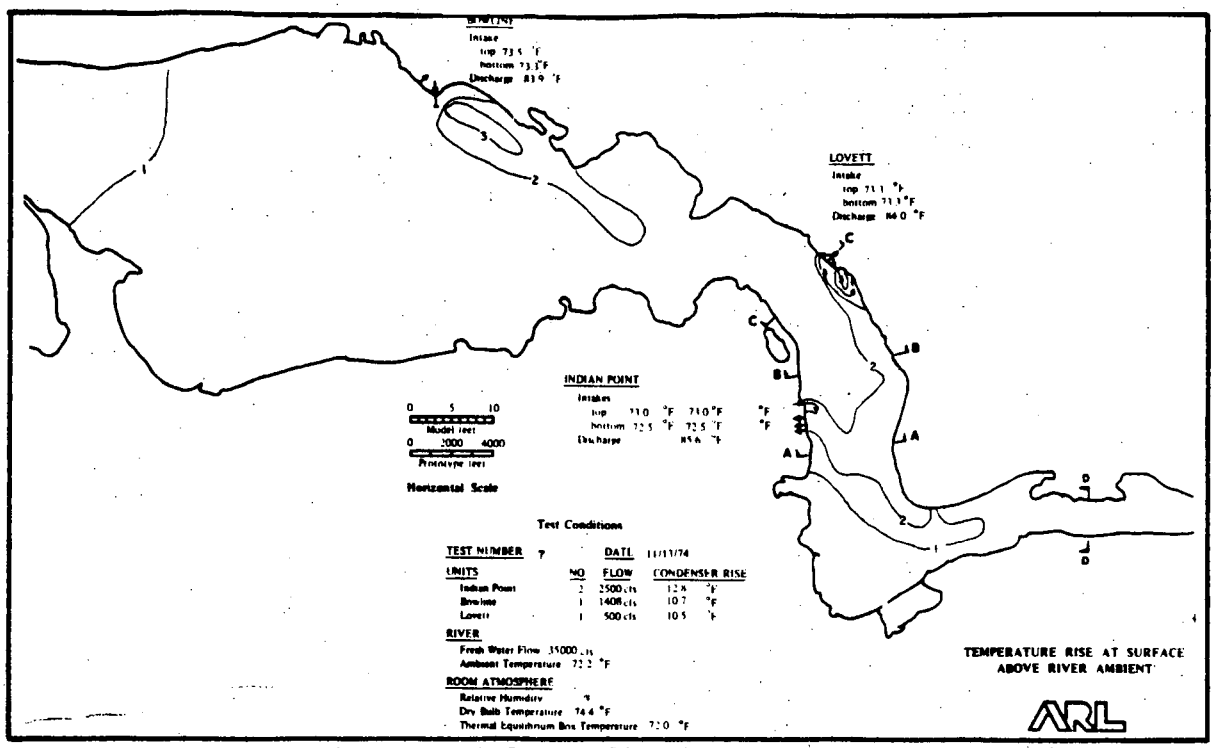


Figure 10. Physical Model Prediction - Temperature Rise at Surface of Flood for August, 1974 Survey

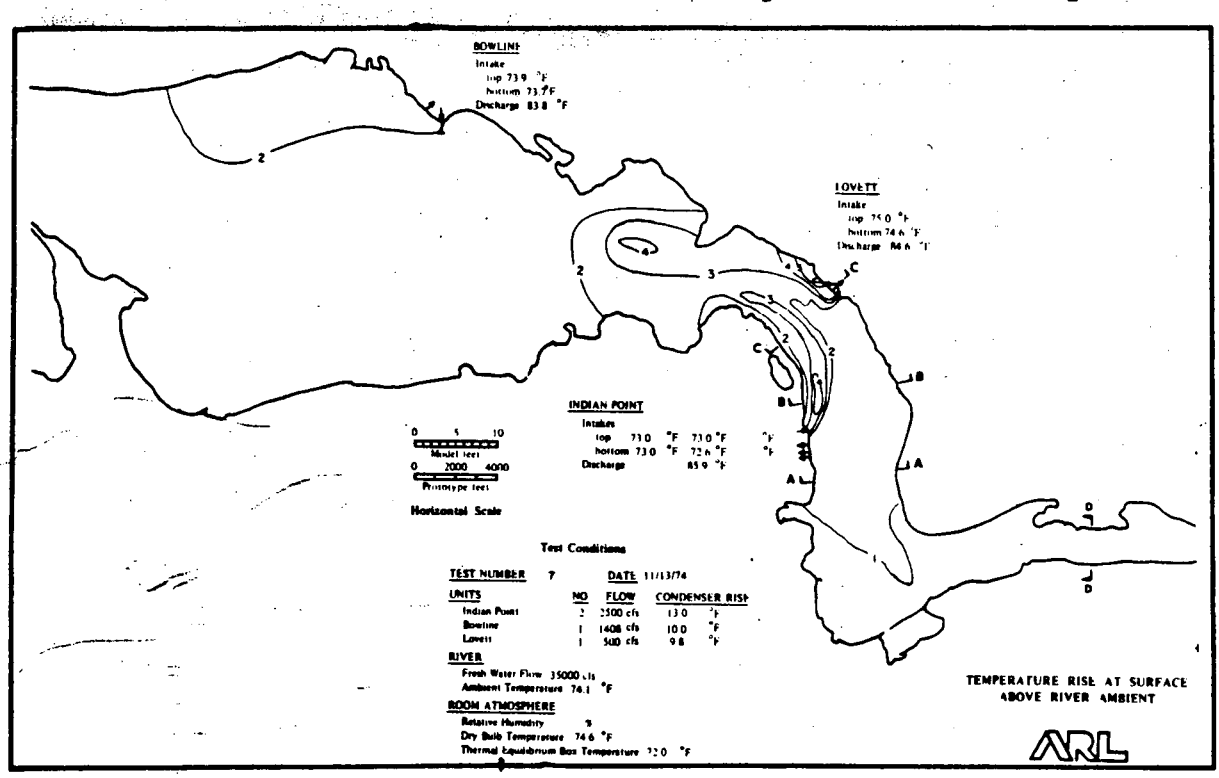


Figure 11. Physical Model Prediction - Temperature Rise at Surface of Ebb for August, 1974 Survey

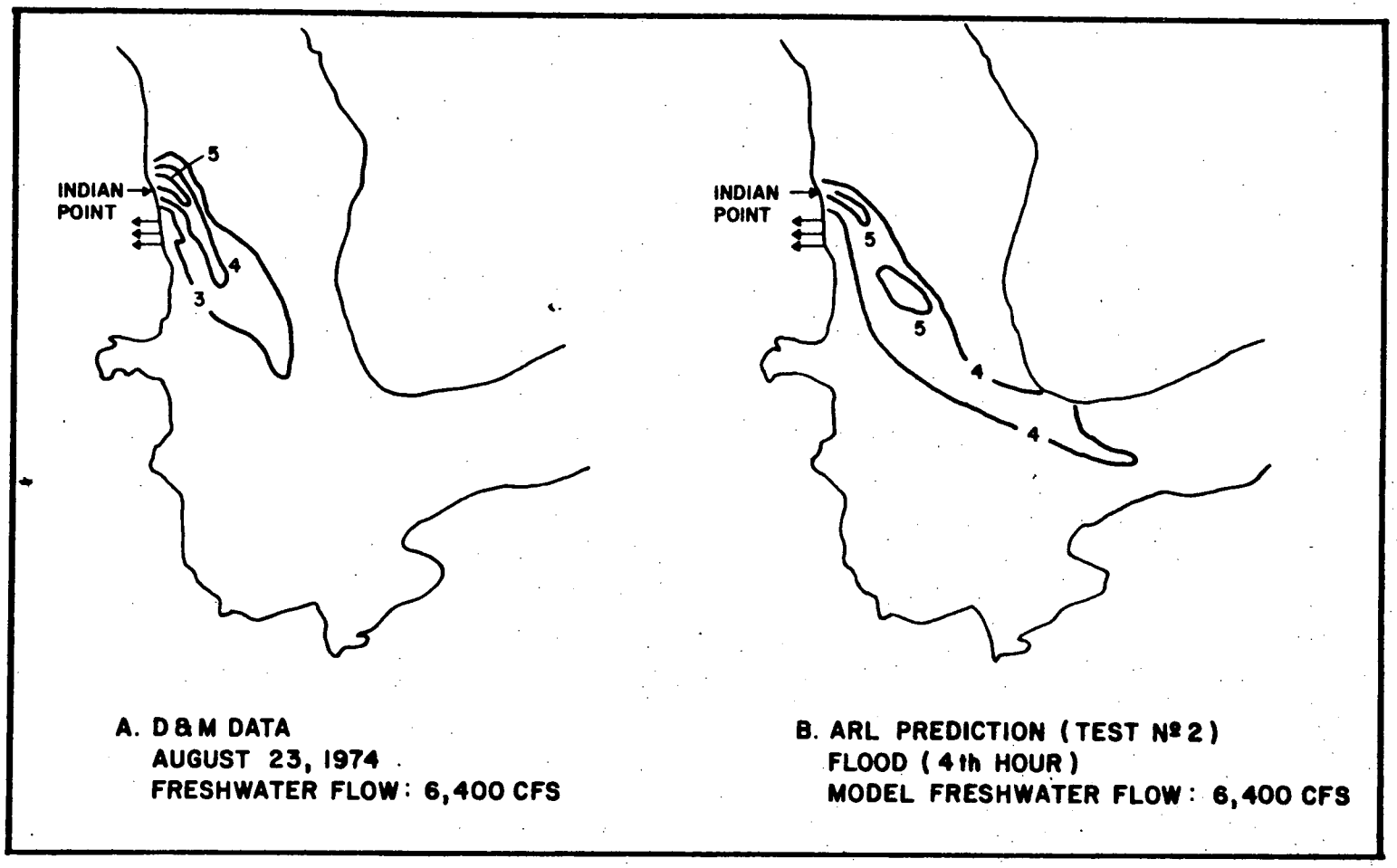


Figure 12. Comparison of Surface Isotherms of Flood for August, 1974 Survey

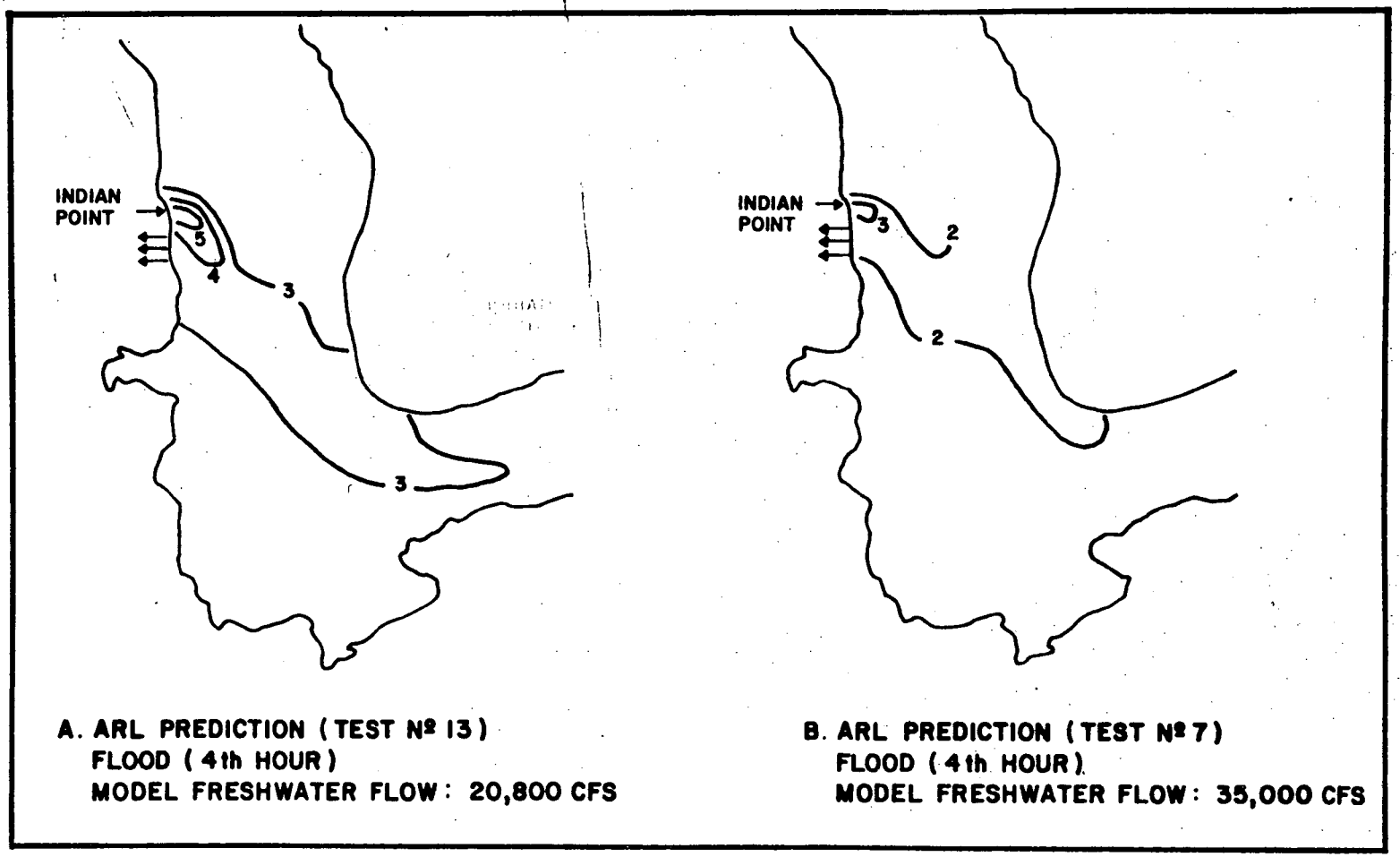
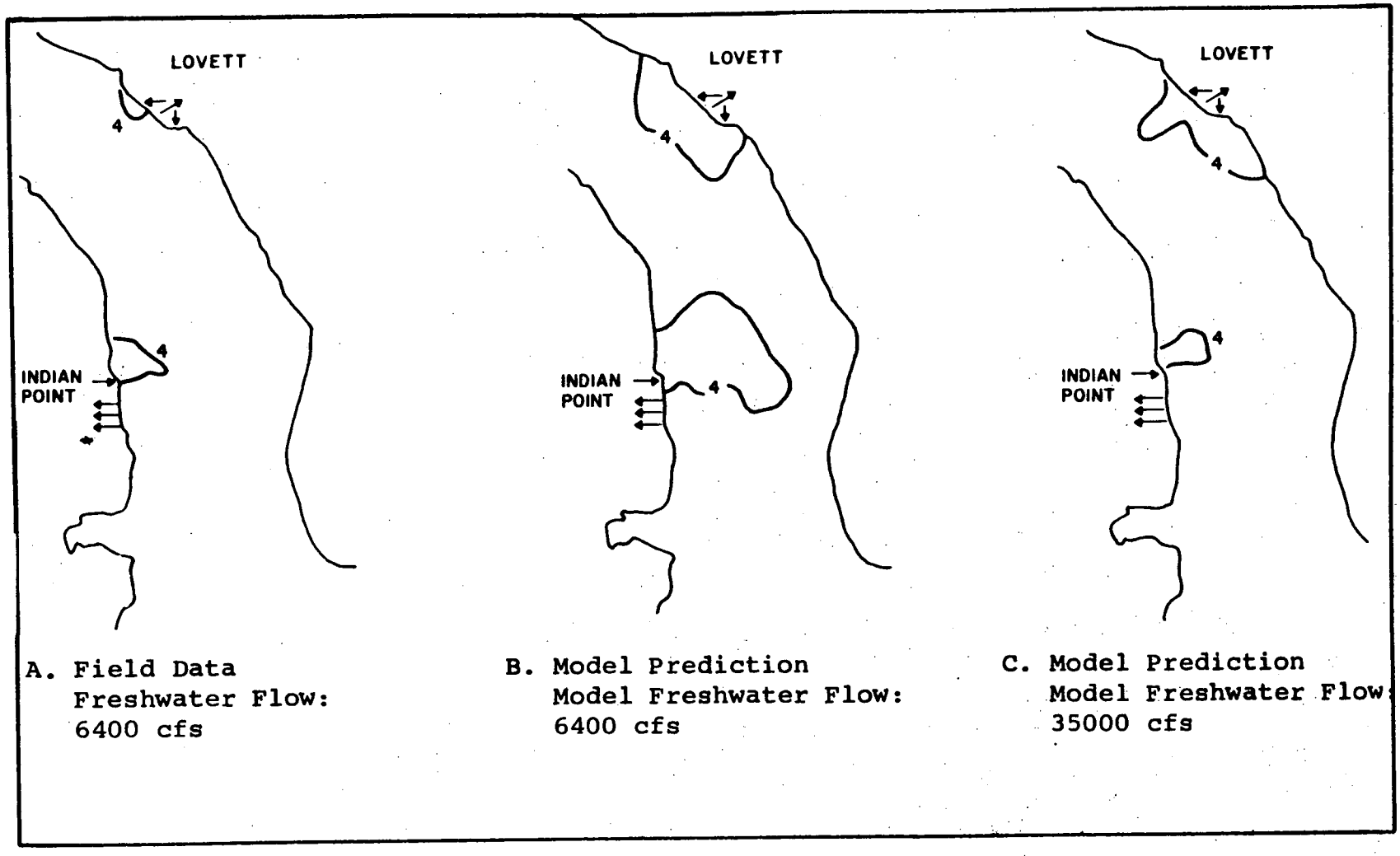


Figure 13. Model Test Results for the August, 1974 Survey with High Freshwater Flows



A. Field Data
Freshwater Flow:
6400 cfs

B. Model Prediction
Model Freshwater Flow:
6400 cfs

C. Model Prediction
Model Freshwater Flow:
35000 cfs

Figure 14. Comparison of Surface Isotherm of HWS for August 24, 1974

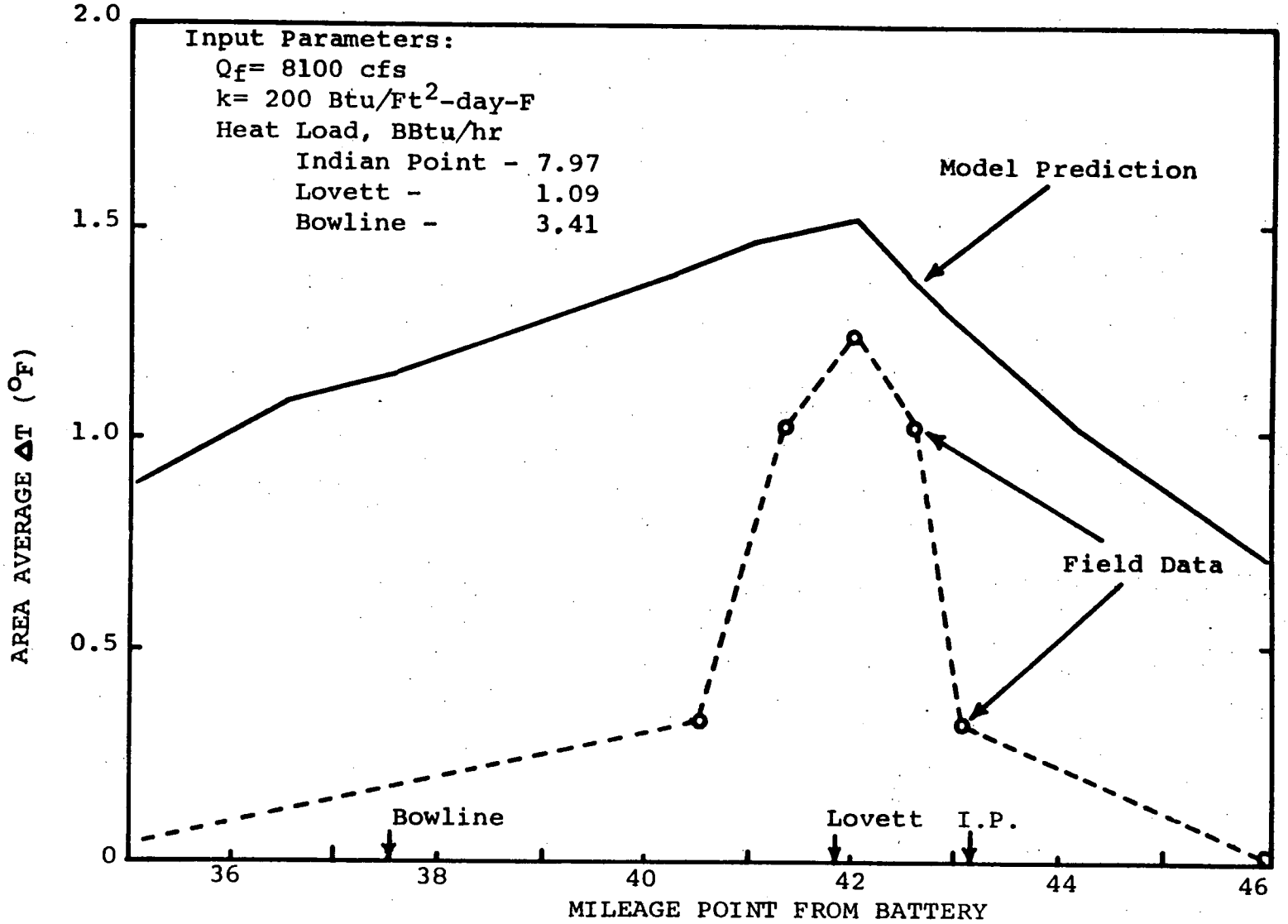


FIG.15 Average Excess Temperature August 20, 1974